*MAGNETO-ELECTRIC MACHINES**

III.

FROM this property of the Gramme machine it may be employed to measure by the method of opposing currents any electromotive force. For this purpose it is only necessary to ascertain the velocity of rotation of the ring when the equilibrium between the currents is established. This may be measured in one of two ways—by the velocimeter of Deschiens, or by a chromoscopic diapason. The mode of operating with the latter when applied to the Gramme machine is thus described in M. Breguet's work. On the axis of the ring is mounted a small plate whose plane surface is covered with lamp-black by holding it over a candle. A tuning-fork vibrating one hundred times in a second, and carrying at one end a little style, is held in the hand, or, still better, fixed on a special support. At the precise moment that the two electromotive forces are shown by the galvanometer to be equal, the style is brought into contact with the blackened surface of the plate, upon which it traces a sinuous line. A very short contact is sufficient to give the required result. On stopping the machine, it will be seen to what fraction of the circumference ten sinuosities of the line traced on the plate correspond, from which it may be inferred in how many hundredths of a second the entire revolution of the ring has been accomplished. It is stated that if the ring in the Gramme machine be turned at a perfectly steady rate, the current produced will be more rigorously constant even than that of a Daniell's battery in good working order.

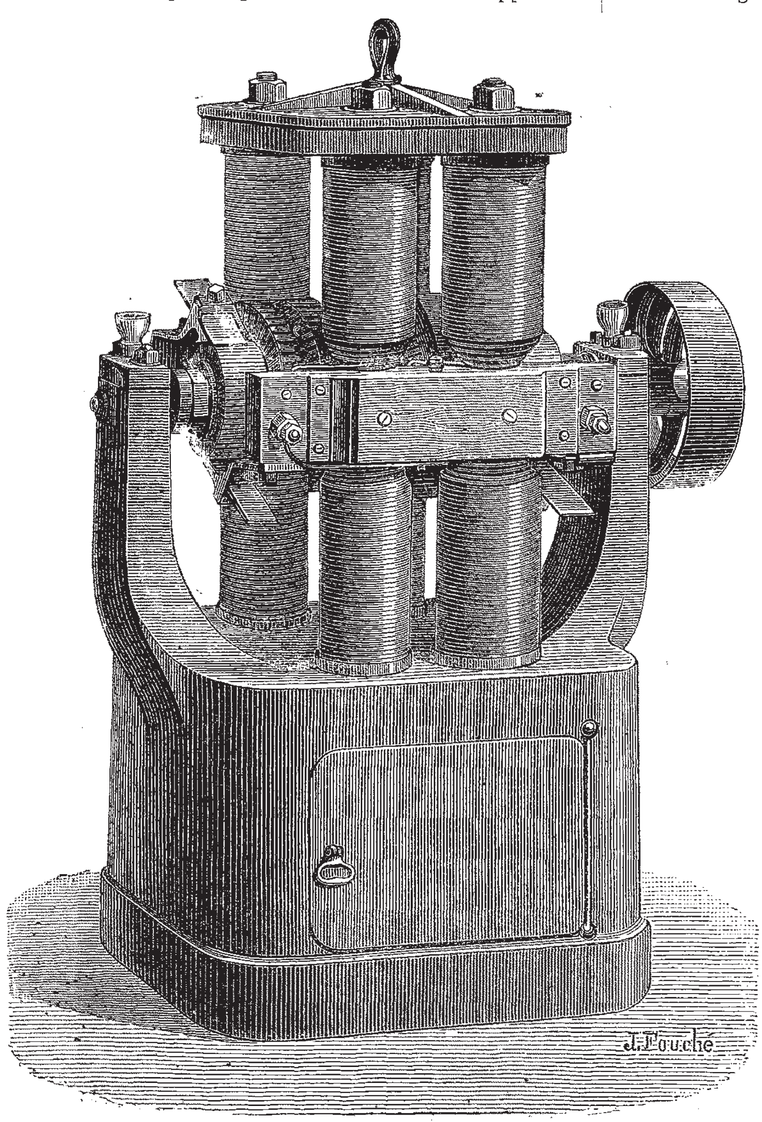

FIG. 7.—Gramme machine for metallic precipitations.

