# EIGHT LIGHT DYNAMO.

By GEO. M. HOPKINS.

UNFORTUNATELY for the tyro in electrical matters, no rule or set of rules exists in the literature of dynamo electric machinery which would enable him, with entire confidence of success, to plan a new form of dynamo, or even to attempt to construct any one of the well known forms. The available information generally fails in some minor details, thus, in some degree, obscuring the whole subject, and awakening doubts as to the best course to pursue. One might follow such information as closely as possible, and proceed so far as to make an operative machine, and yet it might happen that no current could be evoked from it, simply for the want of specific knowledge as to how to secure the first increment of magnetism necessary for starting the inductive process.

The writer knows a case in point where good workmanship, proper proportions, and correct connections failed of giving any results whatever. Naturally, rewinding was resorted to, but to no purpose. Other experiments were tried, with no better results. But, finally, acting upon a hint given by a builder of dynamos, the maker of the machine was out of his difficulty almost in an instant.

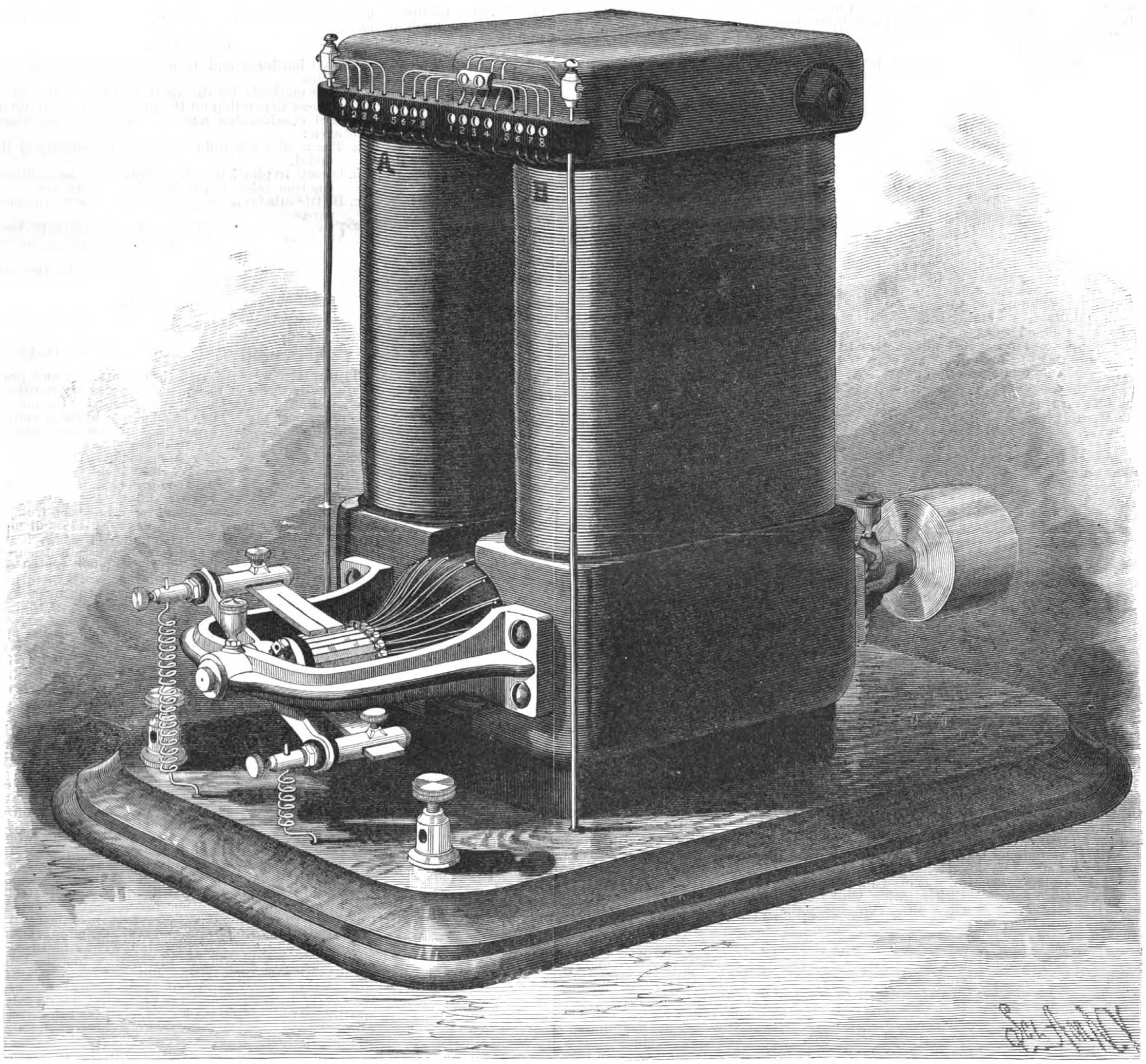



FIG. 1.—EIGHT LIGHT DYNAMO.

It is not the purpose of the present paper to treat on dynamos in general, but to give, as fully as possible, specific information as to the construction of a small dynamo electric machine capable of supplying a current for eight sixteen-candle power incandescent fifty volt lamps, or a larger number of smaller incandescent lamps of suitable resistance, or an arc lamp of ordinary power. The armature speed is 2,200 revolutions per minute, and the machine running normally requires one horse power to drive it. The machine weighs 180 pounds, and occupies a floor space of 8 × 18 inches.

