THURSDAY, JUNE 8, 1876

ON THE ORGANISATION OF THE PROFESSION OF CHEMISTRY

IT has probably happened to many young men who have fallen within the attraction of chemistry at the Universities or elsewhere to receive from their elders the prudent warning—chemistry is not a profession. Nor has this warning, or the fact conveyed in it, been without influence upon the number of chemical students. The complaint is often heard that original research in chemistry is at a low ebb in England at the present time. Comparatively few have both inclination and income enough to pursue chemistry as a scientific study without making it also in some way a means of livelihood. Contributions to biology come chiefly from members of the medical profession, contributions to mechanical science from engineers, contributions to chemistry from those who make a living by teaching or practising chemistry; and in proportion as a knowledge of this science opens a career, and is recognised as the basis of a profession, will a twofold gain accrue. The character and attainments and number of those engaged in educational or practical chemistry will be raised, and as a consequence the quality and number of the contributions made to scientific chemistry will rise also.

At the present time there is a considerable and an increasing demand for young men having a knowledge of chemistry, as teachers, as laboratory assistants, as analysts or experimentalists on chemical and other works. But, partly because the importance of chemistry has not long been recognised, partly perhaps for want of organisation, to be a chemist does not constitute a definite vocation, which a young man of the professional classes may choose with the same confidence as to be a doctor or a lawyer.

A vigorous attempt is now being made to organise an Association, or Guild, or Institute of Chemists, membership of which should confer a professional status and imply fitness for duties requiring chemical knowledge and experience.

Under the Act of Parliament for the prevention of adulteration of food and drink, and of drugs, passed in 1872, a number of persons have been appointed in all parts of the country as analysts. It must frequently have been a difficult task to find "persons possessing competent medical, chemical, and microscopical knowledge" to fill these posts. Where those with whom the appointment lay took pains to assure themselves of the fitness of their nominee, probably as good appointments were made as if professional chemists already formed a well-defined class. But a definition and separation of qualified chemists, such as membership of the proposed Institute might effect, would serve as a guide to those charged with the duty of making such appointments, and would be a barrier against the nomination of wholly unfit persons.

On the other hand, it is worth remarking that the existence of a technical qualification is sometimes unfavourable to the selection of the best out of several candidates who possess it. The friends of an inferior candidate are apt to believe that all who possess the qualification are capable of doing the required work properly, and that the particular choice may fairly be determined by other considerations.

Employment of an unofficial kind, it may be thought, is not likely to be given to incompetent persons, since the employer has an immediate personal interest in being well served. But here also the existence of a distinct qualification, such as a licence to practice in chemistry granted after examination by an authorised body, would aid the choice of the employer, and would increase the chance of employment to those properly qualified.

The duties which fall to the lot of men engaged in general chemical practice are perhaps less grave than those which are discharged by medical practitioners; and the persons who consult or employ chemists are, as a class, more capable of selecting a qualified practitioner than the general public. The need of a professional stamp is therefore much less in chemistry than in medicine. With this limitation, the same reasons which have led to the establishment of a legal distinction between the doctor holding a diploma and the quack doctor, would seem to favour the establishment of a similar distinction between the professional chemist and the amateur.

At a meeting held recently in the apartments of the Chemical Society at Burlington House, which was attended by a large number of the leading members of the Chemical Society, it was unanimously resolved that it is desirable that an organisation of professional chemists should be effected, and that for this purpose a body should be formed, having authority to issue certificates of competence. The questions which next arose, as to the nature of the organisation, and as to the steps by which it might obtain legal recognition, led to the consideration of the advantages or disadvantages of connecting the proposed organisation with the Chemical Society.

This Society includes among its Fellows the most prominent, and by far the greater number, of those who are following chemistry as a profession. It has also the advantage of long standing, having been founded in 1841, of an established position, and, last but not least, of incorporation by Royal Charter. Probably the existence of the Chemical Society might hinder the granting of a Charter of Incorporation to the proposed Institute. It is therefore clear that if the Chemical Society could undertake to issue licences to practise in chemistry, or certificates of competency, it occupies in some respects an advantageous position for doing so.

Nor does it appear that such an undertaking would exceed the wide discretion which is granted to the Society by its charter. The objects of the Society were defined by its founders to be "the promotion of chemistry and of those branches of science immediately connected with it, by the reading, discussion, and subsequent publication, of original communications." Here we breathe the upper air of pure science, of knowledge for its own sake. But the objects which the Charter recites are:—"The general advancement of chemical science, as intimately connected with the prosperity of the manufactures of the United Kingdom, many of which mainly depend on the application of chemical principles and discoveries for their beneficial development, and for a more extended and economical application of the industrial resources and sanatory condition of the community." The Charter proceeds to constitute the Fellows of the Society one body politic and corporate, and empowers a General Meeting of the Fellows, *inter alia*, to "enter into any resolution and make any regulation respecting any of the affairs and concerns of the said body politic and corporate that shall be thought necessary and proper."

It has been urged that it would be difficult to make a distinction between ordinary Fellows of the Chemical Society and qualified practitioners admitted and registered through the agency of that Society. This difficulty lies chiefly in the choice of an appropriate name. "Licensed Fellow" has an awkward sound, and "Licentiate" is, by analogy, a lower title than "Fellow." There seems to be nothing in the Charter to forbid such a distinction, which would be for external use only, and would not differentiate the holders of licenses in respect of eligibility to Council, or any other privilege, from ordinary Fellows of the Society. Indeed it does not appear that it would be *ultra vires* for the Chemical Society to grant certificates of competency as Chemists to those who are not Fellows of the Society.

Leaving, however, the question of what is legally practicable, we must confess that in spite of our sympathy with the proposed organisation, we doubt the expediency of effecting it through the instrumentality of a society which has hitherto occupied itself solely with the extension and diffusion of knowledge.

The first granting of licences would be presumably to those who have already an established position as practical chemists. The task of selection would be invidious, and would involve a responsibility from which the Chemical Society would naturally shrink. Subsequently, we presume, licences would be granted upon an examination, and it would seem to be a wide departure from the functions which the Chemical Society has hitherto performed, for it to constitute itself an examining body, or to undertake the appointment of a Board of Examiners.

If no other plan were practicable we might hesitate to express our dislike to the proposal that the Chemical Society should enter upon this new career. But examining bodies, and bodies that issue certificates to those who pass their examinations, are ready to hand. It should not be difficult to obtain the co-operation of the Universities in this matter; and a Board of Examiners appointed by the Universities of Oxford, Cambridge, and London, without necessarily any restriction that those appointed should have received a University degree, would probably command and deserve confidence better than a Board nominated by a newly-formed Institute, or even by the Chemical Society.

At least such a scheme might serve at the outset; and when through its operation chemistry had begun to be consolidated and recognised as a profession, the proposed Institute of Professional Chemists might be formed, and undertake for the future the selection of its own members.

THE ENDOWMENT OF RESEARCH

Essays on the Endowment of Research. By Various Writers. (London: King and Co., 1876.)

IT is to the untiring exertions of Dr. Appleton in the cause which is here pleaded, that we are indebted for this valuable combination of essays. The eminence and competency of the writers give it an overwhelming force of authority and reason. The list of contributors is as follows:—The Rector of Lincoln College, Oxford, Mr. James Cotton, late Fellow of Queen's College, Dr. Appleton, Fellow of St. John's College, Mr. Sayce, Fellow of Queen's College, Mr. Henry Sorby, F.R.S., President of the Microscopical Society, Mr. Cheyne, Fellow of Balliol, one of the company for the revision of the Bible, Mr. Thiselton Dyer, late of Christ Church, Assistant-Director of the Royal Gardens, Kew, Mr. Nettleship, Fellow of Corpus Christi College. These eight writers treat of various aspects of the Endowment of Research—such as the need for it, the applicability of college revenues to the purpose, the incompatibility of teaching and research—in ten essays. No doubt more remains to be written on the subject, more will have to be said, and what is said will need to be said a great many times before the public—even its more intelligent section—comprehend the importance of research or the necessity for its endowment. The present volume may be taken as a fair statement of some of the most important arguments in the matter, and should furnish the starting point for a determined and unwearying effort *permanently* to affect public opinion in the right direction. Widely as we should wish to see this book read amongst the laymen of science, the Philistines and those who prophesy to them, politicians and professional reformers, it will certainly be found quite as valuable as by any of these, by men of science. Men of science will find in the present volume data and suggestions which should aid them greatly, at this critical moment, to determine what they will urge upon the government, as the fit relationship between the State and scientific research.

The substance of these essays may be summarised in the form of a series of questions and answers, the latter being frequently reiterated, as it were, by one after another of the essayists.

1. What is this "research" which you propose to endow? It is more fully described as "scientific research." It is the "disinterested pursuit of knowledge" (Pattison), the following up of "science for science sake" (Pattison), and "by the introduction of the utilitarian motive its strictly scientific character is destroyed" (Appleton). It is co-extensive with the whole range of human knowledge, and comprises such groups as "historical" science, "mental" science, "linguistic" science, (Sayce, Cheyne, Appleton), equally with molar and molecular physics, astronomy, geology and biology. It has its end and aim in itself, viz., the attainment of truth. We assume that it is necessary for man, necessary for his progress, for his happiness if you please, but inevitable whether for weal or for woe, predestined by the noblest and most commanding passion of his nature—*to know the truth*. To the ignorant or unthinking some truths appear to justify this craving on account of the material gratification which their knowledge enables mankind to obtain, whilst the acquirement of other truths appears to these persons superfluous. A consideration of any one department of knowledge is, however, sufficient to show us "that nature is one, and that no man dare put his finger on any of its secrets and say this is a mere field for ingenious curiosity" (Dyer). The narrower type of utilitarian, with his petty measure of what is and what is not for the happiness of mankind,

has no scope for discussion in this matter; he must bow before the inexorable domination of an impulse planted in the very elements of our being. The importance to the community of mature study and scientific research has been recognised in the past both in our own and other countries; at the present day it is very much less appreciated in England than elsewhere. The immense fields which lie open to us, with their harvest of knowledge waiting for reapers, are to some extent indicated in the essays by Mr. Dyer, "On the Needs of Biology," Mr. Cheyne, "On the Study of the Bible," of Mr. Sayce, "On the Needs of the Historical Sciences." Over and over again it will be necessary to explain, as these essays do, how great and of what kind are the stores of knowledge which students see within their grasp, and how difficult and all-absorbing is the task of reaching them. It is the duty of men of science incessantly to exert themselves in inducing the great public, even though this generation and its successor prove stiff-necked and hardened in heart, to believe their report of the promised land.

2. Granting that "scientific research" is a good thing and to be wished for as the highest development of the life of the community, why should it be endowed? Why should persons be supported by public funds to carry on research? Why not leave every man to follow research for his own delectation, and trust to the attractions which it possesses for its increased cultivation?

Because it cannot be successfully carried on, in the present conditions of society, by men who have to earn their bread in any of the usual avocations. Mr. Sorby, in his "Personal Experience" (Essay No. VI.), with convincing simplicity and candour, tells us how all absorbing is research, how much may be lost by withdrawing the man who is engaged in an investigation, even intermittently, from his pursuit, how necessary is ample time, freedom from anxiety, health of body, "readiness of the mind to take advantage of every circumstance that may occur to press forward the inquiry in the line of truth." Fortunately Mr. Sorby is endowed with a patrimony, and he says, "I never could have done what I have been able to do if it had been necessary for me to attend to any business or profession as a means of support." Men who are capable of or disposed to engage in scientific research are not always thus situated. Unless we are prepared to lose the services which these persons might render—some of them perhaps the very ablest and most productive minds—and to rest our hopes on the chance coincidence of fortune and ability, as for instance in the cases of Lyell, Darwin, and Grote, we must accept a scheme for providing such persons with pecuniary support out of public funds. To a certain extent we already do this, but very inadequately. The posts in the British Museum, the Greenwich Observatory, and a few others here and there, are of the nature of endowments for research. But these are so few in number and so meanly paid that they cannot be regarded as exercising any important influence in attracting men of ability into the career of research. Among Continental nations but especially in the German empire, in proportion to the wealth of the countries in question, very much larger provision is made for the encouragement of research—and with the most perfect success, as tested by results. In Germany, owing to the special view which is taken in that country of a "University," there are 1,250 posts designed for the promotion of research with stipends varying in value from 80*l*. to 600*l*. a year. There is one such post to every 33,000 of the entire population, or to every 1,600 males between the ages of twenty and thirty years. The total cost of the support of these persons and the laboratories, libraries, &c., with which they are connected (leaving out of consideration such special institutions as are the exact counterparts of our British Museum, observatory, &c.) cannot be less than 600,000*l*. annually. An equivalent provision in England would necessitate the creation of 1,000 posts at an annual expense of 800,000*l*., making allowance for the fact that money has at least double the value in Germany which it possesses in England, in relation to the purpose under consideration. It is curious to observe that this sum (800,000*l*.) corresponds very closely with the estimated value of the incomes of the ancient University institutions of Oxford and Cambridge—where, however, the money is not applied to the endowment of research.

3. The reference to Universities and to Oxford and Cambridge brings to mind a suggestion which at first sight appears admirable. "Granted that research must be endowed, there is yet great difficulty in persuading practical men to pay for it in the pure and unalloyed form. It can only be a pleasure to the investigator to communicate to pupils the results which he obtains in his researches, clearly it is his natural function to teach. In fact you have already got what you want in the Fellowships of Oxford and Cambridge, many of the holders of which reside in those Universities and teach—and doubtless spend a large portion of their time in research. Abolish the non-resident Fellowships, remove the immoral condition of celibacy, give two or three Fellowships to the men who stay longest in the place, require them all to teach at a cheap rate (this will be well received by the public) and you may be sure that they will devote all needful energy to original research—is not your demand for the endowment of research liberally met in this way?" Certainly not.

The deadly error embodied in the above bids fair at the present moment to destroy the good hope which we at one time possessed of seeing at Oxford at any rate (it is from Cambridge that the mischief has come) a portion of collegiate endowments applied to the support of research. The chief care of the Oxford men who write in Dr. Appleton's volume is to combat the insidious doctrine that *research* is compatible with *teaching*, in the narrow sense in which teaching is understood in Universities which like Oxford and Cambridge are carried on upon the plan originated by and worthy of the Jesuits (see Pattison, Essay No. 1), viz., that in which competition by examination for prizes forms the pivot of all activity. The watchwords of the German Universities "Lehrfreiheit" and "Lernfreiheit," are (save to a very few) unknown, the idea which they express equally so, in this country.

The suggestion that teaching and research should go hand in hand appears at first sight admirable, because there can be no doubt that in the wider and higher sense of the word "teaching," the investigator is and must be a teacher. In the German Universities it is a small tax upon the professor or holder of a research endowment to give a course of lectures upon the subject with the study of which he is occupied. He is entirely free from the influence of the Jesuit's examination system; that has been long since abolished (where it existed) in German Universities. He is never concerned for one moment with the thought as to what place his hearers may take in an examination—such examination as there is being entirely in his own hands—and having very little importance attached to it. Moreover, he cannot (at any rate in the early part of his career) make anything considerable by the fees of his hearers, and has to look for his promotion and increase of income solely to *success in the occupation which his chair assigns to him, namely, original research.*

The preparation of students for an examination by the results of which they are to gain or fail to gain valuable money-rewards, is a business by itself; and the man appointed to carry on this business, especially when his own income and his promotion depend upon his success in placing his pupils well in the examination, cannot pay much attention to other things. He is in a totally different position from that of the German professor. He is in the position which Mr. Sorby deprecates, viz., that of having an anxious commercial pursuit. But, worse still, as Mr. Pattison and Mr. Nettleship point out in their essays, he deals with knowledge and the results of study in such a way (viz., for examination purposes) that he necessarily is liable to become less fitted than any other man of business to pursue knowledge for its own sake. He and his pupils take up a radically false position with relation to knowledge.

