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Emigration within the British Empire.

THE Report of the Oversea Settlement Committee for 1927,[1] while a distinct improvement on the corresponding report for the previous year, is still far from being a satisfactory production. It is inadequate to its theme, and such detailed information as it contains scarcely does justice to the magnitude of the expenditure incurred by the Home or Overseas governments. An official publication of this kind could be utilised as an effective stimulus to emigration of British stock from our over-populated island to the undeveloped fertile lands in our possession, for prospective emigrants are more inclined to rely upon statements in official publications for guidance than the alluring but too commonly reckless statements which appear in unofficial handbooks and pamphlets. Moreover, it should have an educative value : it should be so framed as to provoke comment in the press and Parliaments of the Dominions, and it is to be feared that this will not happen unless dogmatic assertion of fundamental policy is accompanied by careful statement of the grounds on which policy has been based.

For example, the report states that " The essential need of the Oversea Dominions for an increase of population to develop their resources and the desire that this increase should be effected by means of British stock, are the objectives on which all are agreed." But the Oversea Dominions are not reminded that failure to co-operate with the mother country to satisfy this need is a source of danger to them and of the gravest anxiety to those statesmen at home who realise that the resurgent coloured peoples of the world have legitimate cause for complaint if they are arbitrarily denied access to empty and potentially fertile lands in British possession upon which we are making only half-hearted efforts to settle our own people. Dominion statesmen are not forcibly reminded that their policy of discouragement of immigration of all except agricultural and domestic workers is a contributory cause of the rapidly declining birth-rate in the mother country, and that if this continues the proportion of foreign to British immigrants is bound to increase, with an inevitable lowering of the standard of living of the whole of the peoples of the Dominions. Canada, in particular, should be made to realise that the standard of living of the peoples of central and southern Europe, from the countries of which more than half

[1] Report of the Oversea Settlement Committee for the year ended 31 December 1927. (Cmd. No. 3088.) Pp. 44. (London: H.M. Stationery Office, 1928.) 9*d.* net.

its immigrants for 1927 were recruited, is very much lower than that of the people of Great Britain.

The reluctance of the Dominions to foster immigration is not difficult to understand. They are not yet convinced that unrestricted immigration need not necessarily further congest an already overstocked labour market. Labour leaders overseas need more than the assurance given in this report, based upon the history of the United States, that the open-door policy would effect vast developments in agriculture and primary production accompanied by unprecedented industrial expansion, with a corresponding distinctive rise in the standard of living. They can be pardoned for thinking that Great Britain's offer of pound for pound to assist emigration under the Empire Settlement Act of 1922 is a poor bribe to the Dominions for their acceptance of the responsibility for the after-maintenance of a transferred part of our surplus population.

The statistics given on p. 15 of this report are therefore of the utmost value. They deal in convincing manner with the healthy effect of increased population between 1891 and 1921 on the external trade of Canada, Australia, and New Zealand. In this period the population of Canada increased by 80 per cent, whilst the *per caput* value of its external trade in 1921 was more than six times that of 1891 : in New Zealand the population nearly doubled, while the *per caput* value of its external trade almost trebled : and in Australia, the population between 1891 and 1921 increased by 70 per cent, and the *per caput* value of its external trade by 116 per cent. It is a great pity that the report does not contain statistics of unemployment in the three Dominions for the same period, but it is more than probable that they are unobtainable. The two sets of statistics might reasonably be expected to provide overwhelming proof of the beneficial effects of the transference of Great Britain's surplus population on the prosperity of the Dominions and thus go far to overcome the present opposition of Overseas governments to schemes intended to increase the movement.

It may occasion some surprise that the report of the Oversea Settlement Committee for the year 1927, five years after the passing of the Empire Settlement Act, should contain the following passage :—

"The problem of Empire Settlement is closely interwoven with that of Empire industry and Empire trade, and one of the first steps *to be taken* [the italics are ours] with a view to making passage assistance more widely available should be to ascertain, in consultation with the Dominions :—

"(*a*) What occupations exist throughout the Empire which could be enlarged and provide increased employment if further man-power were made available locally ;

"(*b*) What new industries, primary and secondary, can be created within the Empire and developed by men and women of British descent ;

"(*c*) How far it is possible to extend the preference for British settlers in those parts of the Empire which require fresh settlers for their development."

The Committee rightly says that a satisfactory answer to these questions would go far to solve present difficulties, but it is legitimate to ask why they have not been formulated until now. It passes our comprehension how the Committee could have dealt with its task hitherto without information on these various points.

In commenting on the Committee's report for 1926, it was suggested in these columns that "the immediate need is for a comprehensive survey of the accessible and potential resources of the Empire," but we had no idea that such a survey as we contemplated would have to include the matters enumerated above. We had in mind surveys as that mentioned in Section III. of the present report, namely, a geophysical survey of the mineral resources of certain parts of Australia, upon which task Mr. A. Broughton Ede has lately embarked with the financial support of the British and Australian Commonwealth governments. Apparently, however, these wider schemes are not considered as activities proper to the functions of the Oversea Settlement Committee. Regarding the geophysical survey of Australia, it remarks : "It was decided that the effect on development and immigration was too indirect to justify a contribution to the cost of the proposed survey under the Empire Settlement Act."

Undoubtedly the Committee has a most difficult task to perform ; but it is one of ever-increasing importance. There are abundant empty spaces within the Empire suitable for settlement by our own people. Great Britain, judging by our unemployment, is badly overcrowded. The nation is spending vast sums annually on the maintenance of an army of unemployed, and what is still more disastrous, the will-to-work of a large section of the population is being steadily undermined. The situation calls for almost heroic measures, but the Oversea Settlement Committee appears to be afflicted with a fearful timidity. It is true that Great Britain as a whole suffers from the same disease, but we have the right to expect that those face to face with the problem of Empire settlement, provided with all facilities for arriving at a true appreciation of the situation, should give the Empire a bold lead. So far the Committee has failed to rise more than a few steps to the height of opportunity. The schemes in operation as outlined in the report are quite inadequate to the urgent needs of our time.

What is wanted is a report dealing with the problem of Empire settlement in a thoroughly scientific spirit and couched in such language that it will command the attention of the various governments of the Empire as a whole, and provoke them to energetic action.

World Meteorology.

Manual of Meteorology. By Sir Napier Shaw, with the assistance of Elaine Austin. Vol. 2: *Comparative Meteorology.* Pp. xl + 445. (Cambridge: At the University Press, 1928.) 36*s.* net.

THE science of meteorology has had no very happy or harmonious development. After the invention of the thermometer and barometer, elementary meteorological phenomena such as expansion of air by heating, melting and congelation, evaporation and condensation, were for a time in the focus of physical investigation. But practicable experiments and personal observation did not prove sufficient for penetrating that intricate complex of physical phenomena which constitutes weather. Then the invention of the galvanometer and electrometer, which opened new worlds to the experimental physicist, became simply fatal to progress in the old field. The telegraphic weather chart seemed to open a new era, and led to the transfer of meteorological research from the individual university investigator to richly equipped offices and institutes. But the isobaric chart failed to be that 'lamp of Aladdin' which made all difficulties disappear. Disillusion and pessimism followed upon the highly-raised illusions. "Galton himself," says Sir Napier Shaw, "after twenty-five years of unparalleled effort as chairman of the Kew Committee of the Royal Society, and a leading member of the directing council of the Meteorological Office, the most powerful body of scientific men that ever directed anything, became disillusioned and discouraged at the end. He doubted that anything would come of it all." I could give many parallel examples from other countries of leading men of this science who, like Sir Francis Galton, began in enthusiasm and ended in pessimism.

Sir Napier Shaw has never shared this pessimism. Nor has he been in doubt that there is one, and only one, way out of the difficulties, namely, to see the problem in its *full universality.* This spirit of universality is the most marked feature of Sir Napier Shaw's book, and will secure it a prominent place in the history of meteorology. It marked strikingly already the first introductory volume, "Meteorology in History," which might also have been called "Meteorology and Humanity," as it gives the development of human views upon the phenomena of the weather from the most ancient times to the age of the telegraphic weather chart. The same spirit characterises still more this second volume, "Comparative Meteorology," in which the more special meteorological work is begun.

First of all, Sir Napier Shaw does not see meteorology as anything like an isolated science, bordered by the official duty of a meteorological institute. He sees it as a branch of universal physics. At every opportunity he has emphasised that the cultivation of meteorology as a science remains a university duty, in spite of all special institutes erected; and throughout his book the establishment of the full connexion between meteorology and general physics is a marked feature. It has induced his enthusiasm for the tephigram, of which he shows the universal use for bringing the principles of thermodynamics into application to meteorological processes; and it underlies his attempt to condense our general meteorological knowledge in definitions, axioms, and theorems—certainly a very brave attempt which can but react favourably upon further development.

This spirit of universality takes, however, its externally most striking form by the fact that, wherever the book is opened, we meet with maps of the *entire world.* No more eloquent expression could be given to the principle that only a map which is too great to have a *frame* is a satisfactory meteorological map. So long as a frame is there, the origin of what happens inside the frame may be looked for outside it. But when maps for all atmospheric levels go all round the earth we approach in meteorology to the conditions which have made experimental physics so relatively easy, namely, that all the variables of the problem can be brought under the control of the investigator.

It would lead too far to enter upon the many interesting details of the book, many of which may perhaps be discussed more advantageously when Vol. 3 has appeared. But I must mention Sir Napier Shaw's open-minded and, at the same time, reserved attitude towards the newest subjects of discussion in meteorology. Through his "Life History of Surface Air Currents" he is one of the chief predecessors of those who succeeded finally in formulating what is now called the "Polar Front Theory," and his diagram on p. 381, in which he represents the wind distribution in a cyclone, not by the traditional spirals, but by straight lines, will remain the most eloquent protest ever formulated against the theory of cyclones as homogeneous revolving systems. But at the same time he distinguishes carefully between the unquestionable empirical facts, as the actual existence of a polar front and certain typical phenomena related to it, and the attempts to bring these facts within the scope of theory.

In connexion with this important distinction, I must take the opportunity to mention a correction of historical order, common to Sir Napier Shaw's book and many other books and papers dealing with meteorology which have appeared in recent years. It is true that I was formally the director of the Bergen Institute at the time when the polar front got its name, and was stated to be, not a more or less exceptional phenomenon, but on the contrary a daily characteristic feature of every weather map. But this discovery is not mine. It belongs to the working young meteorologists of the Bergen school, J. Bjerknes, H. Solberg, and T. Bergeron,—the last of the three joined in the work a little later than the first two. For my own part, I have never drawn a weather map, or performed an analysis of such a map according to what is now called those 'Bergen methods,' which have made it impossible for the polar front to escape observation. Thus to state it again, the creation of these methods of weather analysis, and the empirical discoveries which are made by use of them, are due to the three young men I have mentioned, and not to me.

Parallel to and interacting with the empirical investigations of these young meteorologists, my own attempts went to bring the stated facts within the scope of theory. This led to what has been called the 'Wave Theory' of cyclones or of cyclone formation. In its origin, this theory is older than our precise knowledge of the phenomena which it should explain. General dynamical principles led me in the years 1915 and 1916 to assume that a cyclonic vortex could originate in no other way than as some kind of wave, though I was not able to see what kind of wave, or how it transformed into a vortex. I hoped, however, to get a clearer view by generalising systematically the classical wave theory. But only a first and introductory paper relating to this research appeared (Leipzig, 1916). I remained in doubt how to continue it. Sir Napier Shaw's diagram might have brought me on the right track. But I did not at that time feel sure if I should not look upon it rather as a joke than as a serious suggestion. At the Bergen Institute, however, from the summer of 1918 onward, every day brought a new and from day to day more carefully analysed weather chart, giving more and more detailed information on the life cycle of cyclones from birth to death, and the effect upon my theoretical work was an instantaneous one. There could no longer be any doubt, either concerning the character of the initial wave, or of the general dynamics of its development to a vortex of ultimately complete homogeneity. The fact that in these circumstances my theoretical comment on the empirical discoveries came to appear practically simultaneously with the publication of the latter, may explain why the whole 'Polar Front Theory,' taken as including both the now generally accepted empirical facts, and also—though perhaps still rejected by most meteorologists—the 'Wave Theory,' was credited to me, while I can take the responsibility merely for the latter.

Sir Napier Shaw's attitude towards the two cyclone theories, the 'pure' vortex theory, and the theory of the development from wave to vortex, is that of benevolent neutrality. He ends in expressing confidence that under the pressure of both of them the problem must yield. When—we hope within a short time—the next volume of Sir Napier Shaw's great "Manual" appears, we may perhaps find it to have yielded in that direction in which his historical diagram has been pointing as the first fingerpost. V. Bjerknes.

A Popular History of Mathematics.

Histoire des mathématiques. Par W. W. Rouse Ball. Édition française revue et augmentée, traduite sur la troisième édition anglaise par Lieut. L. Freund. Tome 1 : *Les mathématiques dans l'antiquité ; les mathématiques au moyen âge et pendant la renaissance ; les mathématiques modernes de Descartes à Huygens.* Pp. vii + 338 + 9 planches. (Paris : J. Hermann, 1927.) 40 francs.

Mr. Rouse Ball's "Short Account of the History of Mathematics" must be one of the most successful books of its kind that has ever appeared. Originally published in 1888, it reached a second edition in 1893 and a third in 1901. The fourth edition was stereotyped in 1908, and the book has since been five times reprinted, though the preface to the stereotyped edition states that no material changes have been made since the issue of the second edition of 1893. Its success is to be accounted for by the fact that it is eminently readable and is not too technical to be easily followed by the amateur who wishes to get a general idea of the course of the history of mathematics through the ages. As the author explained in the original preface, it may serve as an introduction to more elaborate histories, but it was primarily intended to give a short and popular account of those leading facts in the history of mathematics which many who are unwilling, or have not the time, to study it systematically, may yet desire to know. Accordingly, it is not overloaded with detail or masses of references to authorities.

The greater part of the account is admittedly a compilation from existing histories or memoirs, and especially, so far as the history down to 1799 is concerned, M. Cantor's " Vorlesungen über die Geschichte der Mathematik." This fact brings with it a certain drawback, often inconvenient to the professional mathematician who makes use of the book, namely, that it is in general difficult to be sure whether, when a reference is given to some book or memoir, the author himself has consulted the original work or is merely giving a reference at second hand. This inconvenience, however, does not so much affect the non-professional reader, while the method adopted of dealing in chronological order with the lives as well as the writings of famous mathematicians gives a human interest to the narrative and so enhances the attraction of the book.

After a chapter on Egyptian mathematics, Ball divides his history into three periods : (1) Mathematics under Greek influence; (2) mathematics of the Middle Ages and of the Renaissance (Chaps. viii.-xiii.), ending with Galileo, Kepler, and Desargues; and (3) modern mathematics (Chaps. xiv.-xix.), beginning with Descartes, Fermat, and their contemporaries. In proportion to the wider range and increased complexity of the developments in mathematics as we approach recent times, the story necessarily becomes more 'sketchy,' so much so that the nineteenth chapter on the nineteenth century becomes little more than a list of names and titles of books.

The volume before us is vol. i. of the " Édition française revue et augmentée," translated from the third English edition. Arrangements were apparently made in 1903 for a translation into French, which duly appeared (in two volumes) in 1906–7, though no reference to it is made in the present edition. The translator, in an undated preface, merely states that Ball's work formed only one volume, and that it has been thought proper to complete it by additions " which clear up several important points in the history of science and show the course followed by certain illustrious savants in reaching their discoveries." These additions have, he says, made it necessary to divide the work into two parts. The first volume contains the translation of the first fifteen chapters, the second the last four, beginning with Newton ; the division is an artificial one designed to make the two volumes about equal in bulk, the additions being more considerable in the second volume than in the first. We may hope that this will prove to be the case when the second volume appears, for the additions to the first are, so far as we can see, negligible. The period from 1903 until 1927 has been fruitful in new editions and fresh researches, and Ball himself added in the stereotyped edition a good number of references to such new works ; it is a pity that the French translator, writing in 1927, has incorporated scarcely any of these new references or of others that might have been given, so that in this respect the new edition is much less valuable than it might have been made.

The translator has tried to keep as closely as possible to the original, but he should have exercised more care. Apart from a number of unnecessary misprints (for example, " Dialès " for " Diocles," p. 97) and incorrect spellings of names, for example, " Ænopides " for " Œnopides " and "Menœchmus" for "Menæchmus," there are several statements which will raise a smile. On p. 97 we are told that Dionysodorus found the radius of the earth to be about 42,000 stades, " ce qui correspond à environ 80,000$^{\text{km.}}$," whereas Ball says, correctly, " a little less than 5000 miles." On pp. 21-22 there is a story from Iamblichus about the Pythagorean pentagram, to which Ball applied the well-known remark, " Se non è vero, è ben trovato " ; it will scarcely be believed that our French translator gives for this : " Si elle n'est pas vraie, elle est tout au moins intéressante " (!). The sense of a passage is sometimes destroyed by the mistranslation of a word, as when " partially " becomes " particulièrement." But the most glaring lapse is on p. 45, where we are told that Plato visited Egypt " in company with Eudoxus and Strabo," a remarkable feat, seeing that Eudoxus lived from about 408 to 355 B.C. and Strabo from about 66 B.C. to A.D. 24 ! The explanation is found on reference to the original, where Ball observes that " Plato visited

Egypt with Eudoxus, and Strabo says that in his time the apartments they occupied at Heliopolis were still shown." For the second clause the translator substitutes " On raconte que, de son temps . . .," regardless of the fact that this leaves " in his time " completely in the air.

Incidentally, we cannot but express regret that advantage is not taken of some re-issue to correct mistakes which in places disfigure the original work. Thus we are told that " Archytas taught that the earth was a sphere rotating round its axis in twenty-four hours, and round which the heavenly bodies moved." The second clause of this sentence is difficult to reconcile with the first ; but in any case there is no ground for thinking that Archytas anticipated Heraclides of Pontus in holding that the earth rotates on its own axis in twenty-four hours. The error may perhaps be due to a confusion of the name of Archytas with that of an otherwise unknown person, Hicetas of Syracuse, to whom, alternatively with Heraclides, the discovery in question is attributed. T. L. H.

Sex and the Gene.

The Genetics of Sexuality in Animals. By Dr. F. A. E. Crew. (Cambridge Comparative Physiology Series.) Pp. x + 188. (Cambridge: At the University Press, 1927.) 10*s*. 6*d*. net.

THE chromosome theory of heredity has been of considerable value in advancing our knowledge of how characters are transmitted through the germ cells from one generation to another, but there is an important gap yet to be filled. We have little knowledge of the developmental processes involved. It is Dr. Crew's aim to place before the reader material derived from the study of sexuality in animals " in the hope that someone may be sufficiently stirred as to decide to devote himself to a subject which has always fascinated me . . . how the gene in its action produces its end result, the character." If the solution of this problem were the main end in view, the physiologist, to whom the book is primarily addressed, might question the advisability of selecting such a complex subject rather than one with more immediate prospect of quantitative treatment. However, sexuality is in itself of sufficient importance to justify extensive treatment, and much can be said in favour of it as a subject for the study of developmental physiology.

Goldschmidt, whose own contributions play a primary rôle in the theory developed by Crew, has already dealt extensively with the same subject in " The Mechanism and Physiology of Sex-Determination " (English Translation. Methuen, 1923). Some similarity of treatment was therefore to be expected, but it is disappointing to find in many passages how closely the two books resemble one another. This resemblance diminishes in places the value of Crew's book as an independent critique of the subject. In a work dealing largely with experimental material, more space might perhaps have been devoted to the exposition of original data. For the most part, general inferences only are given, and one gets little information on the relative significance of the actual results from which the inferences are derived. References are, however, amply given, and extensive bibliographies are a valuable feature. The book requires attentive reading, since not infrequently the writing is somewhat involved. On the other hand, the book gains considerably by the style being both emphatic and provocative.

The first two chapters give a compact account of the genetic evidence bearing on sex determination. The third is mainly devoted to Goldschmidt's work on *Lymantria* and his ' time law of intersexuality.' In extending this ' law ' to amphibian development, Crew contributes to the simplification of the subject, but a similar extension to mammals in explanation of hermaphroditism is not so successful. The material described shows varying degrees of abnormality, and it is not unreasonable to assume that a time relationship is involved, but the genetic and embryological evidence seems insufficient to support the elaborate and somewhat lengthy treatment. Many very arbitrary assumptions are made, and the discussion, although not without interest, lacks objectivity.

In Chap. iv. it is shown that in a number of animals extrinsic changes may result in a deviation or reversal of the sexual characterisation primarily established by the genotype. In discussing plumage characterisation in the fowl, Crew abandons the orthodox theory of hormonic specificity of the gonads and advances the hypothesis that male and female types of plumage are expressions of different metabolic levels. The hypothesis accommodates many of the known facts and provides perhaps the simplest explanation of the henny-feathered cock which has yet been advanced, but the term ' metabolic level ' is indefinite and allows considerable elasticity of interpretation. A critical test would be found in the results of gonadectomy and transplantation. Crew groups a series of ' results ' in tabular form, but no specific references are given to the actual data. The majority of the groups can be accommodated by either hypothesis. No detailed account whatever is given of those groups which are really crucial. It is claimed that the case of a single bird described by Greenwood and Crew cannot be accommodated by the orthodox hypothesis, but apart from the numerical inadequacy of the material, it is not free from objection on theoretical grounds. Since the publication of the book, Domm in America has obtained similar results with adequate material but does not consider it necessary to abandon the theory of hormonic specificity as applied to the normal animal. As the account stands in the book, Crew's hypothesis, although provocative of careful consideration, can only be regarded as highly speculative or intelligently prophetic.

Chap. v., on "Sex Reversal in the Adult," contains some interesting material. In the main the theoretical interpretation is similar to that advanced in earlier sections. The short chapter on the "Mode of Inheritance of Sex Dimorphic Characters" suggests that further work might be done on this subject. The book closes with a chapter on the "Sex Ratio." Differential mortality *post conceptionem* will in part explain the significant deviation from equality at birth and later stages, but an entirely satisfactory explanation has not been found to account for the deviation at conception which has frequently been assumed.

As one of the first of the Cambridge Comparative Physiology Series, the general editors are to be congratulated on the format. The printing maintains the high standard of the University Press.

ARTHUR WALTON.

London and Londoners.

The Earlier Inhabitants of London. By Prof. F. G. Parsons. Pp. 240. (London: Cecil Palmer, 1927.) 10*s*. 6*d*. net.

FOR the nonce, Prof. F. G. Parsons has laid aside his calipers and turned historian. These forty years and more he has sought to meet the needs of professional anthropologists by supplying them with data relating to the races and peoples who have lived in England in all periods of its history—from Palæolithic times to the present. He has now written a book to please himself on "The Earlier Inhabitants of London"; he has set down, in easy narrative, with many a sly allusion and pleasant digression, all he has succeeded in learning concerning the founders of his native city, London. Nor will readers have to proceed far to discover that their guide to ancient London is a frank outspoken Saxon whose inborn sympathies are enlisted in favour of that element of the British people which is fair in colouring and long in skull. He brings his history of London to a close just before the coming of the Normans; at that time he estimates that seven-eighths of the inhabitants of London "were of Nordic blood."

We have no direct testimony concerning the beginnings of London; all we know, or can hope to know, concerning its earlier history is, as Prof. Parsons reminds his readers time and again, circumstantial and inferential. He accepts the belief now current, that London began to come into existence between the landing of Julius Cæsar, 54 B.C., and the coming of the legions of Claudius, A.D. 43, and that it began as a port for the midland tribe—the Catuvellauni, whose capital town was the present St. Albans. Having accepted this much, he then infers that its earlier inhabitants must have been recruited in the main from the peoples who occupied adjoining regions—the Cymric Belgæ. His search for evidence bearing on the racial constitution of the people which Cæsar found in possession of England, takes Prof. Parsons far afield. He finds that they were in the main a Celtic-speaking people of Nordic origin, which had absorbed the still older racial elements of England—the round-headed 'beaker' people, the long-headed people of the chambered barrows, and a still older strain derived from Palæolithic times.

Nevertheless, on the evidence obtained from cemeteries of a pre-Saxon date, Prof. Parsons concludes that in the earlier days of London the home countries were inhabited by a people essentially Nordic in its racial constitution. The Saxons who began to invade England in the fifth century of our era found its eastern and south-eastern parts occupied by a people who, like themselves, were Nordic, or north-west European, in origin. No doubt merchants from abroad settled in London and brought their families with them; it may be, as Prof. Parsons hints, that foreign legions stationed near London did leave their mark on the 'earlier' Londoners, but if one may rely on the evidence of skulls of Romano-Britons preserved in the Museum of the Guildhall, the predominant Londoner in Roman times was, as Prof. Parsons suggests, of Belgic or Nordic origin. But the round-headed Gaul from central and southern France was not negligible.

After the departure of the Roman legions, the history of London is darkness, but Prof. Parsons gives reasons for his belief that the Saxon invaders left the city alone until the seventh century, when the Saxons of Essex began to settle in it. In the ninth century, Alfred Saxonised it more effectually. Later still came the Danes and the Norse, to swell the North Sea element in the racial constitution of the Londoner.

Some day, perhaps, Prof. Parsons will give us a racial analysis of the modern Londoner. It is certainly very difficult to find a native of London who can claim that all four grandparents were born in or near London. London draws people to-day, just as it did in its earlier history, from all parts of Europe, and yet, we believe, when full inquiry is made, that even to-day London is still essentially a Nordic city. However this may be, there can be no doubt of our present indebtedness to Prof. Parsons; the book is manifestly a labour of love—a rebound from the repression that our modern methods of investigation impose on all anthropologists. Who has not wished, in the midst of the dry narration of facts—just for a glorious hour in which to set down what is surmised, as well as that of which we have proof? It is just because Prof. Parsons has 'let himself go' that he has succeeded in writing a book which is at once interesting and stimulating.

Our Bookshelf.

Reports of the Progress of Applied Chemistry. Vol. 12, 1927. Issued by the Society of Chemical Industry. Pp. 743. (London: Society of Chemical Industry, 1928.) Members of the Society of Chemical Industry, 7*s.* 6*d.*; Others, 12*s.* 6*d.*

WITH the exception of the chapter on explosives, on which it is evidently intended to report in alternate years, the present issue of the "Annual Report on the Progress of Applied Chemistry" again constitutes a reasonably complete and most valuable survey of a year's achievement. The general form of the reports, with their copious references to the original information on which they are based, their name and detailed subject indexes, is of course perfectly familiar to chemists the world over. This year the chapter on non-ferrous metallurgy is perhaps noteworthy in two respects: it gives the impression of being based to a special degree on experience (although the inclusion of literature references wherever possible is always much to be desired), and, being written by Prof. G. A. Guess, of Toronto, it originates from outside Great Britain. The chapters on plant and machinery, fuel, gas, etc., electrochemical industries, rubber, soils, and sanitation are also provided—with every success—by authors who did not report last year.

