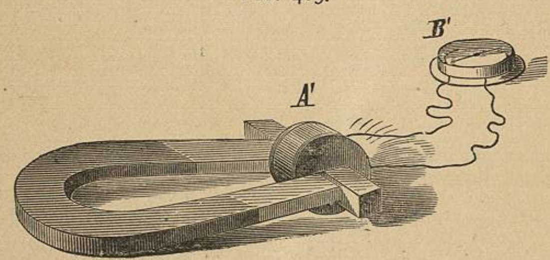
In the diagram only four coils and four commutator bars are shown. In the actual machine the armature is divided up into a large number of sections.

MAGNETO-ELECTRIC MACHINES.

It has been already shown that it makes no material difference in the result whether a magnetized steel bar is introduced into the coil, as in Fig. 448, or whether the coil is provided with a soft iron core capable of being magnetized by induction, by contact with, or proximity to, a permanent magnet.

Fig. 463 illustrates an experiment of this kind, in which ths coil, A′, of very fine wire, is provided with a permanent

Fig. 463.

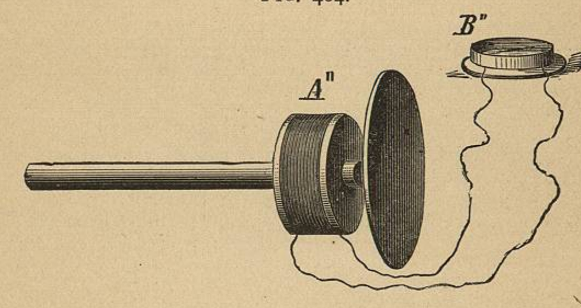


soft iron core, and is connected with the galvanometer, B′. By placing the poles of a permanent horseshoe magnet in contact with the projecting ends of the soft iron core of the coil, the core instantly becomes a magnet by induction, and a current is set up in the coil in the same manner as in the former experiment. When the magnet is removed, the magnetism of the core departs. This is equivalent to the removal of the magnet from the coil in the experiment illustrated in Fig. 448, and the result is a momentary current in a direction opposite to that of the first.

The inductive effect of the magnet is much the same if the bobbin of fine wire be placed around a permanent magnet and the magnetic tension be disturbed by the application and removal of an armature. The Bell telephone (the essential parts of which are shown in Fig. 464) is a familiar exam-

ple of this species of generator of induced currents. When the diaphragm, acting as an armature, approaches the magnet, a momentary current is set up in the bobbin, A″, in one direction, as indicated by the galvanometer, B″, and when the diaphragm recedes from the magnet the current set up in the bobbin is in the opposite direction. In the telephone these currents have sufficient power to operate a second instrument of the same sort; but owing to the fact that the armature is very light, and never touches the magnet nor recedes very far from it, and the further disadvantage arising from the use of a bar magnet, the apparatus cannot rank high as a generator of electric currents, however well it may serve the purpose of a telephone.

Fig. 464.

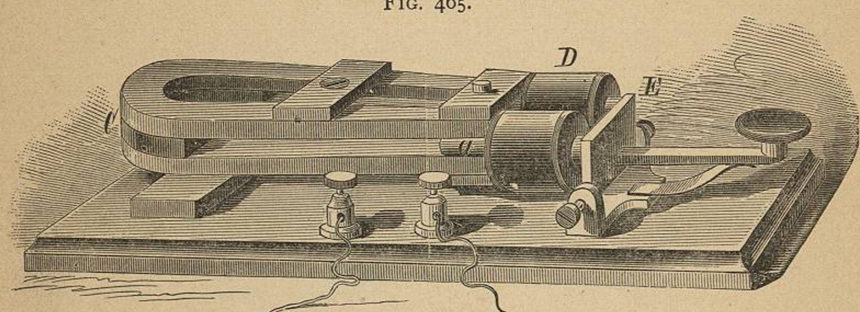


Another form of apparatus (Fig. 465), operating on the same principle, generates currents sufficiently powerful to work a polarized bell or annunciator over a line several miles long. This magneto key is made by clamping two six-inch horseshoe magnets upon opposite sides of two soft iron pole extension pieces, *a*, one-half inch in diameter, one and a half inches long, and projecting one inch beyond the poles of the magnets. Each extension piece is provided with a bobbin, D, one inch long and one and a quarter inches in diameter, filled with No. 36 silk-covered wire. These bobbins are wound and connected like the spools of an electro-magnet, and have a combined resistance of 200 ohms.

