(Model.)

2 Sheets—Sheet 1.

# E. THOMSON.

## Dynamo Electric Machine.

No. 233,047. Patented Oct. 5, 1880.

FIG. 1.

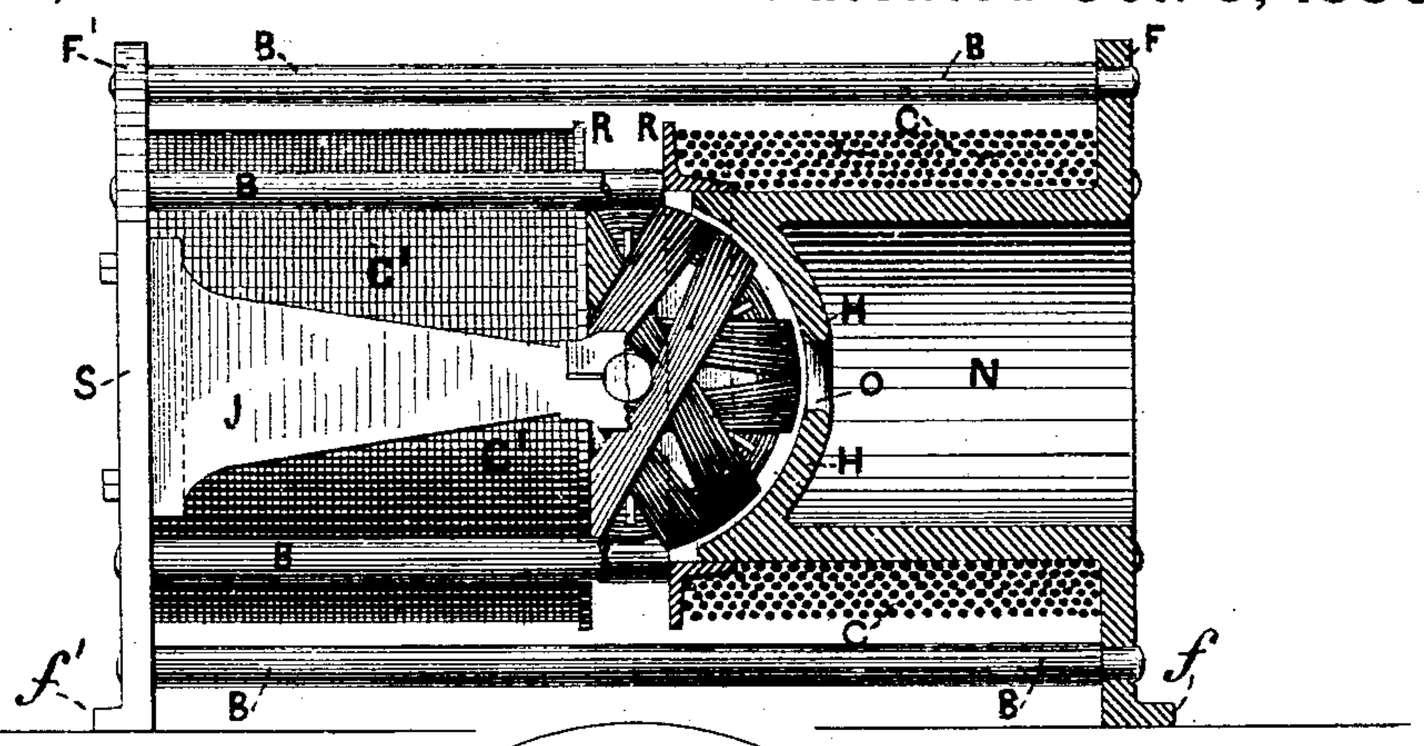



FIG. 2.

