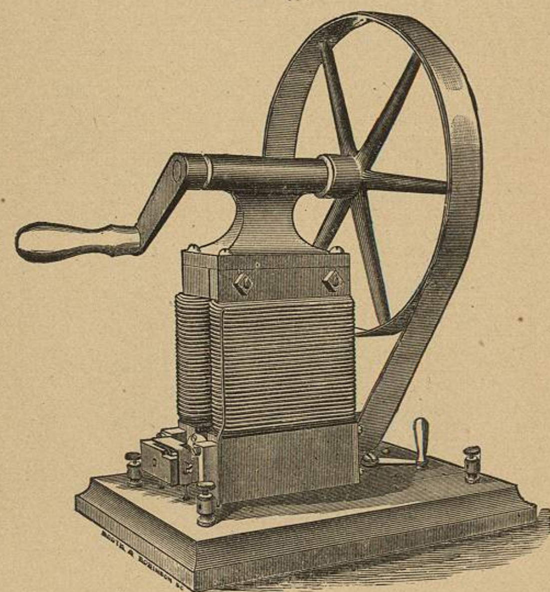
are wound in the same direction, or in such a way that when the two portions, A B, are placed end to end, one coil would be simply a continuation of the other. The inner ends of the coils are connected together, while their outer ends are of sufficient length to run downward through the base, and bend outward at *m o*, and are connected with the binding posts, *n p*.

The armature, G, consists of a cylindrical piece of soft

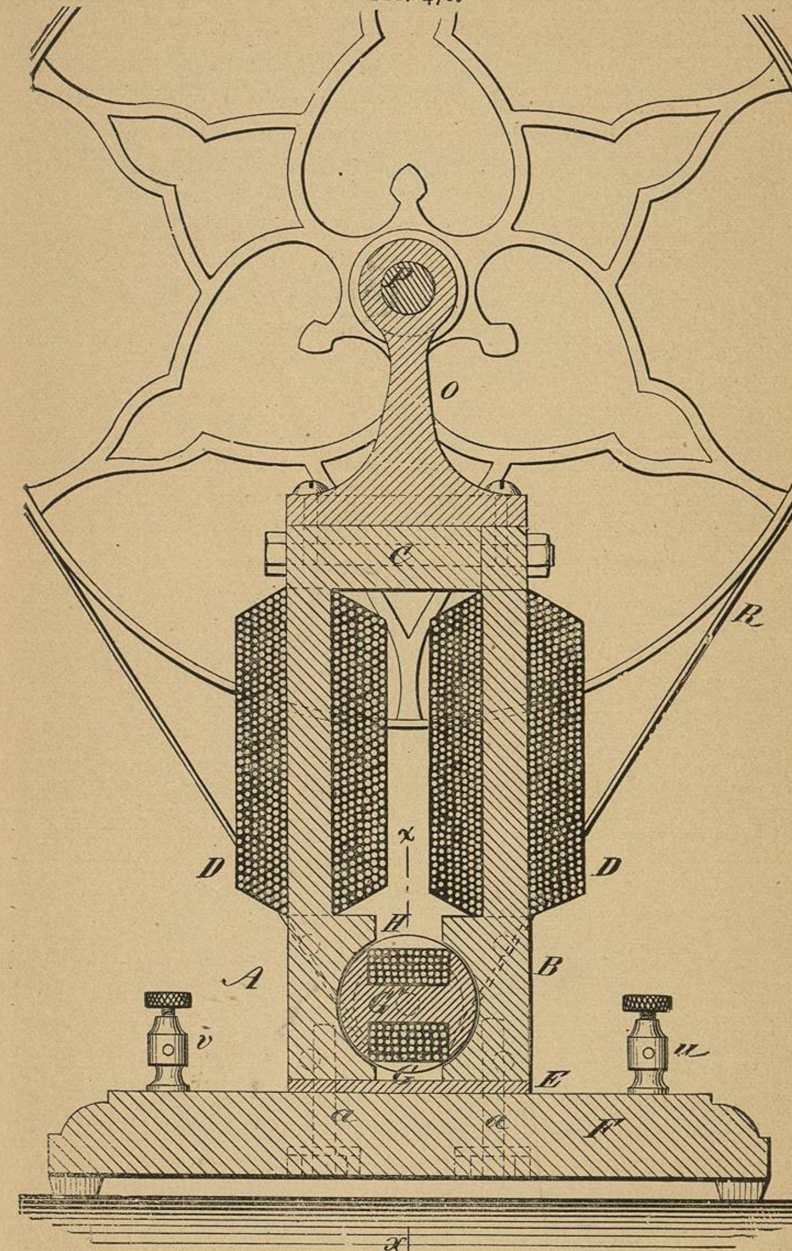
Fig. 477.



