(No Model.) 3 Sheets—Sheet 1.

N. WHICHELLO.

DYNAMO ELECTRIC MACHINE.

No. 548,684. Patented Oct. 29, 1895.

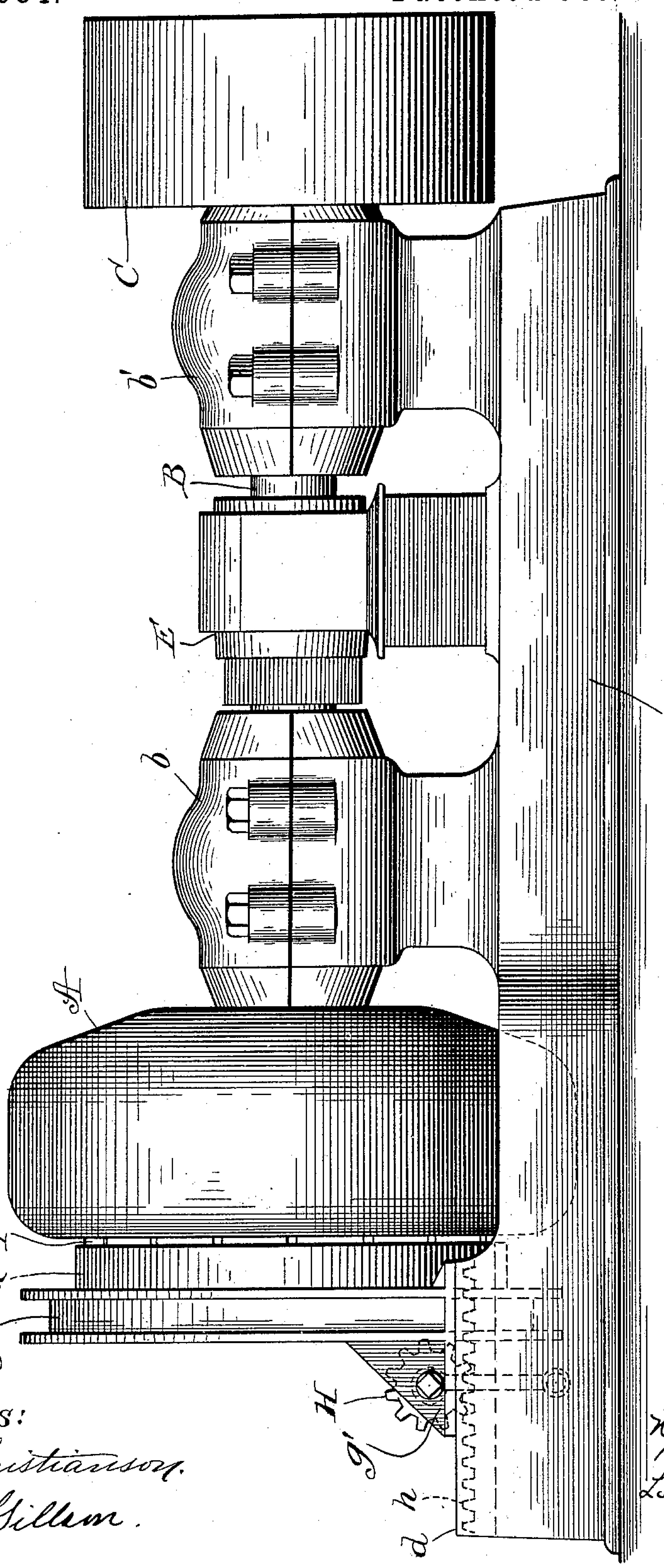