Discussion of any part of the subject matter would be of doubtful profit, so great is its wealth of detail and diversity of interest. Since, however, the chemical control of food must so closely concern everyone, whether chemist or not, and since the reviewer's copy has fortuitously been opened at the page dealing with this subject, the contents of this section of thirty-one pages may be indicated. Vitamins, from the chemical, biological, and industrial points of view, are first considered (8 pages), their origin, production, and evaluation being discussed; then follows an account of milk and dairy products (5 pages), in which not only new and modified analytical methods, but also the results of surveys and researches on dairy troubles are recorded. Sections on fruit and vegetable products (3 pages), canning and storage (5 pages), cereal products (4 pages), preservatives and colouring matters (3 pages), and miscellaneous information (3 pages) complete the chapter, in the course of which 161 references to original papers are quoted.

It is unlikely that many chemists, either in the British Empire or the United States of America, are unaware of the existence of this series of reports; so much general information is brought under review, however, that industrial chemists will not be alone in welcoming the appearance of yet another annual volume.

A. A. E.

(1) *Methods of Applied Geophysics: for the Exploration of Oil, Ores, and other Useful Deposits.* By Dr. Erich Pautsch. Pp. iv + 82. (Houston, Texas: Gulf Publishing Co., 1927.) 6.50 dollars.
(2) *Die magnetischen Verfahren der angewandten Geophysik.* Von Dr. Hans Haalck. (Sammlung geophysikalischer Schriften, herausgegeben von Prof. Dr. Carl Mainka, Nr. 7.) Pp. viii + 150 + 3 Tafeln. (Berlin: Gebrüder Borntraeger, 1927.) 12 gold marks.
(3) *Elektrische Bodenforschung: ihre physikalischen Grundlagen und ihre praktische Anwendung.* Von Dr. Walther Heine. (Sammlung geophysikalischer Schriften, herausgegeben von Prof. Dr. Carl Mainka, Nr. 8.) Pp. xi + 223. (Berlin: Gebrüder Borntraeger, 1928.) 18 gold marks.

(1) THE rapidly growing importance of geophysical methods of prospecting for oil, ores, and other deposits is stimulating the production of numerous books on the subject. Of the three here noticed, that by Dr. Pautsch attempts to cover the whole field, and has chapters on the various classes of method, gravitational, seismic, acoustic, magnetic, electric, and radioactive. The treatment is very cursory. The book deals with the subject rather after the manner of an engineer's pocket-book or collection of formulæ; it seems scarcely likely to be of serious use to anyone desiring to apply geophysical methods in practice.

(2) (3) The two German books are in a different category; each deals carefully and in detail with the underlying principles, the practical applications, and the instrumental equipment connected with a single class of geophysical methods, electric or magnetic. They should be of real value to applied geologists, but it need scarcely be said that success

in the use of geophysical methods of prospecting depends very largely on the possession of sound judgment and experience in interpreting the physical measurements in the light of the geological data for the district.

A Descriptive List of the Printed Maps of Norfolk, 1574–1916: with Biographical Notes and a Tabular Index. By T. Chubb. *And a Descriptive List of Norwich Plans, 1541–1914.* By Geo. A. Stephen. Pp. xvi + 289 + 26 plates. (Norwich: Jarrold and Sons, Ltd., 1918). n.p.

THIS is a useful and scholarly handbook for the geographer, antiquarian, and historian to retain for reference on their shelves. Norfolk was favoured by the old cartographers; moreover, the pioneer work on soils and geology which emanated from the county at a later date helped to maintain contemporary interest in its maps. After an interesting introduction, in which due credit is given to the work of John Norden and others in the sixteenth century, when Norfolk was an active manufacturing county, Mr. Chubb gives a catalogue of Norfolk maps from 1574 until 1916. Each entry is accompanied by informative notes which are bibliographically valuable. Well-selected examples of maps published at intervals of about twenty years help the reader to visualise the advance in the art of cartography, and in the development of the county. But for the fact that reference has been made to geological maps (for example, Samuel Woodward's early map of 1833) and to soil maps, it might be invidious to point out that the first map showing Glacial Drift, that of part of Norfolk and Suffolk, by S. V. Wood and F. W. Harmer (Mon. Palæontograph. Soc., 1872), has not been mentioned. As it was the first of its kind in the world, it is certainly worthy of a note.

The latter half of the book is contributed by the City Librarian of Norwich, who has catalogued and added notes on the various plans of Norwich contained in the Norwich Public Library, Castle Museum, and the British Museum. A compilation of this kind for so ancient and ecclesiastical a city as Norwich was worth doing, and the author has done it well. The tabular index of the whole book, arranged under the cartographers' names, is to be specially commended for its usefulness.

Lehrbuch der analytischen Geometrie: Grundlagen, Projektive, Euklidische, Nichteuklidische Geometrie. Von Prof. L. Heffter und Prof. C. Koehler. Band 1: *Grundlagen, Grundgebilde I. Stufe, Euklidische Ebene.* Zweite wesentlich umgearbeitete und vermehrte Auflage. Pp. xvii + 477. (Karlsruhe: G. Braun, 1927.) 20 gold marks.

THIS is a book for which there is not likely to be any great demand in Great Britain. Yet it may be questioned whether more attention ought not to be paid to this kind of work in the ordinary honours course. For example, there are students who specialise in geometry without learning anything about the modern theory of its foundations. Perhaps some knowledge of the subject matter of the introduction of this volume might be required of them. Again, projective geometry is a subject of increasing reputation, in that its foundations are secure against some of the attacks which are destroying our confidence in anything that depends upon measurement. Lastly, the physicist can no longer afford to regard the non-Euclidean systems as an idle fancy of the mathematician's brain. It is not suggested, of course, that this particular book could be adopted for general use in Great Britain; but rather that something of the same kind, perhaps less elaborate, may before long be considered as part of the general education of the mathematician. A. R.

The Statesman's Year-Book: Statistical and Historical Annual of the States of the World for the Year 1928. Edited by Dr. M. Epstein. Sixty-fifth Annual Publication: Revised after Official Returns. Pp. xxxvi + 1538. (London: Macmillan and Co., Ltd., 1928.) 20*s*. net.

WITH the exception of the usual careful revision in fact and figures, this valuable publication in its present issue has undergone few changes. The plan of the book, with its many subheadings and full index, greatly facilitates its use. Although it is some twenty pages larger than last year, the volume has been slightly reduced in bulk. Iraq has now been removed from the mandated Territories in the section on the British Empire and added to the independent States. A new paragraph on the Saar, and a much-expanded section on the Ægean Islands of Italy, have been added. There are the usual introductory tables of statistics and sections on the International Institute of Agriculture and the League of Nations. Two coloured maps show respectively French, Spanish, and International zones of influence in Morocco, and the new boundary between Canada and Labrador in terms of the Privy Council's report.

Hand-List of Catalogues and Works of Reference relating to Carto-Bibliography and Kindred Subjects for Great Britain and Ireland, 1720 to 1927. By Sir Herbert George Fordham. Pp. 26. (Cambridge: At the University Press, 1928.) 2*s*. 6*d*. net.

SIR GEORGE FORDHAM has laid students of cartography under an obligation by the publication of this volume. In the list he gives the titles of ninety-one works, from "The English Topographer" of Dr. Rawlinson, printed in 1720, to Mr. H. A. Sharp's "Historical Catalogue of Surrey Maps," of 1928. The stream of publication seems to have been fairly continuous during the two hundred year period in question, except for gaps of no publication from 1736 to 1768; from 1780 to 1814; and 1840 to 1870; gaps curiously equal. There seems no probability of the stream drying up now, for no fewer than sixty-seven of the works catalogued have been published during the present century. Sir George Fordham himself, and Mr. Thomas Chubb, have an honourable pre-eminence amongst the modern workers at this subject.

Letters to the Editor.

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

Helium and the Genesis of Petroleum.

VARIOUS hydrocarbons, but more especially methane, are common constituents of the natural gas effusions in many parts of the world, and another very common constituent is helium, though in relatively small quantities, which vary from simple traces to about 1 per cent or more. In the mid-United States of America, where large oilfields exist, and for which more complete information is available, it appears that the region in close proximity to the oil field is also a region of relatively high helium content in the gases (G. S. Rogers, *Professional Paper*, 121, U.S. Geological Survey, Washington, pp. 68-91; 1921).

Lind and Bardwell have investigated the effect of alpha particles upon hydrocarbons, and have found that these hydrocarbons undergo chemical change when subjected to such bombardment, the hydrocarbon molecules becoming more complicated. They have found that for methane two molecules undergo change per ion pair formed, or M/N is 2, whilst for acetylene $M/N = 20$, for ethylene 5·1, and for cyanogen 7·4 (*Jour. Amer. Chem. Soc.*, vol. 48, pp. 2335, 2351; 1926). The effect of alpha rays upon methane was to produce the higher saturated hydrocarbons and liquid olefines, whilst from ethylene a colourless liquid resulted, and acetylene gave rise to a white solid.

It will be assumed that helium arises from alpha particles ejected by radioactive substances. Since each alpha particle produces 2×10^5 ions approximately, one cubic foot of alpha particles ionises 2×10^5 cubic feet of gas. Now each alpha particle eventually becomes a helium atom, and therefore one cubic foot of helium is, in its process of formation, capable of ionising this amount of gas. Taking Lind and Bardwell's result that for methane M/N is 2, each cubic foot of helium may alter 4×10^5 cubic feet of methane (weighing 8 tons) into higher and more complicated hydrocarbons.

The action follows the equations

$$2CH_4 = C_2H_6 + H_2$$
$$\text{or } 2CH_4 = C_2H_4 + 2H_2$$

(Lind and Bardwell, loc. cit.).

Considering liquid hydrocarbons more specifically, it has been calculated from the results already mentioned, that 1·2 milligrams of these resulted from the formation of 0·000015 c.c. of effective helium, or nearly two tons of liquid per cubic foot of helium.

The average helium content of 142 Canadian sources of natural gas is about 0·25 per cent (R. J. Elworthy, Canadian Dept. of Mines, 1926), and from 325 United States sources it is about 0·5 per cent (Rogers, loc. cit.). Since many of these gas wells produce enormous volumes of gas, it is to be expected that radioactive disintegration as measured by the helium produced during long periods of geological time may have played an important part in the formation of petroleum. It is true that, owing to the paucity of experimental results, the figures arrived at may be to some extent a matter of opinion, and it is also a long way from 1·2 milligrams to millions of tons, yet it would seem (if the results of Messrs. Lind and Bardwell are to be relied upon) that in the Petrolia gas field, where the original helium has been estimated at 10^9 cubic feet (cf. Rogers' Report, p. 62), millions of tons—indeed, according to the above calculation, two thousand millions of tons—of liquid hydrocarbon may have resulted in this area.

In view of these figures the question of the origin of petroleum naturally arises. The percentage of helium content in the prolifically oil-bearing tertiary series is generally small, but Lind states (*Nat. Acad. Sci.*, vol. 11, p. 772; 1925) that recent then unpublished estimates show that helium is confined to no particular age of strata but depends rather on the retentiveness of the sands. It might also be mentioned here that the helium in the atmosphere, assuming it to be entirely of subterranean origin, corresponds, under proper conditions of production, to 4×10^{15} tons of liquid hydrocarbons.

The presence of dense compounds in petroleum and of bitumen in meteorites, the high solubility of radon in petroleum, and the wide distribution of the radioactive elements, together with the formation of both paraffins and olefines in the experiments quoted, seem to make these questions worthy of further investigation.

If the reactions quoted above are in progress, it might be expected that hydrogen would be a common constituent of natural gas in some other form than as simply appearing in the hydrocarbons.

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Active Nitrogen.

THE function of impurities which seem necessary to the formation of the afterglow in active nitrogen has been interpreted as being in the poisoning of the surface to the combination of nitrogen atoms. Experiments were commenced to study the rôle of the impurity oxygen. It was felt that the possibility could not be entirely excluded that oxygen was necessary in some physical action to induce the afterglow in the gas phase. Accordingly pure *glowless* nitrogen was introduced into a litre bulb, into the centre of which pure oxygen could be admitted more or less uniformly in all directions. In impure nitrogen the active species which eventually give rise to the glow are created in the discharge and remain for some time after cessation of the latter. If the same occurs in pure nitrogen, and if merely the presence of ordinary oxygen is required for the afterglow formation, then the afterglow may be expected to appear if oxygen is introduced into glowless nitrogen immediately after discontinuing the discharge (electrodeless). Pure nitrogen was prepared by two methods: (1) from bromine water and ammonia (Kenty and Turner, NATURE, **120**, 332; 1927; also, Waran, *Phil. Mag.*, **42**, 246; 1921); (2) from sodium trinitride (NaN_3).

For some time it was impossible to produce absolutely glowless nitrogen (although the afterglow was very weak and of very short duration), even though the utmost precaution had been taken to ensure the complete absence of oxygen and other impurities. Only after continued baking out of the bulb at high temperature and under high vacuum was glowless nitrogen obtained. Upon the introduction of pure oxygen (1 per cent) in the manner described above, *no glow was produced.* This was repeated several times with nitrogen from both sources with the same results. Furthermore, after the oxygen had been admitted and the mixture now subjected to the discharge, little or no glow was discernible. This seemed very strange indeed. I publish these results in view of the recent work of Herzberg (*Z. für Physik*, **46**, 878; 1928), whose investigations offer an explanation of these effects. Herzberg, in some very pretty experiments, finds that freedom of the walls from gases such as water vapour or hydrogen is a factor in the elimination of the afterglow. Even with nitrogen containing more or less oxygen, he reports no afterglow if the vessel has been well baked out. The addition of a small quantity of hydrogen to pure or oxygenated nitrogen, which cannot be made to glow itself, again produces a very intense afterglow. In this connexion Bonhoeffer and Kaminsky's observations (*Z. für phys. Chem.*, **127**, 385; 1927) that impurities, whatever they are, have no effect on the character of the afterglow spectrum, suggests that the impurities as such take no part in the excitation process which produces the luminosity. This is in agreement with conclusions to be drawn from the experiments described above.

The optimum amount of oxygen for production of the afterglow has been given as about 0·23 per cent, while 2 per cent completely obliterates it (Bonhoeffer and Kaminsky, *loc. cit.*; Strutt, *Proc. Roy. Soc.*, **88**, 539; 1913). I have been able to obtain very intense nitrogen afterglows in air (21 per cent oxygen), and even in mixtures up to about 57 per cent oxygen (although with decreased intensity but observable with a spectroscope), in the electrodeless discharge at a pressure of about 0·2 mm. Hg and below. At higher pressures the type of afterglow changes until at about 1 mm. and up to 2 mm. (in air) only the continuous afterglow spectrum of oxygen first noticed by J. J. Thomson (*Phil. Mag.*, **32**, 321; 1891) is observable. The nitrogen and oxygen afterglows were so strong as to be easily distinguished with an ordinary spectroscope. Herzberg reports similar findings. These differences from the results of other workers are readily explained by the differences in the experimental pressures employed. Studies have been made of the afterglow at different pressures with varying mixtures of nitrogen and oxygen and will be published in the course of time.

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Does Methylene Blue penetrate Living Cells?

In Nature (vol. 121, No. 3053, p. 726) the following statement was made under "Research Items" (in connexion with the identification of dye found in the vacuole of cells of *Valonia*): "The methylene blue, moreover, penetrates as such, and it is not the lower homologue, trimethylthionine, that penetrates as Irwin thought. The latter is found in sap which has stood for some time after being expressed and arises from oxidation of methylene blue."

The matter is of far greater importance than would appear on casual reading, since methylene blue is widely used as a vital stain and as an indicator for the oxidation reduction potentials of cells. It therefore seems worth while to direct the attention of readers of Nature to the fact that the problem of methylene blue penetration is by no means so nearly settled as would be gathered from the above statement.

In my publication (Irwin, M., *Proc. Exp. Biol. and Med.*, **24**, 425; 1926–27. *J. Gen. Physiol.* **10**, 927; 1926–27), I have shown by spectrophotometric measurement (made in collaboration with W. C. Holmes, of the Bureau of Chemistry, Washington, D.C.) that it is chiefly trimethylthionin or azure B that is present in the sap extracted from cells placed in methylene blue solution at *p*H 9·5. These measurements were made immediately after extraction of the sap from the cells. This shows conclusively that the trimethylthionin was present in the sap and was not formed from demethylation of methylene blue after the sap had stood in air for some time, as is intimated in the sentences quoted above.

Moreover, it was shown that methylene blue was found in the vacuolar sap of cells (placed in methylene blue solution at *p*H 9·5) *only* (1) when the cells were injured, or (2) when the contamination of the sap by the stained cell wall occurred at the time of extraction of the sap.

The penetration at low *p*H values (namely, at *p*H 5·5) was too slow for analysis unless the cells were injured.

Furthermore, the experiments described in these papers were repeated by me at three different seasons, covering over a year, and using various samples of methylene blue, and identical results were obtained. The necessary optical measurements were made either by W. C. Holmes or by K. S. Gibson, of the Bureau of Standards, Washington, D.C. These additional results have not been published as they bring out no new facts.

Such results are not limited to *Valonia*, since experiments with a freshwater plant, *Nitella*, led to the same conclusions (Irwin, M., *Proc. Soc. Exper. Biol. and Med.*, **25**, 563; 1928).

It is still somewhat uncertain as to whether the trimethylthionin penetrated as such from the external methylene blue solution containing this dye as impurity (in too small concentration for detection by a spectrophotometer but detectable by extraction with chloroform) or whether it has formed from methylene blue after the latter has penetrated the cell. I am, however, from the evidence in hand, inclined to favour the former explanation.

All the results were obtained by examining the sap in the vacuole (that is, the central space in the cell which is surrounded by the protoplasm and filled with sap). The experiments do not show whether or not methylene blue penetrates the protoplasm. The latter question cannot be tested experimentally, since the protoplasmic layer is extremely thin.

There is, therefore, real danger that false theoretical conclusions may be drawn from data based on penetration of blue dye from methylene blue solution.

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Research on the Control of Aeroplanes.

In his most interesting paper, "Research on the Control of Aeroplanes"—published as a supplement to Nature of May 12—Prof. Melvill Jones says, "they [the Wrights] must have experienced the stall or the approach to the stall." In point of fact, during their gliding experiments of 1900 and 1901, they were puzzled by the fact that on a turn the warped wing would invariably touch the ground first, or in other words, they found, as modern science has rediscovered, that increasing the angle of the lower wing accentuates instead of curing the tendency to stall. Their remedy was to fit a vertical surface at the rear of the machine, which before the end of the 1902 experimental season was converted into a movable rudder. The point here is that the Wrights originally fitted a rudder not as a directional organ, but as an aid to the wing-warp in maintaining lateral balance.

Actually they first definitely experienced the phenomenon of the 'stall' in their power-driven machine of 1904, when they found that the machine persisted in sliding down to the ground on one wing tip in spite of all attempts to right it with the combined rudder and wing-warping control. They eventually discovered that the only remedy was to put the nose of the machine down, and quite rightly attributed the trouble to loss of speed causing the controls to become inoperative.

If I may be forgiven criticising so sound an authority as Prof. Melvill Jones, I think he is wrong in lumping all the early experimenters with the Wrights in what I have always called in my own mind the 'acrobatic' as opposed to the 'stability' school. Surely the early French pioneers—such as the Voisins and Santos Dumont—quite definitely tried to produce a stable aeroplane, seeking to attain this end by such devices as 'curtains' between the wings and exaggerated dihedral angles. That their methods proved unsuccessful does not alter the fact that that was their *aim*. The greater success *aerodynamically* of the Wright machine gradually brought the French school to the view that stability must be sacrificed to control, but it has always seemed to me that originally they started from the other of the two extremes Prof. Melvill Jones so graphically describes. It was to me absorbingly interesting in the early days to watch the two 'schools' gradually converging. The French machines discarded their 'stability' devices, while the Wrights in time gave up the front elevator and fitted a wheeled undercarriage, until the Wright biplane of 1910 was in appearance scarcely distinguishable from, for example, the Farman of the same period.

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May 21.

IN referring to the Wrights' use of a powerful rudder as a means of dealing with the stall, I had mainly in mind its use to control the lateral rolling of the aeroplane in the manner indicated in Figs. 6 and 7 of my article. I am much interested to hear from Lieut.-Col. Lockwood Marsh that the Wrights, as I had surmised, deliberately fitted it with this object in view.

My statement that on the whole the men who tried to fly were themselves interested in control, whilst the theorist and model constructor were more interested in stability, was intended to be read in a broad sense only, and in that sense I still think it is correct, bearing in mind such men as Lilienthal, Cody, and a host of others both before and after the Wrights. I had not, however, realised the extreme interest in stability of the French pioneers, and am grateful to Col. Lockwood Marsh for pointing it out.

B. MELVILL JONES.

Base Exchange and the Formation of Petroleum.

I HAVE read with great interest Dr. McKenzie Taylor's letter entitled "Base Exchange and the Formation of Coal" which appeared in NATURE of May 19, and am particularly interested in his description of the experiments conducted by him concerning the bacterial decomposition of fats under a roof containing hydrolysing sodium clay. Fats, as a body, are lighter than water, and I am wondering whether Dr. McKenzie Taylor has conducted any experiments, or has any evidence, to show that in Nature solid fats could be a sedimentary deposit in water and accumulate as such together with sand. Some eighteen years ago I demonstrated that oils can be deposited in considerable quantity as an aqueous sediment together with mud or clay, but my experiments indicated that oils could not be similarly deposited by, or together with, sand. For a full description of the phenomenon and my experiments, and also how in Nature the oil would afterwards be squeezed out of the clay into a sand bed, reference may be made to my book, "The Geology of Oil, Oil-Shale, and Coal."

I gather from Dr. McKenzie Taylor's description that in his experiment the bacterial decomposition under alkaline anaerobic conditions of the fat which was distributed through a sand layer at the bottom of the beaker took place in fresh rather than in saline water. If so, this may possibly account for the yield of methane rather than of higher members of the paraffin series. Connate oilfield waters which occur, together with oil, sealed up in oil-sands, have a distinct resemblance to ordinary sea water. They differ from ordinary sea water in increased salinity and deficiency in sulphates and magnesia. Two years ago I deduced that natural petroleum oil owes its origin to the bacterial decomposition under anaerobic conditions, in some cases of vegetable oils, and in others of protoplasm, by sulphate-reducing bacteria in sea water, and that the differences between connate oilfield waters and normal sea water were just the differences which would be produced by the action of such bacteria. The actual discovery of sulphate-reducing bacteria in the connate oilfield waters of the Illinois, Sunset-Midway, and Coalinga oilfields of America, by Dr. Edson S. Bastin, affords a certain amount of support for my deductions. If, parallel with the experiments which he is conducting, Dr. McKenzie Taylor would conduct a second set of experiments to determine the effect of the bacterial decomposition in sea water under anaerobic conditions by *Microspira aestuarii* (van Delden) and its associates, of protoplasm on one hand, and of vegetable oils on the other, incorporated as sediments in clay, a comparison of the results obtained would be extremely valuable.

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The Nierenstein Reaction.

DURING the past thirteen years, and in conjunction with several different collaborators, I have studied the reaction which takes place when diazomethane is added to various acyl chlorides, and I have shown that the change which takes place is always of the type represented by the equation,

$$R . CO . Cl + CH_2 . N_2 = R . CO . CH_2 . Cl + N_2.$$

The details of the method are described in my first paper (*Jour. Chem. Soc.*, **107**, 1491; 1915) on the subject, and it suffices to state here that the reaction was conducted by passing the diazomethane into the acyl chloride, the latter reactant being always in excess during the reaction. This is commonly known as the Nierenstein reaction.

Quite recently Arndt (*Ber.*, **61**, 1122; 1928) has confirmed my experimental results, and has also shown that if the method of conducting the process be reversed, and the acyl chloride added to the ethereal solution of diazomethane, so that the latter remains in excess, a change takes place which is represented by the equation,

$$R . CO . Cl + CH_2 . N_2 = R . CO . CH . N_2 + HCl,$$

the main product being of the type, $R . CO . CH . N_2$, instead of the type, $R . CO . CH_2 . Cl$.

In a paper published in the *Journal of the Chemical Society* a few days ago (p. 1310), Bradley and Robinson state that when diazomethane is treated with benzoyl chloride the main product is diazoacetophenone, and they therefore suggest that I and my collaborators, in this case Clibbens, have published statements which cannot be corroborated. I would point out that since they conducted the experiment in accordance with the second alternative method of Arndt, it is not surprising that they obtained the result which they might have anticipated had they been acquainted with Arndt's work, and not the result which would have been arrived at if they had followed the procedure of the Nierenstein reaction, as confirmed by Arndt.

I also take this opportunity of correcting a somewhat serious mis-statement which the same authors make in reference to my work. They express surprise that I should have stated that a certain substance containing two active Ph . Br . CO . groups should "crystallise unchanged from alcohol" (*J. Am. C. S.*, **47**, 1730; 1925), referring to this alleged statement as an "unconventionality." Reference to the paper will show that the substance is said to "crystallise in long needles from benzene," and that alcohol is not mentioned as a solvent from which the substance can be crystallised.

M. Nierenstein.

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Infra-red Emission of Carbon Dioxide.

During the course of an investigation into certain infra-red emission spectra, we re-examined that of burning carbon monoxide. In the absorption spectrum of carbon dioxide it is necessary to presume the existence of three fundamental vibrations in the near infra-red; in this way the other bands observed in the so-called rotational-vibrational spectrum can be accounted for as a system of harmonics and combinations: nevertheless the observed values depart from those calculated by several units per cent.

If the emission spectrum is analysed, it is found that most of the bands have shifted towards the longer wave-lengths and so become exact multiples of a frequency, $\nu = 16 \times 10^{11}$, in the far infra-red. Our observations are recorded in the following table: the values for the absorption spectrum are taken from the work of Schaefer and Philipps (*Zeit. f. Physik*, **36**, 641, 1926).

No.	Emission.				Absorption.	
			$\nu \times 10^{-11}$.			$\nu \times 10^{-11}$.
	λ.	$n\nu_0$.	Calc.	Obs.	λ.	Obs.
1.	1·70μ	$110\nu_0$	1760	1764	1·61μ	1864
2.	1·99	$94\nu_0$	1504	1508	2·02	1486
3.	2·40	$78\nu_0$	1248	1250	..	..
4.	2·79	$67\nu_0$	1072	1074	2·69	1115
	2·84	$66\nu_0$	1056	1056	2·72	1102
	2·87	$65\nu_0$	1040	1045	2·76	1086
5.	4·46	$42\nu_0$	672	673	4·25	706
6.	[15·6]	$12\nu_0$	192	..	14·87	202
7.	[187·4]	ν_0	16	..	..	..

No. 3 is new, not having been previously observed either in absorption or emission; No. 4 is a double doublet which can just be resolved with a rock-salt prism spectrometer; No. 5 is generally quoted as 4·40μ, but most careful calibration of the two spectrometers used, together with frequent repetition, confirms our result, the corresponding value for the bunsen flame at a lower temperature being 4·44μ.

