have been reduced. The form of reduction and publication will be similar to the catalogue of bright stars, except that it will be convenient to retain the "Durchmusterung" numbers and places, arranging the stars in the order of the zones in that catalogue. It is hoped that the photographs for this investigation will be nearly all taken by the autumn of 1888, and the remainder during the following year. To provide for a possible increase in sensitiveness of the plates, precedence is given to those completely covering the sky once, the alternate plates, covering the sky the second time, being taken later. The actual improvement in the plates shows itself by an increase in the number of spectra in this second series of plates. In some cases over three hundred stellar spectra appear on a single plate.

3. *Detailed Study of the Spectra of the Brighter Stars.*—These spectra are obtained by placing four prisms, having an angle of about 15°, and each nearly a foot square, over the object-glass of the 11-inch telescope, as described in the last Report. The increased sensitiveness of the plates has greatly increased the number of stars bright enough to produce a satisfactory image in this way. The white stars of the first type give good images when no brighter than the fourth magnitude. These spectra are about 4 inches in length. An improvement has been made in the method of enlargement with a cylindrical lens described in the last Report. When such a lens was used with an enlarging lens having a small aperture, the width of the spectrum was greatly reduced; with a large aperture, the best definition could not be attained. A slit perpendicular to the axis of the cylindrical lens is accordingly placed over it. This reduces the aperture in one direction so that the definition of the lines is good, without affecting the width of the spectrum. Slow plates are also used in the enlargements to increase the contrast. Much more brilliant spectra are thus obtained.

4. *Faint Stellar Spectra.*—As stated above, the 28-inch reflector constructed by Dr. Draper is now ready for use. The difficulties commonly encountered in the use of a large reflector have been met, and it is hoped successfully overcome. A spectroscope has been devised for this instrument which will give a dispersion about equal to that employed in the first and second of the researches described above. As the area of the aperture of this telescope is about eleven times that of the 8-inch telescope, it is hoped that much fainter stars can be photographed with it. A study will be made of the spectra of the variable stars of long period, of the banded stars, and of other objects having peculiar spectra.

But little progress has been made with the other investigations proposed, including the reduction to wave-lengths, and the study of the approach and recession of the stars. It seemed best to concentrate our work on the researches described above, undertaking the other investigations as soon as time permitted.

The investigations described above are illustrated by a plate. A special study was made of the spectrum of the variable star β Persei. A variation in this spectrum would have an important bearing on the theory that the diminution in light is due to an interposed dark satellite. Spectra of this star at minimum were first obtained with one prism. With the increased sensitiveness of the plates more prisms were tried, until finally good spectra were obtained with all four prisms even when the star was at its minimum. At first it was thought that a variation was detected in the spectrum, but this change was not confirmed under more favourable circumstances. The spectrum of this star on February 6, 1888, when at its full brightness, is contrasted in the plate with the spectrum on February 9, 1888, when the star was at its minimum. A careful inspection of the original negatives failed to show any differences in the spectra. Twenty lines are visible at minimum, all of which are seen at maximum. The spectrum of α Orionis is also given. Before the recent increase in the sensitiveness of the photographic plates, satisfactory photographs could not be obtained of the spectrum of this star, on account of its red colour.

INFLUENCE MACHINES.[1]

I HAVE the honour this evening of addressing a few remarks to you upon the subject of influence machines; and the manner in which I propose to treat the subject is to state as shortly as possible, first, the historical portion, and afterwards to point out the prominent characteristics of the later and the more commonly known machines.

In 1762, Wilcke described a simple apparatus which produced electrical charges by influence, or induction, and following this the great Italian man of science, Alexander Volta, in 1775 gave the electrophorus the form which it retains to the present day. This apparatus may be viewed as containing the germ of the principle of all influence machines yet constructed.

Another step in the development was the invention of the doubler by Bennet in 1786. He constructed metal plates which were thickly varnished, and were supported by insulating handles, and which were manipulated so as to increase a small initial charge. It may be better for me to here explain the process of building up an increased charge by electrical influence, for the same principle holds in all of the many forms of influence machines.

This Volta electrophorus, and these three blackboards, will serve for the purpose. I first excite the electrophorus in the usual manner, and you see that it then influences a charge in its top plate; the charge in the resinous compound is known as negative, while the charge induced in its top plate is known as positive. I now show you by this electroscope, that these charges are unlike in character. Both charges are, however, small, and Bennet used the following system to increase them.