The dimensions of the machine are tabulated below :

| | | |
|---|---|---|
| Height of field magnet | 13 | inches |
| Length of field magnet waist | $6\frac{7}{8}$ | “ |
| Width of field magnet waist | $5\frac{3}{8}$ | “ |
| Thickness of field magnet waist | $1\frac{5}{8}$ | “ |
| Depth of polar extremities from waist to base | $4\frac{1}{2}$ | “ |
| Width of polar extremities | $6\frac{3}{4}$ | “ |
| Thickness of polar extremities | 3 | “ |
| Diameter of bore of polar extremities | $3\frac{5}{8}$ | “ |
| Thickness of yoke | $1\frac{7}{8}$ | inches |
| Diameter of bolts passing through the yoke | $\frac{5}{8}$ | “ |
| Length of armature shaft | 18 | “ |
| Diameter of armature shaft | $\frac{5}{8}$ | “ |
| Diameter of armature shaft bearings | $\frac{1}{2}$ | “ |
| Length of parallel faces of armature | $6\frac{3}{4}$ | “ |
| Diameter of iron rings of armature core, outside | 3 | “ |
| Diameter of rings of armature core, inside | $1\frac{7}{8}$ | “ |
| Thickness of rings | $\frac{1}{16}$ | “ |
| Number of iron rings on armature core | 39 | |
| Diameter of wooden armature core | $1\frac{7}{8}$ | “ |
| Length of wooden armature | $6\frac{5}{8}$ | “ |
| Length of armature core | $6\frac{5}{8}$ | “ |
| Number of divisions of the armature core | 24 | |
| Number of divisions of the commutator cylinder | 24 | |
| Length of commutator cylinder | 2 | “ |
| Width of brushes | $\frac{11}{16}$ | “ |
| Size of wire on armature, No. 20 Am. W. G | 0·032 | in. diam |
| Length (approximate) of wire in each armature coil* | 25 | feet. |
| Number of convolutions in each layer | 8 | |
| Number of convolutions in each coil | 16 | |
| Number of layers in each coil | 2 | |
| Number of coils in each space of the armature | 2 | |
| External diameter of armature | $3\frac{3}{8}$ | inches |
| Weight of wire on armature | $2\frac{1}{4}$ | pounds |
| Diameter of pulley on armature shaft | $3\frac{1}{2}$ | inches |
| Width of pulley on armature shaft | $2\frac{1}{2}$ | “ |
| Width of driving belt | 2 | “ |
| Size of wire on field magnet, No. 18 Am. W. G | 0·040 | in. diam |
| Number of parallel wires on each leg of field magnet | 4 | |
| Number of layers of wire on each leg of field magnet | 8 | |
| Number of layers for each wire | 2 | |
| Weight of wire on field magnet | 12 | pounds |

The field magnet is made of two like parts of soft, gray cast iron, joined at the center of the yoke, and bound together by two bolts, as shown in Fig. 1. The adjoining surfaces of the yoke are accurately faced, so that when clamped together, the connected halves of the magnet will be practically the same as if made integrally.

The bore of the polar extremities of the magnet is $3\frac{5}{8}$ inches in diameter, and the sides of the magnet around the bore are faced in the lathe to form a true support for the bronze yokes supporting the ends of the armature shaft. These yokes are bored to receive the armature shaft, and faced in the lathe upon the surfaces abutting against the sides of the magnet. The yokes are secured in their places on the magnet with their centers coincident with the axis of the bore of the magnet.

The armature shaft is fitted so as to revolve freely on its bearings, and there is a clearance between the periphery of the armature and the magnet of about one-eighth inch.

Upon the portion of the armature shaft lying between the poles of the field magnet is placed the cylinder, of thoroughly seasoned hardwood of the size above given. Upon this wooden cylinder are placed the thirty-nine iron rings or washers, with intervening paper rings of the same size and about one thirty-second inch thick. The iron rings are drilled at diametrically opposite points to receive the brass rods by which the entire series is held together. These rods are each inclosed throughout their entire length in a tube of hard rubber or paper, and the nuts on opposite ends of the rods are separated electrically from the end washers by washers of insulating material, such as mica, vulcanite, or vulcanized fiber. The arrangement of the parts of the core of the armature is shown in Fig. 2, in which some of the iron rings have been separated, to more clearly illustrate the construction.

The series of iron rings is secured to the wooden cylinder and the shaft by two pins passing through the rings, the wooden cylinder, and the shaft.

The edges of the end rings are rounded, to prevent them from cutting the insulation of the wires. In two of the rings, at each end of the armature core, are formed twenty-four equidistant radial slots, *b* (Fig. 3), one-eighth inch deep and one-sixteenth inch wide. The armature core thus formed is covered over its entire

* This quantity varies a few inches with the different coils.

**surface with adhesive tape, such as is commonly used by wire men for covering joints in conductors. The tape is wound spirally on the periphery of the core, and is arranged radially on the end of the core. It is also wound spirally upon the shaft one and three-eighths inches in each direction from the ends of the armature core. Into the radial slots, *b*, are driven small wedges, *a*, of hard rubber, which are allowed to project three sixteenths inch beyond the periphery of the core.**

**The winding of the armature is most readily done in**

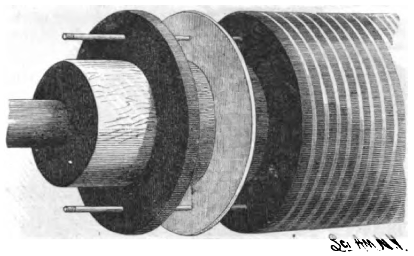


FIG. 2.—PARTS OF ARMATURE CORE.

