(No Model.)

2 Sheets—Sheet 1.

T. L. WILLSON.

DYNAMO ELECTRIC MACHINE.

No. 406,015. Patented June 25, 1889.

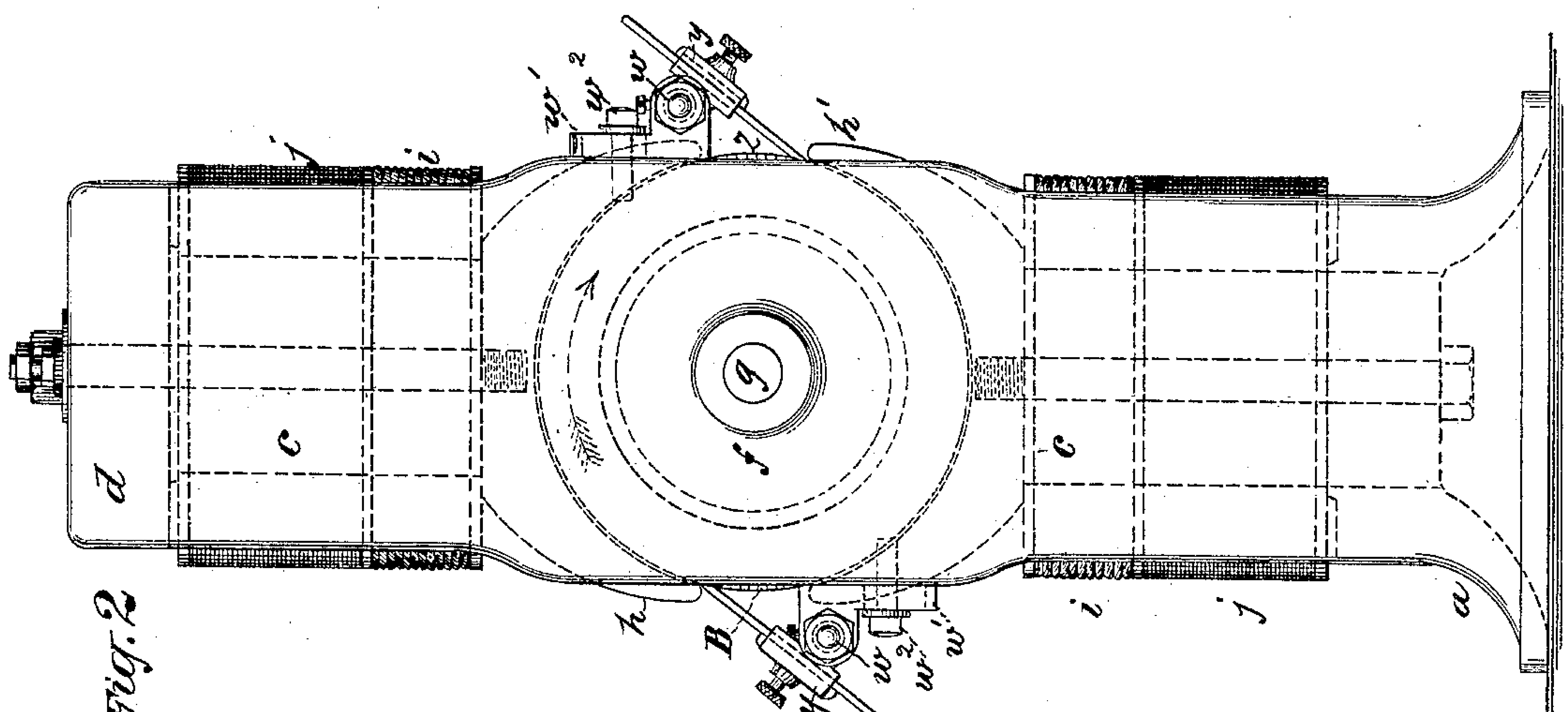

Fig. 2

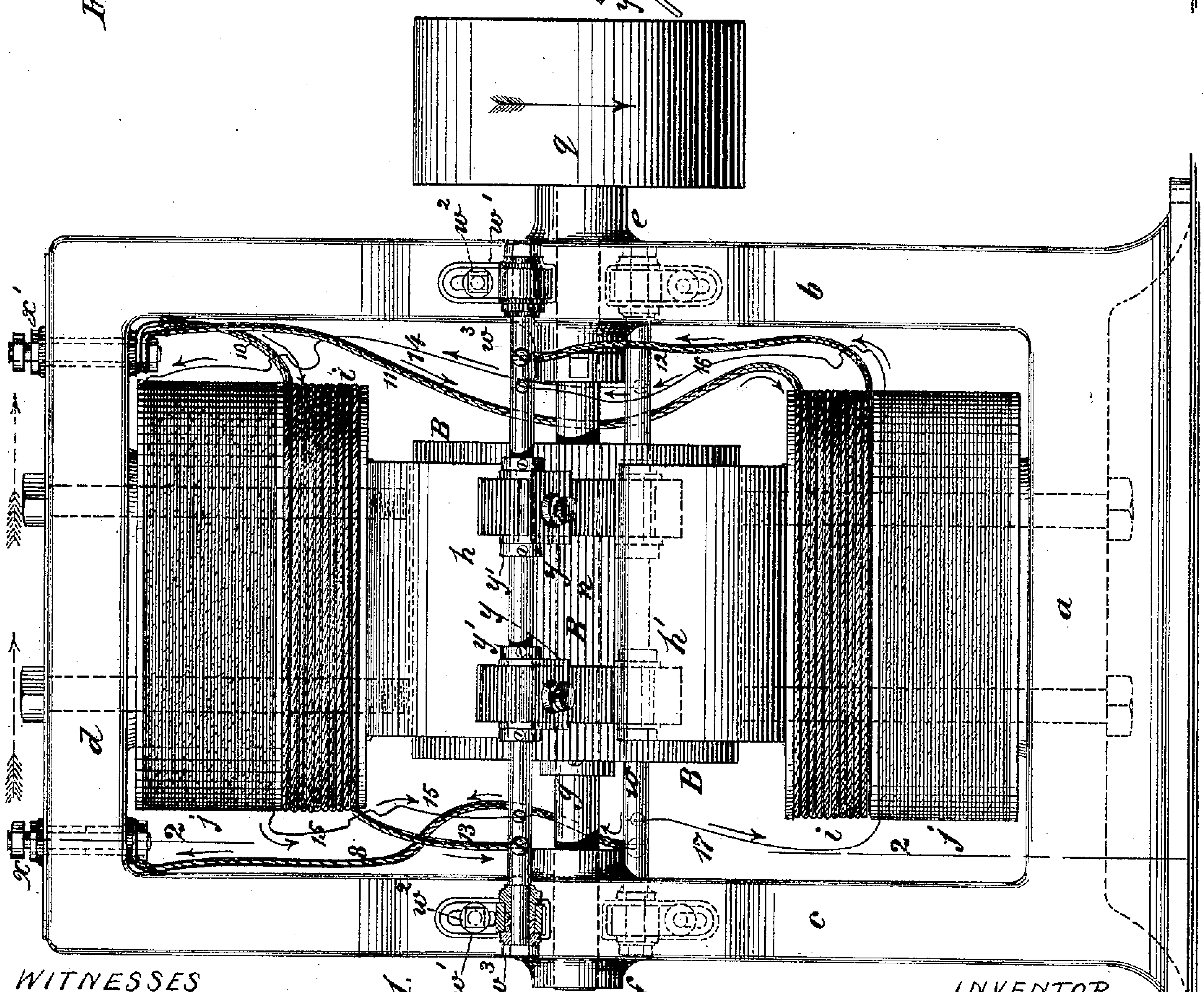

Fig. 1

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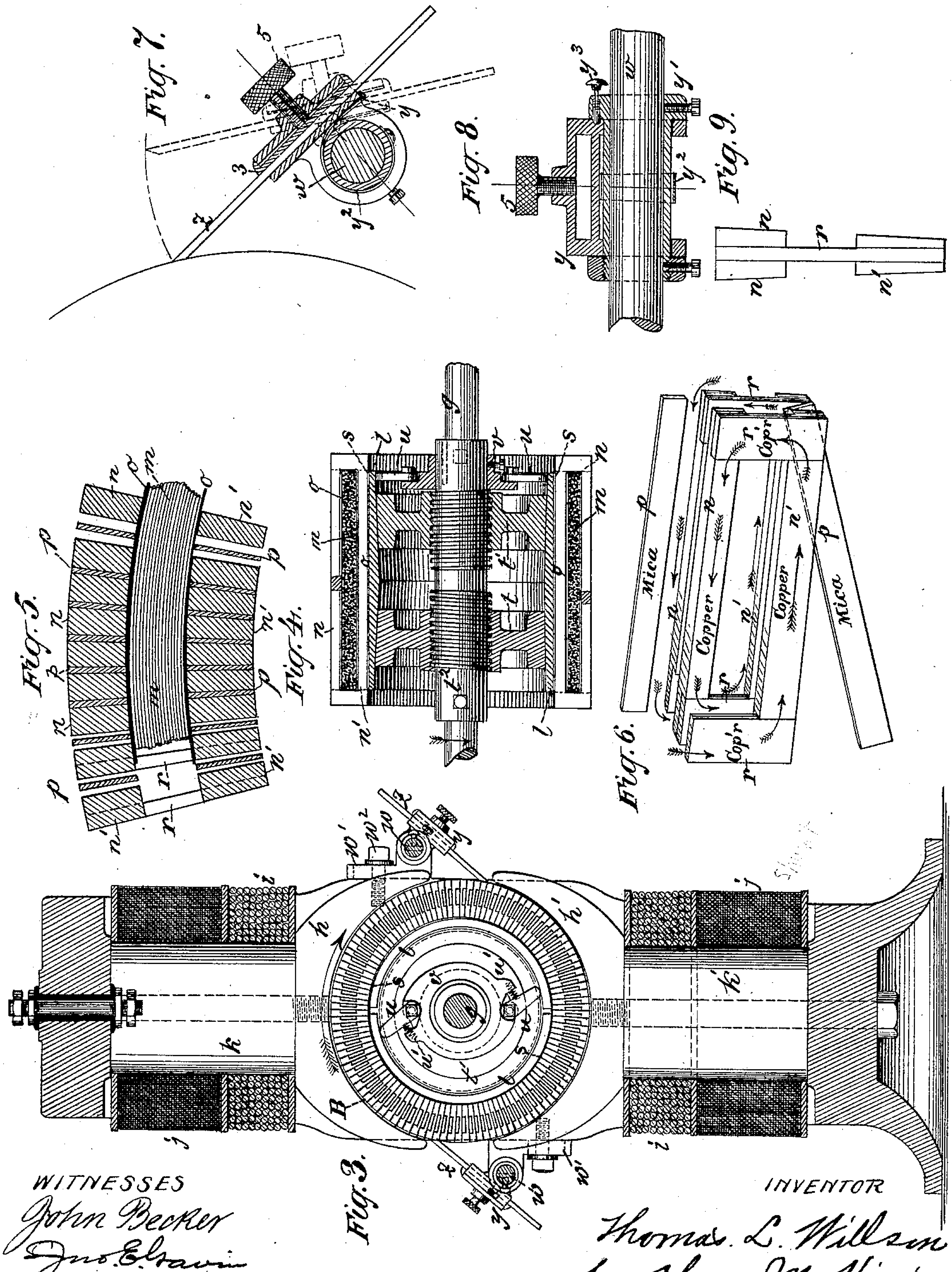

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UNITED STATES PATENT OFFICE.

THOMAS L. WILLSON, OF BROOKLYN, ASSIGNOR OF ONE-THIRD TO GROSVENOR P. LOWREY, OF NEW YORK, N. Y.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 406,015, dated June 25, 1889.

Application filed January 9, 1888. Serial No. 260,256. (No model.)

To all whom it may concern:

Be it known that I, THOMAS L. WILLSON, a citizen of the United States, residing now in Brooklyn, Kings County, New York, have invented certain new and useful Improvements in Dynamo-Electric Machines, of which the following is a specification.

My invention relates more especially to machines of the Gramme type, and my improvements are embodied in the special construction of the armature, and in the relation of the brushes therewith; also in the special form of the field-magnets and frame of the machine, in the details of the brush-holders, in the driving-connection between the armature and its shaft, and in several minor features hereinafter detailed.