Many interesting theoretical points present themselves, but it seems that here we are dealing with a pure rotational spectrum; it is suggestive that the Krüger gyroscopic molecule (founded on the earlier Bohr atom) executes a regular precession at low temperatures which changes to a true rotation at more elevated ones.

A corresponding simplicity underlies the water vapour emission spectrum which we have also investigated.

C. R. Bailey.
K. H. Lih.

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May 25.

The Spectrum of Ionised Sodium.

In a noteworthy article with the above title (*Phil. Mag.*, **5**, 150; 1928), Prof. F. H. Newman has given a new list of wave-lengths of the spark spectrum of sodium, which had previously been investigated by Foote, Meggers, and Mohler. The lines in question lie mainly in the near ultra-violet, between 2300 A. and 4800 A. No analysis of the Na II spectrum is attempted in the above-mentioned paper, but a number of pairs showing constant differences are given. I wish to show that using one of those differences (most of the others seem to be accidental) it is possible to arrange numerous strong lines as combinations of four s terms with ten p terms, corresponding to the transition $(3s^1\,{}^3P - 3p^1\,{}^3(S, P, D)$. The wave-length arrangement is the following:

	$(s_5)^3P_2$	$(s_4)^3P_1$	$(s_3)^3P_0$	$(s_2)^1P_1$
p_{10}	3533	3631	3711	...
p_9	3093			
p_8	3056	3130		3463
p_7	3008	3079	3136	3400
p_6	2918	2984	...	3286
p_5	2860	2924	2975	3212
p_4	2842	2905		3190
p_3		2881?		...
p_2	2810	2872	2921	3150
p_1		2586		2810

The frequency differences between the four lower levels ${}^3P_2$, ${}^3P_1$, ${}^3P_0$, ${}^1P_1$ are respectively: 765, 592, 2481 cm.$^{-1}$. The sum of the second and third of these is the difference 3073 cm.$^{-1}$ the occurrence of which was found by Prof. Newman. It is noteworthy that the difference ${}^3P_2 - {}^3P_0 = 1357$ cm.$^{-1}$, which may be interpreted as an L doublet yields, when inserted into the relativistic doublet law, exactly the same screening constant, 3·20, as the corresponding difference 780 of Ne I. For the comparison of the four differences of Na II with the corresponding ones of Ne I (417, 360, 1070), reference may be made to a paper by Mack, Laporte, and Lang (*Phys. Rev.*, June 1928). In every respect the above arrangement is similar to the first member of the principal series of Paschen's famous neon classification. As is easily seen, the next member of this system of series must lie deep in the Schumann region.

Parts of the diffuse series

$$3p^1\,{}^3(S, P, D) - 3d^1\,{}^3(P, D, F)$$

have also been found. All the strong and many of the weaker lines have thus been classified. The complete numerical material will be published soon.

Otto Laporte.

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Kyoto, May 6.

A Nitrogen After-glow.

IN the course of evacuating glass vessels which were to be used for experiments on the maintenance and starting potentials in argon for continuous high frequency oscillations, we observed that a nitrogen after-glow appeared when a discharge was passed through a mixture of air and argon at low pressures. For pressures greater than two millimetres it is very difficult to pass a discharge through air using external electrodes and a small valve oscillator giving a wave-length of the order of 20 metres. But when the pressure is less than one millimetre a discharge takes place easily in air. A great many experiments have been made on the residual air contained in glass vessels, and in no single case of a discharge of this type have we noticed a nitrogen after-glow, whether or not the more volatile gases were frozen out with liquid air. Even in the preparation of pure nitrogen a glow was noticed in a discharge of this type only on one or two very rare occasions when there were impurities present in small quantities.

If, however, pure argon at about a millimetre pressure be admitted to a vessel containing air at a pressure of the order of 1/10 of a millimetre, a glow at once appears. We have not yet had the opportunity to investigate the relative proportions of the mixture over which this phenomenon may be produced, but they may be varied over a fairly wide range. Mixtures of neon and helium at about the same pressure do not show this effect. The after-glow is greenish-yellow in colour, and under the best conditions will persist for some seconds after the discharge has ceased to pass.

We have tried a Tesla discharge through the mixture, but such a discharge gave no sign of an after-glow. All the experiments with the usual methods of production seem to agree in showing that argon has no effect on the nitrogen after-glow and that the nitrogen after-glow is not produced when the proportion of oxygen and nitrogen is the same as that in the atmosphere. The mixture retains its properties over long periods; for example, we have a sealed-off glass tube in the laboratory which has been used to show this effect for a period of two months.

This method of production should be exceedingly useful in some types of research.

S. P. McCALLUM.
W. E. PERRY.

Electrical Laboratory,
Oxford.

Thames Floods.

THERE is one possible cause of exceptionally high tides which is not always kept in mind. The effect of a system of low atmospheric pressure may be cumulative if the centre is moving in the same direction as the tidal wave and at the same speed. If the centre is at the correct distance in advance of the crest of the wave an exceptionally high tide may be experienced; and it may be inexplicable from consideration of wind and static barometric pressure alone.

I can give an example. A few years before the War, and about the month of June, a well-defined line squall passed up the English Channel. I happened to be in a 3-ton boat about 15 miles west of Portland Bill when it passed, and so I can definitely state that the wind effect was negligible. We had a barograph on board, and it indicated a sudden fall of 0·2 in. and a sudden rise of about 0·1 in. about 10 minutes later. That happened on a Saturday afternoon, and the Monday papers had reports from various parts of the south coast of a rise in the tide after the ebb had started, and of boats refloating after they had taken the ground.

Where the depths are about 20 or 30 fathoms, corresponding with tidal wave speeds of 36 or 45 knots, the *movement* of atmospheric depressions should always be taken into account.

P. J. H. UNNA.

10 Phillimore Gardens,
Kensington, W.8,
May 18.

The Pure Rotation Spectrum of Ammonia.

WITH the assistance of Mr. C. H. Cartwright, I have recently investigated the absorption of ammonia gas in the region of the far infra-red lying between 55μ and 130μ, and have observed an unexpectedly simple spectrum. Six lines were discovered which are approximately equally spaced in the frequency scale, and five of these were accurately measured. Within experimental error all of the lines may be represented, in terms of wave number, by means of the following equation,

$$1/\lambda_m = 19{\cdot}957m - 0{\cdot}00508m^3.$$

A thorough search failed to reveal other lines in the region investigated, and within the resolving power of the spectrometer those observed appeared to be singlets.

Presumably this spectrum is due to changes in the rotational energy of the ammonia molecule, as it rotates about one axis. According to the new theories it is not possible from the observed data alone to calculate the moment of inertia about this axis, for the molecule at rest. The estimate of $2{\cdot}77 \times 10^{-40}$ gm. cm.^{2}, however, is probably not greatly in error. The magnitude of the second term in the equation above shows that the molecule is relatively elastic and stretches considerably in higher rotational states.

A study of the absolute intensities of absorption was also made and will be published shortly.

RICHARD M. BADGER.

California Institute,
Pasadena.

Uncommon Common Salt.

THE top three crystals of sodium chloride shown in the photograph were formed in a gel prepared by addition of sodium silicate to hydrochloric acid.

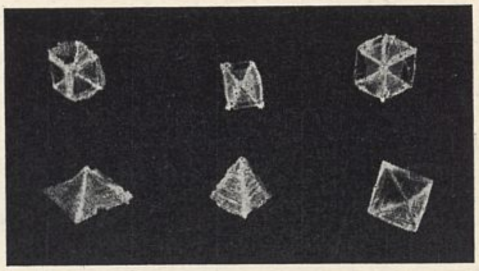

FIG. 1.

The crystals are cubes with hollow faces and bevelled edges, the form being {110}.

In the 'hopper' crystals shown for comparison similar faces are simulated by parallel growth of {100}.

A. F. DUFTON.
C. G. WEBB.

Building Research Station,
Garston, Herts., May 23.

The Sun's Outer Atmosphere.[1]

By Prof. E. A. MILNE, F.R.S.

AT a total solar eclipse, when the moon touches the sun's limb internally, a thin crescent of atmosphere is exposed. Its spectrum is a series of bright lines—general absorption at these levels has vanished. By measuring the lengths of the crescents from tip to tip, astronomers have estimated the heights to which the atoms of different elements exist. The following table gives samples of the observed heights :

HEIGHTS OF ELEMENTS IN CHROMOSPHERE AS SHOWN BY LENGTHS OF ARCS AT DIFFERENT TOTAL ECLIPSES.

	Lockyer. 1898.	Mitchell. 1905.	Davidson and Stratton. 1926.
	Km.	Km.	Km.
H λ6563 (Hα)	7,500	..	8,400
4861 (Hβ)		8,000	8,400
4341 (Hγ)		8,000	8,000
4101 (Hδ)		8,000	7,400
3889 (Hϵ)		8,500	7,000
He λ4713 (1^2P-3^2S)	..	3,900	6,000
5876 (1^2P-2^2D) (D_3)	..	7,500	7,500
4471 (1^2P-3^2D)	6,500	7,500	7,400
4026 (1^2P-4^2D)	4,500	6,000	4,400
4922 ($1\ P-3\ D$)	..	1,000	2,500
4388 ($1\ P-4\ D$)	..	2,000	2,000
4144 ($1\ P-5\ D$)	..	1,500	2,200
He^+ λ4686 ($3D-4P$)	..	2,000	2,500
Na λ5896, 5890 (1^2S-1^2P) (D_1, D_2)	..	1,200	1,000
Ca λ4227 ($1S-1P$)	3,500	5,000	2,500
Ca^+ λ3933, 3968 (1^2S-1^2P)	9,500	14,000	9,200
Sr^+ λ4215, 4077 (1^2S-1^2P)	4,500	6,000	5,200

It will be seen that the thickness in each case is of the order of thousands of kilometres. Roughly speaking, the sequence is : photospheric layer of the order of tens of kilometres, reversing layer of the order of hundreds of kilometres, chromosphere of the order of thousands of kilometres. We may complete the sequence by mentioning that the solar prominences are of the order of at least tens of thousands of kilometres and that the corona is of the order of hundreds of thousands of kilometres.

The mere size of this thickness shows that we are compelled to introduce a new force other than gravity and gas pressure. In ordinary gravitational equilibrium, under solar conditions, the pressure would decrease by a factor 0·07 in 10 km. In 10,000 km. it would decrease by a factor 10^{-1140}. At this pressure there would be no atoms at all at 10,000 km., and the pressure would have fallen to 10^{-18} atmospheres in 100 km. from the limb. When selective radiation pressure is introduced the pressure decreases much more slowly.

To see how this arises we must return to our arguments about selective radiation pressure near the boundary. We have still to explain what was wrong with our former assumptions. It will be remembered that we assumed 'local thermodynamic equilibrium.' This means that we assumed a definite temperature at each point. In strict thermodynamic equilibrium, as in an enclosure at a uniform temperature, the matter is traversed by radiation corresponding to its own temperature. At any point in a star the matter is traversed by radiation arising from places at a variety of temperatures, and strict thermodynamic equilibrium does not occur. But for many purposes the matter behaves as though it had a definite temperature. It can be shown, in fact, that when the density is sufficiently high, that is, when the atoms are sufficiently battered about by collisions with other atoms, the matter behaves according to the laws of Kirchhoff so far as the emission and absorption of radiation are concerned. The ratio of emission to absorption at any point is determined by Kirchhoff's universal function (Planck's function), which contains the temperature as a parameter. When we calculate the laws of transfer of radiation under these conditions, using Schwarzschild's equations, we find first the laws of selective radiation pressure mentioned earlier. We find also that energy is continually being transformed to longer and longer wave-lengths as it runs down the temperature gradient, the mechanism being inelastic and hyper-elastic collisions. Hyper-elastic collisions remove energy of shorter wave-lengths, and inelastic collisions introduce radiation of longer wave-lengths.

As, however, the density decreases, collisions become less important. Radiation, instead of being transformed in wave-length, tends to be handed on at the same wave-length. Ultimately, at sufficiently small densities, the whole of the radiation passes unchanged in wave-length. We call this state of affairs 'monochromatic radiative equilibrium.' Each portion of matter then emits as much radiation of the wave-length in question as it absorbs. Since there is no gain or loss of radiation of the given wave-length at any point, the net amount of λ-radiation crossing any one level—the difference between the inward and outward streams—is the same as that crossing any other level—for otherwise there would be either an accumulation or a loss of energy between the two levels. The net flux in a given wave-length is therefore constant. Hence if the absorption coefficient is constant, the selective radiation pressure will be constant.

We can now trace the origin of our previous contradiction. First, we erroneously assumed local thermodynamic equilibrium to hold right up to the boundary of the star. This led to the possibility of an uncompensated radiation pressure at the boundary. This, we saw, must cause the formation of an outer atmosphere, a chromosphere.

[1] Continued from p. 913.

Secondly, we ignored the inward stream of radiation arising from this outer atmosphere; we calculated the selective radiation pressure at the boundary of the layer in local thermodynamic equilibrium as though there were no inward stream there.

When we now take account of the inward stream from the outer atmosphere, we see that all contradictions are removed. The boundary of the region in local thermodynamic equilibrium is not the boundary of the star as a whole. Outside this there will exist in general, for each particular kind of atom, a region not in local thermodynamic equilibrium but in monochromatic radiative equilibrium. This acts as a cushion, gently pressing on the region beneath and keeping it in equilibrium, to a slight extent by its weight, but principally by its back radiation.

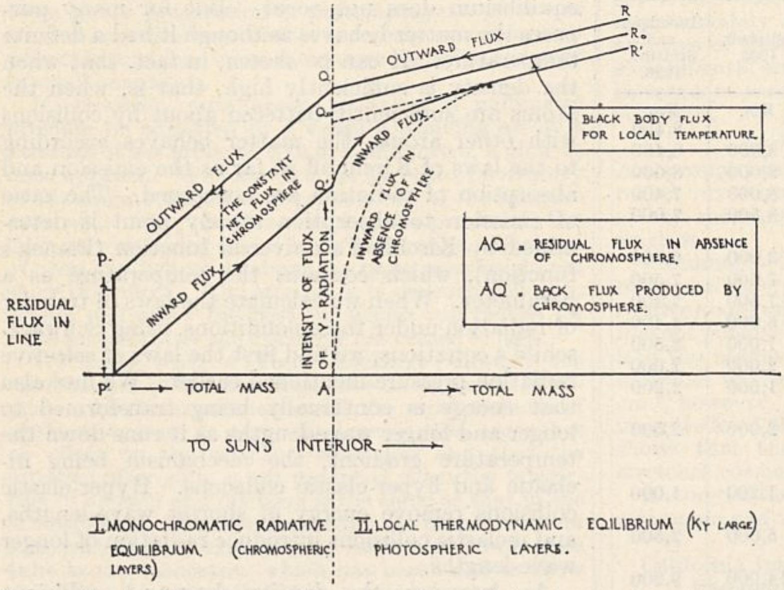

FIG. 3.—The transition from local thermodynamic equilibrium to monochromatic radiative equilibrium, and its influence in the formation of the chromosphere. The slope of PQ and P′Q′ is determined by the theory of radiative equilibrium. The length of PP′ (residual intensity) is determined by the weight of the atom and the atomic absorption coefficient. These two data serve to fix the position of P′. The slope of Q_0R_0 is determined by the temperature distribution, which in turn is determined by the equilibrium of the integrated radiation of all frequencies. Different horizontal scales are used for I. and II. Actually there is no discontinuity between I. and II.; a discontinuity is introduced merely for illustration purposes, to show up the different factors at work. In the absence of the chromosphere, the residual flux AQ would cause expulsion of atoms. The chromosphere grows from A to P′, until its back radiation AQ′ reduces the net flux to QQ′ = PP′ = residual intensity in centre of line.

In this region, the chromosphere, we can now see that the density is likely to fall off very slowly. A decrease of density upwards means a decrease of pressure, and hence a pressure gradient. This balances part of the weight. But we have seen that the creation of the outer atmosphere will go on until its weight is just sufficient to balance the otherwise uncompensated radiation pressure from the region beneath. In this equilibrium there is no part left for pressure gradients to play, and they will be practically non-existent. In other words, the density will be practically constant.

Actually this overstates the case. The density must, in fact, decrease slightly outwards. For it to be accurately constant, the radiation pressure would have to be accurately constant. We have seen that the net flux is accurately constant. But the radiation pressure is proportional to the net flux and the absorption coefficient, and the latter is not accurately constant. It must be smaller at lower levels, because owing to the increased density of radiation there (forward plus backward stream) more of the atoms at any instant will be excited and so not in a condition to absorb; thus the average absorption coefficient will be smaller. The consequence is that at least at the lower levels there must be some pressure gradient to take care of the uncompensated portions of gravity, and so there will also be a density gradient.

Theoretically, the density should fall off as the inverse square of the height measured from a certain datum level.

A further point is, that though we have demonstrated the possibility of the existence of an extended low-pressure outer atmosphere with small density gradient, we have not proved that this is the only type of outer atmosphere. There are a whole range of other possibilities. If, after expelling enough atoms to form an outer atmosphere, the lower regions exude for some reason more atoms, radiation pressure will further diminish. There will be too many atoms to be fully supported by radiation pressure, and the outer atmosphere will partially collapse on to the lower regions. It will then be strongly condensed towards its base. Nevertheless, an all but fully supported outer atmosphere is what is observed in the case of ionised calcium atoms on the sun. The spectral observations made by Col. Stratton and Mr. Davidson at the eclipse of 1926 (Sumatra) have been analysed by Mr. P. A. Taylor. He first extended the theory so as to allow for the curvature of the sun, and then compared the observed outward decrease of intensity of the flash spectrum with the calculated decrease. It appeared that all but about one ten-thousandth of the weight of the calcium chromosphere was supported by radiation pressure. Why this is so we cannot exactly say. One suggestion is that it appears possible that a strongly condensed 'partially supported' chromosphere would tend to re-introduce local thermodynamic equilibrium, in which case atoms would be once again expelled and a fresh chromosphere would be grown. This is a mere conjecture, and such calculations as I have been able to make do not confirm it. We must await further investigations.

Each species of atom occurring in the chromosphere should produce its own radiation gradient, independent of the others, and the complete chromosphere arises from the co-existence of the separate outer atmosphere for the separate species of atom.

We have arranged our argument as though the region of local thermodynamic equilibrium ends abruptly, and is superposed by a region in monochromatic radiative equilibrium. Actually, the two must shade into one another. The precise pressure at which the one set of conditions gives place to the other depends on the effective cross-section of the atom for collisions that are capable of exciting it, and if this cross-section is of the order of magnitude of the cross-section given by the dynamical theory of gases, then the transition pressure where an intermediate state holds is of the order of 10^{-3} atmospheres. If this is to be trusted, it would mean that all lines in the reversing layer are produced under conditions where, on the whole, the state is one of monochromatic radiative equilibrium rather than one of local thermodynamic equilibrium.

As a corollary it would follow that all lines except those due to very heavy atoms should appear in the chromosphere. Roughly speaking, this is what is observed.

The more nearly an outer atmosphere, in a particular kind of atom, is in monochromatic radiative equilibrium, the more nearly the ratio of the residual intensity in the line-centre at the limb to that at the centre of the disc should approach the value $\frac{2}{5}$. It will be a matter of interest to see to what extent this holds—investigations are now in progress at a number of different observatories. Schwarzschild pointed out long ago that on local thermodynamic equilibrium all absorption lines should vanish in the continuous background at the limb, and inferred that since they do not do so there must be a measure of monochromatic radiative equilibrium. Our general theory bears this out. For all atoms, local thermodynamic equilibrium must give place to monochromatic radiative equilibrium at low densities, and the more completely this holds the more completely should the limb-centre ratio approach $\frac{2}{5}$. Schwarzschild found that the ratio was in fact about $\frac{2}{5}$ for the *H* and *K* lines of calcium, for which lines the existence of a high level chromosphere makes it very probable that monochromatic radiative equilibrium holds strictly.

It is perhaps scarcely necessary to add that in the atmospheric structure we have sketched we have highly idealised the problem at a number of points. We have simply attempted to construct a model of the solar atmosphere useful for the points under discussion. It will not necessarily be useful for other points. Even as it stands it is not a complete model. For one thing, we have tacitly dealt only with electronic transitions as the origin of lines—we have ignored the effects of selective scattering as the cause of line-widening, as suggested by Stewart and brought into prominence by the recent work of Unsöld. Again, we have argued as though the boundary between monochromatic radiative equilibrium and local thermodynamic equilibrium coincided with the boundary between the low-pressure chromosphere and the higher-pressure reversing layer. Actually, we have found that monochromatic radiative equilibrium is coming into being at about 10^{-3} atmospheres, whilst, for example, the partial pressure of calcium at the base of the chromosphere can scarcely exceed 10^{-12} atmospheres. This involves no intrinsic self-inconsistency. It is merely that we have not dealt adequately with the few hundred kilometres in which this transition occurs. Somehow or other the sun knows how to arrange its layers in this region in accordance with the laws of physics, and in so doing it propounds an attractive puzzle for the mathematician and the solar physicist.

Centenary Conference of the Institution of Civil Engineers.

THE engineering conference held during the first week in June as part of the celebrations of the centenary of the incorporation of the Institution of Civil Engineers, proved a very successful function. Monday, June 4, was devoted to a reception of the many delegates representing kindred institutions and universities at home and abroad, and to the delivery of the James Forrest Lecture, the main part of which appears as a Supplement to this week's issue of NATURE. Such an occasion affords a very suitable opportunity for a general review of the developments which have taken place in this branch of applied science during the past hundred years. In his lecture Sir Alfred Ewing gave a masterly exposition of these developments, taking as his main thesis the prediction of Tredgold made in 1828 that "the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical science," and emphasising at the same time the extent to which advances in engineering have been associated with many of the most noteworthy advances in physical science.

The mornings of June 5 and 6 were devoted to the presentation and discussion of a series of professional papers. The scope of the subjects chosen for discussion by the selection committee indicates in a striking manner the catholicity of the Institution, the majority of the papers dealing with matters which are commonly understood as coming within the purview of the mechanical or electrical engineer, and relatively few dealing with those branches of constructional and structural engineering with which the members of the Institution are commonly supposed to be most intimately concerned.

Since the papers were chosen with the view rather of considering recent developments in engineering, this is perhaps unavoidable, for there can be little doubt that modern developments in what may perhaps be termed the more dynamical branches of engineering have been much more marked than in those branches which deal with such constructions as railroads, docks and harbours, and bridges. It is somewhat surprising, however, in view of recent developments in this direction, that there should have been no paper dealing specifically with modern dams of the arch type. It is true that this type has been almost exclusively developed abroad, but in view of its interest and importance it would appear to be a subject well meriting discussion at such a conference.

It is worthy of note that no fewer than ten of the papers presented for discussion deal with one or other aspect of the generation of power from solid or liquid fuels. The possibilities embodied in the use of steam at high pressures, especially at high temperatures, are attracting much attention at the present time ; and keen interest in this subject was evidenced in the discussion of papers dealing with such various aspects of the problem as the properties of the materials suitable for use in the construction of boilers for very high pressures ; the design of such boilers, both for land and for marine use ; and the design of steam turbines for utilising these pressures. The general trend of the papers and of the discussion would indicate that developments in this direction are likely to be far-reaching and important in the near future. At present, the difficulty of obtaining a steel which is at once fairly cheap and well adapted for use at high temperatures forms a serious handicap, but when this problem has been satisfactorily solved—and, in view of the attention now being devoted to it, the solution cannot be long delayed—the high-pressure installation is likely to become the rule rather than the exception both for land and marine work.

Discussions on the use of internal combustion engines, and of high-pressure steam for marine propulsion, show that the marine steam plant is very far from being dead, and its advocates see every reason to believe that the use of high pressures on shipboard may do much to bring the balance of advantages once more on to the side of steam propulsion. A paper on the latest types of steam and internal combustion locomotives shows that the battle between the steam and the internal combustion engine is being waged with some intensity here also.

Some interesting facts were brought out in a paper on light high-speed internal combustion engines, and in the resultant discussion. Thus it is probably not generally realised that the output of such engines to-day, measured in horse-power, is more than ten times that of all existing power stations, ships, and railways. Largely owing to its application to aerial flight, this branch of engineering has engaged the attention of some of the most skilful and scientific British designers during the past fifteen years ; and the progress during that time has probably been more marked than in any other branch of motive power engineering. The highest thermal efficiency yet recorded by any heat engine, namely, 39·5 per cent on the brake horse-power, was obtained on the Napier aero-engine which won the Schneider Cup trophy in 1927, while almost, if not quite, the highest thermal efficiency ever recorded on a Diesel engine was obtained by the Royal Aircraft Establishment on a small high-speed Diesel engine of 8 inches bore running at 1000 rev. per minute.

The design of such an engine sufficiently light to be used in an aeroplane is still some way from solution, but in view of the progress already attained in this direction, it would appear extremely probable that the Diesel engine will at no remote date form the power unit for moderate speed heavy aeroplanes intended for long-distance flights.

The general interest shown in the work of the Electricity Commission is reflected by papers on prospective developments in the generation of electricity ; on the electric transmission of power as applied to large areas ; and on domestic lighting and heating and its influence on the load factor of supply. This forms a very interesting and suggestive trilogy of papers.

Two papers on water power were discussed, one dealing with recent progress in hydro-electric installations of conventional type and one with tidal power. In the former paper the remarkable rate of development of water power is emphasised. The total world development now amounts to about 35 million horse-power, practically all of which has taken place in the last thirty years, and this is increasing at the rate of about 1·5 million horse-power per annum. The capacity of the hydro-electric plants now operating in Great Britain, however, does not exceed 100,000 horse-power, which is almost negligibly small compared, for example, with the 12 million horse-power of the United States. At the same time, it is encouraging to know that Great Britain takes a share in the design and manufacture of hydro-electric plants altogether out of proportion to its own meagre water-power supplies.

In view of the investigation of the possibilities of a tidal scheme on the Severn ; of the published particulars of a proposed tidal development on the Wash ; and of the tidal scheme on the French coast at Aberv'rach, the discussion on tidal power was timely and of interest. Such a development probably involves more diverse problems than are to be found in any other single engineering development. There can be little doubt that these problems are on the way to solution, and that sooner or later large-scale tidal development will provide a very large source of energy supply. One can, indeed, visualise the time when water-power development from tides will be relatively as important in Great Britain as is water-power development from rivers in such a country as the United States.

Papers on recent developments in concrete for engineering structures, and on developments in the use of materials in railway engineering, indicate the extent to which the use of concrete, especially in conjunction with steel reinforcement, is extending. Even in the most conservative of engineering circles, interest is now being shown in the possibilities of reinforced concrete, and its use is rapidly extending. The introduction of reliable rapid

(*Continued on p.* 955.)

Supplement to NATURE

No. 3059 JUNE 16, 1928

A Century of Inventions.[1]

By Sir JAMES ALFRED EWING, K.C.B., F.R.S.

THE Council of the Institution of Civil Engineers, when inviting me to deliver the James Forrest lecture as an item in the celebration of our centenary, suggested a very comprehensive text, namely, a prediction which Thomas Tredgold added to the definition of civil engineering which he drew up for the petition for a Royal Charter presented in 1828. It ran thus :—

" The scope and utility of Civil Engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science."