In front of the poles of the magnet an armature, E, one-quarter inch thick, a little longer than the width of the extremities of the magnet, and about one inch wide, is pivoted at its lower edge, and provided with a key lever by which it may be drawn from the poles of the magnet. A spring under the key lever throws the armature back into contact with the magnet. This is a simplified form of Breguet's exploder, used in firing blasts in mines, and although much smaller than the apparatus referred to, it is capable of ringing a polarized bell over fifteen or twenty miles of wire, and will give a powerful shock.

It is a convenient and inexpensive apparatus for signaling, and is particularly adapted to the telephone when used in connection with the polarized annunciator or polarized

Fig. 465.



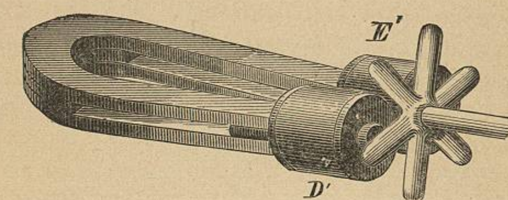
Magnetic Key.

bell, presently to be described. In this apparatus like poles of the magnets must oppose each other, and the clamping pieces and screws should be of non-magnetic material. If two magnets do not produce a current of sufficient strength for the intended use, two more may be added.

In this form of magneto-induction apparatus the action of the magnet and coil is identical with that of the Bell telephone. This action is similar to that of two permanent horseshoe magnets having their unlike poles in contact. In this case the opposing poles neutralize each other to such an extent as to almost destroy all magnetic effects. On separating the poles of the two magnets they regain their normal magnetism. The case is much the same with the magnetic key. The armature, E, when applied to the pole ex-

tensions, becomes a magnet by induction, and by its reaction upon the magnet neutralizes the power of the magnet and produces nearly the same result as withdrawing the magnet from the bobbin. When the armature is withdrawn suddenly from the magnet, the effect upon the wires of the bob-

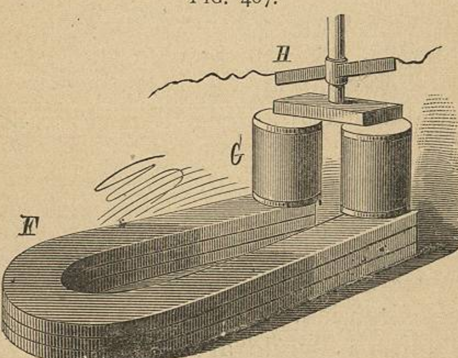
Fig. 466.



bins is the same as would be produced by introducing into them the poles of the magnet.

To render the electrical pulsations of this class of machines very frequent, the armature may be rotated, as shown in Fig. 466, which represents a modification of an old

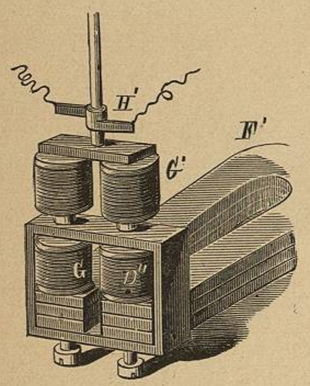
Fig. 467.



and well known magneto-induction machine, in which the bobbins, D′, are placed on pole extensions of the magnets, C′, and the variations in magnetic force are produced by the wheel armature, E′.

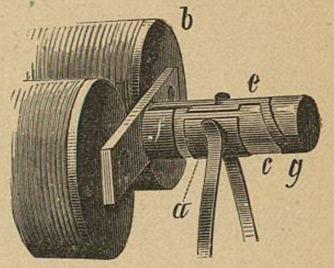
Another method of generating currents by a rotary movement of the armature is to make the armature in the form of an electro-magnet, and mount it upon a rotating spindle so that it may revolve in close proximity to the poles of a strong permanent horseshoe magnet. This form of machine, which is the invention of Clarke, is shown in Fig. 467. It has long been used for medical purposes, and before the invention of the more recent machines was employed for electro-metallurgy and for other purposes.

