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Fundamental Research in Chemical Technology.

INDUSTRIAL research has of late been much before the public eye, and in consequence an appreciation of its utility, if not of its methods or its meaning, has become general, even commonplace. Moreover, the public has learned to look to the universities for the nurture of that kind of investigation which may equally be termed profitable invention or pure research, according to the point of view of the observer. Intensive and accurately directed attacks on specific industrial problems, organised by technical men, have scored many notable successes and made important contributions to general scientific knowledge. With a single industrial aim in view, however, the tendency has frequently been to ignore side-tracks, whether or not they might lead to a broad highway of advance, and to reach the goal in ways that commend themselves to business men as economically desirable. One would say nothing whatever to disparage or discourage this type of research. Resting on fundamental bases usually already in existence—frequently on pillars which have been slowly and laboriously built up in the intellectually invigorating but financially rarefied atmosphere of a university—it has gone far towards consolidating the industrial position of Great Britain in the changed conditions of a post-War world.

It is therefore well to have in mind the character and the quality of the work which is going on among the foundations of the industrial edifice. During the past sixteen years there has, for example, been gradually growing up at the Imperial College of Science and Technology, South Kensington, a school of fuel technology and combustion research, chemical engineering and electrochemistry (together forming the Department of Chemical Technology), of which the British Commonwealth may well be proud. Directed by Prof. W. A. Bone, with the assistance of Prof. J. W. Hinchley (professor of chemical engineering) and Capt. G. I. Finch (assistant professor of electrochemistry), and hitherto supported without any public appeal by the resources of the College supplemented by generous donations from external sources—an achievement of no mean order, since the financial provision required for buildings and equipment alone has already amounted to some sixty thousand pounds—it has now reached a condition in which, after patient preparation, it is on the point of launching a concerted attack on the complex problems presented by reactions between

gases under extremely high pressures. Little indeed is known concerning the domain to be explored, but its study elsewhere in one particular direction, namely, the catalytic interaction of hydrogen and nitrogen, has already resulted in the establishment in Great Britain of a great new chemical industry, comparable with that which originated from similar researches in Germany; further, Prof. Bone's own work with pre-explosion pressures up to 200 atmospheres or so has completely dispelled any reasonable doubt as to whether the excursion justifies the labour and cost which it must involve.

An example of the unexpected behaviour of gas mixtures when exploded at these pressures, in future to be regarded as moderate only, is significant. It will be appreciated that, apart from chemical factors and the influences of temperature and pressure, other considerations such as radiation effects have to be taken into account in interpreting the experimental results obtained in the study of gas reactions under pressures higher than those normally employed. Hence, by the activation of molecules, unexpected new reactions may play a considerable part in the changes which may be followed under such conditions. In point of fact, Prof. Bone and his collaborators have already found that whilst the replacement of even small amounts of carbon monoxide in admixture with air by hydrogen has a very marked influence in accelerating the rise of pressure on explosion, nitrogen retards the attainment of maximum pressure to a surprising degree; moreover, less pressure is developed, and the subsequent cooling is retarded. Evidently, much of the radiation emitted by combustion of the carbon monoxide had been absorbed by the nitrogen (which thereby became activated) and afterwards liberated as heat.

The question of the effect of the presence of moisture on the combustion of carbon monoxide is also one to which a considerable amount of attention has been devoted. Spectroscopic studies of flames of mixtures of carbon monoxide with hydrogen, and experiments on the relative ease of ignition of partly dried mixtures of carbon monoxide with oxygen, have led to the view that undried carbon monoxide interacts simultaneously with oxygen and with water molecules; moreover, the effect of pressure in overcoming the difficulty of causing a dry mixture of carbon monoxide and oxygen to burn is such as to suggest that at high initial pressures the former is the sole course of the reaction. On the other hand, in an ordinary water-gas flame the combustion is almost exclusively indirect, and in either case the probability of some degree of activation or ionisation of the reacting gases cannot be excluded.

Although Prof. Bone is actively developing investigation into certain catalytic reactions, and has designed and had built apparatus with the view of following up results which he has already obtained, his principal aim at present is to extend his fundamental studies of gaseous combustion and explosion in such a manner as would, but a few years ago, have been regarded as beyond the range of practical engineering politics. The investigations, it must again be emphasised, are of an essentially fundamental character; whilst the results which will accrue can scarcely fail to be of major significance in modern practice, the programme will not be confined to immediate needs, or be conceived in narrow terms. The tender plant of a new technique, almost a new science, will be encouraged to develop, to blossom, and to bear fruit under conditions which provide the best possible opportunities for healthy existence and natural growth. Such conditions include the provision of highly trained specialists to lead the 'teams' of researchers, the design and construction of new and costly apparatus, and—for the work is not without risk—ample space and especially appropriate buildings. The nucleus of the staff, thanks to Prof. Bone and his colleagues, is ready; a substantial portion of the new apparatus required for the experiments in immediate prospect has recently been constructed at a cost of some £3300; and as much work is already in progress as can safely be conducted in the limited accommodation offered by the uncompleted buildings of that department of the Imperial College. That its activities, closely related as they are to the needs of the great industries of the mother-land, should not be confined within metropolitan or even insular boundaries, is only to be expected.

The support which responsible commercial organisations have accorded, and continue to grant, to this department of the Imperial College is perhaps itself proof of a realisation that independence of thought and of action, such as is characteristic of the university and is associated with freedom in the exchange of views and ideas, is not at variance with aspirations and considerations necessarily arising out of the hard facts of an industrial situation. It is, after all, a wisely invoked co-operation, rigid here and elastic there, between science and industry which best lubricates the wheels of progress without clogging their differential gear.

The Conductivity of the Atmosphere.

The Electrical Conductivity of the Atmosphere and its Causes. By Prof. Victor F. Hess. Translated from the German by L. W. Codd. Pp. xviii + 204. (London: Constable and Co., Ltd., 1928.) 12*s.* net.

PROF. VICTOR HESS'S book on the conductivity of the atmosphere was published in German in 1926, and was appreciated as the first adequate account of the subject. A hearty welcome to the English edition is assured. The work deals in orderly fashion with the measurement of conductivity, with the nature of the ionisation to which conductivity is due, with the causes which produce ionisation, and with the processes by which ions are destroyed. Of the causes which produce ionisation, the most important is the highly penetrating radiation discovered by Hess himself, and to many readers the section dealing with this radiation will prove the most interesting part of the book. The clear way in which the story is told and the restraint with which the author has abstained from spoiling the balance of the book will be admired, but we may regret that he has not gone into more detail, especially with regard to his own pioneer work.

The first step towards the discovery of the highly penetrating radiation was taken in 1901, when it was announced by Elster and Geitel, and almost simultaneously by C. T. R. Wilson, that enclosed air was continuously ionised. By 1903 it was known that the ionisation was largely due to radiation which could be cut off by heavy screens surrounding the enclosure. By 1908 it had been demonstrated that a large part of this penetrating radiation came from the ground, but observations made at such places as the top of the Eiffel Tower had indicated that the radiation did not decrease with increasing height so rapidly as had been anticipated. In 1910 the first observations in balloons were published. Hess not only improved the apparatus used for measuring the penetrating radiation in a balloon, but also made no less than ten ascents, the highest being to 5400 metres. He found in 1911 that there was a slight decrease of the total radiation up to 1000 metres, then a slow, and finally a rapid increase of the radiation. From this discovery he deduced the existence of a hitherto unknown radiation entering the atmosphere from above and of greater hardness than the known gamma rays. Hess's observations were immediately confirmed by Kolhörster, whose highest ascent reached 9 km. above ground.

In the last few years there has been great activity in the investigation of the ultra-gamma radiation in many parts of the world, notably in America. It is generally believed that this radiation comes from outer space with no preference for any special parts of the sky. Hess quotes the experiments of Kolhörster made on a glacier near the Jungfrau during three summers, from which it appeared that there was a diurnal variation with an amplitude of 15 per cent. The maximum seemed to coincide with the zenith position of the Milky Way and neighbouring regions of the sky. On the other hand, the latest observations,[1] those made by Steinke in the Engadine with improved apparatus, show no influence of stellar time. Steinke's apparatus was sensitive enough for the influence of varying barometric pressure on the absorption of the ultra-gamma radiation to be measured. Clearly, the extension of measurements of the same order of accuracy to other latitudes is desirable. It is to be noted that Hess still regards it as possible that the ultra-gamma radiation is produced in the outer atmosphere of the earth in response to some stimulus from the sun. He suggests that measurements of the penetrating radiation in the auroral zone would settle this question. Less cautious philosophers are convinced that the radiation comes from distant space. In his Trueman Wood lecture, Sir James Jeans says: "There is no reason to doubt that it originates just where it ought to, namely, in the great nebulæ. . . . In a sense this radiation is the most fundamental physical phenomenon of the whole universe." May we add that there is no reason to doubt that some day we shall have telescopes designed to give measurements of the ultra-gamma radiation from individual nebulæ, measurements which will lead to new knowledge of the structure of the universe.

Turning to the main subject of the book, we note that the conductivity of the air near the ground is such that the half-time period for the dissipation of the charge on an exposed conductor is roughly 15 minutes. The air at 9 kilometres conducts ten times as well. The small ions to which the conductivity is due have but short lives. Their usual fate is to be caught by their larger neighbours, the Aitken nuclei, within a minute after their creation.

It is found that on land the small ions are mostly generated by radioactivity. According to Hess's summary, the radium and thorium emanation in the air produce about 5 ions per c.c. per second,

[1] E. Steinke, *Zs. f. Phys.*, **48**, pp. 647-689; 1928. Abstract by Hess, *Zs. f. Geophys.*, **4**, pp. 121-123; 1928.

the α-rays being the most effective. The γ-radiation from the radioactive substances in the earth accounts for 3 ions per c.c. per second. To the 8 ions produced by radioactivity must be added $1\frac{1}{2}$ produced by ultra-gamma radiation, so that $9\frac{1}{2}$ ions per c.c. are produced each second altogether in the cubic centimetre. The most conspicuous variations in conductivity at one place are probably due to variations in the number of nuclei waiting to catch the small ions. In a fog, the small ions are caught so quickly that the conductivity assumes a very low value. On the other hand, variations between localities may be associated with the geological conditions which determine the radioactivity of the ground and of the emanation which is exuded from the ground. The high potential gradient and low conductivity of the air near London may be attributed to the slight radioactivity of London clay as well as to the pollution of the atmosphere. Hess points out that there is no part of the world for which the balance of ionisation is thoroughly known. One factor has been observed by an investigator here, another there. Observatories equipped to record all the elements simultaneously and continually are required.

Whilst the ionisation over the land is mostly caused by radioactivity, that over the oceans is to be attributed to the ultra-gamma radiation. It is perhaps a mere coincidence that the effective ionisation is about the same over land and sea; where there are several ionising agencies, there is also an excess in the number of nuclei ready to absorb the ions.

The important subject of the ionisation of the upper layers of the atmosphere is dealt with very briefly. The introductory paragraph on the composition of the air in these upper layers requires revision already. It is stated that the temperature of the atmosphere above 30 km. is unknown, and the calculations made by Humphreys of the density at heights up to 120 km. on the assumption of a uniform temperature of $-55°$ are quoted. The higher density required by the Lindemann-Dobson theory of meteors and by the records of 'abnormal audibility' is not mentioned. Recent discussions of the auroral spectrum lend no support to the doctrine that the atmosphere at 70-80 km. and upwards consists chiefly of hydrogen. The importance of these comments lies in the fact that Hess gives a table of the conductivity produced by penetrating radiation. The table depends on the assumed density of the air, and should therefore be used with great caution.

The sketch of the part played by the Heaviside layer in the transmission of wireless waves is brought up-to-date, but there is no account of the evidence from terrestrial magnetism for the existence of such a layer. This is the more remarkable, as it is mentioned that Balfour Stewart had "advanced a similar idea" in 1883, long before wireless telegraphy was thought of. It is to be hoped that in another edition some account of the brilliant work of Schuster and Chapman in elaboration of Balfour Stewart's idea will be given.

The book is a pleasure to read, not only on account of the clear exposition of the author, but also because of the smooth English of the translator. The stimulus to the study of atmospheric electricity will be felt in many quarters.

A work of this character has to be read backwards and forwards, and it is therefore particularly unfortunate that the publishers have seen fit to print across the top of every pair of pages the same heading—the electrical conductivity of the atmosphere. Such a heading does not help anyone who is looking for details of some special part of the subject. It is to be hoped that when the second edition is produced, the normal practice of varying the page headings from chapter to chapter will be followed. F. J. W. W.

Classification of the Higher Ferns.

The Ferns (Filicales); treated comparatively with a View to their Natural Classification. Vol. 3: *The Leptosporangiate Ferns.* By Prof. F. O. Bower. Pp. viii + 306 + 2 plates. (Cambridge: At the University Press, 1928.) 30*s.* net.

IN a book of some three hundred pages, beautifully produced and amply illustrated, Prof. Bower has now given us his considered views on the classification of the higher ferns. Both author and publishers are to be congratulated on this work, the former on his consistent treatment of a truly difficult subject which has long called for revision, and the latter on the dignity of the volume itself.

With admirable open-mindedness, Prof. Bower tells us, in effect, that while as the work has advanced, the older classification has suffered many changes in the light of the facts of development, the new classification now offered is by no means final, but must be used as the point of departure for further research, from which may later emerge other conclusions than those now adopted. Reluctantly one is forced to doubt the validity of old comprehensive genera of higher ferns, long accepted, as the evidence from development is laid open in the pages of this book, for the characters on which these

genera have stood provide, indeed, the only criteria readily available to the average worker in the field. This, however, is inevitable to progress, and we are given a new conception of affinity with loosened bonds, a wider view of the complexity of the problems of the ferns, and a readier understanding of the diverse origins of advanced organisms as a whole.

The classification now offered is based in part on characters of development, many of which are observable by the laboratory worker alone, and involving for their fuller appreciation an extensive knowledge of the intimate details of growth. This also is inevitable to progress and must lead in time to more intensive study of the characters themselves, and, perchance, to their widening or revaluation as knowledge of fern physiology is advanced. "To travel hopefully is better than to arrive," is the faith of the author, who aims at no finality in the new classification offered, but seeks to stimulate further inquiry on every possible line.

The general conception of the book is simple, in that it presents, chapter by chapter, a brief and clear statement of the varied views on affinity which have been held for the genera considered. A central genus is then chosen, examined in detail of habit, adult structure, and reproduction, and revised in the light of sporangial development, form, and spore-production. The same principles are involved as in the preceeding two volumes, with which the reader must be fully familiar if the author's findings are to be grasped ; for at many points the matter is condensed and argument on the significance of the characters considered is strictly avoided. For this reason the book calls for intensive reading and might well have benefited by extended argument, for the characters of many of the genera considered are so varied—some being viewed as primitive and others as advanced—that a clear picture of the position of a genus can be readily obtained only by one familiar with the intricacies of the subject. This is, however, of the nature of the case, as, for example, with the Pteroid ferns which have hairs or scales, solenostelic or dictyostelic conductive systems, open or reticulate venation, a double or single indusium, and may have the sporangial receptacle on the leaf margin or superficial with the sporangia spread in the Acrostichod manner.

It is only when the reader has fully studied in detail the genera which the author has grouped round his central types that the true value of his method is apparent. It is then seen that his aim is not to reduce the ferns to a ready scheme for identification, but to give the reader a fuller view of the plasticity of living things, which, though loosely akin, have each gone their own way in descent, and have attained a distinctive individuality which has not wholly masked their origin. It is soon apparent that the characters of general anatomy are no longer to be expected to march abreast in the phyletic advance, and that primitive features may persist or be lost at many points in the progression from the ancestral stock. The spore-bearing organs alone are then considered relatively conservative and trustworthy, and to them the author's faith is mainly pinned. Thus a sporangial mass of marginal origin may tend to pass to a superficial position in the development of the individual, and to a greater extent in the race, the order of sporangial development may be modified, the form of the sporangia themselves may be in a state of change, and the spore output may not yet have settled temporarily to a stable condition. The problem of the individual fern, and its present state rather than its final resting-place in a systematic scheme, indeed become the themes of the book, and the reader finally emerges from an intensive struggle with characters, which have only relative values, with a truer appreciation of the expressions of life than that with which he entered on his study.

Some eleven chapters are devoted to the Davalloid, Pteroid, Gymnogrammoid, Blechnoid, Dryopteroid, and Dipteroid ferns, and each is closed by a well-chosen bibliography. Of these the chapters on the Gymnogrammoids and Blechnoids are intensely interesting, and to those who have worked with the cold systematic treatment of the older classification they are a revelation in evolutionary study.

It is not to be expected that in a study such as this, which seeks to loosen affinities, all the organisms considered should find a ready place in a systematic scheme. Accordingly, a series of genera, including *Cystopteris*, *Acrophorus*, *Monachosorum*, *Prosaptia*, *Deparia*, and *Salvinia*, are treated apart in a chapter on uncertain affinities. The treatment here is necessarily brief, and prefigures some later pronouncement when the field of fact is widened.

The two final chapters are devoted to the summary of results and their bearing on evolutionary theory. Here the author shows clearly that he views his study as indicating the present drift of evolution among the higher ferns rather than defining clearly their evolutionary history, for which he offers a probable picture of earlier events rather than a definite demonstration, for the fossil record is too uncertain and fragmentary. One may do well to read these chapters in detail before the systematic study of the book is begun, as in them the viewpoint

of the author is beautifully expressed towards systematic study as a whole. It may truly be said that with the preceding volumes Prof. Bower has now given us a classical study on affinity, replete with suggestion for work on many lines, and marked by a power of expression which many will envy and admire. J. McL. THOMPSON.

South African Desiccation and the Bushmen.

The Kalahari and its Native Races: being the Account of a Journey through Ngamiland and the Kalahari, with a Special Study of the Natives in that Area. By Prof. E. H. L. Schwarz. Pp. 244 + 24 plates. (London: H. F. and G. Witherby, 1928.) 16*s*. net.

LAKE NGAMI has played a conspicuous part in the discussion whether South Africa is undergoing a progressive desiccation which threatens its whole future, or whether the climatic changes that have happened are temporary fluctuations. The late Prof. Schwarz, during his ten years' work on the Geological Survey of Cape Colony, realised the extent to which some parts of the country have been impoverished by drought. He devoted himself to the question of how this alarming process could be checked, and in 1918 published his well-known scheme for the diversion of water from the Zambezi into the great depressions of Lake Ngami and the western Kalahari.

In 1925, while on the Kalahari Reconnaissance Expedition, sent by the Government to investigate his proposals, Prof. Schwarz found the country suffering from floods, and he returned by canoe from the Victoria Falls to Lake Ngami, which was reoccupied by water, and down the Botletle River until it disappeared in the desert; he then, by an arduous waggon journey, crossed the Kalahari to the railway at Palapye. The book describes this journey, which is of special interest, as the country was then restored to the condition familiar from its description by Livingstone. "A country," says Prof. Schwarz, "that had resigned itself to the condition of permanent drought was for a time gladdened by the sound of rippling water on all sides" (p. 13). A valuable table summarises the history of Lake Ngami from 1760, when it was dry; during the period when it was a great lake, from 1813 to Livingstone's visit in 1849, when it had then begun to decline; from 1854 until 1861, when it held some shallow water surrounded by reeds; and from 1896 until 1922, when there was no water, and the lake-bed was a dry plain. The restoration of Lake Ngami is regarded as evidence of a cyclic climatic change. The account is conclusive that Africa is not threatened by progressive natural desiccation.

The volume describes important features in the geology of the country. The Zambezi Valley above the Victoria Falls is regarded as a recently made rift valley, seven miles wide, with fault-walls 250 feet high, and to this valley is attributed the diversion of the Zambezi and formation of the Victoria Falls. The basin of Lake Ngami is described as also due to a subsidence bounded by faults of recent date.

Prof. Schwarz's work was always characterised by variety of interest and daring originality, and these features are shown in his interesting account of the Bushmen. Evidence is summarised to show that they ranged all through Africa, and into Asia, and it is claimed that some of the South African natives show Australian and Patagonian affinities. The Mongoloid features of some of them are attributed to settlements of Chinese in East Africa in the tenth and eleventh centuries. This view is supported by reference to the Ming pottery found in Kenya Colony, but it is adequately explained as brought by the Arabs, who had acquired it during the overland trade between China and the Persian Gulf. The migration of Malays to Madagascar is well established; but Prof. Schwarz claimed a Malay origin for the Makalaka who live at the normal end of the Botletle River, and of the Nyam-Nyam of the Upper Nile. In regard to the Hereros, the claim is quoted that their matrilineal descent is due to their ignorance that man has anything to do with parentage, and a more reasonable explanation of that custom is adopted.

The book is a valuable contribution to the recent condition of South Africa by an exceptionally keen observer, who was never afraid of unorthodox deductions.

Our Bookshelf.

Elements of Optical Mineralogy: an Introduction to Microscopic Petrography. By Prof. Alexander N. Winchell. Third edition, revised and enlarged. Part 1: *Principles and Methods.* Pp. viii + 238. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) 17*s*. 6*d*. net.

WITHIN the last few years there have been marked advances in petrographic-microscopical technique, and Prof. Winchell, in the revised edition of his well-known text-book, has incorporated selected examples in a chapter entitled "Special Methods of Study." Under this heading he deals with the application of Fedorow methods to the study of thin sections, and in addition, the modern dis-

persion methods of refractive index determinations with immersion oils. The former are now in almost universal use on the Continent, and have been found to be invaluable in the discrimination of plagioclase felspars. The various adjustments of the universal stage are explained, and the author gives full instructions for the location and plotting of symmetry planes and other symmetry elements, bringing out in a very clear manner the extreme simplicity of the method.

Dispersion methods are essentially an improvement on the ordinary immersion methods of refractive index determinations, the refinements not only increasing the accuracy but also decreasing the number of oils necessary. With the double dispersion methods, only thirteen oils are necessary to cover the whole range of refractive indices, ordinarily requiring about sixty oils. The theory depends on the fact that increase of temperature decreases the refractive index of a liquid, whereas that of a solid remains practically constant, and decrease of wave-length of light increases the refractive index of a liquid to a much greater degree than that of a solid. The single-dispersion method employs only the first, while the double-dispersion method employs both. The measurements for the case of quartz are given as an example of the latter, and, in addition, dispersion curves for thirteen liquids are supplied.

The American Indian Frontier. By Prof. W. C. Macleod. (The History of Civilisation Series.) Pp. xxiii + 598. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1928.) 25*s.* net.

IN the classification of the subject matter of "The History of Civilisation" Series, Prof. Macleod's book on the Indian frontier falls into the section entitled "Historical Ethnology," being the fourth to be so included. That such a section should prove of great utility there is no question, though this is perhaps not the occasion to discuss whether the three volumes previously included conform strictly to its requirements; but there can be no two opinions as to the suitability for inclusion of Prof. Macleod's book. He surveys frontier relations between European and Indian from the Indian side of that border line, stressing the institutional changes from precedent conditions which have been brought about by contact and ending with an analysis of conditions as they are to-day.

Prof. Macleod has had a highly complex question to consider, which has involved the examination of a vast mass of detailed evidence. The Colonial policies, for example, of the different European nations involved, whether in war or in peace, are alone an enormous labour to disentangle, while trade relations, if not so extended or complex, entail a most difficult and tedious research. Prof. Macleod's book is a valuable contribution to ethnological and historical literature, but it is more than that. It is a document which should serve as a guide and a warning in our relations with peoples of non-European culture to-day.

Bibliography of Sponges, 1551–1913. By the late Prof. G. C. J. Vosmaer. Edited by Dr. G. P. Bidder and C. S. Vosmaer-Röell. Pp. xii + 234. (Cambridge: At the University Press, 1928.) 15*s.* net.

WHEN G. C. J. Vosmaer died in 1916, he left, all but completed, a monograph on the sponges of the Bay of Naples, on which he had been at work for more than thirty years. Those familiar with the fine quality of his work anticipated great things from this monograph, and it is to be hoped that it may yet be found possible to publish it. Meanwhile the piety of his widow, Madame Vosmaer-Röell, and of his friend Dr. G. P. Bidder, has led them to edit and publish as a separate volume the exhaustive "Bibliography of Sponges, 1551–1913," which he had prepared for the monograph.

Lacking the final touches of the compiler, whom no editor, however painstaking, can perfectly replace, the bibliography, as Dr. Bidder points out, has some imperfections, but they are not of a kind or magnitude likely to impair seriously its usefulness. Like most Continental bibliographers, Vosmaer does not seem to have been aware of the rich store of bibliographical information contained in Mr. B. B. Woodward's "Catalogue of the Library of the Natural History Museum." No one, however, will in the future attempt the serious study of sponges without this volume at his elbow, unless he be one of those younger biologists to whom Dr. Bidder feelingly alludes, who "incline to cut themselves loose from the lengthening chain of literature, and to read nothing that has appeared more than twenty years ago." To these, a consideration of the concluding paragraphs of Dr. Bidder's preface may be strongly recommended.

A Textbook of Biochemistry: for Students of Medicine and Science. By Prof. A. T. Cameron. Pp. x + 462. (London: J. and A. Churchill, 1928.) 15*s.* net.

PROF. CAMERON'S book appears to be a useful addition to bio-chemical literature; it provides an up-to-date and broad outlook on a subject which is advancing so rapidly that a chapter may become out-of-date even before it is printed. The author feels that bio-chemistry has its applications in other sciences besides physiology, and to break down some of the water-tight compartments which so often exist between them, has included chapters on the chemistry of immunology, on the utilisation of bio-chemical processes in industry, and on the relationship of bio-chemistry and pharmacology; in addition, chapters are devoted to comparative digestion, and to chemical actions brought about by moulds and bacteria. In a future edition it might be advisable to amplify somewhat the sections on internal secretions and the vitamins, substances of immense importance to the animal economy.

Although more suitable perhaps for the student of bio-chemistry, the work could be read with profit by the medical student, and also by those who wish to be in touch with the latest developments of the subject. Each chapter has a few references appended, chiefly to monographs or reviews, in which those interested can obtain the fuller information they may desire.

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.*]

The Raman Effect with Liquid Oxygen, Nitrogen, and Hydrogen.

IN some experiments we recently made to see if a Raman effect could be observed with homopolar molecules, we found that the spectrum of the light scattered by liquid air included six sharp and clearly defined lines not included in the irradiating light, which was that from the mercury arc. The wave-lengths of these lines were approximately 4317·7 A., 4674·3 A., 5026·5 A., 4468·9 A., 4849·3 A., and 4980·3 A. They with their frequencies are given below.