Fig. 7 represents a machine constructed with electro-magnets in 1872 by M. Gramme, which, with six others of the same kind, is in use in the well-known galvanoplastic establishment of Christofle and Co., of Paris. These machines weigh 750 kilogrammes, and the weight of copper used in their construction is about 175 kilogrammes. With a small engine of one-horse power, one of them will deposit 600 grammes of silver per hour. By some recent modifications in its construction this machine has been improved so as to increase the weight of silver deposited per hour to 2,100 grammes, or above $4\frac{1}{2}$ lbs. In Figs. 8 and 9 we have the forms of the Gramme Machine now in use for the production of the electric light. They are improvements on the machine which was tried on the Clock Tower of Westminster Palace. This machine had the defect of becoming heated while at work, and of giving sparks between the metallic bundles of copper wire and the conductors from the helices. In the machine represented in Fig. 8 these defects are said to have been completely remedied. The entire machine weighs 700 kilogrammes, and there are 180 kilogrammes of copper in the electro-magnets, and forty kilogrammes in the two rings. It produces a normal light of 500 Carcel burners; but, by augmenting the velocity, it is asserted that the amount of light may be doubled. It does not become heated, nor does it produce any spark where the brushes are applied.

In Fig. 9 we have the latest improvements devised by M. Gramme for producing the electric light. In this machine there are only two bar electro-magnets and a single moveable ring placed between the electro-magnets. Its weight is 183 kilogrammes, and the entire weight of copper used in its construction, both for the ring and for the electro-magnets, amounts to forty-seven kilogrammes. Its normal power is about 200 Carcel burners, but this can be greatly augmented by increasing the velocity. It may be interesting to give the results of some experiments with this machine.

Number of turns.	Carcel burners.	Remarks.
650	77	No heating or sparks.
830	125	,, ,,
880	150	,, ,,
900	200	,, ,,
935	250	Slight heating, no sparks.
1025	200	Heating and sparks.

* The substance of a Lecture, with additions, delivered at the Belfast Philosophical Society, March 17, by Dr. Andrews, F.R.S., L. & E. (Continued from p. 132.)

By uniting two or more machines together, electrical currents of high tension may be obtained. But a more useful arrangement is to divide into two each ring, so that the two halves may be joined either for quantity or tension, and varied effects thus obtained from the same machine. This is effected in the following manner. Suppose the machine to contain sixty bobbins or helices round the ring. If the entrance of the thirty alternate bobbins is placed on one side of the ring and of the thirty other bobbins on the other side, there will be in reality two ring-armatures in one, interlaced as it were into each other; and by collecting the currents by means of two systems of rubbers, one to the right and the other to the left of the ring, we may obtain from each one half of the electricity produced by the rotation of the ring. By applying this principle to machines for producing the electric light, the same machine may give two distinct lights instead of one. In its industrial applications, this is a point of capital importance. The use of the electric light is at present greatly interfered with by its excessive brightness, and the deep shadows which by contrast are produced at the same time. These defects will be to a large extent remedied by the use of two lights, so that the shadow from one may be illuminated by the other. It is proposed to use four electric lights, each of the strength of fifty Carcel burners, for lighting foundries and large workshops. In support of this proposal I may remark that I find Duboscq's lamp of the latest construction gives a singularly steady and mild light, with only twenty Bunsen's cells, and would of course work equally well with currents of the same intensity from a magneto-electric machine.

It would be impossible, within the limits of this lecture, to give an account of the proposed improvements in magneto-electric machines, which will be found in the records of the Patent Office during the last three years. I cannot, however, pass over without notice the machine of Siemens and Alteneck, in which electrical currents are obtained solely by the rotation of a longitudinal helix of insulated wire. This helix revolves in an annular space bounded externally by two semi-cylindrical magnetic poles, and internally by a stationary cylinder of iron, which latter may also be an independent magnet. The following account of this apparatus I give nearly in the words of the inventors. Between the poles of one or more magnets or electro-magnets, an iron core or cylinder is placed so as to leave a space between it and the faces of the magnetic poles, which have a cylindrical form, and are concentric with the iron cylinder. In this annular space a cylindrical shell of light metal is made to revolve, on which a coil of insulated wire is wound parallel to the axis of the shell, and crossing its ends from one side to the other. There may be several such coils each covering an arc of the periphery of the shell. The ends of these wires are