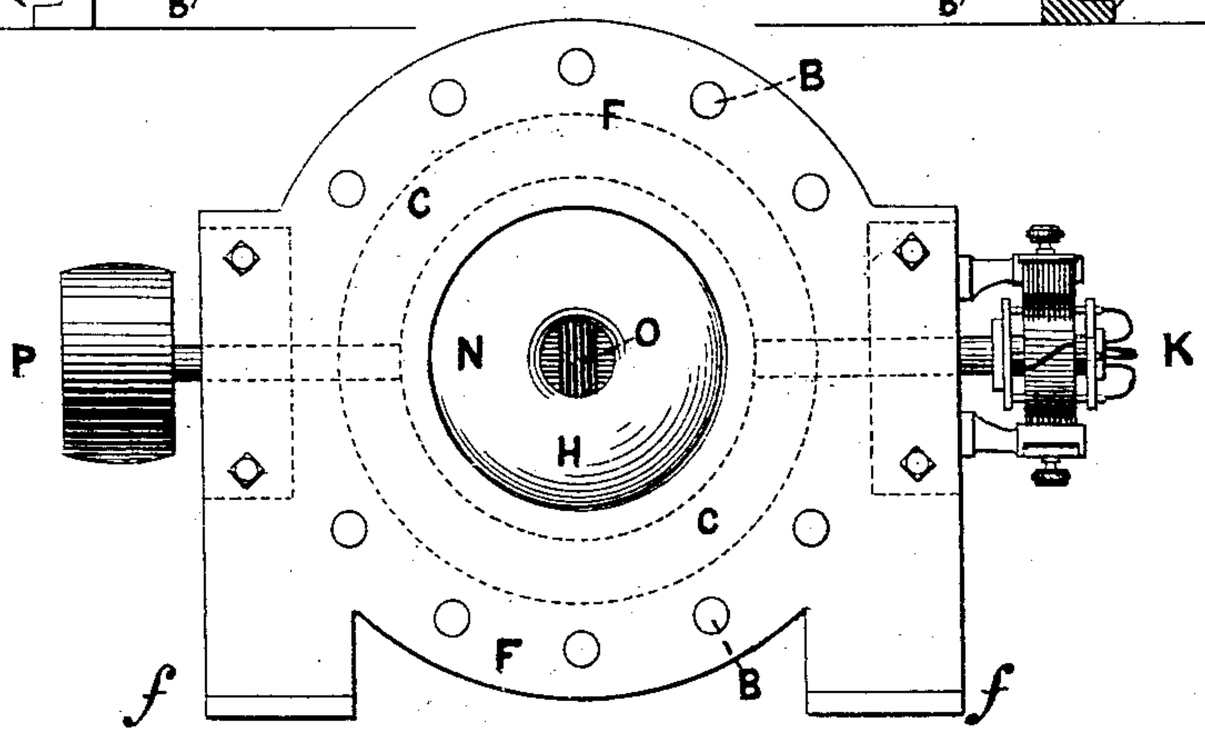
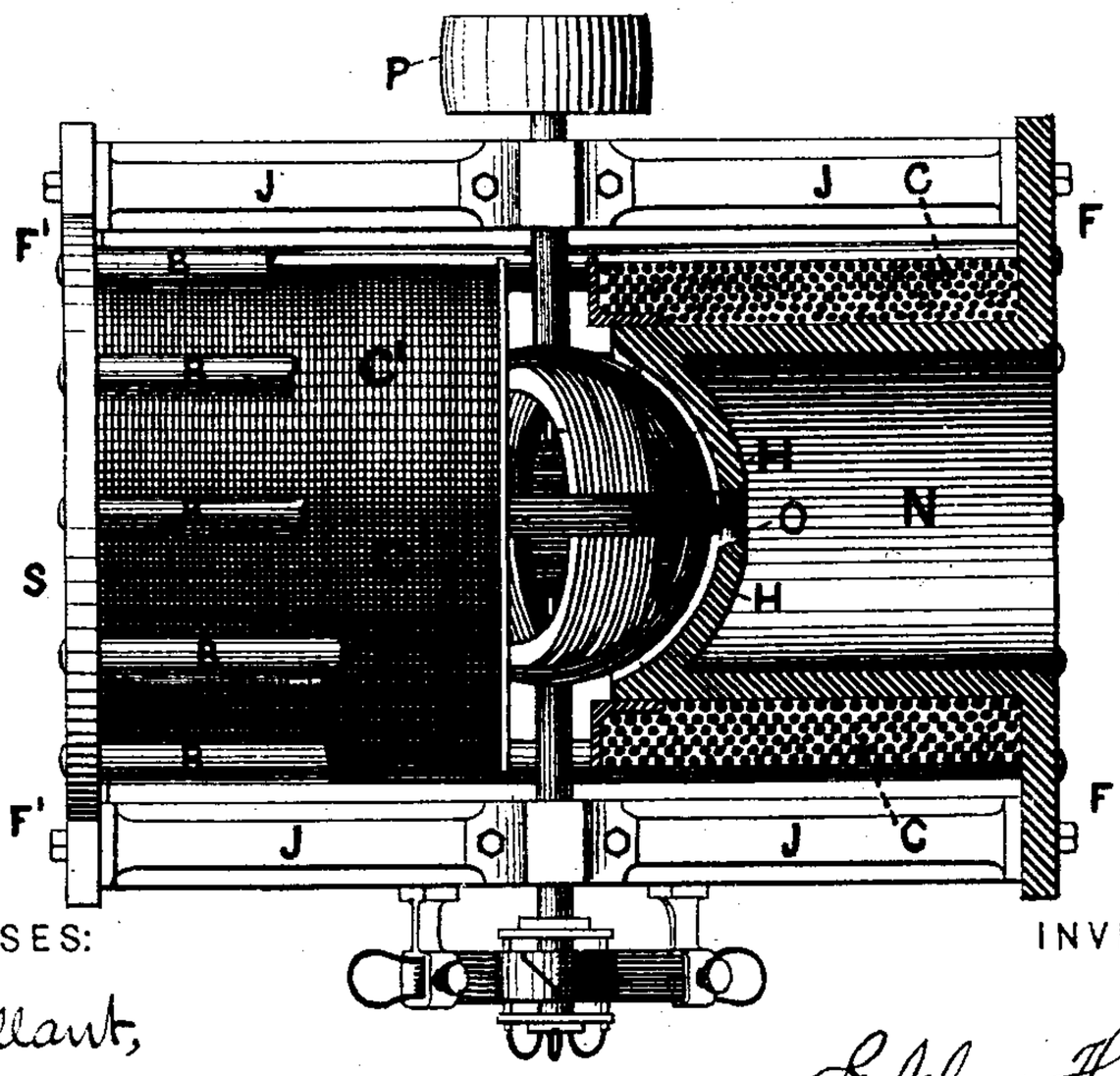