Element.	Exciting Radiation.		Scattered (Raman) Radiation.			$\Delta\nu$ observed.	$\Delta\nu$ calculated from Band Spectra Data.
	λ (A).	ν (vac.).	λ.	Int.	ν (vac.).	cm.$^{-1}$	cm.$^{-1}$
Oxygen	4046·6	24,705	4317·7	1	23,154	1552	1554
	4358·3	22,938	4674·3	2	21,387	1551	1554
	4358·3	22,938	5026·5	0	19,889	3049	3085
Nitrogen	4046·6	24,705	4468·9	1	22,371	2335	2331
	4358·3	22,938	4849·3	00	20,616	2322	2331
	4046·6	24,705	4980·3	0	20,073	4632	4633

The experiment was repeated with pure liquid oxygen and again with pure liquid nitrogen, and it was found that the wave-lengths 4317·7 A., 4674·3 A., and 5026·5 A. only were obtained with liquid oxygen, and the wave-lengths 4468·9 A., 4849·3 A, and 4980·3 A. only with liquid nitrogen. The existence of two of the Raman lines with each liquid can be explained by supposing them to arise from irradiation by light of the two wave-lengths 4358 A. and 4047 A. The frequency difference for the mercury line 4047 A. and the Raman oxygen line 4317·7 A. is 1552 cm.$^{-1}$, and for the mercury line 4358 A., and the Raman oxygen line 4674·3 A. is 1551 cm.$^{-1}$. With the nitrogen lines, the one, 4468·9 A., has a frequency difference with the mercury line 4047 A. of 2335 cm.$^{-1}$, and the other, 4849·3 A. with the mercury line 4358 A., one of 2322 cm.$^{-1}$.

It would seem that a mean vibration frequency of approximately 1551·5 cm.$^{-1}$ was involved in the Raman effect with liquid oxygen and a mean vibration frequency of approximately 2328·5 in the Raman effect with liquid nitrogen.

From the *Bulletin of the National Research Council*, vol. 11, Part 3, No. 57, on "Molecular Spectra in Gases," p. 232, 1554 cm.$^{-1}$ is indicated as the primary vibration frequency of the oxygen molecule in its normal state, and 2331 cm.$^{-1}$ as that of the nitrogen molecule in its normal state. The two-quantum vibration state of oxygen would appear to be 3085 cm.$^{-1}$ and that of nitrogen 4633 cm.$^{-1}$.

Our results would suggest that the primary vibration frequencies are the ones involved in the production of four of the Raman lines observed by us. The other two lines, it would seem, are produced by absorptions corresponding to the frequencies of the second vibration states of the two elements, for if with oxygen the exciting mercury line is taken to be 4358 A., the frequency difference between it and the Raman line at 5026·5 A. is 3049 cm.$^{-1}$, and with nitrogen, if 4046·6 A. of mercury is taken as the exciting line, the frequency difference between it and the Raman line at 4980·3 A. is 4632 cm.$^{-1}$.

In experiments with liquid hydrogen irradiated with light from the mercury arc, we found that in addition to the usual mercury lines there were included in the spectrum of the scattered light lines corresponding to wave-lengths 4426·6 A., 4473·1 A., and 4863·5 A. These with their frequencies are given below.

Element.	Exciting Radiation.		Scattered (Raman) Radiation.			$\Delta\nu$ observed.	$\Delta\nu$ calculated from Band Spectra Data.
	λ (A.).	ν (vac.).	λ (A.).	Int.	ν (vac.).	cm.$^{-1}$	cm.$^{-1}$
Hydrogen	4358·3	22,938	4426·6	2	22,584	354	347
	4358·3	22,938	4473·1	4	22,350	588	578
	4046·6	24,705	4863·5	1	20,556	4149	4159

By the use of suitable light screens, it was found that 4426·6 A. and 4473·1 A. were excited by the radiation 4358·3 A., and 4863·5 A. by radiation 4046·6 A. The available data on the band spectra of hydrogen enable one to show that 347 cm.$^{-1}$ and 578 cm.$^{-1}$ are the frequencies corresponding respectively to $0 \rightarrow 2$ and $1 \rightarrow 3$ rotational transitions for hydrogen molecules in the zero vibrational state. It can be shown, too, that 4159 cm.$^{-1}$ is the frequency of a $0 \rightarrow 1$ vibrational transition for hydrogen molecules in the zero vibrational state. From the numbers given in the table, it will be seen that the Raman effects we observed with hydrogen were due to these three transitions.

The results are interesting in that they constitute a series of violations of generally accepted selection rules. They show (1) that Raman effects can be obtained with homopolar molecules; (2) that part of the energy of light quanta can be taken up directly as rotational energy, the balances appearing as quanta degraded in frequency; and (3) that two-quantum rotational transitions can be demonstrated in connexion with light-scattering phenomena.

The results of the experiments, moreover, constitute experimental proof of the correctness of Dennison's view that hydrogen at low temperatures must be regarded as a mixture of two effectively distinct sets of molecules, symmetrical and antisymmetrical. According to our results, we have in liquid hydrogen (1) some molecules in the zero vibrational and zero rotational states, and (2) others in the zero vibrational and first rotational states. Our intensity measurements show that there were in the latter states considerably more (about twice as many) molecules than in the former ones. The 'distinctness' of the two states is emphasised by the fact that no Raman effects were obtained corresponding to $0 \rightarrow 1$ or $1 \rightarrow 2$ rotational transitions.

J. C. MCLENNAN.
J. H. MCLEOD.

University of Toronto, Dec. 20.

The Understanding of Relativity.

MAY I have space for a last letter about the difficulties of the ordinary man with respect to relativity and kindred puzzles? Of course there is such a thing as relativity. We take it into account in daily life. But I cannot believe that modern mathematicians have overthrown fundamental axioms of thought. Such dictionaries as I have consulted define parallel lines as those which keep equidistant from each other. But a spiral wound around a straight line might keep equidistant, and yet not be parallel. Presumably parallel lines are those which keep equidistant on the

same plane. If that be true, lines of longitude are not parallel for even an inch. But if lines were drawn from points at a given distance on opposite sides of one pole to points in similar relation to the other pole, they would be parallel—like lines of latitude drawn equidistant from the equator. To define parallel lines as those which meet at infinity is merely to confuse the learner by giving a contradictory meaning to an old word. It may be that lines which *seem* parallel in perceptual space are found to be convergent, when more than three dimensions are brought into consideration; but that proves not that a fundamental axiom of thought (that things cannot both be, and not be, at the same time) is wrong, but only that our senses deceive us.

I write as a representative of the ignorant crowd. I have a notion (founded not on knowledge, for the higher mathematics are beyond me, but on hearsay) that mathematicians have reached their conclusions by taking space of more than three dimensions into account. I cannot perceive such space, and therefore cannot imagine it, and I am sure that no mathematician is better able. We can imagine only in terms of the senses which we have already used. Because I have seen, I am able to picture a dragon such as was never yet on land or sea. But a congenitally deaf man has no conception of sound, and one who was born blind thought that scarlet was like the sound of a trumpet. Since our senses do not reveal more dimensions than three, we can gather no clearer conception of four or more than the congenitally blind or deaf have of sight or sound. Nevertheless, on production of evidence, we may believe in these inconceivable dimensions just as the blind or deaf believe in sight or sound.

Doubtless many aspects of reality are outside the range of our senses. If I am right as to what mathematicians have been at, all this seems simple. If, by taking more than three dimensions into account they have been able to predict truths hitherto unknown to us, then we must accept their evidence, and believe, for example, that lines that seem straight or parallel to us are not really so. But the work of mathematicians is one thing; the work of those who expound it to the ignorant is another thing. For example, it is one thing to say that the straight or parallel lines of our perceptions are not really straight or parallel; but quite another thing to declare that space itself is curved, and therefore that straight lines curve and parallel lines meet. In other words, it is one thing to say that our senses are defective, and another thing to announce that contradictory statements are both true.

G. ARCHDALL REID.

20 Lennox Road South,
Southsea, Jan. 11.

ON page 84 of NATURE for Jan. 19, Mr. McLennan expresses polite surprise that I allow myself to accept results, even on good evidence, which are repugnant to uninstructed common sense, or in other words, which run counter to the prejudices born of life-long experience. Unfortunately, it has been my lot to come across phenomena so superficially alien to common sense that they are not acceptable to the scientific world, though they nevertheless presumptuously occur. Apart from those untoward happenings, however, and on more ordinary lines, we have to admit that common sense is not always a trustworthy guide in the face of evidence to the contrary. Even 1 and 1 are not always 2 when the units are concrete things, especially when the element of time is allowed to function. If they are mercury globules, in a little while the result may be still 1; whereas if they are amœbæ the result may be 4. Simple addition is not always the correct rule for compounding quantities; any more than the rule-of-three need be valid when simple proportion is not guaranteed.

The compounding of two velocities certainly looks as if it should be done by simple addition; but we must remember that the speed of a body moving on the earth is not an absolute or complete specification. Something has been ignored. Both bodies are moving through space: and space (or ether) has an unknown constitution. It is certainly afflicted with something which poses as a constitutional velocity,—a constant which declines to be ignored in extreme cases, and which we call c. So our ordinary velocity v may more strictly or fully be specified as v/c, for it is a fraction of the fundamental velocity in space. Hence when compounding u/c with v/c, to get the result w/c, simple addition turns out to be insufficient; the product uv/c^2 is involved as well. Many a schoolboy has found, to his chagrin, that $\tan(a+b)$ must not be written down as $\tan a + \tan b$, but that the product $\tan a \tan b$ is involved as well. That velocities ought to be compounded in this semi-trigonometrical fashion is not the least obvious, but that the fact is so may be intensely important; for it suggests that in space there is something rotational, which makes no appeal to the senses and can be ignored by engineers and practical people, though it may not be ignored by physicists.

To take another example. The velocity of light in stagnant water is c/μ, and if the water is flowing in the same direction with velocity v, common sense might say that the resultant velocity of the light should be $c/\mu + v$; but that is not what Fizeau found to be true. He found experimentally, what Fresnel had previously predicted, that v/μ^2 must be subtracted from the sum in order to give the true result.

All these queer rules of composition follow from the Larmor-Lorentz transformation, which was invented some years before relativity was heard of; though it was Einstein who seized the idea, boldly reclaimed it from abstraction, and applied it to actuality, in spite of the strangeness and apparent absurdity of some of the results. Would that science generally might gradually perceive that occurrences apparently preposterous may nevertheless be true! The universe is regulated by sense, no doubt, but not by common sense or uninstructed prejudice.

In conclusion, I quite sympathise with Mr. McLennan, and indeed with the others, in their temporary bewilderment. Odd results ought not to be accepted too cheaply.

OLIVER LODGE.

Normanton House,
Lake, Salisbury, Jan. 20.

MR. MCLENNAN says (NATURE, Jan. 19, p. 83) that $V + v = V$ is incompatible with common sense. Is $P + \rho = P$ equally incompatible, where ρ is density: and is he forced to believe that the density of a mixture must always be greater than that of either of its components? Doubtless he will say, No. If he will consider very carefully why he thinks velocity, but not density, must be additive, he will probably arrive at a solution of his other difficulties.

N. R. C.

An Iodine Liberator from Laminariæ.

AN aqueous extract of fresh fronds of Laminariæ will, when acidulated, liberate iodine from potassium iodide.

This fact, recently observed by me, does not seem to have been previously recorded. It suggests an explanation of the process by which marine algæ

collect comparatively large quantities of iodine from the sea water in which it occurs in such low concentrations. It seems possible that at certain parts of the plants or at certain times of the year a sufficient acidity is developed to enable this iodine-liberating body to act on the inorganic iodides in the sea water which is in contact with the fronds. The iodine thus liberated would then combine with unsaturated bodies in the plants. According to this theory, the inorganic iodides which are found in the plants would of course be secondary products of metabolism. The existence in various varieties of algæ of unsaturated acids which would serve for the absorption of the free iodine has recently been demonstrated by Tsujimoto (*Chem. Umschau*, **32**, 125; 1925).

The presence of an iodine liberator would also furnish an explanation of the observations of Freundler, Menager, and Laurent (*Compt. rend.*, **173**, 1116; 1923) on the loss of iodine by seaweeds on drying. During the drying, acidity probably increases to the point at which the iodine liberator can act.

The iodine-liberating solution is easy to obtain. In my experiments the fronds of *Laminaria digitata* or *Laminaria saccharina*, freshly gathered from the seashore, where they had been thrown up by the tide, were minced in an ordinary mincing machine, treated with their own weight of distilled water containing a little toluene (5 c.c. per litre) to arrest bacterial action, and left standing for about twenty-four hours. The liquid was poured off through a Buchner funnel (without filter paper), and this liquid, on treatment with a little hydrochloric or acetic acid and a solution of potassium iodide, gave a pink colour on shaking up with carbon disulphide. The pink colour may sometimes be observed without the addition of potassium iodide, sufficient iodides being already present in the solution. The addition of potassium iodide, however, seems to intensify the colour.

When the solution was placed in a parchment filter which was immersed in distilled water for a few days, the iodine-liberating property was found in the outer liquid. In fact, this dialysed product appeared to be more active than the original extract.

Boiling does not appreciably impair the iodine-liberating power of the solution. This fact, together with its property of dialysing through parchment, pointed to the possibility that the active agency consisted of ferric ions. The solution does not give a pink colour with potassium thiocyanate, but I have found that concentrations of ferric chloride which give a doubtful response to this test will when acidulated liberate easily detectable quantities of iodine. When 25 c.c. of the solution were evaporated to dryness and ignited and the resulting ash dissolved in 2 c.c. of dilute hydrochloric acid, this solution gave a pink colour with potassium thiocyanate. Iron is therefore present, but only in such concentration that if it exists as ferric ions, the liberation of iodine by it would be very slow.

Any theory that inorganic ions are responsible for the iodine-liberating activity of the liquid seems, however, to be ruled out by the following experiment. 25 c.c. of the dialysed product were evaporated to dryness in a beaker on a piece of wire gauze, and carefully heated until the yellow residue began to turn brown. This residue was then dissolved in dilute hydrochloric acid and the solution was made up to about 24 c.c. (a little less than the original volume). The solution thus obtained did not liberate iodine.

From the observations so far made, the iodine-liberating agent would appear to be a dialysable organic body. Further study of the substance is in progress. In the meantime it should be of interest to try whether such a body can be detected in the thyroid gland. In this connexion I should mention that while I have never had any difficulty in obtaining an iodine-liberating extract from Laminariæ, in my only experiment with *Fucus* (which contains a much smaller percentage of iodine) I failed to obtain it. If an iodine liberator exists in the thyroid gland, its detection will be by no means so easy as in the case of Laminariæ.

THOMAS DILLON.
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Dissociation of Hydrogen by Collisions of the Second Kind.

HEITLER and London have calculated the potential energy of the ground state of H_2, and they have found besides the known 1^1S state, another potential energy curve which is called by them 1^3S. This curve is higher than the 1^1S curve by an amount equal to the heat of dissociation of the hydrogen molecule. Stuckelberg and Winans have used this curve to explain in a very nice manner the continuous spectrum of the hydrogen molecule. Their explanation, in brief, is that transitions from any one of the excited triplet levels to this 1^3S level give rise to a continuous spectrum.

It is the purpose of this short note to direct attention to the application of this new level to the interpretation of the Cario and Franck experiment on the dissociation of molecular hydrogen in a mixture of hydrogen and excited mercury atoms in the 2^3P_1 state. The usually accepted interpretation is that the energy of excitation of the mercury atom goes into an increase in the vibrational energy of the hydrogen molecule, and since the energy of the mercury in the 2^3P_1 state is more than sufficient to dissociate the molecule, enough energy of vibration is acquired during the collision to dissociate it. Other explanations have been suggested, such as the possibility of a chemical combination taking place between the excited mercury atom and the hydrogen molecule and subsequent dissociation ensuing. It is possible now to propose still another interpretation for the Cario and Franck experiment. The explanation is, briefly, that the result of a collision between an excited mercury atom and a normal hydrogen molecule is the excitation of the molecule from the 1^1S to the new 1^3S level. Since the potential energy curve in this level possesses no minimum, it is an unstable state and immediate dissociation results.

The question arises as to the probability of such a transition occurring. Since 11·5 volts is very close to the height of the 1^3S curve over the 1^1S curve at the nuclear separation corresponding to the minimum of the 1^1S curve, it is quite clear that for electron impact the most probable transition is one corresponding to nearly this energy. This is simply in accordance with the Condon theory of band intensities, and in terms of the potential energy diagrams for the two levels it means that the most probable transition is a vertical one. Elsewhere, Dr. Kinsey and I have directed attention to evidence which points to the fact that in collisions of the second kind between excited entities and diatomic molecules, diagonal transitions are very probable (*Physical Review*, Abstract in press). We have here, therefore, another phenomenon that provides evidence for the truth of the above statement that it is possible to cause diagonal transitions in collisions of the second kind, whereas in electron impact the most probable transitions are vertical ones.

This interpretation of the Cario and Franck experiment requires that dissociation of hydrogen should occur by collisions of the second kind with atoms or

molecules that possess energy greater than the energy of dissociation. It does not follow any longer that dissociation will be most probable when the energy of the excited entity is most nearly equal to the dissociation energy. The most probable conditions for dissociation will now be determined by the most probable jump between the two potential energy curves for the 1^1S and 1^3S levels.

This explanation of the Cario and Franck experiments does not, without further discussion, rule out the explanation that the energy goes directly into vibrational energy in the normal 1^1S level. This question of the transfer of energy from electronic to vibrational energy will be considered in a future communication.

JOSEPH KAPLAN.

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Microseisms associated with Storms in the Indian Seas.

THE ground is never at rest, and a seismograph provided with an aperiodic pendulum and a large magnification will always record these ever-present movements. The types are often so complicated that it is not easy to distinguish those associated with definite weather disturbances. To obviate these difficulties, a Milne-Shaw seismograph was installed some four years ago in the underground constant temperature room of the Colaba Observatory, and its working condition was so arranged that it should just cease to record microseisms when the weather was undisturbed over the neighbouring seas, as in the months of January and February, when the wind velocity seldom exceeds 20 miles per hour over the sea areas. It was then noticed that microseisms made their appearance in the records whenever weather was disturbed over the Arabian Sea or the Bay of Bengal, so as to cause rough seas over a fairly wide area. In particular, three distinct types of microseisms were recognised, and these were associated with (1) the south-west monsoon, (2) the storms in the Arabian Sea and the Bay of Bengal, and (3) local disturbances, such as pronounced land and sea breezes. Those associated with the south-west monsoon are steady vibrations, having periods varying from 4 to 10 seconds, according to the strength of the air current over the sea.

The periods and the amplitudes of these movements are easily explained theoretically if they are considered to be standing vibrations on the earth's surface, combining to form progressive waves, analogous to Rayleigh waves, produced and maintained by the sea-waves generated by the monsoon currents. The microseisms associated with storms have periods varying from 4 to 6 seconds and show typical irregular variations in amplitude owing to superpositions of waves of different periods arising on account of the existence of a marked difference in wind velocity in the storm and surrounding areas. They make their appearance in the seismograms as soon as a storm has formed, and disappear only after it has passed inland and ceased to affect the sea.

The types are readily distinguished, and thus throw open to the meteorologists a new method of forecasting the existence of storms. The amplitudes of microseisms are found to be a function of the distance and the intensity of the storms. For example, the microseisms developed by the storm in the Arabian Sea, which crossed the coast between Bombay and Ratnagiri on Nov. 12, 1927, had amplitudes about four times larger than those due to a storm in the Bay of Bengal, which crossed the coast near Nellore ten days before, but the types were identical.

During the pre-monsoon and the post-monsoon periods, when the records are almost free from monsoon microseisms, the formation and the early development of a storm are easily recognised by the gradual appearance of feeble microseisms of variable amplitude, which become more and more marked as the storm is fully developed. During the four years the instrument has been in operation, several storms formed in the Arabian Sea and the Bay of Bengal, and all of them gave rise to microseisms of this kind from the time of their formation until they passed inland and ceased to disturb the sea.

The microseisms associated with a local disturbance have large periods, varying from 20 to 30 seconds, and appear to be caused by waves over the shallow sea near the coast, for such waves have periods of exactly this order. They are certainly not due to the shaking of buildings and trees by gusts of wind, for such shakings will cause vibrations, which in an ordinary building will have periods less than 0·1 sec. A detailed account of these investigations is now ready and will be shortly published.

S. K. BANERJI.

The Observatory, Bombay,
Nov. 30.

Refraction of Beams of Molecules.

IN the Stern-Gerlach experiment the deviation of a beam of molecules in a magnetic (or electric) field is comparable to the optical case of the refraction suffered by a beam of light in traversing a medium, the refractive index of which varies in a direction perpendicular to the beam; the variation of the refractive index being analogous to the force or gradient of the field. However, in optical instruments the standard method of obtaining refraction is to allow the beam to travel from a homogeneous medium of refractive index n_1 to another of refractive index n_2. The total refraction is then independent of the rate of variation of refractive index in the interface.

It is of interest to follow out the obvious analogy for a molecular beam. In the diagram, a beam of

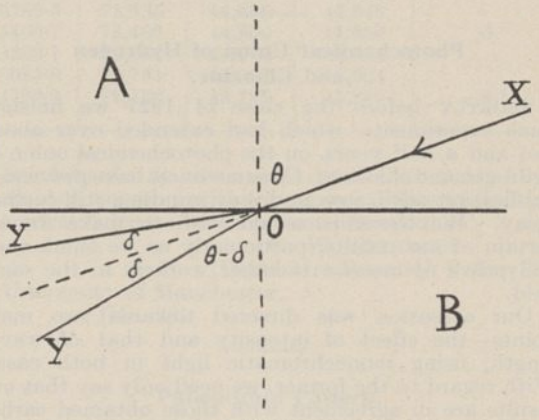

FIG. 1.

molecules XO passes from a region of no magnetic field A to another region B in which obtains a homogeneous magnetic field H perpendicular to the plane of the paper. Such a field can be produced between the flat pole pieces of a magnet. Let the beam be in the plane of symmetry between the pole pieces. We consider for simplicity a beam of alkali atoms in the normal state with kinetic energy E. The atoms will be orientated parallel or anti-parallel to H.

Since there is no component of the force parallel to the edge of the pole piece, we have as in the optical case,

$$\sin(\theta-\delta)v_B=\sin\theta v_A,$$

$$\frac{\sin\theta\cos\delta-\cos\theta\sin\delta}{\sin\theta}=\frac{v_A}{v_B}\frac{\sqrt{\frac{2E}{m}}}{\sqrt{\frac{2}{m}(E+\mu H)}},$$

where μ is the Bohr magneton.

Since δ is small

$$\delta=\left(1-\frac{1}{\sqrt{1+\frac{\mu H}{E}}}\right)\tan\theta.$$

If the ratio $\mu H/E$ is small

$$\delta=\frac{\mu H}{2E}.\tan\theta.$$

For a distance l, the total deviation will be

$$\Delta=\delta l=\frac{\mu H}{2E}.l\tan\theta.$$

What is of experimental importance in the final equations is that the deviation depends on the value of the homogeneous field only, which enables one to dodge the serious technical difficulties involved in determining the inhomogeneity of a magnetic field in a small region.

As a numerical example: if l be 10 cm., $H=10^4$ gauss, $\mu=1$ Bohr magneton, $0{\cdot}92\times10^{-20}$ gauss cm., E the average energy for 0° C., and $\theta=80°$ (app.), then Δ is approximately 0·5 mm., a conveniently measurable deflection.

The above considerations also apply to the case of an electric field; here a parallel plate condenser takes the place of the flat pole pieces. One can also generalise the above procedure and construct analogues of prisms, etc.

A complete discussion, including an experimental investigation, will be published in the *Zeitschrift für Physik*.

I. I. RABI
(International Education Board Fellow).
University of Hamburg.

Photochemical Union of Hydrogen and Chlorine.

SHORTLY before the close of 1927 we finished some experiments, which had extended over about two and a half years, on the photochemical union of hydrogen and chlorine. Circumstances have prevented publication until now, and may impose a still further delay. We therefore would wish to make known certain of our results, particularly as we think they will prove of interest to other workers in the same field.

Our attention was directed towards two main points—the effect of intensity and that of wave-length, using monochromatic light in both cases. With regard to the former, we need only say that our results are in agreement with those obtained earlier by Mrs. M. C. Chapman and with those published after the commencement of our experiments by Kornfeld and Steiner and by Marshall. The effect of wave-length on quantum efficiency was, however, surprising. We worked with moist electrolytic gas, employing the Bunsen-Roscoe technique and used the quartz-mercury lamp lines at (*circa*) 546, 436, 405, 365, 313, and 260 $\mu\mu$, separating these so far as possible by means of filters. Four of the latter let through less than one per cent of foreign light, and the only serious uncertainty arose with the filter for 260 $\mu\mu$. The incident intensities, as also the amount and nature of foreign light in the beams used, were determined by thermopile measurements, and the absorbed intensities calculated from the data of von Halban and Siedentopf. The result was that we found the quantum efficiency to rise from 546 $\mu\mu$ to 405 $\mu\mu$, and then, as the frequency was increased, to fall off to 260 $\mu\mu$. The actual (relative) figures are as follows:

Wave-length	260 $\mu\mu$	313 $\mu\mu$	365 $\mu\mu$	405 $\mu\mu$	436 $\mu\mu$	546 $\mu\mu$
Quantum efficiency	0·10	0·49	0·53	1·00	0·67	0·22

The figure for the first group of lines could only be determined very roughly, but certainly did not exceed fifty per cent of that obtained for the same gaseous mixture, with practically monochromatic 436 $\mu\mu$ radiation. The sensitivity of the gas used in the various experiments corresponded to a yield of the order of 200,000 molecules of HCl per quantum of blue light absorbed. It showed no induction period, but gave a marked Draper effect during the first instants of insolation.

Experiments carried out at 19·7° and at 25° showed the relative temperature coefficients of the quantum efficiency to increase slowly, but unmistakably, with wave-length between 313 $\mu\mu$ and 436 $\mu\mu$. Other experiments in which two 'monochromatic' beams were allowed to act simultaneously gave a velocity equal to the sum of their separate effects, in disagreement with work of Padoa, but in agreement with the conclusion to be drawn from the experiments on the effect of intensity.

It is difficult to explain our main results without recourse to *ad hoc* hypotheses, of which we have considered many. To two points, however, we would direct attention. The relative efficiencies found for the 436 $\mu\mu$ and 260 $\mu\mu$ rays are in agreement with the experiments of Heymer (1927), whilst the definite effect of the mercury green line (most workers seem to assume, on insufficient experimental evidence, that it would be inactive) is in accord with recent work of W. Taylor.

Further experiments, using spectrally dispersed light, are now being started in this laboratory.

A. J. ALLMAND.
EDWARD BEESLEY.

Chemical Department,
King's College,
London, W.C.2,
Jan. 21.

Diffraction of Electrons at Ruled Gratings.