Seldom, surely, has a prophecy been so justified in the event. The history of engineering during the century which has passed since these words were written is in its main features the story of their fulfilment. Every advance in scientific theory has increased the engineer's mastery of the material world. Discoveries, which at first may have seemed wholly unserviceable to him, have in fact furnished new points of departure, leading in ways that were often unforeseen to enlargements of his many-sided art.

It may be doubted whether even Tredgold, with all his vision, saw the outer side of the picture ; whether he realised the beneficent reaction by which science was itself to profit. But we, at any rate, see it now. We see how developments in science are fostered and even initiated by industrial requirements, by engineering enterprise ; how inventions that were made for the purpose of serving a public need have widened the outlook of science and given it new tools for research. Nowadays theory and practice march together in such close association that it is often difficult to distinguish them as separate figures in the procession. In chemistry, in metallurgy, in thermodynamics, in electricity, who would venture to apportion the credit for progress, as between the man who pursues abstract truth and him who strives after technical application ? Looking back, we may assert that there has from the first been some mutual obligation, not indeed so constantly operative as it is to-day or so clearly admitted, but often very influential. From modest beginnings physical science and engineering have advanced, side by side, and in the advance their intimacy has developed ; they have discovered the benefit of relationship and the relationship has itself become closer. A century ago they were both sturdy infants, playing, one may say, in more or less separate nurseries, sometimes meeting and perhaps sometimes quarrelling a little. Now, adult and masterful, they are partners in one firm, still conscious—as partners may be—of differences in temperament and taste and viewpoint, but very conscious also of the strength that comes from co-operation.

To-day we can take no more than an aviator's survey—what used to be called a bird's-eye view. For this purpose I may claim the doubtful advantage of having seen more than half a century pass since I began to teach engineering. I recall as a boy finding inspiration in an account of the doctrine of the conservation of energy then published as a new gospel—a doctrine which flooded with light much that had been very dark in earlier attempts to co-ordinate mechanical ideas. My recollections go back to a period before the coming of the oil engine, of the dynamo, the electric motor, and the transformer, when the only practical application of the electric current was in telegraphy, when the arc lamp was a scientific curiosity and the telephone had still to be born. It is something to have witnessed the whole pageant of electrical engineering display itself before one's own eyes, from tiny beginnings to its present greatness ; to have seen the dream realised of a distribution of power from central stations ; to have watched each stage in the development of the steam turbine and its use on land and sea ; to have observed the internal combustion engine arrive as a modest ally to steam, and gradually turn into a serious rival, after effecting a social revolution by making transport by road easy and transport by air possible. These things are familiar to everyone ; but it is

[1] From the Thirty-fourth James Forrest Lecture, delivered before the Institution of Civil Engineers on June 4, on the occasion of the celebration of the centenary of its incorporation.

perhaps to the old, who saw their first coming, who knew a simpler, homelier world before they came, that they make their strongest appeal. To me, who began engineering experience with the telegraphy of the early 'seventies, it is much to have been a spectator of the wizardry which has so transformed the art of communication that the spoken word literally goes forth to the end of the world.

In this review, however, we have to go back farther than the reach of even the longest individual memory. Try to realise what engineering meant in 1828, what was its relation to the science of the day, and what in fact was, in that day, the state of science. The engineers of that period were mainly concerned with roads, bridges, and canals; the era of railways was about to begin. The steam engine, which first served as a device for pumping water out of mines, had been adapted by Watt and his followers to the driving of machinery in factories, and had thereby become a potent agent in the industrial revolution which followed the Napoleonic wars. It had been applied experimentally to drive carriages on roads, and had established its position, especially in America, as the motive power of paddle-boats for river traffic. To a small extent steam was being adopted as an auxiliary in sailing ships, and reformers were urging that the Navy should give it a trial—alleging what seems to us the curious reason that a steamship would cost less to build than a sailing ship. We have not found the *Hood* cheaper than the *Victory*.

Watt's prejudice against the use of high-pressure steam for a long time dominated English practice. Nevertheless, Jacob Perkins, rightly described by a contemporary as " an experimenter of no common cast," ventured even before 1828 on pressures such as would still be considered very high. He exhibited a piece of steam artillery which, under a pressure of sixty-five atmospheres, projected nearly one thousand musket balls per minute. But Perkins was one of those unfortunate inventors who are born before their time. What is relevant for us to notice is, that in those days the theory of steam was even more rudimentary than the practice; the early development of the steam engine proceeded without the guidance which it would have had if the properties of steam had been known. Carnot had already written his wonderful essay on the motive power of heat. But it had fallen flat. Its meaning was not appreciated; and at the time of which I speak the very alphabet of thermodynamics had still to be framed.

Remember that these early steam engineers had no idea that what they were doing was to convert heat into mechanical work. Many years were to pass before the notion of energy, as a thing neither produced nor destroyed, was to become an established part of natural philosophy; before Joule determined the mechanical equivalent of heat, and the first principles of the subject were formulated by Kelvin and Rankine and Clausius. But it may fairly be claimed that the way was prepared for these conceptions by the work of the engineers, by the invention and frequent use of the indicator, by Watt's numerical definition of the term 'horse-power,' and by the sporting interest of the Cornish mine managers in the 'duty' of their engines, a figure which expressed the relation of what we now call the work done to the coal consumed.

When one looks into the technical literature of that period one is sorry for the early student of engineering. Physicists and engineers alike were groping their way, confusedly, towards mechanical ideas which were as strange then as they are familiar now. The mathematical theory of elasticity is described by its historian Todhunter as having had its birth in 1821, when Navier first gave the equations for the equilibrium of elastic solids. Navier had brilliant colleagues among the other mathematicians of France. But between them and the stolid practicians of Westminster there was a wider difference than one of language or political sentiment. Their ways were not as our ways. Tredgold, in a preface to his " Essay on the Strength of Cast Iron," which discusses the stresses in beams, goes so far as to repudiate the use of fluxions as unsound. He appears to have regarded a differential coefficient as a device for " forcing the assent rather than convincing the judgment." This prejudice against the calculus remained for long a serious handicap to the British student of engineering.

Not less than mechanics and heat, the science of electricity was still in its infancy. Chimerical ideas found vent in engineering papers about the possibility of driving ships by the consumption of a little zinc in a galvanic battery. One sanguine inventor estimated the cost of propelling a ship in this way at 3*s*. 4*d*. a day. Ohm's Law had been formulated in 1825, but in the absence of units and instruments of measurement its significance could not be understood. It was not until the requirements of the telegraph had to be met that engineers and physicists together attacked the problem of framing a logical system of electrical units, determined their magnitude, set up standards, and established practical means of comparing electrical quantities with them. The work was begun in the early 'sixties, mainly at the instigation of William Thomson, afterwards Lord Kelvin. It was done under the auspices of a committee of the British Association, of which the secretaries were Clerk Maxwell the physicist, and Fleeming Jenkin the engineer. What it accomplished was an incalculable boon to the investigator in pure science no less than to the technician.

Not in electricity only, but also in mechanics, in heat, in all the properties and actions of matter where engineers and physicists find common ground, it is through the alliance between practice and science that the art of measurement has been evolved. It was to meet the needs of engineers that Whitworth brought precision into mechanism by laboriously creating for the first time a true straight-edge, a true plane surface, a satisfactory screw. This was no less a service to science: it made practicable the scales and standards and gauges that are now familiar alike in the laboratory and the workshop.

It was to meet the rapidly growing needs of steam engineering that Regnault undertook his researches into the properties of steam, which led to the publication, in 1847, of tables and data which for long remained a classic of the engineer. Now, thanks to Callendar, Mollier, and other workers, we enjoy a fuller and more accurate knowledge of these properties than Regnault could achieve, hampered as he was by the uncertainties of early thermometry. The science of thermometry became definite only after Kelvin introduced the absolute scale of temperature—a brilliant philosophical conception which runs through all physical and chemical science like a thread of gold in a woven fabric. It guides the engineer to the ultimate standard of thermodynamic efficiency; and it was from meditating on the action of heat-engines that the inspiration came.

It was to meet the requirements of the naval architect that William Froude attacked the problem of ship resistance, devised the method of the experimental tank, and showed how measurements on the drag of small models might, through application of what is now called the principle of dynamical similarity, furnish data from which to determine the power required at any speed to drive the largest ships. In more recent days the same principles, applied by aid of experimental wind channels to study the forces which air currents exert on model objects, have been a powerful factor in the development of aeronautics—an art the beginnings of which many of us have witnessed and the progress of which, sensationally rapid, compels attention from day to day.

A new art, such as flying, becomes inevitably and at once a branch of applied science; it advances like a fire-engine in a crowded thoroughfare; it escapes the long period of empiricism through which the older arts had to pass while they were laboriously making their way into the light.

It is to aid engineering no less than pure science that we now supplement private enterprise by the official organisation of research. In this it must be admitted that we followed somewhat slowly the example set by continental neighbours. The National Physical Laboratory was promoted by the joint efforts of physicists and engineers. It was, from the first, fortunate in having for its head a man in the fullest sympathy with both schools of thought, who for many years, and with the happiest results, applied his faculty for leadership to build up an establishment the work of which is accepted as authoritative and the influence of which on the scientific development of engineering has been, and continues to be, profound. Sir Richard Glazebrook has himself dealt with "The Interdependence of Abstract Science and Engineering" in a James Forrest Lecture delivered five years ago. No man could speak with a closer personal understanding and experience of the subject. In his hands the value of the Laboratory was so fully demonstrated that after a time, from being semi-official, it was made official—becoming a truly national laboratory, administered by a new Government office, the Department of Scientific and Industrial Research.

That Department, established in 1916, remains with us as a beneficent legacy of the War. It is a notable item on the credit side of an account that is mainly one of debit. The War turned men's thoughts, as never before, to mechanical problems. From being questions of mere luxury or convenience, such problems became, almost suddenly, questions of national life or death. Physicists and mathematicians whose interests had been wholly abstract were brought, as it were, from the clouds to earth. They faced facts—often, one should add, to excellent purpose. With the community generally, applied science took on a new significance; until then it had meant little to them; they now saw it as a man struggling in the water sees a plank within his reach. Research, and the adaptations of research, from being treated with general indifference, were hailed as a way to public salvation—salvation not only from the immediate menace of the struggle itself, but (after that was past) salvation from the abiding danger of international competition and the burden to industry through waste and debt. The national intelligence was stirred; blind eyes were opened. They have remained open, and the Department does much to keep them open.

The Department works largely through committees where experts in industry co-operate with men of scientific habit. It also subsidises young research workers. For a young worker to attempt research is often educative, and he may discover a real aptitude. But we must not forget that researchers, of the best sort, are like poets; they are born, not made. You may produce in this field competent hewers of wood and drawers of water, men who will usefully assist or follow a real leader. But the wind bloweth where it listeth; no man who says, "Go to, I will research" can count on inspiration, and not even the draught in an air-channel will make dry bones live. On the other hand, when the right man is found, there is no limit to his potential achievement. He may give the world a new idea; he may create a new industry; he may make for himself a name; he may make, generally for others, a fortune.

From time to time in the history of engineering we find a new idea born, resembling what biologists call a 'sport,' which gives an unexpected turn to the process of inventive evolution. No one can confidently extrapolate the curve of engineering progress; its equation is liable to capricious change. Besides those occasional fresh departures we find, especially in modern times, that the scientific method is continuously at work, acting always as an auxiliary to experience in improving what is already familiar. Thus the influence of science is felt in two ways; in occasional spectacular events which open up channels where the stream did not flow before, and also in constant guidance of established currents, giving them greater volume and a more favourable course.

Take an illustration or two from the history of metallurgy. In 1828 the only forms of iron available for construction on a large scale were pig-iron, the product of the blast furnace, and puddled iron, the same product decarbonised in the reverberatory furnace. When railways began there was doubt whether rails should be cast or wrought. Wrought iron had Stephenson's support and won the day. But it was not easy for the output of puddled metal to keep pace with the rapidly increasing demand which arose for rails, for boiler plates, and presently also for ship plates when iron came into use as the material for building hulls. It became urgent to find some other way of obtaining iron in the malleable state. In 1856, Bessemer attacked the problem as an outsider who broke away from the traditions of the trade. His method was a 'sport,' but no accident; it was an outcome of scientific thought. His first success was quickly followed by failures which only stimulated him to investigate their cause and cure. The difficulties were overcome, and mild steel began slowly to take its place as the most valuable of all constructive materials known to the engineer.

A few years later the alternative process of the open hearth was developed by Siemens, not less novel, and not less an offspring of scientifically trained intelligence. Regenerative heating—an idea which had already found engineering expression in the Stirling air-engine—secured the high temperature necessary for the molten bath. Less simple and less rapid than the process of Bessemer, it had the advantage of easier control; it could be made static. Each method has its own field of usefulness; together they supply the world with nearly a hundred million tons of steel a year.

In more recent times electricity, which is the handmaid of every branch of engineering, has given the steel-maker additional types of furnace with large application in the blending and refining of special steels. Steel has become a word of many meanings. We have learnt, and are still learning, the amazing variety of characteristics which can be produced in a metal by adding regulated quantities of other substances. The study of alloys, both ferrous and non-ferrous, is an immense field of research in which the resources of chemistry and physics are placed at the service of the engineer. By their aid he learns how to obtain a product that will fit a special purpose. It is, in each case, a question not simply of composition but of heat treatment, for the atoms are like a community of alien races, subject to collective excitement and liable in their stormy moments to assume new groupings which largely and permanently affect the properties of the piece.

By means of such study the engineer is now provided with cutting steels which have revolutionised workshop practice; stainless steels the use of which goes far beyond the requirements of the cutler; mechanically strong and wear-resisting steels in a profuse variety; magnetically hard steels which are retentive of magnetism to a degree not approached before. It would seem you have only to specify a new requirement, and the metallurgist finds an alloy that will meet it. You want a metal which will not change its dimensions with temperature, and he discovers invar. You want a steel which will refuse to take up any magnetism at all, and he discovers manganese steel. You want a metal immensely susceptible to weak magnetic fields, with which to 'load' a telegraph cable, and he discovers permalloy. You want a metal which will combine the lightness of aluminium with something of the strength and ductility of mild steel, and he discovers duralumin and the Y alloy.

It is a scientific process of high-temperature electrolysis that has made aluminium a commercial product. The designers of aircraft and of motor cars appreciate its value, in the alloyed state, and one may conjecture that in many fields of engineering construction we are on the threshold of an aluminium age. A material, not too costly, which has nearly the strength of mild steel, with little more than one-third its weight, ought to have an unlimited future. It has even been suggested that for the new age we should look to the alloys of another and still lighter metal, magnesium. Research in these directions proceeds apace.

A century ago the development of the steam engine had not emerged from the empirical stage. A change came soon after 1850, when men began to think of energy as protean and imperishable. The mechanical theory of heat was established, and in 1859, Rankine published his "Manual of the Steam Engine." Kelvin rediscovered Carnot, and the Carnot cycle came to be recognised as an ideal criterion of performance which no engine could conceivably surpass. Engineers strove to bring their engines nearer to that standard by compound expansion, by superheating, and by other means of reducing avoidable waste. They also strove to widen the interval between the temperatures at which the working substance took in and rejected heat, for the 'heat drop' between these limits determines how much of the supply of heat is ideally capable of conversion into work. Boiler pressures went up and up: they are rising still. A committee of this Institution helped to spread a sound gospel by recommending the Rankine cycle as a basis of comparison with the results of tests, a cycle which differs from that of Carnot only by assuming that no reversible process is followed in the return of the condensed water to the boiler. But it is interesting to notice that modern steam plants of the most efficient type have introduced a reversible process through the device of 'bleeding,' which enables the condensate to be heated step by step on its way back to the boiler, in a manner so nearly reversible as to make the whole cycle approximate to the ideal of Carnot.

All this exemplifies the continuous steady pressure of scientific ideas in improving the procedure of the practical engineer. In a different category I would place the invention, by Parsons, of the steam turbine. That too was an application of scientific ideas, but it is an example of what I have called a 'sport.' It broke away from established lines, and we may say that in the world of engineering the genius of Parsons opened up a new kingdom. He gave us a power producer, wholly novel in action and design, capable of immensely augmented efficiency, with a concentration and magnitude of effect never even imagined before.

Another 'sport' was the internal combustion engine. Time would fail me to trace its development from primitive forms; to tell of the steps, big and little, but all essentially scientific, which brought into operation the cycles of Otto and Clerk and Diesel; of the multitude of engines which have turned the man in the street into an engineer, crowding the highways, dotting the seas, and achieving in some sense a conquest of the air.

Reverse a heat-engine and you have a heat-pump, which means that by expending power from outside you can make a body colder than its surroundings and keep it colder. From this simple piece of thermodynamics has sprung a branch of engineering with great and growing economic importance. Refrigeration makes the whole world our orchard, our sheep farm, and our cattle ranch. Perhaps in no other field do so many scientific problems arise for solution as in the transport and storage of foodstuffs under such conditions of cold as will, without substantial damage, preserve them from bacterial attack.

The science of refrigeration, too, offers a conspicuous example of how an industrial process, strikingly novel, may take its origin from an apparently insignificant physical fact, and then repay the debt to pure science by promoting the progress of research. Long ago, Kelvin and Joule, in experiments on the properties of gases, discovered that when air escapes under pressure through a throttling orifice it undergoes a small drop in temperature—about one-fourth of a degree for each atmosphere. Years afterwards, Linde and others, by applying a regenerative interchanger to transfer the cold from the escaping air to the stream that was approaching the orifice so as to obtain a cumulative effect, used this as a practical means of liquefying air, and of separating its oxygen and nitrogen, with the result that each of the two may be commercially utilised. This is now the foundation of more than one considerable industry; moreover, it has given to physicists a new tool of research, enabling them to bring temperatures down to an extreme never before reached in any terrestrial laboratory.

In the region of applied electricity, perhaps more than in any other part of engineering, examples multiply themselves of the exchange of benefits between practice and science. One may, of course, say, with perfect truth, that all the applications of electricity are in their origin fruits of scientific research. If we trace, for example, the history of the dynamo, we go back through Hopkinson's formulation of the principle of the magnetic circuit to an experiment of Faraday, which, in 1831, first showed that the movement of a conductor across a magnetic field generates electromotive force. The very language in which one describes this fundamental discovery is language we owe to Faraday himself. From that experiment what a progeny has sprung! May it not be fairly claimed that all the practical devices of electrical engineers, the dynamo, the motor, the transformer, the storage battery, the arc lamp, the vacuum bulb, the electrolysis bath, the electric furnace, the telephone, and many more have advanced the purely philosophic study of electricity? With their help the physicists have now discovered that in positive and negative electrification—in the protons and electrons, which together compose the atom—we have the primitive brick-bats of which the whole material universe is built. Perhaps some day the philosophers, who have analysed matter into these brick-bats, teaching us how many of each kind are in the atom of any element, and the engineers, who are always searching for sources of power, may put their heads together and discover a means of tapping, in some sufficiently controllable manner, the huge stores of internal energy which the atoms are known to conceal. That would, indeed, be a new departure, but I dare not predict that it will ever happen. Prophecy, as George Eliot said, is of all forms of human error the most gratuitous.

When Kelvin, in 1853, discovered as a piece of mathematical reasoning that under certain conditions as to resistance, self-induction, and capacity, a discharge of electricity would be oscillatory, he little knew what he was letting the world in for. From that seed has grown a great tree. The branches, one may say, are visible over many housetops. Through Clerk Maxwell, Hertz, Lodge, Marconi, Fleming, de Forest, and many others, discovery and invention have proceeded, hand in hand, to accomplish what seems to me the most wonderful of all the wonders of applied science. The telephone of Graham Bell, the microphone of Hughes, the phonograph of Edison were arresting marvels the first coming of which I vividly recall. But wireless broadcasting still more impresses the imagination. It gives other marvels an added value, and works an even greater social change.

Towards the end of last century, when physical science seemed to some of its votaries to have settled into a groove, suddenly there was an astounding outburst of discovery. The X-rays, radioactivity, the electron—these followed one another in bewildering succession; discoveries wholly unexpected and pregnant with uses to mankind. Each in turn was a revelation to the philosopher; it gave a fresh direction to his concepts of Nature, and it enriched him with novel methods of research. Each of these discoveries also offered an untrodden avenue of practical application. Let me for a few minutes speak of what engineers have done to harness the free electron.

About 1895, Sir J. J. Thomson, examining the discharge which proceeds from the cathode or negative pole of a Crookes' vacuum tube, established the fact that it consists of a stream of separate particles—corpuscles he called them—of negative electricity, independent and all absolutely alike. These corpuscles are now called electrons; normally, in the absence of electrical disturbance, they make up, as it were, the crinoline or fender of a material atom; but when streaming from the cathode they have escaped from domestic ties. Each electron is a definite quantity of disembodied electricity—an irreducible unit—delightfully free to respond to any electric force, for its inertia is barely the eighteen-hundredth part of that of the lightest atom of ordinary matter. Free electrons are known to be given out by highly heated substances, such as the glowing filament in the vacuum bulb of an electric lamp.

This fact was turned to account by Fleming in an invention which one may, with no exaggeration, call epoch-making. He was in search of a sensitive detector of wireless signals, a detector more sensitive than the types Marconi originally employed. When a telegraphic signal sent by wireless strikes the receiving aerial it sets up a group of electrical oscillations, where crests and hollows alternate in very rapid succession—many thousands of times per second. To get them to make a signal which will be heard on a telephone or shown by a galvanometer, you must rectify the group, cutting out the hollows, one may say, and leaving only the crests. Fleming, in 1905, had the happy inspiration to employ the electrons which are given off by the hot filament in a vacuum bulb as agents in the work of rectification. For this purpose he fitted the bulb with a second conductor, now called the plate or anode, to which the stream of electrons from the hot filament may pass. He connected the bulb with the receiving aerial in such a manner that oscillations due to the wireless signal endeavoured to bridge the gap between filament and plate. When this is done, the crests—as we may call those parts of the oscillating current which flow *with* the stream of electrons—pass easily; but the hollows, which are the parts that try to flow the opposite way, are stopped. Thus the device acts as a rectifier of the received oscillations, keeping the crests but cutting out the hollows, and for that reason the inventor very appropriately called it a valve—a thing that allows passage only one way.

The Fleming thermionic valve soon came into use as a sensitive detector of wireless signals. Two years or so later its capabilities were much extended by the American electrician Lee de Forest, who introduced a third conductor in the form of a grid through which the stream of electrons passed on their way from the filament to the plate. With this addition, the device, now called a triode valve, could be applied as a powerful relay or amplifier, receiving any electrical oscillations and passing them on, greatly magnified. It is arranged that the incoming oscillations shall cause small variations in the potential of the grid; these produce large and sensibly proportional changes in the electron stream which passes to the plate. The triode valve is the essential instrument of modern wireless; it serves not only to rectify and magnify the received signals, but also, at the sending end, to create the oscillations which are radiated into space. Thus, from the great station at Rugby, a group of mammoth triode valves converts hundreds of horse-power into high-frequency electrical oscillations which carry signals to America.

Even this is not the end of the wonderful story, for the triode valve also acts as what is called a modulator, impressing upon the high-frequency waves which constitute wireless radiation the fluctuations of amplitude which enable them to serve as carriers of speech or of music, so that they may thereby convey the relatively slow vibrations of quite another sort which make up sound. Further, in telephoning over wires, the triode valve forms an admirably effective relay, acting, at a succession of points along the line, to restore the energy of the transmitted sound without injury to its quality. Moreover, by using suitable 'filtered' bands of carrier currents, a number of entirely independent conversations can take place simultaneously over the same wire, while it serves also as channel for a multiple group of telegraphic messages. All these wonders are made possible by the triode valve. Its technical applications appear to have no bounds. It is also an instrument of research; in the hands of physiologists and others it measures the slightest and most fugitive of electrical effects.

I have cited enough examples to illustrate the broad truth of Tredgold's dictum that the scope and utility of civil engineering are increased by every discovery in natural philosophy. But so sweeping a statement can scarcely fail to have some exceptions, and exceptions are in fact suggested by the present curious state of physical science. At the moment the very basis of physics is in a state of flux. Its exponents are struggling to assimilate two momentous new ideas—the principle of relativity and the quantum theory. The relation of these ideas to the accustomed body of older physics is obscure. They present dilemmas which are not yet solved. Their exact form and place in the logical scheme of scientific thought has still to be determined. One may say that, while the superstructure remains intact, the philosophical foundation on which it stands is strangely disturbed. Physicists are, as it were, confronted with a difficult but not impossible task; they have to transfer bodily their elaborate and beautifully coherent building, as a going concern, from one foundation to another, and the new foundation is not quite ready. They are hard at work laying it, laying it indeed so deep that the passer-by cannot see what is going on. When the operation is completed it will be a great achievement. But I do not think it will make much difference to the engineer, for his concern is with the superstructure itself. That will doubtless settle down quite comfortably when the necessary adjustments are made. It will function as well as before, and continue to admit of extensions which the engineers will in due time turn to practical account.

The century we now review is but a petty unit in the multitude of centuries that make up the recorded and unrecorded history of man. By comparison it is a mere fragment of time, yet how big when judged by the changes it has wrought! If we test progress by the conquest of inanimate Nature, then the century now closing finds no parallel in the past. It may be likened to the efflorescence of a plant which for long has been quietly growing to maturity and suddenly bursts into flower. We have witnessed as it were the change from bud to blossom. What is to follow ? What is left for the future engineer to do ? When you celebrate the second centenary of this Institution, of what will your lecturer have to tell ? Can the recent astounding pace of discovery and invention be maintained ? Or does a time approach when engineers will sit down like so many Alexanders to lament a too-completely conquered world of mechanical things, just as a time comes to geographers when there are no more regions to explore ? Transport, especially by air, may be made less perilous and more convenient. Communication may be extended to include vision ; that is half done already, and I confess to no enthusiasm for the other half. Power will certainly be more generally distributed.

Can we expect, however, that the engineers of the coming century will bring about developments in the application of natural resources comparable to those of the past hundred years ? I am, as I said, no prophet, but I doubt it. To me it seems more likely that there will be something of a lull in the revolutionary fervour of the engineer. Social changes—drastic social changes—may be looked for, but not, I think, so directly consequent on his activities as in the century now ending. Mechanical devices will, of course, be increasingly used, but probably they will become standardised and taken for granted, like the watches we carry. We cannot be surprised if we find interest in them slacken. Improvements will be made, but they will attract little notice, for the things they affect will already be commonplaces of life. It may very well happen that the mental energy of mankind, now flowing so strongly in this channel of ours, will seek and find outlets in other directions. While as engineers we may regret such an issue, we cannot but admit that it may prove beneficial to the human race, since beyond question there is grave need for progress of quite a different kind.