The essays of Mr. Pattison and Mr. Cotton are particularly interesting as showing how the present enormous revenues of the Colleges and Universities of Oxford and Cambridge came to be employed, as they are for the most part, in the cheapening of cramming (as Mr. Sayce does not hesitate to call it) and the reward of success in being crammed, or in the subvention of resident college-lecturers and tutors on the one hand, and non-resident competition prize-men on the other. Originally this was not the case; Fellowships were even founded for the express purpose of relieving their holders from the distraction of teaching, in order that they might devote themselves to study. It was unfortunately at a time when the Church was entering upon a new phase of its history, no longer to be the great representative of learning and science, but something very different, that Leicester and Laud handed over the University to the Colleges and the Colleges to the Church. The Fellowships became so much capital, by means of which, in virtue of their monopoly of education, the Colleges were able to convert themselves into what they have with general approval, but to the detriment of science and letters, become—proprietary schools[1] for the "finishing" of young gentlemen. Under the present system the resident Fellow doubles his income through the division of the monopolised fees, whilst the young gentleman's parents pay half[2] what they would have to pay elsewhere for the same amount of constant supervision, cramming, and "direction."

Whatever portion of the collegiate revenues is retained by the new University Commissioners for the College tutors, or as the Oxford Hebdomadal Council has expressed it, for "education" (as that word is understood at the English Universities) is clearly enough lost to research. This proposition is perhaps the main result of the arguments adduced in the essays of the rector of Lincoln, Dr. Appleton, Mr. Sayce, and Mr. Nettleship.

4. All this being admitted, namely, that it is a matter of urgent importance to provide an extensive series of fairly-remunerated posts to be held by persons constantly engaged in research, unencumbered even by the plausible condition of preparing young men for examination, the practical questions come—which with Englishmen are generally the first questions—namely, Whence is the money to be obtained for this purpose, and how are you to ensure that true "research-men" will get the posts supposing that they are once created?

These are two distinct questions. As to the first the answer is simple. It is only through the direct intervention of the Government that the thing can be done. Government may assign for this purpose a large part of the revenues of Oxford and Cambridge, of City Companies, or of the Irish Church; or the sum required may be met annually by the taxes. The "Essays" have chiefly in view, no doubt, the appropriation of a part of the revenues of Oxford and Cambridge to this purpose. At the same time we must remember that even were some 200,000*l.* a-year detached from those institutions and deliberately and simply assigned to the promotion of research under State control, yet even then only a portion of the national requirements would be met. A larger sum than this is needed to carry out even a moderate scheme. When, however, it is proposed to leave the 200,000*l.* a year under the control of its present administrators with general directions to them to employ it in the encouragement of research, we must contend that there is very strong reason, indeed, for an additional altogether independent and strictly national endowment of research—such as has been hinted at by Lord Derby—and such as is carried out by continental Governments.

The second question as to the means to be adopted in order to avoid jobbery and sinecurism in connection with the proposed series of posts, is not discussed in any way in the volume under review. It is, however, one of the most serious questions, and we shall therefore venture very briefly to furnish an answer which is, as far as we can see, completely satisfactory. In a question like this, of serious practical importance, the most conclusive answer is to be found in an existing solution of similar difficulties in a very closely similar case.

This we possess in the great German University system. Whatever objections Englishmen may have to German Universities as teaching bodies, the fact remains that as an arrangement for the endowment of research on a truly national scale they are the most unqualified success. Research *is* endowed by this system and *is* abundantly carried on, and this without (to the writer's knowledge) a suggestion or imputation of jobbery or sinecurism in connection with it.

The elements of this success in the German system are the following:—1. The appointments are held by twenty-one groups of men engaged in research. 2. By custom and the conditions of society (legislative prohibition would

[1] See Prof. Max Müller in the *Academy*, May 11.
[2] The Oxford undergraduate pays on an average 20*l.* a year for being prepared for examination. A well-known "grinder" for the Indian Civil Service examinations charges, I believe, 100*l.* a year for similar preparation.

have to be called into use in England) these corporations are not allowed to make money by engaging in commercial pursuits or the keeping of boarding-schools. (3) The appointments are graduated in value from 80*l.* to 400*l.* per annum. (4) New members are chosen in any one corporation by co-optation. The promotion of existing members is effected by the same process—one corporation often inviting a member of another to leave his old associates in order to enjoy an increased salary, or increased facilities for research. This co-optation is carefully supervised but not directed by the State Government. (5) Since commercial operations, such as the acquirement of a large revenue by any corporation from the fees of pupils or wards committed to its care, are out of the possibilities of the case—the sole motive which affects the various corporations in their choice of colleagues is a desire to secure colleagues of eminence in the avocation which is assigned to the corporations, namely, research, and in this way to maintain a high reputation for the corporation and congenial association for its members. (6) The result of this is, that the whole stimulus which the prospect of a step-by-step accession of income from 80*l.* to 400*l.* or 600*l.* per annum can bring to bear upon the nature of man is constantly at work in urging those who enter upon this career to give their full energies to research, and research alone. The habit of research so stimulated and fostered, remains even after a career of twenty or twenty-five years—the length of service which entitles the German professor to retire upon full pension.

The enormous fertility of Germany in all kinds of research is the outcome of this simple and healthy system. There does not appear to be any reason why a parallel system applied in this country should not produce parallel results. E. RAY LANKESTER

QUAIN'S ANATOMY

Quain's Elements of Anatomy. Eighth edition, edited by Dr. Sharpey, Dr. Allan Thomson, and Mr. E. A. Schäfer. Two Vols. (Longmans, Green and Co., 1876.)

THE seventh edition of Quain's "Anatomy" appeared nine years ago under the conjoint editorship of Dr. Sharpey, Dr. Thomson, and Dr. Cleland; in the eighth Mr. E. A. Schäfer's name is found on the title page instead of that of the last-named anatomist. The new edition contains much new matter, and with a larger as well as a clearer type, covers nearly an extra hundred and sixty pages.

The arrangement of the subject-matter is considerably modified in the direction of improvement; the descriptive account of the bones, joints, muscles, vessels, and nerves, together with the surgical anatomy, occupying the first volume; the second, containing the general anatomy or histology, the structure of the different viscera, the organs of special sense, and the embryology.

A much-needed advance has been made in the sections devoted to osteology and myology, which consists in the introduction of paragraphs on general morphology. Teachers of anatomy are too apt to entirely neglect those great strides that have been made in zoology, many of which have an important bearing upon the way in which the human skeleton and soft parts should most certainly be regarded. We, upon this view of the question, are therefore glad to find among other innovations, a classified list of the bones of the head, and their typical component parts, the nomenclature adopted being that employed by comparative anatomists.

The introduction of nitrate of silver, osmic and chromic acids, logwood, &c., as adjuncts to histological manipulation, as well as the efforts of many able investigators, have rendered corresponding changes necessary in the sections of the work devoted to the microscopic structure of the tissues and organs; and Mr. Schäfer has here introduced several fresh illustrations, and much new matter, which makes the "general anatomy" by itself an invaluable summary of the most modern aspect of histology. The development of blood corpuscles, the ground-substance of connective tissue, the ultimate nature of muscle, the serous membranes and their lymphatics, have received the greatest additions in this portion of the work.

Dr. Allen Thomson has entirely re-written the chapter on embryology, having embodied all the more recent results in this rapidly advancing department of biological science, arrived at by Foster and Balfour, Parker, Mihalkovics, Waldeyer, and others. The whole forms a most excellent account of human embryology, as far as it can be known from the incomplete direct, and the much indirect evidence which can be brought to bear upon it.

The editors acknowledge the assistance of Dr. Gowers, Assistant-Physician to University College, in the revision of the paragraphs on the Cranial Nerves; and in the chapter on the Brain and Spinal Cord, Dr. Gowers has introduced a valuable account of the cerebral convolutions, together with some excellent drawings, more elaborate than those of Ecker. The nature of the many layers of the cerebral cortex is fully discussed, at the same time that a careful abstract of the terminology of Meynert is given, with additional figures.

There is one minor zoological error which we have not seen corrected in any anatomical or physiological textbooks. It is in the nomenclature of the animals with peculiarly small blood-discs. The "Napu Musk Deer" is said to possess the smallest blood corpuscles of all mammalia. It is now known that the Musk Deer has no special kindredship with the Chevrotains, or Tragulidæ, to which group the Javan Chevrotain (*Tragulus javanicus*), which formerly went by the name of the "Napu Musk Deer," belongs. A reference to Mr. Gulliver's more recent paper[1] also shows that in the Indian Chevrotain (*Tragulus meminna*) the discs are equally minute.

With reference to the typography we think it much improved in all respects, but of the figures we cannot help remarking that sufficient care has not been taken by the printers in doing justice to the artists or the engravers. Several of the older woodcuts are, no doubt, much worn, but they, as well as the more recent ones, are printed much too black, considerably darker than in the previous edition.

OUR BOOK SHELF

Exercises in Electrical and Magnetic Measurement. By R. E. Day, M.A. (London: Longmans, Green, and Co., 1876.)

MR. DAY'S little book on Electrical and Magnetic Measurement seems to us likely to be of considerable

[1] Proc. Zoolog. Soc., 1875, p. 492.

service both to teachers and to students. The best proof of knowledge of any branch of physics, and the most practical result of the study of any such branch is the acquisition of the power of applying numerical calculation to every question where a numerical result can be obtained. The student knows that he understands a subject thoroughly when he can write down numbers to express definitely the amount of every effect observed and measured by experiment. The importance of numerical calculations in absolute measure is becoming daily more and more appreciated: and in the best English text-books numbers expressing quantities in absolute measure are now to be found, instead of the relative numbers that were alone obtainable from the text-books of only a few years ago. Mr. Day's book brings very fairly together such questions as are likely to present themselves to the student of electricity and magnetism. Anyone who has acquired sufficient knowledge to work through a considerable part of the exercises cannot fail to find them extremely useful.

We have observed some slips that ought to be corrected in future editions. Among them may be mentioned some of his exercises on the tangent galvanometer. No practical experimenter would think of using the tangent galvanometer in such a way as to bring the deflection to 89° 30′, as Mr. Day does in Ex. 23, p. 47, or to the high numbers that he refers to elsewhere. We find readings of Thomson's reflecting galvanometer given in degrees, minutes, and seconds. This seems rather absurd, to say the least of it. In a few of the exercises, as in Ex. 9, p. 33, the data are insufficient.

A few more definitions would, we think, be found useful. Some of the terms employed are uncommon, and some appear to be used somewhat ambiguously. Thus in Ex. 2, p. 17, the word *density* is wrongly used for quantity. Again *density* of an electric current is a term so unusual that some explanations regarding it seem all but necessary. The definition, given in Ex. 2, p. 72, as Bunsen's definition, appears a very incomplete one. According to it, a *current of unit density is a current of unit strength passing through a voltameter between two electrodes each one square millimetre in diameter;* and from this it would follow, we presume, that the so-called density of the current is the same at every part of the voltameter and independent of the form of the voltameter. If so we cannot think of any possible use of such a name. The terms Farad and Weber, given by some of the practical electricians seem to be used indifferently in more senses than one. It is simply unpardonable, in the present state of the science, to *introduce* ambiguities of language.

On the whole, however, we are much pleased with Mr. Day's little book, and can warmly recommend it both to teachers and to those who are studying electricity and magnetism without the aid of a teacher.

Geological Survey of Victoria. Prodromus of the Palæontology of Victoria. Decade 3. By Frederick **McCoy.** (Melbourne.—London: Trübner and Co., 1876.)

We are glad to find that in spite of the unpromising news which has recently reached England concerning the present condition of the Geological Survey of Victoria, the palæontological work, which is in the hands of such a well-tried and indefatigable naturalist as Prof. McCoy, continues to make satisfactory progress. The present decade of the *Prodromus* is of more than local interest, containing as it does interesting new details concerning Owen's marsupial lion, the *Thylacoleo carnifex*. The result of Prof. McCoy's examination of more perfect specimens than those on which the first description species was based, is to suggest modifications in some of the views published by Prof. Owen, but to add confirmation to that author's main position concerning the carnivorous habits of the animal, a conclusion which was called in question by Dr. Falconer and Prof. Flower. Scarcely less interesting at the present time is the illustration and description of a species belonging to the sub-genus of *Nautilus*, known as *Aturia*. A similar form has been found by Dr. Hector in New Zealand, but in rocks of far older date, and the facts which have already come to light concerning the distribution in space and time of this remarkable genus are such as to invest it with the very highest interest both to the geologist and biologist.

On similar grounds the new species of Tertiary *Trigonia* and *Pleurotomaria*—genera which were so abundant during earlier periods of the earth's history, but which, except in Australia, appear to have become almost wholly extinct at the close of the Mesozoic epoch—are especially worthy of the attention of the palæontologist. The other new forms illustrated in this decade, including a number of Trilobites and Tertiary Mollusca, do not call for any special remark. Prof. McCoy's scientific descriptions are admirably clear and exact, and his general remarks on the relationships and distribution of the species very valuable and suggestive. The engraving and printing of these decades afford evidence alike of the progress made by our Australian colonies and the liberality with which scientific research is supported in them. The plan of publication by decades, illustrating the palæontology of the countries geologically surveyed, was commenced in the United Kingdom by Sir Henry de la Beche, and has been followed both in Canada and India. The decades of the Victoria Survey are quite worthy to take rank, both as regards matter and form, with those of either of the older surveys we have mentioned; and higher praise than this it would scarcely be possible to add.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Scientific Poisoning

For giving instruction to *one person* in the art of poisoning without detection, the medical student, Vance, is undergoing the very lenient punishment of eighteen months' imprisonment. What would be the appropriate penalty to inflict upon the responsible editors of newspapers who initiate *the public generally* into Vance's secret?

Chemist

Pyrology—Quantitative Analysis by the Blowpipe

The *estimation* of constituents in compounds by the blowpipe has been hitherto, as is well known, limited to the process of metallic (or, in the case of cobalt, arsenidal) reduction of oxides, &c., and that with regard to a very few metals only. I now propose to inaugurate a new plan, by which this rapid, elegant, and accurate method of analysis may (apparently) be applied far more generally, and, as I hope, successfully. In my published work "Pyrology, or Fire Chemistry," I have, with the exception of a few indications (as in the case of the insoluble balls formed by *lime* in *boric acid*), confined myself to qualitative research only, but many methods will suggest themselves to the attentive student of that book, by which qualitative may be readily extended to quantitative examination.