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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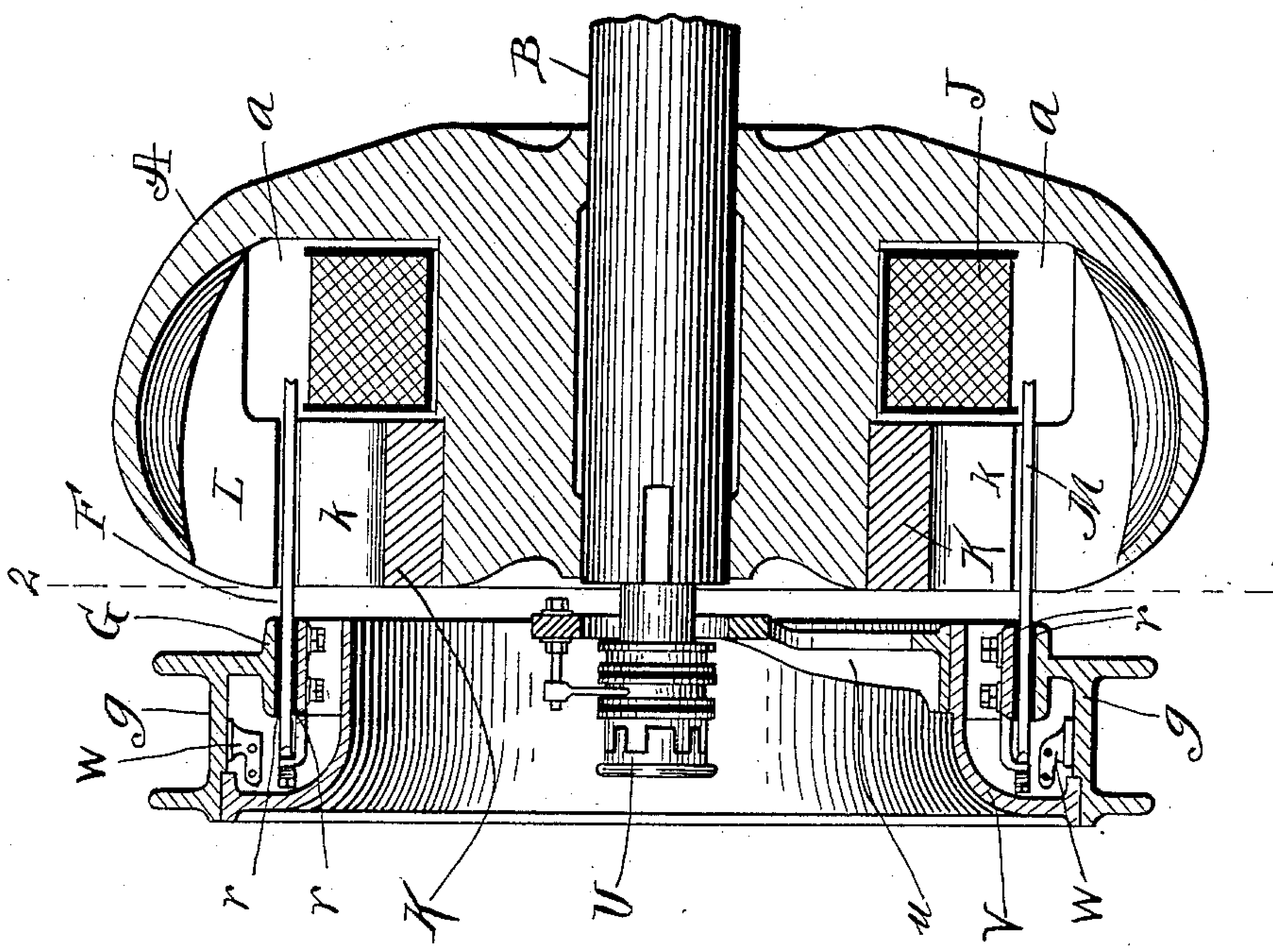

