THURSDAY, OCTOBER 29, 1891.

COPTIC PALÆOGRAPHY.

Album de Paléographie Copte pour servir à l'Introduction Paléographique des "Actes des Martyrs de l Égypte." Par Henri Hyvernat. (Paris: Leroux, 1888.)

IN all the wide range of subjects connected with archæology, it would perhaps be difficult to find one so little studied as that the name of which stands at the head of this article. It is not that it is unimportant; on the contrary, it is most important; it cannot be said to be uninteresting, for the most elementary study of the subject shows it to possess considerable attractions for the philologist, historian, and antiquary. The little interest which, until the last few years, has been shown in matters relating to the Coptic language and literature is probably to be attributed to the fact that printed Coptic texts are scarce, and that the comparatively few manuscripts which exist are scattered throughout the libraries of Europe.

It will be remembered that in the year 1885 M. Hyvernat began to publish the martyrdoms of famous Coptic saints, with a translation in French entitled "Les Actes des Martyrs de l'Égypte"; the Coptic texts were edited chiefly from manuscripts in the Vatican and Borgian Libraries. Considerable interest was aroused by his work, and it was hoped that scholars would soon possess accurate copies of the texts of the martyrdoms which form so large a section of the rich collections of Coptic manuscripts at Rome. It may be argued that the narratives of the sufferings and deaths of Coptic martyrs have much in common, and that a few examples of this class of literature would have been sufficient; but it must be remembered that the historical allusions and incidental remarks made in them give them a value far beyond their importance as religious documents; while the uncommon words, and unusual forms of the Greek words which their writers borrowed, enrich the Coptic lexicon, and afford material for the student of hieroglyphics who makes a comparative study of the dialects spoken by the Copts and by their ancestors the subjects of the Pharaohs. The first volume of the work, in four fasciculi, has appeared, and it is hoped that the second volume, which is promised to contain a critical introduction, &c., will not be long delayed.

Meanwhile, however, M. Hyvernat has given us his "Palæographic Album," and it is to this important publication that we must now give our attention; the scientific plan which he has followed in setting before scholars facts and nothing but facts, and his systematic arrangement of them, make his work most welcome. The first Coptic scholar who gave his attention to the subject of Coptic palæography was Zoega, the Dane, and in his famous "Catalogus Codicum Copticorum," published (after his death) at Rome in 1810, are given seven plates containing specimens of the writing found in Coptic manuscripts of various periods; since that time *facsimile* specimens of important manuscripts have been published, as, for example, a page of the famous Gnostic work, "Pistis Sophia," in the "Facsimiles of Ancient Manuscripts, &c.," issued by the Palæographical Society (Oriental Series, plate 42, 1878).

The work before us contains fifty-seven large folio plates, upon which are reproduced by photography about one hundred examples of Coptic writing; the execution of these plates is perfect, and M. Hyvernat has shown great knowledge and judgment in making the selection. The original manuscripts are preserved in Rome, Milan, Turin, Naples, Paris, London, and Oxford; and the time and labour spent by him in reading and examining them must have been very considerable. The manuscripts—that is, books made of parchment and paper, for M. Hyvernat excludes inscriptions upon stones, and papyri, whether contracts or otherwise—belong to all periods; the earliest cannot be later than the sixth century A.D., and the latest dates from the last century. We have thus for palæographical investigation a field of not less than twelve hundred years.

The specimens of the writings anterior to the ninth century have been taken from manuscripts which are, by the common consent of the best authorities, admitted to belong to this period; all those after the ninth century are taken from dated manuscripts, and thus there is no doubt possible as to their age. The wisdom of this plan is evident, for, in the case of uncial writing, the character of which practically remained unchanged among the Copts for centuries, it is almost impossible to assign an exact date to a manuscript unless a dated standard is forthcoming. Coptic manuscripts which are to be attributed to the sixth or seventh century are rare, and as examples of them M. Hyvernat has selected the Gnostic treatise called "Pistis Sophia"[1] (Brit. Mus., No. 5114) and the life of St. Pachomius;[2] the pages are small quarto in size, with two columns of writing to the page, and ornamentation is rare. In the seventh and eighth centuries the writing becomes firmer and bolder, the pages are larger, and the sides of the columns are ornamented with graceful designs and birds (doves?). The picture of Job and his three daughters (Pl. 5), wearing Byzantine costumes and ornaments, is very instructive. Pl. 6 gives a leaf from a palimpsest manuscript, inscribed in Coptic with verses from the Old Testament, and in Syriac with the martyrdom of St. Peter of Alexandria.

Of the tenth and eleventh centuries we have fine specimens of manuscripts containing homilies, canons, sermons, martyrdoms, &c.; the pages are large, the writing, in two columns, is bold and handsome, the initial letters of paragraphs are large, and stand away from the columns, which are often profusely decorated with birds, flowers, ornaments in the shape of vases, &c. The last pages of works of this period often contain portraits of those who are referred to in them, and the larger manuscripts have full-page illustrations of the subject-matter; as, for example, Theodore the General overthrowing the dragon and rescuing the widow's children (Pl. 16), St. Mercurius destroying Julian the Apostate (Pl. 17), and "Moses the Prophet" standing with bare feet by the side of the burning bush (Pl. 19). On Pls. 14, 21, and 32 are some interesting examples of Coptic cryptography and cursive writing. At the end of the tenth century the first page of each work in a manuscript is ornamented with deep borders of tracery and interlacing

[1] The text, with Latin translation, was published by Schwartze at Berlin in 1851.

[2] The text, with French translation, was published by Amélineau, "Histoire de Saint Pakhôme" (Paris, 1889).

in various colours, and the initial letters are very large (Pls. 34, 38).

A fine example of the writing and illumination of the thirteenth century is that given on Pl. I, from a Coptic and Arabic Evangelarium written A.D. 1250; in it St. Mark, seated, is about to receive in a napkin the book of the Gospels from St. Peter, and by his side is a stand in the shape of that used to hold a Koran; opposite is a scene in which John the Baptist is baptizing Christ in the Jordan, in the presence of two angels, who hold napkins, and above them is descending from blue heavens the Holy Ghost in the form of a dove. Behind John the Baptist is a tree, in the trunk of which an axe has been struck. Of illustrated Gospels of this period we have excellent specimens on Pls. 44-47, where the Transfiguration, the devils entering the swine, the Marriage at Cana, the Last Supper, the Crucifixion, &c., display a quaint mixture of ancient Coptic, Byzantine, and Arab methods of illumination and ornamentation. Of manuscripts of the thirteenth and fourteenth centuries good examples are given on Pls. 50 foll., with *facsimiles* of the elaborate crosses of the period and of the portraits of the four Evangelists in circles. The space at our disposal will not allow a more detailed description of the contents of the "Album de Paléographie Copte" than that given above, which will serve to indicate the great value of the work to scholars.

The Copts, or "Egyptian" Christians, played no unimportant part in the history of Egypt after the preaching of St. Mark at Alexandria, A.D. 64; and from that time until the present day they have steadily and consistently maintained their religious opinions without change. They clung fast to their language, in spite of the widespread use of Greek in Egypt in the earlier centuries of this era; and although they adopted the Greek alphabet, with the addition of some few signs from the demotic, and borrowed largely from the Greek vocabulary, they did not cease to write their books in Coptic nor to celebrate the services of their Church in that language. After the conquest of Egypt by the Arabs, the Copts held positions of dignity and importance there for some hundreds of years; but about the twelfth century they seem to have fallen into poverty and contempt, and about a century later it seems that they ceased to produce literary works; moreover, the growing custom of adding Arabic translations by the side of the Coptic texts proves that the knowledge of Coptic was dying out. During the next few centuries it probably became the study of the learned. In the course of the last two centuries, travellers in the East have brought to Europe numbers of Coptic manuscripts, and among those deserving special mention are Pietro della Valle, and Huntingdon, Assemani, Curzon, and Tattam. The revival of Coptic learning was begun by Abela, a Maltese; and his work was carried on by Kircher, Petræus, Jablonski, Renaudot, Wilkins, Vansleb, Lacroze, Tuki, George, Zoega, Quatremère, Tattam, and Peyron: among those who have done much excellent work in Coptic during the present century are Schwartze, Lagarde, Revillout, and Rückert. The recent works of Amélineau and Hyvernat show that serious attention is now being paid to the Coptic language for philological and ecclesiastical purposes, and that the publication of new material is going on rapidly.

In conclusion, all lovers of Coptic literature owe a debt of gratitude to M. Henri Hignard, formerly President of the Académie de Lyon, for his liberality in undertaking the expense of publishing this work, and to M. Hyvernat for the excellent way in which he has made use of the funds so generously placed at his disposal.

BRITISH MUSEUM (NATURAL HISTORY) CATALOGUES.

Systematic List of the Frederick E. Edwards Collection of British Oligocene and Eocene Mollusca in the British Museum (Natural History); with References to the Type Specimens from similar Horizons contained in other Collections belonging to the Geological Department of the Museum. By Richard Bullen Newton, F.G.S. Pp. xxviii. and 365, with a large Folding Table. (London: Printed by order of the Trustees. Sold by Longmans and Co.; Quaritch; Dulau and Co.; Kegan Paul, Trench, Trübner, and Co.; and at the Natural History Museum. 1891.)

THE interest which attaches to the records of past periods of our earth's history is greatly enhanced when we find them in the strata forming the very ground beneath our feet. Such is the explanation of the origin of the well-known Edwards Collection of Eocene Mollusca, which forms the subject of the volume before us. Mr. Frederick Edwards resided at Hampstead some fifty years ago, at a time when the Primrose Hill tunnel of the London and North-Western Railway was formed, and the Archway Road, Highgate, had lately been cut, and, later still, the Great Northern tunnel under Copenhagen Fields. These, and many brick-field excavations in the north of London, led to the discovery of abundant fossil-remains around his residence, and attracted the attention not only of Mr. Edwards, but of Dr. Bowerbank, Mr. Wetherell, Prof. John Morris, Mr. Searles V. Wood and his son, Mr. Sowerby, Mr. White, Mr. Page, and other geologists living in Highbury, Highgate, Hampstead, and Kentish Town, who formed among themselves a small Naturalists' Society, known as the "London Clay Club," the members of which met periodically at each other's houses, to compare and exchange specimens, and to name the fossils they had discovered in the London clay. Mr. Wetherell, Dr. Bowerbank, and Mr. Frederick Edwards made most extensive collections; but, whilst Wetherell and Bowerbank collected from the London Clay, the Chalk, and other formations, Mr. Frederick Edwards devoted all his attention to the Mollusca of the London Clay and other Tertiary beds of the south-east of England. All his summer holidays were spent in such spots as the New Forest (where, at Brockenhurst, Bramshaw, Lyndhurst, and many other spots, assisted by Mr. Henry Keeping, he opened numerous trial-pits), or at Barton and Hordwell on the coast of Hampshire, Colwell Bay, Headon Hill, Osborne, Hempsted, Bembridge in the Isle of Wight, and Bracklesham Bay, Sussex. He collected at all these places, and *carefully recorded* the localities from whence his specimens were derived. With infinite care he mounted and named these delicate Tertiary shells, and the beautiful specimens so prepared have been preserved in their entirety in the National Museum.

After the formation of the Palæontographical Society, a large number of Mr. Edwards's Mollusca were monographed by him from 1849 to 1860 (five parts), and continued by S. V. Wood, 1861 to 1877 (four parts); and papers were published in the *London Geological Journal*, the *Geologist*, the *Geological Magazine*, and the Quarterly Journal of the Geological Society of London.

The unpublished labour which Mr. Edwards expended on his cabinets greatly exceeded that which he devoted to the publication of a part of their contents, as may readily be seen by a study of his collection; and when it is known that this work was all performed in the leisure hours of a busy life as a Master-in-Chancery, hearing and deciding law cases in Chambers all day, one is astonished to find how much he was able to accomplish.

The collection contains no fewer than 39,191 specimens, referred to 1805 species of Mollusca, divided into the following classes:—

85	genera and	648	species of	Lamellibranchiata,
162	,,	1127	,,	Gasteropoda,
2	,,	14	,,	Scaphopoda,
6	,,	16	,,	Cephalopoda.
		1805		

Of this number 585 are manuscript species, proposed by F. E. Edwards, which have not yet been described; so that nearly one-third has to be deducted from the above total if we would arrive at the actual number of species already figured and described.

It may be objected that these manuscript names ought not to have been printed; but Mr. Newton points out, in the preface to his catalogue, that these have got into circulation abroad in lists published by German and French palæontologists, with whom Mr. Edwards had corresponded, until, like some paper-currencies, they have obtained for themselves an artificial value, and it would be inconvenient to omit to mention them in a list of Mr. Edwards's own collection. Mr. Newton, moreover, promises shortly to describe and figure them, thus giving them their full *specie-value*, a promise which we sincerely trust he will find leisure to perform.

In addition to the specimens in F. E. Edwards's own collection, figured and described by himself and others, all those in the Brander, Sowerby, Dixon, Bowerbank, and Wetherell collections are duly recorded; so that much valuable information as to the whereabouts of these types, and references to the works in which they are recorded, has been carefully brought together in this volume by Mr. Newton.

Apart from the vast variety, as well as the rare beauty of form, by which the Mollusca of the Eocene period at once arrest the attention of even the most unlearned, to the student of palæontology they afford unmistakable evidence of the existence in this earliest Tertiary period of subtropical marine conditions over this portion of the earth's surface, which now forms South-eastern England. Several extinct forms of Nautilus and Cuttlefishes, associated with huge species of *Cerithium*, Cowries, Cones, Volutes, and such genera as *Rostellaria*, *Mitra*, *Marginella*, *Cancellaria*, *Oliva*, *Ovula*, and *Seraphs*, with *Terebra*, *Pirenia*, *Phorus*, *Solarium*, *Nerita*, and *Chiton*, make up a rich display of Mollusca belonging to the warmer seas of the globe, and if we add such genera as *Pholadomya*, *Spondylus*, *Crassatella*, and many of the other bivalves, they tell the same tale. Crustacea, Echinodermata, and Corals were also present, together with numerous Turtles, whilst along the shores of the rivers huge Crocodiles patiently awaited the *Palæotheria* and *Anoplotheria* from the neighbouring lands. Terrestrial vegetation, washed down from the Eocene continent, also proves to be of a tropical kind—Palms, Cacti, Dryandra, Maple, Azalea, Acacias, with others, belonging to more temperate latitudes, forming a part of the vegetation of our island to-day. Nor were the terrestrial Mollusca unaffected by the increased temperature, for we find large *Bulimi* and *Helices* unlike those now living in this country, whilst the species of *Limnea* and *Planorbis* were both large and very abundant, and were associated with *Potamides*, *Melania*, and other exotic genera in its streams. That there must have been at that time a close connection between our English Eocene area and the much larger Eocene area of France, cannot be doubted, for the beds of the Paris basin and those of Hampshire and London are capable of close correlation, and many genera and species are common to both areas.

Mr. Newton has fortunately obtained the co-operation of Mr. George F. Harris, who has, in an appendix, added some valuable tables, showing the probable equivalent horizons of our several English Tertiary beds with those on the Continent, in France, Belgium, and Germany, and as far east as Austria and Italy, and southwards to Spain. These tables will prove of the greatest value to the student who seeks to understand, and even to map out, the former geographical extent of the several successive Tertiary deposits of Europe, with their varied land, freshwater, and marine records of past life, both animal and vegetable.

Most of the points dealt with by Mr. Newton in the introduction to his list have reference to questions of priority in names, and explanatory notes in justification of some which have been abolished—either because the name had been pre-occupied for a genus of fishes, or birds, or reptiles, &c., or because it had been discovered that another author had previously described the same shell, and had at an earlier date given it another name. Many old favourites have thus been relegated to obscurity, whilst fresh names, dug up from some forgotten corner, have, by the law of priority, taken their places. Thus:—*Meretrix*, Lamarck, 1799, takes the place of his better known *Cytherea* of 1806, the latter having been applied by Fabricius, in 1805, to a dipterous insect. *Triton*, De Montfort, 1810, gives place to *Lampusia*, Schumacher, 1817, "having been applied by Linnæus to a Cirripede in 1767." But as no genus of Cirripedes is known by that name at present, this is a needless and undesirable alteration, especially as Mr. Newton remarks, "the genus *Triton* still continues a favourite name among conchologists"; we would add, "long may it continue" so. Darwin says: "I cannot doubt that the *Triton* described by Linnæus was only the *exuviæ* of some *Balanus* (probably *B. porcatus*), Linnæus mistaking the proboscidiformed penis for the mouth of his imagined distinct animal" (Darwin's *Balanidæ*, Ray Soc., 1854, p. 158).

It would be an immense gain if every name proposed to be altered had to pass through a regularly-constituted committee of investigation before it was accepted and allowed to pass current; as it is, endless confusion must arise, and needless alterations will for ever be made, serving no good end to science.

Mr. R. B. Newton's systematic list of the Eocene and Oligocene Mollusca of our British strata will prove extremely valuable to all those who take an interest in our Tertiary deposits and their contained organisms. Every curator of a palæontological collection must have it, as a work of reference, by his side, as, for this section of fossils, it takes the place of "Morris's Catalogue," now long out of date. We shall be very glad to see other sections treated in a similar manner—indeed, Messrs. A. Smith Woodward and C. D. Sherborn have already catalogued the fossil Vertebrata of the British Isles in 1890, and the work has been published by Dulau and Co.

THE LIFE AND WORK OF A NORFOLK GEOLOGIST.