I propose to proceed more in the direction of a kind of *volumetric analysis* than of analysis by means of the successive *separation* of constituents, as in the "wet way," and I trust that the consideration usually accorded to novelty and the difficulties always inseparable from useful novelties will not now be refused by scientific Englishmen to my feeble initiatory researches, especially as I am (I believe) the first Englishman who has published much *original* matter on this subject. It seems likely that the operator who can, by reason of the *rapidity* of his methods, obtain the *mean of a number* of approximate analyses of a particular substance in the same or less time than that required by the employer of an abstractedly more correct but practically more dangerous mode (from the failure of any one of the delicate manipulations introduced) for *one analysis*, will probably arrive in the end, at a result more closely approaching to the truth.

Blowpipe Assay of Ores, Furnace Products, &c., for COBALT.

1. The *rationale* of this process depends upon the observations (*a*), that a trace (say ·5 mgr.) of cobalt oxide affords, when dissolved in a bead of microcosmic salt, *the same* colour (violetish blue) which is afforded by the addition to a similar bead of *five times* as much oxide, or 2·5 mgrs.; and (*b*) that these relative quantities of cobalt oxide afford, when dissolved in *phosphoric acid* beads of the same weight (say 60 mgrs.), *perfectly different* colours; viz., *pink* as regards the smaller proportion, *violet* as regards the greater.

2. The corollary derivable from these premises seemed to me, therefore, that, the quantity of phosphoric acid being kept constant, it would require the addition of more *soda* to turn the pink bead than the violet bead *blue*; first, because violet already contains blue, and second, because the cobalt might be presumed to have already saturated, as a chemical base, part of the phosphoric acid.

3. I was *exactly wrong* in this assumption. Different quantities of soda were, indeed, required to azurise the two beads, but the *violet* bead required *more* than the pink one.

4. Without troubling the reader with tedious details, I may state here that each of three assays constantly showed the necessity of an addition of 14 mgrs. of fused sodium carbonate in order to azurise a 60-mgrs. bead of phosphoric acid, made pink by the solution in it of ·5 mgr. of pure cobalt oxide; and (by three other assays) an addition of 20 mgrs. of soda to azurise a 60 mgrs. bead made violet by 3·5 mgrs. of cobalt oxide. The ratio, therefore, stood thus:—

$$\begin{matrix} Na\dddot{C} & & Na\dddot{C} & & CoO & & CoO \\ 20 & : & 14 & :: & 3{\cdot}5 & : & {\cdot}5 \end{matrix}$$

or the violet standard of cobalt was to the pink standard, as 2·45 : 0·71. It would, by these assays, seem that every half milligramme between those extremes of cobalt oxide dissolved, requires the addition to the bead of one milligramme of fused sodium carbonate, in order to azurise a 60 mgrs. bead of pure phosphoric acid.

5. The way to operate is to compare, by reflected and transmitted light, the blue colour thus obtained, with that of two 60 mgrs. beads of *microcosmic salt*, having the above-named quantities of pure cobalt oxide respectively dissolved in them. Space does not allow me here to describe the *mechanical details* of operations, which must be conducted with the utmost care.

6. From these facts, the following analytical table, as regards *cobalt*, is deduced:—

CoO mgrs.		$NaCO_3$ mgrs.			
0·5	requires	14	=	0·83	per cent. of a 60 mgrs. phosphoric acid bead.
1·0	,,	15	=	1·6	,, ,, ,,
1·5	,,	16	=	2·5	,, ,, ,,
2·0	,,	17	=	3·3	,, ,, ,,
2·5	,,	18	=	4·1	,, ,, ,,
3·0	,,	19	=	5·0	,, ,, ,,
3·5	,,	20	=	5·8	,, ,, ,,

The use of this table is shown in the following example:—

7. *Assay* (*for Cobalt only*) *of Smaltine, from a Freiberg Cabinet.*

		mgrs.	per cent.
α.	Weight of powdered ore crushed between agates ... ... =	50	—
β.	Weight of powdered ore after roasting on aluminium plate... ... ... =	18	36
	Therefore the loss in arsenic and volatile constituents ... ... =	32	64
γ.	Weight of a new platinum wire with a ring of 1 diameter[1] ... ... =	71·5	—
δ.	Weight of the same platinum wire with a bead of phosphoric acid fused on it =	134·5	—
ε.	Weight of the bead and wire after 2·5 mgrs. of (*β*) had been dissolved in the former ... ... =	124·0	—
ζ.	Weight of the bead and wire after the addition of fresh phosphoric acid[1] ... ... =	132·5	—

[1] This refers to the "ringing forceps."

(This bead being *rose* colour,[2] *fused sodium carbonate* was cautiously taken up from an agate slab and dissolved in it under O.P.).

		mgrs.	per cent.
η.	Weight of soda required to colour to the *blue* of mic. salt with 2·5 CoO... =	16·5	—

Now, by the above table (6), 16·5 mgrs. of *soda* correspond to 3 per cent. of a 60 mgrs. bead in *pure* CoO; and 2·5 mgrs. of pure CoO, requiring 18 mgrs. of soda, constitute 4·1 per cent. of the bead. Therefore we have the ratio—

$$4{\cdot}1 \ : \ 3 \ :: \ 100 = \tfrac{3}{4{\cdot}1}\text{ths of } 100 = 75 \text{ per cent.}$$

But, as this is the percentage of the *roasted powder*, or "regulus," we have—

Regulus in 100 mgrs.		Percentage of regulus. mgrs.		Mgrs. of ore.
36	:	75	::	100 = 20·08 per cent. cobalt.

Several assays were made with a similar result, but one other example is given here, with a different platinum wire.

			mgrs.
α.	Weight of a platinum wire	... ... =	61·0
β.	,,	ditto with bead of phosphoric acid =	131·0
γ.	,,	roasted *smaltine* dissolved in (*β*). =	2·5
δ.	,,	this wire with bead coloured rose pink with (*γ*) ... ... =	118·5
ε.	,,	bead and wire with fresh phosphoric acid ... ... =	121·0
ζ.	,,	sodium carbonate required to colour (*ε*) *blue* ... ... =	16·5

8. These data would, of course, give a similar result. Roasting before O.P. on *aluminium plate* is so rapid and efficacious that the whole process only occupies about half an hour; with the *roasted powder*, about a quarter of an hour. A drop of water is placed on the powder to retain it under the blast.

In roasting, *nickel* oxide appears, yellowish green, on the surface, and might possibly be mechanically separated at this stage of the procedure. W. A. ROSS

Page's Introductory Text-book of Physical Geography

IT has been pointed out to me that the same errors which I noted in this book (NATURE, vol. xiv. p. 26), had been corrected as regards Prof. Page's "Advanced Text-book" by Mr. Wallace three years ago. They can scarcely, therefore, be anything but wilful, and it is difficult to understand how they could be allowed to reappear. We do expect teachers of position at least to do their best to teach rightly; and when one has fallen into error it is certainly more manly to correct it than to stick to it, because it has once been committed. It is a good thing to teach science, but it is just the opposite deliberately to teach false science. THE REVIEWER

OUR ASTRONOMICAL COLUMN

THE SECONDARY LIGHT OF VENUS.—By way of supplement to the historical notes on the luminosity of the "dark side" of the planet Venus in last week's "Astronomical Column," a brief enumeration of the various explanations of the phenomenon which have been offered from time to time may not be out of place here.

These resolve themselves into (1) reflected earth-light analogous to the lumière-cendrée exhibited by our moon, an explanation advanced by Schröter, Harding, and many others; (2) phosphorescence of the planet's atmosphere, suggested by Sir W. Herschel to account for the appearances remarked by Schröter, though looked for without success by himself, with which may be mentioned Pastorff's idea of a self-luminous atmosphere; (3) visibility by contrast—"might not a plausible explanation be given," asks Arago, "by referring it to a class of objects which are negatively visible, or which are rendered apparent by way of contrast?" (4) luminosity, similar to our polar-light (aurora borealis); (5) natural light-developments, as luminosity of the ocean; (6) a condition of

[1] This is necessary to make up the weight of the bead to 60 mgrs. After the addition of soda, there is *no* loss from volatilisation.

[2] From the interference of iron and nickel oxides in the assay.

glowing-fire, or intense heat of the surface; and (7) the *Künstliche Feuer* of Gruithuisen.

There is one characteristic of the phenomenon abundantly verified by the numerous observers who have recorded it, which cannot be overlooked in our endeavours to arrive at its true cause, viz., its intermittent or only occasional visibility. This alone appears to render more than one of the explanations which have been advanced highly improbable if not wholly inadmissible. There are also isolated observations which seem rather to favour one or other of the hypotheses. Thus Schröter considered that the change in the colour of the faintly illuminated disc from reddish to ashy-grey remarked by Harding, indicated a connection with our aurora borealis, in exhibitions of which similar rapid changes or alternations of colour are observed, and a very curious observation by Mädler has been cited in the same direction. On April 7, 1833, at 8 P.M., in a sky of extraordinary clearness and tranquillity, Venus, then in crescent-phase, appeared to him accompanied by a beautiful radiating appearance; seven or eight straight rays, at times very bright and sharply defined, at others fainter and more diffused, occupied the north-west quadrant, and were gradually lost in the general ground of the sky. The longest ray extended about 15′, the shortest was about half that length; neither turning round the eye-piece, nor viewing the planet in different parts of the field of the telescope, at all affected the phenomenon, which continued unchanged as long as Venus was observed that evening. A figure of this appearance is attached to Mädler's account of his observation.

Zöllner has expressed his conviction that under spectroscopic examination, the ash-coloured secondary light of Venus will be found to present bright lines, and it may be hoped that opportunities for such observations may occur during the present summer.

By closely watching the form of the crescent towards the extremities, further evidence of rotation in rather less time than is occupied by the earth in her diurnal revolution, may also be obtained. But with this object, observations must be made at very short intervals. In illustration of this may be quoted Mädler's experiences on June 6 and 10, 1836.

	h. m.		
June 6,	10 41	Sid. T.	Both horns equally pointed, and the curvature quite elliptical.
,,	11 10	,,	The same.
,,	11 36	,,	The northern horn appears to be the more pointed.
,,	11 38	,,	The northern horn certainly more pointed: also at 11h. 43m.
,,	11 56	,,	Again uncertain.
June 10,	11 14	,,	Both horns alike.
,,	11 26	,,	The northern is more pointed.
,,	11 38	,,	Again doubtful.

Mädler referring to these and other observations of a similar character, in May and June 1836, expresses his opinion that they are quite irreconcilable with Bianchini's period of rotation, but may be compatible with the shorter one of Cassini and Schröter.

THE MINOR PLANETS.—The following summary is founded upon elements of 153 members of this group, which appear to be sufficiently well determined to afford reliable results. It exhibits the distribution of the perihelia, nodes, inclinations, and excentricities, and will be seen to offer several very decided characteristics.

1. *Longitudes of the Perihelia.*

° °	Number of Orbits.	° °	Number of Orbits.
0– 30	18	180–210	7
30– 60	22	210–240	9
60– 90	11	240–270	10
90–120	15	270–300	7
120–150	12	300–330	19
150–180	7	300–360	16

2. *Longitudes of the Ascending Nodes.*

° °	Number of Orbits.	° °	Number of Orbits.
0– 30	15	180–210	19
30– 60	13	210–240	8
60– 90	19	240–270	5
90–120	6	270–300	7
120–150	16	300–330	13
150–180	16	330–360	16

3. *Inclinations to the Ecliptic.*

0– 5	52	20–25	6
5–10	58	25–30	2
10–15	26	30–35	1
15–20	8		

4. *Excentricities.*

0·00–0·05	7	0·20–0·25	31
0·05–0·10	23	0·25–0·30	6
0·10–0·15	41	0·30–0·35	6
0·15–0·20	38	0·35–0·40	1

A FREE SPANISH UNIVERSITY

OUR readers will easily understand what sort of a foster-mother a Government like that of Spain will prove to education generally, and to scientific education and inquiry in particular. Any educational institution connected with such a state must necessarily be hampered and hindered in many ways, and the only chance of obtaining perfect liberty in scientific education and instruction is in being rid of all state interference. This has been so strongly felt in Spain by some of the foremost Spanish men of science and letters that they have formed an association to found an institution for free education. A prospectus of the institution has been forwarded us, and the difficulties which beset a liberal education in Spain may be learned from the fact that it is signed by ten ex-professors of the highest standing, all of whom have been removed from their chairs by Government on account of their liberal opinions. Among these are the names of Augusto G. de Linares, ex-Professor of Natural History at the University of Santiago, and Laureano Calderon, ex-Professor of Organic Chemistry at the same University. The object of the Association, as stated in the prospectus, is to found at Madrid a free institution dedicated to the culture and propagation of science in its various branches, specially by means of education. A sort of joint-stock company will be constituted by shares of 250 francs, payable in four instalments between July next and April 1877. A preliminary meeting was to be held on the 1st inst. to constitute the Society, and we earnestly hope that a successful start has been made. The Association will be directed by a Council representing all parties interested. The Institution itself will, of course, be perfectly free from all religious, philosophical, or political restrictions, its only principles being the "inviolability of science" and the perfect liberty of teaching. There will be established, according to the circumstances and means of the Society (1) studies for general, secondary, and professional education with the academic advantages accorded by the laws of the State; (2) superior scientific studies; (3) lectures and brief courses, both scientific and popular; (4) competitions, prizes, publication of books and reviews, &c. The greatest precautions will be taken to obtain as professors men of undoubted probity and earnestness and of the highest competence.

We need say nothing to our readers in recommendation of the above scheme. All who sincerely desire the welfare of Spain and the spread of scientific knowledge must sympathise with its promoters, who, we have every reason to believe, are men of the highest character and competency. We hope that not a few of our readers will show their sympathy with the object of the Association by sending the moderate subscription which constitutes a shareholder to M. Laureano Figuerola, Calle de Alcalá, 72, Madrid.