Let these three boards represent Bennet's three plates. To plate No. 1 he imparted a positive charge, and with it he induced a negative charge in plate No. 2. Then with plate No. 2 he induced a positive charge in plate No. 3. He then placed the plates Nos. 1 and 3 together, by which combination he had two positive charges within practically the same space, and with these two charges he induced a double charge in plate No. 2. This process was continued until the desired degree of increase was obtained. I will not go through the process of actually building up a charge by such means, for it would take more time than I can spare.

In 1787, Carvallo discovered the very important fact that metal plates when insulated always acquire slight charges of electricity; following up those two important discoveries of Bennet and Carvallo, Nicholson in 1788 constructed an apparatus, having two disks of metal insulated and fixed in the same plane. Then, by means of a spindle and handle, a third disk, also insulated, was made to revolve near to the two fixed disks, metallic touches being fixed in suitable positions. With this apparatus he found that small residual charges might readily be increased. It is in this simple apparatus that we have the parent of influence machines, and as it is now a hundred years since Nicholson described this machine in the Phil. Trans., I think it well worth showing a large-sized Nicholson machine at work to-night.

In 1823, Ronalds described a machine in which the moving disk was attached to and worked by the pendulum of a clock. It was a modification of Nicholson's doubler, and he used it to supply electricity for telegraph working. For some years after these machines were invented no important advance appears to have been made, and I think this may be attributed to the great discoveries in galvanic electricity which were made about the commencement of this century by Galvani and Volta, followed in 1831 to 1857 by the magnificent discoveries of Faraday in electro-magnetism, electro chemistry, and electro-optics, and no real improvement was made in influence machines till 1860, in which year Varley patented a new form of machine.

In 1865 the subject was taken up with vigour in Germany by Toepler, Holtz, and other eminent men. In 1866, Bertsch invented a machine, but not of the multiplying type; and in 1867, Sir William Thomson invented a form of machine, which, for the purpose of maintaining a constant potential in a Leyden jar, is exceedingly useful.

The Carré machine was invented in 1868, and in 1880 the Voss machine was introduced, since which time the latter has found a place in many laboratories. It closely resembles the Varley machine in appearance, and the Toepler machine in construction.

In condensing this part of my subject, I have had to omit many prominent names and much interesting subject-matter, but I must state that, in placing what I have before you, many of my scientific friends have been ready to help and to contribute; and, as an instance of this, I may mention that Prof. Silvanus P. Thompson at once placed all his literature and even his private notes of reference at my service.

I will now endeavour to point out the more prominent features

[1] Lecture delivered at the Royal Institution, by Mr. J. Wimshurst, on April 27, 1888.

of the influence machines which I have present, and, in doing so, I must ask a moment's leave from the subject of my lecture to show you a small machine made by that eminent worker, Faraday, which, apart from its value as his handiwork, so closely brings us face to face with the imperfect apparatus with which he and others of his day made their valuable researches.

The next machine which I take is a Holtz. It has one plate revolving, the second plate being fixed. The fixed plate, as you see, is so much cut away that it is very liable to breakage. Paper inductors are fixed upon the back of it, while opposite the inductors, and in front of the revolving plate, are combs. To work the machine (1) a specially dry atmosphere is required ; (2) an initial charge is necessary ; (3) when at work the amount of electricity passing through the terminals is great ; (4) the direction of the current is apt to reverse ; (5) when the terminals are opened beyond the sparking distance the excitement rapidly dies away ; (6) it does not part with free electricity from either of the terminals singly.

It has no metal on the revolving plates, nor any metal contacts ; the electricity is collected by combs which take the place of brushes, and it is the break in the connection of this circuit which supplies a current for external use. On this point I cannot do better than quote an extract from p. 339 of Sir William Thomson's "Papers on Electro-statics and Magnetism," which runs :—"Holtz's now celebrated electric machine, which is closely analogous in principle to Varley's of 1860, is, I believe, a descendant of Nicholson's. Its great power depends upon the abolition by Holtz of metallic carriers and metallic make-and-break contacts. It differs from Varley's and mine by leaving the inductors to themselves, and using the current in the connecting arc."