Fig. 468.



The electro-magnetic armature, G, is mounted on a shaft, so that it may revolve very near but not in contact with the poles of the compound magnet, F. One of the terminals of the bobbins is in electrical connection with the shaft, the other is connected with an insulated ferrule on the shaft. The alternating current is taken off by two springs, one touching the insulated ferrule, the other bearing against the shaft. When the current is required to flow in one direction, the insulated ferrule is split longitudinally into two equal separate halves, each of which is connected with one terminal of the armature wire. This split ferrule, together with springs, H, which press upon its diametrically opposite sides, forms a commutator which sends the momentary currents of like name all in one direction.

Fig. 469.



The slots of the ferrule are arranged relative to the springs, H, and armature, so when the polar faces of the armature cross a line joining the poles of the permanent magnet, the springs will leave one-half of the ferrule and touch the other half.

Fig. 468 shows a modification of Clarke's machine, in

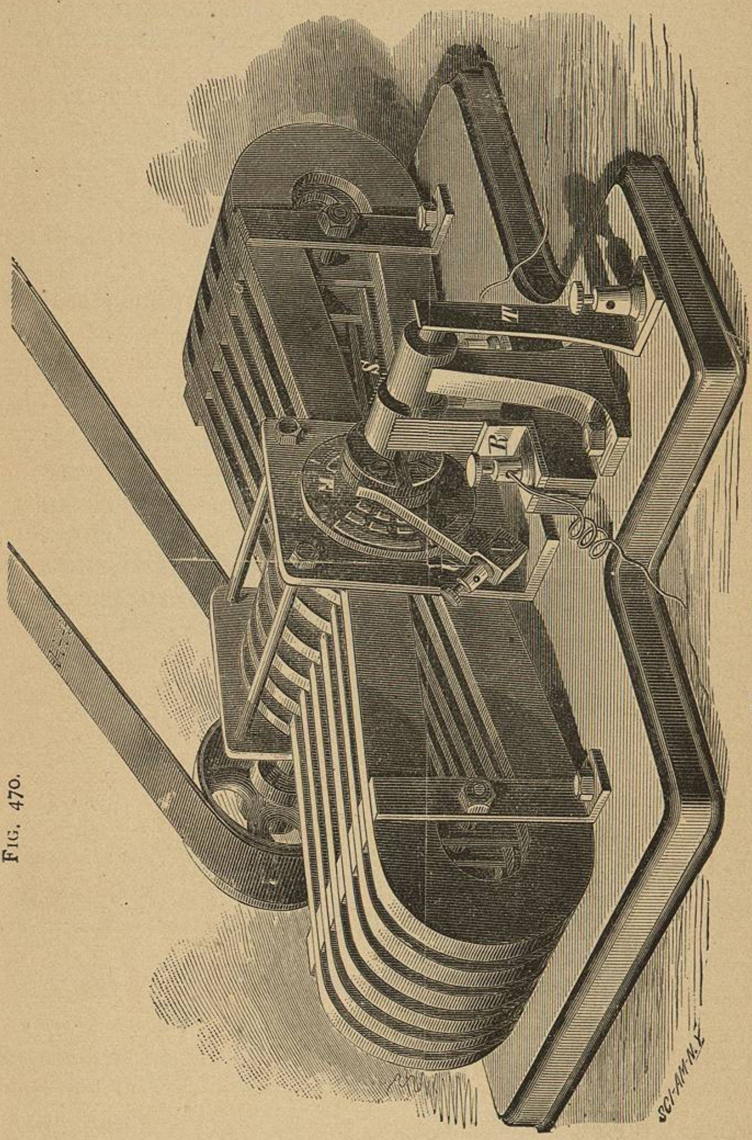


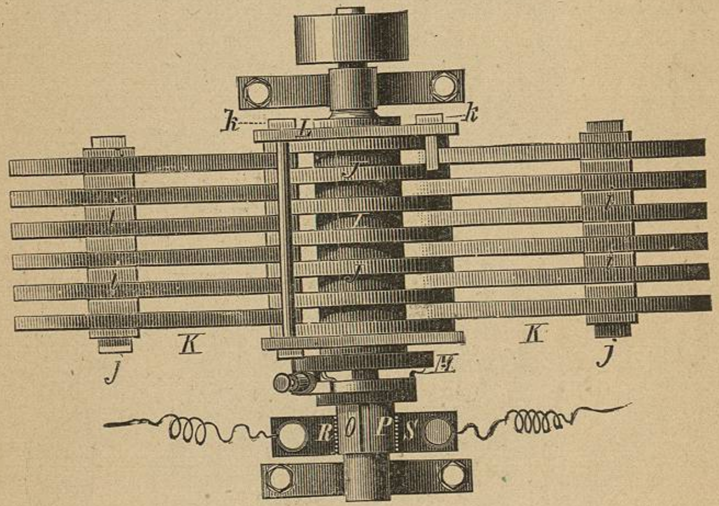
Fig. 470.

Magneto-Electric Machine.

which the permanent magnet, F′, is provided with pole extensions of soft iron surrounded by fine wire bobbins, D″. These bobbins are connected like an electro-magnet, and when the armature, G′, is turned so as to send a direct current through the springs, H′, an alternating current may be taken from the bobbins, D″.

Fig. 469 shows a kind of commutator designed for short-circuiting the machine through a part of the revolution, so that when the short circuit is broken a direct extra current

Fig. 471.



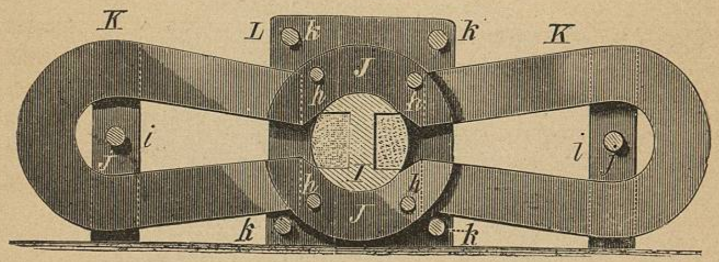
Plan View of Magneto-Electric Machine.