Fig 3

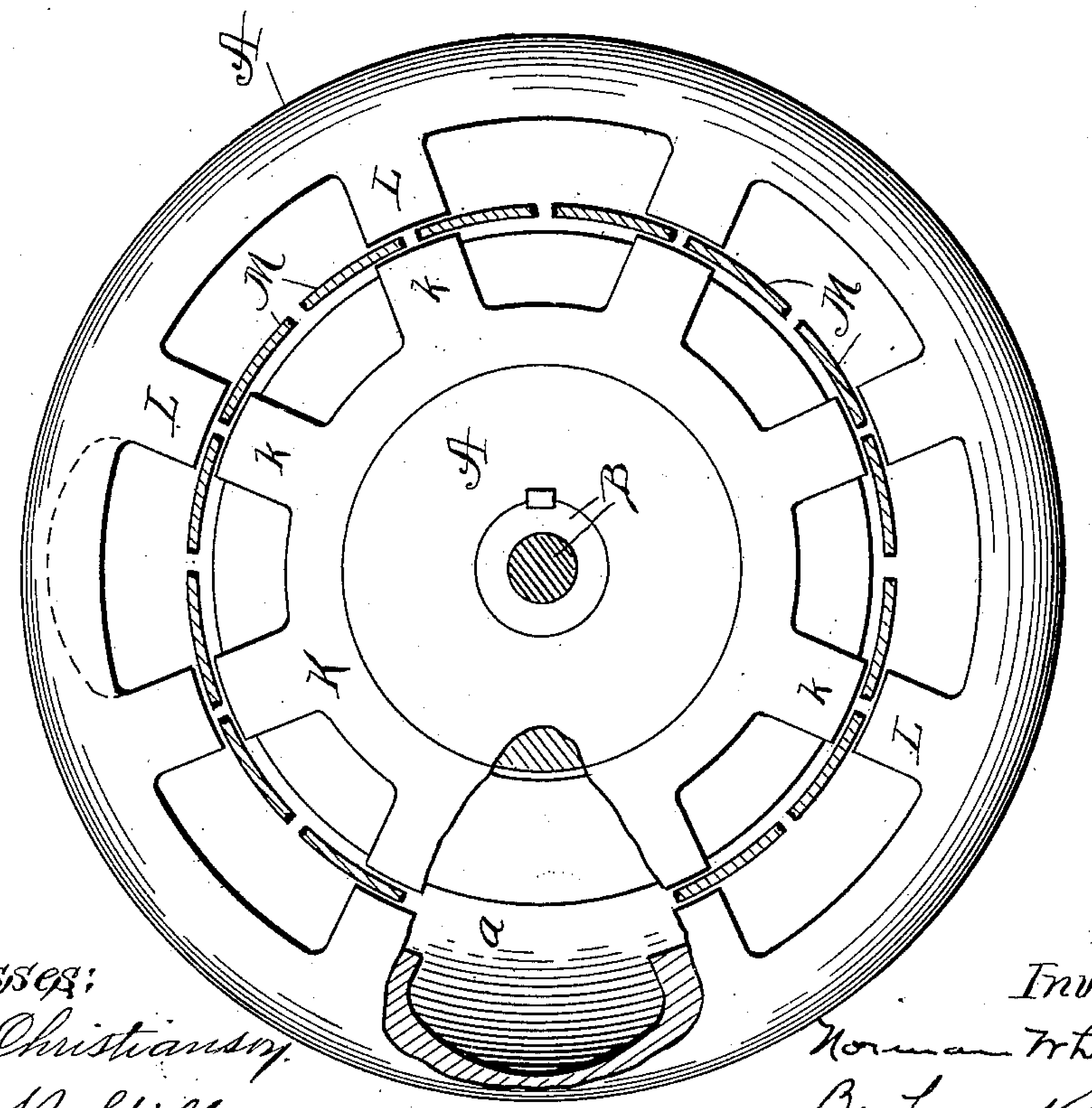

Fig. 2

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3 Sheets—Sheet 3.