For the fact remains that all our efforts to apply the sources of power in Nature to the use and convenience of man, successful as they are in creating for him new capacities, new comforts, new habits, leave him at bottom much what he was before. I used, as a young teacher, to think that the splendid march of discovery and invention, with its penetration of the secrets of Nature, its consciousness of power, its absorbing mental interest, its unlimited possibilities of benefit, was in fact accomplishing some betterment of the character of man. I thought that the assiduous study of engineering could not fail to soften his primitive instincts ; that it must develop a sense of law and order and righteousness. But the War came, and I realised the moral failure of applied mechanics. It was a shock to find that a nation's eminence in this department of intellectual effort did nothing to prevent a reversion to savagery, conscienceless, unbridled, made only the more brutal by its vastly enhanced ability to hurt. I saw that the wealth of products and ideas with which the engineer had enriched mankind might be prostituted to ignoble use. It served to equip the nations with engines of destruction incomparably more potent and ruthless than any known before. We had put into the hand of civilisation a weapon far deadlier than the weapons of barbarism, and there was nothing to stay her hand.

Civilisation, in fact, turned the weapon upon herself. The arts of the engineer had indeed been effectively learnt, but they had not changed man's soul. In our diligent cultivation of these arts we engineers have perhaps forgotten that progress in them has far outstripped the ethical progress of the race. We have given the child a sharp-edged tool before he has the sense to handle it wisely. We have given him the power to do irreparable mischief when he scarcely knows the difference between right and wrong. Does it not follow that the duty of leadership is to educate his judgment and his conscience ? Collective moral sense, collective political responsibility, the divine maxim to do to others as we would that they should do to us—these are lessons in respect of which all the nations, even the most progressive, have still much to learn.

There are people who talk glibly of the next great war. I wonder if they know how near, in the last war, the world came to destruction through misapplying the endowment which it owes to the engineer. Do they realise that with added experience and further malignant ingenuity, the weapons of a future war will be more than ever deadly, more than ever indiscriminate, and the peril to civilisation will be indefinitely increased ?

Surely it is for the engineer as much as any man to pray for a spiritual awakening, to strive after such a growth of sanity as will prevent the gross misuse of his good gifts. For it is the engineer who, in the course of his labours to promote the comfort and convenience of man, has put into man's unchecked and careless hand a monstrous potentiality of ruin.

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hardening brands of cement has been of considerable assistance in this connexion, owing to the reduction in the length of time necessary before a new work can be put into service. The introduction in large numbers of heavy express locomotives has necessitated bringing up the track on fast lines to a very high standard, and much attention is being paid to experiments in the United States on a track consisting of a continuous raft of reinforced concrete on which the rails are directly bedded.

Papers on railway design and maintenance as affected by the application of electricity; on modern road and bridge construction; and on the engineering aspects of the problem of road traffic, focus attention on some of the problems with which recent development in transportation has provided the engineer.

In view of the interest and importance of the various papers, it is unfortunate that the time allowed for discussion was so inadequate.

An interesting series of visits to the National Physical Laboratory, the University of Cambridge, and various engineering works, was arranged as part of the programme, and was attended by a large number of members and delegates.

Obituary.

PROF. C. G. J. PETERSEN.

THE Danes have long been prominent in marine fisheries investigations, and the names of Carl Georg Johan Petersen, Johs. Schmidt, Th. Mortensen, and Commander Drechsel are familiar in this respect. The latter passed away last year, and now the busy life of Dr. C. G. J. Petersen is ended. A native of Denmark, his earlier years of study were at Aarkus, on the east coast of Jutland, and by and by, after graduation, following his natural bent, he entered as a junior helper in the Zoological Museum, Copenhagen, in 1881, acted as assistant curator, 1883–89, meanwhile aiding in the reorganisation of the Danish fisheries investigations. So far back as 1882–83 he had been on board the fishery inspection-vessel *Hauch* with Prof. Japetus Steenstrup and Commander C. F. Drechsel, and afterwards with Prof. Chr. Lütken; his researches, along with those of Cleve, Posselt, Meinert, Levinsen, and Traustedt, being published in 1893 in a 4to vol. with an atlas in Fol. under the title "Det videnskabelige Udbytte af Kanonbaaden Hauch's Togter." In continuation of the work on the fisheries carried on by H. Kroyer, Chr. Lütken, and G. Winther, he was by and by (1888) officially appointed by the Government under the Department of Agriculture. Seeing that his investigations could not be fully carried out on board the inspection-vessel, he, by the aid of Commander Drechsel and Prof. Lütken, got an old transport vessel transformed into a laboratory, which thus had the advantage of easy transference to the scattered fjords and islets of the Danish shores. A small open motor boat and a dinghy were also attached to the station.

Thus settled in a congenial post, Petersen entered into the fisheries work with enthusiasm, producing year by year for nigh forty years a series of important researches on the food-fishes and fisheries of Denmark, occasionally illustrating his memoirs by excellent plates, charts, and tables. The thorough manner in which he dealt with the subject in hand was characteristic. In no memoir was this better shown than in his investigation of the plaice of the Lim Fjord, and his advice for the transplanting of the young to Thisted, Bredning, and Vilsund. Much interest was taken in Great Britain, indeed, at the carrying out of the scheme. The re-stocking of the Lim Fjord fisheries in 1908 had the result of bringing 200,000 Kr. annually in excess of the average figures for the years previous to that date. Of late years two million of young plaice have annually been transplanted to these waters at a cost of 20,000 Kr.

Not only were the food-fishes of Danish waters carefully investigated, but also the distribution of their eggs and young, the nature of the food of both young and adult, and the character of the sea bottom were minutely investigated. Thus a quantitative study of the inhabitants of the sea bottom, with lists and plates showing their distribution, formed one or more of Petersen's various papers, one of his earliest, indeed, dealing with the Mollusca and Echinoderms of the areas frequented by the food-fishes. In his study of the animal communities of the level sea bottom—sand, mud, clay—he distinguished seven as follows: I. the *Macroma baltica* community, including *Mya*, *Cardium*, and *Arenicola*. II. The *Venus* communities, with *Venus*, *Tellina*, *Mactra*, *Abra*, *Psammobia*, *Cyprina*, with *Ethucardium* and *Spatangus purpureus*. III. The *Brissopsis* community, including *Brissopsis*, *Amphiura*, *Calocaris*, *Nucula*, and *Eumenia*. IV. Communities from deeper water than *Brissopsis*, such as *Pecten vitreus* and *Abra longicollis*. V. included *Macoma calcarea* and *Astarte borealis*. VI. The communities of the Lusitanian region, including *Tapes decussatus*. VII. Bottom fauna of the Atlantic. These he illustrated by coloured charts—each community having a special tint. His investigations of the pelagic fauna and flora of the several areas were equally methodical, the oceanic and neritic diatoms and *Peridineæ* receiving careful attention. He held that the organic matter of the sea bottom was due to plant growth and was not derived from the plankton. Both the pelagic and demersal eggs of fishes were studied, and the development of such as the gobies to the adult stage followed—with accompanying figures.

Not only did Petersen work out the life histories of the marine fishes of the Danish waters, the possibility of their increase, the means of protecting them from their enemies, but he also studied the life history of the eel, a fish so important to his countrymen, inspecting the numerous traps which are set singly or in rows, and carrying out experiments with artificial light during its migration. Further, he prepared two reports on the oysters and oyster fisheries of the Lim Fjord, giving a historical summary, an account of the banks, the food, age, spawning, and methods of capture. These oyster fisheries yielded in the decade 1900–1909 an average annual revenue of 70,000 Kr. to the State. Since the introduction of the new rental tariff they have furnished 140,000 Kr. in rental alone, and by the new methods of working this will be still further increased. Amongst other schemes he considered the question of utilising the common starfishes as manure. Nothing, indeed, relating to the Danish fisheries escaped him, and his training and abilities as a practical naturalist enabled him to improve various nets, such as otter-seines, as well as invent an apparatus, 'grab' as it was called, or bottom sampler, to lift samples of the sea bottom with its inhabitants for investigation. In connexion with the organic matter on the sea bottom, he found *Zostera* richer in pentosan compounds than plankton organisms, and that bivalves were capable of digesting it. In 1914 he urged the establishment of a permanent biological station on land on which young men could be trained for the work of the fisheries—with the prospect of regular employment.

Taken all in all, it is seldom that so able and so experienced a naturalist has given his life-long services to his country, or left so noteworthy a record behind him. Petersen often attended the meetings of the British Association, where he was equally welcome as popular. He was no less esteemed abroad than at home, as testified by his honorary degrees of LL.D. from the University of St. Andrews and D.Sc. from the University of Leeds, whilst for seven years he was at the head of the International Council for the Exploration of the Sea. He was inclined to recommend the policy of increasing the size of the fishes—especially flat fishes—rather than increasing their numbers by artificial hatching as in Norway and America.

W. C. M'INTOSH.

PROF. A. H. LEAHY.

ARTHUR HERBERT LEAHY, who died at Littlehampton, Sussex, on May 16, just before he had completed his seventy-first year, will be mourned by many generations of Sheffield students. For thirty years he was one of the best-known members, first of Firth College, then of University College, and finally of the University of Sheffield.

Leahy was born at Corfu in 1857, and was the eldest son of Colonel Arthur Leahy, R.E., of Flesk, Killarney. He was educated at Uppingham School, Trinity College, Dublin, and Pembroke College, Cambridge, and was placed ninth wrangler in 1881. In 1886 he was made a fellow and mathematical lecturer at Pembroke, and in 1892 became professor of mathematics at Firth College, Sheffield.

While at Pembroke, Leahy contributed to the study of spherical and tesseral harmonics and helped to introduce into England some of the continental work in this branch of applied mathematics. At all times he was keenly interested in what may be called the mathematical side of theoretical physics, but his teaching and administrative duties took up his time, and his mathematical interests were satisfied by following developments from afar. An aspect of the breadth of his tastes appears from his work on old Celtic literature and his classical learning. Leahy's interest in astronomy led Pembroke College to give to the University of Sheffield a valuable telescope and transit instrument, housed now in the Observatory in Weston Park adjoining the University. Many were the nights spent there by him, and many the visitors whom he was delighted to welcome there.

Leahy's main achievements were in the building up of what is now the University of Sheffield, in setting the foundations of the Mathematical Department, and in teaching many of those who are now carrying on the torch. The University remembers him with grateful appreciation of his services.

THE issue of the *Physikalische Zeitschrift* for Feb. 15 contains an obituary notice of Prof. Ferdinand Kurlbaum, by Dr. F. Henning, a former colleague at the Reichsanstalt. F. Kurlbaum was born at Burg, near Magdeburg, on Oct. 4, 1857. On the death of his mother, his father, a district judge, placed him in charge of an aunt until he was six, when his father married again.

As he grew up Kurlbaum hated school, and was twenty-three years of age before he passed the university entrance examination and became a student at Heidelberg, and later at Berlin. In 1887 he got his doctor's degree with a research on the wave-lengths of certain lines in the solar spectrum, done under the guidance of Kayser, who was then one of Helmholtz's assistants. On Kayser's promotion to Hanover, Kurlbaum became his assistant and remained with him until 1891, when he was appointed assistant at the Reichsanstalt in Lummer's department. In 1901 he became head of the Electrical Machinery Department, and in 1904 left the Reichsanstalt to become professor at the Charlottenburg Technical School, with Rubens as a colleague. Military occupations had a great attraction for him, and during the War he did a large amount of testing mirrors and guns. He died on July 29, 1927. His work on black body radiation and on the radiation thermometer is well known.

WE regret to announce the following deaths:

Mr. Charles S. Boyer, of Philadelphia, known for his studies of Diatomaceæ, aged seventy-one years.

Dr. John S. Dexter, since 1923 professor of zoology in the University of Porto Rico, on April 19, aged forty-two years.

Prof. Léon Guignard, professor of general botany in the Faculty of Pharmacy of Paris, and president in 1919 of the Paris Academy of Sciences, aged seventy-five years.

Prof. Harris H. Wilder, professor of zoology in Smith College, Northampton, Massachusetts, known for his work on the anatomy of amphibia and also for his anthropological studies, on Feb. 27, aged sixty-three years.

News and Views.

IN this issue we are publishing as a supplement an abridgment of the remarkable James Forrest Lecture on " A Century of Inventions " delivered by Sir Alfred Ewing on Monday, June 4, before the Institution of Civil Engineers. This is the thirty-fourth lecture of the series, and the subject suggested by the council for the lecture was a remark of Tredgold's to the effect that " the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science." This sentence was contained in the same document wherein Tredgold defined civil engineering as the art of directing the great sources of power in Nature for the use and convenience of man. Tredgold himself died a few months after he penned these lines, worn out by incessant study, but his phrases, so often quoted, will remain as long as civil engineering is practised. Sir Alfred Ewing's lecture was listened to with rapt attention by a large gathering of distinguished engineers and men of science, some of whom had themselves witnessed the vast extension of scientific discovery and engineering so eloquently referred to by Sir Alfred. Of absorbing interest throughout, the lecture ended upon a somewhat unusual note and many readers will probably find in its closing paragraphs its most pregnant passages. In proposing a vote of thanks, Sir Richard Glazebrook referred to the work of Sir Alfred Ewing at the Universities of Tokyo, Dundee, and Cambridge, as Director of Naval Education and also as Principal of the University of Edinburgh—and recalled the pioneering work he has carried out in magnetism and other subjects. Sir Alfred, it may be added, was born in Dundee on Mar. 27, 1855, and in the early 'seventies was first a student under Fleeming Jenkin and afterwards a member of his permanent staff, where he obtained experience in cable engineering.

IN connexion with the celebration of the centenary of its incorporation, the Institution of Civil Engineers has issued a brief history of the Institution of some sixty pages. In the course of the short chapters are given some of the most interesting facts regarding the foundation of the Institution, its constitution, its growth in membership, its various homes, its prizes and endowments, and its several activities. Founded in a Fleet Street coffee-house, the Institution had its first permanent home in Buckingham Street, Adelphi; in 1834 a house was taken in Cannon Row, Westminster, from whence the Institution removed four years later to Great George Street, where it has had three homes. The present buildings, completed in 1913, represent a capital investment of more than £350,000. Photographs are reproduced of the fine vestibule, staircase, great hall, theatre, and library. The library contains more than 54,000 volumes, among which are forty editions of Vitruvius in various languages, and 896 volumes of tracts which to some future historian of engineering " may well prove to be a mine of curious information." The *Minutes of Proceedings* published up to the present run to 224 volumes, and on these and the *Abstracts*, etc., more than £400,000 has been expended. A list of presidents and secretaries of the Institution is given, while the interest of the record is increased by a series of marginal illustrations of great engineering works, from the bridges of Rennie and Telford down to the present time.

A BANQUET was given to Mr. A. V. Roe by his aeronautical friends on June 8 to commemorate the twentieth anniversary of his entry into aeronautics. Mr. Roe was a trained engineer and tried athlete, and in this way was specially equipped for the building and testing of his early experimental triplane. His admirers need not bother about the current controversy over his 'hops' in 1908, entirely credible in themselves, but scarcely ranking with flights officially controlled by competent observers. Roe's reputation is independent of such accidents of fortune, and is firmly based on the manner in which he evolved, from his early triplane, a series of designs culminating in the standard biplane, well known as peculiarly free from 'vices.' Looking through the old records, one is struck by the way in which the first freakish-looking triplane is transformed into an entirely modern design. It was a step-by-step process, but now appears almost an organic growth, save for the sudden change from triplane to biplane, since approved by the progress of aerodynamical science.

IT is almost impossible now to project one's mind back into these early days of aeronautics, when a fog of ignorance concealed the most fundamental facts and requirements. The physical principles of flight had then been revealed only to Lanchester's prophetic eye. The circulation theory of lift was scoffed at in the highest places, for one could see that no air 'circulated' round t e wing, and the trailing vortices were invisible to the eye of the pitot-tube. The principles of stability were still wrapped up in Bryan's mathematical statement. Structural stresses were based on the roughest information as to pressure distribution. But one can follow from page to page the steady evolution from a thing of stick and string and cloth, nto an engineering design. It is Mr. Roe's distinction that he was one of the earliest British starters, and that he stayed through the race in which so many fell by the way. If an established position as a successful designer and constructor is not a relevant reward, he may add the esteem of his contemporaries in the old flying days of unforgettable memories.

CAPT. G. H. WILKINS and Lieut. C. B. Eielson, who recently flew across the Arctic Ocean from Alaska to Spitsbergen, arrived in London last week and were entertained at luncheon by the British Government on June 7. Capt. Wilkins gave some indication of his plans for Antarctic explorations. His aim is not to reach the South Pole, but to explore the unknown region lying south of the Pacific between the Ross Sea and Graham Land. This flight will be about 3000 miles over entirely unknown parts of the ice-sheet of Antarctica. One object which Capt. Wilkins has in mind is the selection of sites for meteorological observatories, but there is little likelihood that any descents will be possible in the course of the flight. He proposes to leave the Ross Sea in January, taking off from a whaling ship on the open water which is often found off the Ross Barrier at that season. He hopes to be brought home by a whaler from the Graham Land area. The machine will be a Lockheed Vega seaplane. The *Times*, which gives an outline of Capt. Wilkins' plans, also announces that Commander R. E. Byrd will make his base on the Ross Barrier next southern summer, and explore by aeroplane to the south and east, hoping to reveal the course of the great mountain ranges which are known to border the Ross Sea.

IN addition to the expeditions of Capt. G. H. Wilkins and Com. R. E. Byrd, a third expedition to the Antarctic is announced for next season. According to the *Times*, Com. D. G. Jeffrey, R.N. (retired), will lead an American-financed expedition in September to Graham Land, where a base will be established on the west coast, in the area explored by Dr. J. Charcot. From there it is proposed to explore eastward to Coats Land with the view of filling in the missing western coast-line of the Weddell Sea and determining the course of the Antarctic Andes of Graham Land. A vessel of the deep-sea minesweeper type will be used, and two aeroplanes will be taken, the larger with a cruising radius of 6000 miles. The South Pole is not the objective of the expedition, but there may be a flight in that direction. Com. Jeffrey hopes to include among his staff certain men who served with him on Sir E. H. Shackleton's expedition in the *Endurance* in 1914–17. Only six months' stay in the Antarctic is anticipated, which is rather a short time for the completion of the programme.

ON May 31, the aeroplane *Southern Cross* started from Oakland, California, to cross the Pacific Ocean in three laps, ending in Australia. On June 9 the aeroplane landed at Brisbane, having accomplished safely a journey of 7340 miles. The *Southern Cross* carried a crew of four: Capt. Charles Kingsford-Smith and Mr. Charles Ulm, pilots, both of whom are Australians, and Lieut. Harry W. Lyon, navigator, and Mr. James Warner, wireless operator, both of whom are Americans. The first lap of the journey, California to Hawaii, a distance of 2400 miles, was covered in a little more than twenty-four hours. The second lap, Hawaii to Suva, Fiji, nearly 3200 miles, took about thirty-four hours; this flight is the longest over water that has yet been made. The last stage of the journey, Suva to Brisbane, was about 1500 miles, and took about twenty hours; during this time the weather was often unfavourable. It is a great achievement to have flown and navigated an aeroplane over the Pacific Ocean for the first time, and all the members of the crew are to be congratulated on the successful conclusion to their months of careful preparation.

WIRELESS messages from the airship *Italia* were received by the base-ship, *Città di Milano*, at King's Bay, Spitsbergen, on June 9, after two weeks' silence. The crew of eighteen were all safe on the ice in approximately lat. 80° 30′ N., long. 28° E., a position about fifteen miles from the nearest land in the island of North-East Land of the Spitsbergen group. The airship is reported to have been completely wrecked. Three men were sledging westward to find help, and the others were drifting with the ice. The drift will carry the Italians to North-East Land, but may take them to the inhospitable east coast which is faced with an ice-cliff. They have provisions for a month, and should be able to shoot some seals. The steamer *Braganza*, in trying to reach the shipwrecked men, was stopped by heavy ice near Cape North, about a hundred miles to the west. The difficulty of navigating along the north coast of Spitsbergen this month may delay rescue, but Norwegian airmen will no doubt locate the wreck and bring food to the men, even if they cannot carry them to safety. There are several good dog teams in Spitsbergen, and these are being used to take help. They should succeed, unless the drifting ice in Hinlohen Strait proves impassable. A Russian ice-breaker, which has been asked for by the Norwegian government, could probably get through the ice to North-East Land in four or five days.

WE understand that it has now been intimated that Great Britain will not be represented officially at the International Congress of Americanists which is to be held at New York in September next. As these matters are conducted on behalf of His Majesty's Government through the Foreign Office, it is to be presumed that that Department has now decided that the Congress is not of sufficient importance to warrant the attendance of an official representative. If this should be correct, it is, to say the least, unfortunate. At the last congress in Sweden, when Great Britain was officially present in the special circumstances of a member of the British Royal House being Royal Consort, all the principal governments in the world, including even China, were officially represented. Americanist studies, it is true, are not numerously represented in Great Britain, but British students of American archæology, few as they are, are universally recognised as being in the first rank. It would be interesting to know if the action of the Foreign Office in refusing an invitation to the only congress devoted to Americanist studies, and otherwise recognised by the whole world as of first-rate importance, was taken under advice, and, if so, what body was consulted.

AT the close of the International Congress of Geography at Cambridge, the delegates and others will pay a visit to the Borough of Newbury Museum on July 27. Members will stay in the town overnight and will be received at the Museum on the following morning. The visit takes place at a moment of importance in the history of the Museum. It has been decided to enlarge the premises as a memorial to the late Mr. Walter Money, the historian of Newbury, whose death at the age of ninety years took place last year. The Museum, in addition to the preservation of objects of local interest, aims at being educational on broad lines, and much use has been made by students of the archæological collections which, under the curatorship of Mr. H. J. E. Peake, have been arranged on the 'space for time' method. With the enlargement of the Museum, these collections will be extended to 3000 B.C. instead of 2400 B.C. as at present, with a prelude dealing with the Palæolithic age. For the enlargement a sum of £1200 is required immediately, for which an appeal has been made by the Mayor and Museums Committee. Subscriptions may be sent to the Mayor, Municipal Buildings, Newbury.

In his Friday evening discourse, delivered on June 8 at the Royal Institution, on "The Waves of an Electron," Prof. G. P. Thomson stated that it now seems that the original view of the primitive elements of electricity and matter called electrons, which regarded them as small spheres, is inadequate to explain all the facts, and that an electron has associated with it a group of waves. This idea, originally due to L. de Broglie, has been tested experimentally by Davisson and Germer in the United States, and by Reid and Prof. G. P. Thomson himself in Great Britain. When electrons are scattered by atoms, it is found that if the atoms have a regular arrangement, as in a crystal, the scattered electrons are concentrated in definite directions and form a pattern, sometimes of considerable complexity. This is what would be expected if the electrons are guided and controlled by waves. In the case o iscattering in metals the crystal structure of which is known, the pattern to be expected can be calculated and compared with the experiments. Prof. Thomson showed that there is complete agreement for all the metals which he has tested. In order to allow the electrons to get through the metals, very thin films of the latter are necessary, those used being less than a millionth of an inch thick. At this thickness metals are quite transparent to ordinary light. While the experiments prove the existence of the waves, their exact relation to the mass and electric charge of the electron remains mysterious.

The Slaughter o Animals (Scotland) Bill, which is to be read in the House of Commons for the third time on June 22, provides for the training and licensing of slaughtermen in Scotland and for the use of humane-killers in that country on all animals except pigs, and those killed by the Jewish method or on farms. It is expected that the Meat Traders' Federation, which is opposed to any change in the existing methods of slaughtering, will seek to obtain the exclusion of sheep from the operation of the bill, on the plea that loss of time would be occasioned by the use of the instrument when these animals are being slaughtered at high speed. It has been calculated that time is worth about three-farthings per man per minute under the normal conditions of working in Edinburgh. The humane-killer is simpler to handle than, for example, a Lewis gun, which can be positioned, mounted, and loaded by recruits in 9 seconds, so the time lost per sheep should be considerably less than a minute of one man's time. An average dressed carcase of mutton weighs about 60 lb., and about 18 lb. of home-killed mutton was consumed per head of the population in 1922, so that the loss of time due to humane killing would be worth about a farthing per annum per head of the population.

In 1926 the Ministry of Agriculture issued an Order prohibiting the use in Great Britain of arsenical dips for the second of the two statutory 'dippings' for sheep scab where a dip of that character had been used for the first dipping. This Order was made because of complaints that serious losses had been sustained by farmers where, as is essential for sheep scab, the second dipping had been carried out within 14 days of the first dipping. Since that Order was made the Ministry has received representations from farmers in Wales and other parts of Great Britain urging that they should be allowed their former discretion in the choice of an approved dip, so that they might use an arsenical dip for both dippings where desired, and the National Farmers' Union of England and Wales, in support of these representations, has informed the Ministry that a guarantee against loss has been obtained from the manufacturers of the bulk of the arsenical dip used in Great Britain. The Ministry is therefore satisfied that it can now properly remove its prohibition on the use of an arsenical dip for both dippings. There are some 306 approved sheep dips, of which 222 are non-arsenical; an owner has therefore a wide range of choice, and there is no compulsion upon him to use an arsenical dip if he does not wish to do so.

Felsted School is to be congratulated on the success and enthusiasm of its scientific society. Surely few such societies can boast a half-century of useful work, for in 1877, when the Felsted School Scientific Society was founded, nature study and science courses were still in embryo, and of England's present total of 428 museums only 84 were in existence. The thirtieth *Report* of the Society indicates continued liveliness. A generous donor has presented an observatory, a 4½-inch equatorial telescope, a 3½-inch transit instrument, and an altazimuth, and an astronomical section has been created. Two new dark rooms for photography have been formed, and that good work is being done is shown by the excellent natural history pictures which illustrate the report, and by the descriptions of the use of bird-watching 'hides.' The majority of the papers read before the sections were by the boys themselves, and that is as it should be.

The Zoological Society of Scotland had the misfortune to open its zoological park in Edinburgh just before the War, and as a consequence its survival value was put to a severe test. The *Annual Report* for the year ending March 31, 1928, shows that the test has been safely passed and that the Society is now assured of complete success. The surplus of revenue over expenditure for the year was £3445, as against £735 last year, and this sum has been used in paying off the debt upon a Reptile House and Tropical Bird House, while a sum of more than £10,000 has been raised for the development of the Park and the bringing in of the new ground to the crest of Corstorphine Hill. The Scottish Zoological Park is outstanding on account of the natural beauty of its site, and the extensions foreshadowed in the report promise to add greatly to its amenity, since a track for a service of small motor conveyances is being laid to the top of the hill, which overlooks the Firth of Forth, and fine masses and ledges of weathered rock afford ideal places for the construction of natural enclosures. The Carnegie Aquarium, erected at a cost of more than £20,000, and designed on the most modern lines, was opened in July, and has proved to be a great attraction. Amongst the most interesting of the births in the Park was a Californian sea-lion and a king penguin, the fourth of its kind to have been successfully reared. During the year 346,452 individuals visited the Park. The report contains a number of photographs, which show the attractiveness of the enclosures and their inmates.