SCIENCE IN GERMANY

(*From a German Correspondent.*)

DURING the past year some interesting observations have been published with reference to the alterations in animals through external influences. One series of these researches is by Weissmann, on the transformation of the Mexican Axolotl into an Amblystoma (*Zeitschrift für Wissenschaftliche Zoologie*, xxv., 1875, Supplement). It refers, of course, to a phenomenon which is not now new; but it includes a number of original experiments and observations, and is especially important for the conclusions drawn from these. The Axolotl (*Siredon Mexicanus*) and its allies in Mexico retain there, during life, in the natural state, the form and organisation of the larvæ of our Tritons; but, in artificially breeding them in Europe, they sometimes undergo a metamorphosis into an Amblystoma, *i.e.* an animal of the form of our fully developed Tritons. These peculiar departures from the natural behaviour of the Mexican Siredon, Weissmann desired to produce artificially, and with this view he entrusted the breeding of five eight-day larvæ to a lady, Fraülein v. Chauvain. All five actually underwent the desired transformation, having been put for six to eight months in water that was quite shallow, so that they were compelled frequently to leave the water, and become used to lung-breathing. Now, since, besides the Mexican Siredon species, which are never transformed in the natural state, there occur in the United States of North America quite similar animals, which, however, represent merely the temporary larva stage of various species of Amblystoma, the Mexican Siredon species have hitherto been regarded as forms that have remained at a lower stage of development, and, in the rare cases of metamorphosis by the action of changed conditions of life, have been incited to progression towards a higher stage. Weissmann, however, is now of a different opinion. He believes that the sudden and very remarkable transformation of the Siredon, which affects a whole series of organs, cannot be fully explained by the direct influence of changed conditions of life; and that should one see in such a transformation the leap-like (*sprungweise*) development of a new species or even genus, the hypothesis of a kind of life-force would be necessary. This teleological hypothesis should be avoided, according to Weissmann, and the transformation of the Siredon conceived as a not real but only apparent new formation of species, viz., as a reversion to a form which previously existed among the ancestors of the Siredon. Since the Perennibranchiata, at all events, represent the older form of the tailed amphibians, as it is indicated for the Amblystomas of North America in their Siredon-like larvæ, all Siredons are to be regarded as the descendants of Amblystomas, which were permanently depressed to that older form, and in their occasional metamorphoses have realised a reversion to the second phylogenetic stage (Amblystoma). Such a conception Weissmann supports by the following reasoning:—The possibility of Siredon having come from Amblystoma is proved by the fact that we sometimes see Triton-larvæ, which attain the full size and sex-forms of an adult Triton without being transformed; now the Tritons and Amblystomas are very similar animals, and their larvæ are again extremely similar to the Siredon. But it is possible also to indicate the probable causes which forced the Amblystoma-like ancestors of the Siredon to reversion into the Perennibranchiate form. According to Humboldt's view, the high table-lands of Mexico were formerly covered with extensive lakes, and the evaporation of such large water-surfaces must then have produced a very moist atmosphere, which is necessary to the naked amphibia living on land. Consequently, Amblystoma forms could at that time live in Mexico quite well. With disappearance of the waters, however, came the present extreme dryness of the air on the Mexican highlands, which allows only the Amphibia living in water to survive, and is therefore probably the reason why the Amblystoma larvæ have gradually quite ceased leaving the water and being transformed, and thus have constituted the present Siredon species. If, then, the occasional transformation of Siredon to Amblystoma may be explained as a reversion, the necessity ceases of supposing for so sudden a change a special life force, which in Weissmann's opinion is necessary, should his theory be rejected.

Similar experiments on the change of organisation through action of external influences have been made by Schmankewitsch on low Crustaceans of the order of Branchiopoda. He also was led to experiment by natural occurrences. In the neighbourhood of Odessa (in Southern Russia) there is a salt lake which, with a view to salt production, was divided by a dam into two halves, so that in the lower, shut off part, salt was deposited in solid form, while the less salt upper portion alone, at the commencement, contained the Branchiopod *Artemia salina* in large number. In the year 1871 that dam burst; the very salt water of the lower half of the lake was diluted to about 8° of Baüme's areometer, and at the same time there were carried into it large masses of *Artemia salina.* After the dam was repaired the concentration of the same water rose in 1872 to 14°, 1873 to 18°, 1874 to 25°. At the same time the *Artemia salina* present underwent a remarkable change. In 1871 they still had their characteristic form of tail. In 1874 the two lobes of it, as also their bristles, had entirely disappeared. Simultaneously the gills were enlarged, in correspondence to the smaller proportion of oxygen in the very salt water. The body as a whole, however, decreased in size, so that the new form corresponded almost exactly to that of *Artemia Mühlhausenii*, formerly regarded as a distinct species. This fact was tested experimentally, and the same results were obtained by artificial breeding in salt water of increasing degrees of concentration. Further, by the reverse experiment, the *Artemia Mühlhausenii* was, even in a few weeks, altered in the direction of *Artemia salina;* and this last form was, by continued dilution of the salt water, transformed into a *Branchipus;* i.e. a genus which, of larger dimensions than *Artemia salina*, has a somewhat different tail, and one abdominal segment more, and which also is propagated sexually, whereas parthenogenesis is the rule with Artemia. In natural water-pools, with various proportions of salt, Schmankewitsch found (in accordance with his experiments) various transition stages between the forms named, so that the increase of the amount of salt reduces the Branchipus form in size, segmentation, and initial form of the post-abdomen, and, with corresponding change of the gills, essentially modifies also the propagation, so that the strongest salt solutions harbour only *Artemia Mühlhausenii.* From all these facts it appears that the direct influence of changed conditions of life may, in course of a few generations, transform one species, or even one genus, into another, and this in both directions; so that there can be as little question of the reality of a reversion as of that of imperceptible small changes, which, accumulating through long periods of time, suffice for the formation of a new form. Such facts, however, seem little fitted to give support to the opinion of Weissmann, viz., that reversion only is capable of working a rapid and remarkable change.

SIEMENS' ELECTRIC LIGHT APPARATUS

THE comparatively infrequent employment of electric light, considering the great success achieved in its production, would at first sight appear to be due to something in the application of the electricity itself. It has been repeatedly and satisfactorily proved that a continuous and powerful light can be produced by electricity, and the question naturally arises, Why is it not more frequently employed for practical purposes?

Unquestionably the first experiments with electric light were not successful, but this is generally the case with new inventions. Unfortunately, however, a feeling seems to have arisen directly against the application of electricity for lighting purposes, or at any rate against the employment of the existing apparatus in the hope that more perfect may soon be invented.

The numerous cases in which powerful electric lights

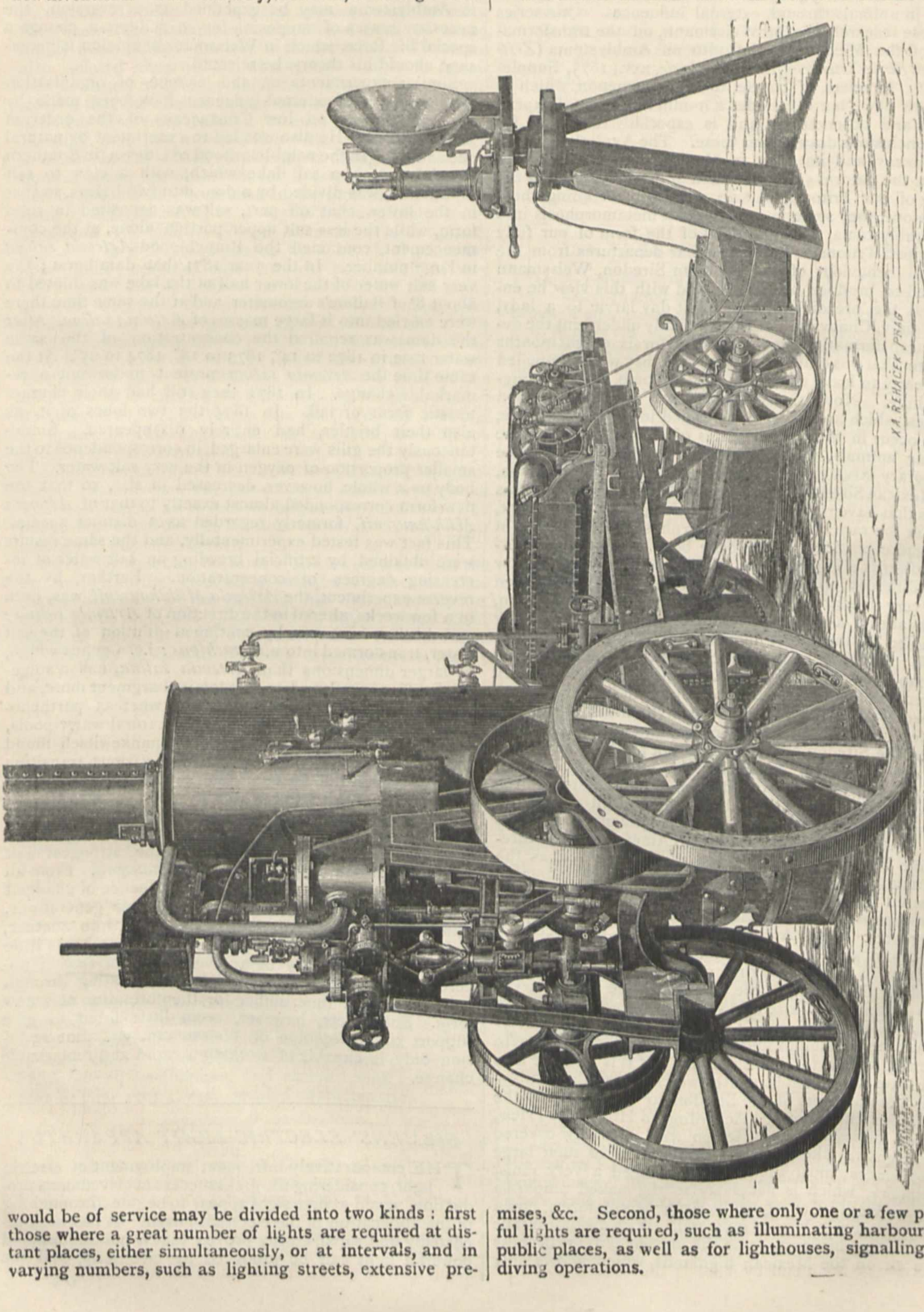

Fig. 1.—Dynamo-electric Light Apparatus with Portable Engine, Lamp, and Parabolic Reflector.

would be of service may be divided into two kinds: first those where a great number of lights are required at distant places, either simultaneously, or at intervals, and in varying numbers, such as lighting streets, extensive premises, &c. Second, those where only one or a few powerful lights are required, such as illuminating harbours and public places, as well as for lighthouses, signalling, and diving operations.

Great difficulty is experienced in properly adjusting the resistances and dividing the current, for the production of such a number of lights as is required in the cases of the first kind, and extensive experiments to overcome this difficulty have as yet been attended with only partial success.

It is to those of the second kind that we purpose to draw attention. Here the circumstances are quite altered, the cases of application are numerous, and the apparatus employed is perfect and proportionally cheap, and yet it is adopted not nearly so frequently as might be expected. A constant light equal to that of from 9,000 to 10,000 stearine candles can easily be produced, with a motive force of from eight to nine horse-power, and this at a cheaper rate than any other artificial light.

Such apparatus have lately been employed in various countries for various purposes, such as for engineering works, torpedo defences, signal lights, and in military field operations. It is to be hoped that its adoption in this country will soon be more general.

The following is a description of Messrs. Siemens Electric Light Apparatus, one of many that have been adopted in various countries. Comparative experiments have proved it to be the most powerful and at the same time the least expensive of all apparatus yet employed in the production of continuous electric light. It is a complete apparatus by itself, in which the core of the armature is fixed and the wire-helix alone caused to rotate. By fixation of the armature core great inductive power is obtained, and consequently powerful currents.

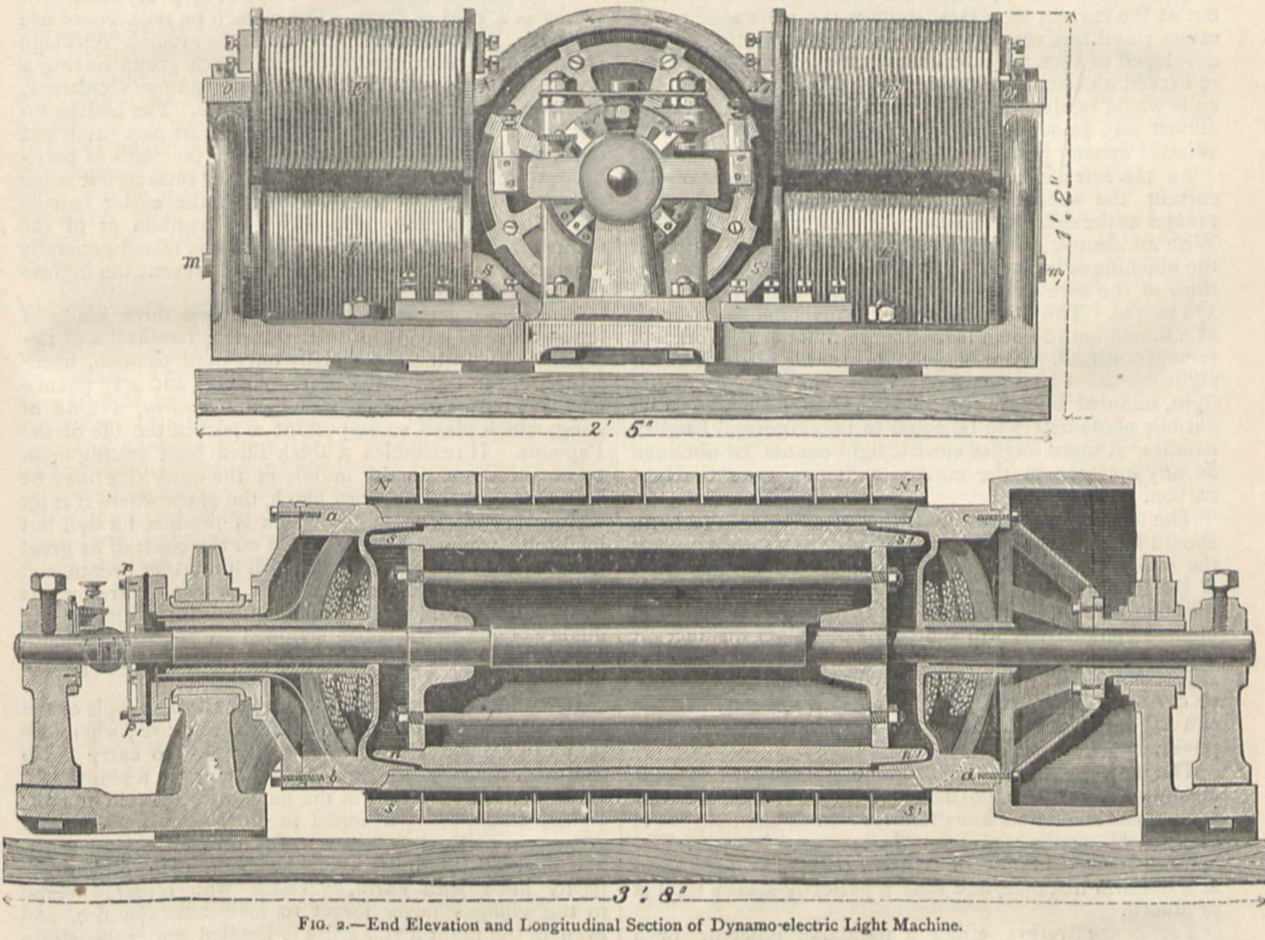

Fig. 2.—End Elevation and Longitudinal Section of Dynamo-electric Light Machine.

With about 380 revolutions of the wire-helix per minute, and nine to ten horse-power, a light equal to 14,000 candles is obtained.

The principle in this and all other magneto-electric machines is, that when part of a closed electrical circuit is passed between the poles of a stationary magnet, a current is generated in the circuit the direction of which depends upon the position of the magnetic poles and direction of motion of the conductor.

In this machine (shown in Figs. 1 and 2) the conductor, by the motion of which the electrical current is produced, is of insulated copper wire, coiled in several lengths, and with many convolutions on a cylinder of thin German silver, and in such a manner that each single convolution describes the longitudinal section of the cylinder. The whole surface of the metal cylinder is thus covered with wire, forming a second cylinder closed on all sides (*a*, *b*, *c*, *d*, Fig. 2).

This hollow cylinder of wire incloses the stationary core of soft iron (*n s s' n'* Fig. 2) which is fixed by means of an iron bar in the direction of its axis, prolonged at both ends through the bearings of the wire cylinder to standards. Surrounding the wire cylinder for about two-thirds of its surface, are the curved iron bars (N N' S S' Fig. 2), separated from the stationary iron core by space only sufficient to permit the free rotation of the wire cylinders. The curved bars are themselves prolongations of the cores of the electro-magnets (E E E E) and the sides of the two horse-shoe magnets (N*o*—S, *m* and N'*o'*—S', *m'*) are connected by the iron of the two standards (*om* and *o'm'*).