capable of giving powerful shocks will pass over the conductors leading from the machine. Each half, *d*, of the commutator ferrule is provided with an arm, *e*, terminating in a curved piece, *g*, attached to opposite sides of the insulating cylinder, *c*. The curved pieces, *g*, are pressed by springs which are electrically connected with the commutator springs on their respective sides of the cylinder, so that when the piece, *g*, is touched by its spring and the ferrule, *d*, is touched by its spring—the two springs being in electrical communication with each other—the machine is for the moment short-circuited, but when contact with *g* is broken,

the extra current passes by the usual channels from the machine.

A magneto-electric machine equal in power to three or four Bunsen elements is shown in Figs. 470, 471, and 472. The compound field magnet is composed of twelve six-inch horseshoe permanent magnets, K, arranged in two groups of six, with their like extremities clamped between curved soft iron bars, J, as shown in the vertical longitudinal section, Fig. 472. These bars consist of sections cut from common wrought iron washers, 3 inches external diameter, $\frac{1}{4}$ inch thick, and having a $1\frac{5}{8}$ inch hole through them. The washers are all drilled to receive the bolts, *h h*, before they are cut in two. The washers, J, and magnets, K, are

Fig. 472.



Transverse Section of Magneto-Electric Machine.

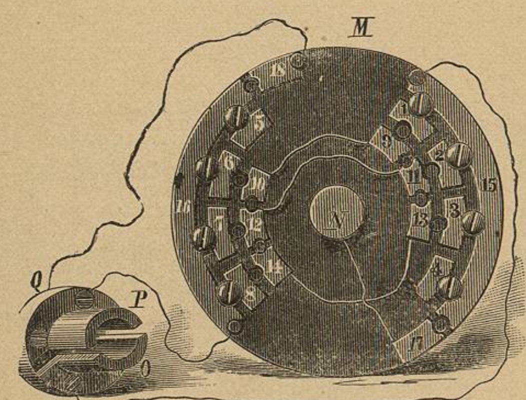
placed in alternation and clamped between brass angled plates, L, by which the middle portion of the field magnet is fastened to its base. The magnets are further secured to the base by standards, *j*, which clamp the sides of each group of magnets, the magnets being kept the proper distance apart by interposed strips, *i*.