IN June of last year (*Proc. Phys. Soc.*, vol. 40, p. 284) I made a preliminary announcement of an experiment on the diffraction of electrons from a ruled grating in much the same way as has been done with X-rays. In a recent publication summarised in NATURE of Jan. 5, p. 29, E. Rupp has published results of an investigation on this subject, using a method very similar to my own, in which he obtains diffraction images on one side of a reflected line, which yield a value of the equivalent wave-length in good agreement with the de Broglie value. In view of the immediate interest in experiments of this type, I give below the results of a preliminary experiment which I obtained in December last.

Electrons from a coated filament were 'collimated' and sent at a glancing angle of the order of 1° on to a ruled grating (speculum). A series of experiments verified that electrons, but no light, were falling on the grating, and a photographic record was obtained which clearly showed a diffracted line on *both sides* of the direct reflected line. Any doubt as to this

being due to secondary X-rays from the slits, etc., was eliminated, as a simple calculation shows that 1300 volts were necessary to produce X-rays corresponding to the upper limit assigned to the observed pattern, whereas the maximum accelerating voltage applied from accumulators did not exceed 85 volts.

The photograph is not ideal for reproduction or precise calculation, but the diffracted lines are clearly visible to the eye and show an assymmetric displacement about the direct reflected line, as is anticipated from theoretical considerations. These points are seen in the accompanying diagram (Fig. 1) which

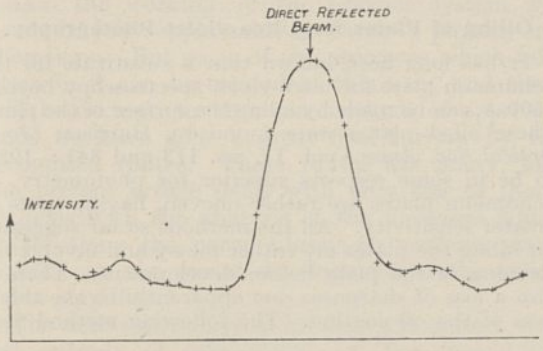

FIG. 1.

shows the result of a photometric examination of the plate, kindly made by Dr. W. H. J. Childs.

The results differ from those of Rupp inasmuch as there are diffracted images at both sides of the reflected line. This is to be anticipated from general considerations of diffraction, and in the X-ray case Compton and his school obtain a similar effect.

The ordinary optical formula for a grating, when using small glancing angles, θ, reduces to

$$n\lambda = \frac{da}{2}(2\vartheta - \alpha)$$

where α is the angle between the reflected and the diffracted line and d is the grating element. Clearly, when $\alpha = \theta$, a limit is reached, which shows that when θ is less than $\sqrt{2\lambda/d}$ no diffracted line will occur on the small angle side of the reflected beam. Rupp uses very small angles, θ, and his one-sided diffracted system is therefore explained on these lines.

These experiments are still in progress, and I hope to make an early announcement of more results, and a description of the experimental details.

B. L. WORSNOP.

Wheatstone Laboratory,
King's College,
London, W.C.2, Jan. 19.

The Refractivity of Gaseous Compounds.

SOME simple relations appear to exist between the refractivities of a number of gaseous compounds and their constituents in the gaseous state which, so far as I know, have not hitherto been published. The refractivity of an atom depends largely on the outer electrons which are loosely bound to the nucleus. Previously it has been considered that when combination occurs between atoms the outer electrons are so distorted that the refractivity of a molecule is not related in any simple way to the refractivities of the constituent atoms and that the deviation from an additive law is a measure of the distortion (cf. Fajans and Joos, *Zeit. f. Phys.*, vol. 23, p. 1; 1924; Born and Heisenberg, *Ibid.*, vol. 23, p. 388; 1924; Havelock, *Phil. Mag.*, vol. 3, pp. 158, 433; 1927).

The following simple relations have been observed. If $(\mu - 1)_R$ is the refractivity of the substance R, *in the gaseous state*, under normal conditions as defined by Cuthbertson (*Phil. Trans. Roy. Soc.*, vol. 204, p. 323; 1905), where μ is the refractive index, then

$$\begin{aligned}(\mu-1)_{HCl} &= \tfrac{4}{7}(\mu-1)_{Cl_2}\\ (\mu-1)_{HBr} &= \tfrac{1}{2}\tfrac{3}{5}(\mu-1)_{Br_2}\\ (\mu-1)_{CCl_4} &= \tfrac{1}{7}\tfrac{6}{}(\mu-1)_{Cl_2} = 4(\mu-1)_{HCl}\\ (\mu-1)_{CS_2} &= \tfrac{4}{3}(\mu-1)_{S_2}.\end{aligned}$$

The ratios $(\frac{4}{7})$, $(\frac{1}{2}\frac{3}{5})$, $(\frac{1}{7}\frac{6}{})$, and $(\frac{4}{3})$ are closely related to the number of loosely bound electrons, which in Cl_2, HCl, CCl_4, S_2, and CS_2 are assumed to be the M electrons and in Br_2 and HBr the M and N electrons. If the chlorine atoms in HCl and CCl_4 and the bromine atom in HBr are singly ionised, and if the sulphur atoms in CS_2 are doubly ionised, then Cl_2 contains fourteen loosely bound electrons, HCl eight, CCl_4 thirty-two, S_2 twelve, CS_2 sixteen, Br_2 fifty, and HBr twenty-six. It is seen that the ratios between the numbers of loosely bound electrons are the same as the ratios between the refractivities.

This way of regarding the problem is obviously much too simple and is applicable in only a few cases. In general, relations of the kind given above do not appear to exist between the refractivities of substances in the gaseous state. It is, indeed, surprising how well the simple relations hold for HCl, HBr, CCl_4, and CS_2. In Table 1, results are given for HCl, and Cl_2 for a series of wave-lengths λ.

TABLE I.

λ.	$(\mu-1)\times 10^6$.			Percentage Difference between (2) and (3).
	(1) $(\mu-1)_{Cl_2}$.	(2) $(\mu-1)_{HCl}$.	(3) $\frac{4}{7}(\mu-1)_{Cl_2}$.	
6707·8	77,563	44,375	44,320	−0·1
6438·5	77,703	44,444	44,400	
5790·5	78,121	44,656	44,640	
5769·5	78,135	44,666	44,648	
5460·7	78,400	44,800	44,800	0
5209·1	78,651	44,930	44,944	
5085·8	78,791	45,007	45,024	
4799·9	79,166	45,187	45,240	+0·1

It is intended to give a more detailed account of this work soon, together with some general observations on the refractivities of other gaseous compounds.

G. W. BRINDLEY
(Darbishire Research Fellow).

University of Manchester,
Dec. 28.

Palæolithic Pottery.

IN NATURE of Jan. 19, p. 104, it is stated, in reference to Mr. Leakey's discovery in Kenya of pottery associated with an Aurignacian industry, that nowhere else does pottery occur at so remote a period.

There are, however, on record certain discoveries which go to show that this statement perhaps needs modification. These are—

1. The finding, in the cultural layer immediately overlying that in which the famous Neanderthal skeletons of Spy were unearthed, of the bones of "fossil animals, also those of a few living species,

several thousands worked flints, some of which still of the Mousterian type, many worked bones, including arrow points, and also fragments of pottery."[1]

2. The discovery, in several caves in Belgium, of the remains of pottery in Upper Palæolithic deposits.[2]

3. The finding, by me, in a small valley to the north of Ipswich, of fragments of pottery, of a hitherto unknown type[3] associated with flint implements of Upper Mousterian or Lower Aurignacian forms, in a geological deposit of manifest antiquity. In regard to this latter discovery, I may say that it was by no means easy to recognise, at first, that the fragments of what looked like charcoal in the geological deposit mentioned were indeed pieces of pottery, and it was only by a very careful examination that this recognition was made possible.

Personally, so small a value do I place upon the making of primitive pottery as an indication of the advancement and capabilities of any prehistoric people, that it would not surprise me to hear of its discovery in, for example, a 'floor' of Late Acheulean age.

It is, of course, possible, for those who do not believe that Palæolithic man made pottery, to deny that any of the discoveries I have enumerated are of Palæolithic age. But this claim carries with it the necessity of proving it to be true.

J. REID MOIR.

Ipswich.

Short Wave Echoes and the Aurora Borealis.

BOTH Prof. Appleton and Dr. van der Pol have suggested in letters in NATURE of Dec. 8 that the echoes observed by Prof. Størmer with delays of about ten seconds might be explained by the disturbance spending a long time in a region containing so many electrons per c.c. that the group velocity of the disturbance was very small.

The effective dielectric constant ϵ and conductivity σ of a region containing N free electrons per c.c. for waves of frequency $\omega/2\pi$ are given by $\epsilon + \frac{4\pi\sigma}{i\omega} = \frac{3+2\alpha}{3-\alpha}$, where $\alpha = -\frac{4\pi Ne^2}{m(\omega^2 - if\omega)}$; f measures the rate at which the velocity of the electron becomes uncorrelated with its initial velocity, so that $f = v/l$ where v and l are the velocity and effective free path of the electron. The condition that the group velocity is zero is that $\epsilon = 0$, *i.e.*, since $f \ll \omega$, $N = 3m\omega^2/8\pi e^2 = 1{\cdot}9 \times 10^6$ electrons per c.c. for wave-length 30 metres (Dr. van der Pol, *loc. cit.*, using the formula valid for small α, obtains $N = 10^6$).

Even if the atmospheric pressure is very low, so that collisions with atoms contribute little to f, a minimum value of f, for given N, is fixed by the effects of the electrostatic forces between the electrons, and between the electrons and other ions. A calculation I have recently made (*Proc. Roy. Soc.*, A, vol. 121, p. 464) gives the following approximate formula for the effective mean free path in such circumstances,

$$l = 3v^4 \Big/ 4\pi\left(\frac{2e^2}{m}\right)^2 N \log\left(3v^6/4\pi\left(\frac{2e^2}{m}\right)^3 N\right).$$

Assuming $v = 1{\cdot}2 \times 10^7$ (P. O. Pedersen, "The Propagation of Radio Waves," p. 44), we obtain $l = 4{\cdot}8 \times 10^2$ cm., $f = 2{\cdot}5 \times 10^4$.

For a delay of t seconds the signal intensity is reduced to $e^{-ft/2}$ of its initial value (Prof. Appleton, *loc. cit.*), that is, for a delay of 10 sec. to $e^{-125{,}000}$. The suggested explanation seems, therefore, to be untenable, unless it is assumed that v is much larger. If v were 30 times as large ($v = 3{\cdot}6 \times 10^8$, corresponding to 37 volts) the minimum reduction for a 10 sec. delay would be to $e^{-4{\cdot}6}$ ($= 1/100$) of its initial value.

The above objection does not apply to the second explanation put forward by Prof. Appleton.

L. H. THOMAS.

Trinity College,
Cambridge, Jan. 14.

Oiling of Plates for Ultra-violet Photography.

IT has long been known that a substitute for the Schumann plate for ultra-violet spectroscopy beyond 2500 A. can be made by oiling the surface of the plate. These oiled plates were found by Harrison (*Jour. Optical Soc. Amer.*, vol. 11, pp. 113 and 341; 1925) to be in some respects superior for photometry, as Schumann plates are rather uneven, having spots of greater sensitivity. All the methods so far suggested for oiling the plates are rather messy and involve the cleaning of the plate before development. There is also a loss of sharpness due apparently to the thickness of the oil coating. The following method used

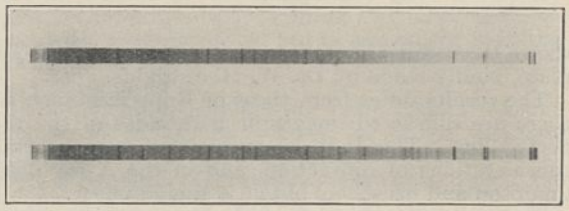

FIG. 1.

by me seems to overcome these disadvantages and may be of interest to other workers in the subject. I use a filtered solution of 5 grams of vaseline in a litre of petroleum ether. The quantity of vaseline may be increased for certain work. The plates are flooded with this solution in a dish and lifted out and rapidly dried. After exposure they can be developed without further treatment by the 'stand method.'

The accompanying photograph (Fig. 1) is of the aluminium condensed spark from the visible to 1830 A. The exposure was 15 sec. in each case on a Wellington anti-screen plate. The first exposure was made, the plate was then flooded with the 0·5 per cent solution three times, being dried between each. The second exposure was then made and the plate developed in glycin.

A. CHRISTOPHER G. BEACH.

Chelsea Polytechnic,
London, S.W., Jan. 7.

Raman Lines from Hydrochloric Acid Gas.

(BY CABLE, THROUGH SCIENCE SERVICE, WASHINGTON, D.C.)

BY employing a long end-on tube excited by a parallel Cooper Hewitt mercury arc with aluminum reflectors, I have obtained the modified lines of gaseous hydrochloric acid at atmospheric pressure corresponding to the vibration–rotation absorption band at 3·6 μ, a double line with indications of fine structure. Improved technique is expected to permit higher dispersion.

R. W. WOOD.

Jan. 28.

[1] Hrdlicka, *Annual Report of the Smithsonian Institution*, 1913, p. 522.
[2] *Bull. Soc. préhist. de France*, 1907–8 (two papers).
[3] "Antiquity of Man in East Anglia." Camb. Univ. Press, p. 87, Fig. 35.

The Mechanism of the Nerves.[1]

By Prof. E. D. ADRIAN, F.R.S.

THE nervous system is a mass of living cells which has the extraordinary property of appearing to influence and be influenced by the mind. It is a material system somehow responsible for such non-material things as emotions and thoughts. These are in a category outside the range of mechanical explanation, and for this reason the working of the nervous system will never be fully explainable in terms of physics and chemistry. But some of the processes which take place in it can be treated in this way, and there will be no need to alter our methods of approach until we have gone a great deal further by the recognised routes. These routes are many, and the present article deals with only one of them. It deals with the analysis of the messages which travel along the nerve fibres—an analysis made possible by the recent development of the triode valve amplifier.

The active elements of the nervous system consist entirely of cells giving off fine thread-like extensions of protoplasm. These make up complex interlacing fibres forming the grey matter of the central nervous system, but most nerve cells give off one thread much larger than the rest (the axon), and this forms the channel of communication between the cell and the more distant regions. It may lead to other parts of the central nervous system or it may pass outside and lead to a sense organ or to a group of muscle fibres or secreting cells. At a short distance from the cell the axon develops a fatty sheath, and outside the central nervous system it is protected by an external covering of tubular cells, the neurilemma. The whole forms a nerve fibre with a diameter ranging from 2 to 20 microns and a length which (in man) may exceed one metre. The peripheral nerves are made up of bundles of these fibres having a common area of distribution, the number of fibres in a nerve trunk often running into several thousand. The communicating tracts of the central nervous system are similarly constituted.

We have known for some time that a nerve fibre can conduct a particular type of message under artificial conditions. A special branch of physiology has been occupied for a hundred years in investigating the changes which take place in a frog's nerve and muscle isolated from the body and stimulated mechanically or electrically. If the nerve is pinched, or if a current is passed through a short length of it, the muscle contracts. Some disturbance has passed down from the stimulated region of the nerve, and this is able to make the muscle develop its normal activity. In a frog's nerve the disturbance, or 'nervous impulse,' travels at the rate of 20-30 metres a second. No visible change accompanies it. The thermal changes are so small that it is only in the last few years that A. V. Hill has been able to detect them, and the chemical changes can only be studied by repeating the stimulation over long periods so as to obtain a measurable result.

One accompaniment of the impulse is more readily detected, however, and this is the electric response or 'action current.' Whenever the impulse arrives in a particular section of the nerve, a change of potential is developed between the active and the neighbouring inactive parts, and a current flows through the fluid surrounding the nerve or through a galvanometer connected to the active and inactive regions. As the active region travels down the fibre, the current flows shift with it, and this electric charge accompanies the impulse whatever form of stimulus is applied to the nerve. The electric charge is small enough—when every fibre in the nerve is in action simultaneously, the potential change is of the order of 10 millivolts, and the whole thing is over in a few thousands of a second. But it can be detected by instruments like the string galvanometer or the capillary electrometer, which combine sensitiveness and high periodicity, and it has given us a great deal of our information about the nature of the impulse.

Briefly, we find the impulse to be a momentary disturbance, the intensity of which at any point is determined entirely by the condition of the fibre at that point. Stimulating the nerve may be compared to firing a gun: we may pull too feebly on the trigger, but if we pull hard enough to fire the bullet no amount of extra pulling will make it travel any faster. In the same way we cannot regulate the intensity or rate of travel of the impulse by regulating the stimulus. Again, the gun needs reloading before it can be fired again, and in a nerve fibre, the passage of an impulse is followed by a very brief interval during which a further stimulus is ineffective. Each impulse is a discrete change with definite time relations, and there can be no continuous activity in the fibre, but only a succession of impulses.

The impulse takes place in a highly complex system, and no doubt it involves a whole succession of reactions which will take many more years to unravel. But it seems fairly clear that one of the principal events is the passage down the fibre of a wave of surface change which allows an interchange of ions to take place between the interior and the exterior in the active region and so to give rise to the action current. Rapidly spreading surface changes are known in many inorganic systems, and R. S. Lillie has developed a model which presents an extraordinary close analogy with the nerve fibre. When an iron wire is immersed in strong nitric acid, its surface becomes coated with a layer of 'passive' iron (probably an oxide), which prevents the acid from acting any further. If the film of passive iron is destroyed at any point, the difference of potential between the active and passive iron produces a current which has the effect of destroying the passive film

[1] Substance of two lectures delivered at the Royal Institution on Nov. 22 and 29.

in the neighbouring section of the wire, and at the same time restores it where it was first destroyed. Thus the area of surface change spreads down the wire, accompanied by an electric change which is a close copy of the action current in a nerve. Moreover, the iron wire model, like the nerve, can be stimulated by electrical as well as mechanical means.

We are still very far from knowing all that goes on when an impulse passes down a nerve fibre, but at least it has none of the variability we might expect, and we seem to be dealing with a definite series of changes following one another with mechanical regularity, changes which can be made to repeat again and again, yielding similar measurements whenever we have instruments sensitive enough to record them.

Unfortunately, the changes are so small that even the electric response can only be recorded directly when all the fibres in a nerve trunk are acting simultaneously. In the body they act more or less independently, and until recently we could not even be certain that the disturbances transmitted from sense organs or nerve cells might not differ considerably from those studied in the isolated muscle and nerve preparation. But the whole position has been altered by the advent of the triode valve amplifier. It is now possible to magnify the smallest and briefest electric changes until they are large enough to affect a recording instrument chosen not for its sensitiveness, but for its ability to give a true rendering of the most rapid fluctuations of current. The delicate string galvanometer may be replaced by the insensitive capillary electrometer, by the moving iron oscillograph recently developed by Matthews, or even by the cathode ray oscillograph used for physiological work by Erlanger and Gasser. In fact, if electric changes do occur in the normal working of the nervous system, we can no longer complain that they are too small to measure.

With the aid of valve amplification it is very easy to show that the messages which pass into or out of the central nervous system are accompanied by rapid fluctuations of potential in the nerve trunk. This, and indeed almost all the features of the nervous messages, can be demonstrated to a large audience by converting the amplified potential changes into sound waves with a loud speaker. A small piece of skin from the frog with the attached cutaneous nerve is set up in a stand with electrodes leading from the nerve to the amplifier input, and whenever the skin is touched, the nervous message set up by the sense organs in the skin becomes audible as a crackling sound in the loud speaker.

This by itself tells us very little about the nature of the message in each nerve fibre, for we are recording the confused effect of a number of fibres acting independently. To restrict the activity to one fibre we have either to divide all but one of the active nerve fibres (a difficult but not an impossible undertaking) or to arrange that the stimulus shall affect only one end organ. The former method has been used for studying the messages sent by the motor nerve cells to the muscles and the latter for the messages from sense organs. The results then become very clear and very simple. To deal first with the sensory message, we find that it consists of a series of impulses quite indistinguishable from those produced by artificial stimulation. These recur fairly regularly at a frequency which varies between 5 and 150 a second. All the impulses are alike, but the frequency with which they recur depends on the intensity of the stimulus to the sense organ. This is true of all the sense organs which have been investigated, although there are characteristic differences in the behaviour of different kinds of sense organ under a continued stimulus.

The changes in frequency will be enough to signal the intensity of the stimulus, but what is there to indicate its quality? There are two possible answers to this. One is that all the messages arising from a touch corpuscle produce sensations which we recognise as touch because they are conveyed by a particular nerve fibre and led through particular channels in the central nervous system. The other is that the impulses from different sense organs are in fact not exactly alike. The sensory nerve fibres differ considerably in diameter: Erlanger and Gasser have shown that the duration and rate of travel of the impulse varies with the diameter of the fibre, and Matthews has added the fact that sensory impulses produced by tension on a muscle travel faster than those produced by touching the skin. Whether there is a distinct size of fibre corresponding to every quality of sensation is uncertain, and it is equally uncertain whether the impulse will preserve a characteristic form as it travels through the terminal branches of the fibre, but, in the nerve trunk at least, the physiologist can tell from its form whether an impulse arises from skin or muscle, and the central nervous system may perhaps differentiate in the same way.

The investigation of the sensory message can be used to study the mode of action of the sense organs, and it can give precise information about the distribution and course of the sensory fibres, for example, in the viscera. A great deal remains to be done on these lines, but we must pass on to messages of a different origin.

The messages which pass from the motor nerve cells to the muscles are equally simple. They consist of impulses of the same kind spaced not quite so regularly, but covering very much the same range of frequency as the sensory impulses. The impulses which produce a feeble reflex or voluntary contraction recur at frequencies as low as 8-15 a second. With more intense excitation the nerve cells discharge at frequencies as high as 60-100 a second, and so produce a contraction of greater force. This agreement in the range of impulse frequency produced by the motor nerve cells and the various types of sense organ is the more striking when we remember the widely different structures involved.

Since all these messages are so much alike, we might reasonably expect to find that all the messages which pass to and fro in the tracts of the central nervous system are of the same type. For one case at least this can be verified. The optic nerve,

though it passes outside the central nervous system, is really a central tract connecting it with the retina, which is an elaborate nervous outgrowth from the brain. The messages which pass down the optic nerve when the eye is exposed to light are therefore one example of the type we might expect to find within the central nervous system. They are more difficult to analyse than those in the peripheral nerves, but there is little doubt that they consist of impulses discharged in fairly regular succession at a frequency which varies with the intensity of excitation of the ganglion cells of the retina and varies over much the same range as before. To generalise on one case may bring a speedy retribution, but it is hard to resist the conclusion that all the messages in the nerve fibres are of one type, with impulses spaced more or less evenly at frequencies which vary according to the urgency of the message.

Much remains to be done before we can be certain of this, and if the generalisation is correct we shall still be very far from knowing how the messages are generated and what determines the pathways through which they travel. The great controlling and co-ordinating stations of the central nervous system may work on lines far too complex to be analysed by methods available at the moment, but at least we can say that they receive their information and issue their orders in an extremely simple manner.

Forestry Research Work in France.

IN the *Annales de l'École Nationale des Eaux et Forêts et de la Station de recherches et expériences forestières* (Tom. 2, Fasc. 1, 1928), M. H. Perrin, of the Nancy Forest School, publishes an account of the past and present position of research work under the title of "Les recherches forestières en France." It is admitted in France that, in spite of the fact that Colbert initiated the first commencement of correct forest conservation so long ago as 1660, the necessity or utility of research work into forestry problems was not only neglected, but also its value was called in question by the executive and practical forest officers who managed the forests. Research, they considered, was pure theory, and had perhaps its correct place in the laboratory; but that its results could have any practical value out in the forests was regarded as chimerical.

In the light of the present-day acceptance of the unquestioned value and necessity of research work into forestry problems, the history of the question in France is not without interest. For two centuries its few advocates remained in the wilderness. A few obtained a partial hearing during their lifetime, but little advance was made in the practical routine methods, based on acquired practice, in force in the forests. Amongst these early enthusiasts were such men as Réaumur (1683–1757), Buffon (1707–1781), Duhamel du Monceau (1700–1782), and Varenne de Fenille (1700–1793), who put forward tentatively new methods of management which were regarded as interesting but unpractical. The next proposals, based on German forms of management and German doctrines, were introduced into France by four men, Baudrillart (1774–1832), Lorentz (1775–1865), Parade (1802–1865), and de Buffévent (1787–1860). The German ideas were considered too theoretical to be of any use in French forestry, which, so the experts maintained, depended not on experiments and research, but on the practical observations and experience of the men in charge of the forests.

The first weakening in this attitude was due to the work of two forest officers, the first products from the Nancy Forest School which was founded in 1825 to train the officers of the Government Forest Service on scientific lines. Between 1840 and 1850, these two men, Dessales de la Gibertie and E. Chevandier de Valdrôme, enunciated the theory that research work was essential if better and more abundant timber and other produce was to be obtained from the forests, and that a formal plan of forest research should be laid down. The ultra conservatism of the French forest regime was hard to break down, and the government showed no sign of having been converted. In 1861, A. Gurnaud resigned the French Forest Service in order to conduct a vigorous campaign in favour of a system of management which has since come to bear his name, and is used in the management of areas of forest in the Jura and in Switzerland.

Gurnaud's 'method of control,' as it was termed, was the subject of heated discussion over long years; but it may be regarded as having aroused the attention of French forest officers, and led them to consider whether their unquestioned acceptance of routine methods, long in force, was in the best interests of the forests. In 1873 a government circular was issued ordering the institution of sample plots of half a hectare in extent in the younger age classes in all State forests managed under the shelter wood compartment system—a system in wide usage in France. These plots were to be measured periodically. Unfortunately, no uniformity was prescribed as to the methods to be used in making the thinnings and calculating the resultant produce. Consequently, the value of the results attained was not uniform, and was of little use for general comparison purposes. It was a first step, however, in the recognition by government that research work might prove of value.

The next step in advance was the inauguration in 1882 of the Research Station at Nancy as an annexe of the Forest School, those responsible for the new departure rightly considering that instructional and research work should go hand in hand. In order to give effect to this idea, a certain number of forests adjacent to Nancy were placed under the management of the school and research centre. The Forest Nursery at Bellefontaine, a few kilometres from Nancy, was also made over to the school; and as time went on other forest areas were included in the school forests, as they are termed. The research officers were also permitted to make use of other neighbouring State forests for

research work. A gazetted assistant forest officer was attached to the Research Station, the professors of the school, mostly drawn from the Forest Service, being chiefly responsible for the research work.

In 1887 a committee was formed consisting of the director of the school, the professors responsible for research work, and the assistant forest officer. The committee drew up the programme of research work to be undertaken. This was a notable departure, but progress suffered from a want of funds, and to some extent from the lack of enthusiasm of the executive forest officers, by no means yet convinced as to the value of research work. It was admitted, however, that there were many problems to settle in connexion with the existing management, sylvicultural, technical, botanical, meteorological, and so forth. There were one or two breaks in the continuity of the work, but by 1914 the lines of research work had been more or less established under Bartet, Claudot, Jolyet, de Bouville, Guinier, and, lastly, Cuif. The latter had directed attention to the numerous problems awaiting solution, and the impossibility of carrying out useful work in the absence of adequate funds.