**a lathe, as shown in Fig. 3. The armature shaft with a dog attached is supported between the centers of the lathe, with dog in engagement with the face plate. A spool of No. 20 wire* is supported in a convenient position at the back of the lathe, and after bending the end of the wire around one of the wedges, leaving about 4 inches projecting beyond the wedge, the winding is begun. The wire is carried by one hand along the surface of the armature core and through the space between two wedges at the opposite end of the core, corresponding with the space in which the coil was started. The other hand grasps the face plate of the** lathe, and as the wire is carried across the end of the armature core, the face plate is dexterously turned through a half revolution, bringing the opposite side of the core uppermost. The wire is then laid between the two pairs of wedges diametrically opposite those embracing the wire on the other side of the armature. The wire is carried across the commutator end of the armature core, and the armature is returned to the position of starting by returning the face plate to its first position, and the wire is laid alongside of the portion first laid on. The wire is carried lengthwise around the armature in this manner until eight parallel convolutions have been laid on. This layer of wire will extend across the space between two of the wedges. In Fig. 4 the inner layer, B, is represented as being raised from the core, to more clearly show the position of the wire on the armature, and the inner and outer coils are widely separated; but it will of course be understood that these wires are to lie as closely as possible to the core in the working machine. The beginning or inner terminal, E, of the coil, B, is represented in black. In practice, this end of the wire is always coated with colored varnish as soon as the coil is complete, and before the two ends of the coil are twisted together, as they always are temporarily, for convenience in winding, so that there cannot be a mistake as to which are the inner and outer ends of each coil.

After winding the inner layer of the first coil, the winding is continued, forming the outer layer, D, on top of the inner layer, by winding in the same direction, but returning by the successive coils of the second layer toward the point of starting. When the outer layer is complete, the wire is cut, leaving a projecting end about 4 inches long. The colored or inner end of the wire is now twisted with the outer or uncolored end. In this manner, the first coil is placed in the spaces 1, 1, of the armature. It will be observed by reference to Figs. 4 and 5 that the two halves of each coil are arranged across the end of the armature on opposite sides of the shaft. This secures a compact end and a minimum amount of dead wire.

After placing one coil in spaces 1, 1, in the manner described, spaces 2, 2, are filled in the same way, then 3, 3, and so on, until twelve coils are wound upon the core. These coils half fill all of the pairs of spaces 1, 1, 2, 2, 3, 3, etc., to 12, 12, with terminals, A, E, projecting from each space around one-half of the periphery of the commutator end of the armature, the end of the armature presenting an appearance which would be indicated by Fig. 5, if the coils, G F, were omitted. When the armature is half filled, the winding is continued in exactly the same manner and in the same direction as before, forming a coil of two layers, F, G, in spaces 1, 1, on top of the first coil, B, D, leaving projecting terminals, as in the case of the first series of coils. Then a similar coil is formed on top of the coil in spaces 2, 2, and so on, until each pair of spaces contains two coils, one superposed on the other, every coil being formed of two layers of wire, with eight strands in each layer.

It is advisable, before winding the outer series of coils, to bind the inner series close to the core by a winding of stout linen thread at three equidistant points in the length of the armature. As a guard against the possibility of short circuiting, the terminals of each coil, where they are in contact with each other or with other portions of the wire, should be provided with an extra wrapping of cotton.

To avoid the destructive effects of centrifugal force, the armature, after winding, is encircled at three equidistant points in its length by three bands, each consisting of 8 or 10 convolutions of unannealed No. 30 brass wire, drawn tightly, and soldered at numerous points. A band of adhesive tape is interposed between the brass wire and the conductor of the armature. The armature thus constructed is known as the Siemens or Hefner-Alteneck armature.

There is another method of constructing the core of the armature which yields good results, but is, in some respects, inferior to the one described. The armature shaft carries a spool of well seasoned wood or other non-magnetic material, upon which is wound varnished soft iron wire—the wire being used instead of the iron rings.

The making of a good commutator is not the smallest item in the construction of a dynamo. It is a very important part of the machine, requiring good workmanship and the best of materials.

The commutator cylinder in a machine of this class is formed of a series of bronze bars, separated a short distance from each other, and carefully insulated. On the eight light dynamo it is 1½ inches in diameter and 2 inches long. The bronze sleeve, A, which is fitted to the shaft and provided with a fixed flange and a set screw at one end, is screw threaded at the opposite end to receive the screw threaded bronze flange, B. On the sleeve, A, between the fixed flange and the removable flange, B, is placed a vulcanite sleeve, C, and to the ends of this sleeve are fitted two collars, D, of vulcanized fiber or analogous insulating material. These collars are beveled on their inner surfaces, and are thickest at their peripheries. To the vulcanite sleeve, C, is fitted a bronze cylinder, E, having conical ends, fitted to the beveled collars, D, as shown at 5 in Fig. 6. The bronze cylinder is slitted longitudinally in a gear cutter, or in any other convenient way, so as to divide it into 24 equal divisions, the slits extending nearly through the cylinder, as shown at 1. Before the bars are separated they are marked with figure punches, in regular order from 1 to 24, so that they may be rearranged after separation. Besides this, a sheet of mica is selected which can be crowded into the slits. Now, if the slits have been made deep enough, the bars may be broken off one after another, and the fin may be removed with a file; but if the bars cannot be broken off in this way, they may be removed by means of a hack saw, as shown at 2.

As many strips, F, of mica are cut from the sheet as

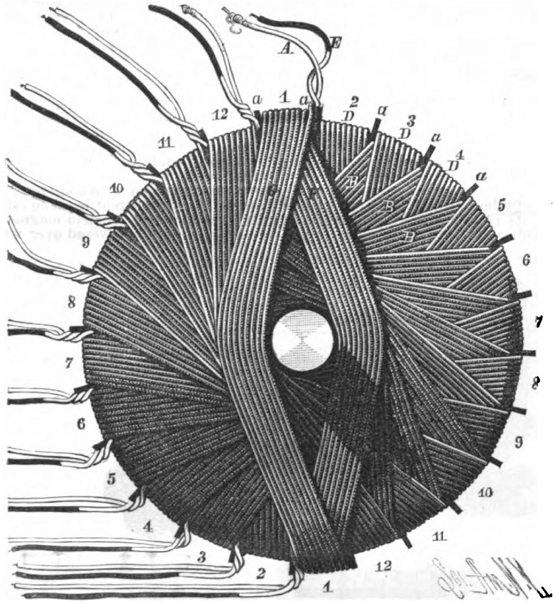



FIG. 5.—STARTING THE OUTER SERIES OF COILS.