In respect to the second form of Holtz machine I have very little information, for since it was brought to my notice nearly six years ago I have not been able to find either one of the machines or any person who had seen one. It has two disks revolving in opposite directions ; it has no metal sectors and no metal contacts. The "connecting arc circuit" is used for the terminal circuit. Altogether I can very well understand and fully appreciate the statement made by Prof. Holtz in *Uppenborn's Journal* of May 1881, wherein he writes that "for the purpose of demonstration I would rather be without such machines."

The first type of Holtz machine has now in many instances been made up in multiple form, within suitably constructed glass cases, but when so made up great difficulty has been found in keeping each of the many plates to a like excitement. When differently excited, the one set of plates furnished positive electricity to the comb, while the next set of plates gave negative electricity : as a consequence no electricity passed the terminals.

To overcome this objection, to dispense with the dangerously cut plates, and also to better neutralize the revolving plate throughout its whole diameter, I made a large machine having twelve disks 2 feet 7 inches in diameter, and in it I inserted plain rectangular slips of glass between the disks, which might readily be removed ; these slips carried the paper inductors. To keep all the paper inductors on one side of the machine to a like excitement, I connected them together by a metal wire. The machine so made worked splendidly, and your late President, Mr. Spottiswoode, sent on two occasions to take note of my successful modifications. The machine is now ten years old, but still works splendidly. I will show you a smaller-sized one at work.

The next machine on which I make observations, is the Carré. It consists essentially of a disk of glass which is free to revolve without touch or friction. At one end of a dicmeter it moves near to the excited plate of a frictional machine, while at the opposite end of the dicmeter is a strip of insulating material, opposite which, and also opposite the excited amalgam plate, are combs for conducting the induced charges, and to which the terminals are metallically connected ; the machine works well in ordinary atmosphere, and certainly is in many ways to be preferred to the simple frictional machine. In my experiments with it I found that the quantity of electricity might be more than doubled by adding a segment of glass between the amalgam cushions and the revolving plate. The current in this type of machine is constant.

The Voss machine has one fixed plate and one revolving plate. Upon the fixed plate are two inductors, while on the revolving plate are six circular carriers. Two brushes receive the first portions of the induced charges from the carriers, which portions are conveyed to the inductors. The combs collect the remaining portion of the induced charge for use as an outer circuit, while the metal rod with its two brushes neutralizes the plate surface in a line of its diagonal diameter. When at work it supplies a considerable amount of electricity. It is self-exciting in ordinary dry atmosphere. It freely parts with its electricity from either terminal, but when so used the current frequently changes its direction, hence there is no certainty that a full charge has been obtained, nor whether the charge is of positive or negative electricity.

I next come to the type of machine with which I am more closely associated, and I may preface my remarks by adding that the invention sprang solely from my experience gained by constantly using and experimenting with the many electrical machines which I possessed. It was from these I formed a working hypothesis which led me to make the small machine now before you. The machine is unaltered. It excited itself when new with the first revolution. It so fully satisfied me with its performance that I had four others made, the first of which I presented to this Institution. Its construction is of the simplest character. The two disks of glass revolve near to each other, and in opposite directions. Each disk carries metallic sectors ; each disk has its two brushes supported by metal rods, the rods to the two plates forming an angle of 90° with each other. The external circuit is independent of the brushes, and is formed by the combs and terminals.

The machine is self-exciting under all conditions of atmosphere, owing probably to each plate being influenced by, and influencing in turn its neighbour, hence there is the minimum surface for leakage. When excited, the direction of the current never changes ; this circumstance is due probably to the circuit of the metallic sectors and the make-and-break contacts always being closed, while the combs and the external circuit are supplemental, and for external use only. The quantity of electricity is very large and the potential high. When suitably arranged, the length of spark produced is equal to nearly the radius of the disk. I have made them from 2 inches to 7 feet in diameter, with equally satisfactory results.

I have also experimented with the cylindrical form of the machine ; the first of these I made in 1882, and it is before you. The cylinder gives inferior results to the simple disks, and is more complicated to adjust. You notice I neither use nor recommend vulcanite, and it is perhaps well to caution my hearers against the use of that material for the purpose, for it warps with age, and when left in the daylight it changes and becomes useless.

I have now only to speak of these larger machines. They are in all respects made up with the same plates, sectors, and brushes as were used by me in the first experimental machines, but for convenience sake they are fitted in numbers within a glass case.

This machine has eight plates of 2 feet 4 inches diameter ; it has been in the possession of the Institution for about three years.

