THURSDAY, MARCH 28, 1918.

RECENT AMERICAN TEXT-BOOKS IN AGRICULTURE.

(1) *The Rural Teacher and his Work in Community Leadership, in School Administration, and in Mastery of the School Subjects.* By Harold W. Foght. Pp. xii+359. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 7*s.* 6*d.* net.

(2) *The Chemistry of Farm Practice.* By T. E. Keitt. (Wiley Technical Series.) Pp. xii+253. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 6*s.* net.

(3) *Soil Biology: Laboratory Manual.* By Dr. A. L. Whiting. Pp. ix+143. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 6*s.* net.

(4) *A Laboratory Manual in Farm Machinery.* By F. A. Wirt. Pp. xxii+162. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 6*s.* net.

(5) *Late Cabbage from Seed until Harvest, also Seed Raising.* By E. N. Reed. Pp. xiii+131. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 6*s.* net.

(1) OF recent years a great movement has been gathering force in the United States towards an improvement of country life. It is felt that rural civilisation should develop on its own lines, which would not necessarily be those followed by urban civilisation. The worker in the country is brought more into contact with things than with men: his environment differs fundamentally from that of the townsman, and his training and outlook on life must be modified accordingly. This movement found expression on the political side in Mr. Roosevelt's famous country life campaign, and on its educational side in Dr. L. H. Bailey's inspiring writings. If anything is to be done it must be through the teacher; Mr. Foght therefore, in the first book on the list, addresses himself to the task of showing what part the school and the teacher ought to play, not only in training the children and the young people, but also in assuming leadership and direction in the new movement.

Mr. Foght points out that the present conditions of rural education in the United States are not entirely satisfactory. There are still too many cases where country teachers are engaged for a period of seven months only, at a salary of 75 dollars per month, who at the end of that time "pass from the community, leaving not the slightest feeling of regret behind." But the author—like the young American generally—is constructive in his mental attitude, and not a mere destructive critic. He proceeds to show what has been done, and then to indicate how existing institutions might be further developed. In his preface he puts the school aims as "(1) good scientific farming, rendering ample returns for labour and capital employed, and (2) a rural social life satisfactory to those living it." For our own part we should prefer to invert the order and adopt the view of Dr. Henry Wallace, quoted a few pages further on: "Give to any people a vision of something better than they have known, and it is at once a better occupation." In practice, however, the author is quite sound, as is evident from his handling of the subject. He proceeds first to discuss the agencies for the betterment of country life: the Church, the Y.M.C.A., the Grange of Patrons of Husbandry,[1] and the more recent organisations, Boy Scouts, Camp-fire Girls, Blue Birds, etc.

The next chapters give an account of certain schools started to improve rural life in general, and in particular to train the teacher. In the second part of the book the author goes on to consider problems of organisation and administration, for it is a fundamental part of his thesis that the teacher must be strong enough to establish himself as a leader of the community, and therefore must have a firm hold on the organisation and management of the school, and show expert ability in dealing with the altered school curriculum. The book is well provided with references to other literature, and illustrated with numerous charts and photographs. Altogether it gives an excellent account of what has already been accomplished.

(2) The connection between agriculture and chemistry is obvious to the man of experience, but not always to the young student, and one of the great difficulties at agricultural schools and colleges is to persuade the student that he cannot make much progress with the science of agriculture until he has a working acquaintance with the fundamental laws of chemistry. In the matter of text-books the American teacher is better off than we are, and this book by Prof. Keitt is a useful addition to the available literature. The laws of chemistry can quite well be taught through the medium of substances familiar on the farm, and experience shows that, when approached in this way, the subject is of great interest and value to the student.

It is unfortunate that efforts in the past to simplify chemistry and to bring it within the comprehension of untrained agricultural audiences have resulted in much looseness of expression. Thus when a farmer applies potassium salts to the soil as fertiliser, he is told that he is applying "potash," and a student is told that he is applying "potassium." This is justified on the score that the farmer and the student are supposed to understand the terms. Then, when the study of pure chemistry begins, the inevitable confusion arises. Anyone who has had to conduct agricultural chem-

[1] A sort of secret society or freemasonry, founded by Kelley in 1867, which reached its high-water mark in 1875; it is described in Buck's "Granger Movement," one of the classical "Harvard Historical Studies," and in Kelley's own words in his interesting "History of the Patrons of Husbandry."

istry examinations knows how completely an otherwise intelligent student can confound free and combined nitrogen, free and combined potassium, etc. We should like to have seen this distinction more strongly emphasised even at the risk of repetition. Thus on p. 39 the passages occur: "Phosphorus has an important part to play in the formation of the seeds of plants and in hastening their maturity. . . . Phosphorus appears luminous in the dark. . . . Potassium is rather abundant in Nature."

For the rest, however, the book will be found helpful. The numerous illustrations are largely taken from bulletins of the various experimental stations, and as the numbers are given they serve not only to emphasise the various points, but also as a guide to the voluminous and growing literature of the subject.

(3) Dr. Whiting's little book is a useful summary of laboratory methods for students wishing to become acquainted with the commoner soil micro-organisms. Methods are given for isolating and studying the common bacteria, algæ and protozoa, from soils, and references are given to original papers where the literature is more fully discussed. We note that Martin and Lewin's method for collecting active protozoa from soil is found to give good results with careful manipulation in the author's laboratory, just as it does in this country; for purposes of enumeration, however, the blood-corpuscle counting apparatus is used by Dr. Whiting instead of the dilution method in favour here. Exercises are also given on soil algæ, which have not yet received the attention they appear to deserve. For a long time the student has been able to obtain help in soil bacteriology, but he has found more difficulty in getting assistance with other organisms, and this little book can be recommended to him.

(4) In the past, farm machinery has been used to cheapen agricultural production rather than to intensify it, and so it has found greater development in new countries where labour is scarce than in older countries where higher yields per acre are aimed at. But in the nature of the case much of the machinery that has been purchased has not been properly used. It is not only the untrained amateurs who know so little about machinery; the trained agricultural student also is not uncommonly helpless before a trivial breakdown. On farms it is essential that someone should know sufficient about machinery to be able to look after it properly, to see that it is used to the fullest advantage, and to attend to the minor troubles, which, if left alone, might develop and cause serious difficulty at a critical time. This being so, it is gratifying to find that attention is being given by teachers and writers to farm machinery, and that some of the past neglect is being remedied.

Mr. Wirt's book will probably prove more useful to his own classes than to other teachers. It consists largely of questions that the intelligent student might be asked, and would, indeed, be likely to ask himself, but it does not provide the material for answers. It supplies, however, a bibliography which will serve as a guide to other books where more information is given.

If later editions are called for we should suggest the inclusion of more working diagrams illustrative of the main principles of the machine, the right and wrong adjustments, and especially the ways in which the machine may go wrong.

(5) Mr. Reed's little book on late cabbage is intended for practical men, and it is written in the terse American colloquial style that always appeals to practical men everywhere. The details of cultivation, manuring, insect pests, etc., are sufficiently clear to afford the necessary guidance. The author states with engaging frankness that he grows not only cabbage, but also seed, and he quite rightly emphasises the need for obtaining good seed; he does not unduly push his wares, however, and his book loses nothing in consequence. It is interesting in connection with our present conditions to note that in the author's experience cabbage does well on newly ploughed-up grassland, forming good hearts and needing no nitrogenous fertiliser. On older arable land more fertiliser is required, but not an excessive amount.

The author keeps rigidly to his title and does not touch on other members of the cabbage tribe, not even the nearly related early cabbage. He shows also that the native-raised seed is fully as good as the imported seed; on his own land he declares that in the past seven years he has not had less than 20 tons of cabbage per acre, whilst on at least one occasion he has had 30 tons. It is a good idea, which might be further extended, to persuade practical men to write little books on crops which they thoroughly understand.

E. J. RUSSELL.

ESSENCES AND VARNISHES.

(1) *Manual for the Essence Industry.* By Erich Walter. Pp. iii+427. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916.) Price 18*s.* 6*d.* net.

(2) *The Industrial and Artistic Technology of Paint and Varnish.* By Alvah H. Sabin. Pp. x+473. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 16*s.* 6*d.* net.

(1) THE phrase "essence industry" in the title of this volume covers more than an English reader might at first sight associate with it. In point of fact, the book is a treatise upon the manufacture of most of the things, or ingredients of things, which are intentionally flavoured, coloured, or perfumed, as a means of preparing them for human use. These include non-alcoholic beverages, such as lemonade and other "mineral" waters; alcoholic preparations like liqueurs, cordials, and bitters; flavourings and spices used in baking, cooking, and confectionery-

making; and essences used for the manufacture of perfumes, dentifrices, and other toilet articles.

Most of the flavouring substances employed in our beverages and foodstuffs are derived from plants, in which they usually exist ready-formed. The art of the essence-maker consists in transferring these flavours from the plant to a medium by which they can be readily conveyed to the potable or edible final product. The transfer may be a simple mechanical one, as when fruit juices are added directly to beverages. On the other hand, the essential principle of the flavouring substance may first have to be separated from the plant, as when the volatile aromatic oils (*e.g.* peppermint) are distilled off in a current of steam. These distilled oils may then be employed directly as flavouring agents, but, as a rule, they are more conveniently first dissolved in alcohol. Such solutions form one kind of "essence." Most fruit flavours, however, are too delicate for isolation in this way, and are obtained by distilling the fruit itself with alcohol, yielding another kind of essence. "Every fruit essence is only a diluted transfer of the volatile flavour of the fruits to alcohol." The same remark holds good for the floral odours which go to make perfumery.

The book under notice treats of the various ways in which this transference of flavours and odours from source to product is best effected. It opens with a dissertation on the sense of taste; this would be improved in parts if specific examples were given to illustrate the author's meaning. The following chapters deal clearly and concisely with the principles and practice of the industry. Fundamentally it is a "chemical" industry; hence a section of the book is rightly devoted to the laboratory. The theoretical chemistry of the products is not dealt with; but analytical methods and the general chemical control of the manufacturing operations make up a useful chapter.

A very large number of formulæ are supplied, and the systematic arrangement of these is a commendable feature. The British reader will need to bear in mind that the values of the alcoholic strengths and of the gallon used are those current in the United States; with this proviso, he will find the work a very useful one for the industry in question.

(2) Readers who are acquainted with the first edition of Mr. Sabin's work will remember that the author is an enthusiast on all matters pertaining to paints and varnishes. His book, consequently, has the quality of readableness usually found in the work of one who knows his subject and writes as if he loves it, even though that subject may not at first sight appear a particularly attractive one. Naturally, this quality is shown more especially in the historical portions of the book, but it is by no means absent from the more technical chapters.

For example, Mr. Sabin is discussing the varnish on Egyptian mummy-cases, and arguing for the antiquity of recipes substantially like some in use at the present day. "Here is the varnish, just as it was applied twenty-five hundred years ago. It is just as real as the mummy itself, and is just as absolute a proof that varnish was made in those days as the mummy is proof that people lived in those days. Here, I say, is the actual and real varnish. It was made with resin and oil. It was smeared on, possibly with a spatula, but more likely with the fingers, certainly not put on with a brush. Such a varnish as Theophilus describes would look as that looks, and in all probability would last as that has endured."

It is some twelve years since the first edition was published. The most important change in varnish-making during that period has been the introduction of tung oil, a product which has a remarkable power of rapid drying. The author believes, however, that the tung-oil varnishes are by no means so durable as the former oleo-resin products which they have so largely displaced. He notes that the general appearance of furniture and railway and other carriages has grown worse rather than better (in America) during the last ten years.

The author has some interesting remarks to make about violin varnish. He does not believe that spirit varnishes were ever used by the great violin-makers. Old violins appear always to have been coated with an oil-resin varnish. One valuable old instrument which he examined had a varnish which he concluded must have been made with at least 35 gallons of oil to 100 lb. of resin. If he were called upon to make a special varnish for violins, it would be, he says, a simple amber varnish with 35 or 40 gallons of raw linseed oil (to 100 lb. of amber).

Mr. Sabin writes from the American point of view, and disclaims any special knowledge of English practice; but his general outline of the principles involved in paint and varnish technology, and many of the applications of those principles which he describes, will hold good on both sides of the Atlantic.

C. S.

OUR BOOKSHELF.

Hand Grenades: A Handbook on Rifle and Hand Grenades. Compiled and illustrated by Major Graham M. Ainslie. Pp. v+59. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 6s. net.

THE introduction states that hand grenades were in use until about the end of the seventeenth century, when they fell into disuse. It has been stated that they were used by the defenders of Mafeking. In the Russo-Japanese War they were employed, and became important weapons in the present war, where "it was proved that under many conditions infantry armed only with rifle and bayonet found it impossible to press home an attack or hold a position against troops armed with grenades." This little book is the result of experience in the present war.