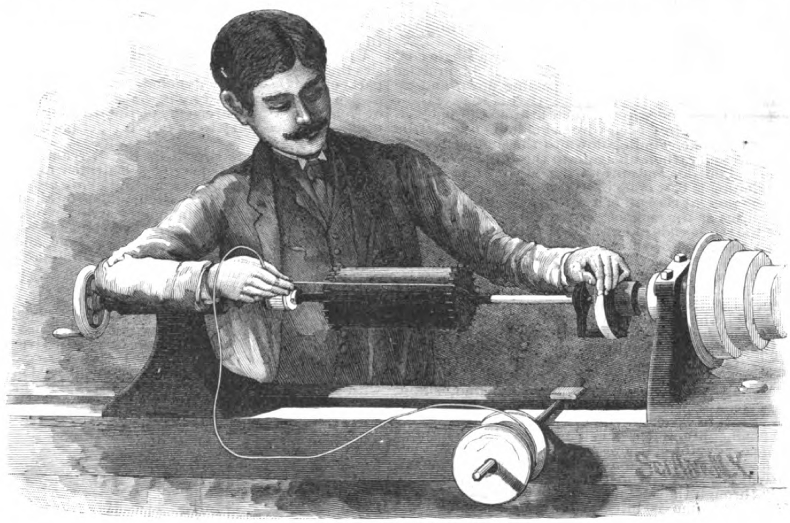


FIG. 3.—METHOD OF WINDING.

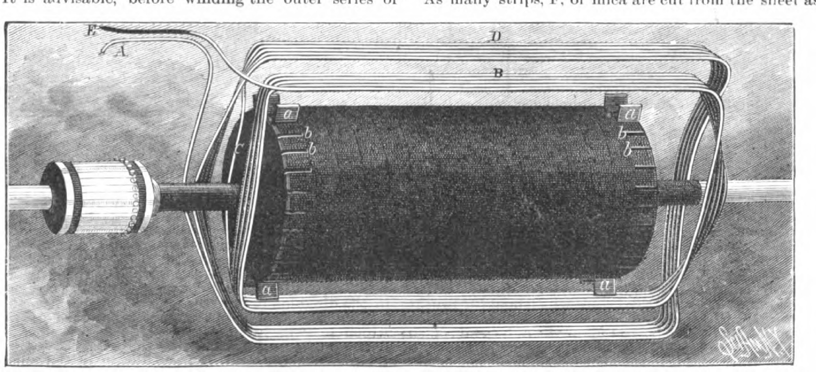



FIG. 4.—THE FIRST COIL ON ARMATURE.

* The wire used is the best cotton covered magnet wire.

there are bars in the cylinder, the mica strips being made a little wider than the bars and of exactly the same length, as shown at 3.

The commutator bars thus formed are placed between the collars, D D, in alternation with the mica strips, with the bars arranged according to their numbers. The flange, B, is then screwed up tightly, clamping all the bars and the mica strips firmly in their places, each bar being thoroughly insulated. The cylinder thus made is placed upon an arbor and carefully turned off to bring it to a true cylindrical form. After turning, each bar is drilled near one end to receive the brass screw by which the armature wire is connected with the commutator bar.

The commutator cylinder, now finished, is secured by the set screw in its place on the armature shaft, with the screws adjoining the body of the armature.

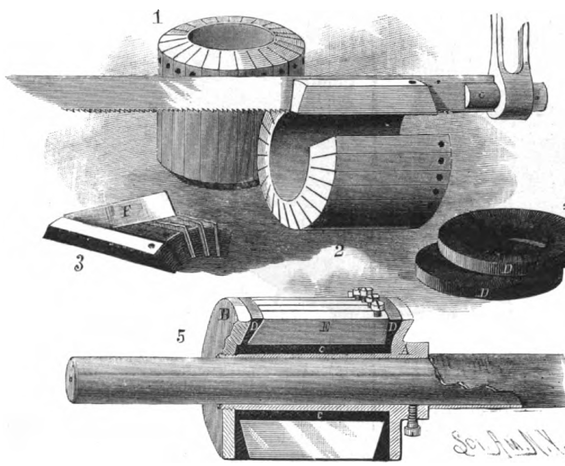


Fig. 6.—THE COMMUTATOR CYLINDER.

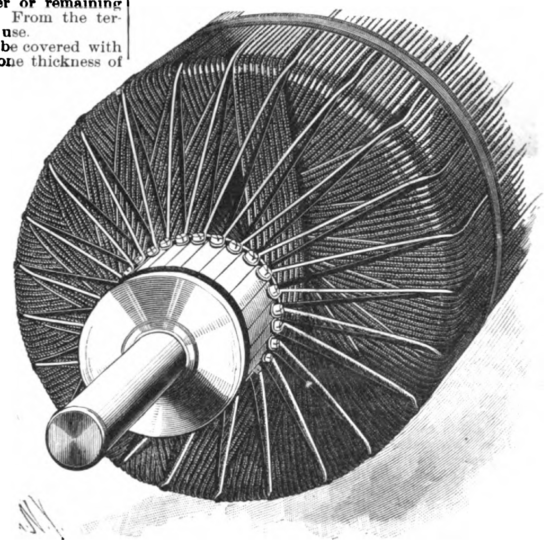


Fig. 7.—CONNECTIONS OF THE ARMATURE COILS AND COMMUTATOR CYLINDER.

