(No Model.)

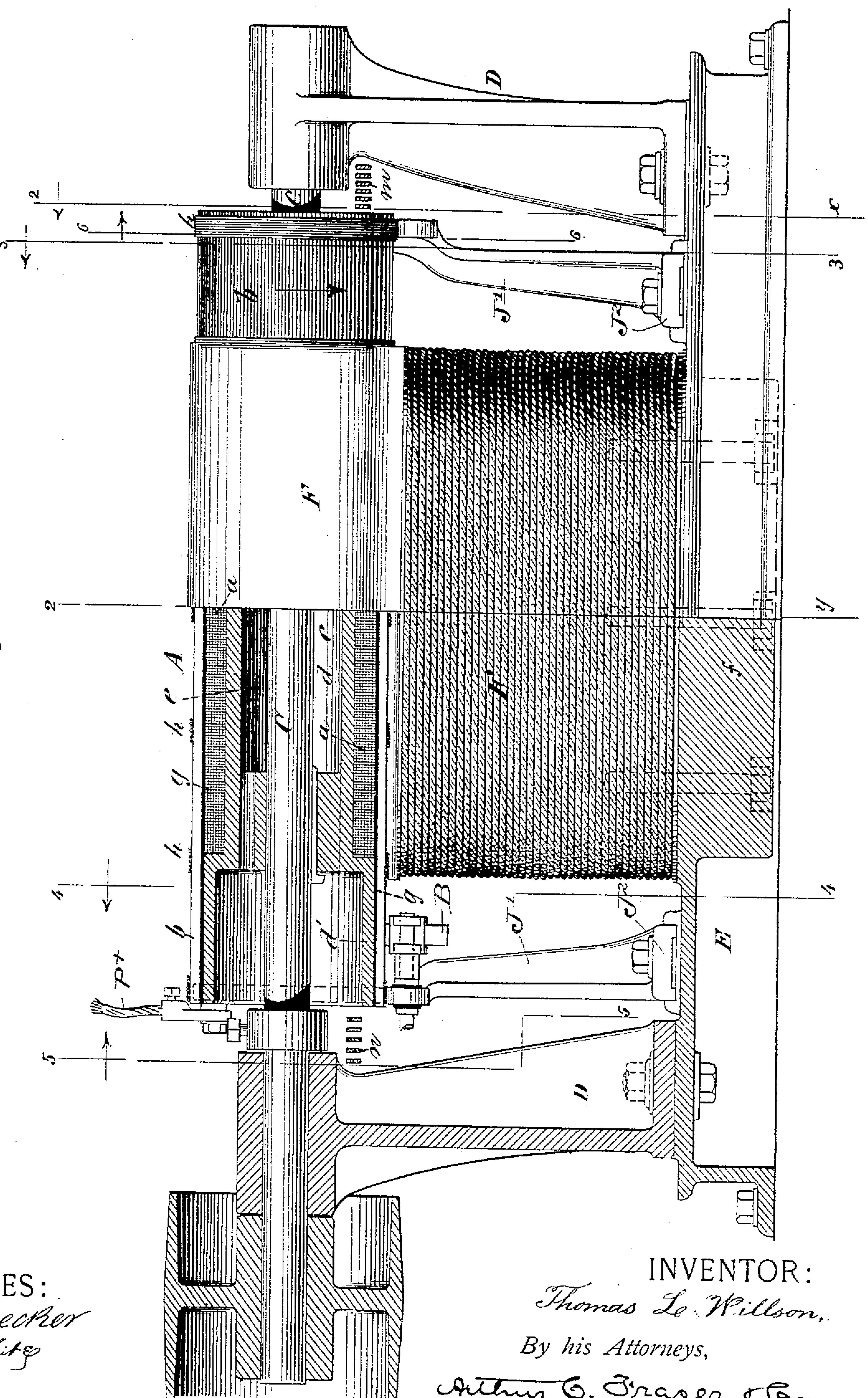
4 Sheets—Sheet 1.

T. L. WILLSON.

DYNAMO ELECTRIC MACHINE.