Hand Power Dynamo.

cast iron grooved longitudinally and across the ends, and wound with No. 18 cotton or silk covered copper wire. It is, in fact, a very short and wide bar electro-magnet, having enlarged and elongated ends of the form of a segment of a cylinder. In diameter the armature is only a very little less than that of the cylindrical space between the parts, A B, of the field magnet, and its length is little less than the width of he field magnet. In Figs. 478 and 480, G′ is the core of the armature around which is wound the wire, H.

Fig. 478.



Hand Power Dynamo—Vertical Section—Half Size.

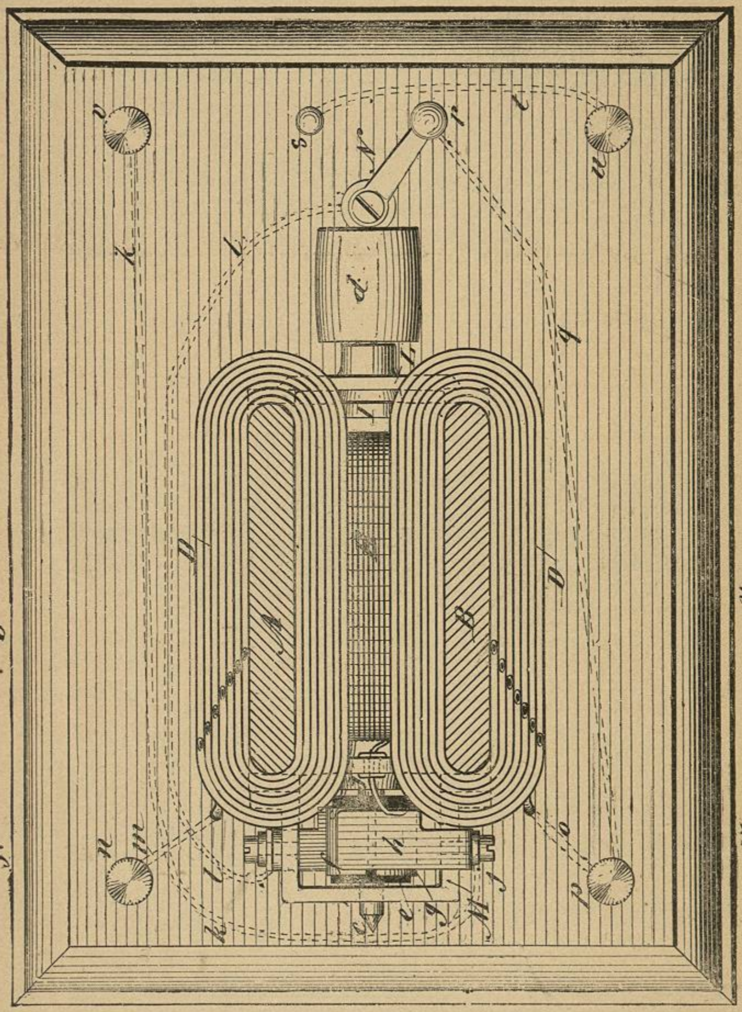
To opposite ends of the armature are fitted the brass heads, I J, into which are screwed the shafts, *b c*. The core, G′, of the armature is filed to remove roughnesses and hard scale, and the heads and shafts are fitted to the ends of the armature before it is turned and fitted to the cylindrical space in the field magnet. The shaft, *b*, is journaled in a brass support, L, which is attached by screws to the edges of the parts, A B, of the field magnet. The shaft, *c*, is journaled in a similar support, M, which is secured to the opposite side of the electro-magnet. Outside of the bearing, L, upon the shaft, *b*, is secured the pulley, *d*, and between the support, M, and the head, J, the commutator is placed upon the shaft, *c*. The commutator consists of a vulcanite cylinder, *e*, having upon its periphery a copper or brass ferrule, which is slit longitudinally at diametrically opposite points, forming the insulated segments, *f g*. These are secured to the vulcanite cylinder by small brass screws, and the slits are placed exactly opposite the center of the longitudinal grooves in the armature. The commutator is prevented from turning on the shaft by a set screw, and with the segments, *f g*, are connected the terminals of the armature coil, H. These terminals pass through holes in the head, J, which are lined with an insulating material.