Now, for convenience in handling, the armature shaft is placed in the lathe, and the inside and outside terminals of one coil are carefully straightened out parallel with the sides of the armature, and their ends are stripped of the insulating covering for a short distance and thoroughly scraped. The screws in two of the commutator bars, say 1 and 2, are loosened so as to permit of placing the looped ends of two wires under them. The outer terminal of the coil is connected with one of the screws, and the inner terminal of the same coil is connected with the screw in the next bar in order in the commutator cylinder. The outer terminal of the second coil is connected with the screw last referred to, and the inner end is connected with the screw of the next bar in advance, and so on around the entire commutator cylinder, the outer end of each coil being connected with inner end of the adjacent coil and with a bar of the commutator cylinder by one of the screws, as shown in Fig. 7.

The brushes which bear upon opposite sides of the commutator cylinder are each made of six thin strips of hard rolled copper, thirteen-sixteenths inch wide and three inches long, split from their free ends toward their clamped ends, to render them more elastic. The brushes are clamped in mortised studs passing through holes in the ends of a bar fitted to and adjustable on a boss formed on the inner side of the bronze yoke around the shaft. By this arrangement the brushes may be adjusted for taking off the current to the best advantage. The mortised studs which hold the brushes are separated electrically from the bar by insulating thimbles and washers, and upon the outer ends of the studs are screwed binding posts, in which are inserted conductors, bent into spirals to permit of the adjustment of the brushes. One of these conductors communicates with one of the binding posts on the machine base, while the other communicates with one of the rods extending to the top of the field magnet. The remaining binding post on the base is connected with the other vertical rod, extending to the top of the magnet. These vertical rods are connected with the terminals of the winding of the field magnet, as shown in Fig. 1.

The circuit of the machine is clearly shown in Fig. 8, the current passing from the armature, C, through the upper brush, thence to the top of arm, A, of the magnet, down that arm, then up to the top, then down the arm, B, and up, then downward to the base of the machine, terminating at *a*. The lower or remaining brush is connected with conductor, *b*. From the terminals, *a b*, the current is taken off for use.

The portions of the field magnet to be covered with wire are carefully covered over with one thickness of cotton cloth, which is made to adhere by means of shellac varnish, and the shoulders of the magnet are lined with leather board, or thin sheets of vulcanite, or vulcanized fiber. The object of thus covering the field magnet is to insure good insulation.

In Fig. 8, for the sake of clearness, only a single conductor is shown on the field magnet, but in practice there are four, each conductor passing down and up once on each arm of the magnet; that is to say, there are eight layers of wire on each arm of the magnet, formed of four wires, each wire being laid on by beginning at the yoke, winding down to the shoulder of the polar extremity, then up again to the top, leaving the inside and outside ends projecting, as shown in Fig. 9. The winding is best done in a lathe.

In the present case all of the inner ends of the wires of the arms of the magnet are connected together, and all of the outer ends of one arm of the magnet are connected with one of the vertical rods, while the outer ends of the wires of the other arm are connected with the other vertical rod, as shown in Fig. 1.

By winding the field magnet with No. 18 wire in the manner described, several advantages are secured, one of which is the facility with which the work of winding may be done; another is the possibility of connecting the wires in different ways, so as to secure more or less resistance in the magnet. Another is that the wires may be conveniently connected up according to the various methods of winding, compound, shunt, series, etc.

As shown in the engravings, all of the wires of the field magnet are in parallel circuit, practically forming a large conductor of small resistance, and the conductor thus arranged is connected in series with the armature, that is, the current from the armature passes directly through the field magnet and external circuit.

If the dynamo is intended to be always used as a series machine, a winding of four layers of No. 12 wire on each leg may be substituted for that above described; the resistance of the No. 12 wire being equivalent to that of the four parallel No. 18 wires.

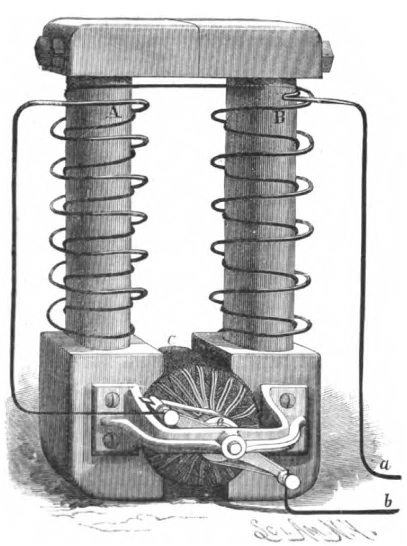


Fig. 8.—THE CIRCUIT OF THE DYNAMO.

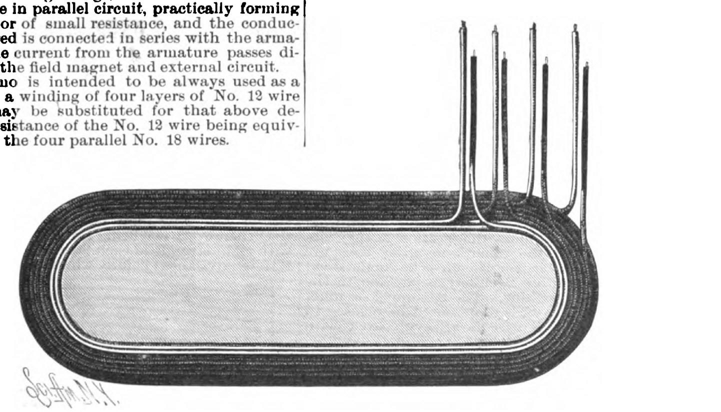


Fig. 9.—SECTION OF ONE ARM OF THE FIELD MAGNET, SHOWING WINDING.