My invention relates to that construction in which the armature, instead of being wire-wound, as usual, is constructed of segmental copper bars arranged in two circles, one inside and one outside the iron core and connected at the ends in spiral order, forming a continuous spiral of copper segments around the iron core, the segments being of course insulated by interposed strips of insulation. Heretofore all armatures of this class have been either provided with commutators in the usual way, one end of the copper segments being connected with the segments of the commutator, or where a commutator is omitted the brushes have been arranged to bear on the inside of the armature or against the inner circle of segments, which is a comparatively contracted, inconvenient, and inaccessible position.

In my improved machine I arrange the brushes to bear directly upon the outer circle of segmental bars on the periphery of the armature at opposite points and in the polar gaps or spaces between the two externally-embracing and radially-approaching pole-pieces. This arrangement forms practically a new and improved type of machine having the great advantage of extreme compactness and solidity with strength, capacity, cheapness, and durability, for by this arrangement the usual commutator is not only entirely eliminated, but the brushes are arranged on the commutating-periphery of the armature itself in the gaps between the pole-pieces, which is the most safe, accessible, and convenient arrangement, and one which provides a large and practically indestructible commutating-surface to receive the brushes, while all the parts and connections of the usual commutator are entirely dispensed with, and great space, weight, and cost thus saved.

My invention therefore consists partly in the leading feature above outlined, and also in the special manner of connecting the two rows of segmental bars in the armature; in a novel form of frictional driving-connections between the armature and its shaft and a device to prevent the independent revolution of the armature on the shaft; in the special form of the brush-holders and adjusters, and in the form of the field-magnet frame and the relation of the armature therewith, as hereinafter fully set forth and claimed.

In the drawings annexed, Figure 1 presents a front elevation of my improved machine, and Fig. 2 gives an end elevation thereof. Fig. 3 is a vertical cross-section on line 2 2 of Fig. 1, showing the armature in end elevation. Fig. 4 is a longitudinal section of the armature. Fig. 5 is an enlarged cross-section of a peripheral fragment of the armature, showing the arrangement of the segmental bars and intervening insulating-strips. Fig. 6 is an enlarged fragmentary perspective view of the armature, showing the spiral-coil arrangement of the segmental bars and the manner of connecting them at the ends in spiral order, also showing the strips of insulation displaced. Fig. 7 is an enlarged section of the brush-holder and adjuster parallel to the brush, and Fig. 8 is a section of the same transversely to the brush. Fig. 9 shows a modified detail of the armature.

Referring to Figs. 1, 2, and 3, *a b c d* indicate the structural frame of the machine, which also forms the frame of the field-magnets, and is made in the form of a simple open rectangular frame, which is longer vertically than horizontally, the longer sides being upright, while the shorter sides, which I shall term the "ends," being at top and bottom of the machine. The lower end *a* is flared or broadened all around and forms the base of the machine, as well shown in Figs. 1 and 2, which base has a flaring recess, as seen in Fig. 3, for lightness and convenience of construction. At the middle of the upright sides *b c* are formed the solid journal-boxes *e f*, in which each end of the armature-shaft *g* is mounted, which shaft thus extends transversely through the middle of the frame, as best seen in Figs. 1 and 2, and is provided with the driving-pulley q on one end. On this armature-shaft, midway within the frame, is mounted the armature B, which revolves between the curved pole-pieces $h\ h'$, which embrace the armature at top and bottom and are secured to the magnet-cores $k\ k'$, which project from the ends $a\ d$ inwardly and radially toward the armature, as best seen in Figs. 1 and 3. These cores are wound with the exciting-coils between the ends of the frame and the pole-pieces, as shown, the winding in the drawings being shown as compound, coarse coils i being placed near the pole-pieces and situated in the direct or working circuit, while the fine coils j are placed on the outer ends of the cores and situated in a shunt, according to the well-known system of compound winding. It will be therefore seen that this general arrangement of the magnet-frame, coils, shaft, and armature is very compact, strong, and simple, and the neutral section of the magnet-frame serves as the supports for the armature-shaft, no separate supports being required, while the armature, magnet-coils, &c., are all inclosed within the frame, and as the frame is preferably cast or otherwise formed in one piece, as illustrated in the drawings, forming an integral frame, this imparts great solidity and steadiness to the entire machine, which conduces to the smooth and easy running of the armature when in operation.