As the coils of the electro-magnets form a circuit with the wires of the revolving cylinder, the revolution of the latter causes a powerful current to pass into the electro-magnetic coils, this again inducing a still more powerful current in the wires of the cylindrical armature. The iron core of the cylindrical armature being very close to the poles of the electro-magnets, becomes itself an intensely powerful transverse magnet of opposite polarity to the electro-magnet. The cylinder of wire thus revolves in a very intense magnetic field.

These electrical currents are collected on two metal rollers or brushes, so that at two points diametrically opposite the single sectors pass under the rollers or brushes with elastic pressure giving up to them their electrical charge.

A slight increase of speed in the rotation of the wire cylinder is followed by a considerable increase of current, but as the current increases, so does the resistance to rotation; and this very rapidly. In addition to this heat is developed to such an extent, that care must be taken not to exceed a certain limit, otherwise, the insulation of the coils would be destroyed. Were it not for this drawback almost any amount of current might be produced with suitable driving power.

As the external resistance affects the strength of the current the speed must be varied accordingly, being greater as the external resistance is greater and *vice versâ*. With an electric lamp in a circuit of small resistance, if the machine is intended to work continuously, the revolutions of the wire cylinder per minute should not exceed 370 to 380. The temperature of the machine will then be at a maximum in about three hours; and during work will remain constant. At this speed the driving power is about eight indicated horse-power. While the intensity of the light, unaided by reflector or lens, has been shown by various photometers to be equal to 14,000 normal English candles. A more intense electric light cannot be obtained as any increase in the current splits up even the best carbon.

The conducting wires from the machine to the lamp should be of copper, offering very little resistance and at the same time possessing a high electrical conductivity. If the lengths of the two wires do not together exceed fifty-five yards, then a wire of 0·157 inches diameter, and of high conductivity will suffice. For longer distances it is advisable to use a strand of larger diameter.

Increased speed will of course compensate for decrease of current due to a too great external resistance, but this can be done only at the expense of increased motive power.

The lamp used with the machine is regulated without clockwork, as the employment of the latter has not only been a source of numerous failures and difficulties, but is liable to disarrangement upon the least rough usage. The lamp of itself regulates the carbon points, keeping them at a uniform distance, and thus a perfectly steady light is produced.

For concentration either a parabolic reflector or a Fresnel dioptric lens may be used.

For transportation the Dynamo-electric Light Apparatus is mounted on a waggon, with steam-engine, the whole weighing 4,960lbs. The combination has proved very serviceable on account of its lightness and compactness.

THE ETHNOLOGY OF THE PAPUANS OF MACLAY COAST, NEW GUINEA[1]

WITH regard to the villages and dwellings. So thickly is the coast of Astrolabe Gulf covered with vegetation that no houses are visible to anyone on shipboard, the only signs of habitation being perhaps columns of smoke. If, however, more careful observation be made with a telescope, separate groups of cocoa nut palms will be noticed. If a landing be effected near one such group, a *pirogue*, or canoe, will probably be seen drawn up on the shore, or else concealed in the jungle, and a path will be found leading through the wood to an open clearing, where stand huts overshadowed by bananas and cocoa-nut palms. Viewed from the side, one such hut seems almost wholly to consist of roof, as the side walls rise scarcely half a yard above the ground. A semi-circular eave-like projection frequently stands out over the doorway. Close in the neighbourhood of nearly every hut there stands upon four legs the *barla*, a kind of table or bench, which serves as the eating and resting-place of the men. Upon this, when the meal is ready, the host and his guests are seated, so that they can take their meal without fear of molestation from pigs or dogs. When the dishes are cleared away the Papuan takes his *siesta* upon the *barla*, which now serves as a kind of divan. The women on no account use the *barla*, but take their meals upon the ground. A village consists of several groups of huts (each group having a particular name) which stand around an open clearing, and communicate through narrow paths. The houses do not stand upon piles,[1] and are for the most part small and dark, though well and strongly built; the roofs in particular, which do not have a flatly-inclined surface, but bulge outside in order that the rain may be the easier carried off. The walls are made either of bamboo or of the stalks of sago-palm leaves. The door is raised generally about half a yard above the ground, to prevent the ingress of dogs and pigs.

There can generally be distinguished three kinds of huts—those of single people, those of families, and the *buambramra*, which is usually only used by men, being intended for the youths of the village, and any chance guest. Here will be remarked the *baroem*, a kind of gong, which plays so important a part in the life of the Papuans. It resembles a thick-sided boat resting upon two trestles, and on the middle of the outer side may be seen a smooth, much-worn patch, the place where it is hit with a very thick stick, by which is produced a dull but loud tone, which has been heard on the coast at as great a distance as five or six miles. All important events, *e.g.* the presence of an enemy, a death, or a feast, are by this instrument heralded to the neighbouring villages, the quality of the news being signified by the varying loudness of the tones produced, and the length of the pauses between each.[2]

It is a most extraordinary fact that all the people of the coast here have no means at all of making fire; wherefore they are obliged always and everywhere to carry a live coal with them, be it either to kindle a fire in a plantation, or, when on a long tour in the mountains, to relight their cigars, which, being wrapped in green leaves, are always going out. On their sea voyages they have generally a live coal at the bottom of the boat, in a broken pot partly filled with earth. Those who remain behind in the villages never forget to look after the fire, and even in the night a small fire is kindled under the sleeping-places, which partly makes up for scanty clothing. The warmth penetrates, together with smoke, through the insterstices of the bamboo bedstead,[3] so that one-half of the sleeper's body is warmed, in fact roasted, while the other half is frozen. They are often obliged to get up in the night to see after the fire. The mountain people are not obliged thus to tend, like the priestesses of Vesta, an eternal flame, but understand how to kindle fire anew, and by the following method. A piece of very dry wood, which they term *Ilol*, is split with a stone axe in such a manner that each half is not quite separated from the other. Into the fissure a strong cord, a split liana,

[1] Continued from p. 109.

[1] The houses of all Malays, whether on the coast or in the mountains, always are built upon piles sometimes nine or ten feet long.—J. C. G.

[2] A similar instrument is figured in Schweinfurth's "Heart of Africa," as in use by the Niam-Niam tribe.—J. C. G.

[3] This is probably the equivalent of the *bali-bali* of the Malays, a frame of split bamboo, raised slightly from the ground.—J. C. G.

in fact, is introduced, and, after that the piece of wood has been firmly pressed against the ground by the foot or knee, is put into a continually increasing frictional movement until some dry cocoa-nut bark fibre, previously placed beneath, takes fire. This is a very tedious proceeding, as it lasts well-nigh half an hour. The aborigines of the coast have repeatedly told Maclay that they are frequently obliged to go to other villages to procure fire when by chance the fires in all the huts of a village have gone out.

The Papuans pass most of their time outside their huts, these latter serving principally as shelter during the night, or in bad weather. To the tie-beam of the hut a cord is fastened, from which hangs a *memu*, i.e. a stick with several hooks. In front of the stick a portion of the covering of the base of the leaf of the sago palm is so arranged that the cord passes through the middle of the same. To the hooks are hung various articles of food wrapped up in leaves. This arrangement serves to keep off the mice, which would otherwise make away with everything eatable in the night. Beyond a pair of spears, a few arrows, and other implements of the chase, there is nothing in the way of furniture in the hut of the Papuan. It would be difficult, in fact, to find a human habitation more meagrely furnished. It is the custom to preserve some portion, *e.g.* the lower jaw, of every animal which has been eaten at feasts. These *souvenirs* are hung around the walls of the large common hut—*buambramra*.

The plantations, or gardens, of the Papuans are seldom laid out near the huts, but for the sake of security are hidden in the jungle. A clearing is made by cutting down the underwood, and, after it has been dried in the sun, it is set on fire. The space thus prepared is then surrounded by a kind of hedge consisting of two rows of a kind of sugar-cane (*Saccharum spontaneum*), which soon takes root, the opposite stems being fastened together with lianas, and the intervening space between the rows filled with rough-hewn logs. In less than a month's time a new plantation is put in full order and planted with bananas, sugar-cane, and the Collocasia and Dioscorea. The tools which are used for this purpose are very simple, being the *udja*, a strong stick about two yards in length, and sharpened at one end—the implement of the men; and the *udja-sab*, which is used by the women, a kind of small spade. The Papuans have throughout the year a rotation of fruit and vegetables. Every day the women go forth to fetch from the plantations what is necessary for the same evening and the following morning. The coast people have the most property in cultivated land, while the islanders are chiefly employed in the manufacture of pots, dishes, and canoes.

Among the Papuans of Maclay Coast there exists neither trade nor a regular system of barter. If, for instance, the coast people visit their neighbours or the people of the hills, or the islanders, they bring with them as a present all the superfluous articles which they possess, and on their departure receive as presents productions of the village which they have visited. Maclay has never seen one single present given or demanded in return for an equivalent gift.

Not many villages are in possession of *pirogues* (canoes), because most of those on the coast are situated in the neighbourhood of a surf so strong as to make landing impossible. The canoes are hewn out of a single tree-trunk, and have an outrigger (Aussengestell), and are manned by two rowers. The inhabitants, however, of Bili-Bili and of the "Archipelago of Contentment," build larger canoes, provided with two masts, "raking" one fore, the other aft. In these canoes the aborigines can sail with the most unfavourable winds. The large sail consists of a pandanus[1] mat, and split bamboo and lianas serve as sheets and shrouds. The anchor is a piece of a tree-trunk, of which four or five branches encircling it, after being cut short and sharpened to a point, serve as the "flukes," and is weighted by means of a number of stones attached to the shank by a sort of basket-work. Neither the coast people nor the inhabitants of the hills undertake voyages of any considerable extent.

With a few words on the daily life of the Papuans this article must be brought to a close. The Papuan of Maclay Coast marries early, and leads, morally speaking, a most model life, extra-connubial alliances being seldom, or never, formed. The marriage settlements are very simple, the bridegroom making, on agreement with the bride's family, a few presents, such as dishes and dyed cloths. A few days after, a pig or a dog is slain, the marriage feast is celebrated, and the young man takes his bride off to his hut. There is a much simpler procedure, the event being marked by no feast, when a man divorces his wife because she is unable to work, perhaps on account of lameness, for he simply sends her off and takes another. In other respects the men treat their wives well, for it is very seldom that a wife is beaten! The women, however, do all the hard work and carry heavy burdens, so that the freshness and healthiness of youth soon passes away. The children are very cheerful, and seldom scream. They are more petted by the father than by the mother, and Maclay has actually seen, what is very uncommon among savages, toys, in the shape of model canoes, and a kind of top. They, however, in childhood learn all the pursuits of manhood, and early accompany their father into the plantations or on his fishing excursions. It is a comical, though not uncommon sight, to see a boy of four years old gravely tend the fire, fetch wood, clean the dishes, help his father to peel fruit, and then, on the entrance of his mother, run to her and begin to take the breast. The women suckle for far too long a time, which, more than even overwork, is the cause of their having such small families. The day of the Papuan begins with the early dawn, and he loves the crow of the cock which heralds the approach of day. Even if he has nothing particular to do, off he goes to the shore, while it is yet dusk, enveloped in his *mal*, and with chattering teeth awaits the sunrise. When his wife is already off to the plantation, he lingers over his breakfast, and then either chews betel or smokes a green cigar. About ten o'clock the men depart to their various occupations; and if a visit be paid to a village at noon, not a human being will be seen, but a dog or a pig or two will come out and inspect the intruder, and then disappear again. About four or five in the afternoon the men return, dripping from their daily bath. In spite of numerous skin diseases the Papuans can scarcely be termed dirty, for they daily, often several times a day, take a bath and rub their skin with sand or grass. Later on in the evening come their wives, sweating and staggering under their heavy burdens. Supper is then made ready. Into the *pot-au-feu* are emptied the most incongruous food stuffs, reminding us almost of the "ingredients" of the witches' caldron in "Macbeth," *e.g.* beetles, snails, crabs, caterpillars, and small lizards! On these collocasia or dioscorea are put, and over all water, a third part being sea-water, is poured, and the pot, covered with green leaves, is then set on the fire to boil. When all is ready, the master of the house distributes the portions, the worst morsels to his wife and children, reserving the best for himself and his guests. In order to obtain a *soupçon* of saline flavour, the brine is drunk in which the food was cooked. After a cigar or a quantum of betel, the men retire to rest, previously taking care to light a fire under their bedsteads. So passes away the day of the Papuan, varied only by an occasional excursion, or a feast, or a preparation for war.

JOHN C. GALTON

[1] *Pandanus* is the generic term for the family of Screw-palms.—J. C. G.

NOTES

THE first of the series of the free science lectures in connection with the Loan Collection of Scientific Instruments was given on Saturday evening at eight o'clock. The notice issued was but short, yet the room was not only as full as it could be, but the crowd was such that if space for 1,000 had been provided, all the places would have been occupied. The lecturer, as we announced, was Prof. Roscoe, and his subject was "Dalton's Instruments, and what he did with them." The following gentlemen have already volunteered to give their valuable assistance for future lectures, which will take place on Monday, Tuesday, and Saturday evenings at 8 o'clock:—Prof. F. A. Abel, F.R.S., President of the Chemical Society, Capt. Abney, R.E., F.R.S., Prof. Roscoe, F.R.S., Dr. Warren De la Rue, F.R.S., Prof. G. Carey Foster, F.R.S., President of the Physical Society, Dr. J. H. Gladstone, F.R.S., Prof. Guthrie, F.R.S., Mr. J. Baillie Hamilton, Mr. Norman Lockyer, F.R.S., Rev. R. Main, M.A., F.R.S., the Right Hon. Lord Rayleigh, F.R.S., Dr. W. J. Russell, F.R.S., Mr. W. Spottiswoode, M.A., F.R.S., Dr. W. H. Stone, Rev. S. J. Perry, F.R.S., the Right Hon. Lyon Playfair, M.P., F.R.S., the Right Hon. the Earl of Rosse, F.R.S., Mr. C. V. Walker, F.R.S., Mr. W. C. Roberts, F.R.S., Mr. W. H. Preece. The next lecture will be given on Saturday evening by Prof. Guthrie, On Cold; on Monday the Rev. S. J. Perry will lecture On the Transit of Venus Instruments. It is proposed to give the following demonstrations on Saturday, Monday, and Tuesday next:—11 A.M., Marine Engines in Motion; 11.30, Fog Horns, Electric Light, Spectrum of Electric Light; 12.45 P.M., Time Gun; 1.30, Radiometers; 2 to 5, Pictet's Ice-making Machine; 2.30, Orreries; 3, Sir J. Whitworth's Millionth Measuring Machine and True Planes (Monday only); 3.30, Electric Light, Musical Instruments (Monday only), Ancient Musical Instruments (Tuesday only); 4.30, the *Times* Type-Composing Machine; 7.30, Telegraphic Apparatus (Monday and Tuesday only); 8, Sir J. Whitworth's Machines (Monday only); 8 to 9, Little Basses' Lighthouse; 8, Lecture in Conference Room (Saturday and Monday). In the list of papers read on Tuesday week we omitted to mention those of Dr. C. B. Fox, "On the Employment of Aspirators in Atmospheric Ozonometry," and Mr. J. Allan Broun "On Barometric Variations and their Causes." On Thursday, besides the papers already mentioned, Dr. Rae made a communication on Arctic Maps. On Friday Mr. W. S. Mitchell read a paper on the MS. tables and maps of William Smith. On Whit Monday 11,964 people visited the Collection; on Tuesday the number was 5,656.