Following the "brief summary of the various grenades, with instructions for preparing and firing," compiled in "drill book" style, but illustrated with most excellent diagrams, which are almost self-explanatory, is a section on grenade tactics. A description of French and German grenades follows, and then a section on explosives used in grenades. Here the author might well have been more explicit; in an attempt to be concise much of the information has been too condensed to be clear. We read, for example: "Picric acid. A yellow crystalline prepared from coal tar. A by-product of gas manufacture." Again: "Lyddite or picric acid. Consists of melted and solidified picric acid. Vaseline is used to melt it." The alternative for benzol is given as benzine. Under cordite no reference is made to M.D., but only to the old Mark I., and the nitroglycerine content of this is wrongly stated. The acetone used for incorporation is described as merely "acetone to harden."

The practical part of the book will no doubt be of assistance to students of grenade work; it is essentially a soldier's book, but its value would have been greater had the author not attempted to impart information in too few words.

Therapeutic Immunisation: Theory and Practice. By Dr. W. M. Crofton. Pp. 224. (London: J. and A. Churchill, 1918.) Price 7s. 6d. net.

IN the earlier chapters of this book the author surveys the processes underlying immunity, and describes the preparation and properties of toxins and antitoxins and the agglutination and precipitin reactions. The principles of therapeutic immunisation by means of vaccines are then considered, and finally the practical applications of therapeutic immunisation to diseases of the alimentary canal, the respiratory system, and other regions of the body are described. The author's system does not appear to differ essentially from the customary routine, with the exception that in some instances he advocates the continuance of treatment until very large doses of vaccine are reached, *e.g.* 30,000 million cocci in the case of some staphylococcic infections. The use of various iodine preparations is also recommended as an adjunct to vaccine treatment in some infections. For the treatment of tuberculosis, tuberculins made by extraction with benzoyl chloride, which is a solvent for the waxy constituent of the tubercle bacillus, are considered to be superior to the ordinary tuberculins.

In addition to vaccine *treatment*, the use of vaccines for *prevention* is also considered where they are applicable, as in the cases of typhoid fever, cholera, plague, etc.

The book gives a useful summary of the practice of vaccine treatment. The practical details of the isolation of the micro-organisms concerned and the preparation of the vaccines therefrom are, however, scarcely touched upon. Full directions are given for the dosage of vaccines and for the proper spacing of the doses, and these will be found very useful by the practitioner who is adopting vaccine treatment. R. T. H.

LETTERS TO THE EDITOR.

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The Stimulation of Plant-growth by Electric Fields.

IN his letter on the above subject in NATURE of March 7 "J. L." states that "the procedure suggests that it is the field of force that is expected to produce the stimulation. The comparatively trifling amount of electricity that leaks from the wires into the atmosphere could scarcely produce directly any sensible effect." It is perfectly clear, however, that Lemström—the professor of physics at Helsingfors who started about thirty years ago the modern phase of electro-culture with overhead wires—held the view that the current leaking from the wires and passing through the plant was responsible for the effects on plant growth which he describes. For the purpose of increasing the discharge he used fine wires, 0·6 mm. in diameter, placed only 40 cm. above the plants, and provided with "barbs" 2 cm. long. In similar experiments in this country the fine wires have been retained, though the "barbs" are usually dispensed with.

It is true that our knowledge of the effects of electricity on plant growth is practically *nil*, and that the currents in question are very small, being of the order of 1 milliamp. per acre in some recent experiments with wires about 7 ft. high. It is, however, not unplausible to assume, although, of course, there are other possibilities, that the passage through the plant of such minute currents may alter the rate of some of its metabolic processes, and so affect plant growth.

In the experiment suggested by "J. L.," where the overhead wire is supposed to be protected from leakage, as, for example, by encasing it in a solid dielectric, it is not clear that a discharge from the pointed aerial portions of the plant would continue unaltered. Although a strong wind may prevent a large part of this discharge from passing to the dielectric enclosing the wire, such a wind will scarcely be able to prevent other atmospheric ions from being attracted to its outer surface. Air currents, in fact, will bring such ions to the dielectric on which they will form a gradually increasing charge tending to weaken the electric field between the wire and the crop. If the overhead wire be bare, but of large gauge so that leakage from it is small, and its potential be increased to such a value that a discharge occurs from the plants, then, with a strong wind, the current passing through the crop may be very much greater than that leaking from the wires.

V. H. B.
G. W. O. H.

Does the Indigenous Australian Fauna Belong to the Tertiary?

THE statement that the indigenous mammalian fauna of Australia belongs to the Mesozoic has been so frequently made that it has come to be generally accepted. It was, therefore, not surprising to find the reviewer of Cleland's "Geology," in NATURE of August 2, 1917 (vol. xcix., p. 441), pointing out as a mistake the opinion expressed in that text-book that the fauna is a Tertiary one.

In order to ascertain the opinion of vertebrate palæontologists on this point, letters were sent to Messrs. J. W. Gidley, W. D. Matthew, and S. W. Williston.

All agree that the indigenous Australian mammalian fauna should be considered a Tertiary one.

"The Mesozoic marsupials were probably exceedingly generalised or primitive in type throughout their whole structure, whereas the numerous widely diversified forms of present-day Australian marsupials show a high degree of structural specialisation which can only be considered modern in character. The fauna of the early Tertiary, so far as we know it from the very imperfect fossil records, contains relatively few marsupials, and there seems to be as marked differences between these and their living relatives as between placentals of that time and their living relatives. Morphologically, therefore, I should consider the Australian fauna quite modern." (J. W. Gidley.)

Dr. W. D. Matthew states that "the amount of diversity among Eocene mammals is not greater than the amount among modern marsupials," and thinks "one can fairly say that the amount of adaptive specialisation among modern marsupials compares fairly well with that of Eocene placentals." Moreover, the brain development and teeth afford other evidence. The brains of Eocene mammals are fairly comparable with those of Australian marsupials, and the teeth have about the same stage of molar specialisation as Eocene placentals. The predaceous marsupials of Australia are also still in the Eocene stage, such as is seen in the Eocene Creodonts. The skeletal adaptations of the Australian fauna are comparable with the more primitive Eocene and Oligocene specialisations.

The continent of Australia seems to have been isolated either before the placentals reached that continent, or, possibly, some predaceous marsupial destroyed the early arrivals. The evidence points to the Basal Eocene as the time during which occurred the submergence which separated Australia from the other continents of the world.

H. F. CLELAND.
Williams College, Department of Geology,
Williamstown, Mass., February 15.

THE BOMBARDMENT OF PARIS BY LONG-RANGE GUNS.

IN the language of sport, the German gunner has "wiped the eye" of our artillery science and defied all the timid preconceived notions of our old-fashioned traditions. The Jubilee long-range artillery experiments of thirty years ago were considered the *ne plus ultra* of our authorities, and we were stopped at that, as they were declared of no military value. To-day we have the arrears to make up of those years of delay. But the German watched our experiments with great interest, resumed them where we had left off, and carried the idea forward until it has culminated to-day in his latest achievement in artillery of a gun to fire 75 miles and bombard Paris from the frontier.

From a measurement of the fragments of a shell a calibre is inferred of 240 mm., practically the same as the 9·2 in. of our Jubilee gun, which, firing a shell weighing 380 lb. at elevation 40°, with muzzle velocity nearly 2400 ft. per sec., gave a range of 22,000 yards—say, 12 miles. This was much greater than generally anticipated, but in close agreement with the previous calculations of Lieut. Wolley Dod, R.A., who had allowed carefully for the tenuity of the air while the shot was flying for the most part 2 or 3 miles high.

The German shell is likely to be made much heavier and very nearly a solid shot, better by its weight to overcome air resistance, the chief factor to be considered in the problem of the trajectory. If it was not for this air resistance a range of 75 miles with 45° elevation could be reached, on the old parabolic theory of Galileo, with so moderate a velocity as $V = \sqrt{(gR)} = 3200$ ft. per sec., with $g = 32{\cdot}2$, $R = 75 \times 5280$; in a time of flight of about $2\frac{1}{2}$ mins., an average speed over the ground of 30 miles per min.

A velocity of 3200 ft. per sec. was obtained by Sir Andrew Noble in his experiments at Newcastle about twenty years ago with a 6-in. 100-calibre gun, with a charge of $27\frac{1}{2}$ lb. of cordite and a shot of unspecified weight, so it may have been the usual 100 lb. or perhaps an aluminium shot of half the weight.

Double velocity is usually assumed to carry twice as far; at this rate the velocity of our gun would require to be raised from 2400 ft. to about 6000 ft. per sec. to increase the range from 12 to 75 miles; such a high velocity must be ruled out as unattainable with the material at our disposal.

But in this range of 75 miles the German shot would reach a height of more than 18 miles and would be travelling for the most part in air so thin as to be practically a vacuum, and little resistance would be experienced.

So it is possible a much lower velocity has been found ample, with the gun elevated more than 45°, for the shot to clear quickly the dense ground strata of the atmosphere. Even with the 3200 ft. per sec. velocity obtained by Sir Andrew Noble a surprising increase in range can be expected over the 12-mile Jubilee range when this extra allowance of tenuity is taken into account, and a range of 60 miles be almost attainable.

A committee should be formed at once, composed of the artillery experts available, theoretical and practical, to make a start to recover our lost ground. If these long-range guns are now mounted afloat our Fleet is outclassed and cannot return their fire. A start could be made with no delay on one of our present 9-in. guns, strengthening the breech with wire coil and lengthening it with a chase of tubes screwed together, as in the Noble experimental 6-in. gun, to a length of something like 80 ft.

With a charge of 100 lb. of the newest powder to a shot weighing 400 lb., Sir Andrew Noble's velocity should be reached and exceeded and a comparison be drawn between calculation and practice. Meanwhile experiments on the model scale should not be despised, as they will give rapid and economical results, from which it is possible to predict a full-scale performance on the laws of mechanical similitude.

With the extra metal for strengthening the breech the gun would be heavy enough to prevent the recoil becoming unmanageable; and if the long chase should be too flexible, droop, and whip, it can be rigged like the bowsprit of a ship.

We can rely on our chemical, metallurgical, and engineering science to provide the material and shape it. But lead and direction are required of theory by preliminary calculation to show how to make use of our resources to the best advantage. As Bacon said: "Experiment not directed by Theory is blind. And Theory unsupported by Experiment is uncertain and misleading."

G. GREENHILL.

COLLOIDS AND CHEMICAL INDUSTRY.[1]

COLLOID chemistry, in its widest sense, deals with chemical processes which occur in the immediate neighbourhood of surfaces—that is, chemical effects which are brought about as a result of capillary and electrocapillary forces. Such effects are necessarily limited to a small range, the thickness of the capillary layer being of the order 10^{-6} to 10^{-7} cm. It is obvious that these effects can become of importance only if the surface area itself is very large. Under ordinary conditions, in which two fluid masses in bulk are separated by a definite surface—as in distribution phenomena—the capillary effects are too small to be observed. To magnify the effect it is usually necessary to realise a state of affairs in which one phase is distributed in a state of fine subdivision or "dispersed" through the other phase or medium. In these circumstances the total interfacial area is enormously great. We find such conditions in the case of fine suspensions (diameter of particle 10^{-4} cm. approx.), emulsions (diameter of particle 10^{-5} cm.), and colloid solutions (diameter of particle 10^{-6} cm. approx.). Colloidal solutions are systems in which the solute individuals or *sols*, though apparently soluble, have not broken down to the molecular limit, but consist instead of aggregates, composed roughly of several hundred molecules or atoms. Such soluble aggregates or *sols* will not diffuse through membranes (as Graham showed in his original work on the colloidal state), and thus differ markedly from the behaviour of dissolved crystalloids, *e.g.* salts.

The most fundamental problem in connection with such disperse systems is the problem of their stability. It is evident that uniformity in size of the particles plays an important part in this connection, as do also the electric charge and the Brownian movement which each particle possesses. The methods whereby the equilibrium is disturbed are equally remarkable and characteristic. A very minute amount of electrolyte added to a stable colloidal solution may bring about complete precipitation or flocculation of the *sol*, the *sol* separating out in a gelatinous form known as a *gel*. In some cases, and possibly in all—though this is a disputed point—such precipitation may be reversed. A closely allied phenomenon is that known as "peptisation," in which a substance, normally insoluble in a solvent, may be made to dissolve by the addition of a peptiser. This is illustrated by the stabilising or protective effect produced by a small quantity of gelatine (itself a colloid) upon solutions of colloidal metals, and also by the well-known phenomenon met with in the case of the hydroxides of zinc and aluminium which "dissolve" in excess alkali. Experiment has shown that the alkali may be dialysed away and the peptised colloidal hydroxide reprecipitated. Such phenomena depend essentially upon selective adsorption or surface condensation of certain parts of the peptiser (usually the hydroxyl ion) upon the suspension or colloid. Gibbs showed, many years ago, that, as a thermodynamic necessity, any substance (solute) which lowers the surface tension of the solvent is positively adsorbed at the surface—that is, the concentration of the solute is greater in the surface layer than it is in the bulk of the solution. This phenomenon lies at the basis of many technical operations, such as dyeing and tanning, though, of course, other effects of an irreversible character enter later.

Another important surface phenomenon is that known as electrical endosmose. If a liquid be divided into two parts by means of a porous partition or membrane, and an electromotive force be applied across the partition, the liquid will be found to pass through the membrane, the direction of motion depending upon the electrical state of the partition in relation to the liquid and its constituents. By a suitable choice of membrane and solution certain constituents may be separated from others, *e.g.* crystalloids from colloids, or certain colloids may be precipitated and others left in solution.