The War brought operations to an end, but in 1919, Cuif's representations were not lost sight of, and with the reopening of the station the government reorganised the management. The director of the school was placed in immediate charge, with a committee comprising the professors of the school and the conservator of forests stationed at Nancy. Research work was organised into four sections: (1) Sylviculture and forest economy; (2) botanical, including the physical and mechanical properties of timber; (3) zoology (entomology and pisciculture—the Forest Department is in charge of fishing in the rivers and its improvement by the rearing of young salmon and trout, etc.) and geology, comprising the study of forest soils; (4) work in connexion with the afforestation of denuded mountain slopes, erosion, and arrestation of dangerous torrents, and so forth. Assistants were attached to the professors in charge of these sections, and annual programmes were laid down by the committee.

The work of the research station concerns itself with the whole of France, but valuable help is now received by a network of what may be termed sub-research centres throughout the country, the investigations carried on at these sub-stations being entrusted to selected executive officers, who undertake special investigations in addition to their ordinary duties. Now that the value of research work has come to be fully appreciated by the executive officer, the central station has had no difficulty in inaugurating the local centres throughout the country. On this question Perrin writes: "Cette organisation d'annexes, nécessaire dans un grand pays où les conditions forestières varient à l'infini, paraît devoir rendre les plus précieux services; elle décharge la Station de Nancy d'une besogne matérielle considérable, tout en faisant rentrer les travaux des annexes dans un cadre commun qui permettra ultérieurement de les rapprocher; et, en même temps, elle assure aux praticiens qui veulent étudier de plus près certaines questions les directives et les subsides nécessaires."

The work of the last few years bears witness to the fact that in France, as elsewhere, the War, with its enormous demands on the forest, has impressed upon the government the recognition of the fact that forestry research work is essential if those forests are to be made to yield the maximum amount of produce the varying locality factors permit.

Obituary.

PROF. M. J. M. HILL, F.R.S.

BY the death of Prof. M. J. M. Hill, on Jan. 11, University College, London, loses one of the personalities that played a dominating part during the critical years which saw the rise of the new teaching University, and the University itself one of the most distinguished of its past *alumni* and teachers.

Micaiah John Muller Hill was the eldest son of the Rev. Samuel John Hill, and was born at Berhampore, Bengal, on Feb. 22, 1856, during the stormy days of the Indian Mutiny. He was educated at the school for the Sons of Missionaries, Blackheath, and entered University College as a student in October 1872. After a brilliant academic career in London he went up to Peterhouse, Cambridge, and in 1879 became Fourth Wrangler and Smith's Prizeman.

When only twenty-four years of age Hill was elected to the chair of mathematics at Mason College, as it then was,—now the University of Birmingham. In 1883 he became a fellow of Peterhouse, and in 1884 he was called to the chair of mathematics at University College, London, a post which he occupied until his retirement in 1924. He was elected a fellow of the Royal Society in 1894, and was an Sc.D. of Cambridge and hon. LL.D. of St. Andrews.

Hill's contributions to mathematics amount to nearly fifty papers, ranging over a wide field. In his earlier days he was much occupied with hydrodynamical problems, and his 'spherical vortex' has remained a classic. The duties of his chair, however, and his own peculiar bent, which prized in mathematics logic and rigour above all things, turned him eventually from applied mathematics, to which, to that subject's loss, he never returned.

Hill made up for this by increased activity in the domain of pure mathematics. To differential equations, in particular to the theory of singular solutions, he came back persistently; his last paper of this class dates from 1921. Another important group of researches deals with the theory of analytic continuation.

The subject to which Hill devoted himself specially during the last thirty years of his life, following in this his great predecessor, De Morgan, of whom

he was a fervent admirer, was the elucidation of Euclid's famous theory of proportion, which he can be said largely to have reconstructed. He was working at this almost to the very day of his death, struggling with amazing courage and success against the almost insuperable handicap of total blindness which overtook him suddenly about fifteen months ago. His work in this difficult and neglected branch of the foundations of mathematics must remain of fundamental importance for all future investigators.

As a teacher Hill had few equals: what impressed all who came in contact with him, apart from his clarity of exposition and extraordinary mastery of detail, was the moral atmosphere that radiated from him and left its mark on all those who approached him, even those who could not follow him into the realms of abstract thought. He gave, indeed, a splendid example of how a real man's work should be done, sparing no pains that the result, however slight, should be perfect; neglecting nothing, facing boldly all difficulties, a rare ideal of intellectual uprightness and moral courage.

This same ideal Hill carried into his everyday life and into the very arduous tasks which he undertook in connexion with the government of the University, a burden which he bore without a murmur, though his friends, well knowing that this meant, too often, the postponement or abandonment of research work of priceless value, sometimes deplored this as a tragedy.

Hill was a member of the Senate of the University from the date of its reconstitution in 1900 until 1926, when failing health compelled his retirement. For ten years he was chairman of the Academic Council, and for two years (1909–1911) vice-chancellor of the University. To his initiative were due many important developments, the full effects of which are only now beginning to be felt; in particular, the establishment of proper machinery for appointments to chairs and readerships and many improvements in the status and qualifications of teachers of the University.

Behind an outward appearance of almost diffident reserve Hill kept a heart full of sympathy and helpfulness and a fund of quiet and serene humour. Both his students and his colleagues looked to him when in trouble or difficulty, nor were they ever disappointed. It was characteristic of him that when, on his retirement, his friends asked him in what way he would wish them to commemorate his long connexion with the College, he remembered the financial struggle of his early years and asked that they should found a loan fund by means of which the difficulties of students in straitened circumstances might be temporarily relieved, while their spirit of independence was to be preserved by an undertaking of eventual repayment, so soon as they felt able to do so. There could, indeed, have been no more fitting memorial.

Prof. Hill married in 1892, Minnie Grace, daughter of Marriott Ogle Tarbotton, of Nottingham. Mrs. Hill died in 1920. He leaves two sons, both of whom earned distinction in the field in the flying service during the War, and one daughter.

PROF. J. M. COULTER.

BY the death of Prof. John Merle Coulter on Dec. 23, after a few weeks' illness, American botany loses one of its most eminent exponents.

Prof. Coulter was born at Ningpo, China, on Nov. 20, 1851. After graduating at Hanover College, Indiana, he was appointed in 1872 botanist to the U.S. Geological Survey in the Rocky Mts., but returned to his old college as professor of natural sciences in 1874. He was then successively professor of biology, Wabash College (1879–91), president and professor of botany, Indiana University (1891–93), and president, Lake Forest University (1893–96). In 1896 he was appointed head of the new department of botany of the University of Chicago, to the development and work of which he devoted nearly thirty years, retiring in 1925. Since his retirement he has been adviser of the Boyce Thompson Institute of Plant Research, Yonkers, N.Y.

Coulter's earlier botanical work was floristic. The "Synopsis of the Flora of Colorado" (1874), a government publication, with Prof. Thomas C. Porter, incorporated the results of his own and earlier investigations in this part of the Rockies. A more extensive piece of work was his "Manual of the Botany of the Rocky Mountain Region from New Mexico to the British Boundary" (1885), a companion volume for the territory included to Gray's classic "Manual of the Botany of the Northern United States," for the sixth edition of which, in 1890 (with some extension of the area westwards), Coulter and Gray's successor, Sereno Watson, were jointly responsible. In association with the late Dr. J. N. Rose, Coulter published a revision of the North American Umbelliferæ (1888) and a Synopsis of the Mexican and Central American Umbelliferæ (1900).

Prof. Coulter is best known in the botanical world, however, for his connexion with the *Botanical Gazette* and his work in the department of botany of the University of Chicago. In November 1875, Coulter started the *Botanical Bulletin*, a modest little monthly of four pages, issued at a subscription price of one dollar a year, to afford a medium of publication for botanists of the western States comparable to those already existing in the eastern. It comprised short notes, mainly of local floristic interest, many of which were provided by the editor himself. With the second volume the name was altered to the *Botanical Gazette* to avoid confusion with the *Bulletin of the Torrey Botanical Club*, and the size was increased to eight pages. The venture prospered, other eminent botanists became associated with Coulter in the editorship, and when in 1896 the senior editor went to organise the new department at the University of Chicago and the *Gazette* became the property of the University, it was already recognised as a leading botanical journal. After more than fifty years of active editorship, Coulter in 1926 handed over the work to his former colleague, Prof. Henry Cowles, himself retaining the title emeritus editor.

With the development of the Chicago School of

Botany the *Gazette* also became a medium for the publication of its work. An important aspect of this work also found expression in the volumes on the morphology of the seed-plants, which are familiar to all students of botany. The original small volume on the seed-plants (1901) by Coulter and his assistant, C. J. Chamberlain, was expanded into the two important volumes dealing respectively with Angiosperms (1903) and Gymnosperms (1910) and represents a concise review of our knowledge of the detailed morphology, especially of the reproductive structures and the embryology in the two groups. The special value of these volumes depends on the fact that the subject matter had its origin or had been critically reviewed in the laboratory of the Chicago botany school.

In addition to his work as teacher and editor, Coulter played his part in the various associations and societies for the advancement of science in America. He had served as president of the Botanical Society of America, and of the American Association for the Advancement of Science. He was also a corresponding member of the British Association. In 1921 he was elected a foreign member of the Linnean Society of London. Botanists who attended the International Congress at Ithaca in 1926 will remember that Prof. and Mrs. Coulter took a prominent part in the reception of the delegates at the opening of the Congress in the Willard Straight Hall of Cornell University. A. B. R.

Dr. G. W. Lee.

GABRIEL WARTON LEE, who died in Edinburgh on Dec. 1, 1928, was the son of the late Dr. A. B. Lee of Geneva, the well-known author of "The Microtomist's Vade-Mecum," and of many valuable papers on cytological subjects. He was born in 1880, and received his education at Geneva, where, after a distinguished university career, he took the degree of D.Sc. In 1905 he joined the staff of Sir John Murray in Edinburgh, and carried out a number of important investigations on the deep-sea deposits brought back by the *Challenger* Expedition. The researches on glauconite which he undertook in collaboration with his cousin and colleague, Dr. L. W. Collet (now professor at Geneva), were published in the *Proceedings of the Royal Society of Edinburgh* in 1905–6.

In 1907, Dr. Lee was invited, on account of his special palæontological knowledge, to join the staff of the Geological Survey of Scotland; he was placed in charge of the Palæontological Department, and became responsible for the determination of the material annually collected from natural sections and from borings. Dr. Lee acquired an unrivalled knowledge of the Carboniferous fauna of Scotland and was a recognised authority on the Bryozoa, publishing in 1911 an important monograph on the British Carboniferous Trepostomata. He made valuable contributions to the Survey memoirs dealing with the Carboniferous rocks of the Edinburgh (1910) and Glasgow (1911 and 1925) districts, of East Lothian (1910), and of North Ayrshire (in the press). He assisted in the mapping of the complex geology of the Island of Mull, and had completed a detailed examination of the Mesozoic rocks of Scotland. His memoir on "The Mesozoic Rocks of Applecross, Raasay, and N.E. Skye" appeared in 1920, and his later work on these rocks was embodied chiefly in the following memoirs: "Pre-Tertiary Geology of Mull, Loch Aline, and Oban" (1925), "Geology of the Country around Golspie" (1925), and "Geology of Ardnamurchan" (to be published shortly).

In addition to his official work, Dr. Lee undertook the description of suites of fossils brought back from the Arctic by various expeditions. Among these may be mentioned the collections made by the late Dr. W. S. Bruce in Prince Charles Foreland in 1906–7 (*Proceedings, Royal Physical Society, Edinburgh*, 1908), and at Cape Cherney on the west coast of southern Novaya Zemlya in 1898 (*Transactions, Royal Society, Edinburgh*, 1909). Part of the material obtained by Prof. O. Holtedahl during the Norwegian expedition to Novaya Zemlya in 1921 was also submitted to him for determination and description (*Report of Scientific Results*, No. 22, Kristiania, 1904).

Dr. E. van Rijckevorsel.

DR. ELIE VAN RIJCKEVORSEL, who died on Oct. 18 last at the age of eighty-three years, was born at Rotterdam. After leaving the gymnasium there he went to the Polytechnic at Zurich and the University of Bonn, taking his doctor's degree in physics and mathematics at Utrecht in 1872. Soon afterwards he proposed to Prof. Buys Ballot a magnetic survey of the East Indian Archipelago at his own expense, only the instruments being provided by the Dutch Government. After a training at the observatories at Kew and Munich, he left for Java in December 1873, and largely extended Elliott's first survey of 1846–49, taking observations at more than a hundred stations. In spite of interruption by malarial fever, a similar survey was carried out in eastern Brasil between 1882 and 1885, with the assistance of E. Engelenburg.

After being nominated honorary assistant of the Dutch Meteorological Institute, Van Rijckevorsel made the first and only magnetic survey of Holland. In the meantime, many intercomparisons of standard instruments had been made, and magnetic observations in the Alps with Van Bemmelen followed; indeed, Van Rijckevorsel was one of the pioneers of international magnetic research, and was recognised as such by the honorary degree given him by the University of Glasgow in 1893, and by his nomination as one of the eight members of the first magnetic commission created by the International Meteorological Committee in 1896 at Paris.

Since 1896, Van Rijckevorsel has developed another side of his scientific interests. At the British Association at Toronto a paper was presented, "On the Temperature of Europe," followed by a series of papers in German, partly published by the Institute at De Bilt, which trace

constant, possibly cosmic, influences causing secondary maxima and minima in the yearly range of meteorological elements and terrestrial magnetism and lead to the calculation of numerous periods, even in mortality and nativity. Part of the material was provided by the author, copying unpublished observations abroad during repeated sojourns in milder climates during winter time.

Van Rijckevorsel was a lonely man for a great part of his life, and always busy—his love of Nature, his skill in drawing, and his taste in forming ethnological collections will be long remembered by his friends and countrymen. Time will judge of the importance of his life-work, but his earnest devotion to international science ensured him the esteem of colleagues from many nations.

E. VAN E.

MR. C. L. TEMPLE, C.M.G.

WE regret to record the death of Mr. Charles Lindsey Temple, C.M.G., formerly Lieutenant-Governor of Northern Nigeria, which took place on Jan. 9 at Granada, Spain. Mr. Temple was a son of the Right Hon. Sir Richard Temple, formerly Governor of Bombay, and a notable figure in the political world of the late nineteenth century, and a brother of the present Sir Richard Temple, the distinguished authority on Indian culture and literature.

Charles Temple was born in 1871, and entered the Consular Service in Brazil in 1898. Through the influence of Sir Frederick Lugard, he joined the Nigerian Service in 1901, where he rapidly showed himself an administrator of sympathetic understanding in dealing with native affairs. Papers on the natives of Northern Nigeria, contributed by him to the *Journal of the Royal Geographical Society* in 1912, and by his wife to the meeting of the British Association in 1913, showed how thoroughly the essential factors of the situation had been grasped. Temple was a staunch upholder of the theory of government that it was the duty of the white races to accept, so far as possible, tribal laws and customs as a guide in shaping the development of backward peoples. He regarded it as essential that natives should be associated with whites as much as possible in the government of their own country. The views and the principles upon which he carried out his administrative duties were embodied in a book, "Native Races and their Rulers," which appeared in 1918 and has since become a text-book for administrators, and a powerful influence in the government of Nigeria.

Mr. Temple was Chief Secretary of Northern Nigeria from 1910 until 1913, and was appointed Lieutenant-Governor of the Protectorate in 1914, holding that office until 1917, when his health broke down. He married Miss Olive MacLeod, daughter of Sir Reginald MacLeod of MacLeod, herself well known as a traveller and the author of a number of studies of the peoples of Nigeria, based on material mostly collected during her husband's term of office.

PROF. A. W. BICKERTON.

PROF. A. W. BICKERTON, whose death on Jan. 23, at the advanced age of eighty-seven years, is announced, was a well-known figure in astronomical and other scientific circles. He was born at Alton, Hants, on Jan. 7, 1842, and educated at the Grammar School there and the Royal School of Mines, South Kensington, of which he became an Associate. After leaving the College he was appointed organiser of science classes at the Hartley Institute (now University College), Southampton, and in 1874 went to Canterbury College, Christchurch, New Zealand, as professor of chemistry and physics. While there he had among his students Sir Ernest Rutherford, who in the *Times* of Jan. 25, pays an appreciative tribute to the stimulating lectures given by his old teacher, and remarks: "His powers of popular exposition, his enthusiasm and versatility were of great value in promoting an interest in science in a young community."

About twenty years ago Prof. Bickerton came to England with the express purpose of developing and making known an impact theory of cosmic evolution conceived by him in 1877, and of which he regarded the appearance of new or temporary stars as examples. His view—described in a number of papers published by the New Zealand Institute and other societies—was that stars were formed by the grazing collision, or partial impact, of two cosmical masses. The new lucid object thus brought into existence was not regarded as made up of the combined masses of the colliding clouds, but as a third body formed by the material detached from the colliding masses. A suggestion of this kind could obviously scarcely be placed in the category of fundamental astronomical theories without substantial observational or dynamic evidence, neither of which Prof. Bickerton was able to provide. He was discouraged by the indifference shown by astronomers generally to his views, yet he never lost his enthusiasm, and believed that he had found the truth and that it would be established in due season by both mathematical physics and astrophysics. He would, we believe, be content with the epitaph, "Magna est veritas, et praevalet."

WE regret to announce the following deaths:

Dr. T. O. Bosworth, author of "Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru," on Jan. 18, aged forty-six years.

Dr. John K. Haywood, chemist in charge of insecticide supervision, food, drug, and insecticide administration in the U.S. Department of Agriculture, on Nov. 30, aged fifty-four years.

Dr. Fernand Widal, professor of internal pathology in the University of Paris, whose name is associated with the agglutination test for the diagnosis of typhoid fever, on Jan. 14, aged sixty-six years.

Prof. R. H. Yapp, Mason professor of botany in the University of Birmingham since 1919, on Jan. 23, aged fifty-seven years.

News and Views.

WE referred last week, p. 138, to the meeting of the Royal Society on Jan. 17, at which Prof. Eddington described some speculations on a new development of quantum mechanics, published in the January issue of the *Proceedings* of the Society. So much prominence has been given to the paper in the public press that some further remarks upon it in these columns may be worth while. The speculations put forward are of a very interesting type, for they attempt to assimilate what we now call interchange of electrons to a transformation in a new co-ordinate or co-ordinates, similar to a Lorentz transformation in space-time co-ordinates in that it can never be observed. The starting point of these speculations is the observation that we now describe the interaction of electrons by two principles, Coulomb's electrostatic forces and Pauli's exclusion principle, and that every principle of scientific æsthetics requires us somehow to weld them into one. This observation is perhaps the most promising and interesting part of the paper. The main part of the paper is concerned with speculations as to how perhaps this might be done, and the description of the interchange of electrons already alluded to is Prof. Eddington's attempt at a weld.

PROF. EDDINGTON'S whole speculation is extremely tentative, even for a new step in quantum mechanics, and very properly so propounded. If his main idea is correct, that the principles of Coulomb and of Pauli are two aspects of the same feature of our world, there must necessarily be a theoretical connexion between the two constants, ϵ^2 and $hc/2\pi$, which they respectively introduce. Prof. Eddington's tentative speculations suggest a value of 136 for this ratio; *all* the existing experimental evidence, provided that our main theoretical formulæ are trustworthy, are in favour of a value very near to 137, a value which of course is not necessarily integral. It is quite possible that Prof. Eddington's theoretical result of 136 may be right, even if every word which he or any one else can as yet say about his theory is a totally wrong interpretation of it, like so much else which we still say of the easier aspects of quantum mechanics. It is far too soon to be confident either way. But if the ratio is really 136, it is already clear that the new theory when complete must involve small but far-reaching changes in the relations between the primary physical constants and, for example, Rydberg's constant. It will be a matter of the highest interest if it ultimately turns out that the formula for Rydberg's constant, the corner-stone of modern physical theory, was slightly wrong after all! At present it is proper to confess that we do not in any sense understand the new theory, still less know if it is right. Its further study will no doubt be prosecuted with interest and vigour.

IN order to introduce into the Leningrad Academy of Sciences, which three years ago celebrated its 200 years of independent scientific life, it was decided last year to enlarge the Academy by adding to it forty new members. A list of candidates has been approved by the authorities, and amongst the new academicians several active supporters of the government have been duly elected. Three of the candidates put forward by communistic organisations failed, however, according to the *Times* of Jan. 28, to obtain the two-thirds majority of votes necessary to secure election, probably because of their insufficient qualifications. The Soviet authorities insist now that the Academy must waive its statutory regulations and take a fresh ballot on the three rejected candidates. A meeting of the Academy summoned to consider this extraordinary proposal decided that, although it was contrary to the statutes, it has to be accepted. Nine academicians, however, voted against acceptance, and their names have been published by the Soviet press as follows: Pavlov (physiologist), Levinson-Lessing (geologist), Borodin (botanist), Liapunov (mathematician), Karsky (ethnologist), Lavrov, Petrushevsky, Vladimirtseff, and Sakulin; every one of these nine names is well known—indeed, some are famous amongst the leading men of science of the whole world. Various startling projects of reconstructing the Academy so as to make it support actively the government policy are discussed by the official Soviet press, but apparently no definite decision has been arrived at so far.

THE neon tubes which are now so familiar to the public in various script sign advertisements have found a useful application in replacing white lights for lighthouses serving air routes. In a new light at Lympne, sixteen tubes twenty feet long are employed in the form of a vertical truncated cone. The light is said to have a candle power of 6000 and to be visible in clear weather for 45 miles. The neon spectrum gives a number of lines lying for the most part towards the red end of the spectrum, the yellow line 5853 A. being specially prominent. Thus the normal colour of the tube is red orange, unless much argon or mercury vapour are also present. It is therefore possible to obtain a radiation which is comparatively little subject to atmospheric scattering (the intensity of scattering is inversely proportional to the fourth power of the wave-length) while yet remaining of high visibility. The characteristic colour of the light is a strong recommendation; it would be made somewhat more red owing to scattering when seen through fog, but the change would be small in comparison with that experienced in connexion with any white light. Experiments have shown that even when the neon light failed completely to penetrate a layer of fog it made a "large red luminous patch on the top of the fog." Such a light has now been installed at the Lympne aerodrome on the London-Paris air route.

FOR some time it has been rumoured that Prof. Einstein has been about to publish the results of a protracted investigation into the possibility of generalising the theory of relativity so as to include the phenomena of electromagnetism. It is now announced

that he has submitted to the Prussian Academy of Sciences a short paper in which the laws of gravitation and of electromagnetism are expressed in a single statement. The *Daily Chronicle* of Jan. 26 reports an interview with Prof. Einstein in which he explains in outline the scope of his new achievement. "For years," he is reported to have said, "it has been my greatest ambition to resolve the duality of natural laws into unity. This duality lies in the fact that physicists have hitherto been compelled to postulate two sets of laws—those which control gravitation and those which control the phenomena of electricity and of magnetism. . . . Many physicists have suspected that two sets of laws must be based upon one general law, but neither experiment nor theory has, until now, succeeded in formulating this law. I believe now that I have found a proper form. I have thought out a special construction which is differentiated from that of my relativity theory, and from other theories of four-dimensional space, through certain conditions. These conditions bring under the same mathematical equations the laws which govern the electromagnetic field and those which govern the field of gravitation. The relativity theory reduced to one formula all laws which govern space, time, and gravitation, and thus it corresponded to the demand for simplification of our physical concepts. The purpose of my work is to further this simplification, and particularly to reduce to one formula the explanation of the field of gravity and of the field of electromagnetism. For this reason I call it a contribution to 'a unified field theory.' . . . Now, but only now, we know that the force which moves electrons in their ellipses about the nuclei of atoms is the same force which moves our earth in its annual course about the sun, and is the same force which brings to us the rays of light and heat which make life possible upon this planet."

PROF. EINSTEIN gives no indication of the line of thought he has followed or of the precise character of the new law. His paper, it is stated, will be published in a few days. As an illustration of the remark that many physicists have suspected the existence of a general field law, we may quote the following passage from Prof. Eddington's recent book, "The Nature of the Physical World." After an account of the relativity interpretation of non-empty space, he writes, "It should be added, however, that this is a summary description and not a full account of the non-emptiness, because we have other exploring apparatus—magnets, electroscopes, etc.—which provide further details. It is usually considered that when we use these we are exploring not space, but a field in space. The distinction thus created is a rather artificial one which is unlikely to be accepted permanently. It would seem that the results of exploring the world with a measuring scale and a magnetic compass respectively ought to be welded together into a unified description, just as we have welded together results of exploration with a scale and a clock." Apparently Einstein's new work has accomplished such a welding, but details cannot be gathered until the paper becomes available.

OF all British men of science, none commands our admiration and respect more than Michael Faraday, who by the simplicity and nobility of his character endeared himself to all those around him and by the variety and importance of his discoveries made possible many of the extraordinary advances of modern science. His life's work was done in the laboratory of the Royal Institution, and it was there, on Aug. 29, 1831, he made his first successful experiment on electromagnetic induction; an experiment which, following in the wake of those of Oersted, Arago, Sturgeon, and Ampère, marks the first of a series of discoveries to which we owe our command of electricity to-day. Recognising the epoch-making character of that experiment, the Royal Institution proposes to take steps to celebrate its centenary, and accordingly has issued an invitation to those interested to be present at a meeting of the Royal Institution on Feb. 5 at 4.30 P.M., when the proposal will be considered. In the invitation the Royal Institution points out that the centenary of the British Association also falls in 1931, and that certain important conferences on electricity will be held in London that year, and in directing attention to this matter says: "It seems probable also that the event may provide a unique and most favourable opportunity for a review of the great contributions which British workers have made to the scientific and industrial advances of the past century. It is certain that such a review might be made a source of inspiration and encouragement to the nation." At a dinner of the American Institute of Electrical Engineers in 1901, the toasts were: "The Land of Ampère," "The Country of Faraday," "The Successors of Ohm," "The Heirs of Volta," and "The Legatees of Franklin." That was a happy demonstration of the freemasonry of science, and it would be a fortunate thing if the efforts of the Royal Institution lead to an international gathering to commemorate the work of one of whom Tyndall said that "he prized the honour of being Faraday's successor less than the happiness of having been his friend."