To opposite sides of the support, M, are secured the copper commutator springs, *h i*, each consisting of five or six thicknesses of thin, hard-rolled copper. They are both secured by screws, and insulated from the support by vulcanite buttons, *j*. The spring, *h*, is bent forward over the commutator and bears upon it with a slight pressure. The spring, *i*, is bent so that it touches the commutator at a point diametrically opposite the contact point of the spring, *h*. To the spring, *h*, a wire (No. 14) is soldered, and extends downward through the wooden base of the machine; a similar wire runs from the spring, *i*. As the design of this machine is such that the field magnet may be connected with a battery, so that all of the current from the armature may be utilized in the external circuit, instead of allowing a portion of it to pass through the helices of the magnet, two extra binding posts, *u v*, and a switch, N, are added.

The connections under the base are as follows:

The terminals, *m o*, of the field magnet are connected with the binding posts, *n p*. The commutator spring, *h*, is

Fig. 479.

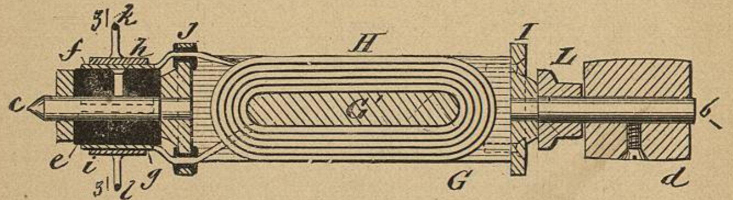


Hand Power Dynamo—Horizontal Section—Half Size.

connected by the wire, *k*, with the binding post, *v*; the commutator spring, *i*, is connected with the switch, N, by the wire, *l*. The switch button, *r*, is connected with the binding post, *p*, by a suitable wire, and the switch button, *s*, is connected with the binding post, *u*, by the wire, *t*. All of these connections should be made with No. 14 wire. A support, O, for the shaft, P, is secured to the top of the electro-magnet. The shaft, P, has at one end the driving wheel, Q, and at the other end a crank for operating the machine. A one inch belt, R, runs around the pulley, *d*, and the wheel, Q.

When the machine is driven by power the pulley, *d*, may with advantage be larger. The size of the wire on the magnet and armature may be varied for some special purpose, but for general use the sizes here given are recommended. The slit in the commutator should be made slightly diagonal, so that one section of the copper ferrule will touch the spring before the other section leaves it. The armature should fit in the magnet as closely as possible without rub-

Fig. 480.



Armature and Commutator—Longitudinal Section.

bing. The parts indicated as brass or copper should be made of these metals, as a magnetic insulation is required wherever they are used.

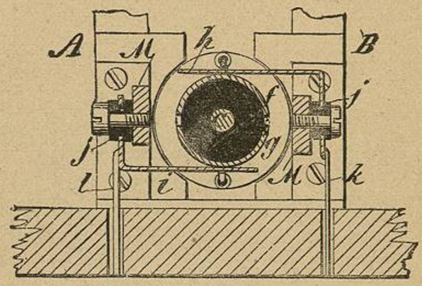
When the switch, N, is in the position shown in the drawing, the binding posts, *n v*, being connected by a wire, the current passes from the post, *v*, through the commutator and the armature, thence by the wire, *l*, to the switch, thence through the button, *r*, and by the wire to the post, *p*, thence through the field magnet to the post, *n*, through the terminal, *m*. When the machine is arranged in this manner, the wires leading from the machine are taken from the posts, *v n*. The full power of the machine is developed an instant after the connection of the posts, *v n*.

By moving the switch, N, into contact with the button, *s*,

and connecting a battery of six or eight Bunsen cells with the posts, *n p*, the magnets are excited without detracting from the power of the armature, and the current from the latter is taken through the wire, *k*, as before, to the post, *v*, but the wire, *l*, is now in electrical connection with the binding post, *u*, through the switch, N, button, *s*, and wire, *t*; therefore the current is taken away from the machine by inserting wires in the posts, *u v*.

When not connected with a battery, this machine will heat from four to six inches of No. 36 platinum wire. It will rapidly decompose water when the ends of the wires are dipped in water slightly acidulated. It will run an

Fig. 481.



Transverse Section of Commutator.