FIG. 3.




WITNESSES:

Geo. A. Vaillant,

John Myers.

INVENTOR:

Elihu Thomson.

(Model.)

2 Sheets—Sheet 2.

# E. THOMSON.

## Dynamo Electric Machine.

No. 233,047. Patented Oct. 5, 1880.

FIG. 6.

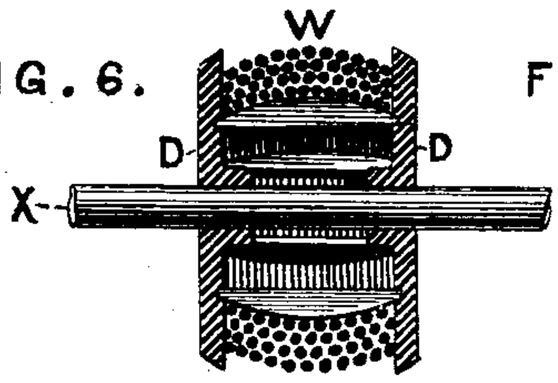



FIG. 5.

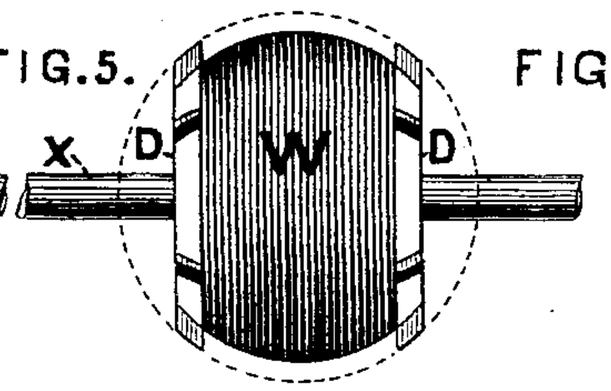



FIG. 4.

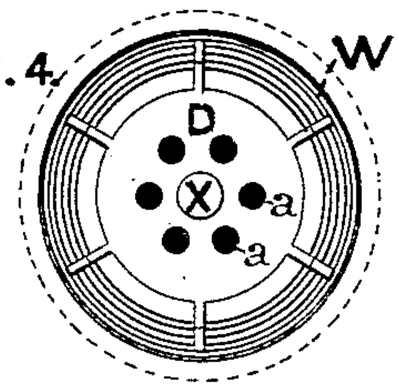



FIG. 7.