Memorials of John Gunn: being some Account of the Cromer Forest Bed and its Fossil Mammalia. Edited by H. B. Woodward and E. T. Newton. Pp. xii, 120; 13 Plates (Portrait and Fossil Mammalia). (Norwich: W. A. Nudd, 1891.)

ALL students of the geology of the eastern and central parts of Norfolk and Suffolk will welcome this book, as giving the well-matured opinions of a geologist whose life-work was chiefly concerned with the Forest Bed and its associated formations, Crag and Drift. Those too who knew Mr. Gunn must be glad to have this memorial of so courteous, kindly, truth-seeking a man. No one enjoyed his friendship but was the better for it, and the writer looks back on days spent in his company, both in the field and at meetings of the Norwich Geological Society, as amongst the happiest events of a long sojourn in the Eastern Counties. Until reading this book he did not know the politics of Mr. Gunn, and he is glad to find another of many instances in which such matters are kept in the background, as regards scientific intercourse and personal friendship.

To those who, like the writer, are not greatly enamoured with biography and its multiplicity of personal details it is satisfactory to find this part of the book artistically treated, by Mr. Woodward, in only 27 pages, which are full of interest. The best memorial of a scientific man is the work that he has done and by which he will be known in the time to come, and it is to Mr. Gunn's work that the editors chiefly direct our attention. After the memoir and about 13 pages of notes on some of his geologic papers, the book takes the form of a short essay on the Cromer Forest Bed and its fossil Mammalia, by the hand of Mr. Gunn himself; that is to say, from notes practically completed by him shortly before his death.

For the task of bringing these matters before the public no better editors could have been chosen. One of them, who, in his Geological Survey work, was brought much in contact with Mr. Gunn, may be called the hereditary geologist of Norfolk. The other has for some years given great attention to the study of the fossil Mammalia of the Forest Bed, and indeed has made himself the chief authority on the subject.

In 1864, Mr. Gunn helped to found the Norwich Geological Society, of which he was the first and the last President, retiring from that post only for six years (1877–83) in order that it should be filled by officers of the Geological Survey who were stationed in Norfolk and Suffolk: a graceful compliment. He was also one of the founders of the Norfolk Archæological Society, an active member of the Norwich Science Gossip Club, and a member of the Norwich Museum, which he enriched by his fine collection of fossil mammals.

Now that coal has been found underground at Dover, and that there may be some chance of a search for it being made in the Eastern Counties, it should be remembered that Mr. Gunn was the first to advocate trial-work in Norfolk.

On the ground that "unanimity does not prevail in regard to the nomenclature of the strata" of the Norfolk cliffs, Mr. Woodward gives a useful table, on p. 40, showing the classifications of Gunn, of Prestwich, and of C. Reid; but that of Wood might have been added with advantage; and he draws attention to the fact that the cliffs are cut back greatly year by year, so that earlier observers may have seen something different from later ones. As the loss of coast is still going on, and the Forest Bed seems not to reach far inland, a happy time may come when that Series will cease to furnish any ground for contention: in this matter the geologists of the future may have to take the work of their foregoers, without the luxury of upsetting it.

In his account of the Forest Bed Series, Mr. Gunn holds to the view that, as a rule, the trees grew on the spots where the stumps are now found. He describes firstly the Estuarine Soil, then the Forest Bed proper, then the Reconstructed Forest Bed (a division not hitherto recognized, and hardly likely to be, reconstruction seeming to occur in various parts of the Series), and lastly the Unio and Rootlet Bed; but it should be noted that other observers take the Forest Bed and the Rootlet Bed to be one. His use of the term Laminated Beds, for the immediate successor of the Forest Bed Series, is unfortunate, as such names usually are, for lamination is common in the Chillesford Clay below and in some of the Glacial Drift above.

Mr. Gunn's notes conclude with remarks, in some detail, on the Proboscidea of the Norwich Crag and of the Forest Bed Series, and on the Cervidæ of the latter, chiefly based, with the plates, on the specimens which he so liberally gave to the Norwich Museum. The notes are followed by a list of his geological and archæological papers, ranging over forty-eight years, from 1840 to 1887.

The plates of Mammalian fossils are well executed; but it is a pity that those of Proboscidea and those of Cervidæ are not numbered consecutively, instead of independently. The portrait that forms the frontispiece is a good one, and the book is well printed.

Few geologists can expect their names to be handed down to posterity by so fine a set of specimens as those of the Gunn Collection in the Norwich Museum, and by so interesting a literary accompaniment as that now noticed. W. W.

OUR BOOK SHELF.

The Melanesians: Studies in their Anthropology and Folk Lore. By R. H. Codrington, D.D. (Oxford: Clarendon Press, 1891.)

IN this book Dr. Codrington gives us the results of observations and inquiries made in the Melanesian Islands from 1863, when he first visited them, to 1887, when he left the Melanesian Mission. He does not profess to offer a complete account of the Melanesian people; nevertheless, the work is one of great value, for it is in the main a record, not of what Europeans say about the natives, but of what the natives say about themselves. The most careful of European inquirers may, of course, mistake the real significance of what natives tell them; but Dr. Codrington seems to have been at all times fully conscious of this danger, and to have done his best to guard against it.

He begins with a chapter on the discovery of the Melanesian Islands, and on their geology and zoology. The ethnology of Melanesia he does not attempt to deal with; but he discusses thoroughly the facts relating to kinship and marriage connection among the Melanesians, starting with the proposition that the division of the people into two or more classes, which are exogamous, and in which descent is traced through the mother, is the foundation of native society. He also gives a good account of the position of the chiefs. A chapter is devoted to property and inheritance, and this is followed by a description of secret societies and clubs, a knowledge of both of which is essential to a proper comprehension of Melanesian life.

The religion of the Melanesians, like that of all savage and barbarous peoples, is a subject of great difficulty; but Dr. Codrington is able to present clearly what seem to be at least its main outlines. Students of the evolution of religious conceptions will read with especial interest what he has to say about "mana," a supernatural power or influence which is supposed to act in all kinds of ways for good and evil, and which everyone tries to possess or control. The objects of worship are spirits, some of which were formerly men, while others belong to an independent and higher class. All these beings are full of "mana," and many suggestive facts about the popular belief in them will be found in the chapters on sacrifices, prayers, spirits, sacred places and things, magic, possession, and intercourse with ghosts. There are also good chapters on birth, childhood, and marriage; death, burial, and "after death."

The chapters on the arts of life, and on dances, music, and games, contain an immense number of interesting facts, well arranged; and in a chapter entitled "Miscellaneous," the author treats of several disconnected subjects, such as cannibalism, head-taking, and castaways. The concluding chapter is in some respects the best of all. It consists of stories, divided into three groups—animal stories, myths and tales of origins, and wonder tales. These stories are not only pleasant to read, but provide excellent materials for those who devote themselves to the comparative study of folk-tales.

We may note that there are some very good illustrations, especially in the chapter on the arts of life.

Guide to Examinations in Physiography, and Answers to Questions. By W. Jerome Harrison, F.G.S. (London: Blackie and Son, 1891.)

THE author of this little work of forty-eight pages is well known as a successful teacher, of wide experience in connection with classes recognized by the Science and Art Department. It is avowedly a guide to the art of passing an examination, the author giving it as his opinion that "knowledge of any subject is not the *only* requisite to successfully passing an examination in it." Unfortunately, this is, to a certain extent, true. Some candidates are apt to make an injudicious choice of questions, while others, again, spend too little time in studying them, and consequently wander from the point. Few who read Mr. Harrison's notes will fail to profit by the sound advice which he gives.

The first part gives general information about the Science and Art Department and its objects, and applies equally to all the subjects in which its examinations are held. The questions which have been given in the elemen y stage since 1882 are answered in Part III. The appear to be sufficiently good to satisfy the examiners.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Difficulty in Weismannism.

WEISMANN'S theories of heredity and sexual reproduction have been criticized from many *a priori* points of view. The following remarks are an attempt to apply to his theory of reproduction a test familiar to the mathematician; and assuming its truth, to follow out the deductions from this assumption. The result is a startling one I believe the following theses will be accepted as an impartial statement of the main points of the theory:—

I. Each primitive germ-cell, of either sex, contains a number of ancestral germ-units, the Ahnenplasmas; and this number is constant, for the species at least.

II. These ancestral germ-units are far more constant and unchangeable in character than the species itself.

III. They lie associated together in the germ-cell without loss or alteration of their individual personalities.

IV. The number contained in the mature ovum and spermatozoon is reduced by one-half; and in the fertilized ovum or oosperm the number is restored to the normal by the summation of the Ahnenplasmas of the two fusing cells. This process is comparable to the shuffling of two packs of cards by taking half from each and joining the talons or remainders to form a new pack.

V. The possible combinations under this process are so numerous as to explain the variations among the offspring of sexual union.

Accepting these statements, we next inquire, How are we to conceive of these ancestral units, the Ahnenplasmas? Two hypotheses may be given in answer to this question:—

A. Each Ahnenplasma unit corresponds to an individual of the species itself; and if put under proper trophic conditions would, singly, reproduce such an individual.

B. The Ahnenplasmas correspond to the primitive Protozoan ancestors, which, according to theory,[1] could alone reproduce modifications due to external causes (acquired modifications).

According to hypothesis *A*, the Ahnenplasmas of living man are Anthropic; those of our Simian forebears were Simian; and so we get Protochordate, and finally Protometazoan Ahnenplasmas in the germ-cells of our more and more remote ancestors. In other words, the *Ahnenplasms have varied indefinitely, and at the same rate with the race.* This inference not only renders the shuffling process unnecessary to explain variation; but it is inconsistent with thesis II., the very foundation of Weismann's theory of heredity.

According to hypothesis *B*, the Ahnenplasmas of all Metazoa being similar and Protozoan, if the *numbers are equal* and the shuffling fair any two parents may beget any offspring whatever; on the plane of thesis V., a lioness might be expected to bring forth a lobster or a starfish or any other animal, which, as we know, does not take place in Nature. The only escape from this result is to assume the postulates—(1) that the

[1] "Hereditary variability . . . can only arise in the lowest unicellular organisms; and . . . necessarily passed over into the higher organisms when they first appeared" (Weismann, "On Heredity," English edition, p. 279). This passage would seem to render hypothesis *B* necessary for the theory.

number of Ahnenplasmas varies from species to species; (2) that the *number* in the combination and not the *character* of the Ahnenplasmas determines the species. And as there is not a particle of evidence for the latter postulate, we may say that on hypothesis *B* the theory breaks down by its non-conformity with the facts.

We have then the dilemma, from which I see no escape, that the theory is inconsistent, on *A* with itself, on *B* with the facts. When once worked out and fairly put into words, which was not so easy as it may appear, this argument seemed so obvious that I felt sure it must have been long since urged, confuted, and dismissed. But not having found any reference to it, I now state it fully, in the hope that the question raised may be thoroughly discussed. MARCUS HARTOG.

Dublin, October 12.

Rain-making Experiments.

YOUR last number contains an article by Prof. Curtis on the "rain-making" experiments in Texas, in which no reference is made to the report published in the October number of the *North American Review* by General Dyrenforth, who directed the operations. I wish to call attention to the remarkable differences which exist between the statements of Prof. Curtis, the meteorologist of the expedition, and General Dyrenforth, its director. On August 10, Prof. Curtis, who had not yet arrived at the scene of the experiments, believes that only sharp showers or "good grass-rain" fell; General Dyrenforth says the amount was nearly 2 inches. On August 18, Prof. Curtis says that only 0·02 inch of rain fell; General Dyrenforth says that "drenching rain fell in torrents for two and a half hours," and that driving from the encampment to Midland, a distance of 25 miles, the road traversed was covered for 6 or 8 miles under 4 to 40 inches of water. It is impossible, under these circumstances, for those interested to come to any conclusion at present with regard to the actual results of the experiments. May I draw your attention further to an article which appeared in the *Manchester Guardian* of the 13th inst., in which a suggestion was made precisely similar to that put forward by Prof. Giglioli in your last number. If, as seems probable, the experiments of Mr. Aitken amply suffice to explain any positive results obtained, it is evident that the explosions of hydrogen and oxygen, on which General Dyrenforth relies so much, are useless, and that the smoke-producing rackarock does all the work. In an extremely sceptical and very justly critical article, which follows that of General Dyrenforth in the *North American Review*, Prof. Simon Newcomb, while scouting the "concussion" theories of General Dyrenforth, says, indeed, that smoke particles may possibly serve as nuclei for the condensation of water vapour; but he is evidently unacquainted with the remarkable work of Mr. Aitken, which throws so much light on the matter. H.

Manchester, October 24.

A Rare Phenomenon.

HAVING just returned from Norway, it may be of interest to record that the band of light which was observed by many of your correspondents on September 11, was remarkably brilliant in N. lat. 62°, extending from the horizon to the zenith, but not beyond. It was nearly, but not quite, equal in width throughout the 90°, and therefore must either have been much wider at the base than at the apex, or else at an immense altitude. Some clue to the estimation of this altitude would be afforded by an accurate record of the zenith distance as observed in England.

I may add that the aurora borealis was distinctly visible in the north and north-west at the same time, but this band rose from the north-east, which led me to conjecture that it might belong to a comet; however, on the following night it did not recur, and I then thought it might have been caused by some sun-lit cirri at a great elevation, but it is now obvious that this was not the case. The remarkable feature was its concurrence with, and yet apparent difference from, the ordinary aurora.

Richmond, Surrey, October 24. W. DUPPA-CROTCH.

THE phenomenon observed by Dr. Copeland (NATURE, September 24, p. 494) at 11.18 p.m. on September 10 at Dunecht, by Mr. W. E. Wilson at 9 p.m. on September 11 in Co. Westmeath, and by other observers on the 11th in several parts of England, was observed by a party of three, including myself, at 9.30 p.m. on September 25 at Ballater, Aberdeenshire.

It appeared as an intense white beam of light stretching from east to west and directly overhead, of uniform width and perfectly steady. It seemed quite low down, almost as if it might light up the summit of the church spire were it moved a little further towards the south. At 11.30 the light had become diffuse, and it appeared at a much greater elevation, though maintaining its general direction from east to west. W. N. HARTLEY.

October 23.

Earthquake at Bournemouth.

WE had a sharp momentary shock of earthquake here at four o'clock this afternoon. I happened to have my eyes fixed on a plant with long variegated leaves on my dining-room table. Suddenly there was a heavy sound as of some subterranean fall, and simultaneously the leaves of this plant were violently agitated—waved up and down—for some seconds. It was as if it had risen vertically and then fallen. It was wholly unmoved by so much as a tremor the rest of the afternoon. I tried to reproduce anything like the same disturbance by hand, but without success. HENRY CECIL.

Bregner, Bournemouth, October 25.

W = M*g*.

I HAD read Mr. Slate's letter (NATURE, vol. xliv. p. 445), and admired it; moreover, I found myself in agreement with him. But it seems to me strange that Prof. Greenhill should approve of it. For Mr. Slate takes as his gravitational unit of force "*the weight of one pound under circumstances specified . . . (locality, vacuum).*" Surely this implies that he agrees with the theorists (Prof. Greenhill's foes) when they say that "the weight of a given body depends on the local value of *g*." Prof. Greenhill, on the contrary, speaking of *goods*, says that "*the weight cannot be said to vary with the local value of g*" (NATURE, vol. xliv. p. 493), I would ask him, then—

(1) What name does he give to the earth's pull on a given body? Or, what is it that a spring balance measures when the said body is hung from it? He cannot say "its weight"; for the pull referred to varies with *g*, while Prof. Greenhill's "weight" does not. I conclude that he has no special name for it. The theorists have; and they thereby gain in brevity without losing by ambiguity, since they do not employ the word "weight" in any other sense in their text-books.

I would also repeat the still unanswered question — (2) How does Prof. Greenhill give the expression for hydrostatic pressure at a given depth in any locality, if he banishes "*g*"? (NATURE, vol. xliv. p. 341). And does he conclude that Mr. Slate does not use "*g*" in hydrostatics?

Again . . . (3) Does Prof. Greenhill, in common with Mr. Slate and the theorists, use the word *mass* in speaking of the fundamental units; and, if so, in what sense?

In the science of dynamics we recognize two properties of matter: . . . (i.) its *inertia*; . . . (ii.) *the attraction between it and other matter.* The theorists use the word *mass* when they refer to quantity of matter as measured by its *inertia*; and they use the word *weight* when they refer to the *attraction* of a given body to the earth. For commercial purposes it is convenient to measure quantity of matter by balancing its weight against that of the standard lump of platinum, its multiples, and sub-multiples. Hence the every-day, slightly ambiguous, use of the word "weight" in matters in which we are not concerned with inertia. But in the science of dynamics, of which Newton's laws are the foundation, we are concerned *primarily* with *inertia*. The theorists, therefore, in their text-books, regard the well-known lump of platinum as *the standard pound, the British unit of mass.* They thus have the word "weight" free, and say (*e.g.*) that *the weight of the standard pound is measured by the resultant pressure that it exerts* (in vacuo) *on the bottom of the box in which it lies.* It requires more than general expressions of condemnation to show that any other system of nomenclature is clearer or less free from ambiguity, or that the equation $W = Mg$ has not as much meaning as any other dynamical equation. (I may refer back to my letter, NATURE, vol. xliv. p. 493). W. LARDEN.

Devonport, September 26.

SOME NOTES ON THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION.[1]

IV.

Alternate Current Motors.

ALTERNATE current motors constitute one of the most striking features at the Frankfort Exhibition, and the commercial use of such motors will probably date from this year, so that the one great objection to the employment of alternating currents for the electric transmission and distribution of power will soon disappear.