AT the meeting of the American Academy of Science, on March 8, the president, Hon. Charles Francis Adams, presented the Rumford medals (in gold and silver) to Dr. John W. Draper, for his researches in radiant energy. In presenting the medals, the president alluded, among other matters, to Dr. Draper's discovery, in 1840, of the peculiar phenomena commonly known as Moser's images, to his method of measuring the intensity of the chemical action of light, afterwards perfected and employed by Bunsen and Roscoe in their investigations, and especially to his elaborate investigation, published in 1847, in which Dr. Draper established experimentally several important facts in spectrum analysis.

ON Thursday, June 1, M. Dumas, the eminent chemist, delivered his inaugural address, as the new member of the Académie Française. M. Dumas read in a clear and impressive tone. His task was to deliver an *éloge* on M. Guizot, whose career touched science at very few points. M. Dumas accomplished his duty with perfect tact, and used language which his hero would have wholly approved.

AT a meeting recently held in Sydney it was resolved to obtain subscriptions to enable Signor D'Albertis to carry out a scheme for the exploration of New Guinea. This well-known naturalist and explorer proposes to ascend the Fly river to the centre of the island, where very probably the river has its sources, and to find his way back by land to Yule Island or Port Moresby. The journey altogether will probably last from eight to twelve months, and he would require a steam-launch, 35 or 40 feet long, with furnaces for burning wood, besides a small contingent of men. He will obtain all possible information as to the geography, fauna, flora, and mineralogy of the district traversed. Signor D'Albertis offers himself to subscribe at least 200*l*. to the expedition. The New South Wales Government, we are glad to see, has put the steam-launch *Neva* at Signor D'Albertis' disposal, and we have no doubt that by this time the very moderate sum required has been subscribed.

SIR JOSEPH WHITWORTH was on Thursday last presented with the freedom of the Turners' Company.

AT the last meeting of the Lisbon Commercial Association it was proposed to ask the Government to send an expedition to carry out Lieut. Cameron's projects, starting from Angola. The suggestion was made that scientific men should accompany the expedition.

THE President and Council of the Geological Society hold a reception on Saturday evening at the Society's rooms, Burlington House.

AMONG the passengers in the mail steamer *Arcturus*, which sailed from Leith on the 2nd inst. for Iceland, are Prof. Jonstrup, M. Fieldberg, surveyor, and M. Gronlund, botanist. On arriving at Iceland these gentlemen are to be joined by Lieut. Njdal, of the Danish gunboat on the station, and an expedition is to be formed to proceed to the scene of the recent volcanic eruption.

ON Saturday afternoon the annual meeting of the Board of Visitors of the Royal Observatory, Greenwich, was held, at which the report of the Astronomer Royal, Sir G. B. Airy, was read.

REGULAR courses of lectures have been established at the Naval Observatory, Montsouris, for the officers of the French national navy attached to the establishment. The general principles of Astronomical Observations are lectured upon by M. Loewy; Special Naval Methods, by Capt. Turquet, the Director of the establishment; Terrestrial Magnetism, by M. Marié Davy, Director of the Montsouris Observatory; Spectroscopy, by M. Cornu; Photography in its Application to Astronomy, by M. Angot, of the National Observatory of Paris. All the observations made by the pupils are submitted to correction, and will be utilised as far as possible for the improvement of *Connaissance des Temps*.

THE Municipal Council of Paris voted some time since money for organising a number of meteorological observatories, to be modelled after the Montsouris pattern, and to be located in the several districts of Paris. The Prefect of the Seine has appointed a Commission, to organise these observatories on the top of several public buildings, divided as far as possible from among the several districts.

A TESTIMONIAL was recently presented at Wisbech to Mr. S. H. Miller, F.R.A.S., F.M.S. The testimonial, subscribed for by a large number of gentlemen in the district, is of the value of about 100*l*., and the inscription on the plate states that it is "presented as some acknowledgment of the value of the services he has rendered to the interests of education, science, and agriculture."

THE French Senate and the French Chamber of Deputies, are both of them busy with educational matters. The Government has proposed to the Senate to restore the National Institute of Agriculture, which had been established at Versailles by the second Republic but was abolished by the Empire. The Chamber of Deputies has voted, after a very interesting address delivered by M. Waddington, the Minister for Public Instruction, the first reading of a Bill restoring to the Government the right of appointing examiners for granting honours to the pupils of the so-called Free Universities.

THE volume of the *Zoological Record* for 1874 has just reached us. Under the editorship of Mr. E. C. Rye, Librarian to the Royal Geographical Society, Mr. E. R. Alston has undertaken the Mammals, Mr. R. B. Sharpe and Dr. Murie the Birds, Mr. O'Shaughnessy the Reptiles and Fish, Prof. E. von Martens the Molluscs and Crustacea, Rev. O. P. Cambridge the Arachnida, Mr. Rye the Myriapoda and Insects, whilst Dr. C. F. Lütken has taken the lower Invertebrata. Mr. Rye acknowledges a grant of 100*l.* from the British Association and 50*l.* from the Zoological Society towards the expenses of the *Record.*

THE Watford Natural History Society now numbers 170 members of all classes.

THE conductors of the Botanical Locality Record Club have shown themselves amenable to criticism, and have rendered their proceedings much less obnoxious to the objection at one time raised against them, that they were doing their best to promote the extirpation of rare plants. Their Annual Report for 1875, just issued, is a valuable publication. It is divided into five parts. In the first division they give new "County Records" of various species and sub-species, very few special localities being given; in the second, a "General Locality List," including all observations of interest made during the year; in the third, a list of "Extinctions, Reappearances, and Confirmatory Records;" in the fourth, a list of "Aliens, Casuals, and Escapes;" in the fifth, "County Catalogues of Plants;" those in the present month being Merioneth and Montgomery and Stirling. In the case of three counties, North Lincoln, Stirling, and Roxburgh, there is in the present Report an addition of upwards of fifty species of flowering plants and Vascular Cryptogams to those previously recorded. The divisions of counties are those adopted by Mr. H. C. Watson. There ought soon to be but little addition possible to our knowledge of the distribution of British plants.

DURING the coming summer (July and August) opportunity will be given at Cincinnatti Observatory, University of Cincinnati, for the study of Higher Analysis, Spherical and Practical Astronomy, and Celestial Mechanics. These advantages are intended, primarily, for teachers who may desire to spend their vacation in the pursuit of studies connected with their own work. Special attention will be paid to the art of computing, in order to give an insight into the practical application of mathematics to astronomy. Opportunity will also be afforded to learn the use of instruments. The Americans certainly seem to be ahead of us in the opportunities they devise for varied practical scientific work.

MESSRS. JARROLD AND SONS will shortly publish "Rambles of a Naturalist in Egypt and other Countries," by Mr. J. H. Gurney, jun.

ON the 29th and 30th inst. an interesting trial of the sagacity, activity, and docility of Collie dogs will take place at the Alexandra Palace. The dogs will be tried successively in the management of one hundred Welsh wethers.

To those of our readers who are fond of either the rod or the gun, and who intend to spend their holidays in Scotland, we strongly recommend Mr. Watson Lyall's "Sportsman's and Tourist's and General Guide to the Rivers, Lochs, Moors, and Deer Forests of Scotland." It contains a vast amount of information, including frequent details as to the natural features and objects of antiquarian interest in the various districts. Those who cannot take a holiday will be quite refreshed by an occasional dip into it at the season when "everybody" is supposed to be out of town. A special large-scale extremely well-constructed map of Scotland accompanies the "Guide," as also a map of England.

BENTLEY AND TRIMEN'S "Medicinal Plants" has now advanced as far as the seventh part. Each part contains seven or eight coloured plates, with full descriptions of plants which are officinal in the pharmacopœias of England and the United States. The quality of both letter-press and figures is well maintained; and when complete the work will be an absolutely indispensable one to the pharmacologist.

"THE Work and Problems of the Victoria Cave Exploration" is the title of an interesting paper read recently by Mr. R. H. Tiddeman before the Geological and Polytechnic Society of the West Riding of Yorkshire. It is printed by McCorquodale and Co., Leeds.

A WORK entitled the "Anatomia dell' Ape," by Clerici, has been recently published at Milan under the auspices and special supervision of the Central Italian Bee-keepers' Association. This highly interesting publication consists of a series of thirty beautiful chromo-lithographic plates, 8 inches wide by 12 inches high, artistically produced, with admirable frontispiece for binding. We understand that the execution of this anatomical work his occupied considerable time, and that prizes have been awarded to it at the Vienna Exhibition and elsewhere. In connection with this we may note the receipt of a useful little "Manual of the Apiary," by Mr. A. J. Cook, of the Michigan State Agricultural College.

WE are glad to see from the 62nd Annual Report of the Royal Geological Society of Cornwall that that Society continues to be prosperous and useful.

THE Twenty-Second Annual Report of the Brighton and Sussex Natural History Society, which is in a prosperous condition, contains the following among other papers:—"On Recent Excavations at Cissbury," by Mr. Ernest Willett; "On Wingless Birds," by Mr. T. W. Wonfor; "What is a Brachiopod?" by Mr. T. Davidson, F.R.S.; and on "The Birds and Mammals of Sussex," by Mr. F. E. Sawyer.

AN English translation has been published of Lieut. Weyprecht's admirable address given at Graz last September, on the "Fundamental Principles of Arctic Exploration," of which we gave an abstract at the time. We believe it may be obtained in London from Trübner and Co.

THE additions to the Zoological Society's Gardens during the past week include an Ocelot (*Felis pardalis*) from Para, presented by Mr. W. A. Sumner; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. C. H. A. Forbes; four Fawn-coloured Field Mice (*Mus cervicolor*) from India, presented by Col. C. F. Sturt; a Blue Jay (*Cyanocitta cristata*) from North America, a Chinese Jay Thrush (*Garrulax chinensis*) from China, presented by Mr. E. Hawkins; two Barnard's Parrakeets (*Platycercus barnardi*) from Australia, deposited; a White-throated Capuchin (*Cebus hypoleucus*) from South America, a White-bellied Sea Eagle (*Haliaëtus leucogaster*) from Australia, a Derbian Screamer (*Chauna derbiana*), two Green-billed Curassows (*Crax viridirostris*), a Red-billed Tree Duck (*Dendrocygna autumnalis*) from Cartagena, purchased; a Bonnet Monkey (*Macacus radiatus*), born in the Gardens.

LOAN COLLECTION OF SCIENTIFIC APPARATUS

SECTION—MECHANICS

PRIME MOVERS [1]

THE subject on which I have now the honour to address you, the subject which is to occupy our attention to-day, is that of prime movers, that is to say, we are about to consider that class of machines which, to use the words of Tredgold, "enable the engineer to direct the great sources of power in nature for the use and convenience of man."

Although machines of this kind are, in truth, mere converters or adapters of extraneous forces into useful and manageable forms, and have not any source of life, power, or motion, in themselves, nevertheless they impress us with the notion of vitality; and it is difficult to regard the revolving shaft of a water-wheel or turbine, set in motion by some hidden stream, or to gaze upon the steam-engine actuated by an unseen vapour, without, as I have said, the idea being raised in our minds that the machines on which we are looking are really endowed with some kind of life.

The invention of such machines marks a very great step in the progress of mechanical science in the world, as it commences an era distinct from that in which mere machines to be acted on by human or animal muscular force were alone in existence. Machines such as these, highly useful as they may be, are, after all, only tools or implements more or less ingenious and more or less complex.

Mankind could not have been very long upon the earth before they must have found the need and must have discovered the utility of some kind of tool or implement; they must soon have found that the direct action of the power of the arm, which was not enough by itself to break up some obstacle, became sufficient if that action were applied by the wielding of a heavy club, or through the putting into motion of a large stone, and thus the hammer or its equivalent must have been among the earliest of inventions. Such an implement must soon have taught its users that muscular force could be exercised through a considerable space, could be stored up, and could be delivered in a concentrated form by a blow.

Similarly it could not have been long before it must have been found that to raise water in the hollow of the hand by repeated efforts was not so convenient a mode as to raise it in a bent leaf or in a shell, and in this way another implement would speedily be invented. We might pursue this line of speculation, and doing so we should readily arrive at the conclusion that (without attributing to the early inhabitants of the earth any profound acquaintance with mechanics) the hammer, the lever, the wedge, and other simple tools and utensils, must soon have come into existence; and we should also be led to believe that when, even with the aid of tools such as these, a man singly could not accomplish any desired object, the expedient of combining the power of more than one man to attain an end would soon be thought of, and that the requisite appliances, such as large beams used as levers, numerous ropes (which must very early in the history of the world have been twisted from filaments) and matters of that kind, would come into use. For a corroboration of this view, if one were wanted, the fact may be cited that on the discovery of any isolated savage community it always is found to have advanced thus far in mechanical art.

But passing from such machines as these, which are rather of the character of tools and implements, than machines, as we now popularly use the word, one knows that even complicated mechanism for the purpose of enabling muscular force to be more readily applied, is of very ancient date. On this point I will quote from only one book, that is the Bible, where, at the 10th and 11th verses of the 11th chapter of Deuteronomy, a statement is made clearly indicating that in Egypt irrigation was carried on by some kind of machine worked by the foot; whether the treadwheel with water-buckets round about it mentioned by Vitruvius, or whether the plank-lever with a bucket suspended at one end and worked by the labourer running along the top of the lever to the other end (an apparatus even now used in India), we do not know; but that it was some machine worked by the foot is clear, the statement being that when the Israelites had reached the Promised Land they would find it was one abounding in streams, so as to be naturally watered, and that it would not require to be watered by the foot as in Egypt. Again, in Chronicles it is related that King Uzziah loved husbandry, and that he made many engines, unhappily not in connection with agriculture, but for warlike purposes, "to shoot arrows and great stones withal." Further, in the 7th chapter of the Book of Job, we have the comparison of the life of man passing away swifter than a weaver's shuttle; this points unmistakeably to the fact that there must in those days have been in existence a loom capable of weaving fabrics of such widths that the shuttle required to be impelled with a speed equal to a flight from one side of the fabric to the other, and no doubt such a fabric must have been made in a machine competent at last to raise and depress alternately the halves of the warp threads. The potter's wheel also is frequently mentioned in the Bible.

Such instances as these are sufficient to show that considerable progress must have been made in the very earliest days of history in the construction of machines whereby muscular force was conveniently applied to an end; but if we leave out of account, as we fairly may, the action of the wind in propelling a boat by sails, and the action of the wind in winnowing grain, I think we shall be right in considering that in the times of which I have been speaking there did not exist any machine in the nature of a power-giver or prime mover.