The bars, J, are cut away on the inner edges, forming an approximately elliptical opening for receiving the armature, I, which is a very little less than $1\frac{5}{8}$ inches in diameter, and is $3\frac{1}{2}$ inches long. It is of the Siemens **H** type, and is wound with four parallel silk-covered No. 32 wires, which terminate in eight insulated metallic blocks on the switch, M, one block to each end of each wire.

The switch is shown in detail in Fig. 473—1, 2, 3, 4, 5, 6, 7, 8 being the terminals of the wires of the bobbin. The blocks, 1 and 5, represent the ends of the first wire, 2 and 6 representing the ends of the second wire, 3 and 7 the third, and 4 and 8 the fourth; 15 and 16 are curved brass pieces capable of being plugged into connection with the blocks just mentioned, by means of screw plugs, shown in place in the engraving. The pieces, 15 and 16, are connected respectively with the two halves, O P, of the commutator cylinder.

At the ends of the curved pieces, 15 and 16, there are metallic blocks, 17, 18—the block, 17, being connected by a

FIG. 473.



Switch of the Magneto-Electric Machine.

wire with the metallic boss of the rubber wheel upon which the switch is mounted; the block, 18, being connected by a wire with a brass ring, Q, on the rubber support of the commutator.

Inside the blocks, 1 to 8, there are six metallic blocks, 9, 10, 11, 12, 13, 14, connected together by wires as shown. The opposite sides of the commutator cylinder are pressed by springs or brushes, R, which are sustained by an insulating support and are provided with binding posts for receiving the wires for conducting away the direct current. A spring, T, touches the end of the armature shaft, and has a binding post for receiving a wire conductor, and a spring, U, sus-

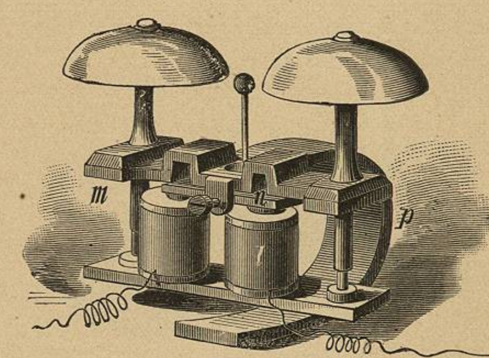
tained by an insulator attached to the angle plate, L, has a binding post for receiving a conductor.

This machine will yield currents of three different intensities, and will deliver them either direct or alternating, and it answers admirably as a motor.

To obtain a quantity current the screw plugs are inserted as shown in Fig. 473, so as to connect 1, 2, 3, 4 with 15, and 5, 6, 7, 8 with 16. In this condition it may be used as a motor.

The success of the machine as a motor depends in a great measure on the adjustment of the commutator. Its

FIG. 474.



Polarized Bell.

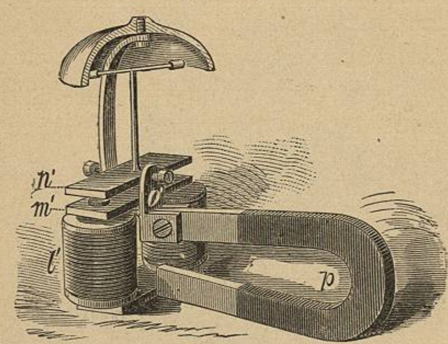
slit should be nearly opposite the center of the open space or groove in the armature.