President Thomas S. Baker, of the Carnegie Institute of Technology, who recently visited Europe in connexion with the forthcoming second International Conference on Bituminous Coal to be held at Pittsburgh on Nov. 19–24 (concerning which a preliminary announcement appeared in Nature on Mar. 3), has already received tentative acceptances from some seventy engineers and other prominent scientific men from twelve countries, to attend or present papers to the conference. The list contains such well-known names as Dr. F. Bergius, Prof. W. A. Bone, Dr. G. Egloff, Prof. F. Hofmann, Dr. A. D. Little, Prof. A. Mailhe, Sir Alfred Mond, Prof. S. W. Parr, and Prof. H. S. Taylor. Scientific workers of all countries who may wish to take part in the congress are requested to notify the secretary, Prof. S. B. Ely, Carnegie Institute of Technology, Schenley Park, Pittsburgh, U.S.A., as soon as possible, and foreign delegates desiring to avail themselves of the opportunity to visit industrial plants in the United States of America are invited to make known their wishes. As has already been announced, the programme will include the discussion of low temperature distillation, high temperature distillation, coal tar products, power, smokeless fuel, complete gasification of coal, hydrogenation, pulverised fuel and its new applications, fixation of nitrogen, coal beneficiation, and cognate matters. The purpose of the congress is similar to that of the first congress held in 1926, namely, to present the results of recent studies of coal that have to do with improved methods of utilisation and combustion.

The *Annual Report and Proceedings of the South-Western Naturalists' Union*—a record up to Dec. 31 last—shows a membership of 70 members, 16 societies, and one institution. Considering the large area covered, this seems small, as very good work has already been done by individual members of the Union since its foundation on Nov. 25, 1922, and the annual conferences offer exceptional opportunities for the meeting together of all concerned. The president for both 1927 and 1928 is Dr. G. P. Bidder; the vice-presidents for 1928 are Prof. C. Lloyd Morgan and Dr. E. J. Allen. Dr. Bidder's presidential address at the fifth annual conference held at Exeter last year on "Some Sponges of the South-West Coast" is contained in the present report. In this interesting survey he describes the common sponges of Britain and suggests a classification based on that given at the Leeds meeting last year of the British Association. His presidential address for this year, delivered at the sixth annual conference, held at Bristol on May 25–28, dealt with "The Relationship to each other of the Various Groups of Animals." The *Proceedings* also contain short sectional reports, a lecture by Mr. C. W. Bracken on "Insect Casuals and Migrants," and concludes with three short papers on Lundy Island. This Union is as yet in its infancy. It was founded in order to bring local naturalists together, that real team work might be done in all branches. A scheme for organising the work was planned, and sections established with recorders and referees chosen from the leading authorities on the various subjects. There is an annual conference, lectures are given and excursions arranged. A glance at the names of the officers for both past and present years, and also of the lecturers, should be a guarantee of efficiency, and it is to be hoped that the Union will enlarge its membership and produce still more good work in the future.

The second conversazione this year of the Royal Society will be held in the rooms of the Society on Wednesday, June 20, at 8.30 p.m.

The following have been nominated by the Council of the Institution of Electrical Engineers for the vacancies which will occur in various offices on Sept. 30 next: *President*, Lieut.-Col. K. Edgcumbe; *Vice-Presidents*, Mr. P. V. Hunter and Dr. A. H. Railing; *Honorary Treasurer*, Lieut.-Col. F. A. Cortez Leigh.

The Right Hon. Sir Alfred Mond, president of the British Science Guild, will take the chair at the annual general meeting of the Guild, to be held in the hall of the Royal Society of Arts, John Street, Adelphi, W.C.2, on Thursday, June 21, at 5 p.m. The annual report of the Guild for the year 1927–28 will be presented at this meeting, which will be open to the public.

Prof. A. W. Porter, who has been associated with the Physics Department at University College, London, since 1892, is retiring from the chair of physics at the end of this term. Prof. Porter is one of the founder members of University College Mathematical and Physical Society, of which he has several times been president, and the past and present members of the Society are entertaining him at dinner in the College on Monday, June 25, at 7.30 p.m.

Many readers of Nature are familiar with the pioneer work carried out by the late Mr. W. H. Dines in investigations of the upper air and other aspects of meteorological science. As a memorial to Mr. Dines, the Royal Meteorological Society has taken steps to establish a fund to be employed to assist and encourage the advancement of meteorological knowledge, especially along the lines which he did so much to create and foster. Contributions to this Dines Memorial Fund are invited by the Society and should be sent to the assistant secretary, 49 Cromwell Road, South Kensington, S.W.7. We hope that the appeal will meet with a generous response, so that the fund raised may provide a worthy memorial of a great meteorologist.

At the annual meeting of the British Association to be held in Glasgow on Sept. 5-12, Sir William Bragg, who succeeds Sir Arthur Keith as president, will deliver an address on the subject of "Craftsmanship and Science" at the inaugural general meeting in St. Andrew's Hall. Dame Helen Gwynne-Vaughan, professor of botany at Birkbeck College, London, has accepted the office of president of Section K (Botany) of the Association, and will address the section on the subject of "Sex and Nutrition in the Fungi." Prof. R. H. Yapp was originally elected president of the section, but resigned when he found he was unable to attend the meeting.

The spring issue of *The Fight against Disease*, the quarterly journal of the Research Defence Society, contains a portrait of its late treasurer, Sir David Ferrier, and an address delivered by Lady Briscoe on "Animal Experimentation and Knowledge," which gives a useful summary of the value of experiments upon animals in advancing our knowledge, prevention, and cure of disease. The annual general meeting of the Society will be held at 11 Chandos Street, W.1, on June 19, at 3 p.m., when Sir Bernard Spilsbury will deliver the Stephen Paget memorial lecture.

The annual summer meeting of the London Students' Section of the Institution of Electrical Engineers will be held in Holland and western Germany. The party will leave London on Saturday evening, July 28, for Rotterdam, where two days will be spent. Visits have been arranged to works at Rotterdam, Eindhoven, and Utrecht, and a pleasure trip to The Hague. In Germany visits have been arranged to works of engineering interest at Essen, Dusseldorf, and Cologne. The party will return from Cologne on the evening of Aug. 6.

The council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1925–27 to be divided equally between Prof. T. J. Jehu and Mr. R. M. Craig for the joint series of papers which have recently appeared in the publications of the Society on the geology of the Outer Hebrides, and the Neill Prize (1925–27) to Prof. Arthur Robinson, professor of anatomy in the University of Edinburgh, for his contributions to comparative anatomy and embryology. The Bruce Prize for the period 1926–28 has been awarded by the joint committee consisting of representatives from the Royal Physical Society, the Royal Scottish Geographical Society, and the Royal Society of Edinburgh, to Prof. Dr. H. U. Sverdrup, of the Geophysical Institute, Bergen, for his contributions to the knowledge of the meteorology, magnetism, and tides of the Arctic, as an outcome of his travels with the Norwegian Expedition in the *Maud* from 1918 to 1925.

The Council of the Royal Statistical Society is this year again awarding the Frances Wood Memorial Prize, value £30, for the best investigation, on statistical lines, of any problem affecting the economic or social conditions of the wage-earning classes. Competitors must generally be undergraduates, or graduates of not more than three years' standing, of a university of Great Britain or Ireland, and less than thirty years of age on Oct. 31 next. Theses submitted or intended to be submitted as university exercises, and also published papers, are admissible. Essays must be sent to the honorary secretaries of the Royal Statistical Society, 9 Adelphi Terrace, W.C.2, not later than Oct. 31 next.

The Booth Steamship Co., Ltd., has arranged a summer cruise to the South American continent of unusual interest. The Booth liner *Hildebrand*, starting from Liverpool, touches the Portuguese Riviera and Madeira, and then crosses the Atlantic to the mouth of the Amazon, up which the liner goes about 1000 miles. The cruise lasts six weeks, during which 11,800 miles are covered. It is stated that the trip costs little more than an equal period of time in a good European hotel.

A general discussion on "Homogeneous Catalysis" will be held by the Faraday Society in the physical chemistry laboratory of the University of Cambridge, on Friday and Saturday, Sept. 28 and 29, under the chairmanship of Prof. C. H. Desch. The subject will be discussed under the following principal headings: (1) Uncatalysed homogeneous reactions and negative catalysis; (2) intermediate addition-compounds in homogeneous catalysis; (3) neutral salt and activity effects in homogeneous catalysis; (4) ionisation as a factor in homogeneous catalysis. A number of foreign guests have been invited by the Society to take part in this discussion. Members and visitors will be accommodated at Pembroke College during the period of the visit. Particulars can be obtained from the secretary of the Faraday Society, 13 South Square, Gray's Inn, W.C.2.

The Report of the Bristol Museum and Art Gallery Committee for 1926–27 mentions that about 800 examples of living wild plants were exhibited during the year, and continues: "It is a matter for regret that so greatly has wild plant life been destroyed by building and other agencies in the neighbourhood of the City in the post-War years, that the area of collecting has had to be increased over a wider two-mile belt around the City." The report bears witness to much good work in all branches of museum activity except perhaps research; this may be because the labours of the staff are bent towards preparing for a move into the extension now being built.

A new part (No. 811) of "Sotheran's Price Current of Literature" has just been issued, and is as interesting and valuable as previous issues. The catalogue is always a mine of bibliographic wealth and should be of great help to collectors of rare editions and to librarians. The present part contains particulars of upwards of 3000 works of science classified under the headings of general and collected works, mathematics, astronomy, physics, meteorology and physical geography, geology, mineralogy and crystallography, chemistry, and rare and valuable books. Copies can be obtained from H. Sotheran and Co., 140 Strand, W.C.2.

Applications are invited for the following appointments, on or before the dates mentioned :—A demonstrator of chemistry at St. Bartholomew's Medical College—The Dean, St. Bartholomew's Hospital Medical College, E.C.1 (June 19). An assistant in the Intelligence Section of the Mineral Resources Department of the Imperial Institute—The Secretary, Imperial Institute, South Kensington, S.W.7 (June 20). An assistant lecturer in mathematics at King's College, London—The Secretary, King's College, Strand, W.C.2 (June 22). An assistant pathological chemist at St. Mary's Hospital, Paddington—The Secretary, St. Mary's Hospital, Paddington, W.2 (June 25). An agricultural economist and a lecturer in agricultural engineering at the Edinburgh and East of Scotland College of Agriculture—Mr. Thomas Blackburn, 13 George Square, Edinburgh (June 25). A woman assistant lecturer in botany in the Department of Education of the University of Birmingham—The Secretary, The University, Birmingham (June 26). A lecturer in electrical and mechanical engineering at the Forest of Dean Mining School, Cinderford—The Secretary, County Education Office, Shire Hall, Gloucester (June 27). A lecturer and demonstrator in the pharmacy department of the Birmingham Central Technical College—The Principal, Central Technical College, Suffolk Street, Birmingham (June 30). An assistant lecturer in the Mathematics Department of the Belfast Municipal College of Technology—The Principal, Municipal College of Technology, Belfast (June 30). A demonstrator of biology at Guy's Hospital Medical School—The Dean, Guy's Hospital Medical School, London Bridge, S.E.1 (July 3.) An assistant lecturer in agricultural chemistry at the University of Leeds—The Registrar, The University, Leeds (July 7). A psychiatrist and medical director, a psychologist and an assistant psychologist under The Child Guidance Council—The Secretary, Child Guidance Council, 24 Buckingham Palace Road, S.W.1. An advisory bacteriologist at the Midland Agricultural and Dairy College—T. Milburn, Sutton Bonington, Loughborough. An assistant mistress at the County School for Girls, Beckenham, with qualifications in either botany or chemistry—The Head Mistress, County School for Girls, Beckenham. A science teacher at the Technical School, Lurgan—The Principal, Technical School, Lurgan, Co. Armagh.

Our Astronomical Column.

Nova Pictoris.—Dr. H. Spencer Jones, H.M. Astronomer at the Cape, gave some interesting information about this object at the meeting of the Royal Astronomical Society on June 8. It appears as an oval nebulosity the major axis of which, lying approximately east and west, is about $1\frac{1}{2}''$ in length; within this there are four nuclei. The relative positions of the nuclei may be indicated by drawing an equilateral triangle with its base upwards; the nuclei are, (1) at the centre of gravity (this is the brightest), (2) at the lower angular point (this is the faintest), and (3) and (4) slightly below the two upper angular points. The three brighter ones could generally be seen, the faintest one only when definition was very good. The sketch that was shown indicated that these nuclei appeared somewhat nebulous.

Dr. Spencer Jones agrees with the Greenwich astronomers in thinking that the large nebulous rings (some 3′ in diameter) surrounding the star are not objective, but are optical phenomena due to the star's light having a different mean wave-length from the average star. Hence no weight can be given to values of the star's parallax deduced from them.

It is fortunate that owing to its position near the pole of the ecliptic, it is possible to observe the star at some time of the night throughout the year. Its behaviour has been in many respects unique among the novæ, and its further development is likely to give valuable information.

Planetary Photography.—Prof. W. H. Wright chose this as his subject for the George Darwin lecture which he delivered at the meeting of the Royal Astronomical Society on June 8. Numerous photographs were shown of Venus, Mars, Jupiter, and Saturn in light of various wave-lengths from infra-red to ultra-violet. The photographs of Mars were the only ones that showed far more surface detail in the long than in the short wave-lengths. The well-known outlines of the so-called seas appeared with very strong contrast in the infra-red photographs, but were practically invisible in the ultra-violet ones, showing that the Martian atmosphere, like our own, exerts considerable absorptive action on the shorter waves, so that the photographs in these show atmospheric detail, but nothing on the surface. On the other hand, the photographs of Venus in short wave-lengths show fairly distinct markings, which were found to vary from day to day, thus giving hope that they may teach something about the planet's rotation; while the infra-red photographs were completely featureless. It may be that these do not penetrate to the actual surface, but only reach a lower cloud layer.

The Jupiter photographs, while not identical in the different colours, do not differ so widely as those of Mars. Very great interest was excited by some remarkable cinematograph films of Jupiter. These were exposed at intervals of minutes, but run through the lantern so quickly that the planet was seen in rapid rotation, its entire surface being rendered visible. The films included the transit of a satellite and its shadow across the disc. The satellite could be traced for part of its course and then became invisible. The film, like those taken during the eclipse of last June, shows the possibility of astronomical applications of the cinema, not merely for popular exhibitions, but for serious scientific work.

Discovery of Minor Planets.—*Astr. Nach.*, No. 5559, contains the annual article from the Berlin Rechen Institut on the discovery of minor planets during the year. There were 112 planets found in the twelve months ended June 30, 1927; only 103 were really new, the others being identified with planets that had been missing for some years. Unfortunately 58 of the new planets were only observed once; thus nothing could be deduced about their orbits. Sixteen planets were observed sufficiently to deduce trustworthy orbits; to these were assigned the numbers 1058 to 1072, also the number 933; it was found that the planet previously numbered 933 was really 715, Transvaalia. The highest inclination of the new planets is 17° (planet 1070), the highest angle of eccentricity is also 17° (planet 1065). Five planets lately discovered have been named Bodea, Zachia, Piazzia, Gaussia, Olbersia, commemorating the names of astronomers concerned in the search for the first minor planets.

Research Items.

GYPSY MARRIAGE.—Mr. T. W. Thompson, in a continuation of his study of gypsy marriage in England, in pt. 4 of vol. 6, Ser. 3, of the *Journal of the Gypsy Lore Society*, deals principally with the question of permanence and divorce. A number of temporary unions are recorded. These lasted for varying periods from a few days or weeks to six months, a year, or even two years. In effect, these seem to have been trial marriages; though the Heron family seems to have been peculiar in this respect and deliberately to have taken their wives on trial, which as a premeditated act can be paralleled in a few cases only in other families. It is suggested, however, that this postponement of the marriage rite may have been a survival of the practice among German gypsies whereby marriages were not ratified by the Hauptmann until they had been in force for two years, during which period the bridegroom had to serve his father-in-law. There is no evidence that service in return for a bride ever existed in England. Marital fidelity after a settled marriage seems to have been more or less the rule, at any rate among the women. Some, however, had a regular succession of lovers or husbands. Among the men the patrilineal Herons claimed to have the right to occasional intimacy with gypsy women, though allowing their wives no liberties. Unfaithful wives were punished by stripping naked, when they were sometimes tied up and whipped or chased round a field; mutilation, such as nose slitting or cutting off an ear, was sometimes practised. Among English gypsies divorce was purely informal; but the Scottish gypsies parted with a good deal of ceremony. A century ago the woman received a token made of cast iron with a mark on it resembling the character T, and she was never permitted to marry again. If she did she was liable to the extreme penalty; she was tied to a stake with an iron chain and beaten to death.

QUATERNARY HUMAN SKELETONS FROM THE VALLÉE DU ROC, CHARENTE.—In the *Bull. et Mém. de la Soc. d'Anthropologie de Paris*, T. 8, Sér. 7, fasc. 1-3, Dr. Henri Martin describes three skeletons from a rock shelter in the Vallée du Roc. The remains were found buried under blocks of fallen stone, by the weight of which they had been much damaged. They belonged to three individuals, possibly the members of one family, a man of about fifty years of age, a woman of about forty, and a boy, probably of about eighteen, in view of the fact that the first wisdom tooth had not yet fully erupted. The remains had evidently been buried and the fall of rock was posthumous. The point of greatest interest in the skeletal remains lay in certain resemblances to Chancelade man as described by Testut. This was manifested in the cephalic index of the man, 72·8, as compared with Chancelade, 72·02, as well as in the scaphocephalic character of the skull of both male and female. Yet notwithstanding the keel-like ridge, both skulls were comparatively low. The supraciliary ridges were well marked. The cephalic index of the woman was 76. The skulls bear no resemblance to neolithic skulls, but are comparable rather with those of Brunn, Cro-magnon (female), and Laugerie Basse, but, as stated, particularly of Chancelade. The cranial capacity is approximately 1350 cm. (female) and 1525 cm. (male). The teeth are large and well formed, the third molar being smaller than the second, which is contrary to the state found in Neanderthal man. The wearing of the teeth shows a lateral bite. There are signs of caries in the man. The remains were found immediately above a Solutrean layer among signs of numerous hearths, and it is suggested that they belong to late Solutrean or the beginning of the Magdalenian period.

CAPROKOL.—We have received from the British Drug Houses, Ltd., London, N.1, a small booklet on Caprokol therapy. Caprokol (or hexyl resorcinol) is used both as a urinary antiseptic by internal administration and also as a general antiseptic by external application, including the cleaning of mucous surfaces. Its use as a general antiseptic has recently been referred to in our columns. Caprokol was introduced as a urinary antiseptic about three years ago, and considerable clinical evidence has now accumulated as to its value in various infections of the urinary tract. In doses of 1-2 gm. daily it clears up cystitis, pyelitis, or urethritis caused by staphylococci, streptococci, gonococci, or *B. coli*. In cases of infection with the latter organism it is advisable to give local treatment also in the early stages. To ensure complete and permanent sterility of the urine, prolonged treatment is sometimes necessary: an immediate effect, however, of the administration of the drug is the cessation of pain and relief from the frequency of micturition which so often accompanies urinary tract infections. The drug's antiseptic action is enhanced by its power of lowering the surface tension of the urine: fluids or alkalis which raise the surface tension should not be given at the same time as Caprokol. The evidence suggests that this compound has a definite use in practical therapeutics.

ATTITUDE OF EMPLOYEES TO INDUSTRIAL PSYCHOLOGY.—In the *Journal of the National Institute of Industrial Psychology* (vol. 4, No. 2) there is an interesting discussion on the attitude of employees to investigations of a psychological nature. It is obvious that no investigation can succeed without the co-operation and goodwill of the workers concerned, and it is equally obvious that workers are quite likely to view with suspicion strangers who come and observe them at work, who suggest alterations in long-established habits, and seem to take up a new attitude to problems. Mr. A. Stephenson points out that the present attitude of the workers towards investigations depends very largely on their attitude to the investigator and on local traditions and temperament, unless political convictions are so strong as to exclude all other considerations. In some industries where there is fear of dismissal it is sometimes very difficult to get rid of the impression that any worker who is being observed must necessarily be inefficient. Older workers are sometimes intolerant of innovations, and tend to consider that twenty years' experience must be worth more than any instruction. Where changes in the firm's policy are imminent and of a kind distrusted by the worker, then an investigator may be regarded as a spy: Mr. Stephenson said that such difficulties can usually be resolved by holding a conference and explaining clearly the objects of industrial psychology. On the whole though, workers prove to be interested in, or at least tolerant of, such investigations, and when one considers their novelty one is surprised at the willing help afforded in so many cases.

MARMOT PLAGUE IN UNITED STATES.—There has been a remarkable increase in recent years in the numbers and extent of the range of the eastern woodchuck (*Marmota monax*), a native of the States east of the Great Plains and north of northern Arkansas, Alabama, and North Carolina. Where these rodents confine their activities to their accustomed haunts on rocky hillsides, thickets, or forest land, no harm results, but their extension of range has led them to transgress on cultivated land, and corn and forage crops, young fruit trees, and poultry have suffered. It is even recorded that disastrous flooding of crops and erosion of soil has followed upon their burrowing in levee and ditch banks. The U.S. Department of Agriculture (*Leaflet 21*) states that the surest practicable method of controlling the pest is gassing the woodchucks in their burrows, and recommends the use of carbon disulphide, calcium cyanide, or exhaust gases from a motor car. No individual effort, however, can afford any but a temporary success, and co-operation over a large area is essential for effective control. The leaflet states that the factors contributing to this recent general increase are not fully known, but curiously enough it says nothing about protecting and encouraging the wild creatures, birds and beasts, which are the natural controllers of such ground rodents.

THE INSECTS OF SAMOA.—Two further fascicles of "Insects of Samoa," a work in course of publication by the British Museum (Natural History), have recently come to hand. Part 4, Fasc. 2, deals with a number of families of Coleoptera, and Part 5, Fasc. 1, with aculeate Hymenoptera. The several accounts are written by specialists well known as authorities in the groups concerned, and should prove specially valuable in connexion with distribution, modification due to isolation and other problems of island life. Certain of the species described or listed are peculiar to the Samoan group: others, such as the beetles *Gnathocerus* and *Tribolium*, are cosmopolitan, while some other insects appear to be limited to certain of the Pacific Islands or extend into the continental tropics. The longicorn beetles are of exceptional interest, since each of the Samoan islands seems to possess endemic species, and four genera are unknown outside the archipelago.

SPERMATOGENESIS IN SPIDERS.—Dr. E. Warren contributes to the *Annals of the Natal Museum* (vol. 6, Part 1, March 1928) an important paper on the comparative histology of the testis of South African spiders, in which special attention has been directed to the nuclear divisions. The nuclei of the young genital cords of the embryo are capable of dividing by amitosis, and in the testis the germinal nuclei at the margin can divide without mitosis, and the spermatogonia can also divide amitotically to form primary spermatocytes, though in some spiders occasional mitoses were present. In some spiders the primary spermatocytes divide without mitosis to form secondary spermatocytes and spermatids, and chromatin structures indistinguishable from spermatozoa are formed in cells which have originated either without mitosis at all or without the full complement of mitotic divisions characteristic of typical spermatogenesis. In many species there are two kinds of sperms originating in different lobules of the testis. The presence of typical spermatogenesis in many spiders indicates that the various atypical methods which have been observed are to be regarded as simplifications of the typical process rather than as something fundamentally new or as a survival of primitive methods. The occurrence of amitosis is too general to be explained as an abnormality resulting from the temporary absence of the correct stimulus for the normal development of the spermatozoa. "The truly remarkable diversity which is seen in the chromatin behaviour of the genital cells of allied spiders is not in accord with the view that heredity depends on a system of material genes lodged in specific chromosomes and bodily passed on as a complete system from one generation to another." In most spiders the spermatozoa in the vesiculæ seminales become enclosed in capsules, and in some species the chromatin of the encapsuled spermatozoon may divide into pieces or may even be transformed into a resting nucleus.

A NEW FAMILY OF TURBELLARIÆ.—N. Nasonov describes in the *Bulletin de l'Académie des Sciences*, Leningrad (1927, No. 9-11, pp. 865-874), a new family Multipeniatidæ of the Turbellaria Allœocœla. The animals were discovered in the mouth of the River Maiche, which flows into Ussuri Bay, Sea of Japan. The representatives of the new family, two species of the same genus (*Multipeniata batalansœ* and *M. kho*), differ greatly from members of other families of Allœcœla, especially in the remarkable structure of the male genital apparatus, since they possess several copulatory organs in different stages of development. A fully developed copulatory organ is a closed system isolated from testes and from glands; when it fulfils its function, it is replaced by the next one when this reaches its full development, and so on.

NON-MARINE MOLLUSCA OF BURU.—The non-marine molluscan fauna of the island of Buru has never been thoroughly investigated, and only scattered notes exist. Mr. Toxopeus has, however, visited a limited portion of the island for something less than a year, and the result of his collection of mollusca is now reported on by Dr. T. van Benthem Jutting (*Treubia*, vol. 7, suppl.). Omitting varieties and unidentified forms, the number of species amounts to 50, only 6 being described as new, while 18 are reported for the first time. There are two excellent plates and a number of rather rough, but effective, text illustrations, including distribution maps of the genera *Isidora*, *Physastra* and *Ameria*. A list of species formerly reported from the island but not found by Mr. Toxopeus is given, with references to the places of their description.

IRON ORES OF SOUTH AFRICA.—While on the staff of the Geological Survey of South Africa, Dr. P. A. Wagner contributed liberally to geological literature of the type that is of far more than local interest, and since his resignation he has prepared for publication still another memoir of outstanding importance, dealing on this occasion with "The Iron Deposits of the Union of South Africa" (*G. S. S. Africa, Mem. 26*, 1928). The types of ores considered include magmatic segregations; contact metasomatic deposits; lode and vein deposits; banded ironstones of the characteristic pre-Cambrian type; bedded ores of various ages; replacement and metamorphosed deposits, including those of the Lake Superior type; and laterites and other surface ironstones. Each chapter contains a wealth of observational data and critical comment—stratigraphical, petrological, chemical, and economic. South Africa possesses the most extensive titaniferous ores in the world, but apart from these her known reserves are exceeded only by those of India, the United States, Brazil, and France. As there are also associated resources on an ample scale of coking coal, limestone, dolomite, manganese, and fluor spar, the production of iron and steel should in the future prove to be a factor of prime importance in the economic development of the Union.