Surface effects, the realisation of colloid equilibrium, electrical neutralisation, preferential adsorption, peptisation, colloid precipitation, imbibition or swelling of *gels*, electrical endosmose, and other phenomena of a similar nature might at first sight appear to have little significance for industrial operations and processes, although their importance has already been recognised to a certain extent in other directions, *e.g.* in agricultural processes (quality of soils, retention of salts, emulsions for crop spraying, etc.), in geological formations, and in biological problems (cell contents, nature and permeability of cell-walls, distribution of electrolytes, blood serum, coagulation of proteins, enzyme action, etc.). That colloidal phenomena enter into numerous technical processes may be demonstrated by a brief enumeration of some industrial operations which depend fundamentally upon what we may call the principles of colloid chemistry.

We have already instanced dyeing and tanning. We find further that colloid chemistry plays a fundamental part in certain stages of soap manufacture; in washing and scouring processes, in connection with textile fabrics, hides, skins, and in fur dressing; in mercerisation and finishing; in the manufacture of photographic materials; in the treatment of cellulose and wood pulp in paper manufacture; in paper sizing and colouring (carbon and other copying papers); in the treatment

[1] First Report of the British Association Committee on Colloid Chemistry and its Industrial Applications. (1917.)

of gums, gelatine, albumin, starch, tragacanth, and adhesive materials generally; in the clarification of wines; in filtration processes, treatment of sewage, river sludge, and the function of charcoal purifiers; in the de-emulsification of water in steam turbines; in the preparation of medicinal emulsions; in the manufacture of margarine and other foodstuffs; in brewing and fermentation industries; in catalytic reactions, such as the hydrogenation process; in chemical analysis, electro-analysis, and electro-deposition processes; in the coagulation of rubber latex and in vulcanisation; in the manufacture of celluloid and celluloid products; in the flotation process of ore separation; in the manufacture and setting of cements, plaster, and mortar; in the preservation of building materials; in the manufacture of ruby glass, opaque glass, and enamel; and in the application of electrical endosmose to peat drying and the preparation of pure colloids for medicinal purposes.

The above rather heterogeneous list—by no means exhaustive—will give some idea of the variety and extent and consequent importance of colloid chemistry for the chemical manufacturer. It is an urgent matter that the great significance of this branch of chemistry should be recognised by all interested in the progress of chemical industry.

In the first report of the British Association Committee on Colloid Chemistry and its Industrial Applications, now before us, several of the processes mentioned above are discussed. The committee has aimed at compiling information regarding the advances which have been made in colloid chemistry itself and in its applications to industrial processes, with the object, in the first place, of making such information as widely available as possible, and, in the second, of emphasising the need for much greater attention being paid to this wide, but hitherto neglected, branch of chemistry. Each subject has been treated by an expert, so that the selection and presentation of material may be regarded as authoritative. It is evident that at the present time there is a very considerable "lag" between scientific knowledge in this field and industrial practice. The result is that the majority of working processes are largely empirical, their mechanism obscure, and the probability of improvement consequently small. This is obviously an extremely unsatisfactory state of affairs. The remedy lies, of course, in the vigorous prosecution of research over the entire range of colloid chemistry in the research laboratories of manufacturers and in the chemical departments of our universities. In this connection it is perhaps worth while to point out that there is not a single chair or independent department of colloid chemistry in any of our universities or university colleges. The time has surely come for development in this direction, in order that a subject of such present importance and possessing great possibilities may become a real source of strength to our chemical industries.

W. C. McC. LEWIS.

DR. G. J. HINDE, F.R.S.

BY the death of Dr. George Jennings Hinde on March 18 another pioneer in the modern methods of studying fossils has passed away. Dr. Hinde devoted the greater part of his long life to the investigation of the remains of the lower invertebrate animals, which need careful and often laborious preparation for the microscope before they can be examined. He thus contributed much to geology by adding to our knowledge of rock-forming organisms, and at the same time promoted the advance of zoology by his discovery and description of many kinds of calcareous and siliceous skeletons, which were either entirely new or revealed new facts in distribution.

Dr. Hinde was born at Norwich in 1839, and emigrated in early life to the Argentine Republic, where he was engaged in sheep-farming. He was always interested in natural history, and as soon as the opportunity occurred at the beginning of the 'seventies he decided to retire from business and follow more congenial pursuits. He left Argentina for Canada, and proceeded to the University of Toronto, where the late Prof. H. A. Nicholson was then starting his professorial career. Stimulated by Nicholson's lectures and personality, Hinde began to follow his teacher in studying the Silurian and Ordovician fossils of Canada. He also became interested in the remarkable glacial deposits, which are so conspicuous a feature of the region in which he dwelt. Nicholson had specially devoted attention to the microscopic structure of the corals and obscure organisms which abounded in the limestones, and it was to the microscope that Hinde naturally turned as the chief instrument for his researches. He travelled extensively and collected industriously in Canada and the United States, where he remained for seven years. Among minute fossils his most important discoveries were conodonts and jaws of annelids in the Ordovician rocks.

Returning to England, Hinde found similar jaws of annelids in the Silurian rocks of this country, and described them in the Quarterly Journal of the Geological Society in 1880. In 1879 he recovered and prepared a remarkable collection of sponge-spicules from a hollow in a chalk-flint at Horstead, near Norwich, and soon recognised that most of them were new. He accordingly went to study his little collection at the University of Munich, under the direction of Prof. K. A. von Zittel, who had just completed there an important revision of the fossil sponges. Hinde published his results in 1880 in the form of a thesis, for which he received the degree of Ph.D. Returning finally to England, he next prepared a descriptive illustrated catalogue of the fossil sponges in the British Museum, which was published by the trustees in 1883; and this was followed by the first volume of a monograph of the British fossil sponges, issued by the Palæontographical Society between 1887 and 1893. Several smaller papers were also the outcome of his researches, the most important being an account of the cherty spongebeds of the Greensand formation contributed to the Philosophical Transactions in 1885.

Hinde continued to pay much attention to cherts in later years, and showed that many of them were rich in the skeletons of radiolaria, which he described in detail. His skill in making preparations was indeed matched only by the patience with which he studied them; and it would be difficult to find more conscientious plodding work than that he accomplished when he examined and described the core from the boring in the coral-atoll of Funafuti for the report of the Royal Society's committee in 1904.

From 1882 onwards Hinde resided near London, and until 1900 he took a very active share in the administration of the Geological Society, serving three terms on the council and being a vice-president from 1892 to 1895. From 1897 until 1915 he was also an active member of council of the Palæontographical Society, and held the office of treasurer from 1904 to 1914. Whatever he undertook he carried out with intense thoroughness, and whenever he formed a judgment as to the right course to pursue, neither argument nor persuasion could alter his determination. He sometimes therefore found himself at variance with his colleagues, but his honesty of purpose was always so evident that he never lost their highest respect and esteem. His scientific worth led the Geological Society to award him the Wollaston fund in 1882, the Lyell medal in 1897, and he was elected a fellow of the Royal Society in 1896.

NOTES.

It was stated in the *Times* of March 21 that Dr. Addison, Minister of Reconstruction, had informed a deputation of Welsh members that a Government Bill for the establishment of a Ministry of Health would probably be introduced in the House of Commons immediately after the Easter recess. Agreement has been reached on the main principles of the measure as the result of conferences with the various departments and parties affected.

A well-illustrated article by M. H. Volta on the relation of inventors to the problem of dealing with hostile submarines appears in *La Nature* for February 23. It seems that the French authorities have been overwhelmed with suggestions which as a general rule show a lamentable want of consideration of the conditions under which the search for submarines and the attacks on them, when found, have to be carried out. Half a dozen ingenious arrangements for netting them and either communicating the fact to the shore or to an attendant destroyer, from which the submarine is then bombed, or providing automatically for the explosion of a bomb when the net is touched, are described. Almost any of them would act in still water not used by surface boats, but none of them are of the least use in water constantly in tidal motion, often tempest-tossed, and with craft of all kinds on its surface. In the same way many of the suggestions for dealing with the problem by the help of aeroplanes display an extraordinary amount of ingenuity, but at the same time a candid ignorance of the conditions of flight and of stability of an aeroplane.

The House of Lords, by a majority, has recently dismissed an appeal from a decision of the Court of Appeal affirming a judgment of Mr. Justice Astbury. The action was brought by the British Thomson-Houston Company to restrain "Duram," Ltd., from infringing a patent granted to the appellants for a process for the treatment of tungsten. The respondents disputed the validity of the patent. The appellants claimed that their invention consisted in the discovery that a mere built-up body of particles of tungsten which had hitherto been known only as a powder could be sufficiently consolidated together by prolonged heating below the melting point, and could then, if worked hot, be treated as though it were a solid piece of metal, that continuous lengths of wire of filament size could be produced therefrom, and that these particles of tungsten could be made so coherent that if hot they could be hammered, rolled, or drawn. Mr. Justice Astbury held upon the construction of the specification that the patent was void for lack of subject-matter in that it covered the working of tungsten while hot, and that the working of a hot metal was merely the utilisation of the tools and routine of the metal-worker, and was not the subject of invention. His judgment has been upheld, both in the Court of Appeal and in the House of Lords.

It is sincerely to be hoped that the very timely appeal of the Duke of Rutland, in the *Times* of March 21, will not fall upon deaf or apathetic ears. His Grace directs attention to the very serious diminution of our truly insectivorous wild birds, and appeals to the authorities at Whitehall, when sending out their commands respecting the destruction of grain-eating wild birds, to urge strongly the advisability of sparing the truly insectivorous species. In May of last year Dr. W. E. Collinge pointed out in these columns the need for the Board of Agriculture to compel the preservation of such birds, and had the suggestion that this Board should establish a Bureau of Ornithology (*cf.* Nature, October 15, 1915) been acted upon, the authorities would have been in possession of evidence which would have shown the real state of affairs as regards such birds, and would ere now have been ready to act. Since the commencement of the war up to the present time tens of thousands of acres of woods and forests have been destroyed in the British Isles. What the effect of this drastic change will be upon wild bird life it is difficult to foretell, but it seems very likely that it will mean a large decrease in the number of insectivorous birds, and as the stumps of recently felled trees in many cases provide an ideal breeding ground for insects, we shall probably, for some years to come, be troubled with plagues of various kinds of insects, in particular those that are injurious to forests. The unusually trying winters of the past two years have taken an enormous toll of tits, flycatchers, warblers, etc., and every protection should be afforded them at once.

The meeting of the Institution of Mechanical Engineers on March 15 was eventful in that a paper was read by a lady—Miss O. E. Monkhouse—on the employment of women in munition factories. Roughly speaking, there are now close on one million women engaged on munitions; these may be divided into three types: (1) The educated type; (2) the domestic type; (3) the ordinary factory type. The first type are already half-educated for the better class of engineering work, and are taught easily; the second train readily into good charge hands and forewomen; and the last-mentioned type are best employed on purely unskilled work of a repetition nature. There are many cases where women have acquired a knowledge of engineering work in excess of what would have been learned by an apprentice in the same period under pre-war conditions. There are three causes for this:—(1) Women have been definitely taught, whereas the apprentice had to pick up the trade; (2) women have, for the most part, been intensively taught everything in the shop itself under production conditions rather than in the school; (3) the conditions of the time have spurred on everybody to greater effort, from patriotic motives. Experience has shown that women should be controlled and organised by their own sex if the best results are to be obtained; also that, wherever there has been proper consideration for women's welfare in factories, there has been no decrease in healthy physical development, and a decided increase in mental capacity.

SOME time ago the council of the Institution of Naval Architects appointed a committee to inquire into the effects of explosions of mines and torpedoes on the structure of merchant ships. This committee, in its report, states that the loss of many cargo vessels has been due to three causes:—(*a*) The existence of watertight doors low down in the bulkheads, which could not be closed after the explosion; (*b*) fractures of suction pipes in the attacked compartment permitting water to flow into adjacent compartments; (*c*) the penetration of bulkheads adjacent to the attached compartments by fragments of plating, frames, rivets, etc. The committee made several recommendations with the object of minimising these risks, and the Government has adopted and circulated most of these. Speaking in the discussion on Sir George Carter's paper on standard cargo ships, read at the institution's meeting on March 20, Mr. Sydney Barnaby, the chairman of the committee, said the committee had expected to find that the effect of the torpedo on merchant ships would be so severe that their survival could not be hoped for reasonably. They expected to find that large areas of the shell plating were disturbed and the riveting started, and that possibly bulkheads were carried away by sudden enormous inrushes of water. Their investigations showed nothing of the kind. Large as the holes were, the ship's structure was not affected even in the immediate neighbourhood, and bulkheads had never given way. In fact, ships were being sunk because watertight compartments were not actually watertight.

WE regret to record the death on March 21 of Dr. R. S. Trevor, pathologist at St. George's Hospital, dean of the medical school, lecturer in pathology, forensic medicine, and toxicology, and curator of the museum.