Now the armature is of novel construction, as is best shown in Figs. 3, 4, 5, and 6. It is of the Gramme or annular type, and consists of a core-ring m of iron wire, (see Figs 4. and 5,) embraced by an inner and an outer circle of segmental copper bars $n\ n'$, running transversely to the core, or nearly parallel with the armature-shaft, as seen in Figs. 3, 4, and 5, and connected at the ends in spiral order, as will be understood from Fig. 6, thus forming a continuous copper spiral about the iron core on the well-known principle of the Gramme ring. Suitable insulation o (see Figs. 4 and 5) is of course interposed between the iron core and the copper segments, and the segments are individually insulated by interposed strips of mica p, as best seen in Figs. 5 and 6, which thus not only insulates the copper segments, but renders the construction fire-proof and indestructible at the same time. The copper segments in the inner circle are made necessarily thinner than the outer segments, owing to the radical contraction, as seen in Fig. 5; but to compensate for this they are made somewhat wider than the outer segments, so as to possess about the same transverse area or conductivity, as will be readily understood from Figs. 5 and 6. The segments are connected at the ends in a very strong and simple manner, (shown best in Fig. 6, also in Figs. 3, 4, and 5,) which consists in scarfing or recessing the ends of the segments to about half their thickness, as shown clearly in Fig. 6, and inserting in the scarf or recess flat strips of copper r of about half the thickness of the segments, so as to be flush with the sides of the segments, but much wider than the segments, so as to have about the same conductive section as the segments, as well shown in Fig. 6. These strips r are preferably soldered into the scarfed ends of the segments, but may be secured thereto by any other suitable means. Where the segments are sufficiently thick, they can be slit in the middle, as seen in Fig. 9, and the flat strip r inserted and secured in the slit; but a thin segment is best scarfed on one side, as this operation leaves a greater thickness of stock for the joint, and is thus a better and simpler method for thin segments. It will be seen on reference to Fig. 6 that the insulating or mica strips p are sufficiently long to extend the full length of the segments between the sides of the segments and the end of connecting-strips r, and do not need to extend radially down into the spaces between the middle of the connecting-strips r, which spaces, as seen in Fig. 6, and at $r\ r$ in Fig. 5, are about twice the width of the space between the segments, and are free and open to the air and need no insulation.

It will now be readily understood that when the armature is thus made up as described, it will form a compound metallic ring of great strength and density, the arched segments of copper both inside and outside the iron core being bound firmly in place by the connecting-strips r, thus forming a structure of great solidity and compactness, in which no space is wasted, as is the case with the wire-wound armature, and yet one in which the insulation is introduced in the cheapest and simplest manner, while the amount of copper conductor is very large in proportion, and hence the capacity of the armature is very high and its resistance very low, thus forming a structure peculiarly adapted for large machines for currents of great power or quantity. The ring or essential portion of the armature being thus formed, it is rotatively engaged with the armature-shaft in the manner best shown in Figs. 4 and 3—that is, within the ring is placed the two sections of a split or divided sleeve or friction-pulley l, which is a nice fit for the interior of the armature-ring, plus the interposed elastic insulation s, which is preferably a band of leather, which not only insulates the armature from the split sleeve, but also forms an elastic frictional engagement between the two. The interior of the split sleeve is formed with opposite tapers or conical inclines, as seen in Fig. 4, and to these are fitted two similarly tapering or wedging disks or nuts $t\ t'$, which respectively engage a right and left hand thread on a screw-sleeve t^2, which is keyed to the armature driving-shaft g.

Now, referring to Fig. 4, it will be seen that the torsional driving strain on the shaft and screw-sleeve which turns in the direction of the arrow will tend to screw the wedging nuts or disks t t' together, and thus diverge or expand the two sections of the split sleeve against the armature, thereby making a firm rotative engagement with the armature, which will constantly tend to tighten in use, and consequently as fast as the insulation s shrinks the sleeve will be automatically expanded by the torsional driving strain transmitted from the shaft through the wedging-screw devices, thus preventing any looseness due to such shrinkage. It will be also noted that the action of these wedging devices is self-centering, so that the armature is also kept in a central or balanced position on the shaft g.

