SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter.]

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY AND MANUFACTURES.

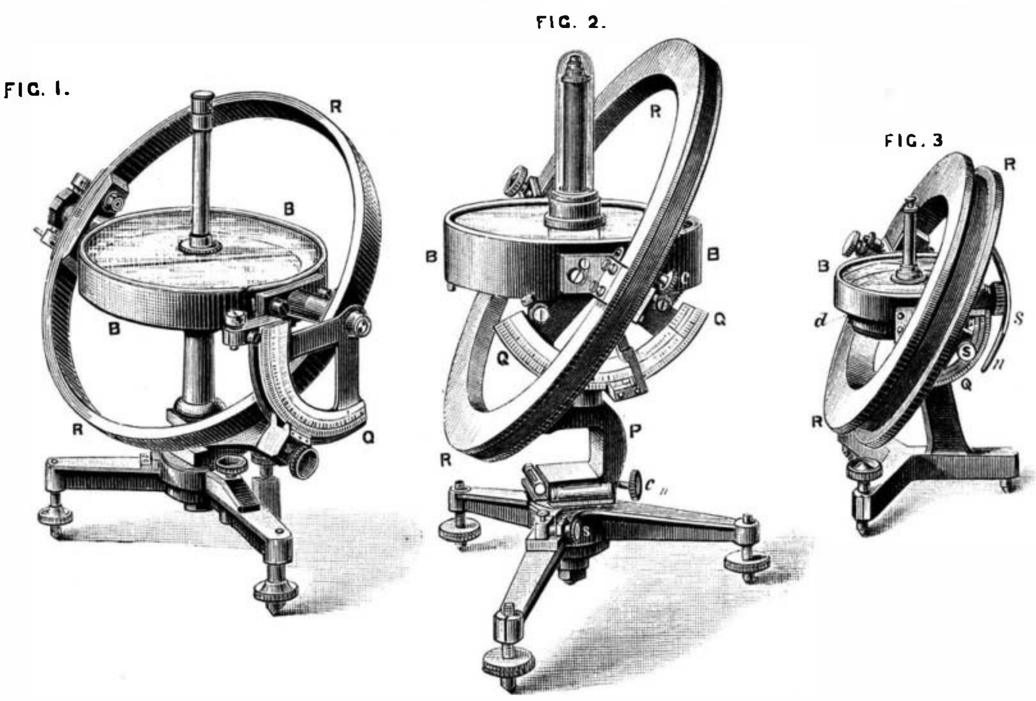
Vol. XLIX.—No. 15. [NEW SERIES.] NEW YORK, OCTOBER 13, 1883. [$3.20 per Annum. [POSTAGE PREPAID.]

EDISON DYNAMO ELECTRIC LIGHT MACHINE.

Now that central stations for the lighting of districts are about to be erected in several parts of London, the subject of generators capable of giving powerful currents acquires a new interest, and at the same time the problem of driving them presses for solution. Hitherto a large installation has been little more than an assemblage within one building of several small ones driven from one or two counter-shafts, and thus it has come that such plants have presented an appearance of complication, and have further, from the creaking and rustling of the belts, given the idea that an immense amount of wear and tear was going on. It is quite certain that before large areas, employing many thousands of lights, can be supplied from one source, great alterations both in the sizes of the generators themselves, and in the means of transmission, will have to be made before practical success is attained.

The earliest and most enthusiastic advocate of district lighting was Mr. Edison, and although his anticipations have not been realized with the rapidity he predicted, yet his system is spreading rapidly in the States, where the company engaged in carrying it out has obtained greater experience of town lighting than any firm in this country. Consequently their operations acquire additional interest to English electricians, who, according to *Engineering*, are about to engage in enterprises of a magnitude far beyond their previous experiences; and in view of this we illustrate on this page the latest type of the Edison dynamo machine, as it appears when designed for feeding 1,200 incandescent lamps from a central station.