It is well known that the direction of rotation of an ordinary series, or shunt, direct current motor is the same whichever way the direct current passes round the motor, in spite of a patent of Mr. Edison's to utilize the contrary fact on electric railways; hence it follows that if an alternate current be sent round such a motor it will start rotating and develop mechanical power. Only a com-

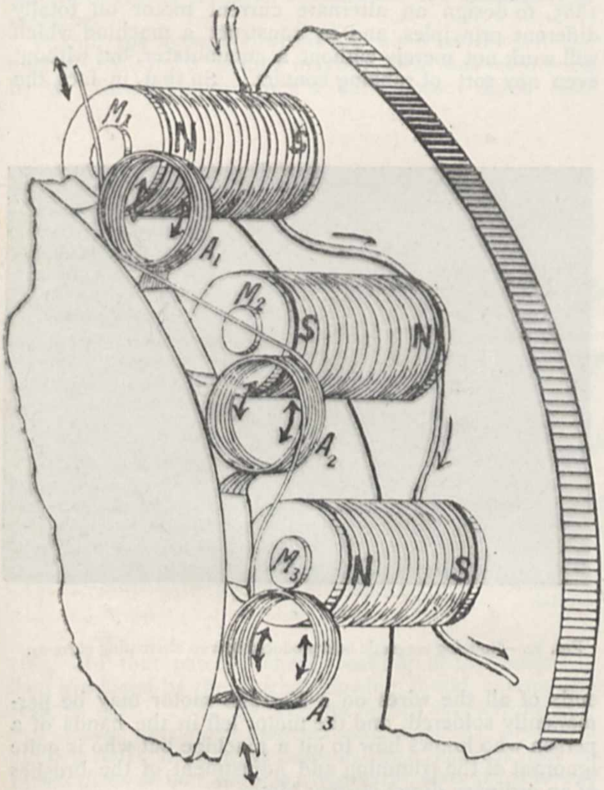

FIG. 10.—Alternate current synchronizing motor. ⟵ Direct current. ⟷ Alternating current.

paratively small power and efficiency, however, will be obtained: first, because the large self-induction of the field magnet of the motor will seriously diminish the strength of the alternating current; secondly, because, in consequence of the rapid reversals of the magnetism, much power will be wasted in heating the iron core of the field magnet, even although this core be laminated like that of the armature.

If, on the other hand, a direct current be sent round the field magnet, M_1, M_2, M_3, of an *alternate* current machine, and an alternating current round the armature, A_1, A_2, A_3 (Fig. 10), the armature will not move, because at every two of the successive rapid reversals of the current the armature receives an impulse in opposite directions. To enable such a machine to work as a motor, it is necessary to first make the armature rapidly rotate by mechanical means at such a speed that any armature coil, A_2, moves forward by the distance between two of the poles M_2, M of the field magnet in half the periodic time of the alternation of the current. When this speed has been once attained, the machine will go on running as a powerful and efficient alternate current motor, at a perfectly definite speed, depending simply on the rate of alternation of the current, and independent within wide limits of the load put on the motor.

So that when the armature of the motor is once "in step" with that of the dynamo the two will continue "in step," whatever be the amount, within wide limits, of the power transmitted.

When a considerable amount of power has to be sent from a source to a distant town, and has there to be distributed for light or for driving machinery, it will certainly be best (as far as our present knowledge goes) to use alternating currents in the transmission of the power between the two distant places, because with alternating currents the pressure can so easily be transformed up at the source, and transformed down again at the other end of the line.

But in the distribution of the received power direct currents are the more convenient, since they can be utilized for light, for electroplating and electrotyping,

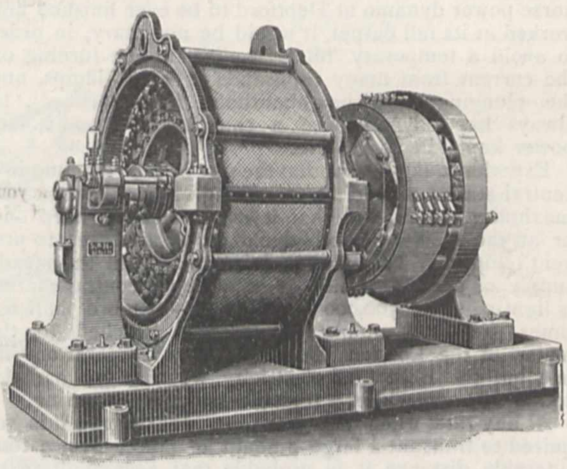

FIG. 11.—Coupled alternate current motor and direct current dynamo.

as well as for small and large direct current electromotors, both of which have already reached a considerable degree of perfection, and are of course self-starting. Hence it is probable that there will be employed a synchronizing alternate current motor, coupled mechanically to a direct current dynamo, the latter being used to supply current to the town and excite the field magnets of the motor. Such combinations, seen in Fig. 11, are exhibited by Messrs. Siemens and Halske in the Frankfort Exhibition, the alternate current motor being to the left and the direct current dynamo to the right in the figure.

In the particular form of direct current dynamo shown in Fig. 11, and which represents a type much used now on the Continent, the field magnets are inside the rotating armature, and the wires on the outside of the Gramme ring itself are bare, and act as the commutator.

The impossibility of starting the simple synchronizing motor with an alternating current will be of little consequence when a large amount of power has to be transmitted, seeing that in the receiving station there will be several sets of geared alternate current motors and direct current dynamos, some of which will be always running day and night. Hence, to start any alternate current motor, all that need be done will be to send round the direct current

[1] Continued from p. 546.

dynamo, attached to the motor to be started, a portion of the direct current that is being produced by one of the running dynamos. This will cause the stationary direct current dynamo to start running as a motor, and when the right speed has been attained—that is, when the motor is in step with the distant alternate current dynamo—the alternate current can be switched on to the alternate current motor.

Actual plans are being seriously got out at the present time, for using this exact method to transmit 5000 horse-power over forty miles in Tasmania, the received power being transformed by ten such combinations as are seen in Fig. 11, each of 500 horse-power.

This subdivision of the machinery at the receiving end, if accompanied by a similar subdivision of the generating plant at the sending end of the line, will have another most important advantage, viz. that a breakdown of a dynamo or of a motor will not cause a stoppage in the supply of power. A factory is, no doubt, worked at present with a single large engine; the propulsion of a steamer depends on the turning of a single powerful screw; but neither the unexpected stoppage of the factory engine for say half-an-hour once every two or three months, nor the delay of an Atlantic liner in mid-ocean for the same time once in every half-dozen voyages, would necessarily mean ruin. Were, however, the 10,000 horse-power dynamo at Deptford to be ever finished and worked at its full output, it would be necessary, in order to avoid a temporary hitch leading to the turning off the current from many thousands of glow lamps, and the plunging of a neighbourhood into darkness, to always have dynamos of a capacity of 10,000 horse-power kept idle in reserve.

Experience has shown that the size of each dynamo in a central station should be something like one-tenth of the maximum output, and that it is sufficient to keep one, or at the most two such dynamos, as a reserve, to prevent temporary breakdowns interfering with the steady supply of current. Until, then, a single central station is lighting some 500,000 glow lamps—or more than ten times the total number at present attached to the mains of the London Electric Supply Corporation—no one but the Brunel of electricity would have had the courage to embark on a 10,000 horse-power machine.

At any rate, when during the next year or two it is required to transmit a large amount of power over a considerable distance, it is probable that several alternate current synchronizing motors, each coupled to a direct current dynamo, will be employed at the receiving end of the line.

In cases, however, where there already exists an extended system of distributing alternate currents for electric light, the introduction of motors into small workshops and private houses will hardly be possible, unless the motors can be made self-starting. Mr. Zipernowski's motors, employed for driving the tools in a carpenter's shop at the Frankfort Exhibition, have been made self-starting, and also fairly efficient, by adopting a compromise between the simple direct current motor, which is self-starting but inefficient when used with alternating currents, and the alternate current synchronizing motor, which is efficient but not self-starting.

The device employed by Mr. Zipernowski, and which is based on a communication made by Prof. G. Forbes to the Royal Society of Edinburgh some eight years ago, is as follows:—Send the alternating current round the field magnet as well as round the armature of an alternate current motor (Fig. 10), and attach a commutator to the armature so as to reverse the current flowing round the field magnet every time the armature coils A_1, A_2, A_3 pass the field magnet coils M_1, M_2, M_3. On sending the alternate current round such a motor, the motor will start, but since at first the rapidity of alternation of the current will be far greater than the rapidity of commutation there will be much sparking at the commutator and waste of power. As, however, the armature turns more and more quickly, the commutation will be effected more and more rapidly, until at last the armature will attain such a speed that every time the current is reversed by the distant dynamo the portion of the current flowing round the field magnet of the motor will be commutated by the rapidly rotating armature. Hence the current flowing round this field magnet will now be always in the same direction. But as it will not be always of the same strength there will be more waste of power than with a simple synchronizing motor.

Such an arrangement as that adopted by Mr. Zipernowski, then, furnishes a motor which, although not as efficient and powerful for its weight as the synchronizing motor previously described, has the advantage of synchronizing fairly well, of being self-starting, and of giving far better results than a direct current motor with laminated field magnets used with alternating currents.

It is possible, however, as proved by Prof. Ferraris in 1885, to design an alternate current motor on totally different principles, and to construct a machine which will work not merely without a commutator, but without even any sort of rubbing contact. So that, in fact, the

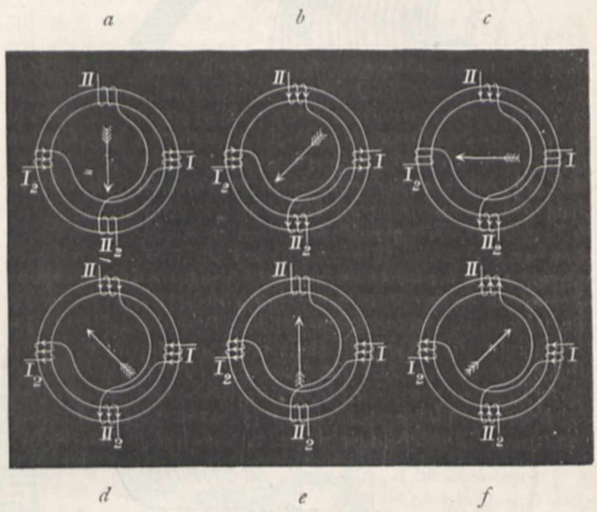

FIG. 12.—Rotating magnetic field produced by two alternating currents.

ends of all the wires on a Ferraris motor may be permanently soldered, and the motor left in the hands of a person who knows how to oil a machine but who is quite ignorant of the trimming and adjustment of the brushes of an ordinary direct current motor.

Round an iron ring are wound four coils, as seen in Fig. 12, and through the two distinct circuits are sent two harmonic alternating currents having the same periodic time and maximum amptitude, but differing by 90° in phase. The ring will therefore receive two magnetizations along two fixed diameters at right angles to one another, the two magnetizations alternating approximately according to the sine function of the time, and differing by 90° in phase. And the composition of these two magnetizations will give a "*rotating magnetic field*," which will make one complete rotation in the periodic time of alternation of the current.

Six values of these two currents are indicated in Fig. 12, the currents in *a*, *c*, and *e*, being of their maximum value in coils I, I_2, and nought in coils II, II_2; while in *b*, *d*, and *f*, the currents in the four coils are equal, being each $\frac{1}{\sqrt{2}}$ of the maximum value. The arrow indicates the position which in each case would be taken up by a suspended compass needle, the point of the arrow indicating the north-seeking-pole of the compass needle.

If in place of the suspended compass needle there be a piece of copper, currents will be induced in this copper by the rotating magnetic field, tending to make the cylinder follow the field. Hence, if the copper take the form of a cylinder, with its axis coinciding with the axis of the ring, and supported so that it can rotate about this axis, the cylinder will run after the rotating field until it catches it up, when the two will move nearly synchronously together. On applying a resistance to the rotation of this cylinder—that is, on making the motor do work—the speed of the cylinder will be checked, but a small diminution of speed will cause large currents to be induced in the copper, and a pulling force to be exerted between the rotating field and the lagging cylinder, tending to drag the cylinder round. Hence this arrangement of Prof. Ferraris produces not merely a self-starting alternate current motor, but one which runs almost synchronously with the dynamo for wide variations in the load, and which has neither commutator, rubbing contacts, brushes, nor the possibility of sparking.

Within the past few weeks we have learnt that the idea of obtaining a rotating magnetic field was mentioned by M. Marcel Deprez, in a French patent dated May 1883. In that patent, when speaking of the magnetic field produced by the current flowing round a Gramme ring, he says: "*Cette rotation du champ magnétique peut être obtenue sans faire mouvoir aucune pièce; pour cela on fera naitre le champ à l'aide de deux courants dont les points d'entrée sont sur deux diamètres perpendiculaires; l'aimentation de ce champ sera alors une résultante dont la position dépend des intensités relatives des deux courants, ainsi que cela a été décrit ci-dessus pour le comparateur des courants; il suffit de faire varier le rapport de ces intensités pour faire tourner cette résultante, et avec elle le champ magnétique.*"

It does not, however, appear to have occurred to M. Deprez that this rotation of a magnetic field might be employed to induce currents, and thus give motion to a piece of metal placed inside the Gramme ring; nor does he say anything about two harmonic alternate currents differing by 90° in phase producing the exact variation of current required. Although, then, what may be called the geometrical idea of producing a rotating magnetic field was certainly clearly described by M. Deprez, the credit of rediscovering this principle, and, what is far more important, of applying it in the design of the two-phase alternate current motor, is due to Prof. Ferraris.

To increase the strength of the rotating magnetic field, the copper cylinder originally used by Prof. Ferraris was next made hollow, and the interior filled with soft iron, the iron being laminated in planes at right angles to the axis, to prevent currents being induced in the iron; and to make the currents induced in the copper cylinder follow the most useful path the next step was to make a number of cuts through the hollow copper cylinder parallel to the axis of rotation. Practically, then, the rotating portion becomes a laminated cylinder of iron, on which is wound insulated wire parallel to the axis, as in a Siemens armature, but with this difference, that all the wires are electrically joined together at each end of the cylinder.

A two-phase alternate current motor was constructed and used by Prof. Ferraris in his laboratory at Turin in 1885. But not appreciating the practical importance of his own invention, and thinking that no motor requiring more than two wires could interest anyone but the natural philosopher, Prof. Ferraris occupied himself with attempts to utilize the rotatory magnetic field in measuring the resistance of conductors and with mathematical investigations on alternate currents. It was not, therefore, until the spring of 1888 that the results of his researches were published; when, a few months later, commercial motors based on exactly the same principles were brought ou with considerable *éclat* by Mr. Tesla, of Pittsburg, who had been working independently in the same direction.

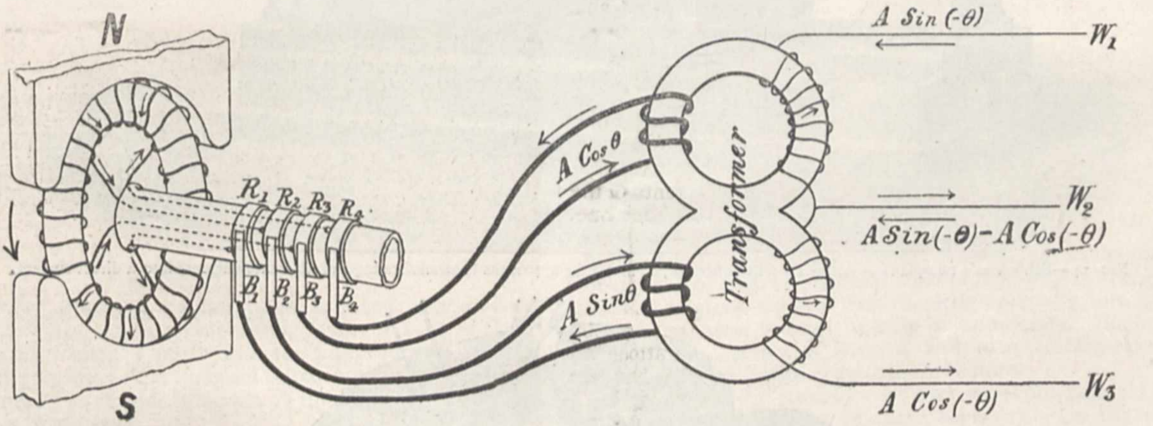

FIG. 13.—Schuckert two-phase alternate current generator and transformer. The arrows indicate the actual direction of the currents for the position of the armature shown.

To produce two alternate currents, differing by 90° in phase, the following device (Fig. 13) may be adopted, and is the one employed by Messrs. Schuckert in transmitting power at 2000 volts from the Palm Garden at Frankfort to the Exhibition, and by Messrs. Siemens and Halske for experiments on rotatory field alternate current motors in the Exhibition; the latter firm, however, not employing the special form of transformer shown symbolically in Fig. 13. In addition to the armature of a Gramme dynamo being joined up in the well-known way with the ordinary direct current commutator (this commutator and brushes rubbing on it not being shown in Fig. 13), four points at equal distances on the armature are permanently connected with four metal rings, R_1, R_2, R_3, and R_4, which rotate with the armature. Then it is easy to prove that while the machine is producing a direct current, used for exciting the field magnets as well as for any other purpose desired, the current passing through the wires attached to the brushes B_1, B_2, and the current passing through the wires attached to the brushes B_3, B_4, each alternate very nearly as the sine function of the time, the one reaching its maximum value when the other is nought.