Having made the dynamo and connected it up in the manner described, the brushes are to be brought into contact with the commutator cylinder at points diametrically opposite each other, and at points about opposite the center of the space between the polar extremities of the field magnet. The armature is revolved in the direction of the free ends of the brushes, and in the binding posts on the base are inserted short wires, which may be brought into contact with each other momentarily as the armature revolves.

If a spark is seen on the separation of the wires, it shows that the magnetism inherent in the iron of the field magnet is sufficient for the starting of the machine, and no further manipulation other than the adjustment of the brushes is necessary. The brushes should be adjusted to a point where the least sparking is produced. This will not vary much from the original position. The machine from which the engravings were made produces no noticeable sparks at the commutator.

If the machine fails to start, when tried in the manner above indicated, a battery of four or five Bunsen cells must be connected with the binding posts, or a dynamo may be used instead of the battery. It sometimes requires a few minutes to start the current, but as soon as it begins, the battery should be removed.

Some care is necessary in handling the conductors, as it is quite possible to receive a severe shock from this machine.

Upon the annexed outline engravings—which are half size linear—are marked the dimensions of the several parts of the eight light dynamo; and as all of the dimensions may be taken from the figures there given, or from actual measurements of the drawing doubled, it will be unnecessary to go into further particulars regarding sizes.

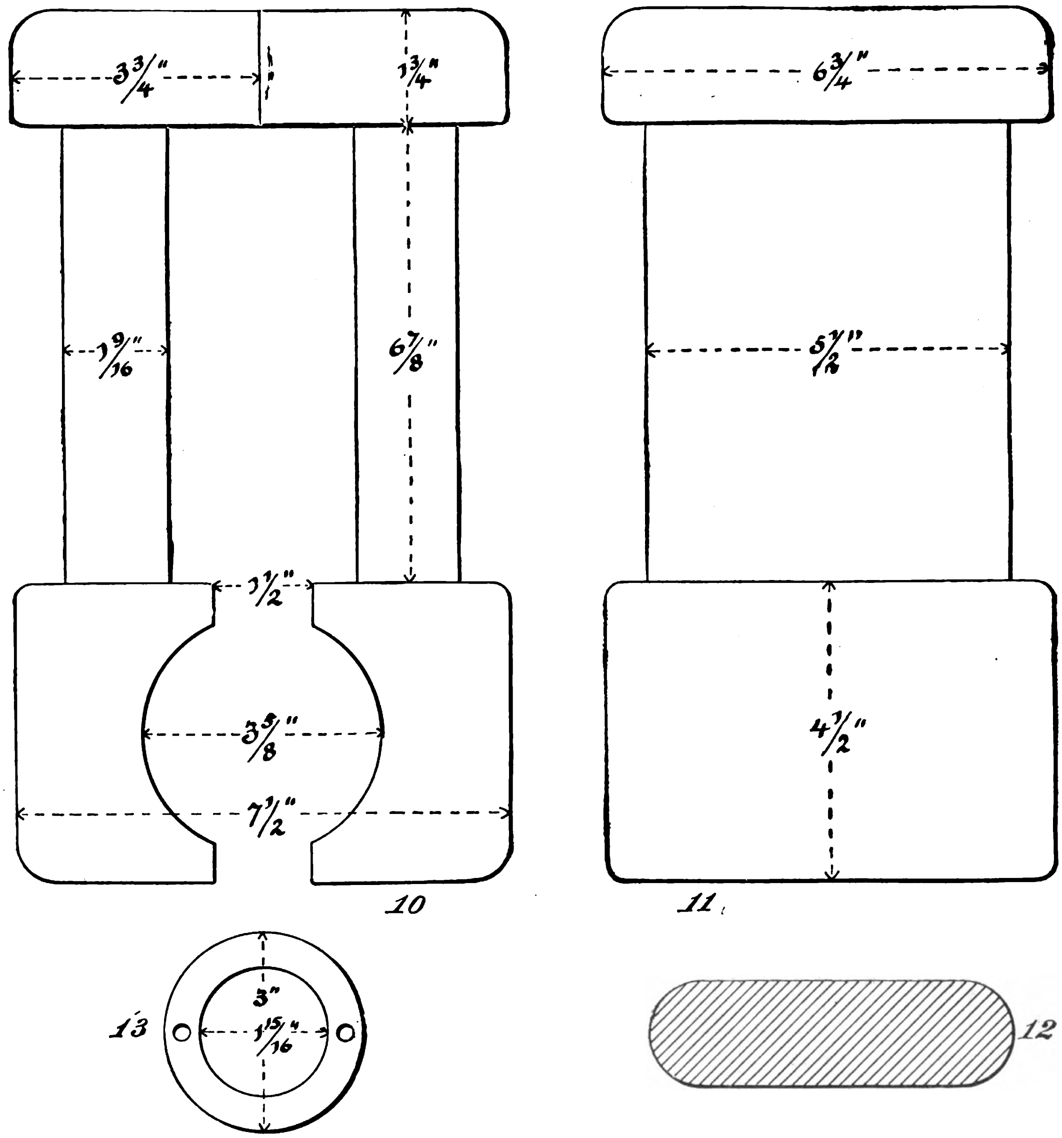
The armature core shown in Fig. 14 requires a brief description. This core may be substituted for the one before described. To the armature shaft are secured two brass disks provided with shoulders on their inner faces which support a thin hollow cylinder or tube of iron or brass. This cylinder and the inner faces of the brass heads are covered with adhesive tape, and upon the spool thus formed No. 20 soft iron wire—previously varnished and dried—is wound in uniform layers until the core is of the proper diameter. The end of the iron wire is secured by scraping it and soldering it to the adjacent coil. The brass heads are slit radially to receive the vulcanite wedges as in the other case, and the entire core is well covered with adhesive tape, when the winding may be proceeded with.