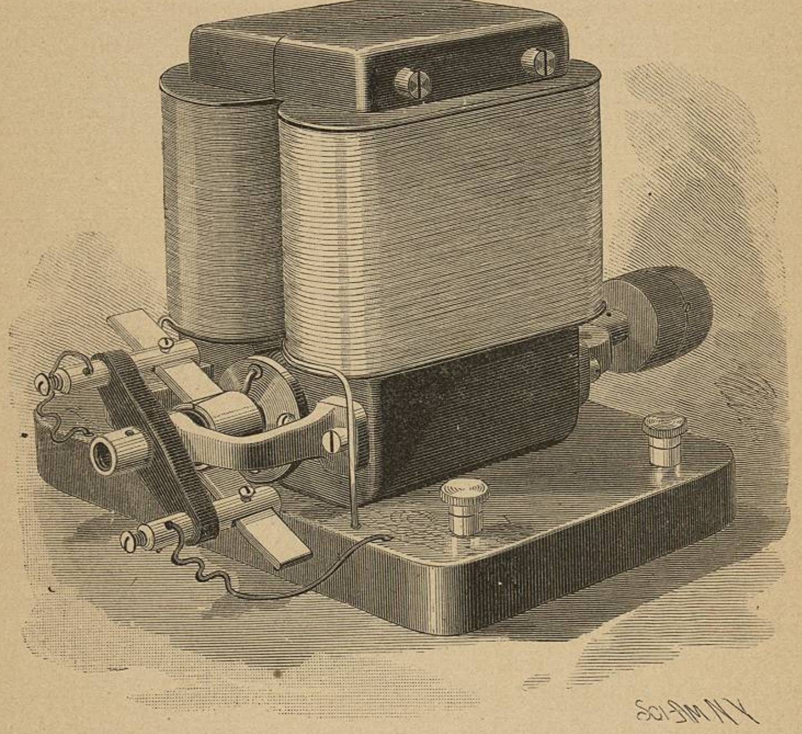
induction coil. The extra current from this machine is sufficient to give strong shocks, ignite powder, etc. By connecting it with a helix or electro-magnet, small permanent magnets may be charged. For many purposes this machine will be found equal to four or six Bunsen cells.

When a battery is employed to excite the field magnet, the current is very much increased. For example, it will then heat twelve inches of platinum wire instead of four or six inches, and it will afford a current sufficient for a strong electric light. The speed has much to do with the amount of current produced by the machine. The speed should be from 1,200 to 1,500 turns of the armature per minute. The drive wheel in the example given may with advantage be made much larger, say two feet in diameter.

ELECTRO-PLATING DYNAMO.

The electro-plating dynamo differs from the one already described chiefly in its winding. For metallurgical work a large current of low voltage is required. For electro-typing, an electro-motive force of three to four volts is suffi-

Fig. 482.



Electro-Plating Dynamo.

cient, while for nickel plating it should run up to about six volts, and for silver plating to about five.

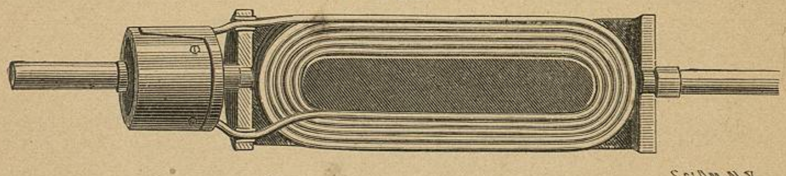
In a small dynamo, like the one illustrated in Fig. 482, it is impossible to secure as wide a range of electro-motive force or of current as can be realized in a larger machine, but by varying the speed and by introducing more or less resistance in the external or internal circuit, the current can

be adapted to most uses of the amateur. In the construction of this dynamo all of the dimensions of the cores and polar extremities of the field magnet and of the armature core, as given in the description of the hand power dynamo, are followed except in regard to the thickness of the waists of the field magnets and their polar extremities. These dimensions are here increased by adding ⅛ inch to the thickness of the waists and ¼ inch to the thickness of the polar extremities, thus increasing the amount of iron in the field magnet.

The armature is wound with five layers of No. 12 cotton-covered magnet wire, and the terminals of the coil are connected with the halves of the commutator cylinder as shown in Fig. 483.

The commutator cylinder is formed of two sections cut

Fig. 483.



Armature of Electro-Plating Dynamo—Half Size.