Science records the death, in his sixty-second year, of Prof. E. A. Engler, president of the Academy of Science of St. Louis. Prof. Engler was professor of mathematics at Washington University, St. Louis, from 1881 to 1901, and dean of the school of engineering there from 1896 to 1901. He was for ten years president of the Worcester Polytechnic Institute.

THE death is announced, in his sixty-first year, of Sir John Anderson, K.C.B., Governor and Commander-in-Chief of Ceylon since 1916. In 1901 Sir John Anderson was in attendance on King George, then Duke of Cornwall and York, as representative of the Colonial Office, during the Royal Colonial tour. From 1904 to 1911 he was Governor of the Straits Settlements and High Commissioner for the Federated Malay States.

THE annual general meeting of the Ray Society was held on March 14, the president, Prof. W. C. McIntosh, in the chair. The report of the council and the account of income and expenditure were read and adopted. Sir David Prain was elected a vice-president in succession to Prof. E. B. Poulton, retiring by seniority, Prof. McIntosh was re-elected president, Dr. S. F. Harmer treasurer, and Mr. John Hopkinson secretary.

THE annual gold medal of the Institution of Naval Architects has been awarded to Prof. G. W. Hovgaard, of the Massachusetts Institute of Technology, for his paper on "The Buoyancy and Stability of Submarines," and the premium to Mr. J. J. King-Salter, of Sydney, for his paper on "The Influence of Running Balance of Propellers on the Vibration of Ships." As already announced, the Martell scholarship for 1917 and the Earl of Durham's prize have been awarded respectively to Mr. H. C. Carey and Mr. H. D. Leggett.

A JOINT meeting of the Institution of Electrical Engineers and the Electrical Section of the Royal Society of Medicine will be held at the Cancer Hospital, Fulham Road, S.W., on Thursday, April 11, at 7.30 p.m., instead of at King's College, as previously announced. The following papers will be read:—Dr. E. P. Cumberbatch, "Diathermy: the Use of Electricity for Heating the Tissues of the Body in Disease"; Dr. R. Knox, "Single Flash (Instantaneous) Radiography: its Possibilities and Limitations." There will also be an exhibition of electro-medical apparatus.

THE annual general meeting of the Chemical Society was held at Burlington House on March 21, when the Longstaff medal for 1918 was presented to Lt.-Col. A. W. Crossley, C.M.G., for his work in the field of hydroaromatic compounds. Prof. W. J. Pope delivered his presidential address, and at the conclusion of his address it was announced that the following new members of council had been elected:—As new vice-presidents, Prof. F. G. Donnan and Prof. W. P. Wynne; and as new ordinary members of council, Mr. J. L. Baker, Prof. J. C. Irvine, Sir Herbert Jackson, and Mr. E. W. Voelcker.

THE annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 2 and 3. On the opening day the retiring president (Sir William Beardmore, Bart.) will induct into the chair the president-elect (Mr. Eugène Schneider), Sir William Beardmore will be presented with the Bessemer medal for 1918, and the president will deliver his inaugural address. On May 3 the award of grants from the Andrew Carnegie Research Fund in aid of research work will be announced. Twenty-one papers are included in the list for the meeting, and selections from them will be read and discussed.

THE death is announced, in his sixty-seventh year, of Dr. Samuel G. Dixon, professor of bacteriology and microscopic technology at the Academy of Natural Sciences, Philadelphia, since 1890, and president of that institution since 1896. For more than twenty years he was professor of hygiene at the University of Pennsylvania. His principal work was done in the prevention and treatment of tuberculosis, and his controversy with Prof. Koch over the priority of discovery of a method of preventing that disease in the lower animals created considerable stir in the scientific world some years ago. Of late years Dr. Dixon had rendered exceptional service in connection with the Department of Health of the State of Pennsylvania, of which he was placed at the head as commissioner when it was established in 1905.

THE following are among the lecture arrangements at the Royal Institution after Easter:—Prof. John Joly, two lectures on scientific signalling and safety at sea; Prof. Arthur Keith, five lectures on British anthropologists; Lt.-Col. C. S. Myers, two lectures on present-day applications of experimental psychology; Sir James Frazer, two lectures on (1) the folk-lore of bells,

(2) the prosecution and punishment of animals; Lt.-Col. Sir Francis Younghusband, three lectures on the abode of snow: its appearance, inhabitants, and history; Prof. E. H. Barton, two lectures on musical instruments scientifically considered; Prof. H. F. Newall, two lectures on modern investigation of the sun's surface; Prof. C. J. Patten, three lectures on problems in bird-migration. The Friday meetings will commence on April 12, when Prof. E. C. C. Baly will deliver a discourse on absorption and phosphorescence. Succeeding discourses will probably be given by Major G. I. Taylor, Sir A. Daniel Hall, Sir George Greenhill, Prof. F. Gowland-Hopkins, Dr. A. Barton Rendle, and Sir Boverton Redwood.

THE annual report of the council of the Institute of Metals, presented at the recent annual general meeting, shows that the stimulating influence of war conditions upon the activities of the institute has continued to make itself felt during the year. The more general employment of scientific metallurgists in works engaged directly and indirectly in the production of munitions of war has aroused the interest of technical and scientific experts and of manufacturers in the work of the institute, and this has led to a large increase in the applications for membership. The research work organised by the Corrosion Research Committee is still being conducted with the assistance of funds contributed by the Department of Scientific and Industrial Research, by various associations and manufacturing firms, and by the institute. The Government grant-in-aid was increased during the year from 650*l.* to 1000*l.* per annum. A further Government grant-in-aid of 450*l.* has been received, together with a grant of a similar amount from the British Electrical and Allied Manufacturers' Association. The aggregate sum of 900*l.* has been placed at the disposal of the institute in order to carry out an investigation into the cause of the corrosion of condenser tubes on land by fresh water. For the purpose of conducting this investigation, a Fresh-water Corrosion Research Committee was appointed as a subcommittee of the Corrosion Research Committee.

ANOTHER Indian "miracle" has been explained by scientific investigation. The *Pioneer Mail* of January 11 reports a lecture by Sir J. C. Bose on "The Praying Palm Tree" of Faridpur. While the temple bells call the people to evening prayer, this tree has recently been seen to bow down in prostration, and to erect its head on the following morning. Large numbers of pilgrims have been attracted to the place, and offerings to the tree are said to have been the means of effecting marvellous cures. Sir J. C. Bose first procured photographs which proved the phenomenon to be real. The next step was to devise a special apparatus to record continuously the movement of the tree by day and night. The records showed that it fell with the rise of temperature and rose with the fall. The records obtained in the case of other trees brought out the fact that all the trees are moving, each movement being due to changes in their environment.

THE history of William Bullock's famous museum, by Mr. W. H. Mullens, which appears in the *Museums Journal* for March, will be read with interest by all who are concerned with the rise and development of museums in this country. This account, which is not yet completed, is devoted to an analysis of the various editions of the catalogue, or "Companion," which served as the guide to the collections, and to the description of the final dispersal of the museum and its contents by auction, which took place in 1819. This issue of the *Journal* also publishes an appeal to museums from the Ministry of Food urging them to spare no effort to instruct the public as to ways and means of food production and food conservation. We are glad indeed to find that the purposes of museums are at last recognised by the Government as serving something more than "places of innocent amusement," activities which, in time of war, might well be suspended. But the work now suggested was put in hand in most museums long since. Nevertheless, this recognition is a hopeful sign. Our museums will be found only too willing to respond to every plea made to them to enlarge the sphere of their activities.

A VERY careful study of the nesting habits of the kingfisher (*Alcedo ispida*), by Mr. W. Rowan, appears in *British Birds* for March. Though brief, this essay adds several points of real value to our knowledge of the life-history of this bird, and, besides, sets at rest one or two matters which have long been in dispute. It is shown, for example, that two broods may be reared during a single season, and that the male takes part in brooding the young. As to whether they are fed at first by regurgitation or not Mr. Rowan was not able to satisfy himself, but it seems clear that the food given during the early stages of development consists of small crustacea and not fish, for fish were not brought to the nest until the young were several days old. By great good fortune observations were also made on the nestlings, first, while making the peculiar purring noise which has been frequently described, but probably never before witnessed, and secondly, during the act of defæcation. The voiding of the fluid excrement by the nestlings of this species assumes importance, having regard to the fact that the nest is placed at the end of a long tunnel. Being fluid, it could not be carried away by the parents, so that only by its forcible ejection from the mouth of the tunnel can the nest be kept clean.

THE Madras Fisheries Bulletin (No. 4, vol. xi., 1917) consists of an interesting account of the Indian bêche-de-mer industry, written by Mr. James Hornell. Only one species of Holothurian (*Holothuria scabra*) is utilised commercially, the other abundant species being either too small or too gelatinous to cure. The Indian curing industry is of considerable antiquity, and it seems to have been introduced by immigrant Chinese. These men are said to be most careful and conscientious workers, and are generally very successful until they become ousted by local fishermen, who are exploited by Mohammedan merchants. As the result of a boycott and the promotion of a rival curing-house, the Chinese exporter become expropriated; the local curers adopt his methods, but gradually allow them to deteriorate until, in turn, the trade languishes and dies out, and is revived by some other Chinaman. Mr. Hornell gives an account of the successful work done by the Madras Government in erecting and running an experimental curing station in Palk Bay. Certain improvements in methods were introduced, and these are described. Statistics of the general Eastern trade in bêche-de-mer during recent years are appended.

THE cheese mite is the cause of much damage to cheeses, especially the unpressed, ungreased cheeses of the Stilton and Wensleydale types. The attacks of this pest give rise to a serious depreciation, both in appearance and value, and in extreme cases nearly one-half of the cheese may be eaten away. An interesting account of experiments and observations on this problem is contributed by Miss N. B. Eales, of the Zoology Department, University College, Reading, to the January issue of the *Journal of the Board of Agriculture*. It was demonstrated that live mites persist in the cheese room throughout the period from December to April when the room is not in use, despite the greatest care in the application of the ordinary cleansing methods. Further experiments showed that the mites could be carried by flies and moths. The common practice of dipping mite-attacked cheeses in hot water or steaming them was found to be useless as a remedy. Fumigation with sulphuretted hydrogen or sulphur dioxide was also futile. Treatment with carbon bisulphide proved very successful, but treatment with formalin was ineffective. In an experiment with carbon dioxide the mites revived after a period of suspended animation lasting for ninety-six hours. Methods of prevention of mite attacks are indicated, and the article, which is illustrated, also includes brief notes on the systematic position, species, and life-history of the mites.

GREAT interest has been taken throughout the wide circle of his acquaintance in the experiment which Prof. W. Somerville has been conducting during the last seven years on his aptly named farm of "Poverty Bottom," with the object of demonstrating in actual commercial farm practice the soundness of the view he has so long and ably advocated, that the improvement of English land offers in many parts of the country an investment of a highly remunerative character. For his purpose a poor, thin soil on the chalk seemed to be best suited as an object-lesson, in view of the fact that the Cretaceous system is the most extensive single geological formation in England, and hence results obtained in it would be capable of wide application. In February, 1910, Prof. Somerville entered into possession of "Poverty Bottom," a farm of 530 acres, situated on the South Downs near Newhaven, and at the time untenanted, unstocked, and apparently all but barren. The outstanding measures of improvement adopted were the liberal application of basic slag, clearing off gorse, sowing of clovers, including wild white clover, and the admixture of cattle with sheep on the pastures. The use of basic slag has effected a very striking improvement of the pasturage through the development of the leguminous herbage, and the tillage land has shared in the improvement through the transference to it in the manure of nitrogen collected in the meadows. Seven years' farming has now been experienced, and the results are summarised in a most interesting article by Prof. Somerville in the current issue (February, 1918) of the *Journal of the Board of Agriculture*. This article gives many details of the system of improvement followed which cannot be summarised here. It is estimated that the head of stock has been increased by 50 per cent., whilst, when the higher quality of the stock is taken into account, the productivity of the farm in terms of meat has been increased threefold in six years. The net financial result in any year was very largely a question of weather, but on the whole period, after deducting losses, rent, etc., a credit balance of more than 2200*l.* remains. The average yearly remuneration of the farmer, it is estimated, would represent a sum of 338*l.*, together with a free house, as a return for the investment of some 4000*l.* of capital.

A RECENT bulletin (No. 102, part i) of the Smithsonian Institution provides, under the title "The Mineral Industries of the United States," a useful popular account of coal and products from coal, which may be read with advantage on both sides of the Atlantic. The writer, Mr. Chester G. Gilbert, is curator of mineral technology in the U.S. National Museum, and his object appears to be to urge the importance of co-ordination and scientific control of chemical industries. This lesson will have to be learned in this country no less than in the United States, but progress in this direction will depend very much on the support given by public opinion. As, however, few of the public know much about such questions, anything which helps towards a popular understanding of them is useful. This bulletin gives within sixteen pages of print an outline of the origin of coal, a comparison of the amount of coal deposits in the several countries of the world, and an indication of the methods used in the production of coke, gas, and the other volatile products obtainable by the application of heat. The illustrations added include a curious diagram of the products derived from coal and some of their uses, which will serve to show to the uninitiated the complex character of coal chemistry.