As before mentioned, the winding of the field magnet with four parallel wires permits of arranging the magnet in various ways to secure a good automatic regulation of the current. The circuit of the machine as arranged in Fig. 1 is shown diagrammatically in Fig. 17, to permit of comparing it with the diagrams that follow.

Fig. 2 shows the machine arranged as a shunt dynamo,* in which the terminals of the field magnet are connected with both commutator brushes, so that part of the current passes around the magnet and part through the external circuit. In this arrangement, however, the four wires of the field magnet are arranged in series, that is, terminal, 1, of the leg, A (see Fig. 1), is connected with one of the commutator

* Introduced by Wheatstone.

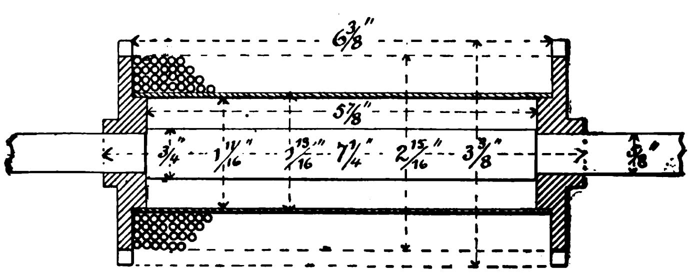
brushes; 2 is connected with 5, 3 with 6, and 4 with 7; 8 is connected with 8 of the leg, B, and 1 is connected with the remaining commutator brush; 2 is connected with 5, 3 with 6, and 4 with 7. Resistance must be placed between one of the terminals of the magnet and the commutator brush, to prevent too much of the




PARTS OF THE EIGHT LIGHT DYNAMO—HALF SIZE LINEAR. (Figures represent full size in inches.)

10.—Side of Field Magnet. 11.—End of Field Magnet. 12.—Cross Section of Waist of Magnet. 13.—One Ring of the Armature.

current from passing through the wire of the magnet. The exact resistance required must be determined by experiment. It is about 20 ohms. A very interesting experiment consists in placing about six 50 volt lamps in parallel, in the shunt between the magnet and armature. When the external current diminishes, and the current increases in the shunt, the glow of the lamps increases from a dull red to incandescence, and *vice versa*.




WIRE ARMATURE CORE—HALF SIZE. (Figures represent full size in inches.)

This is probably the best way to arrange the machine for use by hand power.

In Fig. 19 is shown the machine in which the field magnet is arranged to be excited by a separate generator,* such as a battery or another dynamo.

* Due to Wilde.

In Fig. 20 is represented an arrangement of circuits* in which are combined the features of Figs. 17 and 19. In this case three of the wires of each leg of the magnet are connected together in series, and also connected in series with the armature and with some resistance; the remaining wires of the legs of the magnet are connected together and with an independent generator sending a current in the same direction as that from the armature of the dynamo.

In Fig. 21 is shown an arrangement in which the armature of a magneto-electric machine is included in the circuit of the dynamo when the dynamo is arranged as a series machine.†

Fig. 22 shows an arrangement of circuits in which the regulation is secured by combining the series and shunt systems.‡ To adapt this system to the eight-light dynamo, the three of the magnet wires in series, including some resistances, should be connected as a shunt, and the remaining wires should be connected with the armature and external circuit in series, as indicated by the heavy line.

* Due to Depretz.
† This arrangement was devised by Perry.
‡ Invented by Brush.

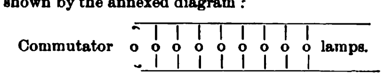
The arrangement shown in Fig. 23* is similar to that last described, but in this case the shunt is much longer, and is arranged across the external circuit. This system cannot be applied to the eight-light dynamo without applying a considerable length of fine wire to the coils of the field magnet. This is probably not advisable in the case of this machine.

In Fig. 24 is shown a system† of circuits in which the field magnet of the shunt machine shown in Fig. 18 is furnished with a conductor (shown in dotted lines), through which a current from an external source passes to constantly maintain the minimum of magnetization, the variation necessary to insure regulation being secured by the shunt.

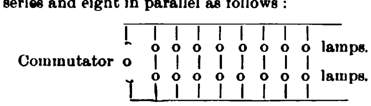
In Fig. 25 is shown a combination of the shunt and magneto above described.

By the careful use of extra resistance, most of the above systems may be tried experimentally on the eight-light dynamo with success. It will be found on trial that the current will not start with less than three lamps in parallel in the circuit when the magnet and armature are in series. It will run eight 50 volt lamps successfully. When the machine is connected up as shown in Fig. 18, it will run from a single 50 volt lamp up to its full capacity.

The method of connecting up the 50 volt lamps is shown by the annexed diagram:




Twenty-five volt lamps may be connected up two in series and eight in parallel as follows:




* S. P. Thompson.
† Depretz.

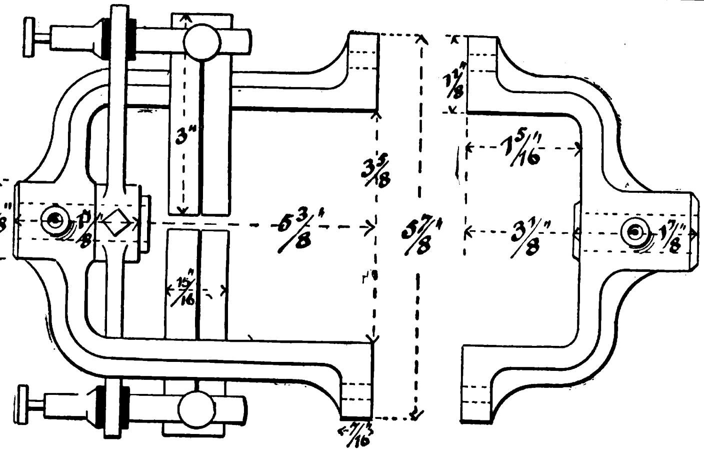


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FIG. 15.—YOKE, COMMUTATOR BRUSHES, AND ARM. FIG. 16.—YOKE SUPPORTING THE PULLEY END OF SHAFT—HALF SIZE.