THE centenaries of scientific interest which occur in 1929 will recall some of the most remarkable men in the history of scientific discovery; men of various nationalities; pioneers in many branches of science, and men differing greatly in character. England, Germany, Holland, France, the United States, and Norway, will all have their celebrations, some of which will no doubt attract world-wide attention. Perhaps the most notable name to be recalled is that of Huygens, who was born at The Hague on April 14, 1629, and died there on June 8, 1695. As a connecting link of the age of Galileo and that of Newton, Huygens is one of the leading figures in seventeenth-century science. Among Englishmen we note the approaching centenary of the death of Davy, who passed away on May 29, 1829, and that of Young, who died on May 10. We have already referred to these famous men in these columns, and it is to be hoped the commemorations will be worthy of the occasions. No less a notable figure is that of Lamarck, who died on Dec. 18, 1829, and whose statue stands at the entrance to the Jardin des Plantes, for which he did so much. On April 6

occurs the centenary of the death of the brilliant but short-lived Norwegian mathematician Niels Heinrik Abel, while later in the year come the centenaries of the births of the German chemists Kekulé and Griess, of the French chemist Schützenberger, the Austrian geologist Hochstetter, the American geologist Hayden; while another notable American man of science born in 1829 was Asaph Hall, the discoverer of the satellites of Mars. The United States and England alike will no doubt in some way pay tribute to the memory of James Smithson, through whose bequest arose the great Smithsonian Institution at Washington. Smithson died at Genoa in June 1829.

BESIDES these anniversaries we may direct attention to the bi-centenary of Thomas Newcomen, who may properly be called the father of power engineering. The steam- or fire-engine had been the subject of experiments by Papin, Worcester, Savery, and others, but the introduction of the atmospheric beam engine for pumping purposes was mainly the work of Newcomen, the Dartmouth blacksmith. Newcomen's engines provided the first solution of the problem of pumping from deep mines, and the form he introduced continued to be constructed right throughout the eighteenth century, and one or two examples were at work within quite recent times. Moreover, it was the model of a Newcomen engine, still preserved in the University of Glasgow, which led Watt to his epoch-making inventions. But Newcomen engines were in use forty years before Watt began his experiments, and when at the Watt centenary of 1919 a small group of engineers founded a society for furthering the study of the history of engineering and technology, they most appropriately called it the Newcomen Society. Though not a large body, the Newcomen Society has by its activities and its excellent *Transactions* admirably fulfilled its purpose, and this coming summer it is holding a joint meeting with the Devonshire Association in order to pay due homage to the memory of Newcomen. Born at Dartmouth in 1663, Newcomen died in London on Aug. 5, 1729, and lies in an unknown vault in Bunhill Fields Burial Ground. Another centenary of interest to engineers is that of the famous locomotive trials at Rainhill in October 1829, when the great competition took place between Hackworth's *Sans Pareil*, Ericsson's *Novelty*, and Stephenson's *Rocket*, the latter the best-known locomotive in the world. To this event the Newcomen Society also rightly proposes to direct attention.

THE second report of the National Fuel and Power Committee to the President of the Board of Trade (Cmd. 3252, London: H.M. Stationery Office, 9*d*. net) recommends that legislation be promoted without delay to provide alternative procedure under section 10 of the Gas Regulation Act, whereby the Board of Trade, by Departmental Order, may grant to gas undertakings, power to raise additional capital and borrow money on mortgage to the extent of the undertakers' paid-up share capital; power to offer new capital for subscription to existing holders, consumers, and employees; power to effect joint working arrangements with other undertakings, and to institute a two-part tariff system of charge for gas. The therm system of charge is considered a fair one, and the Report recommends that, from an appointed day, existing statutory gas undertakers, except very small ones, supplying less than, say, 20 million cub. ft. of gas per annum, should be required to supply gas on a thermal basis and become subject to the purity, pressure, and testing requirements of the Gas Regulation Act. All gas undertakers should fulfil the requirements of the Act as regards purity and pressure of gas, it being understood that, in the case of a non-statutory undertaking, no penalty would be incurred when a deficiency in respect of these requirements was due to circumstances not within its control. The growing practice of supplying artificially dried towns' gas necessitates the amendment of the section of the Act defining the calorific value in terms of unit volume of gas saturated with water vapour. No quarterly average value of calorific value should be assessed unless at least six tests of the gas have been made during the quarter. At present, gas undertakers are customarily permitted to work up residuals purchased from other undertakers or elsewhere to the extent of only one-third of the like residuals obtained from their own manufacture of gas. It is recommended that this restriction as to quantity, where it exists, be removed.

ACCORDING to a recent announcement by Prof. James H. Breasted, the organisation on an extended scale of the Institute of Oriental Research of the University of Chicago is now made possible by an endowment of 9,500,000 dollars, of which the greater part is already assured. Among the objects to which this sum is to be devoted are the provision of a new building on the campus of the University, an annual grant towards carrying out projected researches over a period of the next ten years, and an endowment for teaching which will enable the Institute to avail itself of the services of the leading Orientalists and historians of the world. The plan of work, now in process of being framed, will include a series of expeditions sent out from the central organisation, which will work side by side and in close co-operation along the whole of what is termed the 'archæological front' of the Near East, including Babylonia and Assyria as well as Persia and its neighbours.

THE marvels of Ur multiply. Within ten days of his first report of the season, Mr. Woolley has further sensational discoveries to record. His account of the opening up of another pit shaft, in the *Times* of Jan. 22, leaves the reader in amazement no less at the light they throw on Sumerian burial practices than at the surprising wealth of objects of Sumerian art and their character. Now we learn of the sacrifice of a groom and of asses found with traces of a chariot and the remains of the ornament of the harness, on a sacrificial floor composed of a mat roof covering another sacrificial chamber with its array of victims. This in turn leads to a death pit with forty-five victims, of whom no less than thirty-nine are women, and six are indeterminate. Of headdresses of gold and precious stones similar to those of the nine court ladies found last year, thirty-four have been found, and the other contents of the pit, so far as cleared, are no less remarkable in quantity and character

both of workmanship and conception. Two statues are unique—rampant rams with heads and legs of gold, horns and shoulder hair of lapiz, the fleece of white shell, each tuft carved separately, and the belly of silver.

CAPT. PUREFOY, on behalf of the Committee for the Protection of British Butterflies, appointed by the Entomological Society of London, has presented to the Department of Entomology of the British Museum (Natural History) a set of specimens of the first brood of the imported Dutch form of the large copper butterfly, reared in Wood Walton Fen, near Huntingdon. The British form of this butterfly, formerly moderately common in the fen country, where its caterpillar fed upon the giant water-dock, has been extinct since 1848. About ten years ago a form was discovered in Holland, whence was derived the stock with which it is hoped to repopulate some part at least of the area formerly occupied by the insect. The specimens presented to the Museum are intended to form the commencement of an annual record of the broods, so that any variational tendencies in the colony may be more easily recognised. Capt. Purefoy has also presented a set of specimens from the Irish colony established by him a number of years ago, which has been well maintained ever since. From Dr. J. Schwetz the Department has also received specimens of a new species of tsetse-fly, taken by him in the region of the Lower Lomami River, Belgian Congo. Since the new specimen belongs to the same group as *Glossina palpalis*, the tsetse chiefly responsible for the spread of human sleeping sickness, its discovery may be of medical importance. The skeleton of the large *Ichthyosaurus* extracted at the end of November last from the Lower Lias in the quarry of the Red Triangle Cement Works at Harbury, Warwickshire, has been presented by the Portland Cement Selling and Distributing Co. to the Department of Geology of the Museum. The skeleton is deeply imbedded in nodules of limestone.

PROF. A. C. SEWARD'S Friday evening discourse, delivered on Jan. 25 at the Royal Institution, was entitled "Greenland: As it is and as it was." He gave a brief description of the geological structure of the country, the present inhabitants, the ice-sheet and icebergs, and of the Arctic flora. The only representatives of trees are stunted willows and the prostrate dwarf birch. Many of the flowering plants have a circumpolar distribution; some of them being also members of the alpine flora of Scotland and Switzerland, while others are unknown in Europe and occur in North America. The present conditions in Greenland are much more favourable than in corresponding regions in the far south on the borders of the Antarctic continent. Prof. Seward then discussed the value of fossil plants as evidence of climatic conditions of the past. In rocks of Cretaceous age on Disko Island and at localities on the mainland about halfway up the western coast of Greenland there are fossil ferns closely related to species of *Gleichenia*, now widely spread in the southern tropics, and other ferns related to a species now confined to Malaya; there are conifers now unknown in Europe, and abundance of trees with leaves scarcely distinguishable from those of the maidenhair tree (*Ginkgo biloba*). Special attention was directed to the presence, in the Cretaceous flora, of plane trees, of trees closely related to existing Magnolias and trees akin to the tropical bread-fruit tree, and representatives of other families now characteristic of subtropical or tropical regions.

THE paper dealing with "Colour and its Applications," read by Dr. L. C. Martin before the Illuminating Engineering Society on Jan. 22, contained an interesting survey of colour measurement, in the course of which an ingenious new colorimeter developed at the Imperial College of Science by Mr. W. D. Wright was described. The lecture was aided by some effective demonstrations, by Mr. C. F. Smith, of colour-mixtures and harmonies, for which his 'mutochrome' apparatus proved well adapted. Dr. Martin also discussed the relation between colour and acuteness of vision, and presented a series of curves illustrating the relation between colour and visual speed. Much of the discussion was concerned with 'artificial daylight,' and the need for a practical standard of white light was emphasised. The arbitrary standard, based on the use of an electric incandescent lamp, run at a prescribed pressure and equipped with a standard blue filter, is stated to furnish radiation equivalent to that of a black body maintained at about 2900° K., and has evidently possibilities. It was interesting to learn that a standard specification for artificial daylight is now likely to prove a practical project.

THE current issue of the *Journal of the Marine Biological Association* contains a description of the Laboratory at Plymouth and a list of publications recording the results of researches carried out there or under the auspices of the Association on the North Sea coast from 1886 to 1927. This bibliography of nearly a thousand papers, ranging over morphology, biology, and various branches of economic marine zoology—on fishes, oysters, cockles and scallops, the shipworm, crabs, lobsters, and sponges—serves to emphasise the close correlation between pure and applied science, and shows that the wise policy of the founders of the Association—to aid science and industry — has been consistently followed. The Laboratory provides facilities for all kinds of biological, work and appreciative reference should be made also to the successful courses for advanced students, held during the Easter and summer vacations. The major parts of the organisation of the Plymouth Laboratory has been built up during the thirty-three years' directorship of Dr. E. J. Allen, to whom and to his staff are due congratulations, not only for their many contributions to the advancement of our knowledge of the sea, but also for the fine spirit of helpfulness which prevails in the Laboratory.

THE gradual disappearance of the European bison, which reached its most serious stage during the War, has been watched with much concern, and an association was formed a few years ago with the object of endeavouring to prolong the existence of this interesting species. This good cause has received a severe

blow in the news brought back by Prof. J. Pujanov, of Semferopol, who has just completed a survey of the Caucasus reserve. In 1911 the herd in the Caucasus region numbered 1000, and in 1924, when 25 animals were still known to be alive, the Soviet Government set aside an area of 1100 square miles as a permanent bison reserve. Last year a group of zoologists who had had special experience explored this region thoroughly, searching every valley. Not a single living bison was seen. Bones in plenty were discovered of animals apparently only a year or two dead, and some bore bullet-marks. The bison seem to have been shot by poachers, the patrol of the reserve having been insufficient to stop illegal shooting. It is stated that one or two animals may still possibly lurk in remote fastnesses in the area, but for all practical purposes the Caucasus herd may be regarded as extinct.

AN able summary, over the initials 'I.D.S.,' appears in the October issue of *Psyche*, against the suggestion of some psychiatrists that those patients whose mental disorder is difficult to specify, or does not constitute them a danger to themselves or others, should be detainable by some informal compulsion warranted by their relatives and by medical opinions. The advantages claimed are, that the earlier treatment thus enforced would be more effective than if delayed until the patient should be certified, and that the informal nature of the proceedings would avoid the stigma of insanity. The writer claims in opposition that only a small proportion of mild cases ever reach the asylum, that institutional life does not have a good effect on the individual, that the district asylums have not the staff for the necessary treatment, and the average medical officer is ill-instructed in psychiatry and mental treatment. He also quotes with approval Dr. Millais Culpin's views expressed in a letter to the *Times* last autumn as to the probability of the stigma very quickly being affixed to this compulsory detention. He suggests that the provision of outdoor treatment is the better course to follow, and points out that if there is any treatment worth having, people will gladly avail themselves of it.

WITH the financial help of the firm of Zeiss of Jena, the *Zeitschrift für Instrumentenkunde* has been able to carry out its project of issuing occasional supplements dealing with the history of the progress of optics. The first part appeared in December under the title *Forchungen zur Geschichte der Optik*. It consists of 40 pages of the same size as those of the *Zeitschrift*. Five pages are occupied by an article by Dr. M. v. Rohr, the editor, devoted to an extract from Sir J. F. Herschel's Journal, giving an account of his visit to Fraunhofer at Munich in September 1824, and to other evidence of the rapid spreading of a knowledge of Fraunhofer's work amongst English physicists in the next few years. The remainder of the issue is devoted to an article by Dr. H. Boegehold giving the history of the achromatism of prisms and lenses from the discovery of the effect for glass and water by Newton in 1704, its use by Dollond in 1757, and its general recognition as an optical method by about 1775.

PROF. EJNAR HERTZSPRUNG, of Leyden Observatory, has been appointed George Darwin lecturer of the Royal Astronomical Society for 1929. The lecture will be delivered at the May meeting of the Society.

AN earthquake of moderate intensity was recorded at Kew Observatory at 20 hr. 48 min. 50 secs. G.M.T. on Jan. 24. The epicentre is estimated to have been 5580 miles away, probably in Central America.

SIR ERNEST RUTHERFORD will open a discussion at the Royal Society on Feb. 7 on "The Structure of Atomic Nuclei." Dr. F. W. Aston, Dr. J. Chadwick, Dr. C. D. Ellis, R. H. Fowler, and Prof. O. W. Richardson will take part in the discussion.

THE Pharmaceutical Society of Great Britain will hold a conversazione at the Society's house at 17 Bloomsbury Square, London, W.C.1, on Tuesday, Feb. 12, when the museums, school, and research and pharmacological laboratories will be open to inspection.

THE Progress Medal of the Royal Photographic Society of Great Britain has been awarded by the Council to Mr. Olaf Bloch, in recognition of his various inventions, researches, and publications, which have resulted in important advances in the development of photography.

THE Council of the Institution of Naval Architects has awarded a premium for the year 1928 to Lieut.-Colonel V. C. Richmond for his paper on "Some Modern Developments in Rigid Airship Construction," and a joint premium to Mr. E. Leslie Champness and Mr. Frank McAlister for their paper, "Further Notes on the Relative Strength of Fine and Full Cargo Vessels." The premiums will be presented on Mar. 20 at the opening of the annual general meetings, which will be held at the Royal Society of Arts, John Street, W.C.2.

THE Institute of Physics announces additional privileges for student members. Registered student members pay a fee of five shillings per annum, which is credited against the entrance fee on election to corporate membership. In future, in addition to existing privileges, students will receive the published lectures given before the Institute free of charge, and will be allowed to subscribe to the *Journal of Scientific Instruments* at the privileged rate of ten shillings and sixpence per annum.

THE Council of the Institution of Electrical Engineers has made the eighth award of the Faraday Medal to Signor Guido Semenza, of Milan. This medal is awarded by the Council of the Institution not more frequently than once a year either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution. Signor Semenza has for many years taken a leading part in the development of the applications of electricity.

THE non-magnetic yacht *Carnegie* has reported her arrival at Callao, Peru, on Jan. 14. Because of a storm and loss of an anchor at Easter Island, the vessel left there on Dec. 12, two days before the time originally set. Unfavourable winds drove her south from her course as planned to 40° south latitude in

longitude about 95° west. Captain Ault reports continued excellent observational results for the full programme since leaving Easter Island. Twenty-three bottom samples were obtained on the trip from Balboa to Easter Island to Callao; those from Easter Island to longitude 95° west were red clay with volcanic mud. It is expected that the *Carnegie* will sail on Feb. 3 from Callao for Papeete, Tahiti.

THE claim by Leone Caetani, author of the "Annali del' Islam," that the great Moslem migration into North Africa was due to the increasing desiccation of Arabia at that period, has been discussed by Prof. Alois Musil in an Appendix, No. 10, to his work on Northern Negd in the fifth volume of his "Explorations in Arabia," in process of publication by the American Geographical Society. Prof. Musil insists that this claim is quite invalid, and that there is no evidence of any material climatic change in Arabia during historic times. Prof. Musil's detailed discussion of this question is useful, as the view that the Arab emigration was due to increasing desiccation has been adopted recently by Sir Thomas Arnold (1924), and by Prof. MacMillan Brown, "Problems of the Pacific," 1927.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior assistant (engineer) at the Fuel Research Station, East Greenwich—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Feb. 14). An assistant for work on virus diseases of the potato, and an assistant for field work in connexion with the development of potato culture, each under the Department of Agriculture for Scotland—The Establishment Officer, Department of Agriculture for Scotland, Queen Street, Edinburgh (Feb. 16). A reader in mathematics at Birkbeck College—The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 18). A lecturer in agriculture in the University of Leeds—The Registrar, The University, Leeds (Feb. 18). A professor of electrical engineering at the College of Engineering, Guindy, Madras—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Feb. 23). An evening lecturer in magnetism and electricity at the Wimbledon Technical Institute—The Principal, Technical Institute, Wimbledon, S.W.19. A Secretary to the Technical Institute, Wandsworth—The Principal, Technical Institute, Wandsworth, S.W.18.

Our Astronomical Column.

COMET SCHWASSMANN-WACHMANN (2).—The new comet 1929*a* proves to be one of short period, like the first one discovered by the same observers. Images of the comet were found on plates taken on Jan. 4 and 12 (the latter at Uccle Observatory). From these positions, combined with photographic observations on Jan. 20, Prof. G. van Biesbroeck and Mr. Y. C. Chang have computed the following orbit (*I.A.U. Circ.*, No. 218):

T	1929 April 1·36 U.T.	
ω	2° 15′	1929·0
Ω	126 36	
i	3 39	
log q	0·3075	
Period	6·825 years.	

EPHEMERIS FOR 0^h.

	R.A.	N. Decl.	log r.	log Δ.
Jan. 28.	5^h 38^m 16^s	20° 59′	0·3201	0·0988
Feb. 5.	5 39 1	21 23	0·3174	0·1161
13.	5 41 57	21 47	0·3149	0·1348
21.	5 47 25	22 10	0·3126	0·1546

The distance from the sun is diminishing, but that from the earth increasing; the brightness should not diminish rapidly. The comet should be observable until May at least. If these elements are accurate, there was a near approach to Jupiter (about one-third of a unit) in November 1926.

FORBES'S COMET.—The following are the latest observations to hand of Forbes's Comet:

U.T.	R.A. 1928·0.	S. Decl. 1928·0.	Observer.
Dec. 8·47988	12^h 54^m 21·15^s	31° 55′ 9·4″	G. van Biesbroeck, Yerkes.
9·48678	12 56 50·03	32 22 2·7	,, ,,
10·48032	12 59 15·77	32 47 48·7	,, ,,
8·06210	12 53 19·23	31 43 36·1	H. E. Wood, Johannesburg.

Astr. Nach., 5608, reports an observation of this comet: Oct. 27·81 U.T., R.A. 11^h 1^m 24^s, N. Decl. 8° 32·2′. There is little doubt that the comet was seen, but the position given is very rough.

A POSSIBLE COMPANION TO SIRIUS B.—A letter from Dr. R. T. A. Innes in the *Observatory* for January states that a faint star has been suspected near Sirius B on several nights ranging from Feb. 4, 1926, to Mar. 20, 1928. Its distance from B varies from 1″ to 2″ and the period is estimated to be from 18 months to two years. It is estimated as of magnitude 12. On some evenings several observers saw it. Various eyepieces were tried, and every precaution was taken to guard against illusion, but the object is so difficult that its existence is not absolutely guaranteed. Dr. van den Bos recalls that Prof. Fox suspected the duplicity of B with the 18½-inch Clark refractor. He gave P.A. 231°, distance 0·8″, date 1920·110.

Dr. van den Bos also gives some measures of the companion of Procyon, though this was so difficult that he does not guarantee its objective existence:

	P.A.	Dist.
Feb. 8, 1927 . . .	198·6°	3·06″
Oct. 27, 1928 . . .	230·7	2·07

He had purposely consulted no ephemeris on either occasion, but afterwards found that the first position was in fair accord with Dr. Spencer Jones's ephemeris.

It may be worth while to point out that the distance and period as estimated by Dr. Innes are not compatible with each other. From the meridian observations of the bright star, the mass of Sirius B has been deduced as 0·96 of the sun's mass. If Sirius B is double, this would be the joint mass of its two components. The parallax 0·38″ is very well determined. Taking the mass as equal to that of the sun, a semi-major axis of 1·52″ would give a period of 8 years. One of 1·00″, the smallest value suggested by Dr. Innes, would give a period of 4·27 years. Thus, either the distances given by him are considerably overestimated or the period is underestimated. The distance given by Prof. Fox, 0·8″, would give a period of 3 years, if assumed to be the unforeshortened length of the semi-major axis. The distances were estimated, not measured, at Johannesburg, the suspected star being too faint to set a wire upon.

Research Items.

THE SPEARTHROWER IN AMERICA.—Some remarkable spearthrowers of ancient American origin are described by J. Alden Mason in the *Museum Journal* (Philadelphia) for September 1928. At the present day the spearthrower is used in America only by the Eskimo, certain of the tribes of the Amazon, and the Tarascan Indians of Lake Patzcuaro, Mexico; but formerly it was employed much more widely. Specimens are known from the pre-Cliff Dweller remains of Utah belonging to the people known as the Basket-makers, from pre-Columbian Florida, and from pre-Columbian graves of the coasts of Peru and of Ecuador and Colombia, from the Aztecs of the time of Montezuma and from the Toltecs. The Haitians of the time of Columbus used it, as did certain Californian tribes of a century and a half ago. Not more than about thirty examples have been found in any one of these areas. Of the specimens here described, one belongs to the so-called Thule culture of the early Eskimo, and was found by W. B. Van Valin in the region of Point Barrow in 1919 in a series of mounds. It differs from any of the modern types, being of a superior grade alike from the æsthetic, technological, and utilitarian points of view. It is of a coniferous wood and measures 14½ in. in length by 2¾ in. maximum width. Its peg is of ivory. The second example belongs to the Basket-makers' culture of Utah and was the first to be found in the south-west. It is remarkable for a number of ceremonial objects attached to the handle. These include the tooth of a canine or feline, wrappings of yucca fibre, cotton yarn, and fur; and an X-ray examination has revealed four beads, probably of turquoise and representing the heart of a fetish bird, which lie under the yarn and cannot be otherwise examined owing to the fragility of the material. Two spearthrowers which are unique, and the rarest known in America, come from Marco Key, Florida, where they were discovered in 1896. They are longer and more slender than spearthrowers from other regions, the closest approximations being those in use among certain eastern Colombian tribes. A carved rabbit at the distal end of one is reminiscent of the carved spearthrowers of the Magdalenian period of palæolithic Europe.

RESCUE AND RECLAMATION OF FISH.—The Division of Fish and Game of the Californian Department of Natural Resources has developed a strange industry—the rescue and reclamation of lost, or potentially lost, fishes. Black bass and other spiny-rayed fishes take advantage of flood conditions to spawn in areas which at the time seem perfectly suitable, but as soon as the overflows begin to dry through evaporation, both the newly hatched young and the adult fishes become a prey to predatory birds and mammals, and the result is a total loss. The rescue of this threatened population and its transference to a safe environment has assumed very considerable proportions. One worker reports that up to the end of August 1928, he had saved in his district of Hanford, 158,200 fishes, the majority of which were cat-fish, and these were planted in rivers throughout the country. During the month of August as many as 258,000 valuable angling fishes were saved to the State. Although a certain amount of useless and possibly harmful transportation has been carried out by enthusiasts, the aim of the Division of Fish and Game is to save only food-fishes, and to utilise them in stocking barren waters with the species most adaptable to their particular conditions.

COMBAT-REACTIONS IN FROGS AND TOADS.—Reactions to special stimuli which produce specific phases of pose and movement suggesting a struggle, have been described amongst reptiles, but, according to Georg Hinsche, have not been suspected to occur amongst amphibians (*Biolog. Centralbl.*, Bd. 48, 1928, pp. 577-617). He finds a well-marked series of such reactions, twisting, staggering, stiffening, and kicking, suggesting attack and defence, to be exhibited by *Bufo vulgaris* and *Pelobates fuscus*, and rather less definitely displayed by other native amphibians such as *Bufo vividis*, *B. calamita*, *Rana esculenta* and *Hyla arborea*. Certain tactile as well as optical stimuli are adequate to set free such reactions, but along with the specific stimulus environment is an important factor. Hinsche considers that these combative reflexes are associated with very elementary reflex complexes related to the creature's food supply, burrowing habits, and sexual acts, and that, from the point of view of biological significance, they constitute a specific reply to a definite type of stimulus, and are not simply a reaction against an individual enemy. Their differences in degree in the different species he has experimented with are put down to differences in morphological and anatomical structure in these species. But in general the author finds that where a tendency towards flying leaps occurs, as in many species, the combat-reaction is reduced in intensity.

THE MOSQUITOES OF NORTH AND SOUTH AMERICA.—Dr. H. G. Dyar, of the United States National Museum, has recently contributed an important revisional monograph entitled, "The Mosquitoes of the Americas." It is issued as *Publication of the Carnegie Institute of Washington*, No. 387 (1928), and brings up-to-date the many changes in synonymy that have taken place since the publication of Howard, Dyar, and Knab's standard four-volume treatise on the "Mosquitoes of North and Central America and the West Indies" (1912–17). It is, furthermore, to be regarded as being supplementary to the latter work, since it also includes all the known species from South America. The classification of the group has not been materially altered from that adopted in the larger monograph just mentioned, except that five tribes of these insects are recognised instead of two. The Sabethini are here regarded as a separate division, since the American species all exhibit the peculiar larval feature of the median ventral brush on the anal segment being wanting. Dr. Dyar's work will be found invaluable by special students of mosquitoes, since he describes in concise language the male, female, and larva of every species where material is available, and their salient structural characters are fully illustrated on the 123 plates which accompany this monograph.

PHILIPPINE ECHINOIDS.—Mr. Hilario A. Roxas, in his paper "Philippine Littoral Echinoida" (*Philippine Journal of Science*, June 1928), reports on the littoral sea-urchins and sand dollars in the collection of the Department of Zoology, University of the Philippines. Echinoderms are not very numerous in the Philippines, but eleven species of sea-urchins and five of sand dollars (Clypeasteridæ, Arachnoididæ, Laganidæ, and Scutellidæ) have been found at Puerto Galera, Mindoro, which is the main collecting ground. The only really common species are *Tripneustes gratilla*, *Echinotrix calamaris*, and *Echinometra oblonga*, none of the others being abundant. Photographs are given of all the species, showing the main characters of the tests in most cases, both with and without the spines, which should make identification easy. *Prionocidaris verticillata* is a very striking form,

bright green when alive and having long heavy spines ornamented with whorls of projecting ridges.