The generator is driven directly from the engine without the use of belts or gearing, and consequently revolves at a moderate speed, about 350 revolutions per minute, while there is no fear of a stoppage from the failure of the intermediate parts. The engine is of the Porter-Allen type, and indicates about 200 horse power; it is fitted with a Porter governor and an automatic expansion gear, and drives on to a crank pin fitted between two balance disks. The dynamo follows the ordinary horizontal Edison type, the armature being formed of copper bars upon a core built up of alternate disks of sheet iron and paper, and the field magnets, of which there are twelve, being placed in a shunt circuit. A small fan delivers a constant stream of air on the center of the armature, where it divides and flows to each end, carrying away the heat generated by the current. Five brushes, each in a separate holder, press upon each side of the commutator, and deliver the current into the two mains, shown at the right of the figure, from whence it is distributed through the network of conductors laid all over the district. The point of contact between the brushes and the commutators can be varied, as the whole system is carried on a pivot coaxial with the armature. Mr. Edison's system provides for the connection of several such machines with one set of mains, and for their regulation according to the demands made upon them.



THE OBACH GALVANOMETERS.

OBACH'S GALVANOMETERS.

These instruments are made by Messrs. Siemens Brothers and Co. in three different types. Two of them are suitable for measuring both current strength and electromotive force, whereas the other is for current strength alone.

The principle upon which they are all based is as follows: If the coil of a tangent galvanometer is made movable around a horizontal axis, a given current produces different deflections according to the inclinations given to the coil. If the angles of the

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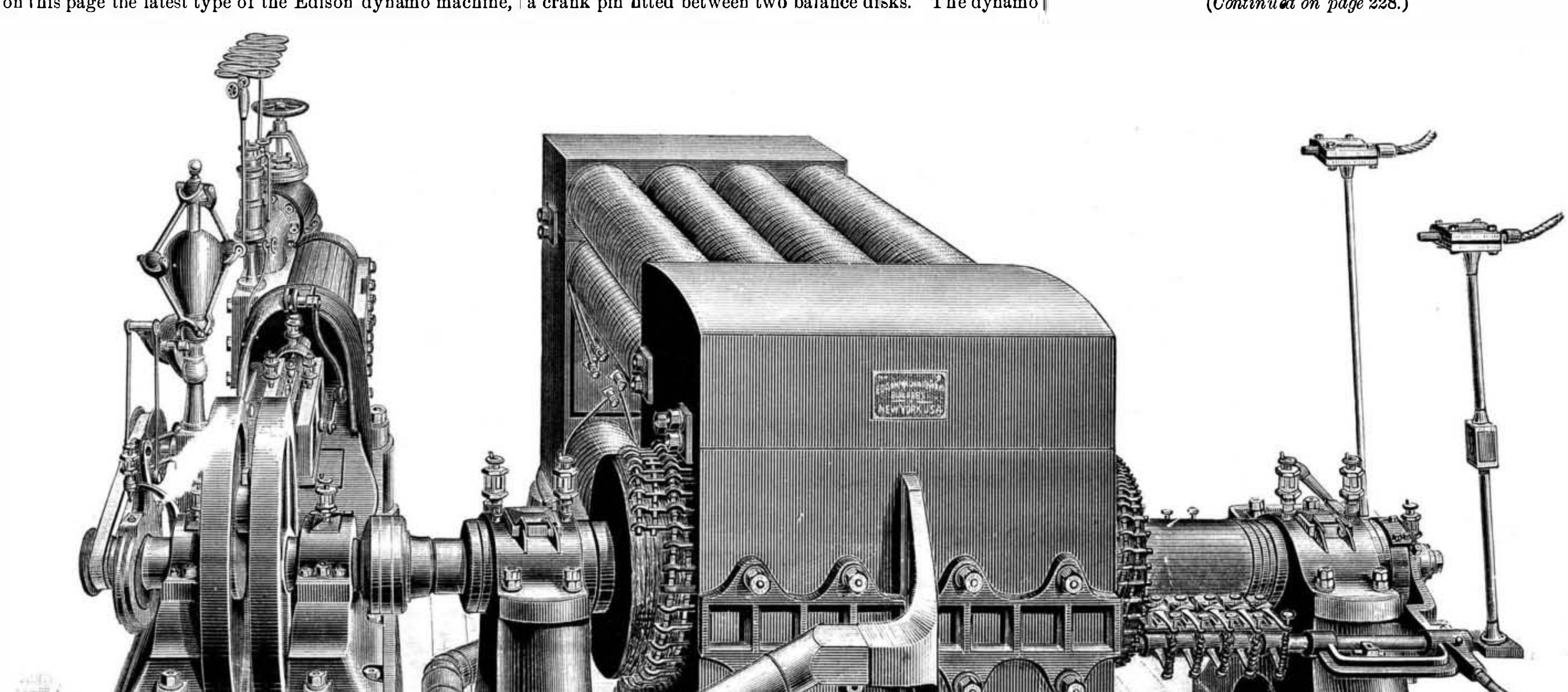
EDISON TWELVE HUNDRED ELECTRIC LIGHT MACHINE.