To secure a current of higher voltage, connect 5 and 6 with 16, connect 1 to 2 and 2 to 11, connect 12 to 7 and 7 to 8, and finally connect 3 and 4 with 15. To get the highest voltage, connect 5 to 16, 1 to 9, 10 to 6, 2 to 11, 12 to 7, 3 to 13, 14 to 8, and 4 to 15. Direct currents are taken from the springs, R, alternating currents are taken from the springs, T, U, after connecting 15 to 17 and 16 to 18. The quantity current is obtained from four parallel wires, which are equivalent to one wire having four times the sectional area of the single wire and one-fourth the length. When the medium current is secured the wire is doubled, so that it is equivalent to a wire having twice the sectional area of the single wire and one half the length. For the high voltage current the full length of wire is used single.

Fig. 474 represents a Siemens polarized bell, in which an iron yoke, *m*, is supported from the elongated ends of the yoke of the magnet, *l*, by two brass studs. The yoke, *m*, supports the pivots of the bell armature, *n*, also the studs upon which the bells are placed, and to it is secured the magnet, *p*, which is bent under the yoke of the magnet, *l*, without touching it.

Fig. 475 shows a similar but simpler device, in which

FIG. 475.



Simple Polarized Bell.

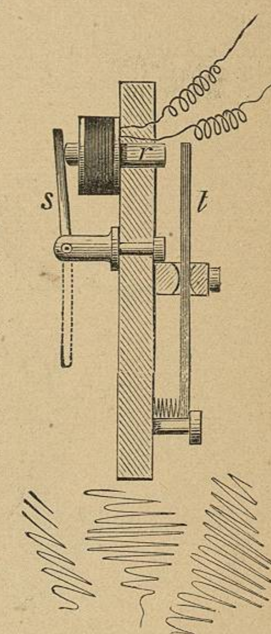
the poles of the magnet, *l'*, are fitted with a brass yoke, *m'*, which supports an iron frame in which is pivoted the armature, *n'*, and to which the bell is attached. This frame has a socket, *o'*, for receiving one of the poles of a horseshoe magnet, *p*, the other pole of which touches the yoke of the magnet, *l'*.

The polarized annunciator shown in Fig. 476 has two soft iron cores, *r*, carrying two bobbins of fine wire connected like the spools of an electro-magnet. In front of these soft iron cores there is a light delicately pivoted plate, *s*, of iron, which is held in contact with the cores, *r*, by magnetism induced in them by a magnet, *t*, clamped in the middle and capable of being adjusted by a spring and screw

at the bottom. The iron annunciator plate, *s*, has sufficient inclination to cause it to drop if released from the cores, *r*. The magnet is placed so near the cores, *r*, as to impart to them just enough attractive force to hold the plate, *s*, and no more.

The polarized bells and annunciator may be worked by either of the instruments shown in Figs. 465, 466, and 467, and will be found for many uses preferable to electric bells and annunciators operated by battery currents.

FIG. 476.



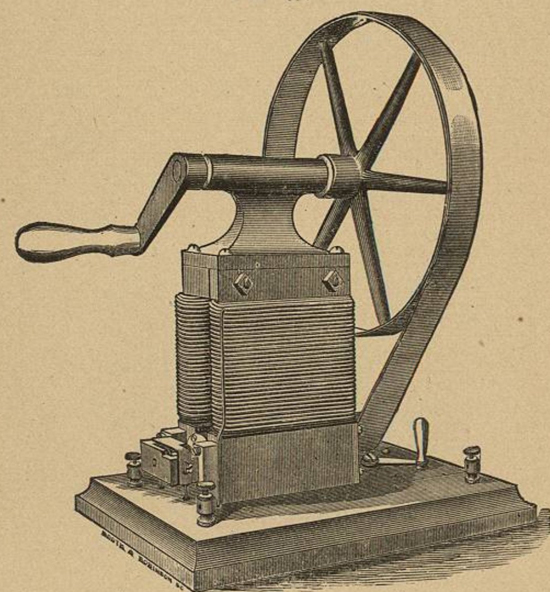
Annunciator.

HAND POWER DYNAMO.