The actual machine employed for this purpose by Messrs. Schuckert is the multipolar dynamo shown in Fig. 14, the direct current commutator and brushes, as well as the four rings and brushes for the two alternating currents, being here seen. If rotated mechanically, it will produce a direct current, as well as two alternating currents differing by 90° in phase; if supplied with a direct current, it will rotate as a motor generating the two alternate currents, and also doing mechanical work if required; lastly, if supplied with the two alternate currents, it will work as a two-phase alternate current motor generating a direct current, as well as doing mechanical work.

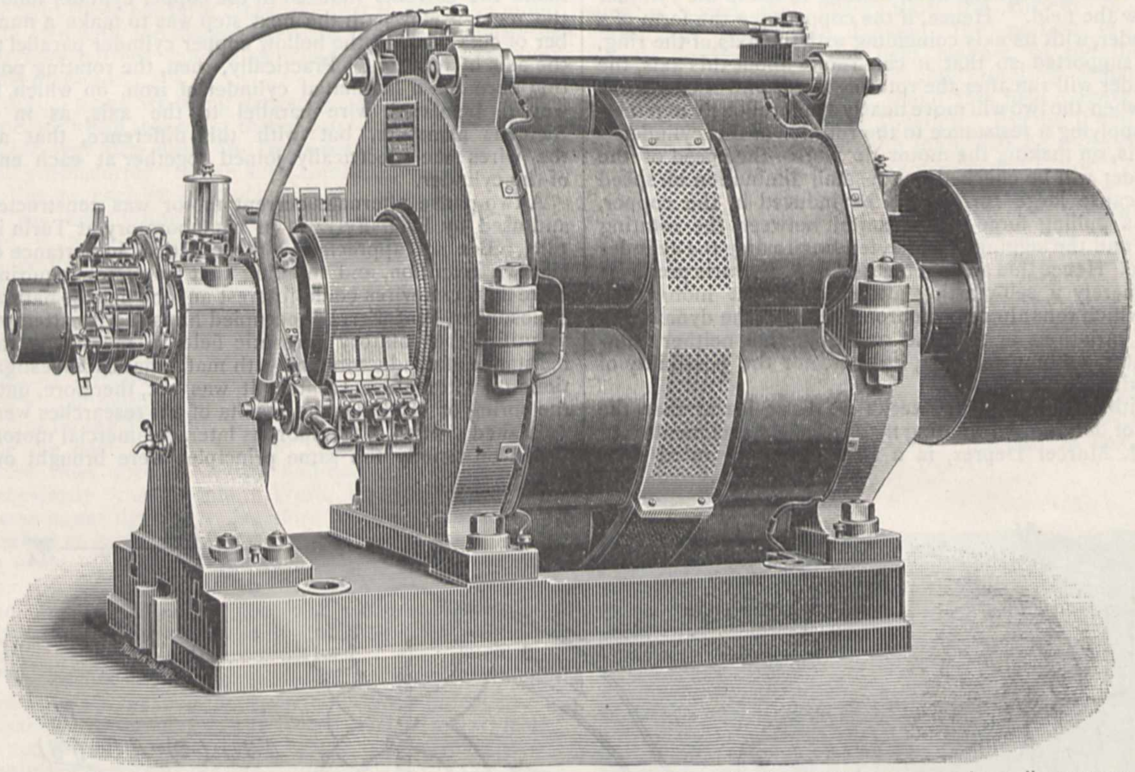

Fig. 14.—Schuckert's two-plane alternate current generator, or motor, or apparatus for transforming two alternate currents into a direct current.

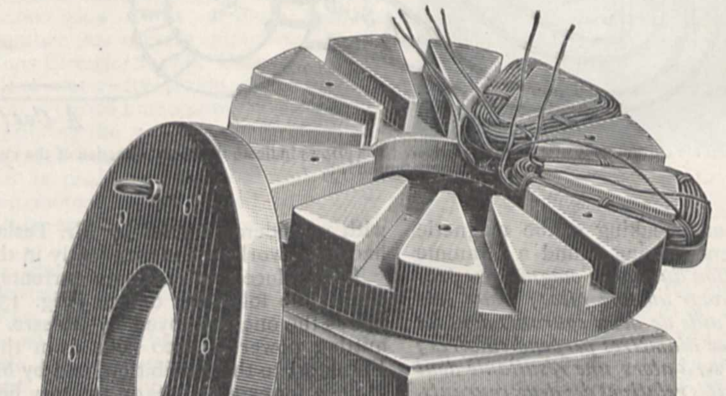

Fig. 15.—Schuckert two-phase alternate current transformer (method of construction).

When transmitting power to a distance, the two-phase alternate potential differences are transformed up from about 100 to 2000 volts; and to enable the transmission to be effected with three wires instead of four, Messrs. Schuckert arrange the transformer at each end of the line as shown symbolically in Fig. 13. Hence, if the currents produced by the dynamo be represented by A sin θ and A cos θ, the currents in the main wires, W_3, W_1, and W_2, will be represented by A cos $(-\theta)$, A sin $(-\theta)$, and A $\{\sin(-\theta) + \cos(-\theta)\}$ respectively.

The actual method employed by Messrs. Schuckert for winding this special transformer, as well as its appearance when completed, are seen from Figs. 15 and 16. This transformer, then, instead of consisting of merely a double ring of laminated iron as indicated in the symbolical diagram, Fig. 13, may be regarded as being composed of a connected series of laminated iron rings, each of a wedge-shaped cross-section.

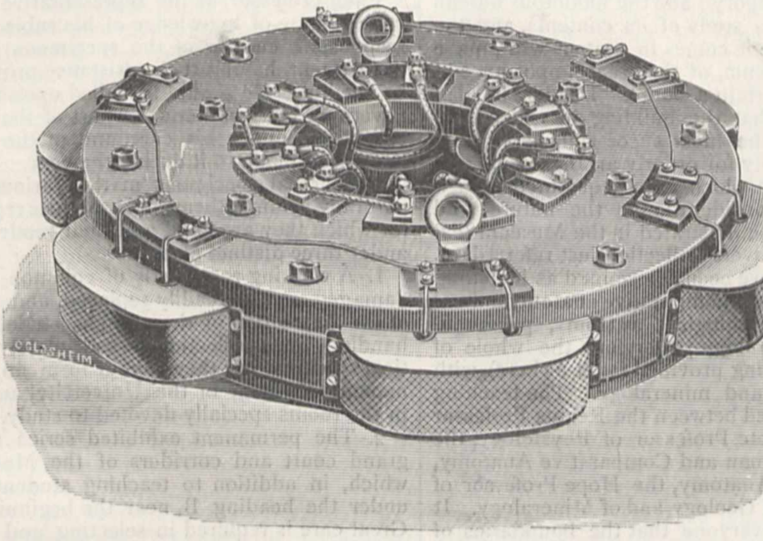

FIG. 16.—Schuckert two-phase alternate current transformer (completed).

(*To be continued.*)

THE OXFORD UNIVERSITY MUSEUM.[1]

THE following memorandum is based, not only upon observations made during a recent visit to Oxford, but also upon a fairly intimate knowledge of the origin and progress of the different departments of the Museum, acquired at various intervals of time extending over more than thirty years.

In entering upon the consideration of the subject which you have referred to me, it will first be necessary to define the purposes for which the Museum is maintained. These I take to be somewhat manifold, but they may be classed as follows:—

A. The first and main purpose is undoubtedly to assist in the educational work of the University, by illustrating the teaching of the professors and lecturers.

Besides this, however, it subserves, to a greater or less degree, other and what may be considered, as compared with the first, secondary, but nevertheless important functions. These are—

B. The exhibition of a collection, arranged in a systematic, orderly, and attractive manner, open to the inspection, under proper regulations, of all members of the University, and also of residents in and visitors to the town, which shall tend to awaken and keep up an interest in various subjects of which most educated persons, besides those actually engaged at the moment in obtaining instruction, desire to possess some knowledge Such a collection is a most legitimate adjunct to the University as a place of general culture.

C. Certain collections have already, and possibly will in future, become added to the general Museum, the aim and scope of which reach beyond either of the above, being of value, not to the ordinary student, not to the man or woman of average general culture, but only to the advanced student who wishes to enter seriously into the pursuit of some special branch of knowledge. Such is the Hope Collection of Insects, and to a certain extent the Pitt-Rivers Ethnographical Collection.

It is a grave question how far such collections should be maintained at the cost of the University. On the one hand, they must be a cause of expense, without which no collection of any value can be maintained; and the larger and better ordered they are, the greater must be the cost of maintaining them. Unless properly cared for, not only as regards actual preservation of the objects contained in them, but also as regards the continual rearrangements and augmentations necessitated by the advance of science, they will become comparatively valueless in the course of time. If the care of many such collections were undertaken unaccompanied by special endowments for their maintenance, the burden would become such as only a national institution could afford.

On the other hand, looking at the University, not merely as a place for the education of youth, but also as a centre of culture for the whole country, the possession of some such collections is of great importance. As they contain in them objects which can be found nowhere else, they attract men of learning and science, not only from other parts of the country, but also from distant places, to visit the University, or even to become permanent residents. The value of collections of rare books, even upon subjects interesting to scholars whose numbers are very limited, have long been recognized. From the same point of view, special collections of rare specimens of natural history or works of art may take their place in the general scheme of a University Museum, but the care of such collections should not be undertaken without full con-

[1] Prof. Flower's Report to the Committee on Collections appointed by the Delegates of the University Museum, Oxford, dated March 14, 1891.

sideration as to whether the means will be forthcoming to maintain them in a state of efficiency.

I have alluded to the Pitt-Rivers Collection as coming partly under this head, but, admirably and instructively displayed as it now is, it may also be considered as belonging to my second category; and the numerous human interests awakened by a study of its contents, and the many branches of culture it comes in contact with, make it an adjunct to the Museum, of the great importance of which no one should entertain a doubt. I should be glad to remark, in passing, that the building in which it is housed appears to me the most successful, as regards economy of space, capacity for orderly arrangement, and good lighting, of any with which I am acquainted.

The next point for consideration is the nature and extent of the subjects to be illustrated in the Museum (excluding the special Pitt-Rivers Collection just referred to). These seem already to have been determined as including physiology, human anatomy, comparative anatomy, animal morphology, zoology, pathological anatomy, palæontology, geology, and mineralogy; therefore the whole of animal biology (botany being provided for elsewhere), with the addition of geology and mineralogy. The teaching of these subjects is divided between the Regius Professor of Medicine, the Waynflete Professor of Physiology, the Linacre Professor of Human and Comparative Anatomy, the Lecturer in Human Anatomy, the Hope Professor of Zoology, the Professors of Geology and of Mineralogy. It must be recognized by everyone that the boundaries of these subjects are most difficult to define, and must be constantly shifting with the advance of knowledge. For instance, comparative anatomy and palæontology may both be included under the broad general heading of zoology, which without the aid of both can be but imperfectly understood. Whatever dividing lines are drawn between different sections of the collection, identical specimens are often required to illustrate more than one subject. The remains of extinct animals are required to complete the story of their living representatives; they are also required to illustrate the ancient history of the earth, and to define the progress of geological time and the order and succession of strata. The relation between the collections used to illustrate the teaching of the Waynflete, the Linacre, and the Hope Professors, must also be more or less arbitrary and artificial. In all these matters mutual convenience must be studied, and the specimens which lie on the borderland of two subjects should be made in some way available for the teaching of both, otherwise a great duplication will be necessary.

With regard to general administration, it appears to me desirable that there should be a governing body for the whole Museum, comparable to the standing committee of the Trustees of the British Museum, or the Museum Committee of the Royal College of Surgeons, or the Museums Syndicate of the University of Cambridge. The Delegates constitute such a body at Oxford, but possibly their constitution or powers might be modified and more clearly defined than they seem to be at present.

This body should be composed of members of the University specially selected for fitness for the office; seven or nine would probably be the most convenient number, so that representatives may be found upon it of various branches of science included in the Museum, and also some members of general business or administrative capacity. They should meet at occasional and stated intervals, and should determine general questions affecting the Museum as a whole, the relations of its component elements one to another, the allotment of space and the apportionment of the grants for the service of each department, the general control of expenditure, and also the care of the building, furniture, &c. It is not advisable that they should interfere with the details of the arrangement of each department as long as these appear to be satisfactorily carried out. The Keeper of the Museum should be the active executive officer of this governing body, carrying out their views in the intervals of the meetings, and bringing before their notice any subjects which seem to require their consideration.

Each professor, as the representative of the most advanced state of knowledge of his subject, should be the responsible curator of the specimens belonging to his department, having such assistance provided him as may be needful. He should be called upon to present to the governing body an annual report of the condition of the collections under his care, and of the accessions which have been made to it during the year.

The actual specimens in the various collections will naturally arrange themselves, both as regards the purpose for which they are kept, and their mode of conservation, under three distinct classes.

1. A working set, mostly of common objects, which, if damaged, can be readily replaced, and which can be put at the disposition of the ordinary student to examine and handle. Such collections are absolutely essential to practical teaching, but they should form no part of the permanent Museum of the University, and should be kept in the rooms specially devoted to study.

2. The permanent exhibited series displayed in the grand court and corridors of the Museum, the use of which, in addition to teaching students, is referred to under the heading B, near the beginning of this report. Great care is required in selecting and arranging these, as well as in their preservation and display. Every specimen exhibited should have a definite object, and should be so placed that it can be thoroughly well seen. As a general rule they should be so arranged as to show what they are intended to teach without moving them from their places, and if this must be done under proper restrictions, all due precautions should be used that they do not become damaged or destroyed. Although for the purposes of custody, arrangement, and nomenclature, these must be under the care of a particular professor, they are in a certain sense the common property of all who have a right of access to the Museum. This is another reason for not removing them from their places (apart from the injury that might thereby accrue to them) without definite cause, as they should be always available for study, the professors and demonstrators rather bringing their classes to them than removing them to the class-rooms.

3. The collections kept for advanced researches. Although these are not exhibited in the ordinary sense of the word, they should, if retained at all, be kept in a situation and under conditions which make them readily accessible to all who can profit by their examination under suitable regulations. Their preservation is of the utmost importance in the progress of science, as among them are often to be found zoological "types," or the individual specimens upon which the name of the species was instituted, and which must be referred to by zoologists for all future time in cases of difficulty in determining that name. To permit the loss or deterioration of a "type" specimen is a serious offence in the eyes of the zoologist. The Hope Collection abounds in such types.

Nothing more need be said at present about the first and third of these sections of the Museum, but the second, the exhibited series occupying the body of the great hall, requires consideration in a little more detail.

It is divided at present into—

(1) Mineralogy. Of the value and arrangement of this section I am not competent to speak.

(2) Geology. This collection is mainly palæontological, and the arrangement appears to be partly stratigraphical and partly zoological. In many groups the collection is rich, but taking it altogether there appears to be a number of unnecessary duplicates, and much rearrangement is

required to bring it into good exhibition and teaching order. I would suggest that in a collection illustrating *geology* (and not the zoology of extinct animals, so often in museums confounded with that science) the stratigraphical arrangement should be followed as strictly as possible, and also that there should be a good series illustrating dynamical geology, or the processes by which the materials forming the earth's crust have been fashioned and arranged as we now see them.

(3) Animal Biology. This section occupies about two-thirds of the floor space of the Museum, and is at present broken up into various small series involving much repetition and duplication, and also difficulty of finding any particular object or illustration required.

In the middle of the hall is a series of specimens merely showing the external appearance of certain groups of animals, stuffed vertebrates and the shells of mollusks, and stony skeletons of corals, &c. If this collection were incorporated in the general series of animal biology, not only would much duplication be avoided, but a more instructive and scientific exhibition would be provided. Many of the present specimens of this series, especially the mounted mammals and birds, are in such bad condition that they have no educational value—they only mislead instead of teaching; but before destroying them they should all be submitted to the examination of some expert in the group to which they belong, as there may be interesting or rare specimens among them, though their value is scarcely to be recognized by the ordinary observer in their present condition.

The imperfection of any zoological series that does not illustrate extinct as well as recent forms is continually becoming more apparent as science advances; some attempts have already been made to remedy this defect in the zoological series, but a considerable transfer of specimens to it from the department of geology will result in advantage to both.

By a rearrangement of the biological series, with incorporation of the so-called zoological specimens (excluding the Hope Collection, which I presume is always to be kept apart) much economy of space could be effected, and some of the confusion which now appears to exist in this department of the Museum in consequence of the numerous apparently independent series of specimens will be obviated.

The great question of the primary arrangement of the biological collection, whether on the physiological or Hunterian system, or upon a system based upon zoological classification, will have to be carefully considered. Much is to be said for either, but whichever is adopted should follow the method of teaching of the professor and his assistants. The point to be aimed at is that every specimen should be readily found, and be in juxtaposition with other specimens which are related to it, and which should be studied in conjunction with it. As the classification of animals, except as regards the greater divisions, is still a matter of much uncertainty, and continually changing according to the advance of knowledge, or the opinions of individual zoologists, it is not a satisfactory basis for the arrangement of a collection intended to illustrate principles rather than details. On the other hand, the Hunterian system often brings into juxtaposition specimens related only by some remote analogy of function, and having no real correspondence or homology. Probably a zoological arrangement for the main divisions, and one based upon a comparison of organs or systems for the secondary divisions, will, on the whole, be found most convenient.

I am hardly in a position to say how far the Professor of Physiology requires a special collection to illustrate his teaching. Probably the general biological series will supply all that is necessary to refer to in illustration of his lectures, especially as the tendency of modern physiology seems to be to separate itself from morphology, and confine itself more to biological chemistry and dynamics.