OBACH'S GALVANOMETERS.

(Continued from first page.)

coil with the vertical are measured, their "secants" are the multipliers of the tangents of the deflections. The current strength or electromotive force to be measured is therefore:

Current strength or electromotive force = tan. deflect. × sec. inclin. × constant.

The constant of the formula being the number of amperes or volts which give the unit deflection of 45° (tan = 1·0) when the coil stands in its vertical position.

The galvanometers for measuring currents and electromotive forces are so arranged that the two constants are identical, *i. e.*, that the same number of amperes and of volts correspond to the unit deflection. This offers the great convenience that the calibration of the instrument in volts at any particular place, by means of some cells of known electromotive force, gives without further trouble the calibration in amperes also. These galvanometers can be provided with a "compensating magnet" made to turn on a horizontal axis, and by means of such a magnet the constant can be kept at the same value for different localities. In order to effect this, a few cells of known electromotive force are required, and the magnet is simply turned until the proper deflection is produced, corresponding, for instance, to a constant of 5 or 10 volts. One-half of the deflection scale is divided into tangents, but the other half bears degrees as usual. The inclination scale has, in addition to the degrees, ten secant marks representing the multipliers 1 to 10. A vernier allows the degrees to be read very accurately. The simple form of current and potential galvanometer has the secant marks, but no other divisions on the inclination scale. Any dipping of the needle is completely prevented by fixing it to a vertical axle loaded at the lower end. The swing of the needle can be made quite dead beat by means of an adjustable air damper.

The particulars and engravings herein given we derive from *Engineering*. Fig. 1 shows the instrument constructed for current strength only. For absolute measurements it can be calibrated by means of a silver or copper voltameter at the particular locality where the currents are measured. It has no compensating magnet, but can be provided with a "constant shunt" for very strong currents. Instruments without a shunt measure from 1 to about 90 amperes, and those with a shunt two or three times as much, according to the adjustment, and with our horizontal component of the earth's magnetism. The solid ring, R, consists of gun metal of high conductivity, and has a rectangular cross-section. The inclination scale is engraved on a quadrant, Q, fixed outside the ring. Three screws and a circular spirit level inside the needle box, B, serve for leveling the instrument.

Fig. 2 shows a highly finished form adapted for currents and potentials. The gun metal ring, R, is V-shaped, and the groove filled with a great many turns of German silver wire. The inclination scale, Q, is between the needle box, B, and the coil, R. The coil as well as the pillar, P, carrying the needle box can be firmly fixed with great nicety by means of clamping arrangements, C_{I} and C_{II}. At the base of the pillar are two straight spirit levels placed at right angles. The screw, *s*, is for adjustment into the meridian.

Fig. 3 is a simplified and smaller model of an instrument of the same construction as Fig. 2, and likewise for currents and potentials. The damping partition, *d*, can be taken out, so that the needle can swing right round. The inclination scale on the quadrant, Q, fixed to the needle box, B, bears only the secants and multipliers, as already stated. The coil is held fast on the quadrant by means of the screw, S, and the instrument is leveled until the needle swings freely; *n s* is the curved compensating magnet used for adjusting the constant to a given value. With this magnet the needle is much less exposed to disturbances from outside. The currents are led to the solid ring by means of flexible leads stranded together in such a manner that they are absolutely inactive upon the needle; they are termed "adynamic leads."

The instrument, Fig. 2, is intended for very accurate measurements, and may, for instance, be used as a standard wherewith other galvanometers can be compared. The mean error of a single observation with the instrument is below one-half per cent, and the probable error below one-quarter per cent.

Fig. 3 is constructed for ordinary purposes, but it should not be placed too close to dynamo machines or single leads conveying strong currents.

Current strengths or electromotive forces can be measured with these galvanometers by either of the following four methods, which may be chosen according to circumstances.

1. *General Method.*—Turn the coil until a deflection a somewhere near 45 degrees is obtained, then read off the inclination φ of the coil.

The formula then is:

$$x = \tan.\ a \times \sec.\ \varphi \times \text{constant}.$$

2. *Method of Equality.*—Turn the coil until the deflection a and the inclination φ are at one and the same angle ψ.