It will be apparent on reference to Fig. 4 that while the driving-connection between the shaft and armature will tighten in the direction in which the shaft turns to drive the armature, yet if the armature should itself turn in the same direction as the shaft—as, for example, by its own momentum after the shaft was stopped—the armature would then tend to loosen the connection. This independent rotation of the armature, however, is prevented by a ratchet-connection between the shaft and armature, which engages in the direction in which the armature would turn forwardly on the shaft, but slips in the direction in which the shaft would turn forwardly in the armature. This ratchet-connection is preferably of a frictional ratchet kind, or consists simply of two toggle-like friction-pawls u u, as seen in Figs. 3 and 4, which are pivoted to a collar v on the shaft g and extend out in an oblique position to engage the rim of the split sleeve l, little springs u' acting to keep the pawls in constant engagement. It will therefore be seen that if the shaft should turn in the armature in its direction of rotation (see Fig. 3) to tighten up the wedging-screw connection before described the pawls u will slip freely on the rim of the friction-pulley. If, however, the armature should itself tend to turn in the same direction independent of the shaft, the pawls u would instantly engage and prevent such relatively reverse motion; hence the connection between the shaft and armature will constantly tend to tighten in use, while the armature can never turn on the shaft to loosen this connection, which is an important provision for this type of armature.

A peculiar and very advantageous feature of my machine lies in the position in which the brushes are arranged in relation with the armature described and in the manner in which they are mounted and manipulated.

Referring to Figs. 1, 2, and 3, it will be noted that the brushes are arranged to bear directly upon the outer segments n on the extreme periphery of the armature and in the gaps or spaces between the pole-pieces h h' at opposite sides of the armature, the periphery of which is turned off true; hence the armature forms in itself the commutator, thus entirely eliminating the usual separate commutator. This feature not only greatly reduces the weight of metal and the number of parts and the cost of the structure, but saves nearly one-third in the axial size or width of the machine, which is a great gain in compactness, besides simplifying the entire design of the machine. Furthermore, the described position of the brushes on the periphery of the armature between the external and radially approaching pole-pieces is obviously of great advantage, as this is the most convenient and accessible position in which the brushes could be placed, and as the brushes of a dynamo are the parts which require continued adjustment and inspection, and the action of which is an index to the proper working of the machine and circuit, their arrangement, as described, is most important, as they are thus brought to the very front of the machine, external to everything else, which is the most convenient to the attendant and the safest and the best situation in both a mechanical and electrical sense.

It will be seen that another great advantage of the segmental commutating-armature with the externally-placed brushes is that a very broad and extended commutating-surface is provided for the brushes to bear against, and hence the commutating-surface will have great range of wear and great durability and will admit a whole gang or series of brushes—a feature particularly suited for large and powerful machines, to which my invention is especially applicable. Another important advantage of this armature with its externally-placed brushes is that the two opposite brushes are thus placed at such a great distance apart as to preclude the possibility of any loss from short circuits from one segment to the other, or flashing around the commutating-periphery from one brush to another, as commonly happens with the small separate commutators, where the segments are narrow and the brushes comparatively close together.

It will be readily understood that with this type of armature the brushes might be arranged to bear on the ends of the segments or strips r at the ends of the ring, or they might be arranged to bear on the concave interior of the ring; but it is obvious that such an arrangement of the brushes anywhere on the interior of the machine or inside the frame would be open to the most serious objections of being very inconvenient and inaccessible and unsafe, and would provide but a very limited brush-bearing surface and be entirely unsuited for an armature and machine of this type designed for most powerful currents and in which commutating-surface and brush accommodation are essential requisites.