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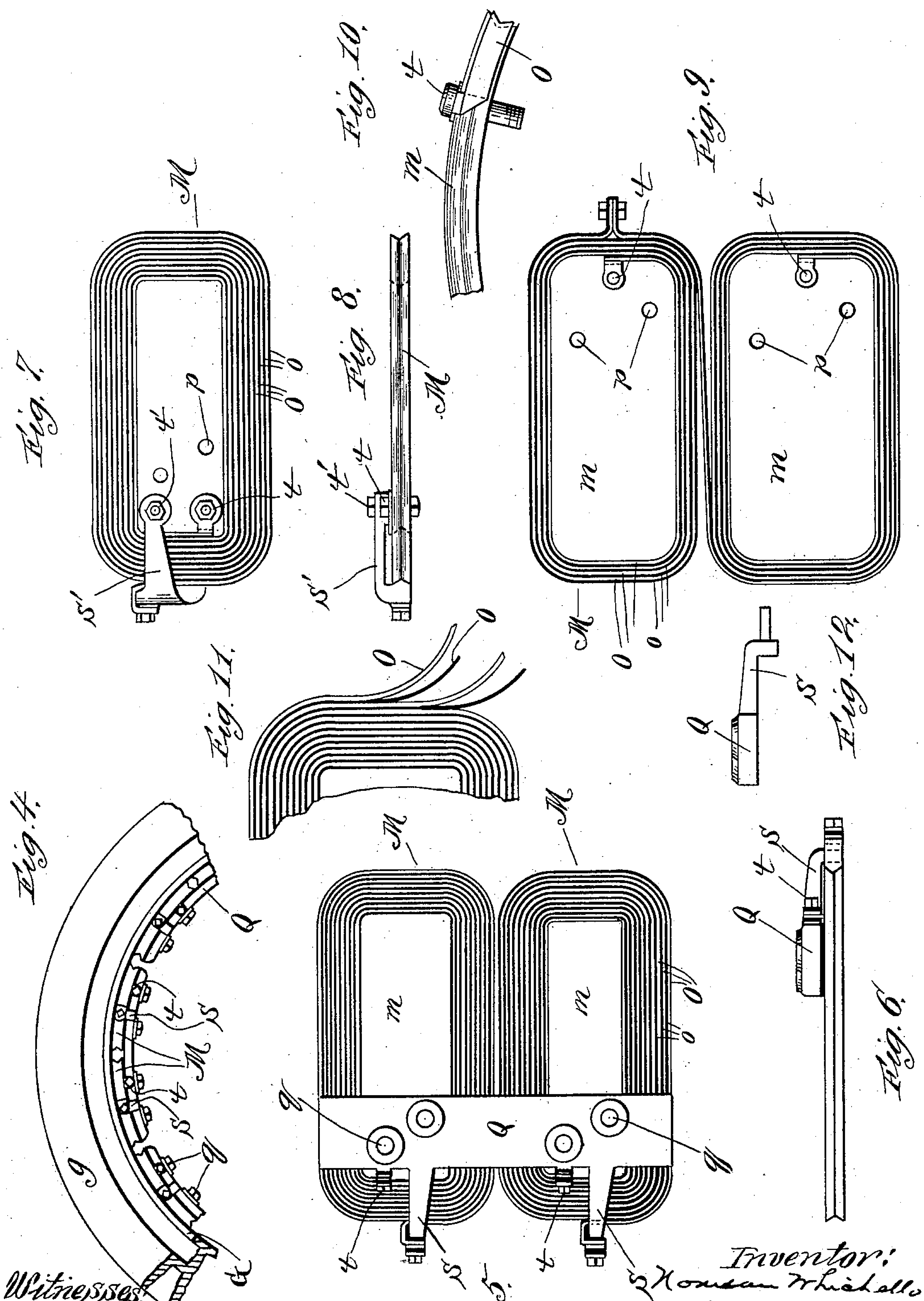

Witnesses:
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UNITED STATES PATENT OFFICE.

NORMAN WHICHELLO, OF CHICAGO, ILLINOIS.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 548,684, dated October 29, 1895.

Application filed July 18, 1895. Serial No. 556,431. (No model.)

To all whom it may concern:

Be it known that I, NORMAN WHICHELLO, a citizen of Great Britain, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Dynamo-Electric Machines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

The invention relates to alternating-current dynamos and the method of constructing certain parts thereof. Its object is to provide the highest possible efficiency by entirely avoiding hysteresis and reducing to a minimum the development of eddy-currents by so disposing the parts that the generating-circuit is influenced by the full magnetic flux and by great steadiness of voltage. Its further objects are economy of construction, convenience of repair, and durability by avoiding the use of cotton in covering the coils and by providing for good ventilation of the generating-coils.

In carrying out my invention I employ a massive field-magnet excited by a single coil and to which the rotary motion is imparted, and a fixed armature of peculiar construction, as hereinafter fully described, arranged in band form and entering an annular air-gap in one of the radial faces of the field-magnet, the armature being non-ferruginous.