GEOLOGICAL HISTORY OF TASMANIA.—A stimulating account of this critical region of Gondwanaland, by A. N. Lewis, has recently appeared in the *Proc. Roy. Soc. Tasmania* for 1926 (pp. 1-24; 1927), with special reference to the relation of the existing topography to the Triassic dolerite intrusions and the major block-faulting. Mr. Lewis considers that after the intrusions the old land surface was reduced to a peneplain, and that the present surface features have been moulded on variously uplifted blocks of country, the faulting and elevation responsible for these being of Tertiary age, probably late Miocene or early Pliocene, about which time there were at least two phases of volcanic activity. A discussion of the paper by P. B. Nye and others, with a reply from Mr. Lewis, appears in the same *Proceedings* for 1927 (pp. 67-77 ; 1928). Mr. Nye contends that the present physiography dates from the time of the dolerite intrusions, while Mr. Lewis retorts that if this had been so Tasmania would long ago have been reduced to a most mature peneplain. He thinks it inconceivable that 200 million years of denudation could still have left conspicuous dolerite-capped hills if the latter had been finally elevated at the time of intrusion. Apart from this controversy, the paper and discussion are valuable as a contribution to our growing knowledge of the great dolerite intrusions of the Mesozoic era.

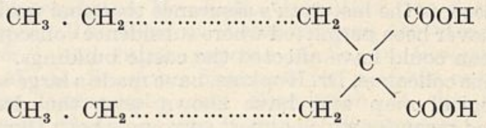
FIELD CURRENTS FROM POINTS.—A paper in the May number of the *Physical Review*, by Prof. Millikan and Messrs. Eyring and Mackeown, on the extraction of electrons from cold, negatively charged points by strong electric fields, is of particular interest in view of recent theoretical investigations of the problem on the basis of the new mechanics. The data which are presented show conclusively that a detectable current is first obtained for a definite strength of the field at the surface of the metal, irrespective of the applied potential and the disposition of the electrodes. The critical field is about the same for a tungsten point as for a tungsten wire, but it is greater for platinum than for tungsten. The importance of the field as variable rather than the potential was shown very clearly with a steel point and plane discharging system. The electric fields used are enormously high, thirty-five million volts per centimetre being attained in one instance.

INTERNATIONAL WEIGHTS AND MEASURES.—The *Proceedings of the International Bureau of Weights and Measures* for the year 1927 show that the question of the gas thermometer scale is to be considered, and that Prof. Keesom and Mr. Tuyn, of Leyden, have been asked to draw up a report on the subject. The various copies of the standard metre have been examined as to their expansion with increase of temperature, but there is a slight difference between the results obtained by the two methods used which has not yet been explained. The standards made at the same time have the same expansion, and the new quartz standards agree very closely with each other. The fine lines which mark the length of the standard are shown in the *Proceedings*, magnified 500 diameters, and it is noticeable how much finer the lines on the newer standards are than on the old. Several of the quartz standard kilograms having decreased in weight by 0·1 milligram in three years after being heated, observations have been made on a platinum kilogram submitted to a current of air at 100° C. for thirteen months, but no change in its weight could be detected. The proposal to make the British yard and the United States yard identical was withdrawn.

LONGITUDINAL STABILITY IN AEROPLANES.—An interesting new presentation of aeroplane stability analysis, in practical form, is contained in a publication of the Aeronautical Research Committee by S. B. Gates, on "A Survey of Longitudinal Stability below the Stall, with an Abstract for Designers' Use" (*R. and M.*, No. 1118. London: H.M. Stationery Office, 1928. 1*s*. 3*d*.). The paper develops in terms of new units, in which the resistance derivatives are expressed as non-dimensional quantities, a more compact analysis of longitudinal stability below stalling than has hitherto been attempted, and throws it into a form to bring it immediately within the scope of designers. The description is in terms of the two quantities, in practice at the disposal of the designer, position of centre of gravity and size of tail. With these co-ordinates the region of longitudinal stability is defined on a series of plane diagrams, and in typical cases curves have been filled in from which the damping and period of the phugoid motion may be estimated.

THE STRUCTURE OF A DETERMINANT.—In his lecture on the Rouse Ball Foundation at Cambridge in 1927, Major P. A. MacMahon gave an account of some recent developments in the theory and structure of determinants. A worker in this field is fortunate in having, in the four volumes of Muir's "History of the Theory of Determinants," a classified summary of the progress of the subject from 1693 until 1900. No important discovery has escaped the notice of Muir, who has spared no pains in mastering the great variety of notations employed at different times. During the last few years, two important advances have been made in the theory of the structure of a determinant. In the first place, various connexions have been established with symmetric functions appertaining to such algebras as that of hyper-determinants. Again, a certain algebraical expression, brought into prominence by Muir and named by him a 'permanent,' has been found to be a corner-stone in the algebraic theory. Both advances, which proceed hand-in-hand, are linked in a remarkable way with MacMahon's own work on the partitions of numbers. As yet the connexion with symmetric functions, arising from the new outlook, is but in its infancy. The study of the symmetric function of the umbral algebras, of which determinants are particular cases, is only just broached. Major MacMahon's very stimulating lecture is printed *in extenso* in *Jour. London Math. Soc.*, vol. 2.

THE STRUCTURE OF LONG CHAIN COMPOUNDS.—The *Proceedings of the Royal Society of Edinburgh*, vol. 48, Part I., contains an account of a further X-ray investigation by E. Henderson of a number of normal saturated dicarboxylic acids. Between the odd and even members of this series there is a definite alternation in physical properties, and this difference is also apparent in the crystal structures. The work has been extended to mono- and di-alkyl malonic acids with interesting results. The structure attributed to dioctadecyl malonic acid indicates that in acids of this type the two long hydrocarbon chains lie approximately parallel to one another, thus :



It has previously been observed that long chain compounds terminating in an incompletely saturated group form bimolecular layers in the crystal, the molecules of one layer being oppositely orientated to those in the other. Results now obtained with fatty acid amides confirm the view that the formation of these bimolecular layers is due to the presence of the incompletely saturated group in the molecule. In the malonic acids these bimolecular layers are not observed, and it appears, therefore, that the two carboxyl groups mutually satisfy their residual affinity.

Ancient Greek Physical Types.

At a meeting of the Royal Anthropological Institute on Tuesday, May 22, the president, Prof. J. L. Myres, read a paper on ancient Greek physical types. He said that though the number of ancient skeletons from Greek sites is still small, evidence already published, especially by Duckworth and Hawes, is sufficient to show that at the beginning of the Bronze Age the population of Crete and the Cycladic Islands was already a mixed one. Both the chief ingredients, 'Mediterranean' and 'Armenoid,' can be traced in separate occupation of certain islands, and where there is mixture of breeds, the proportions of these ingredients vary, both locally and from period to period. Single skulls of neolithic period, from Lycia, Crete, and Leucas, are alike broad-headed. It is, however, only in the early part of the Bronze Age that evidence becomes more copious. In Crete, the proportion of Armenoids begins at about 10 per cent; falls somewhat in the Middle Minoan Age, as though this continental type were being absorbed in the insular; then rises to 46 per cent in the Late Minoan Age, indicating fresh intruders from adjacent mainlands. It is not at present possible, however, to distinguish arrivals from Greece and from Asia Minor.

So early as the 'third city' on the site of Troy (about 2000–1900 B.C.), there is direct evidence of the presence of a northern type, confirming inferences from the distribution of tumulus-burials south of the Lower Danube at a period when tumulus-burying people were spreading from east of the Dnieper into Central Europe. Probably these people were blond, like their descendants farther north; but direct evidence for colour only becomes available at all quite late in the Bronze Age. Blondness, however, is not confined to pure 'northern' strains, but is shared by many mixed breeds in Central and Eastern Europe, which are more or less broad-headed; and there was probably a larger element of relatively fair, and especially of ruddy or auburn-haired people in classical Greece than could be inferred from the prevalent head-forms.

To supplement the scanty records of human remains, ancient representations of bald men are of value; and also the representations of satyrs, giants, centaurs, and low-class individuals, as evidence for the persistence of a 'backwood' type with snub-nose, wrinkled forehead, heavy brow-ridges, and low forehead. This is quite distinct from the markedly Armenoid appearance of Thersites in the "Iliad." That it was a real type and widespread, is shown by the portraits of Socrates, and Egyptian representations of Asiatic captives in the thirteenth century. Other valuable features are the distinct types of beard, Mediterranean and Armenoid, in Greek portraiture and vase-paintings; and the varying proportions of the whole body, indicating co-existence of a slight-built and a thick-set type.

Literary evidence for colour of hair and eyes is supplemented, though scantily, by archæological. The blond and ruddy complexions already mentioned are not to be ascribed solely to the 'coming of the Dorians' in the twelfth century, for they are recognisable rarely so far back as the fourteenth, and characterised the greater heroes of the Trojan War period, in the thirteenth and twelfth. In general, it is inferred that the 'Greek type,' like the Greek people generally, was in process of determination whenever the Ægean was temporarily secluded from invasions; then local conditions, which are peculiar and austere, operated to eliminate the less acclimatisable breeds. The well-marked varieties which are now to be observed in the more remote districts, and especially in some of the islands, show that this process has been going on since the great period of open intercourse in later classical times. The results of this are displayed in Græco-Egyptian mummy-portraits, and in Byzantine mosaics and frescoes.

Durham Castle.

The conclusions reported by Prof. Arthur Holmes in his paper on "The Foundations of Durham Castle and the Geology of the Wear Gorge," published in the *Durham University Journal* for March 1928, should do something to reassure those who have feared for the architectural glories of that ancient palace and fortress building, and make it clear that its repair, though likely to be both difficult and costly, is not impracticable.

Prof. Holmes has refuted the current local hypothesis that percolating waters, short-circuiting across the neck of the river bend, have removed material from under the cracked and broken walls. He accepts the historian's assurance that coal working has never been permitted where subsidence consequent thereon could have affected the castle buildings. He and his colleague, Dr. Hopkins, have made a large-scale geological map and have shown that the deeply incised meander which almost surrounds both Durham Cathedral and Durham Castle is post-Glacial in age and is cut through unweathered Coal Measure sandstones and shales. The 'Cathedral sandstone' on which the Cathedral is firmly founded is recognised as the 'Low Main Post' of the local miners.

Towards the castle the strong rock-beds dip down, and the castle buildings stand partly upon the rubbly top of the Cathedral sandstone, but mainly upon drift-sands and boulder clay which forms part of the filling of the deep pre-Glacial valley long famous as the 'Teme Wash.' The main course of that great drift-filled trough passes some few hundreds of yards to the eastward of Durham Castle; but, under the town and market place, a sand-filled tributary valley comes in and joins it from the west. The drift beneath the castle walls rests against a spur of Cathedral sandstone between the two channels. The Castle was in fact "founded on what is little better than loose rubbish," but the rock, some twenty or more feet below ground level, is strong enough to afford a stable and trustworthy foundation. As and when funds permit, it is proposed to continue the underpinning of the damaged walls and to construct beneath the neighbouring shaken parts of the buildings a reinforced concrete raft which will bear directly on the solid rock.

Appearances may well be deceptive, but to a visitor from another coalfield the character of the cracking and the distribution of the damage done recall occurrences in buildings beneath which old colliery workings are in process of slow collapse. Prof. Holmes points out that at the Durham Castle courtyard boring, the place of the valuable Hutton coal seam is only some 40 to 60 feet below Wear River level, and if one dare suspect the completeness of the historical record in a coalfield where the art and practice of coal working was so early begun, one would suggest that before a great expenditure is incurred upon the work of reconstruction, the presence or absence of ancient coal workings, and the condition of the measures above them, ought to be tested further by modern methods of exploratory boring.

W. G. F.

Association of Teachers in Technical Institutions.

CONFERENCE AT BRADFORD.

THE recent conference of the Association of Teachers in Technical Institutions gave ample evidence that the period of peace as regards such matters as salary and superannuation is being used for the discussion of the larger questions to which teachers should have opportunity of addressing themselves. The presidential address of Mr. W. W. Sirman (Handsworth Technical College) contained no reference to salaries other than a comment that industry is still the highest bidder for the services of what he called the 'ideal teacher,' namely, "one possessing experience in research, experience in industry, and ability to teach," and no reference to superannuation other than a reminder that the minimum number of hours required to qualify for superannuation leaves but little time for keeping abreast of industrial changes and improvements. His address was mainly concerned with points arising out of the recent reports of the Emmott Committee on technical education and of the Board of Education's Consultative Committee (cf. NATURE, Jan. 14, 1928, and Feb. 5, 1927). He made a special plea for the development of day technical classes, and underlined important sections of the Emmott Report dealing with grouped courses, equipment, and the personnel of governing bodies of colleges.

The Emmott Committee's report was also the subject before an open meeting, when the discussion was opened by Mr. A. E. Evans and Mr. Wickham Murray, who used the history and principal features of the report as a background for the Association's educational policy. Mr. T. Boyce (Director of Education, Bradford) emphasised the necessity of linking technical education—which he said is not yet thoroughly envisaged as an intrinsic part of our system—to other forms of education, and he asked that the Hadow Report, in spite of certain criticisms levelled at it by Mr. Evans, should be accepted as a great move forward to those very ideals for which the A.T.T.I. has so long worked. Finally, a resolution urging the establishment of a central committee to co-ordinate the local inquiries suggested by the President of the Board of Education in his reply to the Emmott Committee, received the approval of the meeting.

This attention to the wider developments and implications of technical education was also reflected in other resolutions passed by the Conference. While, at conferences held under the shadow of salary and similar negotiations, much time has been taken by resolutions affecting purely domestic policy, the Bradford resolutions were concerned with several vital points at which educational endeavour may influence the life of the community. Three resolutions dealing with the social significance of biological science, particularly so far as its application can provide a foundation upon which to build a sense of racial responsibility, were passed unanimously

An important feature of the Conference was a visit to the Research Station of the British Research Association for the Woollen and Worsted Industries at Torridon, Leeds. Addressing the Conference dinner, this Association's Director of Research, Dr. S. G. Barker, made reference to an important development in the linking of education and industry so far as research is concerned. Hitherto the science graduate who left the university to enter industry had some difficulty in obtaining the Ph.D. degree, since regulations necessitated further university residence. But such an interruption of his industrial life was not always possible, and strong representations had therefore been made from the industrial research side for permission for Ph.D. work to be carried out completely in industry. It was therefore gratifying to note that two universities have already granted such permission.

An exhibition of books and apparatus was held in the College of Arts and Crafts, but all the Conference meetings were held in Bradford Technical College, which is deservedly known for the scope and standard of its work. Diploma courses are available in textiles, chemistry, dyeing, engineering, physics, and biology, and are specially suitable to students wishing to attempt the honours degree examinations of the University of London. An important link between education and industry also exists in the award of the College associateship to diploma students who have had one year's industrial practice and submit an approved thesis embodying the results of original work.

University and Educational Intelligence.

CAMBRIDGE.—Dr. T. C. Fitzpatrick, president of Queens' College, has been elected as vice-chancellor for the year 1928–29.

In connexion with the International Geographical Congress in July, honorary degrees of Sc.D. are to be awarded to General Vacchelli, Surveyor-General of Italy, the president of the Congress, to Prof. E. de Martonne, of the Sorbonne, and to Sir Charles Close, president of the Royal Geographical Society.

The John Winbolt Prize in engineering has been awarded to A. Callender, Pembroke College, for a dissertation on "A Method of Determination of Impact Allowances for Railway Bridges."

Prof. Baker, St. John's College, Mr. R. H. Fowler, Trinity College, and Mr. F. P. White, St. John's College, have been appointed delegates from the University to the International Congress of Mathematicians at Bologna in September next.

Applications for the John Lucas Walker studentship in pathology, value £300 annually and tenable for three years, should be sent, accompanied by copies of papers containing published work, testimonials, and references, before June 30, to Prof. H. R. Dean, Pathological Laboratory, Medical School, Cambridge.

LONDON.—The following doctorates have been conferred: *D.Sc. in Physics* on Mr. E. G. Richardson (University College), for a thesis entitled "Measurements of Sound Waves and other Periodic Aerial Motions"; Miss Kathleen Lonsdale (University and Bedford Colleges), for a thesis entitled "An X-ray Study of some simple Derivatives of Ethane"; *D.Sc. in Geography* on Mr. J. N. Carruthers, for a thesis entitled "The Flow of Water through the Straits of Dover," and other papers; *D.Sc. in Geology* on Mr. W. G. St. John Shannon, for a thesis entitled "The Petrography and Correlation of the Sedimentary Rocks of the Torquay Promontory," and other papers.

MR. R. A. WARDLE, lecturer in economic zoology in the University of Manchester, has been appointed to the chair of zoology in the University of Manitoba, Canada.

DR. ETHEL M. POULTON has been elected by the corporation of Yale University to the Seessel fellowship for advanced research in biology. Dr. Poulton is at present lecturer in botany in the Education Department of the University of Birmingham.

Calendar of Customs and Festivals.

June 17.

ST. MOLING LUACHRA, Bishop of Teach Moling, now St. Mullins, Co. Carlow (late seventh century, *d. circ.* 696), a descendant of the Leinster royal line. The interest of the legends and cult of the saint lies in their very evident connexion with earlier pagan belief. The saint settled at Rosbrock—'Badger Wood,' an ancient name for Tegh Moling—a place also associated with Finn MacCumhaill. St. Moling is said to have built here the first mill in all Ireland, and in a time of scarcity to have initiated the use of rye for food among the inhabitants. He spent many years in irrigation work with his own hands, and acted daily as a ferryman over the River Barrow.

St. Mullins, situated on the banks of the Barrow near the confluence of one of its tributaries, later became a place of considerable strategical importance. It was the site of a round tower and was a point of defence of the English Pale. The story of the saint's activities as ferryman, his association with milling, the cultivation of rye, and irrigation work, the name 'Badger Wood,' probably a sacred grove, and the existence of a dun or tumulus near by, point to this locality having been a stage on an early line of communication which became an important centre of pagan belief and culture.

The famous artificer Goban Saer is said to have constructed an oratory of oak for the saint, and several stories are connected with the building work of St. Moling. He is also associated in legend with both trees and stones. He lived for seven years in the hollow trunk of a tree, and one of the miracles which took place at his intercession was the transport of a huge oak felled by his workman to the banks of the Barrow to enable it to be cut up. The nature of the story points to this having been a sacred tree. He also shared in the allocation of the wood of the great yew of Lethglen felled by St. Molaise. When his great irrigation channel was completed, after many years of work, all those present waded through it against the current, and the saint undertook to intercede for all who did likewise in after days. This continued to be the practice of all the many pilgrims of both sexes who resorted there in after times, thereby obtaining remission of their sins and relief in illness. It continued to be the practice to walk barefoot through the traditional channel when it had become overgrown with thorns. On one occasion St. Moling cast the dead body of a young man into this channel, whereupon he came to life and swam about, though unable to swim before.

Pilgrims to St. Mullins venerated the saint by saying two prayers each of the nine times they circled on their knees in the largest of the buildings around a great stone on which the saint was said to have celebrated mass, placing a pebble on the stone for each round. They then deposited a leaf in the window of the inner shrine under which the altar had once stood and kissed the stone beneath before they resumed their shoes. The churchyard was much used for interments, and it was the custom to follow the practice, of pagan origin, of bearing the corpse around the churchyard before interment. Both legends and practice point to a survival of a pagan cult.

St. Moling was the patron saint of Leinster, and in particular of the royal Kavanagh clan, who were always buried in his churchyard. He is said to have negotiated the abrogation in favour of Leinster of the Borumha tribute to the High King of Ireland, which was afterwards reimposed in the eleventh century by Brian, known, in consequence, as Boru.

June 23.

ST. JOHN'S EVE—MIDSUMMER EVE.—The summer solstice was the most important of the festivals of the year among the Aryan peoples. The most significant survival of its observance is the wide-spread custom of the midsummer bonfire or need fire. In Celtic Britain the importance of the fire festivals of May 1 and Hallow-e'en point to a different calendrical system; but, either by transference or by superposition, the midsummer observances in the British Isles duplicate the May fire festival.

Under the Christian Church, the popular observances at midsummer have been connected with St. John the Baptist, but there can be no question as to their derivation from earlier pagan custom. Certain rites of Adonis, for example, of which Frazer thinks a survival is to be found in customs connected with St. John which are found in Sardinia and Sicily, were observed in June. There was at Rome a midsummer saturnalia celebrated by slaves and plebeians. It was specially connected with the fire-born Servius Tullius, and was in part a water and flower festival. It is also significant that the Mohammedan Berbers of Algeria and Morocco still observe traditional midsummer customs analogous to those found elsewhere, although this date does not appear in the Moslem calendar.

The turn of the year, when the sun has attained its zenith, is for a primitive people a critical period. Frazer, indeed, has suggested that the midsummer observances may have been intended to strengthen the sun as his power begins to wane. The part played by water in many of them may be taken as an index of the anxiety of the people for the prosperity of the harvest now at hand. The apparent combination of spring and midsummer in the fact that in Sweden St. John's Eve is the day for the observance of the maypole festival, in association with the practice of jumping through fires, may be due to climatic conditions; but in some parts of Russia the death and resurrection of Kupalo, which takes place on this date, is also associated with both fire and water. A straw figure dressed in woman's clothes with necklace and floral crown, and a tree felled for the purpose named Marena (winter or death), are the central figures of the festival, the straw figure being carried by couples as they jump through the fires. On the next day the figure is stripped and thrown into a stream. Frazer quotes a number of similar customs from various localities in Russia which take place between the feast of St. John and the end of the month.

It is significant of the critical character of this period that it should be regarded as a time for divination. By a familiar process of inversion, the measures originally taken to avert a contingent evil or secure a benefit become a forecast of the event. This is especially to be seen in the widespread customs associated with St. John's Eve, which foretell the character of the future partner in marriage, for example, by means of a looking-glass, in which the form of the future husband will appear looking over the inquirer's shoulder, as in Scotland and in Greece, or by placing it under the pillow, as in the Balkans, when it will affect the maiden's dreams. In Russia, the Balkans, Greece, and many parts of Europe, the white of egg, or melted wax, thrown into water, are believed to be equally efficacious, by the symbolism of the forms they produce in solidifying. In England the 'dumb cake,' made, baked, and broken by two and placed under their pillows by a third, brought the desired vision to the three diviners. In Wales spinsters made a garland of nine different kinds of flowers. Walking backwards they tried to throw the garland on a tree. The number of times it fell to the ground foretold the years they would remain unmarried.

Societies and Academies.

London.

Royal Society, June 7.—O. W. Richardson : The emission of secondary electrons and the excitation of soft X-rays. These two groups of phenomena are closely interrelated. In order to harmonise the agreement between the soft X-ray and secondary electron discontinuities with the low soft X-ray and high secondary electron generation efficiencies, it is necessary to postulate an abnormally high absorption of the soft X-rays in the medium in which they originate. The possibility of a similar misfit in connexion with thermionic emission and chemical action is considered. In each case the radiation appears to behave as if it were absorbed about a million times faster near its point of origin than it would if it were separated out into a beam and its absorption coefficient measured elsewhere.

R. H. Fowler and L. Nordheim : Electron emission in intense electric fields. The emission of electrons from a cold metal under a strong applied field is calculated exactly, using the new mechanics, Sommerfeld's theory of metals and the simplest form of boundary field, which is sufficiently representative for the problem in hand at all ordinary temperatures.

O. W. Richardson and F. C. Chalklin : The excitation of soft X-rays (2). Earlier measurements on the critical potentials of iron have been extended. There is now a substantial agreement between different observers as to the complex phenomena displayed by this element. Rollefson's series is probably real ; similar series are suggested for cobalt and nickel and also combination series. The tungsten ' spectrum ' has been re-examined by deposition of tungsten on a carbon target. In this way it has been possible to show that the former ' spectrum ' was a mixture, the probable contaminant being nickel.

G. Timms : The nodal cubic surfaces and the surface from which they are derived by projection. Cayley's classical treatment of the twenty-three types of cubic surface proceeds by the separate consideration of the several cases ; it has been proved, but in a highly abstract manner, that every surface should be obtainable as the projection of a non-singular surface in higher space : the subject of this paper is the actual generation of all the various types of cubic surface by the projection of non-singular surfaces, namely, the non-ruled surfaces of order n in space of n dimensions.

J. M. Robertson : An X-ray investigation of the structure of some naphthalene derivatives. The X-ray investigation of naphthalene tetrachloride and 1.2.3.4.5.8.-hexachlornaphthalene.1.2.3.4.tetrahydride shows that in both cases the lattice is body-centred, and the space group probably C_s^4, involving polarity in the crystals. The reflection molecule and the groups of halogen atoms lie on a virtually different type of lattice and interleave the nearly flat carbon rings, the long axis of the molecule being approximately the c-axis of the crystal.

C. V. Raman and C. M. Sogani : A critical absorption photometer for the study of the Compton effect. The great difference in transmission through a filter on the two sides of the K-absorption edge forms the basis of a very simple and convenient method of studying the characteristics of the Compton effect. The materials of the target for the X-ray tube and for the filter in the path of the scattered X-rays are so chosen that the unmodified scattered ray lies on the short-wave side of the limit, while the modified ray scattered through a sufficiently large angle is on the long wave-length side of the limit. The increased transparency for the scattered radiation at such angles is readily shown by a photographic plate behind the filter, a steel wedge placed side by side with the filter forming the standard of comparison.

C. G. Darwin : The wave equation of the electron. In two papers Dirac has recently reconstructed the quantum mechanics of the electron, accommodating in a natural manner the properties associated with the ' spinning electron.' He works throughout with the calculus of q-numbers. The present work starts from his equation, but develops the same properties by the use of ordinary differential equations. There are four simultaneous partial differential equations of the first order, which are invariant for Lorentz transformations. A comparison with previous theories shows that Schrödinger's equation is a first, and the equations of the present author a second, approximation to the exact equations. In the case of hydrogen the solution leads exactly to Sommerfeld's original values for the levels.

S. Chapman : The molecular displacements in diffusing gas-mixtures. The displacement–distribution function found by Einstein for Brownian grains is applicable to a uniform gas mixture, but the constant D in his formula in general differs from the coefficient of diffusion for the mixture. The form of the function is found for a gas-mixture which is non-uniform in temperature and concentration, in the case where the concentration of one constituent is small.

J. R. Wilton : A series of Bessel functions connected with the lattice-points of an n-dimensional ellipsoid. It is known that the number of lattice-points in a many-dimensional ellipsoid is expressible by a series of Bessel functions. The paper is concerned with the degree of approximation given by a partial sum of this series, and with similar problems of a more general character.

E. H. Linfoot : On the law of large numbers. The paper discusses the following problem : Given an infinite sequence of trials, the probability of a success at the ith trial being p_i and the p_i being subject only to the most lenient possible condition, how can we estimate the probable deviation of the number m of successes actually obtained in the first n trials from the ' normal ' number ?

A. T. Price and S. Chapman : On line-integrals of the diurnal magnetic variations. Line-integrals of the field of the diurnal magnetic variation are calculated, taken round the boundary of an area of 400,000 square kilometres in northern Europe. The data used are the mean hourly inequalities of the two components of the horizontal magnetic force for the 20 international quiet days of the summer of 1924, derived from six observatories. The line-integrals do not vanish exactly, but their values are interpreted as due, not to earth–air currents, but to slight uncertainties in the data, owing to the observatories being too far apart round the boundary curve. If the non-zero line integrals were interpreted as indicating earth–air currents, the current–densities would be of the order 10^{-3} amp./km.^{2}, which is about one-tenth the order of the mean current densities inferred from line-integrals of the whole magnetic field ; but the observed order of magnitude of the vertical electric currents in the atmosphere is 10^{-6} amp./km.^{2}.