Another question which has been raised is, whether human anatomy, as distinguished from general biology, requires a separate section of the Museum, and how the great and important collection of crania of the races of men, which under Prof. Rolleston became one of the special features of the Museum, should be treated and utilized for instruction. These are questions that time will probably solve. Much depends upon the view taken of the duties of the Lecturer on Human Anatomy, whether he should teach upon a broad and philosophical basis, or whether he should aim mainly at enabling his pupils to pass the standard now required by the examining bodies. But this trenches upon the larger and more complex subject of what should be the aim of the University in keeping up a Medical School.

The Pathological Collection will, of course, remain as at present under the care of the Professor of Medicine.

In looking round the Museum at the present time, one of its greatest wants appears to me to be proper labelling. The different sections of the Museum should be distinctly marked off from each other. Every case should have a conspicuous label on the top of it, indicating the nature of its contents. Every specimen should have one indicating why it is there and what it teaches. This will involve a large amount of labour and expense in printing, but it is absolutely necessary, if the collections are to fulfil the purpose for which they are formed. It is a mistake to spend much time, labour, and cost in obtaining, preparing, and preserving a specimen, and then to stop short of the one thing needed to make it of use. Better have fewer specimens in a complete state. A printing press might be established in the building and kept constantly at work, but as it would be difficult to apportion the claims upon its services of the different curators, it might be better to make an arrangement with the University Press by which labels (of a uniform character) for the whole Museum would be printed at a fixed charge, and paid for out of the funds of the department requiring them. As in a large number of cases only a single copy of a label is required, it is possible that some system of type-writing might be more economical, and nearly, if not quite, as effectual.

Of the importance of complete catalogues of every department of the Museum, it would seem almost superfluous to speak, were it not obvious that much is needed in this respect.

Lastly, it appears to me that, although more work-rooms and class-rooms may be necessary for the growing needs of the scientific departments of the University, there is ample space in the present building for some time to come for the exhibited portion of the Museum. The collections are rich, contain many instructive and valuable objects, and do great credit to the zeal and energy of those by whom they have been brought together. What is really required now is, not so much that they should be increased, as that they should be better arranged, better cared for, and that all inferior and defective specimens should be gradually replaced by better ones. Oxford has done very much in past times to initiate and keep up a high standard of museum work, but it must not be overlooked that great advances are being made in this respect, not only in this country but all over the Continent, and the standard is being continually raised. All such work is both laborious and costly, but when done the result is fully commensurate to the labour and expense bestowed upon it. An ill-arranged museum has been well compared to the letters of the alphabet tossed about indiscriminately, meaning nothing; a well-arranged one to the same letters placed in such orderly sequence as to produce words of counsel and instruction.

FURTHER RESEARCHES UPON THE ELEMENT FLUORINE.

SINCE the publication by M. Moissan of his celebrated paper in the *Annales de Chimie et de Physique* for December 1887, describing the manner in which he had succeeded in isolating this remarkable gaseous element, a considerable amount of additional information has been acquired concerning the chemical behaviour of fluorine, and important additions and improvements have been introduced in the apparatus employed for preparing and experimenting with the gas. M. Moissan now gathers together the results of these subsequent researches—some of which have been published by him from time to time as contributions to various French scientific journals, while others have not hitherto been made known —and publishes them in a long but most interesting paper in the October number of the *Annales de Chimie et de Physique*. Inasmuch as the experiments described are of so extraordinary a nature, owing to the intense chemical activity of fluorine, and are so important as filling a long existing vacancy in our chemical literature, readers of NATURE will doubtless be interested in a brief account of them.

IMPROVED APPARATUS FOR PREPARING FLUORINE.

In his paper of 1887, the main outlines of which were given in NATURE at the time (1887, vol. xxxvii. p. 179), M. Moissan showed that pure hydrofluoric acid readily dissolves the double fluoride of potassium and hydrogen, and that the liquid thus obtained is a good conductor of electricity, rendering electrolysis possible. It will be remembered that, by passing a strong current of electricity through this liquid contained in a platinum apparatus, free gaseous fluorine was obtained at the positive pole and hydrogen at the negative pole. The amount of hydrofluoric acid employed in these earlier experiments was about fifteen grams, about six grams of hydrogen potassium fluoride, HF.KF, being added in order to render it a conductor. Since the publication of that memoir a much larger apparatus has been constructed, in order to obtain the gas in greater quantity for the study of its reactions, and important additions have been made, by means of which the fluorine is delivered in a pure state, free from admixed vapour of the very volatile hydrofluoric acid. As much as a hundred cubic centimetres of hydrofluoric acid, together with twenty grams of the dissolved double fluoride, are submitted to electrolysis in this new apparatus, and upwards of four litres of pure fluorine is delivered by it per hour.

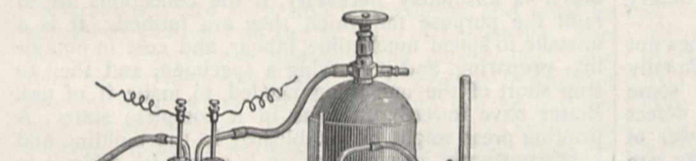

FIG. 1.

This improved form of the apparatus is shown in the accompanying figure (Fig. 1), which is reproduced from the memoir of M. Moissan. It consists essentially of two parts—the electrolysis apparatus and the purifying vessels. The electrolysis apparatus, a sectional view of which is given in Fig. 2, is similar in form to that described in the paper of 1887, but much larger. The U-tube of platinum has a capacity of 160 c.c. It is fitted with two lateral delivery tubes of platinum, as in the earlier form, and with stoppers of fluor-spar, F, inserted in cylinders of platinum, *p*, carrying screw threads, which engage with similar threads upon the interior surfaces of the limbs of the U-tube. A key of brass, E, serves to screw or unscrew the stoppers, and between the flange of each stopper and the top of each branch of the U-tube a ring of lead is compressed, by which means hermetic closing is effected. These fluor-spar stoppers, which are covered with a coating of gum-lac during the electrolysis, carry the electrode rods, *t*, which are thus perfectly insulated. M. Moissan now employs electrodes of pure platinum instead of irido-platinum, and the interior end of each is thickened into a club shape in order the longer to withstand corrosion. The apparatus is immersed during the electrolysis in a bath of liquid methyl chloride, maintained in tranquil ebullition at -23°. In order to preserve the methyl chloride as long as possible, the cylinder containing it is placed in an outer

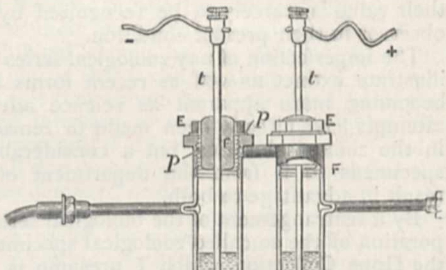

FIG. 2.

glass cylinder containing fragments of calcium chloride; by this means it is surrounded with a layer of dry air, a bad conductor of heat.

The purifying vessels are three in number. The first consists of a platinum spiral worm-tube, of about 40 c.c. capacity, immersed also in a bath of liquid methyl chloride, maintained at as low a temperature as possible, about -50°. As hydrofluoric acid boils at 19°·5 (Moissan), almost the whole of the vapour of this substance which is carried away in the stream of issuing fluorine is condensed and retained at the bottom of the worm. To remove the last traces of hydrofluoric acid, advantage is taken of the fact that fused sodium fluoride combines with the free acid with great energy to form the double fluoride HF.NaF. Sodium fluoride also possesses the advantage of not attracting moisture. After traversing the worm condenser, therefore, the fluorine is caused to pass through two platinum tubes filled with fragments of fused sodium fluoride, from which it issues in an almost perfect state of purity. The junctions between the various parts of the apparatus are effected by means of screw joints, between the nuts and flanges of which collars of lead are compressed. During the electrolysis these leaden collars become, where exposed to the gaseous fluorine, rapidly converted into lead fluoride, which, being greater in bulk, causes the joints to become hermetically sealed. In order to effect the electrolysis, 26 to 28 Bunsen elements are employed, arranged in series. An ampere-meter and a commutator are introduced between the battery and the electrolysis apparatus ; the former affording an excellent indication of the progress of the electrolysis.

As the U-tube contains far more hydrofluoric acid than can be used in one day, each lateral delivery-tube is fitted with a metallic screw stopper, so that the experiments may be discontinued at any time, and the apparatus closed. The whole electrolysis vessel is then placed under a glass bell-jar containing dry air, and kept in a refrigerator until again required for use. In this way it may be preserved full of acid for several weeks, ready at any time for the preparation of the gas. Considerable care requires to be exercised not to admit the vapour of methyl chloride into the U-tube, as otherwise violent detonations are liable to occur. When the liquid methyl chloride is being introduced into the cylinder, the whole apparatus becomes surrounded with an atmosphere of its vapour, and as the platinum U-tube is at the same instant suddenly cooled, the vapour is liable to enter by the abducting tubes. Consequently, as soon as the current is allowed to pass and fluorine is liberated within the U-tube, an explosion occurs. Fluorine instantly decomposes methyl chloride, with production of flame and formation of fluorides of hydrogen and carbon, liberation of chlorine, and occasionally deposition of carbon. In order to avoid this unpleasant occurrence, when the methyl chloride is being introduced the ends of the lateral delivery-tubes are attached to long lengths of caoutchouc tubing, supplied at their ends with calcium chloride drying tubes, so as to convey dry air from outside the atmosphere of methyl chloride vapour. If great care is taken to obtain the minimum temperature, this difficulty may be even more simply overcome by employing a mixture of well-pounded ice and salt instead of methyl chloride ; but there is the counterbalancing disadvantage to be considered, that such a cooling bath requires much more frequent renewal.

CHEMICAL REACTIONS OCCURRING DURING THE ELECTROLYSIS.

In the paper of 1887, M. Moissan adopted the view that the first action of the electric current was to effect the decomposition of the potassium fluoride contained in solution in the hydrofluoric acid, fluorine being liberated at the positive pole, and potassium at the negative terminal. This liberated potassium would at once regenerate potassium fluoride in presence of hydrofluoric acid, and liberate its equivalent of hydrogen :

$$KF = K + F.$$
$$K + HF = KF + H.$$

But when the progress of the electrolysis is carefully followed, by consulting the indications of the amperemeter placed in circuit, it is found to be by no means as regular as the preceding formulæ would indicate. With the new apparatus, the decomposition is quite irregular at first, and does not attain regularity until it has been proceeding for upwards of two hours. Upon stopping the current and unmounting the apparatus, the platinum rod upon which the fluorine was liberated is found to be largely corroded, and at the bottom of the U-tube a quantity of a black, finely-divided substance is observed. This black substance, which was taken at first to be metallic platinum, is a complex compound, containing one equivalent of potassium to one equivalent of platinum, together with a considerable proportion of fluorine. Moreover, the hydrofluoric acid is found to contain a small quantity of platinum fluoride in solution. The electrolytic reaction is probably therefore much more complicated than was at first considered to be the case. The mixture of acid and alkaline fluoride furnishes fluorine at the positive terminal rod, but this intensely active gas, in its nascent state, attacks the platinum and produces platinum tetrafluoride, PtF_4; this probably unites with the potassium fluoride to form a double salt, possibly $2KF.PtF_4$, analogous to the well-known platinochloride $2KCl.PtCl_4$; and it is only when the liquid contains this double salt that the electrolysis proceeds in a regular manner, yielding free fluorine at the positive pole, and hydrogen and the complex black compound at the negative pole.

PHYSICAL PROPERTIES OF FLUORINE.

Fluorine possesses an odour which M. Moissan compares to a mixture of hypochlorous acid and nitrogen peroxide, but this odour is usually masked by that of the ozone which it always produces in moist air, owing to its decomposition of the water vapour. It produces most serious irritation of the bronchial tubes and mucous membrane of the nasal cavities, the effects of which are persistent for quite a fortnight.

When examined in a thickness of one metre, it is seen to possess a greenish-yellow colour, but paler, and containing more of yellow, than that of chlorine. In such a layer, fluorine does not present any absorption-bands. Its spectrum exhibits thirteen bright lines in the red, between wave-lengths 744 and 623. Their positions and relative intensities are as follows :—

λ = 744	very feeble.	λ = 685·5	feeble.
740	,,	683·5	,,
734	,,	677	strong.
714	feeble.	640·5	,,
704	,,	634	,,
691	,,	623	,,
687·5	,,		

At a temperature of $-95°$ at ordinary atmospheric pressure, fluorine remains gaseous, no sign of liquefaction having been observed.

METHODS OF EXPERIMENTING WITH FLUORINE.

When it is desired to determine the action of fluorine upon a solid substance, the following method of procedure is adopted. A preliminary experiment is first made, in order to obtain some idea as to the degree of energy of the reaction, by bringing a little of the solid, placed upon the lid of a platinum crucible held in a pair of tongs, near the mouth of the delivery-tube of the preparation apparatus. If a gaseous or liquid product results, and it is desirable to collect it for examination, small fragments of the solid are placed in a platinum tube connected to the delivery-tube by flexible platinum tubing or by a screw joint, and the resulting gas may be collected over water or mercury, or the liquid condensed in a cooled cylinder of platinum. In this manner the action of fluorine upon sulphur and iodine has been studied. If the solid, phosphorus for instance, attacks platinum, or the temperature of the reaction is sufficiently high to determine the combination of platinum and fluorine (towards 500°), a tube of fluor-spar is substituted for the platinum tube. The fluor-spar tubes employed by M. Moissan for the study of the action of phosphorus were about twelve to fourteen centimetres long, and were terminated by platinum ends furnished with flanges and screw threads in order to be able to connect them with the preparation apparatus. If it is required to heat the fluor-spar tubes, they are surrounded by a closely wound copper spiral, which may be heated by a Bunsen flame.

In experimenting upon liquids, great care is necessary, as the reaction frequently occurs with explosive violence. A preliminary experiment is therefore always made, by allowing the fluorine delivery-tube to dip just beneath the surface of the liquid contained in a small glass cylinder. When the liquid contains water, or when hydrofluoric acid is a product of the reaction, cylinders of platinum or of fluor-spar are employed. If it is required to collect and examine the product, the liquid is placed along the bottom of a horizontal tube of platinum or fluor-spar, as in case of solids, connected directly with the preparation apparatus, and the product is collected over water or mercury if a gas, or in a cooled platinum receiver if a liquid.

During the examination of liquids a means has accidentally been discovered by which a glass tube may be filled with fluorine gas. A few liquids, one of which is carbon tetrachloride, react only very slowly with fluorine at the ordinary temperature. By filling a glass tube with such a liquid, and inverting it over a platinum capsule also containing the liquid, it is possible to displace the liquid by fluorine, which, as the walls are wet, does not attack the glass. Or the glass tube may be filled with the liquid, and then the latter poured out, leaving the walls wet; the tube may then be filled with fluorine gas, which, being slightly heavier than air, remains in the tube for some time. In one experiment, in which a glass test-tube had been filled with fluorine over carbon tetrachloride, it was attempted to transfer it to a graduated tube over mercury, but in inclining the test-tube for this purpose, the mercury suddenly came in contact with the fluorine, and absorbed it so instantaneously and with such a violent detonation that both the test-tube and the graduated tube were shattered into fragments. Indeed, owing to the powerful affinity of mercury for fluorine, it is a most dangerous experiment to transfer a tube containing fluorine gas, filled according to either the first or second method, to the mercury trough; the tube is always shattered if the mercury comes in contact with the gas, and generally with a loud detonation. Fluorine may, however, be preserved for some time in tubes over mercury, provided a few drops of the non reacting liquid are kept above the mercury meniscus.

For studying the action of fluorine on gases, a special piece of apparatus, shown in Fig. 3, has been constructed.

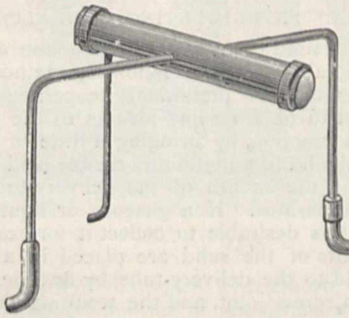

FIG. 3.

It is composed of a tube of platinum, fifteen centimetres long, closed by two plates of clear, transparent, and colourless fluor-spar, and carrying three lateral narrower tubes also of platinum. Two of these tubes face each other in the centre of the apparatus, and serve one for the conveyance of the fluorine and the other of the gas to be experimented upon. The third, which is of somewhat greater diameter than the other two, serves as exit-tube for the product or products of the reaction, and may be placed in connection with a trough containing either water or mercury. The apparatus is first filled with the gas to be experimented upon, then the fluorine is allowed to enter, and an observation of what occurs may be made through the fluor-spar windows. One most important precaution to take in collecting the gaseous products over mercury is not to permit the platinum delivery-tube to dip more than two or at most three millimetres under the mercury, as otherwise the levels of the liquid in the two limbs of the electrolysis U-tube become so different owing to the pressure, that the fluorine from one side mixes with the hydrogen evolved upon the other, and there is a violent explosion.

ACTION OF FLUORINE UPON THE NON-METALLIC ELEMENTS.

Hydrogen.—As just described, hydrogen combines with fluorine, even at $-23°$ and in the dark, with explosive force. This is the only case in which two elementary gases unite directly without the intervention of extraneous energy. If the end of the tube delivering fluorine is placed in an atmosphere of hydrogen, a very hot blue flame, bordered with red, at once appears at the mouth of the tube, and vapour of hydrofluoric acid is produced.