It will be noted, on reference to Fig. 1, that I show the machine fitted with two brushes on each side of the armature; but one or more may of course be used, preferably two or more in all cases. Each brush projects from a brush-holder y, of about the usual construction, which is mounted on a fixed but adjustable brush-carrier or supporting-bar w, which extends across the face of the machine at front and back parallel to the axis of the armature, and is secured at each end in small brackets w', which have a slotted base which abuts against the sides b c of the frame, and is secured thereto by the studs w^2. It is therefore obvious that by loosening the studs w^2 the brackets may be adjusted up or down on the frame, and hence the bars w, with their brushes, may be thus adjusted tangentially up or down in relation to the commutating-periphery of the armature. Besides this tangential adjustment of the brushes, the brush-holders are capable of partial rotation on the bars w, as seen best in Fig. 7, thus providing a radial adjustment of the tip of the brush to and from the commutating-surface, as is usual in brush-holders—that is, referring to Figs. 7 and 8, the brush-holder y is rotatively mounted between two collars on the sleeve y', which is secured to the bar w. A coiled spring y^2 (seen best in Fig. 7) is fixed at one end to the sleeve y' and bears at the opposite end on the brush-holder, thus tending constantly to press the tip of the brush against the commutating-surface with an even and regular pressure, which is important to the efficient action of the brush. By rotating the brush-holder away from the commutating-surface into the position shown by dotted lines in Fig. 7 a small spring-bolt y^3 (seen in Fig. 8) will spring into engagement with a recess on the brush-holder, as shown in Fig. 8, and thus hold the brushes safely in their retracted position, as shown by dotted lines in Fig. 7, when the machine is not in operation, or when it is desired to throw any brush out of action, as will be readily understood. The brushes are of course longitudinally adjustable under the gib 3 and clamp-screw 5 in the brush-holder in the usual manner, as seen in Fig. 7, to set the brush forward or back for wear or position. When it is desired to put the brush again in action, the spring-bolt y^3 is withdrawn and the spring y^2 will return the brush to the commutating-surface and hold the same evenly and elastically thereon, as will be understood, which is superior to the usual rigid attitude of the brush.

By referring to Fig. 1 it will be seen that the brush-supporting bars w w are of course insulated from the brackets w' by the non-conducting bushings w^3, and it will be also observed that I prefer to extend all the circuit-connections of the machine to and from the said bars, which is a very simple and convenient arrangement, and brings all the connections in sight and accessible on the exterior of the machine—that is, the circuit-connections of the machine are made as follows: The terminal binding-posts x x' of the machine are arranged in the upper corners of the frame, as fully shown in Figs. 1 and 3, and are heavily insulated therefrom, as indicated. The positive conductor 8 (see Fig. 1) therefore extends from the positive brush-bar w to the positive post x, and the current flowing from thence in the external or working circuit back to the opposite post x' divides at this post between the wires 10 and 11, and thus goes to one end of each of the main field-coils i, and thence by wires 12 and 13 back to the negative brush-bar w. The wires 14 and 15 connect each end of the upper shunt-coil to the positive and negative brush-bars respectively, and the wires 16 and 17 connect the ends of the lower shunt-coil with the respective bars. The circuit-wires are secured to the brush-bars by simply inserting the naked ends of the wires in socket-holes bored through the bars, in which they are held by clamp-screws, as illustrated in Fig. 1.

On reference to Figs. 1 and 8 it will be understood that the sleeve y', with its brush-holder and brush, is longitudinally adjustable on the axial bar w, so that the brush may be set to bear on any desired longitudinal part of the armature.

In the drawings I have shown my improvements as applied to a generator, and in which the field-magnets have a compound winding; but it is obvious that the invention is equally applicable to motors, and the field-winding may be entirely of the shunt, series, or other kind adopted in electrical practice.

My present application is in part a renewal or continuation of my application Serial No. 218,678, filed November 12, 1886. I have chosen to make in this application the generic claims to the matters shown in both.

What I claim is—

1. The combination of the field-magnet, a commutating-armature, and brushes bearing upon the periphery of the armature within the polar gaps.

2. The combination, with a commutating-armature, of a field-magnet having two pole-pieces embracing the armature on opposite sides, and commutator-brushes bearing upon the portion of the periphery of the armature exposed in the gaps between the pole-pieces.

3. A dynamo-electric machine having a commutating-armature and a field-magnet constructed to leave the entire length of the exterior of the armature exposed on opposite sides between the pole-pieces, and brushes arranged to bear against the exposed periphery of the armature in the polar gaps.

4. The combination, with a commutating-armature consisting of segmental bars arranged spirally around a core, and field-magnets having polar ends radially approaching the exterior circumference of said armature on opposite sides, of brushes bearing directly on the external peripheral segments of said commutating-armature at the exposed portions between the radially-approaching magnet-poles, substantially as herein set forth.