The formula is now:

$$x = \tan.\ \psi \times \sec.\ \psi \times \text{constant}.$$

These products of tan. × sec. can be calculated beforehand and tabulated.

3. *Method of Constant Deflection.*—Turn the coil until the needle each time points to the same degree, say for convenience 26½ degrees, 45 degrees, or 63½ degrees. The tangent of this deflection enters the constant and the formula is reduced to:

$$x = \sec.\ \varphi \times \text{constant}.$$

The instrument here acts as a secant galvanometer, and the method has the peculiarity, that for a number of measurements the needle occupies the same position, which, in some cases, may be found of advantage.

4. *Method of Constant Inclination.*—Set the coil at a proper angle, of which the secant now enters the constant.

The instrument here simply acts as a tangent galvanometer with the formula:

$$x = \tan.\ a \times \text{constant}.$$

As will be seen from the foregoing description, the movable coil galvanometer offers several advantages over other constructions which have been proposed for the same purpose.

The Methods and Aim of Electrotechnical Instruction.

Prof. Braun, in his inaugural address at the Polytechnic School, in Carlsruhe, discussed the subject of educating practical electricians in a careful and exhaustive manner. Some of his remarks will doubtless prove of interest to those who intend taking up this study here.

The first question, said he, that arises is whether a technical school for electricity should be arranged and conducted like the special schools for engineers, machine builders, and the like. The lecturer was of the opinion that electricity, in its present state, is not adapted to such treatment, since everything is still in the evolutionary stage, where theory is imperfect, and the physical basis can by no means be referred to a few axioms from which everything else can be deduced. In electricity, even more than in the application of mechanical principles, Grashof's statement holds good, that "polytechnic schools should not follow in the tow of practical requirements, but, on the contrary, should be the forerunners that precede them. The scientific culture that they afford should not merely satisfy the demands of the present state of the arts, but as far as possible fit them to fill all the demands that may arise up to the time when they shall pass from the stage of action a generation later."

Men educated in such an institution must be able to study and test the literature of their profession with an independent judgment of their own. They must be able to solve the new and difficult problems that present themselves, with ease and a clear understanding when there is no rule at hand that applies directly to the case. How is this to be obtained? Lectures that go more into detail than those on experimental physics generally do, but which are based essentially upon an equality of previous preparation, are insufficient, however desirable they may be for a general oversight of the subject.

To be brief and to the point, something like the following requirements should be made: A year and a half of mathematics, a good insight into analytical mechanics, practice in solving the simpler problems of higher mathematics, exercise in the use of the so-called principles of mechanics, in chemistry, a firmly grounded knowledge of inorganic chemistry, such as can only be obtained by laboratory practice; in physics, a clear and full understanding of the whole of experimental physics; a clear knowledge of electricity based upon mathematical principles, and especially in galvanic electricity; and experience in the application of theory to special cases.

To this must be added practical work in the laboratory, so as to become familiar with the principal methods of physical and electrical measurements in general use. It would also be desirable for him to carry out successfully some scientific physical research, especially in galvanism. Of course a knowledge of machine building must be added to these.

The lecturer then goes on to show, indirectly, that these rather high requirements are really necessary. Suppose that any one has listened understandingly to experimental physics, that he possesses some knowledge of higher mathematics, can use the rules for calculating the division of the current in any desired system of wires, and is practically acquainted with the methods of measuring resistances, electromotive force, intensity of currents, mechanical work, and the intensity of light; knows how much current a lamp needs; is acquainted with the machines now in use; in short, is in possession of a whole lot of positive information which is of practical value. This man can certainly be employed with advantage in many establishments, but he is not able to conduct and manage one alone. These acquirements are not difficult to attain; some theory and a year's earnest work in a physical laboratory.

But more than this is required of the technical electrician. At present he is required, more than in any other technical pursuit, to produce something new, to bring up new questions, or answer difficult ones. He must, therefore, stand in the same intimate connection with science as those who would produce anything in a purely scientific field.

Hence he must know: First, theory. This does not stand, as many believe, opposed to practice, but is rather the shortest recapitulation or summary of all the facts obtained by observation and experiment, sometimes of a very tedious nature. This knowledge saves time and prevents mistakes.

Secondly. In order to understand the theory a previous knowledge of mathematics is necessary. Even if this mathematical knowledge is never actually employed in solving a problem mathematically, it is, nevertheless, an indispensable aid in climbing up to the theoretical view and the simple principle.