WHEN heat flows through the surface of a solid to or from a gas in contact with the surface, it is well known that the layer of stagnant gas close to the solid interposes a considerable resistance to the flow. When the object of the arrangement has been to get the maximum flow, it has been the custom to make the gas flow rapidly over the surface of the solid. The advantage of this was pointed out by Osborne Reynolds in 1874, and it has been verified experimentally by Stanton in 1897, Nicolson in 1905, and more recently by Jordan (Proc. Inst. Mech. Eng., 1909). Another method of obtaining the same result is described by Dr. C. Hering in a paper on "A New Principle in the Flow of Heat," in the January number of the Journal of the Franklin Institute. It is found that the resistance of the film of gas in contact with the solid may be greatly reduced by increasing the temperature of the surface of the solid. The flow through the bottom of a kettle may, according to Dr. Hering, be increased twenty-sevenfold by raising the temperature of the metal surface in contact with the gas flame to 725° C. This can be done by interposing a thermal resistance between the surface in contact with the flame and that in contact with the water. It is proposed to secure the same result in steam boilers by attaching metallic lugs to the flame side of the flue, of such length that their ends will be at about 725° C. The results of a trial of the method on a practical scale will be awaited with considerable interest.

AN interesting discussion on nitre-cake held by the Nottingham Section of the Society of Chemical Industry is reported in the Journal of the society for December 15 last. According to Mr. G. C. Grisley, the most successful method of utilising nitre-cake is to substitute it for sulphuric acid in the manufacture of hydrochloric acid and salt-cake from salt. It has also been employed to obtain ferric sulphate for sewage precipitation by furnacing burnt pyrites with nitre-cake, grinding, and leaching the product with water. Further, it could be used as a diluent for sulphuric acid in the manufacture of superphosphate. Dr. Terlinck stated that he had used nitre-cake as a substitute for sulphuric acid in the recovery of fats from wool wash-waters, and he proposed to use it in the purification of ammonium salts. The necessity for workmen who handled nitre-cake being provided with wooden clogs and india-rubber gloves was emphasised by Mr. W. G. Timmans, who stated that in the Nottingham district nitre-cake was used for lace bleaching, grease extraction from wool, pickling metals, and mineral-water manufacture. Dr. E. Naef pointed out that the suggestions hitherto advanced were based on the acidity of the nitre-cake, and that the sodium sulphate remaining had still to be utilised. One way of doing this was to reduce it to sodium sulphide by grinding with anthracite, charcoal, or boiler coal and heating at 500°–600° C., the yield obtained being 95–98 per cent. Sulphur dioxide is evolved if nitre-cake (rather than sodium sulphate) is used, but this could be avoided by neutralising the free acid with soda ash during the grinding. For the production of sulphur dyes alone 50,000 tons of sodium sulphide are required per annum. Dr. Naef has found that by treating nitre-cake at 300°–350° C. with superheated steam 90 per cent. of the free acid is driven off, but the product is too dilute to concentrate.

VOL. ii., No. 4, of the Memoirs of the College of Science, Kyoto Imperial University, contains a series of metallographical publications by Prof. Chikashige and his pupils. These deal with the working out of the equilibrium diagrams of the following series of binary alloys: (1) Tellurium and aluminium, and (2) selenium with antimony, cadmium, zinc, and aluminium respectively. The methods adopted are those in general use and do not call for any special mention. The authors content themselves with the determination of the main features of the diagrams, without saying anywhere whether any of the alloys are likely to prove of practical value.

THE reviewer of Dr. Knox's book on "Radiography and Radio-therapeutics," in NATURE of March 14, remarked: "We regret the omission of the bibliography." The publishers direct our attention to the fact that a selection of the literature of the subject appears on p. iv. at the end of the volume. We are sorry that our reviewer did not notice this bibliography in spite of having looked for it, and that he incorrectly said it had been omitted.

OUR ASTRONOMICAL COLUMN.

PLANETARY PERTURBATIONS AND ÆTHER-DRIFT.—In a paper entitled "Continued Discussion of the Astronomical and Gravitational Bearings of the Electrical Theory of Matter" (*Philosophical Magazine*, February, 1918), Sir Oliver Lodge continues a discussion commenced by the suggestion that the shift in Mercury's perihelion might be explained by a drift of the solar system through the æther. Prof. Eddington showed that a drift that would account for this would bring inadmissibly large errors into the other elements of the inner planets. Sir Oliver Lodge admits an error in his former work in the following words: "If the additional inertia due to motion is acted on by gravity the varying factor m will enter twice into the equation of motion and the perturbation will be increased instead of being annihilated." Making this change, he examines once more whether it is possible to find a drift that will satisfy the observed perturbations within their limits of error. After many trials, he concludes that they cannot all be satisfied in this way. He tends to the conclusion that gravity has joined the conspiracy to defeat our efforts to detect motion through the æther, and that we are led to accept the conclusion that the gravitation-constant itself is a function of the speed of the attracting masses. In support of this he quotes some electrical results which lead him to believe that electrical attraction does actually vary with speed. "If such a fact be established [for gravity] it may begin to throw some light on the family relationship of that force."

PERTURBATIONS OF NEPTUNE'S SATELLITE.—In a communication to the *Observatory* for March, Prof. Armellini states the chief results of an investigation referring to the well-known perturbations of the satellite of Neptune. The pole of the satellite's orbit describes a circle about a point in R.A. 288° and declination 40°, and two hypotheses have been suggested to account for this motion. Tisserand attributed it to the attraction of the protuberant matter about the planet's equator, whilst H. Struve suggested that it might be due to some unknown perturbing mass. Prof. Armellini has investigated the latter hypothesis on the supposition that the unknown body is a satellite, which may not have been observed on account of its small mass. He has shown that a satellite having a mass sufficient to explain the observed perturbations would probably not be much fainter than the 14th magnitude, and would be unlikely to have escaped detection. Struve's hypothesis is accordingly considered much less probable than that of Tisserand.

MOTION OF OUR STELLAR SYSTEM.—Dr. V. M. Slipher, director of the Lowell Observatory, has made a preliminary investigation of the motion of our stellar system, on the supposition that the spiral nebulæ are stellar systems, similar to our own, situated at very great distances (Proc. American Philos. Soc., No. 5, 1917; quoted in Journ. R.A.S. Canada, vol. xii., p. 72). The radial velocities of twenty-five spiral nebulæ have been determined, and the motion of our system with respect to them has been derived in the same way as that of the sun with respect to the stars of our own system. The somewhat scanty material available indicates that we are moving in the direction of R.A. 22 hours, and declination −22°, with a velocity of about 700 km. per second. Dr. Slipher considers that these observations strengthen the view that our stellar system and the Milky Way are to be regarded as a great spiral nebula which we see from within, and that if the solar system has evolved from a nebula, the nebula was probably not one of the class of spirals dealt with in this investigation.

FOOD RATIONS FOR MANUAL WORKERS AND SCIENTIFIC LABORATORIES.

IT has been announced in the Press that the Ministry of Food intends to grant extra rations to manual workers from some date after April 7. The extra ration will not be ordinary butcher's meat, but bacon; and the eligibility of applicants will be determined by sub-committees of the local Food Control Committees, to which the Food Ministry will issue a classification of those persons entitled to extra food. The motive of this proposal is evidently sound from the scientific point of view. Considerable difficulties are, however, likely to arise in practice owing to the lack of exact knowledge respecting the energy needs of different kinds of industrial work. Relatively few experiments have been made and published, those of Amar upon metal filers being the best known. It is to be hoped that the scientific advisers of the Food Ministry will organise physiological investigations to elucidate disputed points. Complete calorimetric measurements are, of course, impracticable, but sufficiently precise results can be reached through a study of the respiratory metabolism by Zuntz's method, the apparatus needed for which is portable.

The Medical Research Committee has recently brought to the notice of Lord Rhondda the special difficulties confronting the directors of pathological and other scientific laboratories in the regulations relating to food supply. Many instances have been brought to the notice of the committee in which scientific work of the highest national importance has been endangered by difficulties in obtaining under existing conditions necessary foodstuffs in sufficient amount or variety, though the total amount required is quite negligible in relation to the general food supply. The Ministry of Food has now issued the following memorandum for the guidance of Food Control Committees:—

SUPPLIES OF FOODSTUFFS TO PATHOLOGICAL LABORATORIES.

(1) Lord Rhondda's attention has been directed to the difficulties experienced by scientific laboratories in obtaining the small quantities of foodstuffs required by them for the purposes of their scientific work.

(2) These laboratories throughout the country are engaged on work of the greatest importance both for civilian medical practice and for the maintenance of the health of the Navy and Army.

(3) The Food Controller is authorising laboratories duly licensed by the Home Office under Act 39 and 40 Victoria, cap. 77, to obtain supplies of any rationed article on production to the supplier of a certificate signed on behalf of a laboratory to the effect that they are necessary for the purposes described above. In due course special order forms will be issued to such laboratories for this purpose. Committees should also assist such laboratories in obtaining necessary supplies of unrationed foodstuffs in case they experience difficulty in securing them.

(4) A statutory order will shortly be issued by the Ministry of Food exempting from the provisions of the Food Controller's orders the use of grain and other foodstuffs in any such licensed laboratories for the maintenance of animals or for the preparation of laboratory materials.

THE PALMS OF SEYCHELLES AND THE MASCARENES.

SINCE the publication, just forty years ago, of Dr. I. B. Balfour's elaboration of the palms in J. G. Baker's "Flora of Mauritius and Seychelles," there has been considerable botanical activity in the islands of the Indian Ocean. Cordemoy's "Flore de l'Ile de la Réunion" appeared in 1895, and many novelties have been discovered, especially in Mahé, and published; but no addition has been made to the number of genera and species of palms inhabiting this insular region. Nevertheless, a number of interesting facts have come to light, partly through Prof. Stanley Gardiner's published notes, partly through various collectors' notes, and especially through Mr. P. R. Dupont's direct communications. Mr. Dupont, it should be explained, has been for many years curator of the Botanic Station at Mahé, and has thoroughly explored that island and more or less the rest of the Seychelles group, famous for its peculiar palms. The following table shows the composition and distribution of all the palms of the islands of the western Indian Ocean, excluding those of Madagascar:—

Distribution of the palms of Seychelles and the Mascarenes—Genera and Species		Seychelles	Rodriguez	Bourbon	Mauritius
Lodoicea sechellarum	Borasseæ	×			
Latania commersonii	Borasseæ			×	×
,, *loddigesii*	Borasseæ				×
,, *verschaffeltii*	Borasseæ		×		
Hyophorbe indica	Areceæ			×	×
,, *amaricaulis*...	Areceæ				×
,, *verschaffeltii*	Areceæ		×		
Dictyosperma alba	Areceæ		×	×	×
Acanthophoenix rubra	Areceæ			×	×
,, *crinita*	Areceæ			×	×
,, *nobilis*	Areceæ	×			
Nephrosperma vanhoutteana	Areceæ	×			
Roscheria melanochaetes	Areceæ	×			
Verschaffeltia splendida	Areceæ	×			
Stevensonia grandifolia	Areceæ	×			
		6	3	5	7

With possible exceptions in Madagascar, the genera named in this table are restricted in their natural distribution to the islands and groups of islands named, and the Seychelles species and two out of three of the Rodriguez species are endemic, while the five Bourbon species are common to that island and Mauritius. Lodoicea and Latania are diœcious, and belong to the tribe Borasseæ, which is restricted to the African region in a broad sense, and comprises only two other genera, namely, Borassus, the palmyra, and Hyphæne, to which the characteristic branching palms of Africa belong. The rest of the genera in the table are all referred to the large, and generally dispersed, tribe Areceæ. Palms constitute the most striking feature in the vegetation of Seychelles, especially of the principal island, Mahé, where five out of the six species were formerly more or less abundant, and still persist in plenty. Lodoicea, the coco de mer, or double coconut, does not occur in a wild state in Mahé. Travellers have differed in opinion as to in which of the islands it is really indigenous, but trustworthy evidence points to Praslin, Curieuse, and Round Islands. A statement to this effect, by J. Harrison, appears in the *Botanical Magazine* for 1827, in the text to plates 2734–38. There is the further statement that this palm was "growing in thousands close to each other, and the sexes intermingled." Mr. Dupont communicates independent testimony to the existence of local evidence confirming this record. In favourable situations the double coconut attains a height of 100 ft., or occasionally even more.