FLOWER SIZE AND CHROMOSOME SIZE IN PETUNIA.—A peculiar genetic behaviour in Petunia is briefly described by Mr. E. Malinowski (*Jour. Heredity*, vol. 19, No. 11). He shows that in a variegated strain of *P. violacea* Lind. obtained from de Vilmorin, there is great variability in the size and colour of the flowers on some plants, other plants producing only large purple flowers or small lilac ones, and the same variable progeny being produced from seeds of any of the type. But plants cannot be inbred because of self-sterility. It is suggested that this range of variation, although phenotypical, is produced by the presence of one gene. It is further stated (and this needs confirmation) that the large purple flowers show larger chromosomes in their cells than the small lilac flowers, although in any one flower bud the meiotic divisions may show some cells with large and others with small chromosomes. The statement is also made that, following the reduction division, one of the daughter cells may have large and the other small chromosomes. It is suggested that the differences in flower size may be the result of the difference in size of the chromosomes. The whole subject requires fuller investigation, which might yield significant results.

DIŒCISM IN THE GARDEN ASPARAGUS.—A paper on the degree of diœcism in the garden asparagus by T. Shoji and T. Nakamura, in the *Japanese Journal of Botany* (4, 125-152; 1928), raises many points of general interest. In male plants the pistil was developed in the flowers to an extent that varied with the individual plant, but was very constant in the flowers upon any one plant. In the male flowers, instead of the typical trilocular ovary, bi- or unilocular ovaries may be found, and in some cases one carpel is modified into an anther. An interesting test is made of Robinsohn's reagent for determining the receptivity of the stigmatic surface for pollen, by the extent to which it stains when immersed in a aqueous solution of sodium potassium tartrate and silver nitrate. According to Robinsohn, the stigma should only stain deeply when it is in a receptive state, and tests of the normal pistils of asparagus were in accordance with this statement. On the other hand, heavy staining of certain regions of the imperfect pistils in the male flowers, which were quite without stigmas, rendered the reagent useless in distinguishing between fertile and infertile carpels. Wounds at the surface of the carpels tended to take up the stain, and the authors raise the question as to whether the degree of staining with this reagent is connected with the extent to which the cuticle is interrupted at the stigmatic surface, itself a question of some general interest. Many details of the cytology of the degenerating mega- and micro-sporangia are given in this paper.

LAND SHELLS FROM THE WEST INDIES.—Dr. H. A. Pilsbry and E. G. Vanatta describe three new land shells from Tortuga Island and one from Haiti, whilst Dr. Pilsbry appends a paper on the species of *Lucidella* (subgen. *Pœniella*), including two new, from Haiti and Santo Domingo (*Proc. Acad. Nat. Sci. Philad.*, vol. 80). Figures illustrating both papers are combined on one plate. Fig. 17, which is stated to represent a form of *Cerion tortuga*, n.sp., differs so much from Fig. 15, the type, and Fig. 16, a coloration variety, as to suggest that, variable as these shells are, an illustration of some other species has accidentally been substituted when making up the plate.

CARBONIFEROUS BRACHIOPODS.—The first part of a monograph on British Carboniferous brachiopods, by the late Dr. Ivor Thomas, was published in 1914. The second part (*Mem. Geol. Surv. Gt. Britain, Palæont.*, vol. 3, pt. 1, pp. 1-217, plates i-xii, 1928) is the work of Miss H. M. Muir-Wood and deals with the *semireticulatus* and *longispinus* groups of *Productus* (*sensu stricto*), of which 41 species or varieties are described. The Producti can be divided into at least eight genera, namely, *Productus* (restricted), *Avonia*, *Buxtonia*, *Pustula*, *Overtonia*, *Sinuatella* (gen. nov.), *Proboscidella*, and *Etheridgina*; they include the largest brachiopod known, *Productus giganteus*, with a breadth of 300 mm. The shell of *Productus* was apparently anchored by means of spines, sometimes five or six inches long, which are developed on the larger valve. The Producti are very abundant in the Carboniferous, but afterwards diminished in numbers and became extinct at the close of the Permian period. The group is said to have been derived from a Strophomenid ancestor in the Ordovician or Silurian. The earliest British representatives are found in the Pilton Beds of North Devon (Upper Devonian or basal Carboniferous). Shells of the *semireticulatus* group make their appearance in the Zaphrentis zone and evolved rapidly, but during *Seminula* times conditions were unfavourable to the development of this group. A multitude of new forms appeared in *Dibunophyllum* times and includes some over-specialised species with a very limited range in time and space. The sudden disappearance and extinction of the Producti is thought to be due in part to the excessive secretion of carbonate of lime.

THE SHAP GRANITE.—An important contribution to the petrology of the well-known Shap Granite has been made by Dr. D. R. Grantham, with the collaboration of Dr. H. F. Harwood, who has made seven excellent analyses. The results appear in the *Proc. Geol. Assoc.*, pp. 299-331; 1928. The 'granite' is a composite intrusion made up of a suite of porphyritic biotite-granites allied to adamellite. The oldest solid product of the original magma appears to be a chilled peripheral facies of basic type and probably hybrid origin. This 'early basic granite' was disrupted by the ascent of the main intrusions, distinguished as Stages I. and II., within which it occurs as the inclusions hitherto regarded as 'basic segregations.' The main mass of the granite shows successive increase in porphyritic felspars and decrease in accessories. A fourth phase is represented by Stage III., dyke-like masses of granite still richer in phenocrysts. The inclusions in Stage II. comprise not only 'early basic' and Stage I. types, but also numerous blocks of hornfelsed andesites and (rarely) Coniston limestone. Evidence is brought forward to show that contamination of the original magma by reaction with, and assimilation of, the andesites of the country rock is beyond reasonable doubt. Dr. Harwood's analyses give practically a straight-line diagram from 'andesitic inclusions' to Stage II., and this alone is weighty evidence in favour of assimilation. Further joint work on the andesites themselves is in progress.

SOUNDING AT SEA.—The December issue of the *Journal of the Franklin Institute* contains an account of the methods used by the United States Coast and Geodetic Survey for the measurement of the depth of sea water, by Lieutenant J. H. Service, of the Survey Department. For soundings in water too deep for the hand line the sound-wave method in the form known as the 'fathometer' is most used. An electrically driven oscillator strikes a diaphragm under water outside the ship and the sound reflected from the bottom of the sea affects a microphone in a water tank inside the ship's plating below water level. In

series with the microphone is a neon tube which lights up when the reflected sound arrives at the microphone. The tube is placed behind a radial slit in a revolving disc in front of which is a circular dial marked in fathoms. The oscillator acts as the neon tube passes the zero of this scale, so that the depth is read at the end of the revolving slit when it flashes out red owing to the lighting up of the neon tube behind it. The speed of sound in sea water of salinity 35 parts per 1000 at the surface and at 0° C. is taken as 1450 metres per second. It increases 4 metres per second per degree rise of temperature, 3 per 100 fathoms depth, and 1 per part per 1000 increase of salinity.

STRONG ELECTROLYTES.—The revival of interest in the properties of strong electrolytes which followed the publication of the Debye-Hückel theory in 1923 shows no signs of falling off, and a further group of papers on this subject has appeared in the issue of the *Physikalische Zeitschrift* for Nov. 1. One of these, by M. Wien, on departures from Ohm's law, is of particular importance. An electrolyte has been shown to undergo a decrease in resistance when it is subjected to high electric stress. In relatively weak fields the increase in conductivity is approximately proportional to the square of the field strength; for larger fields, the rate of increase is linear; and finally, when an intensity of the order of a hundred kilovolts per centimetre has been attained, a new value of the conductivity is reached, which is several per cent above that for weak fields, and is practically unchanged by any further increase in the applied potential. These effects depend in a characteristic way upon the valencies of the ions in the solution, and the ultimate value of the conductivity corresponds, within the limits of experimental error, with the conductivity of the same electrolyte in a weak field at infinite dilution. These observations, together with some others made by M. Wien on the effects of alternating fields on electrolytes, have been discussed by G. Joos, and have been shown to be at least in qualitative accord with the newer versions of the Debye-Hückel theory.

LUMINESCENCE.—A report upon cathodo-luminescence and the luminescence of incandescent solids by E. L. Nichols, H. L. Howes, and D. T. Wilber, that has been issued as a *Publication of the Carnegie Institution of Washington* (No. 384), furnishes a valuable summary of the experimental work that has been carried out by the authors and others in this little-known branch of optics. Their object has been to bring together investigations on the relations between the emission of light from hot bodies, other than purely thermal radiation, and such phenomena as fluorescence and phosphorescence at lower temperatures. Some of their results are very surprising, for example, the frequent excess of the radiation over that from a black body at the same temperature, and in general they find that selective emission, when excited thermally, shows the effects characteristic of ordinary fluorescence. The position of the bands in the spectra is often, moreover, the same under the different modes of excitation, of which exposure to a hydrogen flame and to the light of an iron arc are two typical examples, and from the evidence that they have presented they conclude finally "that the luminescence superposed upon the incandescence of the various solids is simply a *fluorescence* in all essentials identical with that commonly excited by light, cathode rays, and other familiar agencies."

A MULTIPLE-DOME ARCH DAM.—A reinforced concrete dam of unusual design has recently been completed in a canyon of the Gila River, Arizona, U.S.A. The dam is for a reservoir for the storage of water for flood control and power supply and for the irrigation of some 100,000 acres of land held as a reservation for the settlement of certain Indian tribes. The dam is the subject of a well-illustrated article in the *Engineer* for Jan. 18, from which it will be seen that not only is it of unique design but it is also a handsome structure. Many single-arch and multiple-arch dams have been constructed, and in these inclined arches spring from the piers, each arch sustaining the vertical weight of water as well as its horizontal pressure. In the new Coolidge Dam, as it is called, these arches are replaced by dome-shaped structures something of the form of the half of a very thick eggshell cut along its major axis. In the Coolidge Dam there are four piers, 180 feet centre to centre, and from these spring three ferro-concrete domes which are 21 feet thick at the base and 4 feet thick at the crown. The height of the dam is 250 feet. The first of its kind, the dam was designed by Major C. R. Olberg, of the United States Indian Bureau, and in his description of it he states that the maximum compression stresses for the dome were fixed at 600 lb. per sq. in., and in the buttresses at 400 lb. per sq. in. At first sight the shuttering for the construction of such domes would appear to be a matter of great difficulty, and not the least interesting feature of the work was the method used by the contractors for this shuttering.

NITRALLOY STEELS.—The issue of the *Chemical Age* for Jan. 5 contains some interesting information concerning the case-hardening of steels by nitrogen. When iron and steel are heated in an atmosphere of ammonia, nitrogen is absorbed, and with special steels (nitralloy) a very hard surface is produced. The 'nitration' is carried out after machine finishing, since no deformation occurs, providing that all strains have been relieved by suitable heat treatment, but only a small regular swelling, for which due allowance can be made. The resulting hardness is 900-1100 on the Brinell scale (chromium vanadium steel, case hardened, being 742) and permits glass and quartz to be cut. The nitrated steels are capable of taking a mirror finish, and it is claimed that they show exceptional resistance to wear. They retain their hardness up to 500° C.

OXIDATION OF PYRITES IN COAL SEAMS.—The Safety in Mines Research Board has issued a report of an investigation by H. Macpherson, N. Simpkin, and H. Wild (S.M.R.B. Paper No. 47. London: H.M. Stationery Office; 1*s.* 6*d.*) recording an examination of the occurrence of pyrites and its oxidation by air, particularly in the Ravine seam of Lancashire. Their work supports the view that pyrites acts not so much by initiating combustion as by promoting disintegration of the massive coal. This disintegration is brought about by the volume change on oxidation and assists access of air to the coal substance itself, which can then take up oxygen and so become heated.

FIRING COAL DUST.—A paper, by T. N. Mason and R. V. Wheeler, issued by the Safety in Mines Research Board (S.M.R.B. Paper No. 48. H.M. Stationery Office. 3*d.*), records experiments on firing coal dusts in a steel gallery, 7½ feet in diameter. The results confirm the view that the inflammability of the dust increases with the content of volatile matter of the coal, inflammability being measured by the mean speed of the flame. Explosability—measured by the maximum pressure developed—is of the same order and in close agreement with the proportion of incombustible matter which must be mixed with the coal dust to suppress its inflammability.

High Pressure Gas Research.

AT the invitation of the governing body and the rector of the Imperial College of Science and Technology, a distinguished company assembled at the College on Jan. 21 to inspect the new equipment of the high pressure gas research laboratories and the work in other sections of the Department of Chemical Technology. An opportunity was thus afforded of observing the results of a consistent policy of fundamental research, conducted in the atmosphere of intellectual freedom traditionally associated with British universities, into matters which from their very nature form the prop and stay of important sections of the industrial structure. The Department, which was inaugurated in 1912 under the direction of Prof. W. A. Bone, now comprises three sections: (1) fuel technology, with refractory materials, combustion, and high pressure gas reactions and explosions, retained by Prof. Bone under his immediate personal supervision; (2) chemical engineering, in the charge of Prof. J. W. Hinchley; and (3) electrochemistry, superintended by Assistant Prof. G. I. Finch. The breadth of its scope and aims has remained unchanged since its inception, the recent establishment of a special chair in chemical engineering being a natural consequence of the increasing size and influence of the department.

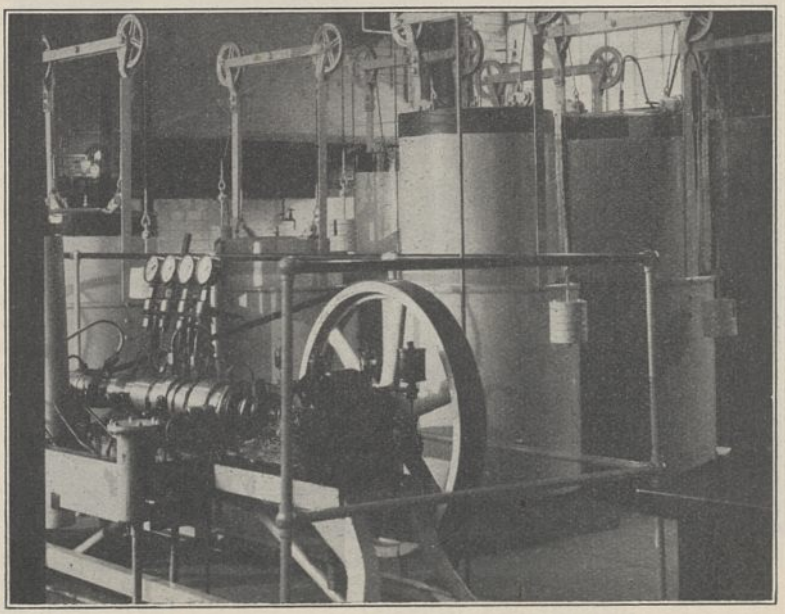

FIG. 1.—Gas-holders and the 1000 atm. 5-stage compressor.

The work of the Department is exclusively of a post-graduate and research character, being chiefly directed to giving graduates in chemistry from the Imperial College or elsewhere a broad and practical training on fundamental lines; a training calculated to combine true intellectual development with an acquisition of the knowledge and skill required of holders of responsible positions in industry. In addition to the professorial staff there are three lecturers and an instructional assistant, whilst the personnel of the fine modern workshop consists of four skilled mechanics. The students (excluding sundry occasional students) at present number 25, and there are 18 paid research assistants and fellows. The cost of the Department, in which there are thus 50 people continually prosecuting scientific and technological studies, amounts to about £13,000 per annum, of which about £7000 is defrayed out of the ordinary College funds, the remainder being in the form of aids and grants from various extra-mural sources. Of more than 150 post-graduate students who have already passed through the Department — some hailing from Australia, Canada, India, South Africa, the United States of America, China, or Japan —most now occupy responsible posts as fuel technologists, plant managers, chemical engineers, or research chemists in industrial concerns.

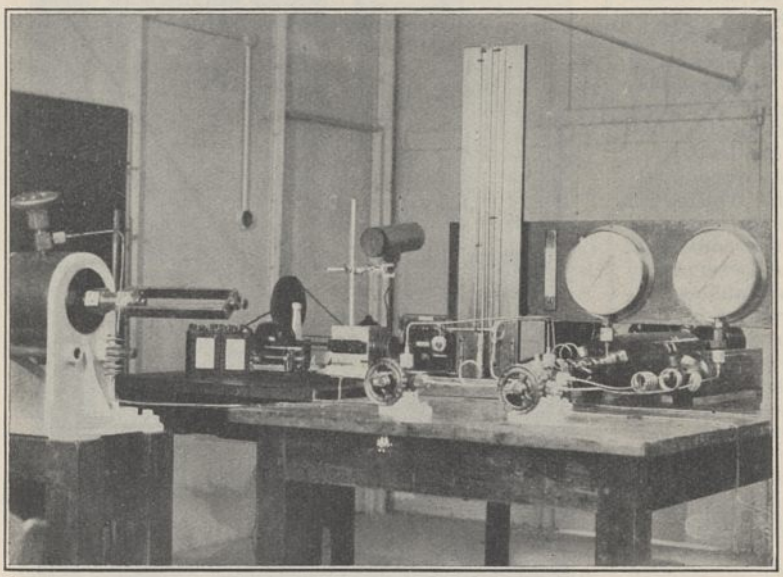

FIG. 2.—An explosion bomb with filling and optical recording systems.

The successful growth and operation of the Department has been achieved in buildings which, even after sixteen years, are far from complete. The first two stories (providing for fuel technology and in part for chemical engineering) were erected in 1913–14; after the War two further stories (for chemical engineering and electrochemistry) were added, but the continuous growth of the Department, and more especially its research developments, have rendered the present accommodation quite inadequate for the increasing needs of its work and activities. A scheme for the further enlargement of the building has therefore been approved, and will be carried out as soon as the necessary funds are forthcoming. The capital

expenditure on buildings and equipment to date has been approximately £60,000, and about £50,000 more is required for the extension now contemplated.

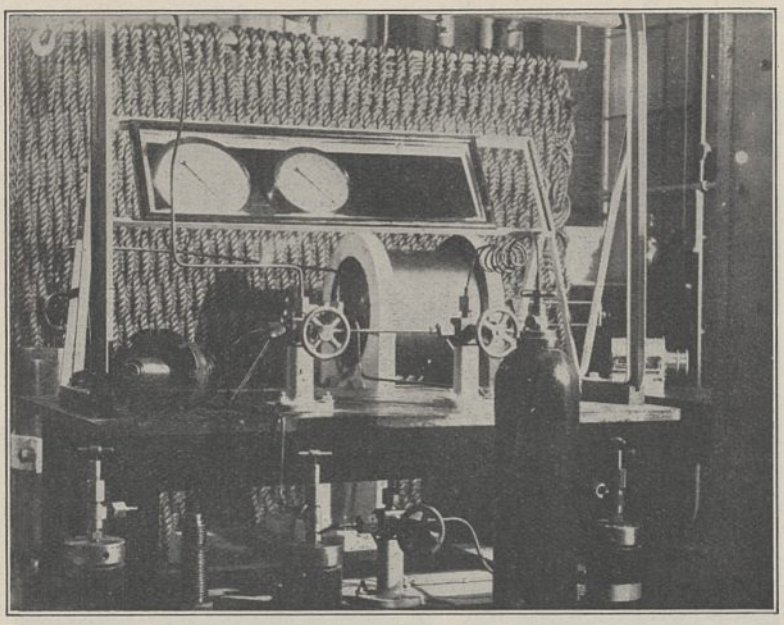

FIG. 3.—Bomb which withstands explosion pressures up to 15,000 atm., with filling system, mirror for reading gauges, and safety curtain.

It has been the constant policy of the Department to base its activities on a bedrock of fundamental research, and it now has a highly trained staff of research assistants who, organised in groups, prosecute systematic lines of research which are carefully planned in advance. After two terms, the student is attached for about a year to one of these groups, afterwards being allowed to proceed independently or to become a group-leader; he is thus disciplined in technique and accuracy, and he learns the value of co-operation and the benefit of leadership, whilst at the same time a continuity of skilled workers over a period of years is assured. Each of these men is, of course, supported by extra-mural grants or aids, and the leader, on passing out into the industrial world, immediately occupies the post which is awaiting him. During his period of leadership he has added to his scientific qualifications valuable experience in the control of technical men, in the preparation of weekly reports of progress, and in the discussion of his own and cognate researches at frequent and regular intervals, both with Prof. Bone and with his fellow group-leaders and researchers. It may be of interest to give a brief account of the principal lines of fundamental work which are being actively pursued in the Department.

CHEMISTRY OF COAL.

The group investigating, with the aid of grants from the Fuel Research Board and a fellowship maintained by the Sensible Heat Distillation Co., the chemistry of coal has already examined brown coals, lignites, bituminous, semi-bituminous, and anthracitic coals from all parts of the world. It has devised means for the extraction, by benzene at 250°, of the primary oils and the coking constituents of coals; this operation is naturally conducted in a separate fireproof shed. Much light has been thrown on the chemical aspects of the maturing of coals, and it has been found possible to oxidise the residue after extraction to about 40 per cent of its weight of benzenecarboxylic acids.

GASEOUS COMBUSTION AND REACTIONS AT HIGH PRESSURES.

The work on mixtures of air with carbon monoxide, hydrogen, or methane at initial pressures up to 200 atm.—itself of a pioneering nature—is, with the assistance of grants from the Department of Scientific and Industrial Research, Imperial Chemical Industries, Ltd., and the Gas Light and Coke Co., Ltd., being extended to initial pressures of 1000 atm. A single preparation of the pure gas affords 10 cub. ft., which is purified, collected in one of a series of small, distinctively coloured gas-holders, and then compressed in five stages up to 1000 atm. (Fig. 1); it is then stored in boldly painted cylinders—red (hydrogen), brown (methane), black (air), green (carbon monoxide), or yellow (helium); of 60 cub. ft. of the latter obtained from America four years ago, 35 cub. ft. remain. Every cylinder is numbered and records are kept of its use; one person is in charge of them, whether filled at 1000, 400, or 200 atm., and analyses each fresh charge. The most stringent rules guard, so far as is humanly possible, against accidents. Incidentally, the absence of exact data requires that compressibility measure-

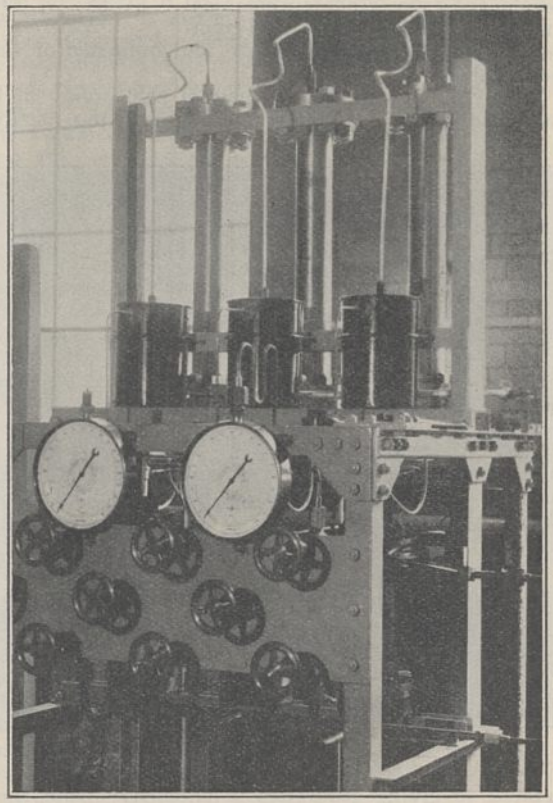

FIG. 4.—Multiple unit high-pressure catalytic circulating system.

ments be made on every gas mixture employed. There are three bombs for experiments employing up to 200 atm. initial pressure (Fig. 2)—the old bomb used by Prof. Bone at Leeds, a spherical bomb, and a cylindrical bomb with quartz windows for spectrographic work—and one, having 9-in. walls, wire-wound, and protected by thick rope curtains (the best known device), for experiments at initial pressures up to 1000 atm. (Fig. 3). This bomb is charged by a one-stage process with gas, and then by a two-stage process with air, in order to attain the requisite pressure; the charging is controlled from a distance, and the gauges are observed in a mirror. All the large apparatus, with the exception of the new 1000 atm. compressor, the compressor for catalytic experiments, and a few cylinders, which were made in Germany (from designs which, like those of most of the apparatus, were prepared by Dr. D. M. Newitt in consultation with Prof. Bone), are of British manufacture. Another new apparatus, with quartz windows, maintains steady continuous flames at pressures up to 100 atm. Experiments on the catalytic production of methyl alcohol in a single-tube unit will be extended with a new plant having three vertical catalytic tubes operated under 1000 atm. pressure at 600° C. (Fig. 4).

Photographic Study of the Development of Gaseous Explosions.

Supported by Nobel's Explosives Co., Ltd., this work has included the investigation of phenomena associated with the initial stages of gaseous explosions, and the influence of 'shock waves' in speeding up combustion and developing detonation, and it is now being extended to that of the influence of strong electrical and magnetic fields on flame-propagation in gaseous explosions. A novel form of camera designed by Mr. R. P. Fraser, and constructed for these researches, attains a film-speed of 200 metres per sec. A similar camera has been sent to Messrs. Nobel's at Ardeer, and another is to be despatched to the Australian Government.

Combustion of Carbon Monoxide, etc.

With the aid of fellowships maintained by the Gas Light and Coke Co. and Radiation Ltd., the influence of moisture on the combustion of carbon monoxide has been shown to be essentially electronic. The limit of drying capacity of phosphorus pentoxide on a mixture of carbon monoxide and oxygen is attained in about 200 days, but however carefully dried, the two gases always explode if a sufficiently powerful spark is employed.

Blast Furnace Reactions.

These investigations, which are being carried out under the auspices of the National Federation of Iron and Steel Manufacturers, aim at studying each reaction fundamentally, and at the gas-speeds—up to 20 m.p.h.—actually obtaining in the blast furnace. In particular, the phenomenon of carbon-deposition, which occurs on interaction of ferrosoferric oxide and carbon monoxide, and at 450° by the change $2CO = C + CO_2$, but not above 650°, is being followed up with the view, broadly speaking, of discovering whether or not the deposition should be encouraged, and what factors influence its appearance. Such knowledge is a positively essential preliminary to any marked chemical advance in the manufacture of iron, and the results will be of great value in the characterisation of ores. To acquire them is costing some £1600 per annum.

Surface Action and Ionisation.

Gaseous combustion in electrical discharges, and the electrical condition of surfaces during catalytic combustion, are under investigation. Work supported by the Department of Scientific and Industrial Research, and directed by Asst.-Prof. Finch, has already shown that combustion is conditioned by a prior 'ionisation' of both the combustible gas and oxygen.