No. 495,538. Patented Apr. 18, 1893.

FIG. 1.



WITNESSES:

John Becker

Fred White

INVENTOR:

Thomas L. Willson,

By his Attorneys,

Arthur C. Fraser & Co.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.)

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FIG. 3.

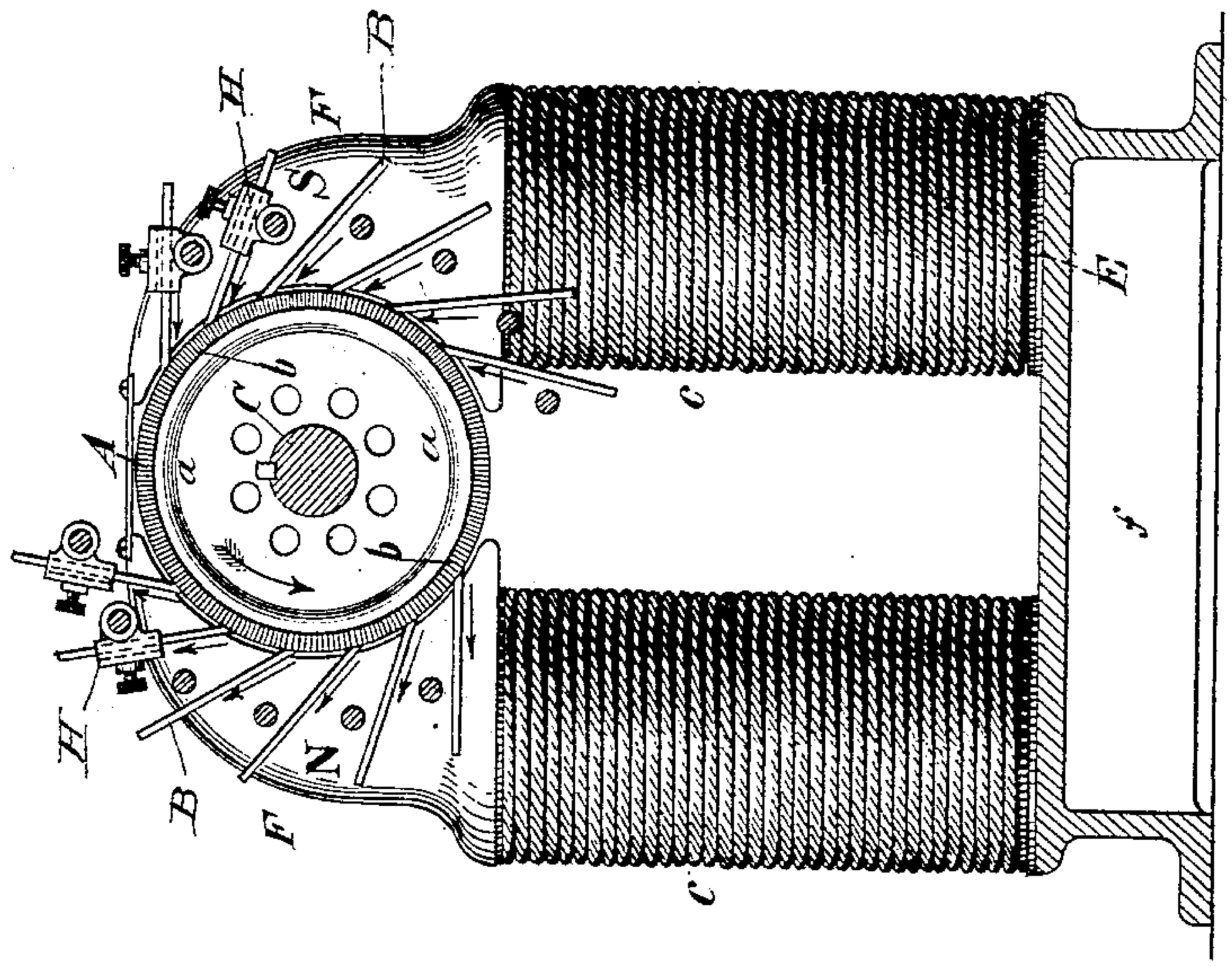
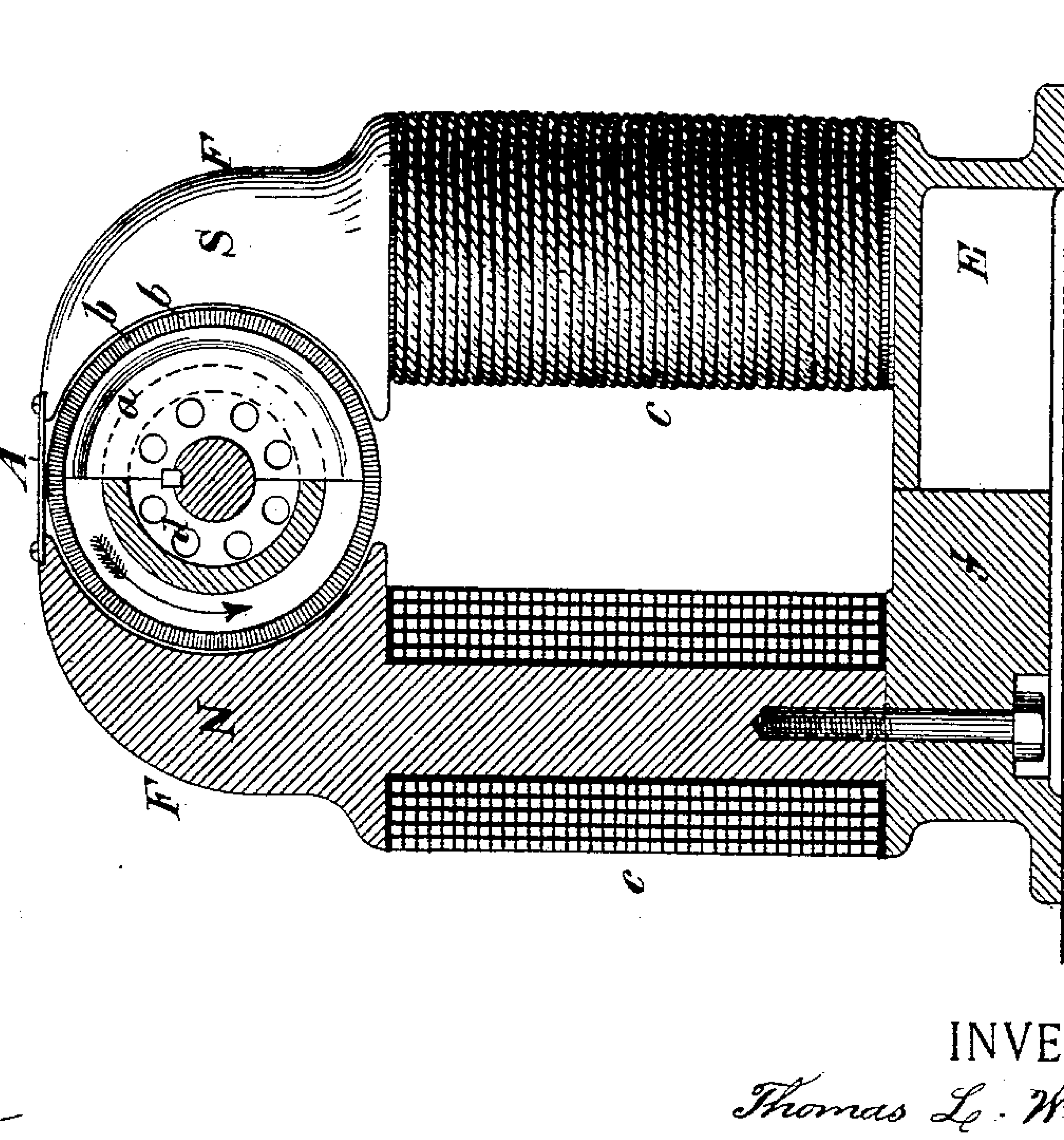


FIG. 2.