W. G. Bickley : The influence of vortices upon the resistance experienced by solids moving through a liquid. Two cases of two-dimensional streaming past a cylinder, with vortices present, are worked out in detail. Where there are two symmetrically disposed vortices, the resultant is a force in the line of motion. With one vortex and circulation, the force is inclined to the direction of motion. The lift–drag curves show a resemblance to those found experimentally for the Flettner rotor.

H. S. Edwards: The effect of temperature on the viscosity of neon. The new method previously described for the accurate determination of the variation of the viscosity of air with temperature is modified to deal with a gas of which only a limited quantity is available. Neon was purified by a simple method of fractional distillation over charcoal surrounded by liquid air and measurements taken over the range $-78 \cdot 4°$ to $444 \cdot 5°$ C.

W. G. Bickley: The distribution of stress round a circular hole in a plate. The paper considers the distribution of generalised plane stress in a uniform, infinite, elastic plate due to an arbitrary distribution of traction round the boundary of a circular hole. The stresses are expressible in terms of two pairs of conjugate functions, and these in turn are expressible as definite integrals involving the boundary tractions. A physical interpretation of these integrals in terms of 'stress sources' is obtained. The results are in fair accord with experimental determinations.

J. D. Cockcroft: On phenomena occurring in the condensation of atomic streams on surfaces. The conditions under which atomic streams of cadmium and silver condense on different surfaces have been investigated. As shown originally by Wood, condensation into a homogeneous deposit does not occur unless the surface temperature is below a certain critical value; this value is a function of stream density, which varies by a factor of 10^4 as the surface temperature varies over a range from $-80°$ to $-150°$ C. When no precautions are taken to outgas the surface, the surface adsorption forces are identical for different metallic surfaces and glass. When the effect of gas is eliminated, the surface forces are increased. The experiments confirm Frenkel's theory of formation of surface films.

C. D. Ellis and G. H. Aston: The dependence of the photographic action of β-rays on their velocity. Measurements have been made of the relative photographic activity of β-rays in the range of speeds $H\rho$ 2000—$H\rho$ 8000 by direct comparison of photographs of the continuous spectrum of radium -*B* and -*C* with Gurney's electrical measurements. The results show, for example, that electrons of speed $H\rho$ 5000 have only one-half the photographic effect of electrons of speed $H\rho$ 2000.

P. Kapitza: The study of the specific resistance of bismuth crystals, its change in strong magnetic fields, and some allied problems. Part 1. Growth of crystal rods with definite orientation of crystal planes, and specific resistance of the crystals. In order to obtain crystal rods with perfect cleavage plane orientated in any desired direction relative to the axis of the rod, no strain must be set up during crystallisation. During the growth of the crystals, cracks and imperfections are developed in the lattice, which account for the variation of specific resistance observed in previous researches; in the case of a perfect crystal the specific resistance along the trigonal axis is $1 \cdot 38 \times 10^{-4} \pm 1$ per cent, and perpendicular to the axis $1 \cdot 07 \times 10^{-4} \pm 1$ per cent at 16°. The cracks are produced during cooling at a temperature very close to that at which bismuth solidifies. A perfect bismuth crystal has no well-defined cleavage plane at room temperature, and is very flexible. There seem to be two crystalline bismuth modifications; one at present unknown but probably cubic, and transferred to the ordinary rhombohedral modification at a temperature slightly below melting-point, accompanied by a change of shape, which accounts for the occurrence of the crack.

Part 2. Methods for observation of change of resistance in strong fields. The study of the change of resistance of a conductor in a magnetic field which exists for 1/100 second is made possible by the fact that larger current densities are permissible in the conductor, during this short interval, without heating the conductor. The measurements can be made with an oscillograph. A special switch is used, the make-and-break of which can be adjusted relatively to the current wave through the coil producing the magnetic field, with an accuracy of about 0·0002 sec.

Part 3. Change of resistance of bismuth and time-lag in magnetic fields. A method is described of eliminating time-lag in measuring the change of resistance in a magnetic field. Experimental results at 290°, 196°, and 91° abs. are given for change of resistance when the current is perpendicular to field, for different orientations of crystal axis relative to the field. Impurities and imperfections in the crystal lattice greatly influence the change of resistance, especially with low temperatures and strong fields. In weak fields the change of resistance of a perfect crystal follows a square law, and in strong fields a linear law; the linear law is practically independent of orientation of the crystal relative to field. In the case of current parallel to lines of force of field, a 'saturation effect' was found; the change of resistance is very small and strongly affected by imperfection of crystal lattice.

Geological Society, May 23.—P. G. H. Boswell (lecture): Geological features of the New Mersey Tunnel. The tunnel will be the greatest subaqueous tunnel in existence. The subaqueous portion of the tunnel (44 feet in diameter) and the two Birkenhead approach-tunnels lie in the Middle Bunter Sandstone ('Pebble-Beds'), which dips eastwards at about 3° to 5°. A fault-system, apparently of small aggregate throw, was met with at about 1828 to 1870 feet from the Liverpool shaft. The hade was eastwards, whereas in the case of the sub-river fault in the Mersey Railway Tunnel it was westwards. On the Liverpool side, the presence of the 'Castle Street Fault,' which throws down the Upper (Soft) Bunter Sandstone on the east, was confirmed. At the Old Haymarket entrance another north-north-west and south-south-east fault throws eastwards, and brings Lower Keuper Sandstone into contact with Upper Bunter. It has been possible to construct exceptionally accurate profiles of the system of buried channels. They appear to be of subglacial origin, and do not deepen seawards; they are filled with gravel and sand, overlaid by boulder-clay. In place of the single channel found in the Mersey Railway excavations, two (or more) feeding-channels occur farther north. Interesting, and at present unexplained, features have been observed in the levels of underground water. As would be expected, the fresh water table rides on the back of the salt water table in the neighbourhood of the Mersey estuary.

PARIS.

Academy of Sciences, May 14.—A. Mesnager: A rectangular specimen, submitted to normal pressures on its bases.—Pierre Termier and Eugène Maury: New geological observations in eastern Corsica; the tectonic unities.—Ch. Gravier and J. L. Dantan: Some results obtained in the course of night fishing (with a light) in the Bay of Algiers.—P. Helbronner: The altimetry of Corsica. Outline of some results of measurements of heights above sea level of some points in Corsica.—E. Mathias: A curious photograph of lightning obtained in the region of the Lake of the Four Cantons. This photograph supports the theory of lightning put forward by the author in 1924.—W. A. Tartakowsky: An expression for the number of representations of a number by a positive quadratic form with more than three variables.—Paul Alexandroff: The homeomorphy of closed ensembles.—Bertrand Gambier: Ruled algebraic surfaces: singularities and classification.—A. Th. Masloff: The deformation of surfaces with conservation of a conical conjugated system.—Rodolphe Raclis: Theorems of existence for the integral equation of Fredholm of the first species, the nucleus of which possesses lines of discontinuity.—Alex. Froda: A new classification of the discontinuities of a uniform function of real variables.—Corps: The experiments of M. Esclangon and their application to the study of the movements of the ether in the neighbourhood of material masses.—C. Gaudefroy: Observations on the fringes obtained in convergent light.—J. Gilles: The structure of the spectrum of the second order of sulphur.—Paul Mondain Monval and Paul Schneider: The refractive index and specific mass of liquid sulphur and of viscous sulphur. Curves are given showing the variations of refractive indices, densities and specific refraction as a function of the temperature. These afford evidence of an internal transformation at 160° C.—J. Trividic: The absorption of iodine by carbon from solutions in mixed organic solvents. In all the experiments the Freundlich equation covered the observed facts.—R. Locquin and V. Cerchez: Ethyl amino-malonate. This has been prepared with a 90 per cent yield by reducing ethyl isonitrosomalonate $(CO_2Et)_2.C=N(OH)$ with aluminium amalgam and water. One atom of hydrogen in this ester is still replaceable by sodium, which reacts with alkyl halides in the usual way.—Charles Jacob: The metamorphism of limestones and the structure of the North Pyrenees slope.—Marcel Roubault: The tectonic of the neighbourhood of Arbas (Haute-Garonne).—A. Pereira Forjaz: Spectrochemistry of the Portuguese mineral waters: the water of Gerez. Germanium, cæsium, silver, and lead have been detected in this water.—Roger Guy Werner: Study of the family Gyrophoraceæ.—A. Sartory, R. Sartory, and J. Meyer: Contribution to the study of the morphological and biological characters of *Mucor spinosus* (*Zygorhynchus spinosus*) cultivated on media resembling the habitat from which it has been isolated.—Pierre Dangeard: The conditions of release of free iodine in Laminaria. Details of experiments on *Laminaria flexicaulis*. With the exception of young specimens less than 10 cm. long, all the *Laminaria* in their natural state give off iodine vapour. The rate of evolution of the iodine is increased if the plant is cut or treated with acid or alcohol.—Gard: Rotting of the cultivated walnut, *Juglans regia*, and calcium carbonate. The distribution and intensity of diseased walnuts due to *Armillariella mellea* varies greatly from one region to another. After eliminating numerous possible factors, a distinct connexion was proved between the proportion of chalk in the soil and the disease, absence of disease corresponding with high proportions of chalk. The principal cause of the disease is considered to be the progressive decalcification of the soil by the intensive use of chemical manures.—Georges Nichita: Follicular atresia in *Girardinus Guppyi*.—J. J. Rouzaud and L. C. Soula: The influence of pinching the subhepatic veins on glycæmia and cholesterinæmia.—A. Policard: The proportion of calcium of the various regions of the ossification cartilage of the long bones.—Edouard Chatton and André Lwoff: The structure, evolution, and affinities of the ciliated Opalinopsidæ of the Cephalopods.—Labbé, Nepveux, and Hiernaux: The influence of insulin on the disturbance of nitrogen metabolism in diabetes.

Official Publications Received.

BRITISH.

Cambridge Natural History Society. Fauna List No. 1: Dermaptera and Orthoptera of Cambridgeshire. By E. B. Worthington. Pp. 8. (Cambridge.)

Board of Education. Educational Pamphlets, No. 58: Report on the Teaching of Electrical Machine Design. Pp. 11. (London: H.M. Stationery Office.) 3*d*. net.

Journal of the Royal Statistical Society. Vol. 91, Part 2, 1928. Pp. xii+153-302. (London.) 7*s*. 6*d*.

Ministry of Health. Voluntary Hospitals Commission: Final Report. Pp. 10. (London: H.M. Stationery Office.) 3*d*. net.

Journal of the Chemical Society: containing Papers communicated to the Society. May. Pp. xii+v+1061-1401. (London: Gurney and Jackson.)

A Brief History of the Institution of Civil Engineers, established 2nd January 1818, incorporated by Royal Charter 3rd June 1928. Pp. 62. (London.)

Memoirs of the Indian Meteorological Department. Vol. 25, Part 1: Sky-Illumination at Sunrise and Sunset. By Dr. K. R. Ramanathan. Pp. 13+2 plates. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1*s*.

Annual Report of the Calcutta School of Tropical Medicine, Institute of Hygiene and the Carmichael Hospital for Tropical Diseases, 1927. Pp. 107. (Calcutta: Bengal Government Press.)

Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1928 June 2. Pp. 18. (Greenwich.)

Publications of the South African Institute for Medical Research. No. 21: Studies on Cell Growth. Part 1: Serum Cultures of Young and Adult Mammalian Tissues and their Relation to Growth Processes *in vivo*. By Dr. M. J. A. des Ligneris. Pp. 257-384+34 plates. (Johannesburg.)

Quarterly Journal of the Royal Meteorological Society. Vol. 54, No. 226, April. Pp. 79-160. (London: Edward Stanford, Ltd.) 7*s*. 6*d*.

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1114 (Ae. 287): Charts for the Calculation of Airscrew Thrust and Torque Coefficients. By Dr. J. D. Coates. (T. 2508.) Pp. 7+12 plates. 6*d*. net. No. 1119 (Ae. 292): Model Experiments with Rear Slots and Flaps on Aerofoils R.A.F. 31 and R.A.F. 26. By H. B. Irving, A. S. Batson and A. L. Maidens. (T. 2527.) Pp. 8+6 plates. 6*d*. net. (London: H.M. Stationery Office.)

Report of the Director of the Royal Observatory, Hong Kong, for the Year 1927. Pp. 19. (Hong Kong.)

Journal of the Institute of Actuaries. Vol. 3, No. 2. Pp. ii+75-158. (London: C. and E. Layton.) 3*s*.

FOREIGN.

Smithsonian Miscellaneous Collections. Vol. 80, No. 11: The Legs and Leg-bearing Segments of some Primitive Arthropod Groups, with Notes on Leg-Segmentation in the Arachnida. By H. E. Ewing. (Publication 2962.) Pp. 41+12 plates. (Washington, D.C.: Smithsonian Institution.)

Carnegie Endowment for International Peace: Division of Intercourse and Education. Annual Report of the Director for the Year 1927. Pp. 64+4 plates. (New York City.)

General Catalogue of Stellar Parallaxes. Compiled by Frank Schlesinger, with the assistance of Margaretta Palmer and Alice Pond. Edition of 1924, including all Determinations available in January of that Year. Pp. vii+57. (New Haven, Conn.: Yale University Observatory.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Circular Bulletin No. 101: Cockroaches, Silver-fish and Book-lice. By E. I. McDaniel. Pp. 12. Special Bulletin No. 169: Profit and Loss in Pruning Mature Apple Trees. By Roy E. Marshall. Pp. 39. Special Bulletin No. 172: Farm Real Estate Assessment Practices in Michigan. By R. Wayne Newton and W. O. Hedrick. Pp. 80. Technical Bulletin No. 89: Ultimate Effect of Hardening Tomato Plants. By John W. Crist. Pp. 22. (East Lansing, Mich.)

Bulletin météorologique de l'Observatoire météorologique de Beograd. 1: Observations diurnes à Beograd et résumés annuels 1920–1924. Publié sous la direction de P. Vujević. Pp. 39. (Beograd.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 80. Minute American Zonitidae. By H. Burrington Baker. Pp. 44+8 plates. (Philadelphia, Pa.)

Proceedings of the United States National Museum. Vol. 73, Art. 13: Fossil Nutlets of the Genus Lithospermum. By Edward W. Berry. (No. 2734.) Pp. 3+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 16, Nos. 23 and 24. 23: Report of the President of the Academy for the Year 1927, by C. E. Grunsky; 24: Report of the Director of the Museum for the Year 1927, by Barton Warren Evermann. Pp. 689-758. (San Francisco, Cal.)

Bulletin of the Imperial Earthquake Investigation Committee. Vol. 11, No. 2: List of the After-Shocks of the Great Kwanto Earthquake. By A. Imamura and K. Hasegawa. Pp. 65-93+3 plates. (Tokyo.)

Japanese Journal of Astronomy and Geophysics. Transactions and Abstracts. Vol. 5, No. 1. Pp. 79+6. Vol. 5, No. 2. Pp. 81-125. Vol. 5, No. 3. Pp. 127-174+7-19. (Tokyo: National Research Council of Japan.)

Spisy Lékařské Fakulty, Masarykovy University, Brno, Československá Republika, Svazek 5, Spis 41-51. (Publications de la Faculté de Médecine, Brno, Tchécoslovaquie, Tome 5, Fascicule 41-51.) Pp. iii+68+20+16+21+17+15+32+32+8+41+52. (Brno: A. Píša.) 40 Kč.

Biologické Spisy Vysoké Školy Zvěrolékařské, Brno, Československá Republika, Svazek 5, Spis 61-75. (Publications biologiques de l'École des Hautes Études vétérinaires, Brno, Tchécoslovaquie, Tome 5, Fascicule 61-75.) Pp. iv+14+10+9+10+44+21+56+15+14+39+32+21+12+21+8. (Brno: A. Píša.) 40 Kč.

Sborník Vysoké Školy Zemědělské v Brně, ČSR., Fakulta Lesnická. (Bulletin de l'École supérieure d'Agronomie, Brno, RČS., Faculté de Silviculture.) Sign. D8: Fauna lesni hrabanky (Fauna of the Forest Soil). Napsal Dr. Štěpán Soudek. (With an English Summary.) Pp. 24. (Brně: A. Píša.)

CATALOGUES.

Heat Treatment Bulletin, No. 40: High Speed Steel. By A. R. Page. Pp. 8. (London: Automatic and Electric Furnaces, Ltd.)

Americana from the Time of the Discovery: with a Selection of other Voyages and Travels particularly to India and the East. (Catalogue No. 20.) Pp. 152. (Newcastle-on-Tyne: William H. Robinson.)

Cambridge Instruments for Heating and Ventilating Plants. Pp. 6. (London: Cambridge Instrument Co., Ltd.)

Second-hand and Shop-soiled Instruments and Apparatus at Reduced Prices. Pp. 8. (London: Ogilvy and Co.)

Disposal of Shop-soiled Instruments and Apparatus at Reduced Prices. Pp. 12. (London: E. Leitz.)

Diary of Societies.

SATURDAY, JUNE 16.

ROYAL SOCIETY OF MEDICINE (Therapeutics Section) (at Pharmacological Laboratory, Oxford), at 3.—Annual General Meeting and Laboratory Meeting.

MINING INSTITUTE OF SCOTLAND (at Dunfermline).

MONDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.—Anniversary General Meeting.—Presidential Address, Presentation of Medals and Awards, etc.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of Royal Gold Medal.

TUESDAY, JUNE 19.

RESEARCH DEFENCE SOCIETY (Annual General Meeting) (at 11 Chandos Street, W.1), at 3.—Sir Bernard Spilsbury: The Work and Responsibilities of a Pathologist (Stephen Paget Memorial Lecture).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—John Hilton: Some Further Enquiries by Sample.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Rev. Neville Jones and Col. W. E. Hardy: Stone Implements of South Africa.

WEDNESDAY, JUNE 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. Edmund Clark, I. D. Margary, R. Marshall, and C. J. P. Cave: Report on the Phenological Observations in the British Isles, December 1926 to November 1927.—C. K. M. Douglas: On the Relation between Temperature Changes and Wind Structure in the Upper Atmosphere.—R. M. Poulter: Simple Formulæ for Computing Relative Humidity.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Café Royal, Regent Street), at 7.30 for 8.—Dinner to celebrate the Society's 21st Anniversary.

FOLK-LORE SOCIETY (at University College), at 8.—Madame Fia Fastré: Exhibition of Toys from Mexico, France and Japan.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (Summer Meeting at Stourbridge) (continued on June 21, 22, 23).

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.—Sir Robert Robertson: Studies in the Infra-Red Region of the Spectrum. Part I. Description of Prism Apparatus. Part II. Calibration of Prism Spectrometer; General Procedure and Preparation of Pure Ammonia, Phosphine, and Arsine Gases. Part III. Infra-Red Spectra of Ammonia, Phosphine, and Arsine. Part IV. Consideration of Bands of Ammonia, Phosphine, and Arsine. With Exhibition of Apparatus.—C. V. Boys: Solid Dipleidoscope Prisms.—Prof. G. I. Taylor: The Forces on a Body placed in a Curved or Converging Stream of Fluid.—S. S. Cook: Erosion by Water-Hammer.—*To be read in title only*:—J. Hollingworth: The Polarisation of Radio Waves.—A. C. Menzies: The Spark-Spectrum of Copper.—W. H. Taylor and W. W. Jackson: The Structure of Cyanite.—F. H. Constable: A New Interference Method of Measuring the Surface Area of Film Catalysts. Part I. Theory. Part II. Nickel.—S. J. Davies and C. N. White: An Experimental Study of the Flow of Water in Pipes of Rectangular Section.—L. P. Davies: The Photoelectric Properties of some Metals in the Soft X-Ray Region.—C. F. Powell: Condensation Phenomena at Different Temperatures.—J. M. Walter and S. Barratt: The Existence of Volatile Intermetallic Compounds. The Band Spectra of the Alkali Metals and of their Alloys with each other.—G. Temple: The Theory of Rayleigh's Principle as applied to Continuous Systems.—E. S. Semmens: The Selective Photo-chemical Action of Polarised Light. Part II.—W. R. Brode and Dr. R. A. Morton: The Absorption Spectra of Solutions of Cobalt Chloride, Cobalt Bromide, and Cobalt Iodide in Concentrated Hydrochloric, Hydrobromic, and Hydriodic Acids.—Prof. T. M. Lowry and G. G. Owen: The Mechanism of Chemical Change. I. Promotion and Arrest of the Mutarotation of Tetra-Acetylglucose in Ethyl Acetate.—C. H. Gibson and C. N. Hinshelwood: The Homogeneous Reaction between Hydrogen and Oxygen.—R. Schlapp: The Stark Effect of the Fine Structure of Hydrogen.—H. Glauert: The Characteristics of a Karman Vortex Street in a Channel of Finite Breadth.—D. M. Newitt: Gaseous Combustion at High Pressures. X.—K. R. Rao and A. L. Narayan: On Series in the Spark Spectra of Germanium.—N. K. Adam: The Structure of Thin Films. Part XI.—E. Newbery: A Revision of the Theory of Transfer Resistance.—E. Newbery: Metal Overvoltage Measurements with the Cathode Ray Oscillograph.—Lord Rayleigh: Observations on the Band Spectrum of Mercury.—G. B. Bandopadhyaya: Photoelectric Effect of Soft X-Rays.—A. Caress and Dr. E. K. Rideal: On the Chemical Reactions of Carbon Monoxide and Hydrogen after Collision with Electrons.—F. P. Bowden and Dr. E. K. Rideal: The Electromotive Behaviour of Thin Films. Part I. Hydrogen. Part II. The Areas of Catalytically Active Surfaces.—W. Payman: The Detonation Wave in Gaseous Mixtures and the Pre-Detonation Period.—Prof. G. P. Thomson: Experiments on the Diffraction of Cathode Rays. II.—R. Ironside: The Diffraction of Cathode Rays by Thin Films of Copper, Silver, and Tin.—A. Reid: The Diffraction of Cathode Rays by Thin Celluloid Films.—Prof. W. E. Curtis and W. Jevons: The Zeeman Effect in the Band Spectrum of Helium.—B. F. J. Schonland: The Scattering of Cathode Rays.—Prof. H. M. Macdonald: Note on Total Reflexion of Electric Waves at the Interface between two Media.—Prof. G. I. Taylor: The Energy of a Body moving in an Infinite Fluid, with an Application to Airships.

CHEMICAL SOCIETY, at 5.30.—H. M. Dawson and W. Lowson: Acid and Salt Effects in Catalysed Reactions. Part XV. The Catalytic Activity of Hydrochloric Acid in the Hydrolysis of Ethyl Acetate.—A. A. Goldberg and R. P. Linstead: The Chemistry of the Three Carbon System. Part XVIII. Quantitative Investigations on the $\alpha\beta$-$\beta\gamma$ Change in Unsaturated Acids; Observations on the Reduction of Sorbic Acid and a New Synthesis of Pyroterebic Acid.—G. M. Bennett and W. G. Philip: The Influence of Structure on the Solubilities of Ethers. Part I. Aliphatic Ethers.—G. M. Bennett and W. G. Philip: The Influence of Structure on the Solubilities of Ethers. Part II. Some Cyclic Ethers.—R. G. W. Norrish and J. G. A. Griffiths: The Photochemical Decomposition of Glyoxal Vapour.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at the Royal Anthropological Institute, 52 Upper Bedford Place), at 6.—Elton Mayo: The Practical Outcome of Psycho-Pathology.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.—Annual General Meeting.—Prof. E. Brumpt: The Differential Diagnosis of the Intestinal Amœbæ of Man.

NEWCOMEN SOCIETY (at Stourbridge) (continued on June 22 and 23).

FRIDAY, JUNE 22.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section) (Annual General Meeting), at 8.—Dr. J. A. Glover: Some Observations on Naso-pharyngeal Infections in Public Schools.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Long Ashton, nr. Bristol).

SATURDAY, JUNE 23.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.

FRIDAY, JUNE 22, AND *SATURDAY*, JUNE 23.

ANATOMICAL SOCIETY OF GREAT BRITAIN AND IRELAND (Summer Meeting) (in the Department of Anatomy, University of Manchester).—J. M. Yoffey: Essentials of Hæmopoiesis as seen in Fishes.—D. Stewart and S. L. Wilson: Regional Anæsthesia and the Innervation of the Teeth.—G. Jefferson and H. M. Morris: Movements of the Spine with Reference to the Localisation (Incidence) of Spinal Injury.—A. J. E. Cave: (*a*) Case of Symmetrical Thinness of the Parietal Bones; (*b*) Two Cases of Congenitally Enlarged Parietal Foramina; (*c*) Nerve Markings on the First Rib.—G. Elliot Smith: The Optic Connexions in the Brain—the Need for a Revision of the Traditional Description.—G. L. Streeter: The Lewis-Gregory Film showing the Living Rabbit Egg and the Phenomena of Cleavage and Formation of the Segmentation Cavity.—J. Beattie: The Sympathetic Nervous Control of the Heart.—J. Beattie and R. B. Malcolm: The Cerebro-spinal Circulation in Man.—W. E. LeGros Clark: The Optic Thalamus of Tupaia.—T. Wingate Todd: A Study of the Normal Mobility of the Alimentary Tract.—R. D. Lockhart: (*a*) Variations Coincident with Congenital Absence of the Zygoma (Zygomatic Arch); (*b*) The Anterior Commissure of the Brain.—E. Fawcett: A Few Remarks on the Vertebræ.—H. A. Harris: (*a*) The Closure of the Cranial Sutures in Relation to the Evolution of the Cortex Cerebri; (*b*) A Preliminary Note on the Relation of Ossification in the Hind Limb and Skull to the Index of Cerebral Value of Anthony and Coupin.—Tudor Jones: Note on the Evidence concerning the Minute Structure of Striped Muscle.—C. J. Patten: The Syrinx, and Mechanism of Voice Production.—A Discussion on Anatomical Terminology will be opened by T. B. Johnston.

SATURDAY, JUNE 30.

GENETICAL SOCIETY (at the John Innes Horticultural Institution, Merton, S.W.19), at 1.—Annual Meeting.

PUBLIC LECTURES.

MONDAY, JUNE 18.

KING'S COLLEGE, at 5.30.—Prof. E. L. Stevenson: The Expansion of Geographical Knowledge in the Early Renaissance as illustrated by Contemporary Maps (III.): Early Spanish Discovery in the New World.—Prof. H. Wildon Carr: Some Problems in Metaphysics (II.): The Mind-Body Relation.

UNIVERSITY MUSEUM, OXFORD.—Dr. Harlow Shapley: A Search for the Centre of the Milky Way (Halley Lecture).

WEDNESDAY, JUNE 20.

KING'S COLLEGE, at 5.30.—Prof. E. L. Stevenson: The Expansion of Geographical Knowledge in the Early Renaissance as illustrated by Contemporary Maps (IV.): Early French and English Explorations in the New World.—Prof. H. Wildon Carr: Some Problems in Metaphysics (III.): The Idea of a World Soul.