Chemical Engineering.

Prof. Hinchley's section of the Department, in addition to providing systematic post-graduate instruction in the operation of chemical plant—instruction in which special attention is given to costing and to the actual construction of suitable units—is, with the support of the Distillers' Company, engaged in investigating fundamental problems connected with heat transmission and filtration. As soon as space is available, and further equipment installed, it will be possible to attack more adequately and systematically from a fundamental point of view the many problems encountered in the design and operation of chemical plant.

The Henri Poincaré Institute in Paris.

IN November last a new institute of mathematics and mathematical physics was formally inaugurated in Paris. It was both the official opening of a new building and the beginning of new courses of lectures, all to be a part of the Faculty of Sciences of the University of Paris. The building is now ready, but the internal arrangements are not yet complete.

The history of the new institute is brief. It had been noted by the International Education Board that on several occasions it had given large sums of money to different universities in Europe and that gifts to French universities had been on a much smaller scale. The importance of the French mathematical school suggested that help might usefully be given to mathematics in France. The decision was taken after consultations in which Prof. Trowbridge, who represented the International Education Board, and Prof. Birkhoff took leading parts. Prof. Émile Borel was asked to draw up a scheme. The plan, which was approved, provided for an institute to be named 'L'Institut Henri Poincaré,' as a centre for teaching and research on mathematical physics and the calculus of probabilities.

The courses on physical theories will be given in the new Institute by Prof. Léon Brillouin and M. Louis de Broglie. Prof. Léon Brillouin has made himself known by his researches on the theory of quanta and its applications; and he was invited last year to lecture in several universities of the United States and Canada. Dr. Louis de Broglie is one of the creators of wave mechanics, which now play a leading part in mathematical physics. These courses form an important addition to those already given in Paris by Prof. Brillouin and Prof. Langevin at the Collège de France, and by Prof. Eugène Bloch and Prof. Villat at the Sorbonne.

The calculus of probabilities already has its great exponent at the Sorbonne in Prof. Émile Borel. His researches on this subject have done much to revive interest in France in this subject, which owes so much to French workers such as Pascal, Fermat, Laplace, Poisson, Bienaymé, Cauchy, Cournot, Bertrand, Henri Poincaré. To Prof. Borel's course will now be added a new course by Maurice Fréchet, formerly professor of higher analysis at the University of Strasbourg. His theory of abstract spaces and functions has already made him known in the United States, where he delivered a course of lectures

at the University of Chicago in 1924. More recently, he has devoted much attention to the theory of probability, on which he has published (in collaboration with Prof. Halbwachs) "Le calcul des probabilités à la portée de tous."

The Henri Poincaré Institute will not, however, confine its attention to the new courses. It aims at being international in scope; in addition to the regular courses, single lectures or brief series of lectures will be given by distinguished scientific workers. Profs. Vito Volterra, of Rome, and de Donder, of Brussels, have already promised to co-operate.

The ever-increasing numbers at the Sorbonne has made additional accommodation necessary, and it was decided to erect a new building where not only the new courses but also all the advanced courses on mathematics will be given and where the mathematical library will be moved. The International Education Board is contributing one hundred thousand dollars towards these expenses; Baron Edmond de Rothschild has also contributed twenty-five thousand dollars, and the French Ministry for Education three hundred thousand francs. It is thus hoped to create in Paris a great scientific international centre for mathematical physics and calculus of probabilities.

Development and Morphology of Tunicates.

A RECENT issue of the *Quarterly Journal of Microscopical Science* (vol. 72, pt. 1) is entirely occupied by two memoirs on Tunicata. In the first, on the development of *Botrylloides* and its bearings on some morphological problems, by Miss Sylvia Garstang and Prof. Walter Garstang, uniformity in the purely ectodermal origin of the Ascidian atrium is established, which finally negatives the homology suggested by Van Beneden and Julin (1887) between the larval atrial canals of Ascidians and the spiracles of Appendicularians.

The investigation of the neuro-hypophysial system shows that the anterior part of the neural tube in front of the sensory vesicle undergoes a conspicuous development, and becomes longitudinally differentiated into two parts—a large ventral precerebral lobe which disappears entirely before the tadpole stage is reached, and a slender dorsal precerebral duct which persists and agrees essentially with the hypophysial duct of other Ascidians. This duct communicates with the oral region of the pharynx by a ciliated funnel, and gives rise to the brain by proliferation from its ventral wall.

It would appear that a considerable development of the pre-sensory region of the neural canal and its glandular modification was a primitive feature of the Tunicata, and distinguished them from *Amphioxus* and the Vertebrata. The comparative morphology and significance of the precerebral lobe is fully discussed.

The second paper is by Prof. Garstang alone. It is an interesting and speculative essay on the morphology of the Tunicata and its bearings on the phylogeny of the Chordata. He regards the current views of Tunicate ancestry—that the tailed larva represents the primitive or ancestral form from which the adult has been evolved by degeneration—as untenable. The neuro-muscular relations in Ascidian larvæ and Appendicularians are much more consistent with a theory of incipient than of vestigial metamerism and the development of atria before the gill-slits is in accordance with the phyletic history of the Protochordate type of gill-slit. The discontinuity between larval and adult nervous systems ("it is an error to assert that any part of the actual nervous system of the adult has formed a part of the larval nervous system") in Tunicates is unintelligible on the theory that Tunicates have been derived from *Amphioxus*-like ancestors, and points to a derivation of Tunicates from ancestors with a metamorphic life history before the typical chordate nerve-tube had come into existence.

The author has re-studied the symmetry of *Amphioxus*, which he explains as the consequence of the secondary reduction of yolk in the egg entailing premature hatching and the improvisation of a larval feeding mechanism. A great enlargement of the mouth and special ciliation of its entrance seem to form the basis of this mechanism, which involves a temporary dislocation of the adjacent parts and is held to have entailed changes which have left a mark on the permanent organisation of the adult. The author concludes that the ancestors of *Amphioxus* were essentially primitive Ascidians. In a future communication he proposes to deal with the origin of the chordate nervous system, and with the various cephalic organs associated with it.

University and Educational Intelligence.

LONDON.—The Senate has accepted an offer of the Committee of the Bayliss-Starling Memorial Fund of the sum of £2500 for the establishment at University College of a scholarship for training in physiology and biochemistry, to commemorate the connexion with physiology of the late Sir William Bayliss and Prof. E. H. Starling.

The following doctorates have been conferred: D.Sc. (in anatomy) on Mr. H. A. Harris (University College), for a thesis in the form of a series of memoirs dealing with the problems of bone growth, radiology, and teratology, published in various medical and scientific journals; D.Sc. (in botany) on Mr. W. B. Turrill (Chelsea Polytechnic), for a thesis entitled "The Phytogeography of the Balkan Peninsula"; D.Sc. (in chemistry) on Mr. Edgar Stedman (Birkbeck and Goldsmiths' Colleges), for a thesis entitled "The Relationship between Chemical Constitution and Physiological Action"; D.Sc. (in psychology) on Mr. J. C. Flugel (University College), for a thesis entitled "Studies in Mental Oscillation and Related Functions."

Dr. A. Sterling Parkes has been awarded the William Julius Mickle Fellowship for 1929 in respect of the work he has carried out during the past five years on the physiology and biochemistry of the organs of reproduction. The Fellowship this year is of the value of about £250.

Dr. G. P. Crowden has been appointed lecturer in applied physiology in the Division of Public Health at the London School of Hygiene and Tropical Medicine as from Aug. 1.

In March last a committee was appointed "To consider the question of the limitations placed upon the Medical Education of Women Undergraduates and to report to the Senate thereon." This report has now been issued. The problem was to provide clinical facilities for women requiring them in schools open to both sexes. The report points out that the prepossession of the University is in favour of co-education in medicine as in all other faculties, and suggests that there should be three types of clinical education: (1) for men only, (2) for women only, and (3) for men and women. The Senate has given general approval to the report, and schools of medicine not at present admitting women are to be invited to admit a quota of women students.

THE annual meeting of the Association of Technical Institutions will be held at the Grocers' Hall, London,

on Friday and Saturday, Feb. 22 and 23, under the presidency of the Right Hon. Lord Melchett. The programme includes papers by Sir Gerald Bellhouse, H.M. Chief Inspector of Factories, on industrial safety; by Mr. C. A. Siepmann, of the British Broadcasting Corporation, on broadcasting and its relation to technical education; and by Miss E. E. Cox, Principal, L.C.C. Barrett Street Trade School, London, on technical training for women. The Lord Mayor of London will entertain members and guests of the Association to luncheon on Feb. 22 at the Mansion House.

THE Commonwealth Council for Scientific and Industrial Research recently directed the attention of the Australian universities to the paucity of suitable candidates for the senior studentships in biological sciences which are being provided from the Science and Industry Endowment Fund. These studentships, if held abroad, are of the value (including fares) of £425 per annum for two years, and candidates are required to have given some evidence of capacity for original research work. To stimulate interest, it is now proposed to make available a number of junior studentships tenable either in the Council's laboratories or in Australian universities. They will be awarded to young graduates who have completed satisfactory courses but have not yet had sufficient opportunity to demonstrate their capacities for original work. At the end of their tenure the holders may become eligible for senior studentships abroad, or may perhaps be appointed to junior positions in one or other of the Council's research divisions.

"EDUCATION for Industry and Commerce" (H.M. Stationery Office, 6*d*. net) is the title of a pamphlet recently issued by the Board of Education. It is particularly timely in view of the reports of committees which, during the past three or four years, have touched upon the impact of scientific research and industrial development upon our educational theories. Already, arising out of those reports, Lord Eustace Percy has instituted two specific inquiries (salesmanship and engineering), and the present pamphlet, a survey of the arrangements at present in force for securing co-operation between technical schools and industries, is intended as an introduction to the new series of inquiries which are to be made into the organisation and methods of technical education. The pamphlet contains a preface by Lord Eustace Percy, which is an amplification of the detailed reply he made to the Emmott committee of inquiry into technical education and industry. It is a detailed view of the present educational facilities, but it is no mere tabulation. Especially worthy of attention are the passages dealing with the origin and purpose of our existing secondary schools. Referring to the Emmott committee's suggestion (which came from industry) that a memorandum should be prepared by the Board "covering the main features required in any technical training," the preface clears up one or two possible misunderstandings, but we still hope that such a memorandum will be issued, for without some national lead many employers find themselves in not a little difficulty. The arrangements for co-operation between industry and technical education are described in their two broad divisions—local arrangements under a local education authority, and the wider forms of co-operation on a national or regional basis. Developments since the War, such as the formation of joint industrial councils and research committees, are shown, as is also a useful list of places which have established advisory committees in specific subjects.

Calendar of Patent Records.

February 5, 1863.—The optical illusion known as 'Pepper's Ghost,' in which the images of living people could be projected on to the stage at will, and which proved an attraction at the Royal Polytechnic Institution for many years, was patented by Henry Dircks and J. H. Pepper on Feb. 5, 1863.

February 6, 1855.—The first 'artificial silk' patent was granted in England to George Audemars of Lausanne on Feb. 6, 1855. Audemars dissolved nitro-cellulose in an alcohol and ether mixture, and drew out threads from the solution by means of a steel pointer; the thread could be worked in the same way as silk and could be used as a substitute for it. It was not, however, until after many years of experiment and research that commercial success for the new thread was achieved by Chardonnet, the real pioneer of the vast industry of to-day.

February 7, 1589.—The art of papermaking reached Great Britain comparatively late. Down to nearly the end of the sixteenth century, our old linen cloths and rags were bought up by foreigners and all the best paper was imported from abroad. A very successful paper-mill was, however, set up by 1588 near Dartford, in Kent, by John Spilman, one of Queen Elizabeth's jewellers, who brought over workmen from Germany, and was granted a patent for ten years on Feb. 7, 1589, to make white writing paper. The patent was renewed in 1597 for fourteen years and extended to cover all kinds of paper, and the mill continued to work under different owners until well into the eighteenth century. Spilman was knighted by James I. in 1605, on the occasion of the King's visit to his works.

February 8, 1827.—The achievement of perpetual motion has been the aim of a multitude of inventors from Wilars de Honicort in the thirteenth century down to the present day, and some hundreds of patents for more or less ingenious machines have been applied for and granted in England. One of the most interesting of these was granted to Sir William Congreve, of rocket fame, on Feb. 8, 1827. An endless band of sponge runs round three rollers arranged in a frame at the angles of a right-angled triangle, and has attached to it on its outside an endless chain of weights so that the two bands move together—the parts of the chain and band being so uniform in weight that when the frame is placed with the hypotenuse upwards and the shorter side vertical, the system is in exact equilibrium. In this position the frame is placed in water with the lower part and two rollers immersed. The water is absorbed by the sponge on the vertical arm of the band because on that side it is not compressed by the weights, and the water will rise above its level and create a load that will set the band in motion.

February 8, 1841.—On Feb. 8, 1841, a patent was granted to W. H. Fox Talbot for his 'calotype' process of photography. This was the first process in which both a negative and positive were employed, and in which, therefore, a number of prints could be obtained from the one sitting. Talbot's process was cheaper than Daguerre's, which had been patented in Great Britain two years earlier, but did not give such clear impressions and was not very extensively used.

February 8, 1898.—Aspirin was put on the market as a drug by the German firm Fr. Bayer, which applied for a German patent on Feb. 8, 1898. The grant was, however, successfully opposed and no patent was actually issued. A corresponding English patent was granted in December 1898.

Societies and Academies.

LONDON.

Royal Society, Jan. 24.—**D. Denny-Brown**: (1) On the nature of postural reflexes. Postural reflexes are all based on Liddell and Sherrington's stretch-reflex. This basic reflex is a discharge of motor impulses at a slow rate, and no mechanical plastic or fixing mechanism is involved, except contraction caused by those impulses. The magnitude of reflex response changes by alteration of number of nerve units in discharge. This is effected by variations in excitation of units, either from changes in tension on muscle or from changes in excitatory effect relayed from higher levels of nervous system.—(2) The histological features of striped muscle in relation to its functional activity. Speed of contraction is a property of muscle fibres independent of observable histological differences, although development of rapid contraction occurs in fibre groups which are more highly differentiated for storage of lipoid substances or factors increasing fibre diameter.—**W. S. Stiles**: The effect of glare on the brightness difference threshold. A method is described for determining brightness-difference threshold in presence of point-source of glare. The value, for two subjects, of Fechner's fraction in absence of glare has been found for field brightness 0·001–2·2 candles/sq. ft. Threshold in presence of glare source is best expressed in terms of equivalent background brightness and a formula is developed which serves over this range.—**L. J. Harris**: The combination of proteins, amino-acids, etc., with acids and alkalis. Part 2. Titration curves of amino-acids, in presence of formol. Curves are given for variation in *p*H value (colorimetrical) with amount of soda added when amino-acids are titrated in aqueous formaldehyde, each addition being corrected for the acidity of the 'solvent.' The hydrochloric acid titration curve remained virtually unchanged by addition of formaldehyde. The results are explained on the basis of the 'zwitterion' hypothesis, according to which the caustic soda and hydrochloric acid titrations relate not to the apparent, but to the *true*, basic and acidic constants.—**F. W. R. Brambell** and **G. F. Marrian**: Sex-reversal in a pigeon (*Columba livia*).—**J. B. Gatenby** and **Sylvia Wigoder**: (1) The effect of X-radiation on the spermatogenesis of the guinea-pig. X-radiation prevents mitosis in those cells entering prophase. It is suggested that the X-radiation breaks up lipoids in some way essential to mitosis. Mild doses cause only temporary interference with lipoid metabolism, so that cells not already entering prophase of mitosis are able to recover. No evidence of stimulation effects by X-rays was procured.—(2) The post-nuclear body in the spermatogenesis of *Cavia cobaya* and other animals. In probably all flagellate sperms, the flagellum is fixed to the nucleus, not by the head centrosome, or by a protoplasmic membrane, but by a special structure called the post-nuclear body. This has often been mistaken for centrosome, middle-piece, or acrosome. It is a separate and distinct structure which (especially in molluscs) can be traced back into the spermatocyte.—**J. B. Gatenby**: Study of Golgi apparatus and vacuolar system of *Cavia*, *Helix*, and *Abraxas*, by intra-vital methods.—**A. B. Macallum**: Ionic mobility as a factor in influencing the distribution of potassium in living matter.

DUBLIN.

Royal Dublin Society, Dec. 18.—**W. R. G. Atkins** and **H. H. Poole**: The integration of light by photo-electrolysis. A vacuum sodium photoelectric cell of the Burt type was used. It was found possible to detect the production of alkali within ten seconds in daylight. The action of light may be integrated by titrating the alkali produced by a standardised cell. The deposition of copper appears preferable for longer periods, about 0·13 mgm. being deposited in a winter day; the potassium ethyl xanthate method serves for the estimation of the copper.

EDINBURGH.

Royal Society, Jan. 7.—**H. S. Allen**: Remarks on band spectra. A review of recent progress in the interpretation of band spectra. It is now known that band spectra originate in molecules containing more than one atom. Emphasis is laid on the close similarity between the electronic levels of molecules and those of 'corresponding' atoms, *i.e.* atoms with the same number of outer electrons. The application of the new quantum mechanics has removed outstanding difficulties as regards quantum numbers in band spectra.—**Ian Sandeman**: The Fulcher bands of hydrogen. An examination of Richardson's arrangement of these bands in the light of recent accurate measurements of the hydrogen spectrum by Gale, Monk, and Lee, while strongly confirming Richardson's allocation of the Q branches, has failed to yield confirmation of the remaining branches which he gives. A number of new combination relations holding between the lines of the Fulcher bands are given. These indicate that there are three main branches in each band, designated the R', Q, and P' branches, the Q branch being identical with that of Richardson. The R' and P' branches have a common initial level differing from that of the Q branch, while all three branches have a common final level.—**F. B. Hutt**: (1) On the relation of fertility to the amount of testicular material and density of sperm suspension in the fowl. Fertility in the male and the number of spermatozoa per cubic centimetre of semen are not determined by the amount of testicular material present. In cases of unilateral castration in which testis grafts had been implanted, the remaining testis did not undergo hypertrophy.—(2) The frequencies of various malpositions of the chick embryo and their significance. Of 39,760 eggs incubated, 11,797 which failed to hatch were examined. Of these, 5050 contained embryos that had died after the eighteenth day of incubation. In 56 per cent of these cases the chick had assumed an abnormal position within the shell, and this malposition was responsible for death. The malpositions seem to follow upon an incorrect orientation established by the first few cleavage divisions.—**F. B. Hutt** and **A. W. Greenwood**: (1) Chondrodystrophy in the chick. Among 7135 embryos of nine days or older found dead in the shell, 112 cases of chondrodystrophy were encountered. From 1900 eggs incubated, 124 chondrodystrophic embryos were obtained. The condition is greater in January and February, and thereafter declines to an almost complete absence in June. It is hereditary and expressed under certain unfavourable environmental conditions, such as lack of direct sunlight.—(2) Chick monsters in relation to embryonic mortality. Among the 11,797 dead-in-shell examined, 433 monsters were encountered. Hyperencephaly, exencephaly, and microphthalmia provided 93 per cent of these. Both sexes were equally affected. The incidence of these monsters was highest in February and thereafter declined. Chilling of the egg in the early stage of gastrulation seems to be a cause of arrested development observed.—**L. A. Harvey**: The oogenesis of *Carcinus mœnas* Penn., with special reference to yolk-formation. Observations on yolk-formation in *Carcinus mœnas* support the idea that yolk is formed not by the solitary action of the

various components of the cell, as has for a long time been considered to be the case, but by the interaction of the majority of the constituents of the egg. Probably the extent to which the different elements participate varies in different families, orders, etc., but fundamentally the same method of yolk-formation is present in all animals, as would be expected on an evolutionary theory.—**John Wishart**: The correlation between product moments of any order in samples from a normal population. A new method of determining sample moments exactly in semi-invariant form up to any desired order and from any population the moments of which are known, is applied to the particular case of a normal population, and the correlation between all product semi-invariants of the same order in two varieties is reached.

PARIS.

Academy of Sciences, Jan. 2.—**H. Deslandres**: Simple relations between the most intense and the highest radiations of the chemical elements in the bright atmosphere of the sun.—**L. Léger**: A mycetogen pseudo-tumour of alimentary origin causing an obstruction in the stomach of the trout. The pseudo-tumour was found to consist of a mass of undigested material covered with a growth of the fungus *Ichthyphonus intestinalis*.—**Paul Delens**: The calculus of spherical operations.—**Marcel Vasseur**: Deformable surfaces with a persistent conjugated conical network.—**Nicolas Cioranesco**: The problem of Dirichlet for systems of partial differential equations of the second order.—**J. Delsarte**: Oblique co-ordinated systems in functional space.—**T. Bonnesen**: Linear approximations.—**Georges Calugaréano**: The determination of the exceptional values of integral and meromorph functions of finite order.—**N. Podtiaguine**: Regular functions of higher order than two.—**S. B. Nicholson** and **Nicolas G. Perrakis**: The presence of the absorption line D_3 in the solar spectrum. The atmospheric line A (5875·603) is so close to the D_3 line (5875·620) that it is possible that the two have been confused by earlier workers. An account is given of observations, utilising the 43 cm. telescope of the Mount Wilson Observatory, for which the dispersion of the first order spectrum is 1 mm. = 0·72 A. The atmospheric line makes visual observations uncertain, but definite results could be obtained from photographs, making use of a modified Koch microphotometer. The dark line D_3 has only been observed in the regions covered with faculæ in the absence of visible spots.—**R. Swyngedauw**: The variation of the velocity and of the tension of a pulley belt along the pulley.—**Thadée Banachiewicz**: The ellipticity of the terrestrial equator.—**J. Kampé de Feriet**: A necessary condition for the absence of negative pressures in a perfect plane fluid in permanent movement round an obstacle.—**Henri Villat**: Concerning the sign of the pressures in a perfect fluid.—**R. Darbord**: A mercury and oil manometer. A description of a simple form of two-fluid manometer, suitable for pressures over the range of a few millimetres to some centimetres of mercury and possessing fifteen times the sensibility of a plain mercury manometer.—**R. Audubert** and **Mlle. M. Quintin**: The mechanism of the unsymmetrical conductivity of imperfect contacts. The hypothesis of electronic emissions accompanied by ionisation phenomena leads to a qualitative and quantitative interpretation of the unsymmetrical conductivity of imperfect contacts of silicon, and probably also of the mechanism of the silver sulphide and lead sulphide detectors.—**Jean Thibaud**: Longitudinal magnetic actions on bundles of slow electrons (concentrations and periodic expansions).—**Marcel Cau**: The double refraction and dichroism of thin layers of iron obtained by distillation.—**Ch. Bouhet**: The elliptical polarisation produced by reflection at the surface of solutions of the fatty acids in water. The results described, shown graphically for acetic, propionic, butyric, and valeric acids, agree with Langmuir's hypothesis. The molecules of fatty acids are, for these solutions, arranged with the hydrocarbon chain placed perpendicularly to the surface of the liquid.—**Pierre Daure**: The secondary radiations observed in the molecular diffusion of light (Raman effect). Results of observations on solutions of the chlorides of antimony, bismuth, magnesium, and aluminium, calcium bromide, liquid ammonia, and liquid methane.—**J. Gilles**: The structure of the third order spectrum of sulphur (S III.).—**Mme. Irène Curie**: The measurement of the active deposit of radium by the penetrating γ-radiation. The fraction K of ionisation attributable to radium-B, when radium-B and -C are in radioactive equilibrium, has been determined by Slater for varying thicknesses of lead. These results are now confirmed by a totally different method, and Slater's curve can be used to apply the necessary correction in the measurement of radium-C, made with respect to a radium standard.—**P. Fallot**: The secondary of the subbetic massifs between Moratalla and the edge of the Betic zone.—**Maurice Blumenthal**: The tectonic relations between the Betic of Malaga and the Betic of Granada.—**A. Demay**: The tectonic rôle of the granites and granulites of the western edge of the Sainte-Etienne coal basin.—**Louis Dangeard**: Circles of large pebbles observed at Jan Hagen Island.—**G. Chalaud**: The spermatozoid of *Cephalozia bicuspidata*.—**F. Obaton**: The origin and evolution of mannitol in plants. The study of the evolution of mannitol in two plants, *Sterigmatocystis nigra* and celery, proves that its function is that of a reserve substance; the alcohol appears to play the same part as saccharose and trehalose, but its formation is not in direct relation with the two latter substances.—**R. Combes** and **M. Piney**: Proteolysis and proteogenesis in ligneous plants at the commencement of the active period of growth.—**Marc. Simonet**: New researches on the number of chromosomes in the hybrids of the garden iris (*Iris germanica*).—**Aug. Chevalier**: The degradation of tropical soils caused by bush fires and the regressive plant formations which are the consequence of it. A discussion of the effects of bush fires, leading to production of soils either sterile or only capable of supporting certain useless plants.—**Louis Semichon**: The vesicular cells in *Anomia ephippium*.—**Alphonse Labbé**; The pallial sensorial organs in *Rostanga coccinea*. The dorsal part of the mantle of *Rostanga coccinea* is covered with small tubercles, hitherto described as simple conical papillæ. These are, in reality, complex sensorial organs, of unknown function.—**Remy Collin**: The passage of hypophysial cells in the cephalorachidian liquid of the infundibular cavity.—**Ch. Pérez**: Sexual characters in *Macropodia rostrata*.—**Tchang-Yung-Taï**: The localisation of intestinal absorption and the behaviour of the absorbent cells in the caterpillars of *Galleria mellonella*.—**J. Legendre**: The competition between zoophile and anthropophile mosquitoes. In an earlier paper an account was given of a race of mosquitoes avoiding man. These replace the mosquitoes attacking man when both are in the same locality, and this biological method of fighting the mosquito attacking man is suggested as worthy of trial.—**P. Wintrebert**: The digestion of the internal tubular envelope of the egg by ferments proceeding from the spermatozoids and the ovule in *Discoglossus pictus*.—**P. Reiss** and **E. Vellinger**: The potential of the arrest of egg-division in the sea-urchin.—**E. Gabritschevsky**: Compensation and regeneration in *Thomisium onustum*. Phenomena

of reversion and of accelerated evolution of the tegumentary characters under the influence of regeneration.—**Marcel Duval**: The proportion of carbon dioxide in the blood of the snail, *Helix pomatia*, in the course of the annual cycle. The amount of carbon dioxide is relatively slightly influenced by the state of activity of the animal.—**R. Fosse** and **Mlle. V. Bossuyt**: The quantitative analysis and characterisation of allantoin. The allantoin is hydrolysed, first in alkaline solution to potassium allantoate, and then in acid solution to glyoxylic acid and urea; the urea is determined as the xanthydrol compound.—**A. Machebœuf**: Researches on the phospho-aminolipides and the sterides of blood plasma and blood serum.—**A. Blanchetière**: The hydrolysis of egg albumen by trypsin in relation with the formation of the diacipiperazines.—**André Lwoff**: The nutrition of *Polytoma uvella* (Chlamydomonadinæ flagellate) and the power of synthesis of the heterotroph Protists. The mesotroph Protists.