The resistance of the field magnet with the four wires of each leg parallel is 0·086 ohm. The resistance of the field magnet with all the wires in series is 14 ohms. The resistance of the armature is 1·8 ohms.

The resistance of the machine arranged as a series

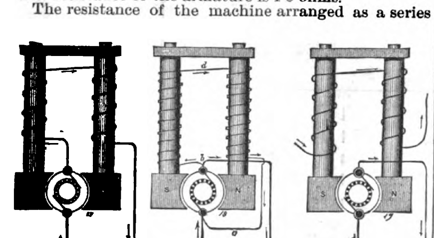

FIG. 17. FIG. 18. FIG. 19.

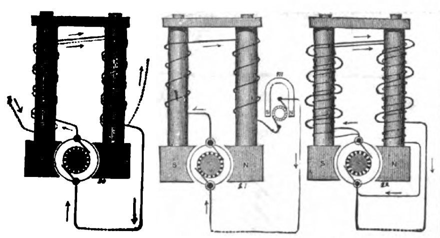

FIG. 20. FIG. 21. FIG. 22.

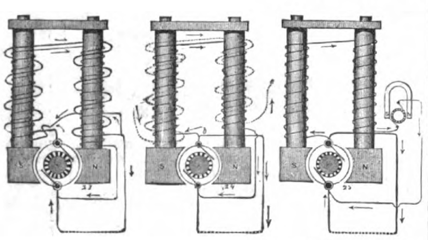

FIG. 23. FIG. 24. FIG. 25.

FIG. 17.—Series. FIG. 18.—Shunt. FIG. 19.—Separately Excited. FIG. 20.—Series and Separate. FIG. 21.—Series and Magneto. FIG. 22.—Series and Shunt. FIG. 23.—Series and Long Shunt. FIG. 24.—Series and Separate. FIG. 25.—Shunt and Magneto.

dynamo, with the wires of the magnet parallel, is 1·886 ohms.

This machine yields a 10 ampere current having an electromotive force of 60 volts.

## EFFECT OF THE ELECTRIC LIGHT UPON BOOKS.

PROF. WIESNER, of Vienna, has just called attention to an inconvenience attending the use of the electric light in libraries. It has been found that a large number of works in the library of the Technical School had become very yellow, and this led the director of the establishment to ask Prof. Wiesner to ascertain the cause of it. Experiment has shown that the coloration is due to light, but that it occurs only with paper containing ligneous substances, such as wood, straw, and jute, and that it does not take place when, through some chemical process, the lignine that forms the essential part of the wood is removed. The yellowing is due to a phenomenon of oxidation. Solar light acts more energetically than dispersed daylight, which itself exerts but a very slight action when it is much diffused, and especially in a very dry room.

Gas light is nearly harmless, by reason of the few refrangible rays that it contains. On the contrary, as the arc electric light, and, in general, all intense luminous sources, emit numerous refrangible rays, they favor the yellowing. As regards the preservation of papers, then, it will be well to choose gas rather than the electric light for the illumination of libraries.—*Revue Internat. de l'Electricite.*

## THE UPWARD BATTERY.

WE present herewith some data concerning the form of the Upward battery that is now in operation at Woodhouse & Rawson's. In this model there is no longer any need of expelling the air that may enter, and but two elements are employed, the charging of the accumulators being effected continuously by means of a commutator connected with the battery.

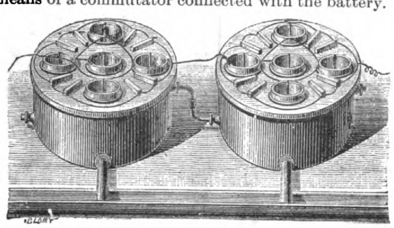

FIG. 1.

The gas always enters through the base of the elements, and thus drives the air before it. It is asserted that there is no disengagement of chlorine in the pile room.

As may be seen in Fig. 1, the form of the elements is slightly modified. Each of them comprises eight carbon plates connected for quantity, and five cleft cylinders of zinc placed in porous vessels and connected with each other.

But it is the retort (Fig. 2) that has been especially improved. The perforated vessel of terra cotta contains a sufficient quantity of binoxide of manganese to last for about three weeks. The daily charge of acid is easily introduced into the receptacle, which is independent of its cover. The acid is therefore never manipulated. It enters through a closed tube ending

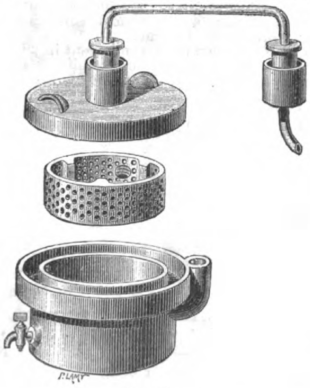

FIG. 2.

in a graduated reservoir, and the spent liquid flows into a drain. When it is necessary to renew the binoxide, the retort is washed with water, which enters through the same aperture that the acid does.

The entire surveillance of this plant is reduced to the daily maneuver of two cocks, and to a renewal, from time to time, of the charge of binoxide, an operation which, as we have seen from the description of the retort, is very easily performed. It seems certain, then, that this battery may be confided to the care of ordinary workmen.—*La Lumiere Electrique.*

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