5. In a Gramme armature, the combination, with a core, of an inner and outer circle of

segmental bars n n', embracing said core, with their ends recessed or scarfed, and with cross connecting-pieces r let into said recesses and soldered or secured therein, substantially as shown and described.

6. A Gramme armature constructed with an annular core, exterior and interior metal strips extending longitudinally of the axis of the armature, plates of insulating material alternated with said strips, and radial metal strips connected at their inner ends to the inner strips and at their outer ends to the outer strips, the respective strips being coupled in spiral order, and the radial strips being of less width than the longitudinal strips, whereby they are held out of contact with and insulated from one another, substantially as set forth.

7. In a dynamo-electric machine, field-magnets made in the form of a rectangle or frame cast in one integral piece, with the polar limbs made separate and bolted on the ends of the integral frame and directed inward, with the armature-shaft extending transversely and centrally through the sides of the frame, and the armature mounted on the middle thereof in the center of the integral frame between the attached polar limbs, substantially as herein shown and described.

8. In a dynamo, the combination, with a field-magnet, of a commutating-armature arranged with its axis coincident with the plane of the field-magnet, whereby the portions of the periphery of the armature exposed within the gaps between the pole-pieces are on opposite sides of the plane of the field-magnet, and commutator-brushes bearing upon the periphery of the armature within the polar gaps, whereby the brushes are conveniently accessible upon the exterior of the machine.

9. The combination, with an annular armature, of an expansible clutching-sleeve within the same, an armature-driving shaft concentric to said sleeve, a wedging-screw connection between said shaft and expansible sleeve, acting to tighten or expand said sleeve by the forward rotation of the shaft within the armature, and a friction-clutch between the shaft and the sleeve acting to slip in the direction of said forward rotation of the shaft and to catch in the reverse direction, substantially as and for the purpose set forth.

10. In a dynamo-electric machine, the combination, with an armature and its driving-shaft, and a wedging-screw connection between the shaft and armature, constructed to tighten by a forward rotation of the shaft within the armature, of the disk v, secured to the shaft, and the frictional pawls u, pivoted thereon and engaging the armature in the reverse direction, substantially as shown and described.

11. In a dynamo-electric machine, the combination of brush-holding bars arranged parallel with the armature-shaft, with brushes mounted thereon to bear upon the commutating peripheral surface of the armature, and adjustable supports for said bars, substantially as shown and described.

12. In a dynamo-electric machine, a brush-carrier extending parallel to the shaft of the armature and adjacent and exterior to the periphery of the armature, with a brush mounted on said carrier and bearing upon the periphery of said armature, substantially as shown and described.

13. The combination, with the supporting-frame, of the brush-holding bars w, brushes mounted on said bars, and brackets w', adjustably supporting each end of the bar on the frame, substantially as shown and described.

14. The combination of the brush-carrier extending parallel with the armature-shaft and external to the periphery of the armature, with angularly-adjustable brushes mounted on said carriers and bearing directly on the armature, substantially as set forth.

15. The combination, with the fixed frame a b c d, of the bars w, extending entirely across the frame and secured thereto at each end and disposed parallel with the armature, with brushes mounted thereon and bearing on the commutating-surface, substantially as shown and described.

16. The combination, with a commutating-armature, of brush-holding bars on opposite sides of the armature and extending parallel with its axis, and brushes mounted thereon bearing upon the periphery of the armature and adjustable longitudinally on said bars, in order to bear upon different portions of the length of the armature, substantially as set forth.

17. In a dynamo-machine, the combination of a brush-supporting bar extending parallel with the armature-shaft external to the armature and in electrical connection with the brushes and attached to the frame, with the circuit-wires of the field-magnets extending to and from said bar, substantially as shown and described.

18. In commutator-brush adjusters, the combination, with a brush-carrier adjustable tangentially in relation to the commutating-surface, of a brush mounted on said carrier, and having a radial adjustment to and from the commutating-surface, substantially as set forth.

19. In commutator-brush adjusters, the combination, with an axial bar adjustable tangentially in relation to the commutating-surface, of a movable brush mounted on said axial bar and rotatively adjustable thereon to and from the commutating-surface, substantially as herein shown and described.

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