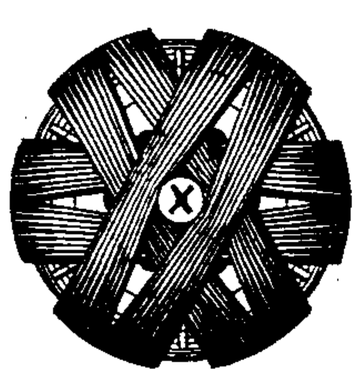



FIG. 8.

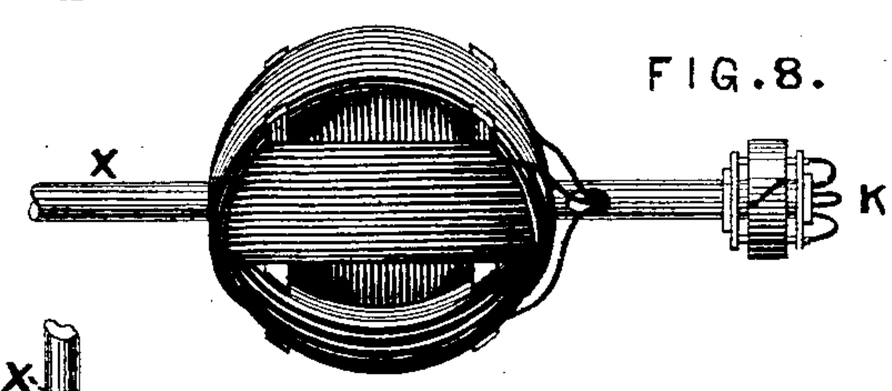



FIG. 9.

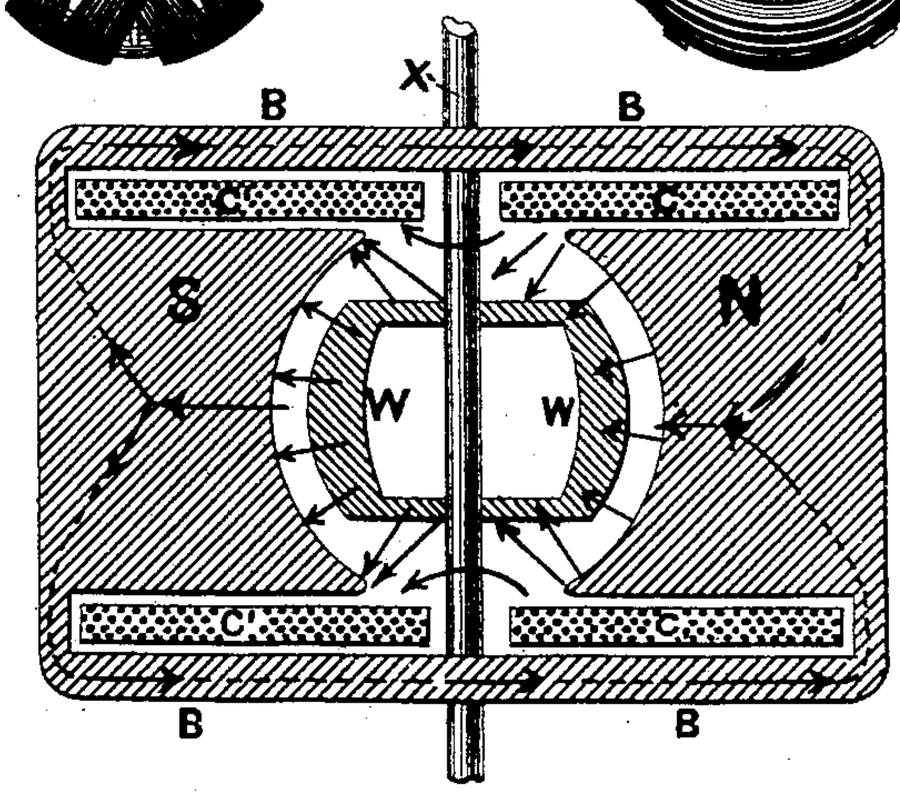



FIG. 10.

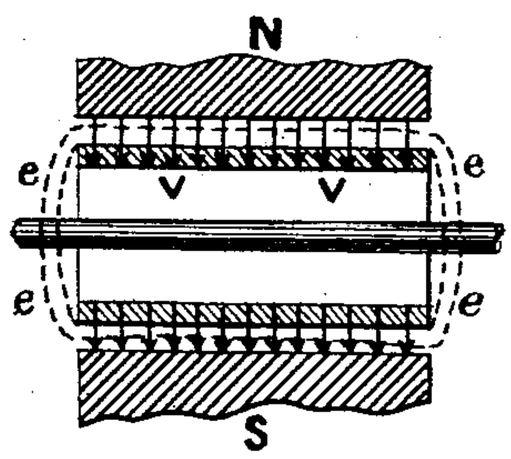



FIG. 11.