In the drawings, Figure 1 is a side elevation of my improved dynamo. Fig. 2 is an elevation on the line 2 2 of Fig. 3 of the field-magnet, a portion being broken away. Fig. 3 is a central vertical section through the armature and field-magnet. Figs. 4 to 10 are details of the armature. Fig. 11 shows a portion of one of the armature-sections with portions of the ribbons frayed out to illustrate the construction. Fig. 12 is a detail of a portion of the armature.

The field-magnet is shown at A, the shaft upon which it is mounted and keyed at B, the drive-pulley at C, the bed or frame carrying the dynamo at D, and at E an exciter, being any desired form of dynamo, mounted upon the shaft B.

The field-magnet A is shown as overhung, and as it is very heavy the shaft B is proportionately large and the journal-boxes b b' for carrying it are wide. The particular manner of mounting the field-magnet forms no part of the invention, however.

The field-magnet is formed with a single annular chamber a, within which is located the primary or exciting coil J. To admit of the introduction of this coil into the chamber a, a section K of the magnet is removable and is in the form of an annulus, one of whose sides constitutes one of the walls of the chamber a and the other a portion of the face of the field-magnet. The annulus K has its periphery notched to form polar projections k. The field-magnet A is extended radially from its core upon the side of the chamber a opposite the annulus K, and is overturned to inclose the chamber a, and prolonged and turned inwardly toward the polar projections k and itself provided with corresponding projections L, whose faces are spaced apart from those of the faces k to form an annular air-gap or magnetic field, within which the armature is placed.

All of the polar projections k on the inner annulus K are of one magnetic polarity, and all of the projections L of the main magnet A on the outer side of the air-gap are of opposite polarity.

The armature F is composed of a number of oblong coils M, formed by wrapping a thin copper ribbon O around the edge of a core-piece m, which is non-ferruginous and preferably of a non-conducting material, such as porcelain or vulcanized fiber, a non-conducting ribbon o being wound with the ribbon O for the purpose of insulation. The ribbon O is prevented from slipping laterally by forming the core m with a V-shaped groove extending entirely across its edge and creasing the ribbon so as to fit into it. The several coils M are carried by a ring G, formed integrally with a circular frame g, mounted by means of brackets g' upon the bed D, the brackets g' being adapted to slide upon the longitudinal ways d on the bed D, so that the frame g may be adjusted with reference to the core A or moved back from it to afford access to the armature. The movement of the armature-frame is accomplished by means of racks *h*, formed on the bed D, and crank-actuated pinions H, carried by the brackets *g'*, co-operating therewith. This method of supporting and moving adjustable portions of heavy machinery is so common I have not deemed it necessary to show the details, and I have thought it best to omit from Fig. 3 a view of the inner surface of the armature-band between the ring G and the face of the field-magnet.

The ring G is preferably bored to insure accuracy. The several armature-coils are secured to its inner surface by means of screw-bolts *q*, passing through suitable apertures, as *p*, formed in the cores *m* near one end, segmental plates Q (shown as of such length that each covers two coils) being applied to the inner surfaces of the cores to receive the pressure of the heads of the screw-bolts *q*. Insulating material is interposed between the coils M and the ring G and plates Q, as shown at *r r*.

The size of the ring G is such that when the coils are secured to it they form a band of such diameter that it will enter the annular air-gap between the faces of the polar projections without contact.

The coils M are preferably curved transversely as to their length to correspond with the circumference of the circle within which they are arranged, though they may be formed flat, provided the air-gap between the polar-faces of the field-magnet is wide enough to accommodate them.

In manufacturing the armature-coils the ribbons may be wound directly upon a core-piece, which is in its final form, or they may be wound upon a flat core, which may be pressed into the desired curvature and hardened in that form, or a flat sectional former or dummy-core may be used, the ribbons being wound upon it, and the dummy then removed and the coil bent to the proper curvature by the use of pressure, after which a permanent core of the desired form may be inserted. A convenient method of introducing this permanent core is by compressing a plastic mass of material, which may be hardened and possess strength, into the central aperture of the coil and retaining it there until hardened by any suitable process.