Oxygen.—Fluorine has not been found capable of uniting with oxygen up to a temperature of 500°. On ozone, however, it appears to exert some action, as will be evident from the following experiment. It was shown in 1887 that fluorine decomposes water, forming hydrofluoric acid, and liberating oxygen in the form of ozone. When a few drops of water are placed in the apparatus shown in Fig. 3, and fluorine allowed to enter, the water is instantly decomposed, and on looking through the fluor-spar ends a thick dark cloud is seen over the spot where each drop of water had previously been. This cloud soon diminishes in intensity, and is eventually replaced by a beautiful blue gas—ozone in a state of considerable density. If the product is chased out by a stream of nitrogen as soon as the dense cloud is formed, a very strong odour is perceived, different from that of either fluorine or ozone, but which soon gives place to the unmistakable odour of ozone. It appears as if there is at first produced an unstable oxide of fluorine, which rapidly decomposes into fluorine and ozone.

Nitrogen and *chlorine* appear not to react with fluorine.

Sulphur.—In contact with fluorine gas, sulphur rapidly melts and inflames. A gaseous fluoride of sulphur is formed, which possesses a most penetrating odour, somewhat resembling that of chloride of sulphur. The gas is incombustible, even in oxygen. When warmed in a glass vessel, the latter becomes etched, owing to the formation of silicon tetrafluoride, SiF_4. Selenium and tellurium behave similarly, but form crystalline solid fluorides.

Bromine vapour combines with fluorine in the cold with production of a very bright but low-temperature flame. If the fluorine is evolved in the midst of pure dry liquid bromine, the combination is immediate, and occurs without flame.

Iodine.—When fluorine is passed over a fragment of iodine contained in the horizontal tube, combination occurs, with production of a pale flame. A very heavy liquid, colourless when free from dissolved iodine, and fuming strongly in the air, condenses in the cooled receiver. This liquid fluoride of iodine attacks glass with great energy, and decomposes water when dropped into that liquid with a noise like that produced by red-hot iron. Its properties agree with those of the fluoride of iodine prepared by Gore by the action of iodine on silver fluoride.

Phosphorus.—Immediately phosphorus, either the ordinary yellow variety or red phosphorus, comes in contact with fluorine, a most lively action occurs, accompanied by vivid incandescence. If the fluorine is in excess, a fuming gas is evolved, which gives up its excess of fluorine on collecting over mercury, and is soluble in water. This gas is phosphorus pentafluoride, PF_5, prepared some years ago by Prof. Thorpe. If, on the contrary, the phosphorus is in excess, a gaseous mixture of this pentafluoride with a new fluoride, the trifluoride, PF_3, a gas insoluble in water, but which may be absorbed by caustic potash, is obtained. The trifluoride, in turn, combines with more fluorine to form the pentafluoride, the reaction being accompanied by the appearance of a flame of comparatively low temperature.

Arsenic combines with fluorine at the ordinary temperature with incandescence. If the current of fluorine is fairly rapid, a colourless fuming liquid condenses in the receiver, which is mainly arsenic trifluoride, AsF_3, but which appears also to contain a new fluoride, the pentafluoride, AsF_5, inasmuch as the solution in water yields the reactions of both arsenious and arsenic acids.

Carbon.—Chlorine does not unite with carbon even at the high temperature of the electric arc, but fluorine reacts even at the ordinary temperature with finely-divided carbon. Purified lampblack inflames instantly with great brilliancy, as do also the lighter varieties of wood charcoal. A curious phenomenon is noticed with wood charcoal: it appears at first to absorb and condense the fluorine, then quite suddenly it bursts into flame with bright scintillations. The denser varities of charcoal require warming to 50° or 60° before they inflame, but if once the combustion is started at any point it rapidly propagates itself throughout the entire piece. Graphite must be heated to just below dull redness in order to effect combination; while the diamond has not yet been attacked by fluorine, even at the temperature of the Bunsen flame. A mixture of gaseous fluorides of carbon are produced whenever carbon of any variety is acted upon by fluorine, the predominating constituent being the tetrafluoride, CF_4.

Boron.—The amorphous variety of boron inflames instantly in fluorine, with projection of brilliant sparks and liberation of dense fumes of boron trifluoride, BF_3. The adamantine modification behaves similarly if powdered. When the experiment is performed in the fluor-spar tube, the gaseous fluoride may be collected over mercury. The gas fumes strongly in the air, and is instantly decomposed by water.

Silicon.—The reaction between fluorine and silicon is one of the most beautiful of all these extraordinary manifestations of chemical activity. The cold crystals become immediately white-hot, and the silicon burns with a very hot flame, scattering showers of star-like, white-hot particles in all directions. If the action is stopped before all the silicon is consumed, the residue is found to be fused. As crystalline silicon only melts at a temperature superior to 1200°, the heat evolved must be very great. If the reaction is performed in the fluor-spar tube, the resulting gaseous silicon tetrafluoride, SiF_4, may be collected over mercury.

Amorphous silicon likewise burns with great energy in fluorine.

ACTION OF FLUORINE UPON METALS.

Sodium and *potassium* combine with fluorine with great vigour at ordinary temperatures, becoming incandescent, and forming their respective fluorides, which may be obtained crystallized from water in cubes. Metallic *calcium* also burns in fluorine gas, forming the fused fluoride, and occasionally minute crystals of fluor-spar. *Thallium* is rapidly converted to fluoride at ordinary temperatures, the temperature rising until the metal melts and finally becomes red-hot. Powdered *magnesium* burns with great brilliancy. *Iron*, reduced by hydrogen, combines in the cold with immediate incandescence, and formation of an anhydrous, readily soluble, white fluoride. *Aluminium*, on heating to low redness, gives a very beautiful luminosity, as do also *chromium* and *manganese*. The combustion of slightly warmed zinc in fluorine is particularly pretty as an experiment, the flame being of a most dazzling whiteness. *Antimony* takes fire at the ordinary temperature, and forms a solid white fluoride. *Lead* and *mercury* are attacked in the cold, as previously described, the latter with great rapidity. *Copper* reacts at low redness, but in a strangely feeble manner, and the white fumes formed appear to combine with a further quantity of fluorine to form a perfluoride. The main product is a volatile white fluoride. *Silver* is only slowly attacked in the cold. When heated, however, to 100°, the metal commences to be covered with a yellow coat of anhydrous fluoride, and on heating to low redness combination occurs, with incandescence, and the resulting fluoride becomes fused, and afterwards presents a satin-like aspect. *Gold* becomes converted into a yellow deliquescent volatile fluoride when heated to low redness, and at a slightly higher temperature the fluoride is dissociated into metallic gold and fluorine gas.

The action of fluorine on *platinum* has been studied with special care. It is evident, in view of the corrosion of the positive platinum terminal of the electrolysis apparatus, that nascent fluorine rapidly attacks platinum at a temperature of − 23°. At 100°, however, fluorine gas appears to be without action on platinum. At 500°-600° it is attacked strongly, with formation of the tetrafluoride, PtF_4, and a small quantity of the protofluoride, PtF_2. If the fluorine is admixed with vapour of hydrofluoric acid, the reaction is much more vigorous, as if a fluorhydrate of the tetrafluoride, perhaps $2HF.PtF_4$, were formed. The tetrafluoride is generally found in the form of deep-red fused masses, or small yellow crystals resembling those of anhydrous platinum chloride. The salt is volatile and very hygroscopic. Its behaviour with water is peculiar. With a small quantity of water a brownish-yellow solution is formed, which, however, in a very short time becomes warm and the fluoride decomposes; platinic hydrate is precipitated, and free hydrofluoric acid remains in solution. If the quantity of water is greater, the solution may be preserved for some minutes without decomposition. If the liquid is boiled, it decomposes instantly. At a red heat platinic fluoride decomposes into metallic platinum and fluorine, which is evolved in the free state. This reaction can therefore be employed as a ready means of preparing fluorine, the fluoride only requiring to be heated rapidly to redness in a platinum tube closed at one end, when crystallized silicon held at the open end will be found to immediately take fire in the escaping fluorine. The best mode of obtaining the fluoride of platinum for this purpose is to heat a bundle of platinum wires to low redness in the fluor-spar reaction tube in a rapid stream of fluorine. As soon as sufficient fluoride is formed on the wires, they are transferred to a well-stoppered dry glass tube, until required for the preparation of fluorine.

ACTION OF FLUORINE UPON NON-METALLIC COMPOUNDS.

Sulphuretted hydrogen.—When the horizontal tube shown in Fig. 3 is filled with sulphuretted hydrogen gas and fluorine is allowed to enter, a blue flame is observed on looking through the fluor-spar windows playing around the spot where the fluorine is being admitted. The decomposition continues until the whole of the hydrogen sulphide is converted into gaseous fluorides of hydrogen and sulphur.

Sulphur dioxide is likewise decomposed in the cold, with production of a yellow flame and formation of fluoride of sulphur.

Hydrochloric acid gas is also decomposed at ordinary temperatures with flame, and, if there is not a large excess of hydrochloric acid present, with detonation. Hydrofluoric acid and free chlorine are the products.

Gaseous *hydrobromic* and *hydriodic acids* react with fluorine in a similar manner, with production of flame and formation of hydrofluoric acid. Inasmuch, however, as bromine and iodine combine with fluorine, as previously described, these halogens do not escape, but burn up to their respective fluorides. When fluorine is delivered into an aqueous solution of hydriodic acid, each bubble as it enters produces a flash of flame, and if the fluorine is being evolved fairly rapidly there is a series of very violent detonations. A curious reaction also occurs when fluorine is similarly passed into a 50 per cent. aqueous solution of hydrofluoric acid itself, a flame being produced in the middle of the liquid, accompanied by a series of detonations.

Nitric acid vapour reacts with great violence with fluorine, a loud explosion resulting. If fluorine is passed into the ordinary liquid acid, each bubble as it enters produces a flame in the liquid.

Ammonia gas is decomposed by fluorine with formation of a yellow flame, forming hydrofluoric acid and liberating nitrogen. With a solution of the gas in water, each bubble of fluorine produces an explosion and flame, as in case of hydriodic acid.

Phosphoric anhydride, when heated to low redness, burns with a pale flame in fluorine, forming a gaseous mixture of fluorides and oxyfluoride of phosphorus. *Pentachloride and trichloride of phosphorus* both react most energetically with fluorine, instantly producing a brilliant flame, and evolving a mixture of phosphorus pentafluoride and free chlorine.

Arsenious anhydride also affords a brilliant combustion, forming the liquid trifluoride of arsenic, AsF_3. This liquid in turn appears to react with more fluorine with considerable evolution of heat, probably forming the pentafluoride, AsF_5. *Chloride of arsenic*, $AsCl_3$, is converted with considerable energy to the trifluoride, free chlorine being liberated.

Carbon bisulphide inflames in the cold in contact with fluorine, and if the fluorine is led into the midst of the liquid a similar production of flame occurs under the surface of the liquid, as in case of nitric acid. No carbon is deposited, both the carbon and sulphur being entirely converted into gaseous fluorides.

Carbon tetrachloride, as previously mentioned, reacts only very slowly with fluorine. The liquid may be saturated with gaseous fluorine at 15°, but on boiling this liquid a gaseous mixture is evolved, one constituent of which is carbon tetrafluoride, CF_4, a gas readily capable of absorption by alcoholic potash. The remainder consists of another fluoride of carbon, incapable of absorption by potash, and chlorine. A mixture of the vapours of carbon tetrachloride and fluorine inflames spontaneously with detonation, and chlorine is liberated without deposition of carbon.

Boric anhydride is raised to a most vivid incandescence by fluorine, the experiment being rendered very beautiful by the abundant white fumes of the trifluoride which are liberated.

Silicon dioxide, one of the most inert of substances at the ordinary temperature, takes fire in the cold in contact with fluorine, becoming instantly white-hot, and rapidly disappearing in the form of silicon tetrafluoride. The *chlorides* of both *boron* and *silicon* are decomposed by fluorine, with formation of fluorides and liberation of chlorine, the reaction being accompanied by the production of flame.

ACTION OF FLUORINE UPON METALLIC COMPOUNDS.

Chlorides of the metals are instantly decomposed by fluorine, generally at the ordinary temperature, and in certain cases, antimony trichloride for instance, with the appearance of flame. Chlorine is in each case liberated, and a fluoride of the metal formed. A few require heating, when a similar decomposition occurs, often accompanied by incandescence, as in case of chromium sesquichloride.

Bromides and *iodides* are decomposed with even greater energy, and the liberated bromine and iodine burn in the fluorine with formation of their respective fluorides.

Cyanides react in a most beautiful manner with fluorine, the displaced cyanogen burning with a purple flame. Potassium ferrocyanide in particular affords a very pretty experiment, and reacts in the cold. Ordinary potassium cyanide requires slightly warming in order to start the combustion.

Fused *potash* yields potassium fluoride and ozone. Aqueous potash does not form potassium hypofluorite when fluorine is bubbled into it, but only potassium fluoride. *Lime* becomes most brilliantly incandescent, owing partly to the excess being raised to a very high temperature by the heat developed during the decomposition, and partly to the phosphorescence of the calcium fluoride formed.

Sulphides of the alkalies and alkaline earths are also immediately rendered incandescent, fluorides of the metal and sulphur being respectively formed.

Boron nitride behaves in an exceedingly beautiful manner, being attacked in the cold, and emitting a brilliant blue light which is surrounded by a halo of the fumes of boron fluoride.

Sulphates, *nitrates*, and *phosphates* generally require the application of more or less heat, when they too are rapidly and energetically decomposed. Calcium phosphate is attacked in the cold like lime, giving out a brilliant white light, and producing calcium fluoride and gaseous oxyfluoride of phosphorus, POF_3. *Calcium carbonate* also becomes raised to brilliant incandescence when exposed to fluorine gas, as does also normal *sodium carbonate*; but curiously enough the bicarbonates of the alkalies do not react with fluorine even at red heat. Perhaps this may be explained by the fact that fluorine has no action at available temperatures upon carbon dioxide.

ACTION OF FLUORINE UPON A FEW ORGANIC COMPOUNDS.

Chloroform.—When chloroform is saturated with fluorine, and subsequently boiled carbon tetrafluoride, hydrofluoric acid and chlorine are evolved. If a drop of chloroform is agitated in a glass tube with excess of fluorine, a violent explosion suddenly occurs, accompanied by a flash of flame, and the tube is shattered to pieces. The reaction is very lively when fluorine is evolved in the midst of a quantity of chloroform, a persistent flame burns beneath the surface of the liquid, carbon is deposited, and fluorides of hydrogen and carbon are evolved together with chlorine.

Methyl chloride is decomposed by fluorine, even at −23°, with production of a yellow flame, deposition of carbon, and liberation of fluorides of hydrogen and carbon and free chlorine. With the vapour of methyl chloride, as pointed out in the description of the electrolysis, violent explosions occur.

Ethyl alcohol vapour at once takes fire in fluorine gas, and the liquid is decomposed with explosive violence without deposition of carbon. Aldehyde is formed to a considerable extent during the reaction.

Acetic acid and *benzene* are both decomposed with violence, their cold vapours burn in fluorine, and when the latter is bubbled through the liquids themselves, flashes of flame, and often most dangerous explosions, occur. In the case of benzene, carbon is deposited, and with both liquids fluorides of hydrogen and carbon are evolved. *Aniline* likewise takes fire in fluorine, and deposits a large quantity of carbon, which, however, if the fluorine is in excess, burns away completely to carbon tetrafluoride.

Such are the main outlines of these later researches of M. Moissan, and they cannot fail to impress those who read them with the prodigious nature of the forces associated with those minutest of entities, the chemical atoms, as exhibited at their maximum, in so far as our knowledge at present goes, in the case of the element fluorine.

A. E. Tutton.

THE HUXLEY LABORATORY FOR BIOLOGICAL RESEARCH, AND THE MARSHALL SCHOLARSHIP.

SCIENTIFIC friends and former pupils of Prof. Huxley will alike be gratified to learn that an appropriate method has been devised for establishing a permanent memorial of his great services to the institution with which his name has been so long identified. The late Sir Warington Smyth, whose loss we had to deplore rather more than a year ago, was the last surviving member of the original staff of the School of Mines, as founded by Sir Henry de la Beche in 1851. Prof. Huxley, who, as long ago as 1854, succeeded Edward Forbes in the Chair of Natural History, continues to hold the post of Honorary Dean of the Royal College of Science, with which the School of Mines is now incorporated; and although, since 1885, compelled by ill-health to discontinue the work of lecturing, he is still, we are happy to say, able to take a kindly interest in, and to exercise a general supervision over, the biological studies carried on in the school.

How much the Central Institution for training teachers in science, which is now located at South Kensington, owes to the organizing faculty and unremitting labours of Prof. Huxley, only those who have been associated with him in the work can form any just estimate. During the first twenty years of its existence all attempts at practical teaching in the School of Mines were restricted to the subjects of chemistry and metallurgy, the space available in the Jermyn Street buildings only permitting of the existence of very small and inconvenient laboratories in connection with those two branches of science.

Soon after the first establishment of the school, larger and more convenient premises for carrying on the chemical instruction had to be obtained in Oxford Street; and in 1872, on the unanimous recommendation of the Council, the teaching of chemistry, physics, and biology, was transferred to the building at South Kensington, which had been originally designed as a School of Naval Architecture. At subsequent dates, as the inadequacy of the Jermyn Street buildings to accommodate both the school and the Geological Survey made itself more strongly felt, the divisions of geology, mineralogy, metallurgy, applied mechanics, and mining, were successively removed to the same place.