Doubtless the want of a greater force than could be obtained from the muscles of one human being must have soon made itself felt; and intelligent men, conscious of their own ability and of their mental power of directing a large amount of work, must have been grieved at finding the use of that power circumscribed by the limited force of their own bodies, and therefore early in the world's history there must have been the attempt, by the offer of some consideration or reward, to induce other men (men gifted with equal or stronger muscles, but probably not with equal minds) to work under the directions of these men of superior intelligence. But when such aid as this became insufficient, the way in which, in all probability, the people of those days endeavoured to satisfy the further demand would be to make captives of their enemies and to reduce them into a state of bondage, to grind at the mill, to raise water, or, yoked by innumerable cords and beams to some heavy chariot or sledge, to draw along the huge blocks required in the foundations of a temple, or for the building of a pyramid, or to act in concert on the many oars of a galley, although by what means this last-named operation was performed is not very clear. Doubtless under this condition of things there must have been an amount of human suffering which is too frightful to be contemplated.

Such machines as those to which I have called attention could not have been invented and brought into use without the exercise of much mechanical skill; but considerable as this skill must have been it had never originated a prime mover; it had given no source of power to the world, but had left it dependent on the muscular exertions of human beings and of animals.

Great, then, was the step, and a most distinct era was it in mechanical science, when for the first time a prime mover was invented and a machine was brought into existence which, utilising some hitherto disregarded natural force, converted it into a convenient form of power, by which as great results could be obtained as were obtainable by the aggregation of a large number of human beings, and could be obtained without bondage and without affliction.

There are probably few sights more pleasing to one who has been brought up in factories than to watch a skilful workman engaged in executing a piece of work which requires absolute mastery over the tools that he uses, and demands that they should have the constant guiding of his intelligent mind. Handicraft work of such a kind borders upon the occupation of the artist, and to see such work in the course of execution is, as I have said, a source of pleasure. But when descending from this the work becomes more and more of the character of mere repetition, and when it is accomplished by the aid of implements which, from their very perfection require but little mind to direct them, and demand only the use of muscle, then, although the labour, when honestly pursued, is still honourable, and therefore to be admired, there comes over one a feeling of fear and of regret that the man is verging towards a mere implement. But when one sees, as I have seen in my time, in England, and as I have seen very recently on the Continent, men earning their living by treading within a cage to cause it to revolve and thereby to raise weights, an occupation demanding no greater exercise of intelligence than that which is sufficient to start, to stop, and to reverse the wheel at the word of command, one does indeed regret to find human beings employed in so low an

[1] Address delivered by F. J. Bramwell, C.E., F.R.S., one of the vice-presidents of the Section, May 25.

occupation, an occupation that places them on a level with the turnspit. It is one which is most properly meted out in our prisons as a punishment for crime, accompanied, however, with the degradation that the force exerted shall be entirely wasted in idly turning a fan in the free air, and thus the prisoner, in addition to the fatigue of his body, undergoes the humiliation of, as he expresses it, "grinding the wind."

If they played no other part than that of relieving humanity from such tasks as these, prime movers would be machines to be hailed.

True it is that the labourers who were thus relieved would not thank their benefactors, and indeed so far as the individuals subjected to the change were concerned they would have cause not to thank them, because they having been taught no other mode of earning a livelihood, and finding the mode they knew set on one side by the employment of a prime mover, would be at their wit's end for a means of subsistence, and would be experiencing those miseries which are caused by a state of transition. But in some way the men of the transition state must be relieved, and in the next generation, it no longer being possible to subsist by such wholly unintelligent labour, the energies of their descendants would be devoted to gaining a livelihood by some occupation more worthy of the mind of man.

Early prime movers, from their comparatively small size, probably did little more than thus relieve humanity; but when we come to consider the prime movers of the present day, by which we are enabled to contain within a single vessel and to apply to its propulsion 8,000 indicated horse-power, or an equivalent of the labour of nearly 50,000 men working at one time, we find that the prime mover has another and most important claim upon our interest: it enables us to attain results that it would be absolutely impossible to attain by any aggregation of human or other muscular effort, however brutally indifferent we might be to the misery of those who were engaged in that effort.

Excluding from our consideration light and even electricity, as not being, up to the present time, sources of power on which we rely in practice, there remain three principal groups into which our prime movers may be arranged, viz., those which work by the agency of wind, those which work by the agency of water, and those which work by the agency of heat. But some of these great groups are capable of division, and indeed demand division into various branches.

Water power may be due to the impact of water, as in some kinds of water-wheels, turbines, and hydraulic rams, or to water acting as a weight or pressure, as in other kinds of water-wheels, and in water-pressure engines; or to streams of water inducing currents, as in the case of the jet-pump, and of the "Trombe d'eau," or to its undulating movements, as in ocean waves. The ability of water to give out motive force may arise from falls, from the currents of rivers, from the tides, or, as has been said, from the oscillation of the waves.

Prime movers which utilise the force of the wind are few in number and in all cases act by impact.

As regards those prime movers which work by the aid of heat, we may have that heat developed by the combustion of fuel, and being so developed applied to heating water, raising steam, and working some of the numerous forms of steam-engines; or, as in the case of the Giffard injector, performing work by induced currents, by the flow of steam; or we may have the heat of fuel applied to vary the density of the air, and thus to obtain motion as by the smoke-jack; or the fuel may be employed to augment the bulk and the pressure of gases, as in the numerous caloric engines; or we may have heat and power developed in the combustion of gases, as in the forms of gas-engines; or in the combustion of explosives, as in gunpowder, dynamite, and other like materials, used not only for the purposes of artillery and of blasting, but for actuating prime movers in the ordinary sense of the word.

Again, we may have the heat of the sun applied through the agency of the expansion of gases or surfaces to the production of power, as in the sun-pumps of Solomon de Caus and of Belidor, and as in the sun-engine of Ericsson. Finally, we may have the sun's rays applied direct, as in the radiometer of Mr. Crookes.

A consideration of the foregoing heads, under which prime movers range themselves, will speedily bring us to the conclusion that the main centre of all mechanical force on this earth is the sun. If the prime movers be urged by water, that water has attained the elevation from which it falls, and thus gives out power by reason of its having been evaporated and raised by the heat of the sun. If the power of the water be derived from the tidal influence, that influence is due to the joint action of the sun and the moon.

If the prime mover depend upon the wind for its force either directly, as in windmills, or indirectly, as in machines worked by the waves, then that wind is caused to blow by variations of temperature due to the action of the sun. If the prime mover depend upon light or upon solar heat, as in the case of the radiometer and of the sun engine, then the connection is obvious; but if the heat be due to combustion, then the fuel which supports that combustion is, after all, but the sun's rays stored up. If the fuel be, as is now sometimes the case, straw or cotton stalks, one feels that they have been the growth of the one season's effect of the sun's rays. If the fuel be wood, it is equally true that the wood is the growth of a few seasons' exercise of the sun's rays, but if it be the more potent and more general fuel coal, then, although the fact is not an obvious one, we know that coal also is merely the stored up result of many ages exercise of solar power.

And even in the case of electrical prime movers, these depend on the slow oxidation, that is burning, of metal which has been brought into the metallic or unburnt state from the burnt condition (or that of ore) by the aid of heat generated by the combustion of fuel.

The interesting lecture-room experiment with glass tubes charged with sulphide of calcium, or other analogous sulphides, makes visible to us the fact that the sun's rays may be stored up as light; but that they are as truly stored up (although not in in the form of light) in the herb, the tree, and the coal we also now know; and we appreciate the far-seeing mind of George Stephenson who astonished his friend by announcing that a passing train was being driven by the sun. We know that Stephenson was right, and that the satirical Swift was wrong when he instanced as a type of folly the people of Laputa engaged in extracting sunbeams from cucumbers. The sunbeams were as surely in the cucumbers as they are in the sulphide of calcium tubes, but in the latter case they can be seen by the bodily eye, while in the former they demand the mind's eye of a Stephenson.

Although the sailing of ships and the winnowing of grain must from very early time have made it clear that the wind was capable of exercising a moving force, nevertheless, being an invisible agent, it is not one likely to strike the mind as being fit to give effect to a prime mover, and therefore it is not to be wondered at that prime movers actuated by water are those of which we first have any record, unless indeed the toy steam-engine of Hiero may be looked upon as a prime move anterior to those urged by water. It would appear that in the reign of Augustus water-wheels were well known, for Vitruvius, writing at that time, speaks of them as common implements, but not so common as to have replaced the human turnspit, as we gather from his writings that the employment of men within a tread-wheel was still the most ordinary mode of obtaining a rotary force. It would seem, however, that water-wheels driven by the impact of the stream upon pallet boards were employed in the time of Augustus not merely to raise water by buckets placed about the circumference of the wheels, but also to drive mill-stones for grinding wheat, and Strabo states that a mill of this kind was in use at the palace of the King of Pontus.

(*To be continued.*)

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, No. 2, 1876.—In the opening paper of this number Dr. König describes a series of researches in which he sought to study more closely the phenomena which occur when two sets of sound-waves meet in air; using sources of sound that were entirely isolated and could not act directly on each other, nor in common on a third body; he also chose sources that would give as simple tones as possible. The paper is in four parts, treating, severally, of primary beats and beat-tones, secondary beats and beat-tones, difference-tones and summation tones, and the nature of beats and their action, compared with the action of primary impulses. On the last head he finds, *inter alia*, that beat-tones cannot be explained by the cause of difference and summation tones, and that the audibility of beats depends only on the number and intensity of the primary tones, not at all on the width of the interval. The number of beats and primary impulses with which both may be perceived as separate impulses is the same; so, too, with the number at which beats and primary impulses pass into a tone. Intermittences of a tone, as well as beats and primary impulses, may pass into a tone, and the periodic maxima of vibration of a tone, when in sufficient number. The beat tone formed by two primary tones must be always weaker than these, though separate beats are stronger than the tones forming them.—In M. Grotrian's researches on the constants of friction of some salt solutions, and their relations to galvanic conductivity, the method for ascertaining the constants was that of observing the oscillations of a suspended disc with attached magnet (under the influence of a neighbouring magnet) in air and in the liquid examined. The observed generally similar course of temperature coefficients for fluidity and galvanic conductivity, with change of concentration, leads the author to conclude that the overcoming of internal friction forms an essential part of the work done by a current in passage through an electrolyte. In the case of chloride of potassium, it is found that the increase of conductivity is almost exactly proportional to the per-centage proportion (in the liquid); and M. Grotrian infers that the chemical changes he conceives generally to occur in chemical constitution of electrolytic molecules, on altering the concentration, do not occur here, but that with varied concentration, at the same temperature, the conductivity is only conditioned by the proportion of salt and the viscosity. With the numbers obtained in the experiments, it is possible to estimate for variously concentrated solutions of a salt, the temperatures for which the constants of friction have some determinate constant value; then to calculate the numbers for the conductivity at this temperature, and inquire according to what law these alter with the concentration. He thus shows that in the case of NaCl, KaCl, $CaCl_2$, and $BaCl_2$, the concentration and the viscosity are the principal factors which determine the amount of the conductivity.—In the next paper M. Wiedemann makes some adverse criticism on the recent researches of some French physicists in the domain of magnetism.—M. Holtz shows that wire-net is very well suited for proving that in the interior of conducting surfaces there is no electrostatic action. In one experiment, a bell-shaped cover, made of the net, is brought down by an insulating handle on an insulated metallic disc connected with an electric machine, and on which stands a pith-ball electrometer. The two balls do not diverge in the least on working the machine; but if the bell be removed, they do so at once. He shows further, how such a bell is like a filter or sieve, holding back the electricity while it affords partial passage to gaseous matter or dust. If a metallic point connected to earth be brought near the electrified bell, the balls are moved, but do not diverge, &c.—Dr. Wichmann studies the properties of doubly-refracting garnets; and we note a paper by Dr. Sohncke on the figures eaten out by dissolving liquids on blocks of rock salt, and Exner's method for producing solution-figures.—There is an account of an interesting inquiry, lately conducted by Dr. W. Siemens, on the velocity of propagation of electricity in suspended wires.

Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire. New Series. Part 2. Pp. 57 to 112.—This part contains several very interesting papers on various points of local geology. Some of the papers will be of use to a wide circle of readers, such as Mr. C. Bird's on the red beds at the base of the carboniferous limestone in the north-west of England, and Prof. Green's on the variations in thickness of the Silkstone and Barnsley coal seams in the southern part of the Yorkshire coal-field, and the probable manner in which these and similar changes have been produced. Mr. Bird considers it better to regard the red beds in question as basement beds of the carboniferous limestone than to attempt to draw any arbitrary line in a series whose members appear so closely linked together. Mr. Tiddeman's concise account of the work and problems of the settle Victoria cave exploration will also be welcome. Five good plates accompany this number of the *Proceedings.*

Bulletin de l'Academie Royale des Sciences, 2 ser. tome 40, No. 12.—M. van Beneden contributes a long paper divided into six chapters on the early stages of the embryological development of mammals. In 1874 M. Beneden published his paper, in which he showed that in Hydractinia spermatozoids are derived from the ectoderm and ova from the endoderm. He suggested that the same law probably applied to vertebrata. Observations supporting his view with regard to Cœlenterata have been made by Koch and Fol, and M. Beneden has made embryological studies on the rabbit. A monograph with plates is promised. This paper is a *résumé.*—On the skeleton of a fossil whale in the museum at Milan, by P. J. van Beneden. Following up the descriptions of Pachyacanthus and Aulocetus already given, M. Beneden proceeds to describe the fossil found in 1806 at Mount Pulgnasco, preserved in the Milan Museum, figured by Cortesi and described by Cuvier. The description is accompanied by a plate, and there are references to fossil whales in the museums at Turin, Florence, Bologna, Parma, and Pisa.—On the period of cold of the month of December, 1875, by M. E. Quetelet.—On the Devonian sandstones of Condroz, in the Basin of Theux, in the basin between Aix-la-Chapelle and Ath, and in the Boulonnais. The paper is illustrated with a folding plate giving nine coloured sections, and its scope is to show that the beds of the different localities mentioned have the same relative stratigraphical relations as at Condroz. All of the subdivisions show a remarkable constancy in their petrological and palæontologica aspects.—On the description of some new birds, by M. Alph. Dubois. They belong to Cyanscitta and Icterus.—The theory of carnivorous and sensitive plants, by E. Morren. The article is a *résumé* of observations that have been made, and is well furnished with foot-notes. The index accompanies this number.

SOCIETIES AND ACADEMIES

London

Royal Society, May 18.—"Observations on Stratified Discharges by means of a Revolving Mirror, by William Spottiswoode, M.A., Treas. R.S.

In a paper published in Poggendorff's *Annalen*, Jubelband, p. 32, A. Wüllner has described a series of observations made, by means of a revolving mirror, upon the discharge of a large induction-coil through tubes containing ordinary atmospheric air at various degrees of pressure.

Wüllner's observations appear to have been directed rather to the nature of the coil discharge than to that of the stratifications.

For some time prior to the publication of the volume in question I had been engaged upon a series of experiments very similar in their general disposition, but with a somewhat different object in view, viz., the character and behaviour of the striæ; and of these, together with some recent additions, I now propose to offer a short account to the Society.

My general instrumental arrangements appear to have been similar to those of Wüllner; in fact, they could hardly have been very different. The tubes were attached to the coil in the usual way, and a contact-breaker of the ordinary form with its own electro-magnet was in the first instance used. For this and some other intermediate forms there was finally substituted a mercurial break (successfully arranged by my assistant, Mr. Ward), the plunger of which works on a cam attached to the axle of the mirror, so that the action of the contact-breaker is regulated by that of the mirror, instead of the reverse as in the former arrangement. With the broader tubes a slit was used; with the narrower this adjunct was less necessary; while with capillary tubes, such as are used for spectrum-analysis, it could be dispensed with altogether.