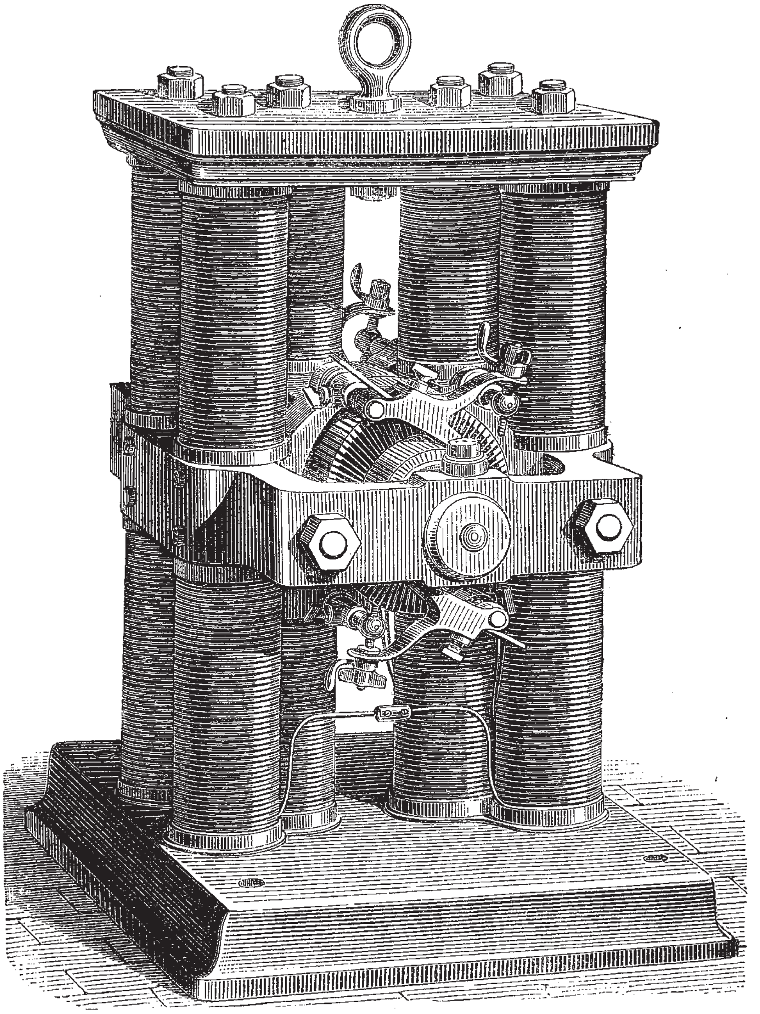

FIG. 8.—Gramme machine for electric light.

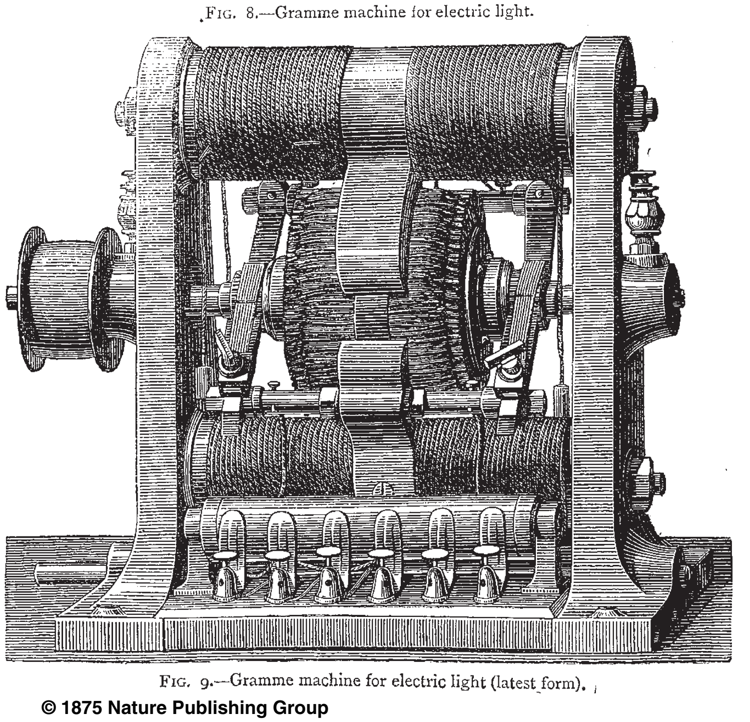

FIG. 9.—Gramme machine for electric light (latest form).

connected by metallic rollers or brushes with two stationary conductors, which are insulated, and constitute the poles of the machine. The currents obtained on rotating the shell may be made either continuous or intermittent, or they may be alternately reversed. The iron cylinder itself may be rendered magnetic by coiling upon it longitudinally an insulated wire after the manner of the rotating armature of Siemens.

To enumerate the possible applications of induction machines would be simply to describe all the applications which have already been made, or may hereafter be made, of current electricity to useful purposes. Among the former, the electric telegraph, the electric light, and electro-plating are perhaps the most important; among the latter, it will be sufficient to mention two proposals, one to facilitate the ascent of steep gradients by increasing, by means of magnetism, the adhesion of the wheels of locomotives to the iron rails; the other, to decompose, by electrolysis, common salt so as to obtain directly, and in a state of purity, the valuable chemical products hydrochloric acid and soda.

THE GOVERNMENT ECLIPSE EXPEDITION TO SIAM

THE following few details concerning the above Expedition will probably be of interest to the readers of NATURE; having just returned from Siam, I am unable at present to give full particulars. The general results obtained by our party have already been published in this country by means of the telegraph. The fact that any results were obtained at all is far more than might have been expected considering the very brief time we had to adjust the instruments. We had only five days to land, unpack, fit up, and test the instruments, most of which were quite new and untried. This want of time was in the first place owing to unavoidable delays on the way out, and to the fact that there was no steamer ready to take us on to the Observatory Camp at once, thus necessitating a visit to Bangkok prior to the eclipse. Our partial success is in a large measure due to the valuable assistance of Capt. A. J. Loftus, an English gentleman in the service of his Majesty the King of Siam; Capt. Loftus was sent out by his Majesty to prepare the camp for us at Choulai Point.