Little is on record of the general distribution in the islands of the palms of Seychelles; but Dupont furnishes the following particulars of their altitudinal distribution in Mahé:—

Nephrosperma	0–300 m.	Acanthophœnix	0–750 m.
Stevensonia	150–600 ,,	Verschaffeltia	150–750 ,,
Roscheria	600–900 ,,		

He also distinguishes three zones of the predominating palms in Mahé:—

Zone of *Stevensonia grandifolia* ...	150–300 m.
Zone of *Verschaffeltia splendida* ...	300–600 ,,
Zone of *Roscheria melanochaetes* ...	600–900 ,,

These palms constitute a striking feature in the vegetation of Seychelles, especially that of Mahé, where they are associated with other singular endemic types belonging to various families. In stature and foliage they conspicuously overtop most of the other trees, with an average height of the five species of 45 to 65 ft., and extreme heights of *Acanthophoenix nobilis* of 80 to 120 ft., and of the magnificent *Verschaffeltia splendida* of 80 ft. All these palms are, or have been, in cultivation in the United Kingdom, but are rarely seen on account of their large dimensions and heat requirements. But characteristic paintings of all these palms are to be seen in the Seychelles section of the north gallery at Kew, together with many other of the endemic types of the archipelago. It may be worth mentioning here that some confusion has arisen in consequence of the local misuse of the terms male and female of the double coconut. This palm is really diœcious, and the large fruit is usually either two- or three-lobed, the two-lobed being named female and the three-lobed male! The presence of so many endemic palms in a small insular flora is almost unique in the geographical distribution of plants. Lord Howe Island, situated about 300 miles off the coast of New South Wales, presents the nearest approach to a parallel, supporting, as it does, four endemic palms belonging to three different genera, two of which are peculiar to the island. The profusion and elegance of these palms excite the admiration of all who see them. Of the Howe palms, *Kentia belmoreana* is one of the very best for dwelling-room decoration, the writer having kept a plant in excellent condition for twenty-six years.

In connection with the insular distribution of palms, it may be added that New Zealand, the Kermadec Islands, Norfolk Island, Juan Fernandez, and Bermuda each possess one species of palm, which seems to indicate a very ancient vegetation. The coconut is left out of consideration here, because Mr. O. F. Cook seems to have proved beyond doubt that it is of American origin, and that it owes its present distribution almost entirely to human agency.

W. BOTTING HEMSLEY.

NATIONAL LABORATORIES AND INDUSTRIAL DEVELOPMENT.[1]

I.

A NATIONAL INDUSTRIAL RESEARCH LABORATORY.

SOME seventeen years ago I spoke in this room on "The Aims of the National Physical Laboratory." I endeavoured to make clear the reasons for its establishment and to indicate some of the work we hoped to accomplish. I concluded:—"It has been my wish to state in general terms the aim of the laboratory to make the advances of physical science more readily available for the nation, and then to illustrate the way in which it is intended to attain these aims. I trust I may have shown that the National Physical Laboratory is an institution which may deservedly claim the cordial support of all who are interested in real progress."

Much has happened since then; how far we can assert that we have made good is for others to say. At any rate, our growth and the generous aid we have been given by many valued friends are evidence that the support for which I asked has not been wanting. And now that another great change in our position is about to take place and, as I trust, a wider sphere of usefulness is offered to us, it is not unfitting to put on record something of what has been done and to indicate, though it must only be in general terms, plans for the future. "Plans for the future": to-day it is hard to plan; one thought only fills all our minds, and every effort is needed to secure that victory without which future plans are useless.

Let me commence, then, with a few statistics as to growth and work. In 1901 the staff consisted of three scientific assistants working in some small rooms at the Kew Observatory, and the former observatory staff; the income was perhaps 5000*l.* When I lectured last arrangements were in progress for moving the laboratory to Bushy House, Teddington. To-day—or rather from April 1, 1918—we shall be organised in eight different departments, each with its own superintendent and a large staff of scientific assistants and observers. The staff now numbers well above 500 persons, of whom about 180 are women. The expenditure during the current financial year will be considerably above 100,000*l.*

As to finance, it may be of interest to give some figures. The ordinary expenditure—excluding sums spent on capital account—increased from 5479*l.* in 1900 to 38,003*l.* in 1913–14, the total income from January, 1900, to March 31, 1914, being 282,545*l.* The sources of this income were distributed thus:—

Treasury grants to the laboratory ...	£80,500
Treasury grants for aeronautics ...	20,182
Receipts for work done	166,633
Donations	15,230
	£282,545

During the same period the capital expenditure was 156,198*l.*, provided thus:—

From Treasury grants	£75,941
From private donations	55,967
Provided out of income	24,290
	£156,198

The enormous growth in expenditure from 38,000*l.* in 1913–14 to more than 100,000*l.* this year is, of course, due to the war.

During this period the ultimate control of the laboratory has rested in all particulars with the president and council of the Royal Society. They have been responsible for the finances of the institution. Any loss—I am glad to say there has been no loss—would have fallen on the funds of the society; the laboratory, in spite of its name "National," has really been a private concern of the Royal Society, supported most cordially throughout by six of the leading technical societies, and dependent for part of its income on a grant-in-aid from the Treasury, but in the main from the receipts from fees.

From April 1 of this year there is to be a change. The scientific control of the laboratory is still to be exercised by the president and council of the Royal Society; the property of the laboratory is to be vested in the Imperial Trust for the Encouragement of Scientific and Industrial Research—it is now vested in the Royal Society. The income of the laboratory, including receipts from fees, is to be vested in, and is to be under the control of, the Committee of the Privy Council for Scientific and Industrial Research. The laboratory will be managed by an Executive Committee appointed as heretofore, and containing representatives of the great technical societies. In this manner it is hoped to secure financial stability and to retain at the same time the great benefits which have come from the close connection with the Royal Society.

In the future, as in the past, the laboratory will endeavour to discharge two functions; it will be a laboratory of industrial research, and a national testing institution or proving house. To-day we deal with the laboratory of industrial research.

Industrial research—what is it? In recent years much has been written on this subject; the idea of a laboratory devoted to industrial research is by no means novel, and the steps by which ordinarily a scientific discovery develops into a manufacturing process are generally recognised. First and foremost we have the research student impelled by his thirst for knowledge; his desire to penetrate ever deeper into the mysteries of Nature; he does not work with the deliberate intention of making something of service to humanity. Faraday's discoveries of electromagnetic laws, made in this building, were at first as useless as the new-born babe, but had within them that power and potency which have transformed the industry of the world. Röntgen, when he discovered X-rays, or J. J. Thomson, when he tracked down ions and corpuscles in the manner he has often demonstrated here, thought little of their application to surgery and the countless benefits they have brought to suffering humanity.

There must be institutions where research work is carried on for its own sake, where—to apply Sir J. J. Thomson's recent remark—men may make discoveries which may revolutionise and not merely reform the world, where they may train students in those fundamental laws and principles which must be at the root of every successful endeavour to apply science to industry. But there is a wide gap between such homes of science and the works of the manufacturer, and it is to fill this that laboratories of industrial research are needed.

[1] Abridged from two lectures delivered at the Royal Institution on February 26 and March 5 by Sir R. T. Glazebrook, C.B., F.R.S.

xx Laboratories — National

Or, again, looking at our problem from the opposite side, a manufacturer has some question to solve—the utilisation of a waste product which, if it were not waste, would make all the difference between commercial failure and success, the discovery of a material with some special properties—*e.g.* a light alloy of great strength at a high temperature—needed before a new machine can be completed. Such a man must have access to a laboratory fitted and equipped for the purpose with a trained staff having stored experience as the result of previous work or researches on cognate questions. Let me try to indicate some of the methods in which the National Physical Laboratory has endeavoured to fulfil these duties.

Three of the researches referred to in my earlier lecture related to the production of optical glass, the work of the Alloys Research Committee of the Institution of Mechanical Engineers, and the measurement of wind pressure on various structures and surfaces. On all these subjects much has been done. It was some time before the authorities could be persuaded that in neglecting to study the production of optical glass in England they were adding seriously to the risks and dangers of war. Many years ago a strong committee, formed under the chairmanship of the late Sir David Gill, took the matter up and laid before the Government a scheme for a complete study of the problem. Nothing was done until war taught us the need for attending to key industries, but since then real advances have been made, not only at the laboratory, but elsewhere also, and some of the more serious difficulties of the problem have been overcome; it is hoped that in the near future it may be possible to introduce changes of procedure which will greatly simplify the process of manufacture and lead to an increased output. Closely bound up with this is the study of the properties of refractory materials used in furnaces and elsewhere.

But it is sometimes urged: "Why do you need a special laboratory for such work? Can it not be done equally well in one of the university or technical college laboratories? Is it not enough to multiply and organise these, to bring the teachers into direct contact with the manufacturers of their districts, and to encourage the students at an early stage to interest themselves in the scientific problems they will have to solve later in their daily work?" To this my answer would be that it is not enough. The primary work of the professor is to teach and to advance knowledge, while that of the student is to learn how to research and to apply his knowledge. The professor will no doubt keep in close contact with the industry, and take his illustrations from the manufactures of his district, but before his students can usefully engage in industrial research they must have a thorough grasp of the principles underlying all research and of the methods of employing them. Industrial problems are usually too complex for students, and, moreover, the answers are wanted too rapidly to make them subjects of a student's exercise; he will learn by failures; by the inexperienced the right road is found at last only after many tempting tracks leading nowhere have been vainly tried. The manufacturer who comes with a problem which cannot wait will be more sure to find a solution if he applies to men whose daily work it is to attempt such problems, and who have the experience of the past to guide them. Moreover, the plant and equipment required are special; the industrial research laboratory must be fitted on the industrial scale. A rolling-mill is not an adjunct required in every technical school where the principles of metallurgy are taught, and yet without a rolling-mill the study of the light alloys at the National Physical Laboratory could not have been brought to the pitch it has been. The plant and equipment of an industrial research laboratory are provided for the purpose of applying science to industry. The requirements of students and the educational value of the apparatus need not be studied. There must, of course, be many specialised laboratories of industrial research; much more than the National Physical Laboratory is required. I will return to that point later. At present I merely wish to urge that university and technical college laboratories cannot fill all our needs.

And now let me come back to another illustration of the industrial research done at the laboratory closely connected with our original work on wind pressure. The Advisory Committee for Aeronautics was first appointed in 1908 by Mr. Asquith, then Prime Minister. It owes its inception to Lord Haldane, and much of the experimental work which it has initiated, and which has had so marked an effect on the efficiency of British aircraft, has been carried out at the laboratory. At present there are five air channels in practically continuous use, and more are being erected. Some years ago I gave some account here of the work by which Bairstow and Busk, starting from Bryan's theory, had solved the problem of stability. It is impossible to tell at present of the progress made since that time, but when the day comes on which the tale can be told it will form a striking example of the work of a laboratory of industrial research, and the results obtained for purposes of war will bear fruit in the rapid progress of civilian aircraft.

And now, turning to the future, let us consider what is to be the position of the institution as a central laboratory of industrial research.

In a lecture delivered in Birmingham rather more than a year ago, shortly after Lord Crewe had announced the formation of the Department of Scientific and Industrial Research, I referred to such laboratories, and I said:—

"There must be more than one; in many cases an industry can be best served by a laboratory near its principal centre. Large firms, again, may each prefer to have their own trade secrets—this must be so to some extent—and trade jealousies may interfere with full co-operation, but a private laboratory on a really sufficient scale is expensive; too often it becomes little more than what I have called a works laboratory for testing the products of the factory, and, for the smaller firms at least, the only way to secure the full advantage of scientific advance is by co-operation—co-operation in the laboratory, co-operation, with specialisation in production, in the works themselves. . . .

"The body controlling industrial science research must have access to a laboratory in which may be studied the many problems which do not require for their elucidation appliances of the more specialised 'works' character, or opportunities only to be found in particular localities; where a staff is available, able and experienced, ready to attack under the advice of men skilled in industry the technical difficulties met with in applying new discoveries on a manufacturing scale or to develop ideas which promise future success.

"Such a *rôle* the National Physical Laboratory should be prepared to play; such is the future which I trust may be in store for it."

This work has already been begun. The various trades associations have been, or are being, formed for the promotion of research on matters of interest to the members of the trade.

Each such association will probably require its own laboratory, situated, for preference, at the centre of the trade concerned. This will deal with the special problems of the trade, problems which need intimate association with works conditions for their solution and for which the close supervision of men in works is important.

But there are numerous industrial problems which can best be dealt with in a central laboratory; let me give some instances of what I mean. Such, for example, are:—

(1) Investigations into methods of standardisation or of measurement generally.

(2) Investigations into the physical and mechanical properties of materials used in many trades.

(3) Investigations useful to a trade which has no fixed centre, but is widespread over the country.

Or again, (4) a central laboratory will be of service as a means whereby information as to large questions of general interest, investigated either at the central laboratory itself or at the local special laboratories, may be circulated and time saved by placing at the disposal of any special laboratory requiring them the results obtained elsewhere.

Let me take these heads more in detail. I will postpone the consideration of No. 1—standardisation problems—to my next lecture. It is sufficient to remark here that the work already done in this direction has been very great, and to point out that unification of standards used in various trades is highly desirable, and can be secured only by the existence of a central standardising institution working in close co-operation with local institutions.

Turning then to (2)—investigations into the properties of materials used in many trades—the work done on light alloys affords a good example of this, work for which the British Aluminium Co. has recently shown its appreciation by sending a generous donation of 500*l*. to the funds of the laboratory.

Or, again, the following are a few of the problems which it has been recently stated need solution to satisfy the needs of one important industry:—

(1) An investigation into the physical properties of alloy steels.

(2) An investigation into the conditions affecting the flow of liquid fuel through an orifice with reference to: (*a*) proportions of orifice; (*b*) temperature of fuel and air; (*c*) viscosity of fuel.