Fig. 477 is a perspective view of a small hand dynamo, which is shown half size in detail in Figs. 478, 479, 480, and 481. This is a Siemens **H**-armature machine, which is as efficient as any small dynamo, while it has the advantage of being readily understood and easily constructed. The field magnet is, for the sake of convenience, composed of two pieces, A B, which are exactly alike excepting that the connecting piece, C, is cast with the piece, A. The parts, A B, are planed at their juncture at the top, and secured together by two bolts which pass through the part, C. The lower ends of these parts are also planed to receive the brass plate, E, which is secured in place by dowels and screws, two of each entering each part. The cylindrical cavity which receives the armature, G, is bored out truly and smoothly of a uniform caliber from end to end. The edges of that portion of the field magnet around which the wire, D, is wound are rounded and a piece of cotton cloth is wrapped around each core, and secured by means of shellac varnish. Upon this is wound seven layers of No. 16 cotton-covered copper wire. The limbs of the magnets 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

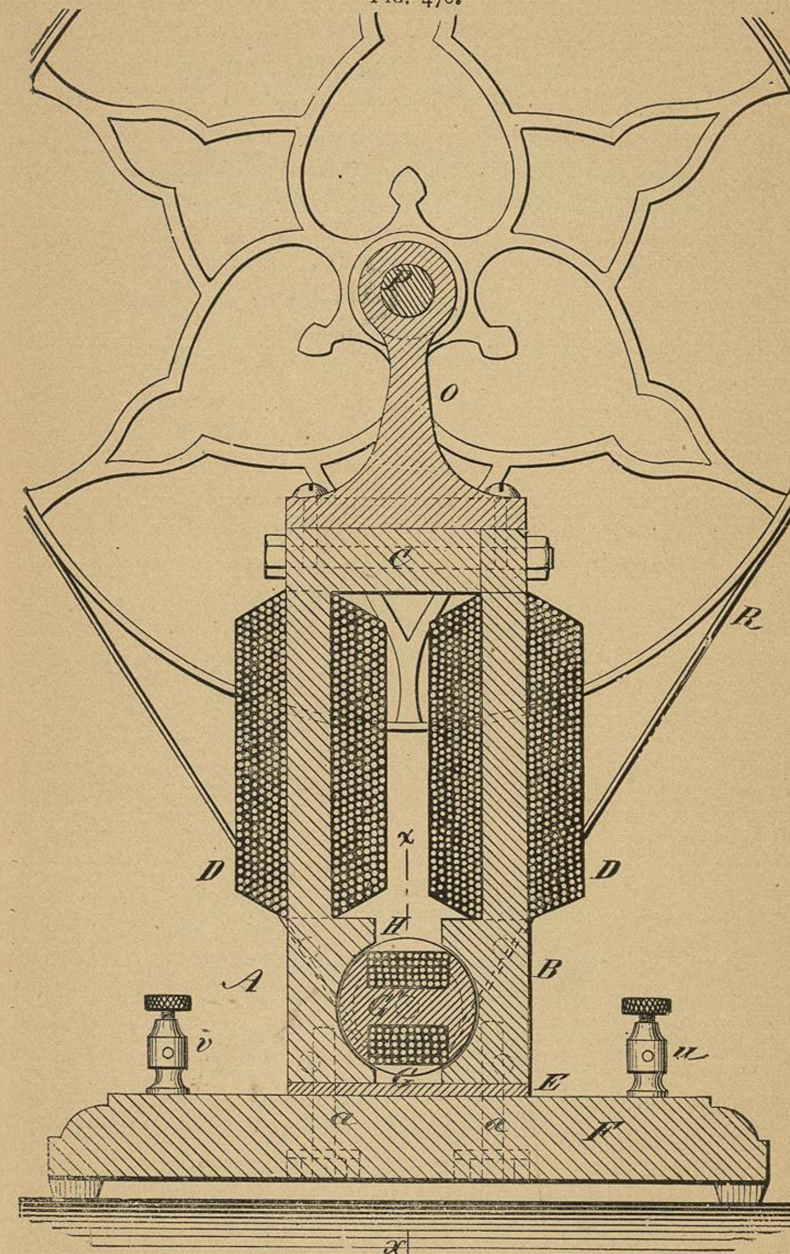
Fig. 477.



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.