No sooner did Prof. Huxley find an opportunity afforded to him, than he energetically devoted himself to the realization of a long-cherished scheme for establishing a system of practical laboratory-instruction in biology, including both its zoological and its botanical aspects. The ground was broken by a short vacation course, in which an attempt was made to supply such practical instruction to persons engaged in teaching; this course was given in the summer of 1871, and in the following year the same system of laboratory-instruction in biology was introduced into the ordinary School of Mines curriculum. In establishing at South Kensington the biological laboratory which has become the model of so many similar institutions at home and abroad, Prof. Huxley sought and obtained the advice and cooperation of many of his fellow-workers in science, among whom may be specially mentioned Profs. Michael Foster, Thiselton Dyer, Ray Lankester, and Rutherford, with Dr. Martin and Dr. Vines. In carrying on and further developing the work, he has had the assistance of Profs. Jeffrey Parker and F. O. Bower, in the zoological and botanical departments respectively, and, in succession to them, of Mr. G. B. Howes and Dr. D. H. Scott.

From the period of the first foundation of the School of Mines, the importance had been kept in mind of combining original research with the work of teaching. No one at the present day needs to be reminded of the numerous important investigations which have been prosecuted by Prof. Huxley, both at Jermyn Street and South Kensington. Memoirs of the highest value on various branches of comparative anatomy and palæontology have been interspersed with notable contributions to geology, to anthropology, and to botany; and from time to time excursions have been made still farther afield (predatory excursions they were regarded by some), into realms of thought more remote from the ordinary domain of the zoologist. But in all these varied avocations the interests of the teaching work were never forgotten; and it was made evident that the teacher, while carrying on investigations himself, was ever ready to suggest, stimulate, and supervise the investigations of others.

When, in 1885, ill-health compelled Prof. Huxley to relinquish his daily occupations in the school, it was found that, during the more than thirty years' occupancy of his post, he had accumulated a most valuable library of research, composed of treatises and journals dealing with every branch of biological science. This library he generously determined to present to the institution, the interests of which he had so long and earnestly laboured to promote. The Council of the School, in accepting this valuable gift, recommended that the room where these books were kept, and in which Prof. Huxley had so long carried on his work, should be entirely set apart for biological research; and the proposal at once met with the sanction of the Lords of the Committee of Council on Education.

The Huxley Laboratory for Biological Research is now arranged to accommodate two students, who will undertake investigations in connection with some branch of zoology, botany, or palæontology, the work being carried on under the supervision of the professors and assistant professors of the school. With a valuable library and all necessary appliances for work supplied to them, it may be hoped that the *genius loci* will not be without its influence upon these research students, and that a long series of important observations may be made, which will constitute an enduring and a worthy memorial of Prof. Huxley's connexion with the school.

It happens, very opportunely, that something in the way of a small endowment has already been provided to aid this scheme of biological research. As long ago as 1882, Miss Sarah Marshall, of Warwick Gardens, Kensington, wrote to Prof. Huxley, informing him of her intention to bequeath the sum of £1000, and her scientific books and instruments, to the Department of Science and Art, with a view to the establishment of a prize or scholarship in biology, in memory of her father, the late Mr. Marshall of the Bank of England. By the recent death of Miss Marshall, this bequest has now passed into the hands of the Lords of the Committee of Council on Education, and, by the advice of the Council of the Royal College of Science, it has been decided that the interest of the legacy shall be annually paid as a scholarship to a meritorious student, to aid him in carrying on some biological investigation in the Huxley Laboratory. We can only hope that this modest attempt at the endowment of research may be attended with success; and that this success may be so conspicuous as to encourage others to imitate the example of Miss Marshall, so that bequests of a similar character may be made in connexion with this and other institutions where scientific researches can be carried on.

ON VAN DER WAALS'S TREATMENT OF LAPLACE'S PRESSURE IN THE VIRIAL EQUATION: IN ANSWER TO LORD RAYLEIGH.

MY DEAR LORD RAYLEIGH,—From the heading of your first letter, and from the wide scope of the passage you quoted from my paper, I imagined that you intended to raise the whole question of Van der Waals's treatment of Laplace's pressure. Otherwise I should not, in my answer, have referred to his b or to the unfortunate results of comparing his formula with experiment. I should, in fact, have contented myself with the acknowledgment that you had given an accurate account of the contents of a portion of Van der Waals's earlier chapters, which I had carelessly missed on the first hasty perusal; and that these contents justified the expression $3Kv/2$ as the virial of Laplace's pressure. But to this I should certainly have added that, even had I been fully cognizant of that portion of the pamphlet when I wrote my paper, I should probably not have modified (at least to any serious extent) the passage you quoted.

For (1) that passage contains the distinct statement that, from the statical point of view, reasons "satisfactory on the whole" were given by Van der Waals for regarding Laplace's pressure as proportional to the square of the density. And it would have been illogical on my part to object, except on the ground of insufficient generality, to the equation

$$\left(p + \frac{a}{v^2}\right)v = \tfrac{1}{3}\Sigma(mu^2),$$

though I might have regarded the mode of its establishment as obscure or even doubtful.

In fact, the equation which is one of the main features of my own paper, viz.:—

$$pv + \frac{A}{v+a} = \tfrac{1}{3}\Sigma(mu^2)\cdot\left(1 + \frac{e}{v+a}\right),$$

includes it as the particular case when

$$e = 0, \quad a = 0.$$

What I objected to was a totally different thing:—viz. the above equation manipulated by the introduction of the factor $(v - b)/v$ in the left-hand member.

Again (2) the equation

$$p(v - \beta) = \tfrac{1}{3}\Sigma(mu^2)$$

is obtained in my paper (§ 64), and is there spoken of as "perfectly *legitimate*," but *only* on the distinct condition that

$$\beta\Sigma(mu^2)/3v,$$

where β is four times the sum of the volumes of the particles (§ 30), "*be small in comparison with the other terms in the* [virial] *equation.*" As one of these terms is the quantity $\Sigma(mu^2)/3$ itself, this implies that for the truth of the equation β/v must be a small fraction; and it is most certainly not so at the critical point of carbonic acid, which furnished the first and one of the most important cases for the application of the virial method. In fact the equation above, when correctly obtained, comes originally in the form (in which it ought to be preserved)

$$pv = \tfrac{1}{3}\Sigma(mu^2)\cdot\left(1 + \frac{\beta}{v}\right);$$

again a particular case of my own equation, viz. when

$$A = 0, \quad a = 0, \quad e = \beta.$$

Here the factor $1/v$ is (roughly) proportional to the number of collisions per particle per second, and it is in that capacity that it appears in the equation. As I said in my former letter, it is impossible (at least with Van der Waals's mode of interpreting $\Sigma(mu^2)$) to derive from this a cubic in v; even when the term a/v^2 is introduced as a simple addition to p:—unless, for the express purpose of obtaining the indispensable cubic, we write $v/(v - \beta)$ in place of $(v + \beta)/v$, on the right-hand side; which is, practically, what Van der Waals does. The true mode of getting a cubic here, if we keep to Van der Waals's interpretation of $\Sigma(mu^2)$, is to write $\beta/(v - \gamma)$ instead of β/v. This can, to a certain extent at least, be justified; the other method can not.

On the question of the introduction by Van der Waals of the factor $(v - b)/v$, whether or not it is applied alike to p and to K, I regret to find that our views must continue to differ. For it appears to me that when once the various terms of the virial equation have been correctly extracted from the expression $\Sigma(Rr)$, we have no right to modify any of them. There seems therefore to be no doubt whatever that the procedure in Van der Waals's sixth chapter is entirely wrong in principle:—except in so far as (in the German version) he borrows some correct expressions from Lorentz. The meanings of v and of p, in the term pv of the virial equation, are (from the very beginning of the inquiry) definitely assigned as total volume and external pressure:—so that this term cannot in any way be altered. No more can the term $\Sigma(mu^2)/3$, or the ratio of these two terms. Van der Waals's argument seems (for his pamphlet is everywhere somewhat obscure) to be that (when there is no molecular force) *in consequence of the finite diameters of the particles the pressure, for a given amount of kinetic energy, will be greater than if these were mere points.* Perfectly true:—but we must seek the expression for this increase of pressure in the remaining parts of the term $\Sigma(Rr)$, and *not* artificially introduce it by diminishing the multiplier of p in a term already definitely extracted. And further, if this procedure of Van der Waals were allowed to pass without protest in so far as the term pv is concerned, I think that we should logically be forced to treat the term Kv (not to the same but) to a very different factor:—for *here* the consideration of the finite volumes of the particles would appear to call for a *reduced* rather than an increased value of K; and therefore analogy would require a multiplication of the term Kv by some such expression as $(v + \gamma)/v$, where γ is essentially *positive*.—Yours very truly,

P. G. TAIT.

Edinburgh, 17/10/91.

NOTES.

TO-DAY the Senate of Cambridge University will decide whether official inquiry shall be made as to the expediency of allowing alternatives for one of the two classical languages in the Previous Examination, either to all students or to any classes of students other than those already exempted. Everyone who devotes attention to questions connected with the higher education recognizes the importance of the issue, and the discussion of the subject has been followed with wide-spread interest.

THE ordinary general meeting of the Institution of Mechanical Engineers began yesterday evening, and will be continued this evening, at 25 Great George Street, Westminster. The papers to be read and discussed, as we have already stated, are by Mr. Samuel Boswell and Prof. W. C. Roberts-Austen, F.R.S.

THE Geologists' Association will hold a *conversazione* at University College, Gower Street, on Friday evening, November 6. Members are invited to send exhibits, and to let the secretary know the nature of the object or objects they propose to show.

AT the meeting of the Royal Horticultural Society in the Drill Hall, Westminster, on Tuesday, there was an interesting display of autumn foliage arranged for æsthetic effect. A lecture was delivered by Mr. H. J. Veitch, who urged that trees and shrubs in gardens and plantations should be selected, not only with a view to their summer beauty, but also with regard to their autumn hues; and he had many suggestions to offer as to the various ways in which these hues may be most effectively contrasted.

PROF. BOYS has arranged his apparatus for the repetition of the Cavendish experiment in the basement of the Clarendon Laboratory, Oxford. The experiment will be proceeded with immediately.

WE regret to have to record the death of Dr. Philip Herbert Carpenter, F.R.S., the fourth son of the late Dr. W. B. Carpenter, C.B., F.R.S. He was found dead in his dressing-room at Eton College, on Wednesday, October 21. At the inquest it was found that he had killed himself by the administration of chloroform during temporary insanity. Dr. Carpenter was in his fortieth year, and had been a science master in Eton since 1877. The following summary of his scientific work in given by the *Times*. He was a member of the scientific staff of the deep-sea exploring expeditions of Her Majesty's steamships *Lightning* (1868) and *Porcupine* (1869–70); and in 1875 he was appointed assistant naturalist to Her Majesty's ship *Valorous*, which accompanied Sir G. Nares's Arctic expedition to Disco Island, and spent the summer sounding and dredging in Davis Strait and the North Atlantic. Dr. Carpenter devoted himself continuously from 1875 to studying the morphology of the Echinoderms, more particularly of the Crinoids, both recent and fossil. In 1883 he was awarded the Lyell Fund by the Geological Society of London in recognition of the value of his work, and in 1885 was elected a Fellow of the Royal Society. His chief memoirs and papers were as follows:—"Notes on Echinoderm Morphology," i.–xi., 1878–87; "On the Genus Actinometra," 1877; "Report upon the Crinoidea dredged by H.M.S. *Challenger*," Part I. "The Stalked Crinoids," 1885, Part II. "The Comatulæ," 1888; "Report upon the Comatulæ dredged by the U.S. Coast Survey in the Caribbean Sea," 1890. In conjunction with Mr. R. Etheridge, Jun., he prepared the "Catalogue of the Blastoidea in the Geological Department of the British Museum," 1886; and he also wrote numerous papers published in the Proceedings or Transactions of the Royal, Linnean, and Geological Societies.

MR. GEORGE SIBLEY, who was for many years well known as an engineer in India, and had also a considerable reputation as a traveller, died at his residence at Catherham on Sunday last at the age of ixty-seven. It is understood that Mr. Sibley has left a legacy for the purpose of founding engineering scholarships in the University of Calcutta.

DR. J. EDUARD POLAK, who died at Vienna on October 8, at the age of seventy-one, was one of the most eminent Persian cholars of his time. He went in 1851 to Teheran, where he lectured at the medical school, and became physician to the Shah. During his nine years' residence in Persia he visited most parts of the country; and on his return to Vienna he wrote his well-known work, "Persien: das Land und seine Bewohner," in which he presented an excellent summary of the knowledge he had acquired. In response to an invitation from the Shah, he again visited Teheran. He read before the Geographical and Anthropological Societies of Vienna many valuable papers on Persia and its antiquities.

THE International Geological excursion in America, which started on September 2 last, ended on October 9 after a most successful and interesting trip. In all there were ninety geologists, and the arrangements as regards trains, &c., left nothing to be desired. The route chosen lay through the petroleum districts of Pennsylvania, the prairies of Wisconsin, Minnesota, and Dakotah, the corn-lands of North America, and the twin centres St. Paul and Minneapolis. From the Yellowstone River the party journeyed to the beautiful geyser region of the National Park, where they made a stay of seven days, then to the rising mountain district of Butte, as well as to the Mormon town situated in the middle of the salt wastes of the Great Salt Lake. They then skirted the table-lands in South Utah, and turned towards the Rocky Mountains, where they visited the chief places of geological interest, including Pike's Peak, the Garden of the Gods, &c. At this point many of the party returned home, going by way of Chicago, Niagara Falls, and New York. The smaller number that remained undertook a laborious and exhausting expedition through the deserts of New Mexico and Arizona to the San Francisco mountains and to the Grand Cañon of Colorado; they visited a group of 165 volcanoes and craters, and also a deep valley the sides of which, with their many and various-coloured stones, fall 58co to 6000 feet to the great Colorado River below. From this standpoint they had an excellent view of the materials composing the upper surfaces of the earth's crust, and they could not but be struck by the magnitude and grandeur of the work accomplished by Nature in digging out this enormous river cañon. The following are some of the places visited on the return journey: La Junta, Kansas City, Chicago, Niagara Falls, Albany, and Boston. Altogether the excursion was a thorough success, and the Americans deserve much credit for having arranged so good a programme for their visitors.

PROF. RUSSELL and his party have returned from the Alaskan wilds, which they penetrated to a distance of forty miles inland, from Icy Bay to the base of Mount St. Elias. They constructed a camp, and remained there two months, making geological surveys and taking observations. Prof. Russell says:—"We began the ascent of Mount St. Elias on June 3. Our progress was not obstructed until we reached an altitude of nearly 10,000 feet. Then we found glaciers. After many perilous adventures we attained the height of 14,500 feet. This has been the estimated height of the mountain, but we found it nearly 5000 feet higher. It was impossible for us to proceed any further, as we were suffering too much from the hardships already endured. Many of the men were exhausted and very weak. The Alaskan Indians were most hospitable to us."

THE report by Mr. James Dredge and Sir Henry Trueman Wood on their recent visit to Chicago is printed in the Journal of the Society of Arts (October 23). This report was presented last week to the Royal Commission which has been appointed to organize the English Section at the Chicago "World's Fair." The Commission have decided to appoint the following Committees: Finance, Fine Arts, Indian, Colonial, Engineering, General Manufactures, Electricity, Agriculture, Mines and Metallurgy, Textile Industries, Science and Education, Transportation; also a Committee of Ladies to correspond with the Ladies' Committee at Chicago. They propose to invite the assistance of Chambers of Commerce as Local Committees. A prospectus relating to the Chicago Exhibition has been issued by the Royal Commission

THE Council of the Institution of Civil Engineers have issued for general circulation their regulations as to the admission of students. This is followed by an excellent account of the various educational institutions in the British dominions where instruction is given bearing on the profession of civil engineers.

IN his report on the working of the Central Museum, Madras, during 1890–91, Mr. Edgar Thurston, the Superintendent, notes that he made two official tours in company with his taxidermists. During the first of these, as in several previous years, he stayed on Rámesvaram Island, where he was mainly engaged in the collection and preservation of marine worms and molluscan shells, which have since been sent to England and Germany to be worked up. Many specimens of the brightly coloured "coral-fishes," which abound over the fringing coral-reefs, were also preserved by the glycerine process introduced by Mr. A. Haly, of the Colombo Museum, for the preservation of colours. His stay on Rámesvaram Island completed, he paid a short visit to Tuticorin, to work out some doubtful points in connection with the anatomy of the pearl oyster. In his second tour he made large collections illustrative of the arts, industries, manufactures, and natural history of the places visited in the Bangalore, Hassan, Shimoga, and Mysore districts. These collections include Srávanbelgola brass-ware, Soráb and Sagar sandal-wood carving, Channapatna silk and toys, Mysore inlaid ware, gold jewellery from Bélur, butterflies, lizards, snakes, &c. A report on this tour will be published after a further visit to the Mysore province, a large area of which remains to be explored.