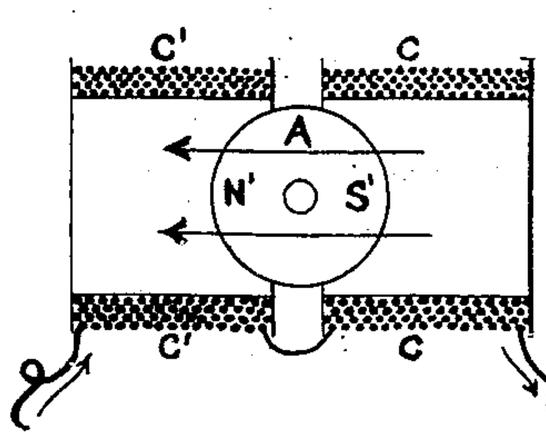
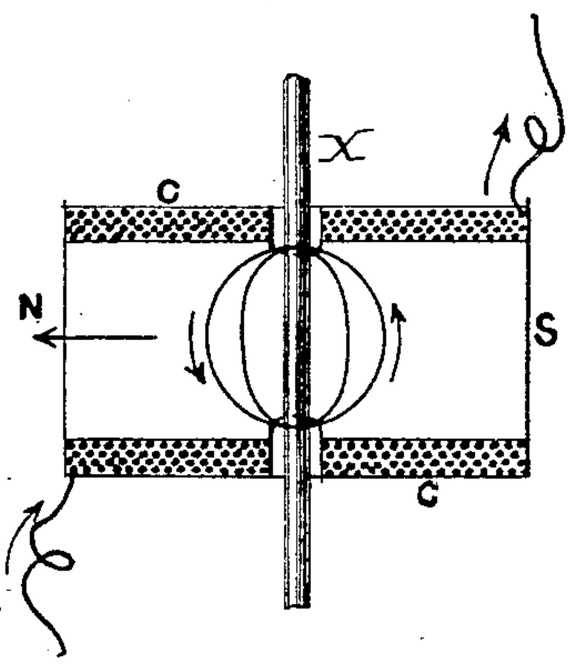



FIG. 12.




WITNESSES:

Geo. A. Vaillant,

John Myers.

INVENTOR:

Elihu Thomson.

# UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO AMERICAN ELECTRIC COMPANY, OF NEW BRITAIN, CONNECTICUT.

## DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 233,047, dated October 5, 1880.

Application filed May 4, 1880. (Model.)

*To all whom it may concern:*

Be it known that I, ELIHU THOMSON, residing in the city and county of Philadelphia, Pennsylvania, have invented certain new and useful Improvements in Dynamo-Electric Machines, whereby a very high electro-motive force is obtained with the advantages of lightness, compactness, and durability; and I do hereby declare the following to be such a description of said improvements as will enable those skilled in the art to make and use the same.

In United States Patent No. 219,157, dated September 2, 1879, to Houston and Thomson, accessory magnetizing-coils surrounding the armature and operating in conjunction with the field-magnet coils in polarizing the armature are described.

One of the objects of the present invention is to combine in a single coil the functions of the accessory coils with those of the field-magnet coils of said patent, and thereby secure simplicity and ease of construction. This is accomplished by winding coils upon the field-magnets shaped in conformity thereto, so as to inclose said magnets, and also, as far as practicable, to inclose the armature, which revolves between the poles, as hereinafter to be described.

Another object of the present invention is to provide a form of field-magnet frame which shall fully utilize both the internal and external magnetizing effects of the field-magnet coils. To this end the field-magnets, instead of simply being inclosed by the magnetizing-coils, have extensions, which serve, in turn, to inclose said coils, in the manner as hereinafter described.

Another object of the present invention is to provide an armature for dynamo-electric machines all parts of the insulated wire of which shall at all times be under the direct influence of the field-magnets, and thus avoid the use of inactive wire, increase the electro-motive force of the currents generated, and reduce to a minimum the length of wire necessary to generate a given electro-motive force.