(3) An investigation of the stress distribution in irregularly shaped members—crankshafts and the like.

(4) An investigation into the wear of bearings.

(5) Investigations into the material suitable for valves, cylinders, and other parts of internal-combustion engines.

(6) The efficiency of radiators for such engines.

(7) An investigation into the cause of the lubricating properties of oils with the view of framing a specification for such oils.

It is obvious that the results of all these investigations, while of special importance to the automobile industry, are of great interest to others. Any of them could go on in a properly equipped laboratory, while it is clear that to carry out many a very complete physical and, in some cases, chemical equipment is needed.

And that leads to another very important point. A special laboratory, if it is to be really of use, must be complete. Many of the investigations just indicated involve thermal and electrical measurements of high accuracy. Elaborate apparatus is involved and a skilled staff to use it. These conditions can be satisfied only if the laboratory possesses a large and varied staff, capable of advising on each special point as it arises, and the necessary outfit of delicate and expensive apparatus. In many instances the difficulty lies in the development of the method of measurement and the calibration and standardisation of the apparatus employed rather than in the actual experiments.

Or to take another instance. There have been some conferences lately with regard to research in refractories, and it was clear that there is much work to be done and ample opportunity for the development of research in special laboratories in close contact with the industry, whether at Sheffield, Middlesbrough, or South Wales, for steel-making and other metallurgical processes, or in the Potteries for the china and earthenware trades. It was clear, too, that there was much work which could best be done at a central institution such as the National Physical Laboratory. Such work, for example, would embrace, among other things, an investigation into many of the physical and other properties of refractories.

As instances of (3)—investigations useful to a trade which has no fixed centre—I may give the following:—

(1) A research has been in progress for some time at the laboratory into the heating of buried cables carrying electric currents. In connection with the Wiring Rules Committee of the Institution of Electrical Engineers much has been done to determine the temperature to which the cables used in house wiring are raised in various circumstances, and to fix the safer currents to be used in each case. Our knowledge of the temperature reached in cables when buried in the ground is very scanty and somewhat conflicting; much depends on the nature of the covering used to protect them, and possibly something on the nature of the soil. Cables laid in ducts, again, differ from those protected merely by the ordinary forms of lead or other covering, and yet the life of the insulation depends in great measure on the temperature reached when the current is flowing, and thus regulates the carrying capacity of the cable. Thanks to the co-operation of supply authorities in many parts of the country, much valuable information has been collected, and, though the research at the laboratory proceeds but slowly, results of great importance are being obtained. Such a research needs large appliances, and currents up to eight or ten thousand amperes will be employed. It needs also the resources of a fully equipped physical laboratory in order to measure accurately the temperature differences due to varying conditions; when complete it will be of value to all supply companies. This is true of many other electrical tests and experiments; the results are of wide application; it is desirable that they should be widely published.

(2) The building trade offers another example of this kind. Brick and stone, wood and iron, have been used for long, and their properties when employed for building construction are generally well known. This is less true of other more modern materials—ferro-concrete, for example. There are rules—based no doubt on the best experience available—for estimating the strength of beams, columns, and floors, but there is much scope for inquiry. Accordingly, at the instance of Sir John Cowan, of the firm of Messrs. Redpath, Brown, and Co., who is bearing the expense, apparatus is being built to test columns up to 15 ft. or 20 ft. in length, and floors of considerable size. War conditions again are interfering, but the work is progressing slowly and must be done. There are other materials besides ferro-concrete urgently calling for examination. Nor is the strength of the materials the only factor to be considered. Materials transmit heat in very varying amounts, and the comfort of a house, to say nothing of the cost of living in it, will depend on whether it is possible easily to keep it warm in winter and cool in summer.

(3) Recently we were asked to compare the heat losses from two enclosures exactly alike in all respects, except that the one was roofed with corrugated iron, the other with some preparation of asbestos. It was found that the latter cooled 20 per cent. faster than the former; the loss of heat depends, in part on the conductivity

of the material, in part on the emissivity of its surface, and the superior emissivity of the asbestos sheet more than made up for its inferior conductivity. In this connection it is clear there is much to be done, and for such work a central laboratory, with proper equipment, is the most suitable place. Arrangements are in progress by which it is hoped many of these questions will be thoroughly investigated.

Little need be said as to the fourth section of the work suggested for a National Industrial Research Laboratory.

The importance of the collection and dissemination of information on matters connecting industry and science is clear. At a central laboratory much of the information will be to hand; the accumulated experience of the staff, their knowledge of the work done in the sectional laboratories, their appreciation of the bearing on industry of inquiries in the region of pure science, are all valuable assets, and a proper organisation only is needed—by means of a bulletin or in some such way—to circulate their information where it is most wanted.

There is ample room for a central laboratory without trenching in the least on the spheres of the local sectional institutions. If the Department of Scientific and Industrial Research is to carry out effectively the work it contemplates, such a laboratory is essential, and my hope is that the National Physical Laboratory may develop into such an institution in close connection, through the Department, with local laboratories throughout the country.

One word in conclusion. The workman is worthy of his hire. In the past the scale of pay has certainly not been extravagant, and there is no call for extravagance in the future, but the remuneration offered must be sufficient and the conditions of work fair. Much has been written lately as to the inadequate remuneration of scientific workers, whether teachers or the expert staff of laboratories and factories, and it is realised, I trust, that the time has come to change this for men and for women alike. To-day there is a great demand for scientific workers, and while, as in other walks of life, commercial life must offer greater prizes than Government service, it is essential, if the necessary work is to be done and the workers are to be retained, that the emoluments of technical posts under Government, and the conditions attached, should be as good as those of the regular administrative staff of the Civil Service. This must apply not merely to the heads of the various institutions, but also to the rank and file on whose work success depends. This point I need not labour here, but in pressing it I feel confident I shall have the support of all who appreciate the importance of science to the nation.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—During the present term two research fellowships, in medicine and science respectively, have been founded. The Faulds fellowship in medicine is of the annual value of 200*l.*, and is tenable for three years. It will be awarded to a recent graduate who has shown capacity for original investigation. He will be required to devote himself to research in some branch of medical science approved by the Senatus, and will not engage in private practice. He may be authorised or required to spend a year of his tenure away from Glasgow. The Ferguson fellowship in applied chemistry is of about the same value. It will be awarded to a bachelor of science who has taken chemistry as a subject for his honours degree. He may carry on his fellowship work either in the University itself or in the affiliated Royal Technical College.

LEEDS.—The thirteenth annual report, which has just been issued, for the year 1916–17, contains a record of great activity in most of the departments of the University. Three aspects of the work have exceptional significance. The first of these is in the sphere of applied science, particularly in connection with the textile, dyeing, leather, and fuel industries. As a result of conferences organised and held in the University, a committee has been formed by members of the woollen and worsted industries in the West Riding for the purpose of developing research. In the colour chemistry department important research work has been carried out on behalf of British Dyes, Ltd.; a laboratory has also been placed at the disposal of Messrs. L. B. Holliday and Co., for research work, in charge of their head chemist; conferences have been held with the Leather Trades' Federation for developing instruction and research in that industry, whilst in the fuel department investigations are being made into the comparative efficiency of different grades of gas under the direction of a Joint Committee of the University and the Institution of Gas Engineers. As regards the second aspect of the work, members of the staff of the agricultural department have undertaken official responsibilities in connection with the food supply of Yorkshire. As to the third, the new departments of Russian and Italian language and literature, which owe their inception to the generosity of Sir James Roberts, Lord and Lady Cowdray, and Mr. Walter Morrison, have been organised. The number of students shows a slight decrease since the previous session, and although some of the advanced classes and technical departments have been depleted of men students owing to the war, the number of first-year students is maintained. The casualty lists include 462 names, of which 176 have been killed, died on active service, or reported missing. Military distinctions have been conferred upon ninety-nine members of the University.

LONDON.—The Senate has resolved to institute degrees in commerce for both internal and external students, and in this connection to accept with thanks an offer from Sir Edward Stern of 2000*l.* to found a scholarship for the promotion of the study of that subject.

The following doctorates have been conferred:—*D.Sc. in Biochemistry:* Mr. J. C. Drummond, an internal student, of the East London College, for a thesis entitled "A Comparative Study of Tumour and Normal Tissue Growth." *D.Sc. in Experimental Psychology:* Miss I. B. Saxby, an internal student of University College, for a thesis entitled "Some Conditions affecting the Growth and Permanence of Desires."

Dr. H. Wildon Carr has been appointed by the Senate professor of philosophy at King's College.

SOME years ago, Lord Haldane, the protagonist of the university movement, pictured the United Kingdom as partitioned into provinces, in each of which the various grades of primary and secondary schools, technical schools, and colleges are to be held together and co-ordinated by a university. His scheme has been derided by some as an "educational heptarchy," but, provided the several kingdoms are united states, admitting the overlordship of the Minister of Education, their limited autonomy will be the surest guarantee of efficiency in administration. The jealousies of technical institutes and municipal colleges, one of another, and all of the university college, if there be one, would subside in patriotism to the university—*i.e.* to the province. The North, the Midlands, and the West of England are already portioned out; the needs of the South have yet to be provided for. Owing to the absence of large centres of population, the problem of how this is to be done is exceptional. Lord Haldane imagined a university of the South, at Southampton, the natural focus, and one farther west. A movement is now on foot for securing the establishment of the latter, to serve the needs of Cornwall, Devon, and parts of Dorsetshire and Somersetshire. In many ways this corner of England has its own peculiar interests. It comprises the great port of Plymouth, mining centres, fisheries, and large areas devoted to agriculture and orchards. The Royal Albert Memorial College at Exeter is doing excellent work of a university standard, the technical institutes of Plymouth and Devonport are fitted for research in shipbuilding, the Marine Biological Association's laboratory for problems connected with fisheries, the old-established School of Mines at Camborne for investigation of the metalliferous rocks and industries, the Seale-Hayne College in agriculture; but possibly the strongest of all reasons for multiplying universities is the urgent need for teachers qualified by intellect and training to make a success of the new Education Act to which we are looking forward, with its enormous extension of secondary and technological education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 14.—Sir J. J. Thomson, president, in the chair.—A. W. **Conway**: An expansion of the point-potential. The general solution of the equation $C^2\nabla^2\psi=\ddot{\psi}$, which is infinite at the origin, is of the form $f(Ct\pm r)/r$. This is infinite to the first degree. Referred to a different origin, a known expansion gives the series $\sum Y_n U_n$, where Y_n is a spherical harmonic and U_n is a certain function of t and of the distance to the new origin. This is a generalisation of the Legendre expansion of the inverse distance. In the paper the potential scale or vector of a moving point-charge is expanded in a similar series of spherical harmonics, the only restriction on the motions of the point-charge and of the origin being that the speed of the former must be less than that of light.—E. G. **Bilham**: The lunar and solar diurnal variations of water-level in a well at Kew Observatory, Richmond. The mean solar and lunar diurnal inequalities have been computed from two-hourly measurements of the Kew Observatory water-level records over a period of two years. Results are given for each month, for the year, and for groups of months, representing high, intermediate, and low levels. Both the lunar and solar diurnal ranges are found to be largely dependent on the level of the water, high levels being associated with large diurnal range. In a paper recently communicated to the society it was shown that a similar relation exists between the mean level and the sensitiveness to the effects of barometric pressure. There are well-marked lunar and solar semi-diurnal oscillations throughout the year, the amplitude varying with the level in a manner similar to the diurnal range. In both cases the phase also varies with the level, the effect being most pronounced in the lunar results. The times of occurrence of the maxima become later as the water-level falls. In comparison with the total oscillations in the neighbouring River Thames, the well shows larger solar diurnal movements than were to be anticipated from the magnitude of the lunar oscillations. If, however, allowance is made for the effects of the solar diurnal variation of barometric pressure, the residual effects attributed to the solar tides are of the expected order of magnitude.

Faraday Society, February 14.—Prof. C. A. Edwards in the chair.—H. **Etchells**: Applications of electric furnace methods to industrial processes. The remarkable growth of electric furnace industries during the war was due not only to the greater output demanded, but also to the fact that the electric furnace enabled us to use raw materials formerly considered inferior for the quality of product desired. A plea was made for the greater development of the resistance furnace, which, from the electrical point of view, was ideal. In the author's opinion, the electric furnace is not fulfilling its highest function in the foundry when used for simply melting steel scrap, to turn out an unrefined product on an acid lining. Typical wave-form diagrams of the chief types of furnace were shown, and considerable emphasis was laid on the steadiness of load produced by the buffering effect of bottom electrode furnaces. The unsatisfactory performance of refractory lining materials at present in use was commented upon, and the author stated it as his belief that satisfactory linings would not be available until electrically fused refractories were put on the market.—J. **Bibby**: Electric steel refining furnaces. A system is described by which a four-phase furnace with a bottom electrode, such as is called for as furnaces get larger, can be run on the ordinary three-phase supply system.—A. P. M. **Fleming** and F. E. **Hill**: Electric furnace control. An important feature of electric furnaces is that by suitable control the temperature can be accurately and quickly regulated. The paper sets forth the general principles on which such control is based.