This large machine, which has been made for this lecture, has twelve disks, each 2 feet 6 inches in diameter. The length of spark from it is $13\frac{5}{8}$ inches.

During the construction of the machine every care was taken to avoid electrical excitement in any of its parts, and after its completion several friends were present to witness the fitting of the brushes and the first start. When all was ready the terminals were connected to an electroscope, and the handle was moved, so slowly that it occupied thirty seconds in moving one half revolution, and at that point violent excitement appeared.

The machine has now been standing with its handle secured for about eight hours ; no excitement is apparent, but still it may not be absolutely inert ; of this each one present may judge, but I will connect it with this electroscope, and then move the handle slowly, so that you may see when the excitement commences and judge of its absolutely trustworthy behaviour as an instrument for public demonstration. I may say that I have never under any condition found this type of machine to fail in its performance.

I now propose to show you the beautiful appearances of the discharge, and then in order that you may judge of the relative capabilities of each of these three machines, we will work them all at the same time.

The large frictional machine which is in use for this comparison is so well known to you that a better standard could not be desired.

In conclusion I may be permitted to say that it is fortunate I had not read the opinion of Sir William Thomson and Prof.

Holtz, as quoted in the earlier part of my lecture, previous to my own practical experiments. For had I read such opinions from such authorities I should probably have accepted them without putting them to practical test. As the matter stands I have done those things which they said I ought not to have done, and I have left undone those which they said I ought to have done, and by so doing I think you must freely admit that I have produced an electric generating machine of great power, and have placed in the hands of the physicist, for the purposes of public demonstration, or original research, an instrument more trustworthy than anything hitherto produced.

NOTE ON THE TARPON OR SILVER KING (MEGALOPS THRISSOIDES).

THE genus Megalops belongs to the family Clupeidæ, and, amongst other features, is characterized, according to Dr. Günther,[1] by an oblong compressed body, the presence of a narrow osseous lamella attached to the mandibular symphysis and lying between the halves of the mandible. Further, the latter is prominent, the intermaxillary short, the maxillary forming the lateral part of the mouth. There are bands of villiform teeth on the jaws, vomer, palatines, pterygoid, tongue, and base of skull.

The interest in the species above-mentioned has been considerably increased of late by the fact that the huge fish (between 5 and 6 feet in length, and weighing from 90 to 150 pounds) can be caught by rod and line, and I am much indebted to Lady Playfair for giving me all the information she had obtained on the subject through her father and Mr. W. G. Russell of Boston, United States.

The tarpon (*Megalops thrissoides*) frequents the Atlantic shores of North America, and is especially found "on the western or Gulf coast of Southern Florida, haunting the shallow bays and creeks inside the bars and keys which stretch along that coast; and the fishes are supposed to enter by the passes from the outer Gulf.[2]

"In shape the tarpon somewhat resembles the salmon, but, as becomes one of the herring tribe, it is deeper and less rounded, and the head is larger, the scales (cycloid) are thick and large, more than an inch in diameter" (a fine scale sent by Lady Playfair measures 2¼ inches both in antero-posterior and transverse diameter), "and the exposed portion is of a bright silvery hue, indeed it looks as if it had been dipped in silver and burnished: hence the name 'silver king.' I have seen specimens weighing from 50 to 137 pounds, and have heard of none above 150 pounds.

"The tarpon has always been upon the Gulf coast, but was formerly captured, as the sword-fish is, by the harpoon. In 1885, however, a Mr. Wood undertook successfully to secure the fish by rod and reel. . . . About 150 have been caught in this manner during the seasons 1885 and 1886, the time being in March and April, perhaps a little earlier in a warm season: after April it is too hot for fishing.

"The fish is caught on the edge of the channels in 15 to 25 feet of water with a bait of (half a) mullet. The rod should be very stiff, not more than 9 feet in length, such as is used for large sea-bass, and the line strong, but fine enough to carry 200 to 250 yards on the reel, which must therefore be large and heavy. A snood or gauging of about 3 feet of cod-line, copper-wire, or chain, should be fixed to the hook[3] as the dental apparatus of the fish efficiently combines a file and shears, with which even a double cod-line may be frayed or worn off, or severed without a sensible strain.