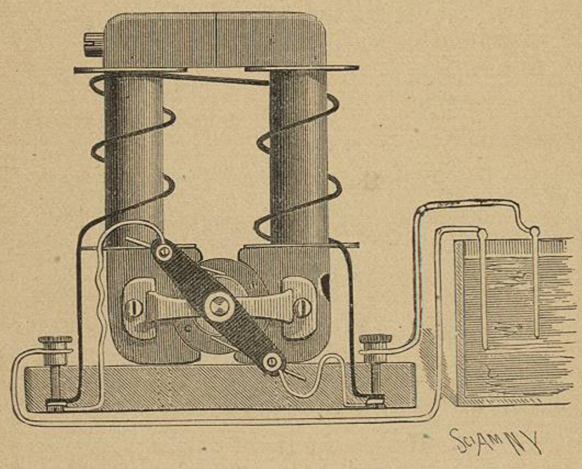
from a copper tube and mounted upon a hub of vulcanite or vulcanized fiber, the tube sections being separated from each other so as to form diagonal slits in diametrically opposite sides of the cylinder, as shown.

The brushes are supported by mortised studs inserted in the ends of a cross bar of vulcanized fiber mounted on the journal box of the armature shaft. The threaded ends of the mortised studs project through the cross bar to receive binding posts which are screwed down tightly on the bar. In the mortises of the studs are placed the brushes, which press lightly upon the commutator cylinder. The brushes are formed of several thicknesses of thin hard-rolled copper. The field magnet is wound with twelve layers of No. 18 magnet wire, and is connected as a shunt to the armature. That is to say, the terminals of the field magnet wires are connected with the same binding posts that receive the wires from the commutator brushes, as shown in Fig. 484.

The conductors of the external circuit are also connected with these binding posts. When the connections are arranged in this way, the current divides at the binding posts referred to, a part going through the wire of field magnet, another part going through the external circuit, which in the present case includes a plating solution.

To the negative conductor is attached the cathode or the plate or object which is to receive the deposit, and upon

FIG. 484.



Connections of Plating Dynamo.

the positive conductor is suspended the anode or plate from which the metal for the deposit is supplied to the solution.

Unless the dynamo is at first started with a battery in circuit, it will be impossible to tell, without a test of some sort, which is the positive and which the negative binding post. This can be determined in a moment by trial in the plating solution.

If on starting the machine a deposit is made on the cathode, the connections are correct. If, however, no deposit appears, the conductors should be transposed either at the dynamo or at the plating bath.

Large wire should be used for carrying the current. Within certain limits the electro-motive force of the current may be varied by changing the speed of the machine, and the current may be controlled by inserting resistance into the external circuit or into the shunt.

The hand-power dynamo may be converted into a shunt machine by arranging the connections according to Fig. 484, but it will be necessary to introduce resistance into the shunt or field magnet circuit to prevent too much current from going through the field magnet.

The electro-plating dynamo may be used successfully in copper, nickel, and silver plating on a small scale, also for electro-typing.* This dynamo acts well when used as a motor in connection with the plunge battery shown in Fig. 394.

The length of wire on the armature is 40 feet and on the field magnet about 500 feet.

SIMPLE ELECTRIC MOTOR.

It is generally understood that an efficient electric motor cannot be made without the use of machinery and fine tools. It is also believed that the expense of patterns, castings, and materials of various kinds required in the construction of a good electric motor is considerable.

The little motor shown in the engravings was devised and constructed with a view to assisting amateurs and beginners in electricity to make a motor which might be driven to advantage by a current derived from a battery, and which would have sufficient power to operate an ordinary foot lathe or any light machinery requiring not over one man power.

The only machine work required in the construction of the motor illustrated is the turning of the wooden support for the armature ring. The materials cost less than four

* "Electro-plating" and "Electro-typing," by Urquhart, and "Electro-Deposition," by Watt, are excellent works on their respective subjects. The *Scientific American Supplement* also contains valuable information on these subjects and on the construction of dynamos for these uses.