Another object of the present invention is to provide an armature for dynamo-electric machines the magnetizing effect upon which shall not be limited to the point of magnetic saturation of the field-magnets, but shall be further re-enforced by the direct action upon the iron core of said armature and the insulated wire surrounding the same of the currents traversing the whole of the field-magnet coils, which coils are made to inclose and surround the revolving armature, so that the iron core of the armature becomes practically but a movable extension of the field-magnet poles themselves.

It will be understood by those versed in the art that various modifications of the forms and disposition of the parts from those to be presently described may be made without affecting the essentials of the invention itself, it being here purposed to describe a typical arrangement of parts that has been found very successful in practice.

Figure 1 is a side elevation, partly in section, of a machine embodying my improvements. Fig. 2 is an end elevation of the same. Fig. 3 is a top view or plan of the same. Fig. 4 is an axial view of a form of armature-core adapted to use in the present invention. Fig. 5 is a side view of said armature-core. Fig. 6 is a section of said armature-core parallel to the axis of rotation. Fig. 7 is an axial view of a form of armature winding adapted to use in the present invention. Fig. 8 is a lateral view of the armature winding. Figs. 9, 10, 11, and 12 are designed to elucidate the manner of operation and the principles involved.

In Fig. 1, N is a hollow shell or cylinder of iron, (which may, however, in certain cases, be solid,) constituting one pole of the field-maguet. Its outer edge, F, is flanged, and its inner face, H H, shaped to conform to the rounded outline of the armature of the machine, as shown. An opening or openings through the face H H are provided, as shown at O, to allow circulation of air through the center of the shell N. A similar shell of iron, S, is placed opposite to N, it being also flanged, as at F′, and constituting the opposite pole of the field-magnet. Bars or masses of iron B B B B, &c., join the flanges F F′, being preferably inserted in holes in the latter, and are sufficient in number and size to make thorough magnetic contact between the flanges F F′.

Coils C C and C′ C′ of insulated wire surround the field-magnet poles N and S, and also

the armature of the machine, and serve for the direct magnetization of said poles and of the armature-core itself.

Rings R R, of metal or other suitable material, may be provided to keep the coils C C and C′ C′ in place, since in most cases they project beyond the poles N and S.

The coils C C and C′ C′ can be united into a single continuous coil, extending from one flange, F, to the other, F′, if openings are provided for the passage of the shaft of the armature.

The electric current sent through the coils C C and C′ C′ is in the same direction in both coils, and may be derived either from the machine itself or from any other suitable source.

The bars B B B B, &c., are situated near the outside of the coils C C and C′ C′, and are therefore magnetized by said coils, the direction of magnetization being that proper to intensify the magnetization of the poles N and S. The opposing faces H H of both magnet-poles N and S, and between which faces the armature revolves, are in the figure portions of a hollow sphere, the revolving armature being spherical in outline, the construction and operation of which are to be hereinafter described.

In Fig. 1, J represents a portion of the arm supporting the journals of the shaft of the armature. *f f′* are the feet of the machine.

In Fig. 2 similar parts to those in Fig. 1 are designated by similar letters of reference. The commutator is shown at K, and the driving-pulley at P. In Fig. 3, also, similar parts to those in Fig. 1 are designated by similar letters of reference.

The armature employed in the present invention is preferably of spherical form, it being found to possess great advantages over other forms. It must be understood, however, that I do not confine myself to an armature of spherical shape, but may shape the field-magnet poles so as to make use of other curved forms—a prolate or oblate spheroid, an ellipsoid of revolution, or figures of armature, the outlines of which are partly curved and partly straight, the main requisites being that the armature shall permit of almost complete inclosure by the field-magnet coils, and that the wire and iron of said armature shall not present too great inequalities of surface to the poles of the field-magnets.

The core of the armature may be made in a variety of ways, the necessary condition being that it contain sufficient iron for thorough magnetization, and that the iron be sufficiently subdivided to prevent the circulation of local currents in it.

Fig. 4 shows a form of armature-core employed to obtain a spherical outline in the armature when wound with its insulated wire. Fig. 5 is the same seen from the side.

Two plates, D D, fastened to the shaft X, and perforated or otherwise provided with slits or openings *a a*, Fig. 4, are set at such a distance apart as to leave space between them for the winding of soft-iron wire or strips to a spherical form, W, Figs. 4 and 5. The core, which thus presents the form of a sphere flattened at those portions where the axis X enters, is afterward wound with insulated wire to the outline shown by dotted lines, Fig. 5. Fig. 6 shows the same core in section, the central portion being left hollow, as shown, while the iron wire W is supported in a suitable manner to form a hollow curved shell.