As previous to our departure from London there appeared in one of the leading journals a letter, signed "Monitor," in which some very unpleasant statements were made with regard to the probable reception our party would receive in Siam—although Mr. D. K. Mason, the Siamese Consul in London, published at the time a total denial of the absurd insinuations—I feel it my duty, in the name of all who took part in the expedition, to state that during our prolonged stay in the kingdom of Siam we received nothing but the greatest hospitality and kindness. Everybody, from the King downwards, showed the greatest desire to make our visit as pleasant as possible, and to aid the expedition in every way; difficulties were surmounted at great expense and trouble, and everything we asked for was at hand or was obtained with the least possible delay. Our drinking-water was brought nearly 100 miles by water to the camp; many tons of ice were brought up from Singapore, and every kind of wine was ready at hand.

The King sent several of his officials, both European and Siamese, to assist us, and ordered such observations to be made at Bangkok as the chief of the expedition, Dr. Schuster, might consider of use to the expedition; the King himself observed and made a drawing of the corona. Our camp and observatory were situated some fifty miles from the city of Bangkok, on the west of the Gulf of Siam, in the central line of totality. On our arrival we found what had formerly been a waste of jungle converted into a magnificent camp, and all the houses fitted up ready for our reception.

The eclipse itself differed from former ones in respect to the greater brightness of the corona and the smallness and fewness of the red flames. As far as we could make out, the time as calculated by the *Nautical Almanack* was some ten seconds wrong.

In a "Reuter's" telegram, Dr. Schuster stated that the spectroscopic cameras had failed. As failures arise from many sources, this must be regarded as only a general statement. It merely implied that no results were obtained by these instruments, not that as instruments for observing eclipses they were found to be a failure. Several of the instruments were to have been tested during the outward voyage, but owing to the breaking-down of the *Surat*, and consequent transshipment of cases, no opportunity for such work was found, and, on arriving at the camp, the time was far too short, owing to other accidents, to enable anything like satisfactory focussing and adjustments.

There were two sets of instruments employed as telespectropes, one working in the large observatory, the other in the Siderostat Observatory, where we had the large new siderostat working with Mr. Lockyer's $9\frac{1}{4}$-inch reflecting telescope and a spectroscopic camera. The first two instruments were in splendid order, working together beautifully, but the spectroscopic camera, not having been tested previously, could not be brought to give anything like a well-focussed photograph prior to the eclipse. The image of the corona, which appeared very distinct and bright on the slit-plate, although exposed during the whole of totality, gave no visible results on the photographic plate; even the sun itself, exposed for two seconds for the purpose of obtaining an index, gave likewise no result.

Before making any statements on the results obtained, I must wait the issue of the report of the Royal Society's Eclipse Committee.

Numerous drawings were sent in by the Siamese, which will be very valuable along with the general observations. After the eclipse, owing to three of our party being too ill to leave, we remained longer in the city of Bangkok than we had expected. During our stay Mr. and Mrs. Henry Alabaster, our hosts, on behalf of the King, entertained us in the most hospitable manner, taking care that those who were ill should have all possible attention, and be restored to health as fast as good doctors and kind nursing could accomplish it.

The following is a complete list of all who assisted us in the observatories during the eclipse, as well as of the members of the expedition sent out, with the part taken by each person:—

THE EXPEDITION.

DR. ARTHUR SCHUSTER.—Chief of the Expedition; in charge of large Observatory, attending to the Equatorial.

FRANK EDWARD LOTT.—Dr. Schuster's Assistant. In charge of the Siderostat Observatory.

F. BEAZLEY, Jun.—Photographic Department. Developing negatives in dark room No. 1.

OSCAR ESCHKE.—Photographic Department. Preparing plates in dark room No. 2.

Officers from H.M.S. Lapwing.

Hon. H. N. SHORE, Lieut. R.N.—Taking drawings of Corona in large Observatory.

ANDREW LESLIE MURRAY, Nav. Lieut. R.N.—Keeping time in large Observatory by Chronometer from H.M.S. *Lapwing*.

W. J. FIRKS, Assist. Eng., R.N.—Attending to the clock of Mr. Penrose's instrument.

Europeans and Siamese from Bangkok.

Capt. A. J. LOFTUS, R.S.N.—Founder of the Observatory and Camp. In charge of Mr. Beazley's Camera, taking direct photographs of Corona with 2—4—8—16 seconds' exposure.