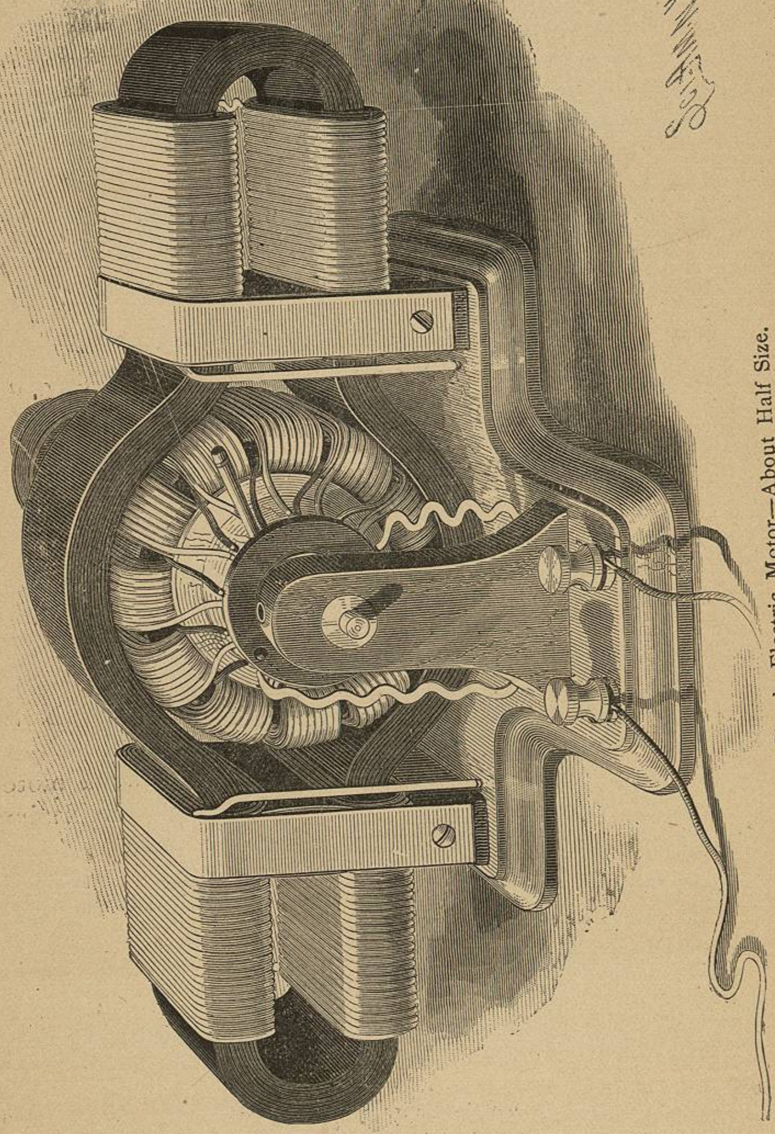


Fig. 485.

Simple Electric Motor—About Half Size.

dollars, and the labor is not great, although some of the operations, such as winding the armature and field magnet, require some time and considerable patience. On the whole, however, it is a very easy machine to make, and, if

Fig. 489.

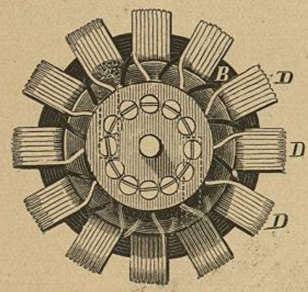


Fig. 490.

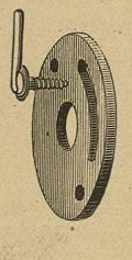


Fig. 486.

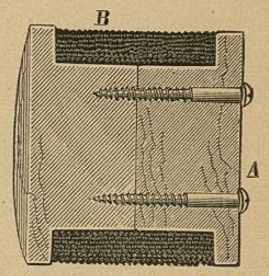
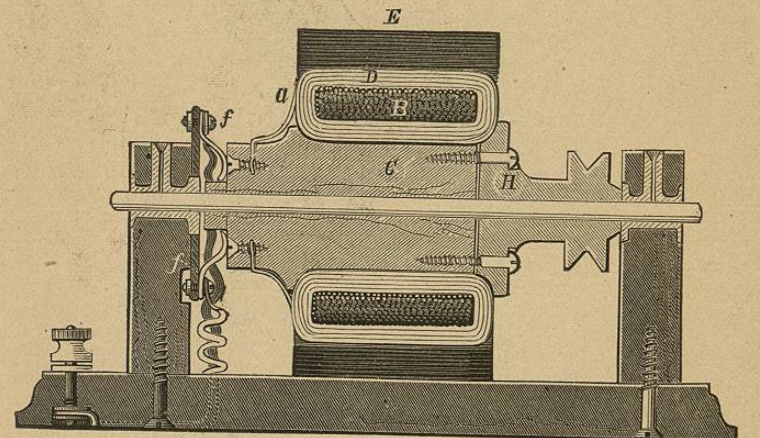


Fig. 486.—Armature Core. Fig. 489.—End View of Armature, showing Commutator. Fig. 490.—Brush-holding Disk.

Fig. 488.



Transverse Section.

carefully constructed, will certainly give satisfaction. Only such materials as may be procured anywhere are required. No patterns or castings are needed.

Beginning with the armature, a wooden spool, A (Fig. 486), should be made of sufficient size to receive the soft