Thirdly. Even this is not enough, for a theoretical knowledge of the methods will not suffice. Not all the details can be obtained in this way, even when they can be calculated upon theoretical bases. A full insight into the thing, such as can only be obtained by practical work, is necessary in order to become so familiar with a thing as to be able to estimate approximately from experience what can be calculated more accurately with numbers. A view obtained by theory alone bears the same relation to one that is supplemented by your own observations, as the picture that you form of a certain region from descriptions compares with that formed by visiting the place yourself.

Fourthly. Just as a person does not begin to appreciate all the perplexing details on the map until he begins to travel, and feels thankful for them when he has to use them, so it is here. When he stands before a new problem and is seeking a new road, then he begins to really thank the theory that led him, and is able to appreciate the guide posts and conscientiously hunt them up. The apparently unnecessary fullness of the theory, which is liable to be despised, begins to be appreciated, and the contempt for it vanishes.

Many difficulties are to be encountered in physics. The time of study is too short to overcome all of them; they follow the investigator through life. But it is necessary to have got over those, at least, which lie nearest, to have grappled with the difficulty yourself, and to have come out victorious, to have made the beginning to a clear and transparent mastery over matter, and this can only be accomplished by some scientific work of your own. Neither the scientific nor the practical results of this early work are to be taken as the measure of their value, nor does it depend upon the importance of the question, but it depends upon the value that the work has for the author, its effect upon him. Then only will he be able to actually combine theory and practice, even if in after life he allows himself to be led more by one than the other, according to his natural inclination and taste.—*Poly. Notizblatt.*

Death of a Noted Electrician.

Richard Sigismund Karl Werdermann was born in 1828, in Silesia, Prussia, served for some time as officer in a Prussian artillery regiment, went then to Paris, and established himself there as a civil engineer. In Paris he made the acquaintance of M. Gramme, at that time a workingman, and seeing the Gramme machine, he began to be interested in the electric light and transmission of power. Like many other Germans, he found it advisable to leave Paris in 1870, but before leaving he bought M. Gramme's English and American patents. He came to England in September, 1870, and exhibited here the first Gramme machine. Ever since then he has been actively engaged in the introduction of the electric light, and the development of the Gramme machine on a large scale. Only a few months before his death, a large modified Gramme had been finished at Stockport, which was built to his designs.

He was the first to show—in the Institution of Civil Engineers—the transmission of power by the Gramme machine, and he had also a little Gramme working for some months in the Postal Telegraph Office, taking the place of batteries. In 1875 he exhibited the electric arc light from the top of Charing Cross Hotel, and in 1878 he invented—and exhibited in a factory in the Euston Road—his well known Werdermann semi-incandescent lamp. He invented, simultaneously with Jablochkoff, the electric candle, and sold his patent to the original Jablochkoff Company. At the Paris Exhibition of 1881, the Salle du President, one of the most attractive rooms of the Exhibition, was lit by Werdermann lamps. Like many inventors, says the *Engineer*, from whose columns we copy, Mr. Werdermann, although very fertile in brilliant and ingenious ideas, was not a sufficiently shrewd business man to reap material benefits by his inventions. There was a certain child-like simplicity in his character which made him look only to the successful carrying out of an invention, and not to what it might bring commercially. He left the commercial part to others, and with the usual results, viz., very little benefit to himself; law suits and interminable vexations, which at last undermined his health. It is a fact which redounds very much to Mr. Werdermann's credit, and is characteristic of his scientific dignity and honesty, that last year, when, during the electric light craze, inventors could ask and obtain their own price for inventions, good, bad, or indifferent, he would have nothing to do with limited companies. Mr. Werdermann leaves a widow, three daughters, and one son.

The Geology of the Great West.

In his report to the Secretary of the Interior, Mr. J. W. Powell, director of the United States Geological Survey, gives some interesting facts. In Colorado, valuable beds of anthracite and of bituminous coal have been found, surpassing in quality any heretofore discovered in that region, and indications of large deposits of iron are visible. Evidences of the former existence of a large fresh water lake in western Nevada have been discovered. Traces of a vast continental glacier have been found, of so well defined a character as possibly to change the present geological conclusions of previous explorations. In the work done is included a survey of the Cascade range in Oregon and Northern California. Mr. Powell says that this region is perhaps the holder of the grandest and most extensive display of natural phenomena in the world, and its exploration and thorough investigation will add greatly to the facts of geologic science.