THE other day, Mr. Flinders Petrie delivered at the Owens College, Manchester, a most interesting address on exploration in Egypt. It had been thought, he said, that the immense mounds of rubbish indicating the sites of towns had been made on purpose, but they resulted from the natural decay of the mud-brick buildings. These heaps of ruined walls and earth and potsherds rose even to eighty feet high in some places; but other ancient sites were much less imposing, and might even not attract notice on the open desert. The higher the mound the longer the place had been inhabited; and if the surface was of a late period, the earlier parts, which were most needed, were under such a depth of rubbish as to be practically inaccessible. Much could be known at first sight; and prospecting had now become as scientific a matter in antiquities as in geology. Knowing, by a glance at the sherds on the top, what was the latest period of occupation of the site, and knowing the usual rate of accumulation of a mud-brick town—about five feet in a century—we could guess how far back the bottom of the mound must be dated. Other remains had different indications. If in the midst of a great mound there was a wide flat crater, that was probably the temple site, surrounded by houses which had accumulated high on all sides of it. Speaking of the results of exploration, Mr. Petrie said that we now realized what the course of the arts had been in Egypt. In the earliest days yet known to us—about 4000 B.C.—we found great skill in executing accurate and massive stonework, such skill as had hardly ever been exceeded. We found elaborate tools used, jewelled saws and tubular drills. We saw the pictorial arts as fully developed as they were for thousands of years later. But what led up to this we were still feeling for.

To what uses did primitive men apply the stone hammers which they made in such large numbers? This question Mr. J. D. McGuire tries to answer in a paper in the *American Anthropologist* for October. His theory is that the hammer was probably "the tool upon which races living in the Stone Age relied more than upon any other object to fashion stone implements." It was used, he thinks, not only to peck an axe or celt into shape, but to rub or polish the implement after it had been shaped; and, to illustrate this, he gives a figure representing a typical hammer of quartzite, from McMinn County, Tennessee, the periphery of which is pitted by use, while the flattened sides show that it must have been a rubbing-stone as well. To prove that the work suggested could be done by a stone hammer, he represents an axe of close-grained black porphyry, which he himself pecked out and grooved by means of such an implement. The task occupied him about five hours. As ordinary stone axes are made of softer material, he thinks they were probably produced in a much shorter time.

DR. H. VON WLISLOCKI contributes to the current number of *Globus* a capital paper on the handicrafts of Hungarian gypsies, whom he has had many opportunities of observing. If we may judge from the illustrations, they have a considerable aptitude for design. In the summer they make bottles out of pumpkins, which they decorate with various drawings. On each bottle the space is divided into four zones, crosses being cut into the uppermost zone, serpents into the second one, circles into the third, and zigzag lines into the fourth. The crosses mean "May you be happy!"; the serpents, "May you have no enemies!"; the circles, "May you always have money!"; the zigzag lines, "May you be healthy!" Brandy is kept in the bottles; and when a guest is received, the first gypsy who drinks says, "May you be happy!"; the second, "May you have no enemies!"—and so on. Pretty walking-sticks are also among the things made by the Hungarian gypsies. On the top of one of those sketched in the article two female heads are admirably carved. These represent Ana, the Queen of the Keschalyis, or forest fairies, who dwell among the mountains, where they sit—three being always together—on rocks, spreading out their long hair over the valleys, thus giving rise to mists. Queen Ana lives in a black palace, and sometimes wanders over the world in the form of a frog. Frogs, toads, and serpents are her favourite animals. When she meets anyone in her natural form, she exclaims "Ana!", which means "Bring!" Should the person understand the cry and bring a frog, a toad, or a serpent, he is richly rewarded. If he fails to do so, he is either killed with a piece of a rock, or struck by some terrible malady.

THE *Times* of October 22 has an interesting article on "Our Position with regard to Rainfall," compiled from the statistics published by Mr. Symons and the Meteorological Office. The rainfall during the present month has been so heavy that in many places the amount up to the morning of the 18th was in excess of the average for the whole month. In London this excess amounted only to 0·3 inch, while at Valentia Island and at Stornoway it amounted to nearly 2 and 3 inches respectively, and the amount which fell during the next few days has greatly increased the excess. But for the 10 years ending with 1889 the rainfall over the United Kingdom differed only by 1 per cent. from the average of the last 50 years. The values for the present year, up to the 18th instant (as shown by the last Weekly Weather Report then published), were rather in excess of the average over the southern, midland, and western parts of England, and the north of Scotland, while in the remaining districts there was still a deficiency. For the whole period since the end of 1889, there was only one district, viz. Scotland (N.), in which the total fall was in excess of the average. In Scotland and the midland and south-western counties of England, the deficiency was still very large. The question is asked—Are we likely to have in the years immediately advancing more or less rain than during the last few years? While the question cannot be answered with absolute confidence, the grouping of years into decades or other regular periods eliminates most of the non-periodic variations, and shows whether any secular alterations are taking place. There is no doubt that since 1887, at all events, the rainfall over England has been much below the average; and a consideration of all the facts leads to the conclusion that such a period of scarcity is very likely to be followed by one of abundance, and that the coming few years will probably be more rainy than those recently experienced, although possibly the increase will not occur in the summer months—at a time when it would be most noticed.

THE new number of *Petermann's Mitteilungen* opens with some interesting extracts from the diary of the late Dr. Anton Stecker, written during his journey in Abyssinia and the Galla countries in 1880–83. Stecker died before he had an opportunity of writing a full and systematic account of his travels. In the present extracts he notes not only the physical characteristics of the regions to which they relate, but the manners and customs of the natives. A good map makes it easy for the reader to trace his route.

A GREEK gardener lately expressed the opinion that oranges, figs, olives, and grapes grown in Australia are inferior to those grown at Smyrna and Athens. This having been brought to the attention of the Department of Agriculture, New South Wales, letters were addressed to the British Consuls at Naples and Marseilles asking for a consignment of the best varieties of grapes, figs, and olives grown in Italy and France. On receipt of these cuttings, experiments are to be carried out at the most suitable of the experimental stations about to be established throughout the colony, with a view to the propagation of the finest varieties of the respective fruits. With the same object in view application has been made to Mr. T. Hardy, of South Australia, for a number of cuttings of various vines he has cultivated, and to Sir Samuel Davenport, of Beaumont, South Australia, for cuttings of the olive and fig trees grown by him. The whole of these cuttings will go to form the standard collections of all the different kinds of fruit which it is intended to establish at each of the experimental stations.

IN the *Revue Agricole*, published in Mauritius, M. A. Daruty de Grandpré gives an account of his attempts to raise sugar-cane from seeds. The seeds were sent from Barbados by the Governor in March 1890. M. de Grandpré planted them with the greatest care, and after five days was fortunate enough to obtain five minute seedlings out of the hundred seeds used. The young plants he raised did not all prove equally vigorous, and he was able to save only one, which, at the time when his report was written, had formed a fine clump of twenty shoots with long ribbon leaves. "I believe," he says, "that we may with reason cherish the most sanguine hopes from the propagation of sugar-cane from seeds—more especially if we try an intelligent system of cross-fertilization of the varieties we possess—rather than by planting cuttings, which maintain without appreciable alteration the respective characteristics of the parent plants. Thus we shall be able to supplement the weak points in our best varieties of sugar-cane by crossing them with others which are remarkable for the qualities it is intended to infuse into them, and we shall moreover obtain, by a process of selection, a cane rich in saccharine matter, which will enable us to compete successfully against the highly improved sugar-beet."

MR. A. W. MORRIS contributes to the current number of the Journal of the Bombay Natural History Society an interesting paper on abnormal horns of the Indian antelope. We have as yet little definite information as to the cause or causes of such abnormalities. Mr. Morris suggests that severe injuries to the skull, inflicted either during battle or through some accident, are the main causes that produce abnormalities, the horn on the injured side being thrown out of its natural course by the concussion or damage sustained.

THE Academy of Natural Sciences of Philadelphia prints in its Proceedings a list of the Echinoderms obtained by Mr. Frederick Stearns, of Detroit, in the Bahama Islands in the years 1887 and 1888. The list has been drawn up by Mr. J. E. Ives. It includes a description of a new species of Amphiura.

A VALUABLE revised list of British Echinoidea, by Mr. William E. Hoyle, has been printed in the Proceedings of the Royal Physical Society, Edinburgh, and is now issued separately. The author gives a brief diagnosis of each species, such as will enable the collector to identify it on the spot.

MESSRS. J. AND A. CHURCHILL have published a second edition of the English translation of Dr. A. Chauveau's "Comparative Anatomy of the Domesticated Animals." Dr. George Fleming is the translator and editor. In preparing the new edition, Dr. Fleming has kept in view the necessities of advancing veterinary education in the English-speaking schools. He has introduced, therefore, a considerable number of "amendments, alterations, and additions."

MESSRS. HENRY SOTHERAN AND CO. propose to issue a work entitled "Game Birds and Shooting Sketches," by J. G. Millais, F.Z.S. The work will illustrate the habits, modes of capture, and stages of plumage of game birds, and the hybrids and varieties which occur among them.

THE University College of North Wales has issued its Calendar for the year 1891–92.

LECTURES on the following subjects will be given at the Royal Victoria Hall on Tuesday evenings during the month of November:—November 3, Mr. F. W. Rudler, "Some Very Ancient Britons"; November 10, Dr. Rideal, "London Fogs"; November 17, Dr. W. D. Halliburton, "Skin and Bones" (second lecture); November 24, Rev. C. E. Brooke, "A Holiday in the Far West."

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Lemur (*Lemur albifrons* ♂) from Madagascar, presented by Mr. J. M. Nicholl; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. A. D. Watson; a Buffon's Skua (*Stercorarius parasitica*), North European, presented by Mr. Edward Hart, F.Z.S.; two Common Cuckoos (*Cuculus canorus*), British, presented respectively by Mr. H. Lindsay and Miss Ord; a Burbot (*Lota vulgaris*) from the Trent, presented by Mr. F. T. Burrows; a Macaque Monkey (*Macacus cynomolgus* ♀) from India, a Lion Marmoset (*Midas rosalia*) from South-East Brazil, an Australian Cassowary (*Casuarius australis*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

THE ZODIACAL LIGHT AND AURORÆ.—On the supposition that the zodiacal light is an extension of the solar corona, and that the latter mainly consists of light reflected from meteoritic particles circling round the sun over the spot zones and parallel to the plane of the equator, Mr. M. A. Veeder explains (Rochester Academy of Sciences, January 26, 1891) why in middle latitudes the phenomenon is brightest in March and October, in the former case after sunset, and in the latter before sunrise, and also the fact that at these times one margin of the band is better defined than the other, and more exactly included within the plane of the ecliptic, whilst at other seasons there is decreasing brightness, and both edges become ill-defined.

An investigation of observations of auroræ and magnetic perturbations shows that they may be arranged in periods having the same length as that of a synodic rotation of the sun. And it appears that the areas most frequented by sun-spots are most actively concerned in the production of auroræ. Extending the research, Mr. Veeder believes that the belt-like distribution of atmospheric pressure about the magnetic poles as a centre is very largely dependent upon magnetic induction of solar volcanic origin, conveyed from the sun to the earth through the medium of the coronal extensions referred to above.

COMET *e* 1891.—The following orbit has been computed by Prof. Campbell for the comet discovered by Prof. Barnard on October 2:—

$$T = 1891 \text{ November } 8{\cdot}75 \text{ G.M.T.}$$

$$\left.\begin{aligned} \pi &= 117^\circ\ 44' \\ \Omega &= 215\ \ 38 \\ i &= \ \ 75\ \ 50 \end{aligned}\right\} \text{Mean Eq. } 1891.$$

$$q = 1{\cdot}0166.$$

On October 30 the comet is in the position R.A. 10h. 53m. 7s., Decl. − 54° 43′. It is therefore not visible in our latitudes.

TWO NEW ASTEROIDS.—A new minor planet, (319), of the thirteenth magnitude was discovered by M. Charlois on October 8, and another, (320), by Dr. Palisa on October 11.

The latter observer has given the name of Thora to (299), Olga to (304), and Fraternitas to (309).

DOUBLE STARS.—Mr. S. W. Burnham announces that he is preparing a general catalogue of all the double stars discovered by him, and would be glad to receive any unpublished measures of them, Nos. 1 to 1224.

JUPITER'S FIRST SATELLITE.—Some recent observations made at Lick Observatory show that the first satellite of Jupiter is ellipsoidal, and that one of its longer axes is directed to the planet's centre.

THE INTERNATIONAL METEOROLOGICAL CONFERENCE.

THIS meeting, which was more or less of a private character, as it was not organized in any way through diplomatic channels, took place at Munich from August 26 to September 2. It was held in the building of the Technical High School, and was attended by 32 members, representing most European and some extra-European countries. As to the latter, the United States contributed four members, while Brazil and Queensland sent one each. Roumania and Bulgaria for the first time took part in one of these meteorological gatherings. Dr. Lang, the head of the Bavarian meteorological system, was appointed President, and Prof. Mascart (Paris) with Prof. Harrington (Washington) Vice-Presidents. The Secretaries were Dr. Erk (Munich), Mr. Scott, and M. Teisserenc de Bort (Paris).

The following is a brief summary of the most important practical results and recommendations of the Conference.

All temperatures published after 1901 are to be referred to the readings of the air thermometer. Actinometrical observations are not held to be sufficiently certain to justify their general introduction. The application of a ventilating arrangement to wet-bulb thermometers was recommended. *Rain.*—It was decided to count as days of rain those on which 0·005 inch (0·1 mm.) of rain was measured, and to print monthly the number of days on which 0·05 inch (or 1 mm.) fell. *Snow.*—A note is to be made in monthly schedules of the number of days on which about half the country surrounding the station is under snow. *Clouds.*—A new classification of clouds to replace Howard's, proposed by Prof. Hildebrandsson and the Hon. R. Abercromby, was adopted by a large majority, England and the United States being dissentients. A committee was then appointed to consider the question of typical cloud pictures in general, taking the above classification more or less as a basis of arrangement. A report was also received and adopted on the observation of the motions, &c., of cirrus and other high-level clouds. *Wind.*—Robinson's anemometer was the only form of instrument discussed. It was decided that no instrumental results should be published unless the instrument had been previously compared with a standard, either directly or indirectly. *Time.*—A proposal to recommend the adoption of universal or zone time was emphatically rejected, on the ground that local time can alone be used for climatological inquiry. It was further decided in all publications to insist on commencing the day with midnight as 0 hours. *Gravity correction.*—It was decided to introduce the practice of correcting barometrical readings for the force of gravity at lat. 45° after the beginning of the year 1901.

Mr. Wragge, for Queensland, and Captain Pinheiro, for Brazil, gave interesting notices of what is being done for meteorology in their respective countries. It was resolved that an International Meteorological Committee should be constituted to prepare for a possible Congress in Paris in the year 1896. The Committee is to consist of 17 members, of whom 14 were elected, and it was decided to fill the 3 vacancies by the co-option of extra-European meteorologists. The officers of the Committee—Messrs. Wild and Scott—were reappointed.

The questions relating to terrestrial magnetism were referred by the Conference to a special sub-committee, whose decisions will appear in the published report of the proceedings.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 19.—M. Duchartre in the chair.—Memoir on the underground temperatures observed at the Muséum d'Histoire Naturelle, during the winter 1890–91, by M. Henri Becquerel. A thermo-electric arrangement was used for the determination of the temperatures beneath two surfaces, one of which was covered with sand and devoid of vegetation, whilst the other had grass and some plants growing upon it. The two soils were similar, and in each case the temperatures were taken at five points, having depths ranging between 5 cm. and about 60 cm. The observations extend from November 1, 1890, to March 31, 1891, the temperatures being taken at 6 a.m. and 3 p.m. daily. These have been plotted, and the resulting curves strikingly show the variations which occurred in the interval, and the extinction of detail with increased depth. The diurnal variation at the greatest depth was a few tenths of a degree, whilst that of the air was about 14°. At a depth of 18 cm. beneath the sandy covering the variation was the same as in air, but at all the other points the effect was reversed—that is, the temperature fell from 6 a.m. to 3 p.m., and rose during the night. It also appears from the observations that Fourier's theory of the differential relation existing between temperature, time, and depth of thermometer represents very well the propagation of heat in a superficial layer of soil, and that the coefficient of conductivity of this layer for determined conditions of humidity may be deduced from observations of underground temperatures. A certain thickness of earth protects the roots of plants from the effects of a sharp frost, but it may not be equally efficacious against a long one of less intensity, for the velocity of propagation of a variation of temperature, and the depth at which this variation is felt, depends upon the duration of its period. A layer of grass, covering soil, has the same protecting effect during the winter as that of about 50 cm. of mould.—Researches on the cause of rheumatic diathesis, by M. F. P. le Roux.—Observations of Wolf's periodic comet, made at Algiers Observatory with the telescope of 0·50 m. aperture, by MM. Rambaud and Sy. Observations for position were made on August 4, 5, 8, and 31, and on September 7.—On the reduction, to a canonical form, of equations from derived partials of the first order and the second degree, by Mr. Elliot.—On cyclic systems, and on the deformation of surfaces, by M. E. Cosserat.—Calculation of the magnetic rotation of the plane of polarization of light, by M. G. Hinrichs. The simple law connecting the rotation of the plane of polarization with the thickness of the medium traversed is shown to be applicable to the molecular rotation of a normal paraffin.—On a new method for estimating nitric acid and the total nitrogen, by M. E. Boyer. The method is founded upon the reduction of nitric acid to ammonia, by oxalates and sulphur, in the presence of soda-lime.—On the action of nitric acid on dimethyl ortho-anisidine, by M. P. van Romburgh.—On the *globulicide* power of blood serum, by M. G. Daremberg. The author terms "*pouvoir globulicide*" the power possessed by the serum of the blood of one animal to destroy the red corpuscles of the blood of another of a different species. And the destructive power of serum for microbes is called "*pouvoir microbicide.*" The effects produced in each case have been studied.—On the nature of the movement of the chromatophores of Cephalopods, by M. C. Phisalix.

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