Striæ, as observed by the eye, have been divided into two classes, viz., the flake-like, and the flocculent or cloudy. Of the former, those produced in hydrogen tubes may be taken as a type; of the latter, those produced in carbonic tubes. But upon examining some tubes especially selected for the purpose, it was found that, while to this apparent a real difference corresponds, a fundamental feature of the striæ, underlying both, was brought out.

The feature in question was this: that the striæ, at whatever points produced, always have during the period of their existence a motion along the tube in a direction from the negative towards the positive terminal. This motion, which I have called for convenience the proper motion of the striæ, is for given circumstances of tube and current generally uniform; and its variations in velocity are at all times confined within very narrow limits. The proper motion in this sense appertains, strictly speaking, to the flake-like striæ only. The apparent proper motion of the flocculent striæ is, on the contrary, variable not only in velocity, but also in direction; and on further examination it turns out that the flocculent striæ are themselves compounded of the flake-like, which latter I have on that account called elementary striæ.

Elementary striæ are in general produced at regular intervals along the tube. The series extends from the positive terminal in the direction of the negative to a distance depending upon the actual circumstances of the tube and current. The length of the column, and consequently the number of the striæ, depends mainly upon the resistance of the tube, the duration of the entire current, and to a certain extent upon the amount of the battery surface exposed, and in that sense upon the strength of the current. The velocity of the proper motion, other circumstances being the same, depends upon the number of cells employed.

The paper next gave descriptions of the phenomena exhibited by several tubes; and drawings illustrative of the descriptions were added.

The following are some of the general conclusions to which the experiments detailed in the paper seem to lead:—

1. The thin flake-like striæ, when sharp and distinct in their appearance, either are short-lived or have very slow proper motion, or both.

2 The apparent irregularity in the distribution of such striæ during even a single discharge of the coil, is due, not to any actual irregularity in their arrangement, but to their unequal duration, and to the various periods at which they are renewed. The striæ are, in fact, arranged at regular intervals throughout the entire column. The fluttering appearance usually noticeable is occasioned by slight variations in position of the elementary striæ at successive discharges of the coil. With a view to divesting the coil discharge of this irregular character, as well as for other purposes, I devised two different forms of contact breakers (one of which is described in the Royal Society's *Proceedings*, 1874); but I postpone a description of the second, as well as of the experiments arising from its use, to another occasion.

3. The proper motion of the elementary striæ is that which appertains to them during a single discharge of the coil. This is always directed from the positive towards the negative terminal. Its velocity varies generally within very narrow limits. It is greater the greater the number of coils employed. In some tubes it may be seen to diminish towards the close of the discharge, and even in rare instances alternately to increase and to diminish during a single discharge.

4. Flocculent striæ, such as are usually seen in carbonic acid tubes, are a compound phenomenon. They are due to a succession of short-lived elementary striæ, which are regularly renewed. The positions at which they are renewed determine the apparent proper motion of the elementary striæ. If they are constantly renewed at the same positions in the tube, the flocculent striæ will appear to have no proper motion, and to remain steady. If they are renewed at positions nearer and nearer to the positive terminal, the proper motion will be the same as that of the elementary striæ; if they are renewed at positions further and further from the positive terminal, the proper motion will be reversed.

5. The velocity of proper motion varies, other circumstances being the same, with the diameter of the tube. This was notably exemplified in the conical tube. In tubes constructed for spectrum analysis the capillary part shows very slight, while the more open parts often show considerable proper motion.

6. Speaking generally, the discharge lasts longer in narrow than in wide tubes. In spectrum tubes the capillary part gives in the mirror an image extending far beyond that due to the wider parts.

7. The coil discharge appears, in the earlier part of its development at least, to be subject to great fluctuations in extent. In all cases there is a strong outburst at first. This, although sometimes appearing as a bright line, is always, I believe, really stratified. Immediately after this there follows a very rapid shortening of the column. The extent of this shortening varies with circumstances; but when, as is often the case, it reaches far down towards the positive terminal, a corresponding diminution of intensity is perceptible in the negative glow. The column of striæ, after rising again, is often subject to similar fluctuations. These, which are sometimes four or five in number, are successively of less and less extent, and reach only a short distance down the column or striæ. The rifts due to these fluctuations then disappear, and the striæ either continue without interruption, or follow broken at irregular intervals, until the close of the discharge.

8. The effect of the proper motion, taken by itself, is to shorten the column of striæ. But, as we have seen, the striæ are in many cases renewed from time to time. In regard to this point, the head of the column presents the most instructive features. After the cessation of these rifts, the general appearance of the field is that of a series of diagonal lines commencing at successive points which form the bounding limit of the column at successive instants of time. If the points are situated in a horizontal line, the striæ are renewed at regular intervals at the same place; and the length of the column is maintained by a periodic renewal of striæ, a new one appearing at the head of the column as soon as its predecessor has passed over one dark interval. If the boundary of the illuminated field rises, the length of the column increases; if it descends, the column shortens. In every case, however, the growth of the column takes place by regular and successive steps, and not irregularly. The intervals of the new striæ from one another and from the old ones are the same as those of the old ones from one another.

9. The principal influence of a change in the number of cells used appears to consist in altering the velocity of proper motion. A change in the amount of battery-surface exposed produces a corresponding change in the duration of the entire discharge, as well as apparently in the development of some of the minor details of the striæ.

10. When the proper motion of the elementary striæ exceeds a certain amount, the striæ appear to the eye to be blended into one solid column of light, and all trace of stratification is lost. When this is the case the mirror will often disentangle the individual striæ. But there are, as might well be expected, cases in which even the mirror is of no avail, but in which we may still suppose that stratification exists. A variety of experiments have led me to think that the separation of the discharge into two parts, viz., the column of light extending from the positive terminal, and the glow around the negative, with a dark space intervening, may be a test of stratified discharge; but I cannot affirm anything certainly on this point.

Chemical Society, May 18.—Prof. Abel, F.R.S., president, in the chair.—The first paper read was on the action of malt extract on starch, by Mr. C. O'Sullivan, showing that under these circumstances it is converted into a mixture of maltose and dextrin, the proportion of which varies with the temperature at which the reaction takes place.—A communication was then made by Dr. H. E. Armstrong and Mr. Gaskell on metaxenol, the metadimethylated phenol.—There were also papers on the gases enclosed in cannel coals and in jet, by Mr. J. W. Thomas, on phenomena accompanying the electrolysis of water with oxidisable electrodes, by Dr. J. H. Gladstone and Mr. A. Tribe, and on the estimation of hydrogen occluded by copper, with special reference to organic analysis, by Dr. J. L. W. Thudichum and Dr. H. W. Hake.

Meteorological Society, May 17.—Mr. H. S. Eaton, president, in the chair.—James Lloyd Ashbury, John Broun, John Brown, Edmund Cruise, James Eldridge, George Garnett, John Hopkinson, Robert Pickwell, William Ford Stanley, Rupert Swindells, Charles Tarrant, Thomas Taylor Smith, were elected fellows of the Society. The following papers were read:—Remarks on the present condition of maritime meteorology, by Robert H. Scott, F.R.S. This paper gives a history of all that has been done in maritime meteorology since the Brussels conference in 1853, up to the present time.—In the mean temperature of every day at the Royal Observatory, Greenwich, from 1814 to 1873, by James Glaisher, F.R.S. This paper, which is a continuation of former ones on the same subject, contains the observations for the ten years, 1864 to 1873, which being combined with the previous ones, give the mean for sixty years. On the meteorology of Mozufferpore, Tinhoot, for 1875, by C. H. Pearson.—New wind chart, by Lieut.-Col. G. E. Bulger.

Physical Society, May 13.—Prof. G. C. Foster, president, in the chair.—The following candidates were elected members of the Society:—Prof. T. Andrews, Rev. R. H. M. Bosanquet, M.A., and David Howard.—Mr. Thompson, B.A., B.Sc., concluded the communication on the supposed new force, which he commenced at the last meeting of the Society. In the arrangement which he has adopted for obtaining the spark, the secondary current of a Rhumkorff's coil is made to traverse a short coil of wire which is thoroughly insulated from the internal core, and into the circuit an arrangement is introduced by means of which the current may be made to traverse a variable thickness of air in its course round the short coil. It is found that if this spark is very short the spark obtained from the internal core is also short, but as we increase the thickness of air to be traversed, the spark which may be drawn off increases; the greatest effect, however, is produced when one terminal of the coil is connected with the earth, the spark then obtained being about half an inch in diameter. Mr. Edison considered that the spark was retro-active, but Mr. Thompson showed, by an experiment, that deficient insulation might lead to such a conclusion. He then proceeded to show that just as the charge given to a gold-leaf electroscope is at times positive and at times negative without any apparent reason for the change, so if the core of the arrangement employed be connected with a Thomson's galvanometer, the needle will be found to wander irregularly about the scale on both sides of the zero. In order to show that these experiments are identical with those conducted as originally described by the discoverer, the terminals of the induction coil were connected with the coil of an electro-magnet, the same means of including a layer of air in the circuit being introduced. The effect in this case was found to be precisely similar to that obtained with the special arrangement previously used; with a brush discharge a Geissler's tube could be illuminated, and, when the layer of air was infinitesimal, the spark produced was also infinitesimal. It was then shown that, if the spark at the point of contact in the key when a direct battery current traverses the coil be done away with by shunting the extra current which gives rise to it, no spark can be obtained from the core. It thus appears that no spark is obtained when there is no necessity for an inducing current to accumulate until it has sufficient tension to leap over a resisting medium, and that, as the thickness of this resisting medium increases, the spark obtained becomes greater. Evidently on these occasions the current has time to attract unlike and repel like electricity in the core, and if a conductor in connection with the earth be presented to this core, the like electricity will escape; hence a spark will result. As soon, however, as the tension has become sufficient to leap over the layer of air, it will be necessary to restore equilibrium in the core. Hence there will be a return spark in the opposite direction. From these experiments it will be seen that the phenomena observed may be explained by the ordinary laws of induction.

Institution of Civil Engineers, May 23.—Mr. Abernethy, vice-president, in the chair.—The paper read was on the permanent way of railways, by Mr. R. Price Williams.

Cambridge

Philosophical Society, May 8.—Mr. W. M. Hicks drew attention to some experiments of Messrs. Stewart and Tait on the heating of discs by rapid rotation in vacuo, and which they referred to the friction of the ether. It was shown that it was not necessary to have recourse to this explanation; that nearly all the effects could be accounted for if it is supposed that the disc, through the rapid rotation, has expanded and consequently been lowered in temperature; that whilst rotating it is raised to the temperature of the surrounding region; and therefore when the rotation is stopped, and the disc has shrunk to its former size, it will give out the heat it had taken in whilst rotating. In the case of silver it was shown that the disc ought to show a rise of ·4° C. if the rotation had been continued for some time, and this was compared with the rise of ·47° C. which Messrs Stewart and Tait had observed in an aluminium disc, thus showing that the effect was of the same order of magnitude in the two cases. It was also shown that if the whole heating were due to ethereal friction, that this friction would be ·0006 lbs. per square foot, and that if we suppose this amount to act on the surface of the earth, the day would be lengthened in the course of a century by something like ·006".—Prof. Maxwell afterwards made a communication on the equilibrium of heterogeneous substances.

Stockholm

Royal Academy of Sciences, Feb. 9.—Herr Gyldén communicated a transformation of the formula—

$$\left\{1 + 2l_1 \operatorname{Cos}\left[2\,am\,\frac{2K}{\pi} + \Lambda\right] + l_1^2\right\}^{-\frac{n}{2}}$$

which plays an important *rôle* in the method of deducing a general formula of perturbation for periodic comets worked out by him. This transformation is mainly grounded on the relation—

$$e^{\sqrt{-1}\,am\,\frac{2K}{\pi}} = e^{\sqrt{-1}\,x}\,\frac{\eta(-x)}{\eta(x)},$$

where

$$\eta(x) = \left(1 - qe^{2\sqrt{-1}x}\right)\left(1 - q^3e^{-2\sqrt{-1}x}\right)\left(1 - q^5e^{2\sqrt{-1}x}\right)$$

and upon certain algebraic relations between different η-functions. The final result is specially applicable when a comet comes to that part of its path which lies nearest the perturbing planets; in this case l becomes inconsiderably less than 1, and Λ may be taken to fall within exceedingly narrow limits in the neighbourhood of 0. The following papers were given in:—Myriopoda from Siberia and Waigat's Island, collected during Nordenskjöld's expedition, 1875, by Anton Stuxberg. Eighteen species are described, of which only one was previously known to exist in Siberia, and fifteen are new to science, viz.—Lithobius 10, Iulus 1, Polydesmus 2, and Craspedosoma 2. Of the twenty-seven Siberian species now known only two are European.—Determinations of geographical position during the Swedish expedition to Novaya Zemlya and the Kara Sea, 1875, calculated by E. Jäderin.—On monœcism in fishes, by A. W. Malm.—Prof. Borenius communicated magnetic observations made at Helsingfors simultaneously with those made by the Swedish expedition at Spitzbergen during the winter 1872–3.

Berlin

German Chemical Society, May 8.—A. W. Hofmann, president, in the chair.—E. Schunck and H. Römer by fusing Anthraflavinic and isoanthraflavinic acids with potash, have obtained two isomeric purpurines $C_{14}H_8O_5$. Anthrapurpurine is identical with a substance formerly obtained by Mr. Perkins; flavopurpurine obtained from the second of the two substances is the fourth isomeric purpurine.—A. Boettinger in studying anew the decomposition of tartaric acid by heat, believes that the formation of pyruvic acid is preceded by that of glyceric acid.—Dr. T. Stenhouse and C. E. Groves in treating pure naphthaline with sulphuric acid, obtained not only β-naphthaline-sulphurous acid, but also two napthaline-sulphones $C_{20}H_{14}So_2$, easily separated by sulphuret of carbon. They yield by oxidation two isomeric naphthaline-sulphuric acids.—T. Annaheim described dibromonitrooxysulphobenzid $(C_6H_2BrNO_2OH)_2SO_2$ and the corresponding iodo-compound. The same chemist described a red colouring substance obtained by the action of fuming sulphuric acid on cresol.—W. Rimarenko described β-chloronaphthaline obtained from β-naphthol and from β-naphthaline-sulphuric acid with PCl_5,—the method formerly described by M. Clare.—E. v. Gorup Besancy and H. Will have investigated the liquid secretion of insectivorous plants (Nepenthes phyllaniphera). Albumine, fibrine, &c., are transformed into peptone. This digestion takes place in a very short time, when the secreting organ of nepenthes has been excited by contact,—the liquid having under these circumstances an acid reaction. The secretion of non-excited glands is rendered equally active by the addition of any acid, particularly of malic and citric acids.—H. Vogel published researches on the influence of different rays of light on bromide of silver.—F. Tiemann and N. Matsnold have prepared nitro-protocatechic acid and some of its derivatives, also nitro-vanillinic acid and acetyl-nitro-vanillinic acid.—F. Tiemann and C. Reimer have obtained paraoxybenzoic aldehyde by treating phenate of potassium with chloroform.—E. Hoffmann described derivatives of hesperidine, particularly an acid $C_{10}H_{10}O_4$, which with potash yield protocatechic acid.

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