Instead of the iron wire W, rings or bars of iron which, when fitted together, give the required outline, may be used.

Considerable latitude in the construction of the armature-core used in my invention may be exercised, since said core is not alone dependent for its magnetization on the induced magnetism from the field-magnet poles, but is directly magnetized by the field-magnet coils themselves.

With the form of armature-core described it is not difficult to wind upon it insulated wire so as to obtain a nearly spherical outline. The number and connection of the coils on the armature will vary according to the form and arrangement of the commutator or the purpose to which the current developed is to be applied, and it is not intended, therefore, to limit the present invention to any particular arrangement of the coils on the armature. I find, however, the winding and connection of coils described in United States Patent No. 223,557, dated January 13, 1880, to Thomson and Houston, to be well adapted to the conditions of operation of the present invention, and will therefore take it as an example in further describing my invention.

Fig. 7 shows a spherical armature provided with three coils intersecting one another near the axis X. The manner of winding said coils to secure equality in lengths of wire and uniformity of outline is substantially as follows: First, one-half of the wire of one of the coils is wound on; then, second, one-half of the wire of the second coil; then, third, the whole of the wire of the third coil is wound; then, fourth, the remaining half of the second coil, and finally the remaining half of the first coil, so that equal portions of the first coil respectively underlie and overlie the other coils where they intersect, and equal portions of the second coil underlie and overlie the whole of the third coil in like manner. The connection of the three coils so wound is made, as before stated, in accordance with Patent No. 223,557, before referred to, and a suitable commutator, K, consisting of three insulated copper segments, is provided and mounted on the shaft in accordance with said patent. If the armature be run for reversed currents, no commutation is, of course, necessary, but the ends of the armature-coils are carried out in the manner usual in such a case.

In the drawings the connection of the conductors of the machine into a circuit is not shown, as it admits of several unimportant

modifications well understood by those versed in the art, and virtually shown in the previous Letters Patent before referred to.

The commutator-brushes being positive and negative, respectively, the current may be sent through the magnetizing-coils C C and C′ C′ in series or in multiple arc, according to the size of wire used in winding them. Single, double, &c., windings may in like manner be used.

Fig. 9 is an outline section intended to elucidate the distribution of magnetic polarity in a machine constructed as hereinbefore described. The armature-core W receives an inductive action from all directions, as indicated by the arrows converging upon it from the concave spherical surface of the magnet-poles N and S. It will thus be seen, also, that no portion of the wire surrounding the core W can escape the powerful direct action of the field of force from the poles N and S. In all machines hitherto produced a considerable portion of the armature-wire has escaped this direct action. In the Paccinotti, Gramme, and similar machines it is the wire in the interior surface of the ring which thus escapes. In the Siemens, Weston, and similar machines it is the wire that passes over the ends of the cylindrical core, and from the overlapping of the numerous coils at the ends of the cylinder this inactive portion is made to bear a very considerable proportion to the rest or active portion.

In Fig. 10 an outline section of a cylindrical armature as commonly used is shown, where N and S are the poles of the field-magnets. The portions of armature-wire at *e e e e* in dotted lines do not at any time come under the action of the field-poles N and S.

To reduce the loss due to inactive wire *e e e e* to a minimum, a cylindrical armature whose length is relatively several times its diameter is commonly employed, giving rise to inconvenient form of machine and diffusion of magnetic field. Moreover, there is no convergence in all directions of the magnetic force upon the armature, the arrows, Fig. 10, showing its distribution, being sensibly parallel.

In Fig. 9 the distribution of the magnetic polarization induced by the coils C C and C′ C′, both in the poles N and S and in the connecting-bars B B, B B, is shown by arrows, both inner and outer sides of the magnetizing-coils being utilized. This feature enables great concentration of magnetic force to be obtained.

Besides the convergence of the field of force upon the armature in all directions, there is yet to be considered the direct magnetizing and inductive action of the coils C C and C′ C′ upon the whole of the armature-wire.

In Fig. 11 the coils C C and C′ C′ are alone supposed to surround the armature-core A, which, with its wire coils, revolves. A powerful current is sustained in the coils C C and C′ C′ from a suitable source of electricity. The armature being revolved, currents of considerable strength are induced in the coils of said armature, which result mainly from the effect of the coils C C and C′ C′ in giving polarity N′ S′ to the armature-core, and also from direct induction of the stationary-wire coils upon the moving armature-coils. Indeed, it would be sufficient to revolve only the coils of the armature and allow the core itself to remain stationary, but the practical difficulties of construction are thereby increased.