"The tarpon takes the bait lying on the bottom, and moves off, swallowing it, until he is struck, and the moment he feels the hook he is out of the water, perhaps 3 or 6 feet in the air, shaking his head fiercely—as does the black bass—to disengage the hook, and then begins such a fight as, I believe, no other game fish ever shows. It frequently leaps with a clean breach twenty times before the game is over, and so close that it occasionally sends a douche over the boatmen; while in one instance a large one made a run of 100 yards, the whole of which was a succession of frantic leaps and plunges, leaving a wake like that of a steamer. The same fish towed my boat, with three men in it, about two miles, and, after more than an hour's hard fight, ended by three huge leaps out of the water amongst some mangrove-trees, the oysters on the roots of which cut my line, so that we parted company after a close and protracted intimacy."

There is little doubt, from the foregoing remarks, that the splendid sport of tarpon-fishing must make it most fascinating. In April 1887, indeed, a single rod caught nine fish in eleven days, two of them weighing respectively 151 and 149 pounds, and in length 6 feet 4 inches, and 6 feet 5 inches. These were taken at Punta Rassa on the western coast of Florida, the total weight of the catch being 1042 pounds, or an average of about 116 pounds for each. The tarpon, like others of its tribe, has the advantage also of being good food. W. C. McINTOSH.

[1] "Introduction to Fishes," pp. 661-62.
[2] Extracted from a description (from personal observation) by Mr. W. G. Russell, of Boston.
[3] Described elsewhere as "an O'Shaughnessy knobbed 10-0 hook."

SCIENTIFIC SERIALS.

Bulletins de la Société D'Anthropologie de Paris, tome dixième, 4e fascicule, 1887.—This closing number for the last year enumerates the various presentations made to the Society since the previous publication of the Bulletins. Among the recent communications attention is due to M. Boban's report of the interesting collection of North American flint instruments presented to the Society by the Smithsonian Institution. They appear to be almost identical with those existing in Europe, and belonging to the Stone Age.—M. Verneau, on presenting various stone instruments from the Canary Isles, drew attention to their rude forms, due, he believes, to the relatively brittle character of the basalt and obsidian from which they were cut. The few specimens of polished stone belong only to Gomère and Canary Proper, and are, therefore, conjectured to have been introduced by some of the numerous North African invaders who landed on those islands.—M. André Sanson's paper on experimental craniology in reference specially to domestic animals, which he considers under two cephalic types only, viz. the dolicocephalic and the brachycephalic, is directed against the systems of craniometry and anthropometry at present in vogue. M. Fauvelle took a leading part in the discussion to which the paper gave rise, and gave his views in regard to the value of the cephalic index, which he considered to have been greatly overestimated by Broca and his followers. These remarks, and the refutation of Broca by M. Topinard, form, with M. Sanson's paper, a complete exposition of the various views maintained in different provinces of anthropological science in France.—Report on the various papers presented by competitors for the Godard Prize in 1887, by M. Moudière.—On aphasia and its history since the original observations of Broca, by M. M. Duval.—On the distinctive characteristics of the human brain considered from a morphological point of view, by M. le Dr. S. Pozzi.—On a case of supernumerary digits on the cubital margin of each hand, by Dr. Béranger.—On the morphological variability of the muscles under the influence of functional variations, by Mme. Clémence Royer.—On the abnormal elongation of the cuboides, accompanied by the pressure of a round pronator in a horse, by M. E. Cuyer.—On the tumulus of Kerlescan at Carnac, by M. Gaillard. The remains of this interesting monument, with its double dolmens similar to the covered allées, known as "Hunebeds" in Holland, were first described in 1860, since which time they have suffered so much from neglect and wanton injury that M. Gaillard is making a strong appeal to the Government for their protection.—Note on the tumuli of a covered gallery, examined in 1887, near Montigny l'Engrain (Aisne), by M. Vauville, and report of the crania found there, and referred to the Furfooz men of the dolmen age, by Dr. Verneau. The preponderating character of these crania was their length and straightness. Several bore marks of cicatrised wounds.—On a Quaternary equidean, similar to the *kertag* of Kirghis, described by M. Poliakoff under the the name of *Equus Przewalskii*. The description of the kertag with its short and straight mane, its relatively large head and inferior height, corresponds remarkably well with the numerous representations of the Quaternary equidean found in different parts of Western Europe among the varied debris that mark the site of primæval settlements. In the Magdelian carvings found in the cavern at Arudy among mammoth bones, special prominence is given to the thin, rat-like character of the tail of the animal, a feature that is very marked in the kertag, which appears to be the nearest living representative of the horse of the Quaternary age.