Royal Microscopical Society, February 20.—Mr. J. E. Barnard, president, in the chair.—Col. H. E. **Rawson**: Illustrations of photo-synthetic action induced in living cells. The author exhibited *Tropaeolum majus*, in which changes of colour and structure were produced by a system of selective screening from an English sun at selected intervals of daylight. Low sun of the early morning fostered the yellow colouring matter, and the highest sun of midday the violets, blues, and purples, while middle sun stimulated the reds. The colour of the foliage also changed, as well as the lobing of the leaves. The scent of the flowers varied with the colour. Changes of structure also appeared, which became identified with low, middle, and high sun, and could be repeated at will. Flowers grew with six, seven, and eight petals, instead of the normal five, and their shapes were altered. Spurs were formed to extend a petal instead of a sepal, and the number was increased to four. Colour changes depended upon the form, size, and number of the epidermal papillæ, the turgidity of the living cells, and the concentration of their contents. In the leaf-division of *T. tuberosum* a precipitation of the cell contents was first observed, by which the cord conveying the nutrition to the margin became blocked.—F. I. G. **Rawlins**: The technique of the vertical illuminator. It was found unnecessary to use objectives in special short mounts with the vertical illuminator up to and including one-sixth powers, provided the objectives were corrected for work on uncovered objects. Levelling of the specimen was best done by pressing the specimen face downwards upon a piece of plate glass with a small quantity of plasticine on a common 3-in. by 1-in. slip. The latter was rested on the two edges of an accurately cut ring, and held there until the preparation had become embedded in the plasticine. For preserving metal specimens a thin coating of a concentrated solution of guncotton in amyl acetate was recommended—as a preventive against rust. This was dropped on to the surface, and the section tilted until the drop found its own level, and set quite evenly to a thin layer, sufficiently transparent for use with a one-sixth objective. The varnish must not be applied with a brush, or ridges resulted which gave brilliant interference colours when viewed under the microscope.—J. **Ritchie**: Acetone as a solvent for mounting media. The author claimed for his medium that it cleared specimens from various grades of alcohol direct without the use of essential oils. It did not cause a precipitate or any uneven shrinkage of the tissues of specimens where these had been properly fixed. It did not affect stains such as borax or lithium carmine, Van Giesen's, hæmatoxylin, Jenner, Leishman, or Giemsa stains.

Röntgen Society, March 5.—Capt. G. W. C. Kaye, president, in the chair. — C. R. C. **Lyster** and Dr. S. **Russ**: A biological basis for protection against X-rays. In this contribution the study of the protection of X-ray operators was approached from a somewhat different point of view from that usually adopted. In previous investigations the materials have generally been tested to ascertain what fraction of the incident rays are transmitted, while in this case an attempt was made to measure the total quantity of radiation received by the operator during, say, a day's work under normal conditions. For this purpose the operator carries a photographic plate upon his person, and at the end of the period under consideration the plate is developed. The density of the resulting image is compared with that of another plate termed the "biological basis plate," which has been exposed under standard conditions of radiation. A preliminary investigation enables the harmful effects of the standard source of radiation to be determined, and thus gives a meaning to the indication of the biological basis plate. Radium forms a useful source of radiation for practical purposes after the initial tests have been made, and it overcomes difficulties in the employment of an X-ray tube as a constant source. The effect of hard and soft radiation (12-in. spark to 2 in.) on the photographic plate was fully investigated, and it was concluded that for the same ionising effect the hard and soft rays produced about the same photographic effect; the effect, however, varies with different makes of plates, and in consequence all comparisons must in practice be made with the same variety.—H. C. **Head**: A mobile X-ray unit. A detailed description illustrated by numerous photographs was given of a motor X-ray unit recently designed and constructed for use in Mesopotamia, etc. The Austin chassis was chosen on account of its low load line, and the body was divided into two portions, one to serve as dark-room, while the other contained the X-ray equipment. In operation a tent is erected at one side of the car, with the result that it is unnecessary to remove the coil or switchboard for use. Electric current is supplied from a dynamo run off the motor engine and from a small battery of accumulators, and is sufficient to render possible the production of short-exposure radiographs.

Geological Society, March 6.—Mr. G. W. Lamplugh, president, in the chair.—J. F. N. **Green**: The igneous rocks of the Lake District. The author first directed attention to some of the manuscript 6-in. maps of the Lake District prepared nearly fifty years ago by the Geological Survey, and pointed out that, although undoubtedly most accurate, they differed greatly in the volcanic area from his own. He suggested that the reason was that there was a fundamental difference in the classification of tuffs and lavas. A large proportion of the Lake District rocks were brecciated, and had been supposed to be altered tuffs. With the unbrecciated rocks into which they passed they had been mapped as ashes. Recently, manuscripts had been found in the possession of the Geological Survey proving that Aveline, whose maps were extraordinarily accurate and detailed, had anticipated by thirty years the author's separation from the volcanic rocks of the basal beds of the Coniston Limestone Series. When re-mapped on this basis, the Borrowdale Series appeared as a simple and regular sequence, strongly folded, and cropping out in long bands.

Physical Society, March 8.—Prof. C. H. Lees, president, in the chair.—E. A. **Owen**: The asymmetrical distribution of corpuscular radiation produced by X-rays. (1) The ratio of emergent to incident corpuscular radiation in the case of the two salts, potassium bromide and silver nitrate, has been investigated, when the exciting X-radiations were the characteristic radiations of copper, bromine, silver, and tin. (2) The ratio has the same value whether the salt is in the wet or in the dry state. (3) The value of the ratio was found to be approximately the same for each two of the salts, and is equal to 1·17. This is approximately the same figure as that found by other observers in the case of the metals, gold and silver.—Prof. C. H. **Lees**: "Air standard" internal-combustion engine cycles and their efficiencies. It is well known that the efficiency of an air standard internal-combustion engine working through a cycle bounded by two adiabatics, and either two isothermals, two constant volume lines, or two constant pressure lines, is given by $1-(1/r)^{\gamma-1}$, where r is the compression ratio and γ is the ratio of the two specific heats of air. In the present paper it is shown that the efficiency is given by the same expression if the cycle is composed of two adiabatics and two curves $pv^{\alpha}=A$, $pv^{\alpha}=a$, where α has any positive or negative value, and A and a are constants. Since α may be chosen so that any explosion curve may be followed as closely as desired by short lengths of α curves, a cycle can be drawn with the above efficiency and any prescribed explosion curve. The ratio of the efficiency of a cycle with prescribed explosion and exhaust curves to that of the cycle so drawn is shown to be the ratio of the two areas on the indicator diagram. The thermal efficiency of a cycle with prescribed explosion and exhaust curves is therefore readily found.

Optical Society, March 14.—Mr. S. D. Chalmers, vice-president, in the chair.—T. **Smith**: The detection of ghosts in prisms. Ghosts in prisms are caused by reflections other than those which form the principal image. They are apt to be more serious than those in lenses, inasmuch as a single additional reflection may cause a ghost in a prism, while at least two are necessary in a lens. Moreover, in lenses the ghost-producing reflections occur at unsilvered surfaces at small angles of incidence, but in prisms the surface may be silvered or the ghost may be produced by total internal reflection. Every possible way in which a ghost can arise in a prism may be determined by a suitable development of the prism, or of a section of the prism, on a plane. If a diagram is drawn showing all possible positions of a prism derived from a given initial position, the entire path of any ray within the prism is represented by a straight line, and the deviation of the ray is of the constant type if the ray has crossed an even number of lines representing reflecting surfaces, and of the variable type if the number is odd.

Royal Meteorological Society, March 20.—Sir Napier Shaw, president, in the chair.—Dr. J. S. **Owens**: The measurement of atmospheric pollution. The need for exact measurements of suspended impurities in the air was explained. The era when a harmless gas like carbon dioxide was taken as a measure of impurity was rapidly giving way to a recognition that the really important thing to measure was suspended dust and dirt. It was shown that the latter connoted great waste of human life, and also of fuel, light, and other important modern needs. As showing the kind of air city dwellers were sometimes obliged to breathe, Dr. Owens gave figures for deposits from the air for one year, April to March, at the following places:—Oldham, 1915–16, 950 tons per square mile; Manchester, 1915–16, 635 tons; London, 1915–16, 453 tons; Sheffield, 1914–15, 395 tons; Malvern Wells, 1915–16, 56 tons. He stated that there was evidence of a general reduction of atmospheric impurity during the winter of 1916–17 as compared with the preceding one, probably due to reduced consumption of raw coal. Mention was made of certain problems awaiting solution, such as the relation of impurity to wind and distance from source, also to incidence of disease. Does smoke in the air reduce or increase the number of bacteria? What is the vertical distribution of suspended matter and the selective power of rain or snow in bringing down impurity?

MANCHESTER.

Literary and Philosophical Society, March 5.—Mr. W. Thomson, president, in the chair.—E. L. **Rhead**: The corrodibility of cast-iron. The paper dealt with the effects of the impurities in producing during the solidification of the metal various solutions, in which the impurities were concentrated. This was especially the case with the phosphide. The concentration depended on the lower melting point of the solution thus formed. Reference was made to the production of graphite. Specific instances in which the failure of cast-iron vessels was due to the increase in volume resulting from the corrosion, and the influence of the structure due to the segregation and coarse graphite, were dealt with and specimens shown. Attention was also directed to the high silicon iron now used for chemical plant, and segregation was shown to take place to a marked extent.

PARIS.

Academy of Sciences, March 4.—M. Paul Painlevé in the chair.—The president announced the death of Prof. Blaserna, correspondant of the Academy for the section of physics.—A. de **Gramont**: The ultimate rays of great sensibility of columbium (niobium) and zirconium.—C. **Guichard**: A particular class of curves several times isotropic.—W. **Kilian**: The fauna of the Hauterivian stratum in the south-east of France.—Mr. Amundsen was elected correspondant of the Academy for the section of geography and navigation in succession to the late Dr. Albrecht.—J. F. **Ritt**: The repetition of rational functions.—M. **Valiron**: Demonstration of the existence, for integral functions, of paths of infinite determination.—M. **Doyère**: Remarks on the resistance to motion of geometrically similar vessels.—J. **Rey**: Entropy diagram of petrol.—Sir R. **Hadfield**, C. **Chéneveau**, and Ch. **Géneau**: The magnetic properties of manganese and of some special manganese steels. Manganese, when freed from occluded gases, is paramagnetic. Data are given for manganese-carbon steels, and steels containing, in addition to these two elements, nickel, tungsten, chromium, and silicon.—A. **Valeur** and E. **Luce**: The reduction of the CH_2I group joined to nitrogen.—G. **Fouque**: Di*cyclo*hexylamine, its solid hydrate and alcoholate.—P. **Russo**: Geology of the plain of El Hadra, western Morocco.—J. **Repelin**: New species of the genus Entelodon.

March 11.—M. Paul Painlevé in the chair.—Ch. **Lallemand** and J. **Renaud**: The substitution of civil time for astronomical time in nautical almanacs. At sea sailors use civil time, but for their observations make use of tables where astronomical time is employed, and it is desirable that this possible source of confusion should be removed. Both the French and British Admiralties considered the proposal favourably, and the volume of the "Ephémérides nautiques" now in preparation (1920) will have civil time substituted for astronomical time.—W. **Kilian**: New remarks on the fauna of the Hauterivian, Barremian, Aptian, and Albian strata in the south-east of France.—M. Tilho was elected a correspondant for the section of geography and navigation in succession to the late General Gallieni.—Tr. **Lalesco**: A point of the theory of nuclei capable of symmetry.—M. **Brillouin**: Biaxial media.—F. **Cloup**: Tempering and work hardening in carbon steels.—M. **Travers**: The colorimetric estimation of tungsten. The method is based on the reduction of tungstic acid by titanous chloride to a blue oxide, which, under certain conditions, remains in colloidal suspension. The reaction cannot be applied if vanadium, phosphorus, or molybdenum is present.—J. H. **Sinclair**: The age of the sandstones of French Guinea.—L. **Gentil**: The age of the strait connecting the Mediterranean and the Atlantic through Morocco in the Miocene epoch.—A. **Guébhard**: Remarks on the "écorce résistante."—G. **Reboul**: A method of predicting barometric variations.—J. **Amar**: The law of cicatrisation of wounds. The number of factors is so large, and the phenomenon so complex, that it is doubtful whether any attempts at mathematical expression can be successful.—B. **Geslin** and J. **Wolff**: New observations on the degradation of inulin and "inulides" in the root of the chicory.

BOOKS RECEIVED.

The Theory of Electricity. By G. H. Livens. Pp. vi+717. (Cambridge: At the University Press.) 30*s*. net.

Electricity Meters: Their Construction and Management. By C. H. W. Gerhardi. Second edition. Pp. xx+504. (London: Benn Bros., Ltd.) 15*s*. net.

Stanford's War Maps. No. 27: Europe and Northern Asia. (London: E. Stanford, Ltd.)

Some Problems of Modern Industry. By W. L. Hichens. Pp. 61. (London: Nisbet and Co., Ltd.) 6*d*. net.

Proceedings of the Aristotelian Society. N.S. Vol. xvii. (London: Williams and Norgate.) 12*s*. 6*d*. net.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN AND CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.