In illustration of the direct inductive action of the magnet-coils upon the armature-coils reference is made to Fig. 12, where a coil, C C, through which a current is circulating, is crossed transversely by a shaft, X, bearing several wire hoops, whose planes pass through the axis of rotation and are at angles with one another. If this arrangement be revolved, currents are set up in the wire hoops, due to direct inductive action of the currents in the coil C C.

In my present invention the same coils that give magnetism to the field-magnets are made to fulfill, in addition, the other functions, as above described, at the same time that all the wire of the armature is useful in generating effective current, being placed constantly under the influence of the field-magnets and field-magnet coils.

Besides many advantages from an electrical and economical point of view, my invention possesses several mechanical advantages.

From the fact of the complete inclosure of the armature by the magnet-frame, injury to it by objects being brought into contact with it while it is revolving is avoided. The field-magnet poles, also, being thoroughly inclosed, cannot attract masses of iron inadvertently left near the machine, and thereby become injured. The external iron of the machine serves also as an effective protection to the magnet-coils, preventing injury during shipment or otherwise.

I claim as my invention—

1. In a dynamo-electric machine, a set of two magnetizing-coils directly surrounding both the field-magnets and the revolving armature of the machine, for the purposes specified.

2. In a dynamo-electric machine, a set of two magnetizing-coils, which may, if desired, be combined into a single coil, as described, directly surrounding the iron cores of the field-magnets and also the revolving armature, and constituting the sole source of magnetic field and inductive action in the machine.

3. In a dynamo-electric machine, magnetizing-coils C C and C′ C′, inclosing and surrounding the field-magnet poles N S, and in turn surrounded and inclosed by iron bars B B, or plates of iron uniting said poles externally, the whole arranged for the purpose of utilizing the internal magnetizing effect of said coils upon said poles, and also external magnetizing effect of said coils upon the bars B B, as described.

4. In a dynamo-electric machine, an armature-core of spherical or similar outline, flattened at the parts where the shaft enters, placed between poles N and S of field-magnets, also shaped to a corresponding hollow spherical or similar outline, the shaft of said armature-core occupying a position transverse to that of a line joining the centers of said magnet-poles, as described.

5. In a dynamo-electric machine, an armature-core of spherical or equivalent outline, as described, placed between the poles N S of the field-magnets, as specified, said core to be inductively magnetized by a convergence upon it from all sides of the lines of magnetic force from the field-magnets, and at the same time to be directly magnetized by the coils of the field-magnets surrounding and inclosing said armature-core.

6. In a dynamo-electric machine, an armature-core wound with insulated wire to a spherical outline, or nearly so, inclosed and surrounded as far as practicable by the field-magnet poles, except at the gaps or spaces separating said poles, and revolved upon an axis which is transverse to lines joining the field-magnet poles, or which axis passes through the gaps or spaces separating said poles, for the purpose of placing all the insulated wire of the armature under the direct influence of the magnet-poles, so as to avoid the use of inactive wire.

7. In a dynamo-electric machine, a spherical inclosed armature consisting, essentially, of a core of iron, W, of suitable construction, with insulated-wire coils surrounding the same, and in turn surrounded as far as practicable by the field-magnet coils, for the purpose of obtaining the maximum inductive effect in the insulated wire of the armature, substantially as described.

8. In a dynamo-electric machine, a magnet-frame consisting of hollow shells N and flanges F F′, as described, and with connecting-bars B B between said flanges, the bars B B constituting an outer surrounding open casing, in the center of which the armature revolves between the opposing faces of the magnet-shells N and as described.

9. A dynamo-electric machine in which the following elements of effective action are severally combined: magnetizing-coils surrounding and surrounded by iron masses placed so as to utilize both the internal and external magnetizing effects of said coils, said magnetizing-coils surrounding and directly magnetizing both the field-magnet poles and the armature-core; an inclosed armature wound with insulated wire, upon which a convergence of magnetic force takes place at the same time from all sides, thus placing the whole of the insulated wire in a powerful field, and an armature the coils of insulated wire of which are inductively acted upon by the currents in the surrounding field-magnet coils.

ELIHU THOMSON.

Witnesses:
GEO. A. VAILLANT,
JOHN MYERS.