In place of the plastic material a core may be used, of fusible material, and after being placed in the coil portions of it melted by the use of a blowpipe and molded to secure it in place, or such core may be sectional and its joints closed by fusion. Any means of inserting and securing a permanent core within the coil would come, broadly, within the scope of my invention, such as the introduction of a core flanged along one side of its edges and then being upset by any means upon the opposite side.

The absence of cotton as an insulating-covering admits of the use of heat in constructing the coils.

The length of the coil-sections M is such that when the ring G is brought suitably near to the face of the field-magnet, the armature being inserted into the air-gap between the polar projections, the transverse turns at the ends of the coils lie beyond these projections, so that no waste of magnetic energy results from traversing the field with portions of the coils which are parallel with the direction of rotation.

Various methods of securing the terminals of the ribbons are shown. The inner end of the ribbon O is folded upon a right angle, the fold being upon a forty-five-degree crease, and lapped over onto the core *m*, where it is secured by means of a binding-screw *t*, set either in the core or in the plate Q, and which also serves as means for connecting the coil with the line.

The outer end of the ribbon is secured to an arm S, projecting laterally from the plate Q and turned over the edge of the coil. The end of the ribbon after passing under the arm is folded back over it and secured by the binding-screw, which also serves to hold the wire leading to the line. Suitable insulation must be employed to separate the ribbons electrically from the arm *s* and the binding-screw. The form of attachment is plainly shown in Figs. 5 and 6. In Figs. 7 and 8 I show an arm *s'*, secured to the core *m* by a screw-bolt *t'* and extending over the edge of the coil, the ribbon being secured to it in the same manner as when the arm *s* is employed. The advantage of the form of attachment last described is found in the fact that the coil is complete in itself, while in the construction shown in Figs. 5 and 6 it is necessary to secure the coil to the plate Q for transportation.

In Fig. 9 I show a pair of sections wound together, the outer ends of their coils being united and their inner ends forming the two terminals. In this case also it is necessary to secure the pair of sections to a plate Q for transportation.

At U is shown an ordinary rectifying-commutator with brushes for use, if it is desired, to make the machine self-regulating by using a compound coil in the field. The commutator is mounted upon the end of the shaft B, which is turned down to accommodate it. The brushes are carried by a bracket *u*, secured to a circular shield V, which is secured to the frame *g* and covers the inner portion of the armature. This shield may be dispensed with, if desired, the bracket *u* being attached directly to the frame *g*.

The current may be taken from the machine in any desired manner. One convenient arrangement is to string wires, as W W, around the inside of the frame *g* to be connected as may be desired to the coils and the line. It is obvious that these wires may be so arranged and connected with the armature-coils as to arrange the latter in groups, having any desired number of coils in each series, for the purpose of producing various terminal voltages and to render the machine capable of safely generating correspondingly-varying currents. To avoid confusion, I have omitted from the drawings the connections between the wires W W and the armature-coils. I make the armature-coils quite thin, using a narrow ribbon. The metal ribbon and also the insulating-ribbon may be very thin, so that I may have a large number of turns upon each coil.

Using no iron in the armature, I escape hysteresis entirely, and by using non-electric conducting material for the core of the armature coils the Foucault currents are almost entirely avoided, being limited to those which will be generated in the ring G and the segments Q.

While the machine could, of course, be so designed as to admit of rotation of the armature instead of the field-magnet, I prefer the form shown for the reason that the great mass of the field-magnet, disposed, as shown, by its momentum, corrects any irregularities in the action of the engine and insures regularity of the voltage. A further advantage in the form shown is found in the ability to use a comparatively light armature, as it is not called upon to resist centrifugal strain.

My machine is distinctly differentiated from those known as "inductor-machines," in which a keeper of iron forms a part of the magnetic circuit and is rotated for the purpose of periodically changing the reluctance of the magnetic circuit and causing the magnetic flux to pulsate. In my machine all ferruginous portions of the magnetic circuit are relatively fixed, and the magnetic flux is therefore constant. The fact that the magnetic flux does not pulsate enables me to avoid laminations and to form the field-magnet of a solid mass capable of resisting the centrifugal force, so that high peripheral velocity may be secured. This, together with the high magnetic density which is permissible in consequence of the absence of hysteresis and Foucault currents, results in increasing the efficiency of the machine, since it raises the gross output without increasing the internal losses of the machine.