CAPE TOWN.

Royal Society of South Africa, Oct. 17.—**James Moir**: An empirical formula for the absorption-bands of ammonia, phosphine, and arsine (Robertson and Fox) in the near infra-red. The formula is that of a fundamental wave-number multiplied by a vulgar fraction, the denominator of which depends on the gas: the result is modified by small corrections involving constants and integers.—**Th. Schrire** and **E. G. Greenfield**: On some new species of organisms isolated from *Xenopus Lævis*. Three new organisms have been isolated from a spontaneous abscess in a frog. One is of an Anthracoid nature, and is extremely pathogenic to frogs and guinea-pigs. No toxin could be isolated from this organism.—**J. W. C. Gunn**: The susceptibility of the African chameleon to digitalis bodies. Amongst cold-blooded animals, the grass-snake and the toad (*Bufo*) are tolerant of very much larger doses than the frog (*Rana*). The South African clawed toad (*Xenopus lævis*) is, on the other hand, susceptible to the same degree as *Rana*. Solutions of strophanthin, and tinctures of digitalis, squills, and strophanthus, were tested on *Xenopus* and *Chameleo* at the same time. The symptoms in the chameleon are similar to those observed in the frog. The heart is slowed and finally stops, with the ventricle in complete systole and the auricles engorged. Pallor of the skin was noted in 40 per cent of cases. The chameleon reacts to digitalis bodies like the frog, and does not show any special tolerance like the grass-snake.—**H. Zwarenstein**: The excretion of creatine in *Xenopus Lævis*. The urine was collected by keeping 10 frogs in a glass receptacle for from one to five days. Pure urine was obtained by tying the skin around the anus and releasing the ligature every 24 hours. The results indicate that *Xenopus* excretes creatine, but not creatinine. The amount excreted is about 0·04 mgm. by each frog in 24 hours. 100 c.c. of pure urine contains about 2 mgm. creatine.—**N. E. Brown**: Contributions to a knowledge of the Transvaal Iridaceæ.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation.—**G. Giorgi**: The sufficiency of the differential equations of mathematical physics. Ritz's criticism (1908) of the electromagnetic theory based on differential equations of the field is refuted, it being shown that, in the classical interpretation of the problems of mathematical physics, the insufficiency is not in the differential equations, but in the accessory conditions. If these are modified and the functional condition equivalent to that of succession is introduced in place of one of the conditions of the Cauchy type or of the infinity condition, integrals are obtained which are determined by the data usually presented in the effective problems.—**L. Lombardi** and **P. Lombardi**: Measurement of the local dissipations of energy in a circumscribed part of the magnetic circuit. Details are given of an apparatus for the measurement in watts of the energy dissipated in a circumscribed part of the magnetic circuit, use being made of two induced windings, connected respectively with the two coils of an electrodynamometer and employed for measuring, one the principal flux, and the other the magnetomotive force used to maintain it in the core.—**A. Angeli, D. Bigiavi**, and **Zwi Jolles**: Scission of certain sulphohydroxamic acids. The fact that, when sodium hydroxylaminosulphonate and benzaldehyde react, the detection of the hydroxamic acid formed by means of the violet coloration with ferric chloride is unsatisfactory, rests, according to Raschig, on the necessity of using a large amount of alkali and the temperature 70° to effect the decomposition of the sulphonate. The authors find, however, that this reaction proceeds rapidly at the ordinary temperature and that the non-appearance of the coloration with ferric chloride is due to the reduction of this reagent by the sulphite liberated.—**P. Vinassa**: The fusibility of the elements and the electronic number. Irregularities are observed when the fusibility of the elements is considered as a periodic function either of the atomic weight or of the atomic volume. If, however, the absolute melting-point is divided by the electronic number, the result, termed the coefficient of fusion, ϵ, is an exact multiple of 0·5 for all elements, or, if the value obtained for helium is doubled, integral numbers. According to this relationship, the element solidifying at 0° absolute should have a zero electronic number, that is, should consist of proton alone.—**T. Boggio**: Bianchi's identity and gravitation homograph. In continuation of the ideas developed in recent communications, a new and very simple demonstration is given of Bianchi's identity for the derivative of Riemann's homograph. Further, application to the calculation of the vector gradient of Riemann's homograph leads to Einstein's gravitation homograph, the gradient of which is zero.—**Silvia Martis in Biddau**: Investigation of a rational expression for the powers of a matrix of the second order.—**G. Supino**: Certain limitations valid for harmonic functions.—**A. Tonolo**: Studies of the metric geometry of surfaces of linear four-dimensional space.—**G. Colonnetti**: New contribution to the theory of elastic co-actions and to its technical applications (2).—**B. Rossi**: Study of the electric field in homogeneous anisotropic media. Application of the theory of vectorial homographs to the problem of the electric field in anisotropic media greatly simplifies the treatment and often leads to a ready determination of the field.—**A. Carrelli**: A new phenomenon of diffusion. If the Raman effect is regarded as diffuse radiation foreseen from the quantistic theory of diffusion, the intensity of the Raman light becomes much less than the ordinary intensity. The number of lines observed depends on the number of characteristic frequencies of the monads in the ultra-red, but if the interpretation suggested is correct, the diffuse light should exhibit frequencies greater than the exciting frequency, the intensity of which is, however, less than that of the frequencies following Stokes's law.—**E. Persico**: Optical resonance according to wave mechanics (2).—**G. Canneri**: The separation of pure yttrium from yttrium earths. A method of purifying yttrium based on the fractional crystallisation of its double carbonates gives satisfactory results.—**D. Bigiavi**: Relations between certain aromatic compounds. The analogous compounds, benzyl

alcohol, phenylhydroxylamine, and benzenesulphenic acid, containing groupings including respectively carbon, nitrogen, and sulphur atoms, are able to undergo simultaneous reduction and oxidation, yielding: toluene and benzoic acid (from benzaldehyde formed as an intermediate product); aniline and nitrosobenzene; thiophenol and benzenesulphinic acid. Toluene, aniline, and thiophenol also exhibit analogies in behaviour, since they are able to yield respectively dibenzyl, hydrazobenzene, and diphenyl disulphide on oxidation.—F. Rodolico: Phosgenite from Monteponi.

Official Publications Received.

BRITISH.

Proceedings of the Society for Psychical Research. Part 109, Vol. 38, December. Pp. 209-279. (London: Francis Edwards, Ltd.) 4s.

The National Institute of Agricultural Botany. Ninth Report and Accounts, 1927-28. Pp. 19. (Cambridge.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Kitts-Nevis, 1927-28. Pp. iv+25. (Trinidad, B.W.I.) 6d.

Leeds University. Report to the Worshipful Company of Cloth-Workers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1927-28. Pp. 14. (Leeds.)

British Museum (Natural History). Picture Postcards. Set F22. British Trees: Alder. 2 cards in Colour and 2 in Monochrome. 6d. Set F23. British Trees: Wild Apple. 2 cards in Colour and 2 in Monochrome. 6d. Set F24. British Trees: Ash. 2 cards in Colour and 2 in Monochrome. 6d. Set F25. British Trees: Beech. 2 cards in Colour and 2 in Monochrome. 6d. Set F26. British Trees: Sweet Chestnut. 2 cards in Colour and 2 in Monochrome. 6d. Set F27. British Trees: Horse-Chestnut. 2 cards in Colour and 2 in Monochrome. 6d. Set F28. British Trees: Sycamore. 2 cards in Colour and 2 in Monochrome. 6d. (London: British Museum (Natural History).)

Quarterly Journal of the Royal Meteorological Society. Vol. 54, No. 228, October. Pp. 287-360. (London: Edward Stanford, Ltd.) 7s. 6d.

The Ninety-fourth Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 6, Part 1, 1927. Pp. xv+75+14. 5s. The Ninety-fifth Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 6, Part 2, 1928. Pp. xvi-xxviii+77-182+13. 5s. (Camborne.)

Union of South Africa: Department of Agriculture. 13th and 14th Reports of the Director of Veterinary Education and Research. Part 1. Pp. 729. 10s. Part 2. Pp. 731-1270. 10s. (Pretoria: Government Printing and Stationery Office.)

Transactions of the Mining and Geological Institute of India. Vol. 22, Part 3, October. Pp. 177-274+x+plates 27-48. (Calcutta.) 4 rupees.

Journal of the Royal Microscopical Society. Series 3, Vol. 48, Part 4, December. Pp. xvi+379-503. (London.) 10s. net.

Society of Chemical Industry: Chemical Engineering Group. Proceedings, Vol. 9, 1927. Pp. 147. (London.) 10s. 6d.

Journal of the Indian Institute of Science. Vol. 11A, Part 10: i. Studies on Soil Protozoa, Part 1: Protozoan Fauna of some Mysore Soils, by H. S. Madhava Rao: ii. Studies on Soil Protozoa, Part 2: The Function of Mitochondria in some Soil Protozoa, by H. S. Madhava Rao. Pp. 111-119+1 plate. 1 rupee. Vol. 11A, Part 11: i. Studies in Enzyme Action, Part 1: Amylase from Cholam (*Sorghum vulgare*), by V. N. Patwardhan and Roland V. Norris; ii. Studies in Enzyme Action, Part 2: The Nature of Amylase, by D. Narayanamurti and Roland V. Norris. Pp. 121-139. 1.8 rupees. (Bangalore.)

FOREIGN.

Spisy vydávané Přírodovědeckou Fakultou Masarykovy Univerzity (Publications de la Faculté des Sciences de l'Université Masaryk.) Čis. 96: "*Lonchopteris Jongmansi* nov. sp." z kamenouhelné pánve rosicko-oslavanské ("*Lonchopteris Jongmansi* nov. sp." du bassin houiller de Rosice-Oslavany en Moravie (Tchechoslovaquie).) Napsal J. Augusta. Pp. 11. Čis. 97: Pásmo porfyroidové ve Vrbenském devonu na východním okraji Vysokého Jeseníku (La zone de porphyroïdes dévoniens de Vrbno aux abords Est de Vysoký Jeseník en Silésie). Napsal Jan Stejskal. Pp. 34. Čis. 98: La réfraction de l'hélium et de l'argon et sa dépendance des pressions inférieures à une atmosphère. Par Fr. Schacherl. Pp. 15. Čis. 99: La réfraction de l'oxyde de carbone, de l'azote et de l'oxyde azoteux et sa dépendance des pressions inférieures à une atmosphère. Par. Fr. Schacherl. Pp. 29. Čis 100: Contribution à l'étude des propriétés projectives du contact. Par Miroslav Konečný. Pp. 19. Čis. 101: Quod momentum significet *Carex pediformis* in stepposis silvaticis Europae mediae. Scripsit J. Podpěra. Pp. 22. Čis. 102: Generis Trigonella L. revisio critica, I. Scripsit G. Širjaev. Pp. 57. (Brno: A. Píša.)

Spisy Lékařské Fakulty Masarykovy University, Brno, Československá Republika. Svazek 6, Spis 52-60. (Publications de la Faculté de Médecine, Brno, Tchécoslovaquie, Tome 6, Fascicule 52-60.) Pp. 64+40+8+6+14+21+12+61+24. (Brno: A. Píša.) 40 Kč.

Biologické Spisy Vysoké Školy Zvěrolékařské, Brno, Československá Republika. Svazek 6, Spis 76-95. (Publications biologiques de l'École des Hautes Études Vétérinaires, Brno, Tchécoslovaquie, Tome 6, Fascicule 76-95.) Pp. 10+28+28+37+16+15+7+7+87+6+7+6+7+13+8+28+5+22+11+5. (Brno: A. Píša.) 40 Kč.

Práce Moravské Přírodovedecké Společnosti, Brno, Československo. (Acta Societatis Scientiarum Naturalium Moraviae, Brno, Čechoslovakia.) Svazek 3, Spis 21-32. (Tomus 3, Fasciculus 21-32.) Pp. 344. 80 Kč. Svazek 4, Spis 33-41. (Tomus 4, Fasciculus 33-41.) Pp. 536. 100 Kč. (Brno: A. Píša.)

Sborník Vysoké Školy Zemědělské v Brně, ČSR. (Bulletin de l'École Supérieure d'Agronomie, Brno: RCS.) Sign. C12: Mykologický rozbor rozkladu rostlinné hmoty a jeho význam pro praksi konservování píce (Analyse mycologique de la décomposition de la matière végétale et son importance pour la pratique de la conservation du fourrage). Napsal Dr. Miloš Bayer. Pp. 64+8 tabulkami. Sign C13: Příspěvek k rozšíření zoocecidií v Jugoslavii a zemich sousedních (Contribution à la distribution des zoocécidies en Yugoslavie et dans les pays voisins). Napsal Dr. Eduard Baudyš. Pp. 99. Sign. C14: Studie o významu štítné žlázy a brzliku pro opérování, vzrůst a jakost masa drůbeže (Studies on the Importance of the Thyroids and of the Thymus in the Feathering, Growth and Flesh-quality in the Poultry). Napsal Michail Nevalonnyj. Pp. 137. Sign. D9: Lesnické pokusnictví přestební; Nástin soustavy a pracovních zásad (The Silvicultural Experimentation; a Short Outline of the System and Work's Manner). Napsal Prof. Jos. Konšel. Pp. 52. Sign. D10: Stálost rostlinnych buněk proti vyschnutí (La stabilité des cellules végétales contre la sécheresse). Napsal Prof. Vasil Sergějevič Iljin. Pp. 18. Sign. D11: Závislost přírůstku dřevní hmoty na obsahu ústrojných látek v půdě. Několik poznámek k práci A. Němce a K. Kvapila: Studie o chemické povaze profilů lesních půd. Napsal Alexandr Leporsky. Pp. 25. (Brno: A. Píša.)

Methods and Problems of Medical Education. Eleventh Series. Pp. iii+263. (New York: The Rockefeller Foundation.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 24, Part 1: Beitrag zur Chemie der Haut (i. Die Hydrolyse in sauren und alkalischen Medien), von G. Grasser, Dr. Sh. Taguchi und Sun Tau; Beitrag zur Chemie der Haut (ii. Einfluss der Ascher- und Beiz-Methoden auf die chemische Zusammensetzung der Blössen), von G. Grasser und H. Nakanishi; Die gerbenden Eigenschaften der Methylendinaphthole, von G. Grasser und K. Hirose; Die Reduction der Bichromate zu basischen Chromsalzen, von G. Grasser und T. Nagahama. Pp. 38. (Tokyo: Maruzen Co., Ltd.)

Diary of Societies.

FRIDAY, FEBRUARY 1.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—S. Scott: Vertigo.—A. R. Tweedie: Some Notes on the Rotation, Caloric, and Galvanic Tests.—Dr. A. L. Yates: Demonstration of Some Graphic Records of Instability, illustrative of Cases referred to by Mr. Sydney Scott.

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 3.15.—Dr. R. Hay: Manufacture of Sulphuric Acid by the Contact Process.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

ROYAL SANITARY INSTITUTE, at 5.—F. R. Humphreys and others: The Civilian Population and Chemical Warfare.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. A. Pannett: Local Anæsthesia in the Surgery of the Upper Abdomen.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Prof. V. G. Childe: Philology and Archæology.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. A. S. Eddington: Engineering Principles in the Machinery of the Stars (Thomas Hawksley Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Liverpool Section) (at Engineers' Club, Manchester), at 7.—Dr. F. Challenger: The Sulphur Compounds of Shale Oil and Petroleum.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—J. L. Carr: Recent Developments in Electricity Meters, with particular reference to those for special purposes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.—P. Fripp: Some Aspects of Craftsmanship

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with Institute of Chemistry) (at Thomas' Café, Swansea), at 7.30.—E. A. Tyler: Further Notes on Pure Chemicals.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—T. H. Cross: Notes on Road Construction.

TEXTILE INSTITUTE (Lancashire Section) (joint.y with Nelson Textile Society) (at Nelson), at 7.30.—O. S. Hall: The Economic Aspect of some Developments in the Textile Industry (Lecture).

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. R. D. Lawrence: Post-operative Acidosis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. L. Myres: Geometrical Art in S.E. Europe and Western Asia.

SATURDAY, FEBRUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish and Belgian Art (III.): Genre Painting.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at College of Technology, Manchester), at 4.30.—J. O. Gray: Works Accounting and Foundry Practice.

MONDAY, FEBRUARY 4.

ROYAL SOCIETY, EDINBURGH, at 4.30.—Dr. Nellie B. Eales: On the Anatomy of a Fœtal African Elephant (*Elephas africanus* (*Loxodonta africana*): Pt. 3—The Contents of the Thorax and Abdomen, and the Skeleton.—A. D. B. Smith and J. R. Brown: The Rôle of Inbreeding in the Development of the Jersey Breed of Cattle in England.—Dr. A. W. Greenwood and J. S. S. Blyth: Experimental Study of the Thyroid Gland in the Domestic Fowl, with Special Reference to Plumage Characterisation.—*To be read by title only:*—Prof. C. W. Stump: A Human Blastocyst *in situ*.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—P. J. Le Riche: Scientific Proofs of a Universal Deluge.

BIOCHEMICAL SOCIETY (at Lister Institute), at 5.—H. Chick and M. H. Roscoe: (*a*) Methods for the Assay of Vitamins B_1 and B_2; (*b*) On the Separation of Vitamins B_1 and B_2 from Yeast.—M. H. Roscoe: Rats Reared Eight Months after Weaning on Diets Deprived of B Vitamins.—T. Lumsden: The Effect of Various Reagents upon Cells Cultured *in vitro*.—L. F. Hewitt: Hormones of the Anterior Pituitary Lobe.—N. F. Maclagan: The Use of Decinormal Hydrochloric Acid for

Standardising Electrometric *p*H Measurements.—E. Boyland: The Sequence of the Formation of Phosphoric Esters and Carbon Dioxide in Fermentation by Dried Yeast.—R. Robinson and E. King: Hexosemonophosphoric Ester.—E. King and W. T. J. Morgan: Methylated Derivatives of Hexosemonophosphoric Ester.—W. T. J. Morgan: The Constitution of Hexosediphosphoric Ester.—*Demonstrations (from 3.30)*: —G. H. Eagles: Growth of Vaccine Virus in Tissue Culture.—A. Felix: Flocculare and Granular Agglutination Phenomena.—T. Lumsden and A. C. Kohn-Speyer: Serum as a Culture Medium for Serological and Other Tests.—E. M. Hume, N. S. Lucas, and H. Henderson Smith: Three Common Marmosets (*Hapale jacchus* Linn.) Bred in Captivity with the Aid of Ultra-violet Irradiation.

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

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R. J. McNeill Love: The Treatment of some Acute Abdominal Disorders.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—A. K. Dodds: Berwick's Bridges (Presidential Address).

INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—Dr. F. W. Lanchester: Coil Ignition.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. R. Rawlings and others: Discussion on Earthing and the Safety of the Public.

RAILWAY CLUB (57 Fetter Lane) (Annual Meeting), at 7.30.—Presidential Address.

ROYAL SOCIETY OF ARTS, at 8.—Dr. C. H. Lander: The Treatment of Coal (Cantor Lectures) (III.).

SURVEYORS' INSTITUTION, at 8.—H. J. Vaughan: The Significance of the Timber Merchant in Estate Forestry.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.

TUESDAY, FEBRUARY 5.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of November, December 1928, and January 1929.—E. G. Boulenger: Remarks on the Behaviour of Certain Inhabitants of the Society's Aquarium.—G. C. Robson: On a Case of Bilacteral Hectocotylisation in *Octopus rugosus*.—G. C. Robson and Prof. L. Joubin: On a New Species of *Macrotritopus* (Cephalopoda) obtained by Dr. J. Schmidt's *Dana* Expedition, with Remarks on the Genus.—W. N. F. Woodland: On a New Species of *Rhabdometra*, with a Note on the Nematodiform Embryos of *Anonchotænia globata* (Cestoda).—H. C. Wilkie: The Attachments of the Auditory Ossicles of the Common Mole (*Talpa europæa*).—Dr. H. Boschma: The Fungidæ (Anthozoa) collected by Mr. Cyril Crossland at Tahiti and Neighbouring Islands.—C. S. Garnett: Some Notes and Observations on the Flight of Flying-Fishes.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at University College, Nottingham), at 6.45.—W. B. Woodhouse: Overhead Electric Lines.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffs. Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—D. J. MacNaughtan: Electrodeposition.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates) (at Broadgate Café, Coventry), at 7.15.—R. A. Clapham: Free Wheels.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at Lamb's Restaurant), at 7.30.—Discussion on Earthed *versus* Insulated Systems.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—H. K. Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—G. H. Barron: Ice-making.

TELEVISION SOCIETY (at Engineers' Club, Coventry Street), at 8.—R. R. Poole: Methods of Light Modulation in Receivers.

WEDNESDAY, FEBRUARY 6.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. P. G. Wakeley: The Etiology, Pathology, and Treatment of Tumours of the Intestinal Tract.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (II.).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—E. St. John Burton: The Horizons of Bryozoa (Polyzoa) in the Upper Eocene Beds of Hampshire.—M. Black: The Upper Estuarine Series of Yorkshire.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Dr. B. Hodgson, L. S. Harley, and O. S. Pratt: The Development of the Oxide-coated Filament.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Prof. T. P. Hilditch and Eveline E. Jones: The Fatty Acids and Component Glycerides of some New Zealand Butters.—A. S. Dodd: A New Test for Boric Acid and Borates.—B. E. Dixon: The Determination of Beryllium in Rocks.

ROYAL SOCIETY OF ARTS, at 8.—Sir J. Alfred Ewing: The Vibrations of Railway Bridges: an Example of Co-operative Research (Trueman Wood Lecture).

ROYAL SOCIETY OF MEDICINE (War and Surgery Sections), at 8.30.—Group-Capt. H. V. Wells (War), Sir Percy Sargent (Surgery), and others: Special Discussion on The Necessity for Early Diagnosis in the Treatment of Spinal Injuries.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section).—Dr. T. Callan Simplified Methods of Electrometric Analysis.

THURSDAY, FEBRUARY 7.

ROYAL SOCIETY, at 4.30.—Sir Ernest Rutherford, Dr. F. W. Aston, Dr. J. Chadwick, Dr. C. D. Ellis, R. H. Fowler, and Prof. O. W. Richardson: Discussion on The Structure of Atomic Nuclei.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Early History of X-rays (II.).

CHEMICAL SOCIETY, at 8.—C. S. Gibson and J. L. Simonsen: Indian Turpentine from *Pinus longifolia* Roxb. Part V. The Oxidation of d-Δ^3-carene with Beckmann's Chromic Acid Mixture.—A. W. Chapman: A New Method for Preparing Substituted Diphenylamines.—C. S. Gibson, J. D. A. Johnson, and B. Levin: Compounds of the Tryparsamide Type. Part I. Resolution of N-phenylalanine-4-arsinic Acid and of its Amide.—C. S. Gibson and J. D. A. Johnson: 10-Chloro-5:10-dihydrophenarsazine and its Derivatives. Part VII. The Synthesis of the 1-methyl- and of the 3-methyl-homologues.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases Section), at 8.15.—Monkeys and Human Disease:—R. I. Pocock: Zoological Relationships of Primates (Apes and Monkeys).—R. Lovell: Bacterial Diseases.—E. Hindle: Virus Diseases.—Dr. J. G. Thomson: Protozoal Diseases.—T. W. M. Cameron: Helminthic Diseases.—Dr. V. B. Wigglesworth: Insect Diseases.—Col. A. E. Hamerton: Morbid Anatomy.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—Prof. C. K. Ingold: Mechanism of Atomic Structure: Significance of the Thiele Hypothesis.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—A. J. Hall: The Action of Alkalis on Cotton and Artificial Silks.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).

FRIDAY, FEBRUARY 8.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Capt. E. J. Headlam: The History of the Indian Marine.

ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.—Presentation of the Gold Medal to Prof. E. Hertzsprung, for his Determination of the Distance of the Lesser Magellanic Cloud and other Pioneering Work in Stellar Astronomy.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Stanley: The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua.—H. C. Webster: (*a*) Photographic Measurement of the Relative Intensities of the La_1, La_2, La_3 Lines of Silver; (*b*) Spark Satellites of the *La* Lines of Silver.—Demonstration of a New Instrument for the Rapid and Accurate Determination of the Specific Gravities of Solid Substances, by W. A. Benton.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R. T. Payne: The Treatment of Varicose Veins and Varicose Ulcers by Injection.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College for Women), at 5.30.—Dr. H. Lowery: Musical Memory and Rhythm.

MALACOLOGICAL SOCIETY OF LONDON (at University College), at 6.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 6.—L. A. Legros and others: Discussion on The Profession of the Mechanical Engineer.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 6.—Dr. G. W. Todd: The Prediction of the Properties of Engineering Materials from their Ultimate Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—H. H. Taylour: Electric Welding.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Technical Talk), at 7.—B. C. Wickison: Lantern Slides.

GEOLOGISTS' ASSOCIATION (Annual General Meeting) (at University College), at 7.30.—Prof. A. Morley Davies: Formal Migrations since the Cretaceous Period (Presidential Address).

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—W. T. Griffiths: Some Recent Developments in Nickel Metallurgy.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Dr. A. E. Dunstan: Recent Developments in the Art of Oil Cracking (Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Society of Arts), at 8.—Prof. W. E. Gibbs: The Rôle of Surface Energy in Chemical Engineering.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—R. F. Moore and Mr. Scott: Clinical and Pathological Report of Bilateral Glioma Retinæ.—R. F. Moore: Cirsoid Aneurysm of the Visual Cortex.—B. Graves: Scleral Illumination.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. E. R. Sherrington: Recent Problems of Rail Transport at Home and Abroad.

SATURDAY, FEBRUARY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. S. Marchant: Music in Cathedral and Collegiate Churches (I.).

MINING INSTITUTE OF SCOTLAND (at Edinburgh).

PUBLIC LECTURES.

FRIDAY, FEBRUARY 1.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—C. E. R. Sherrington: The Steam Railways and the Localisation of Industry in the Nineteenth Century.

SATURDAY, FEBRUARY 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Ancient Egyptian Potter and his Clay.

MONDAY, FEBRUARY 4.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 5.15.—F. Rodd: Saharan Nomads.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—J. A. Venn: Some of the Causes of the Agricultural Depression and Suggested Remedies.

TUESDAY, FEBRUARY 5.

UNIVERSITY COLLEGE, at 5.30.—Julia Bell: The Handicapping of Men by Diseases transmitted by but not developing in Women.

FRIDAY, FEBRUARY 8.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Railway Electrification and the Redistribution of Industry.

SATURDAY, FEBRUARY 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Life Beyond the Low-Tide Mark.