The fact that there is but one magnetizing-coil also raises the efficiency, since the length of a turn of wire capable of embracing the single magnetic core which carries the entire flux is much less than would be required to embrace a number of separate cores having the same aggregate area. This fact not only diminishes the amount of wire required for excitation, but, as is well known, diminishes also the power wasted in exciting the field.

In order to repair the armature, the carrying-frame is drawn back by the means described, when any of the sectional coils may be removed without disturbing others, or, at least, only the one with which it is directly connected.

An essential feature of my invention is that the armature and gap in which it is placed being cylindrical no thrust-bearing is required, as a small amount of end play of the rotating system will in this case carry with it no danger of contact between the armature and the fields, but will even be desirable as a means of equalizing the wear on the commutators and other rubbing surfaces.

The fact that the armature and gap are cylindrical has the further advantage of permitting the withdrawal of the armature without the necessity of dividing it into two parts or in any way dismantling it or its electrical connections.

While I prefer to form the armature-sections wholly without iron for the reasons stated, the machine has other points of advantage independent of this, and I do not therefore desire to be limited to non-ferruginous coils.

I claim as my invention—

1. In a dynamo-electric-machine the combination with a field magnet comprising a central mass cylindrical in form and having an annular radial extension at one end, such extension being overturned toward the opposite end to inclose an annular chamber and terminating in inwardly extending polar projections, L, and an annulus adapted to the central mass to form a part of the field magnet and having radial polar projections *k*, adapted to cooperate with the polar projections L, and spaced apart therefrom to form an annular air gap, such annulus forming one wall of the annular chamber, of a field coil located within the annular chamber, and an armature comprising a plurality of oblong non-ferruginous coils comprising a core and metallic and insulating ribbons interwrapped about the edges thereof, the metallic ribbon having its inner end folded so as to project laterally and being laid over onto the side of the core, and a binding screw for securing such end, a rigid arm projecting from the core and being turned over the edge of the coil the outer end of the metallic ribbon passing under such arm and being folded back over it, and a binding screw for securing the end of the ribbon to the arm, said coils being arranged in band form with their long edges adjacent, and of a supporting frame for carrying such band and attached thereto near one of its edges, the relation between the armature frame and the field magnet being such that the projecting coil pieces enter the air gap.

2. In a dynamo-electric-machine having its armature composed of a plurality of non-ferruginous coil sections, the combination with the core, *m*, of metallic and insulating ribbons interwrapped about the edges of the core, the metallic ribbon having its inner end folded so as to project laterally and being laid over onto the side of the core, and a binding screw for securing such end, a rigid arm projecting from the core and being turned over the edge of the coil, the outer end of the me-

tallic ribbon passing under such arm and being folded back over it and a binding screw for securing the end of the ribbon to the arm, substantially as described and for the purpose specified.

3. In a dynamo-electric-machine having its armature composed of a plurality of coil sections, the combination with the core *m*, of metallic and insulating ribbons interwrapped about the edges of the core, the metallic ribbon having its inner end folded so as to project laterally and being laid over onto the side of the core, and a binding screw for securing such end, a rigid arm projecting from the core and being turned over the edge of the coil, the outer end of the metallic ribbon passing under such arm and being folded back over it and a binding screw for securing the end of the ribbon to the arm, substantially as described and for the purpose specified.

4. In a dynamo-electric-machine whose armature is composed of a plurality of non-ferruginous coils, the combination with a flat or curved core having its edges V-shaped, of metallic and insulating ribbons interwrapped about the edges of such core and conforming to the shape thereof, substantially as described and for the purpose specified.

5. In a dynamo-electric-machine whose armature is composed of a plurality of coils, the combination with a flat or curved core having its edges V-shaped, of metallic and insulating ribbons interwrapped about the edges of such core and conforming to the shape thereof, substantially as described and for the purpose specified.

In testimony whereof I affix my signature in the presence of two witnesses.

NORMAN WHICHELLO.

Witnesses:

SPENCER WARD,

LOUIS K. GILLSON.