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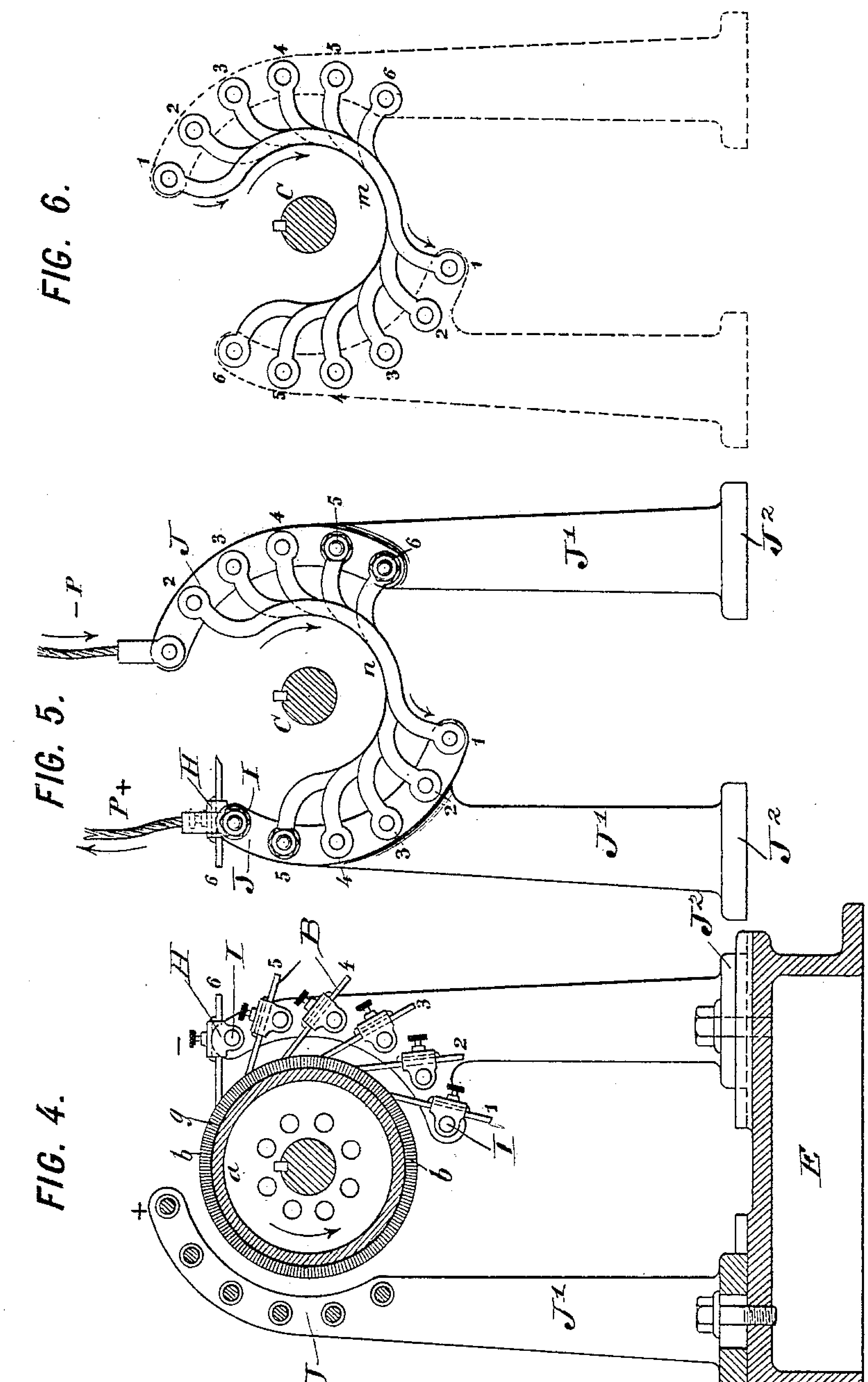

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Fred White

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FIG. 7.

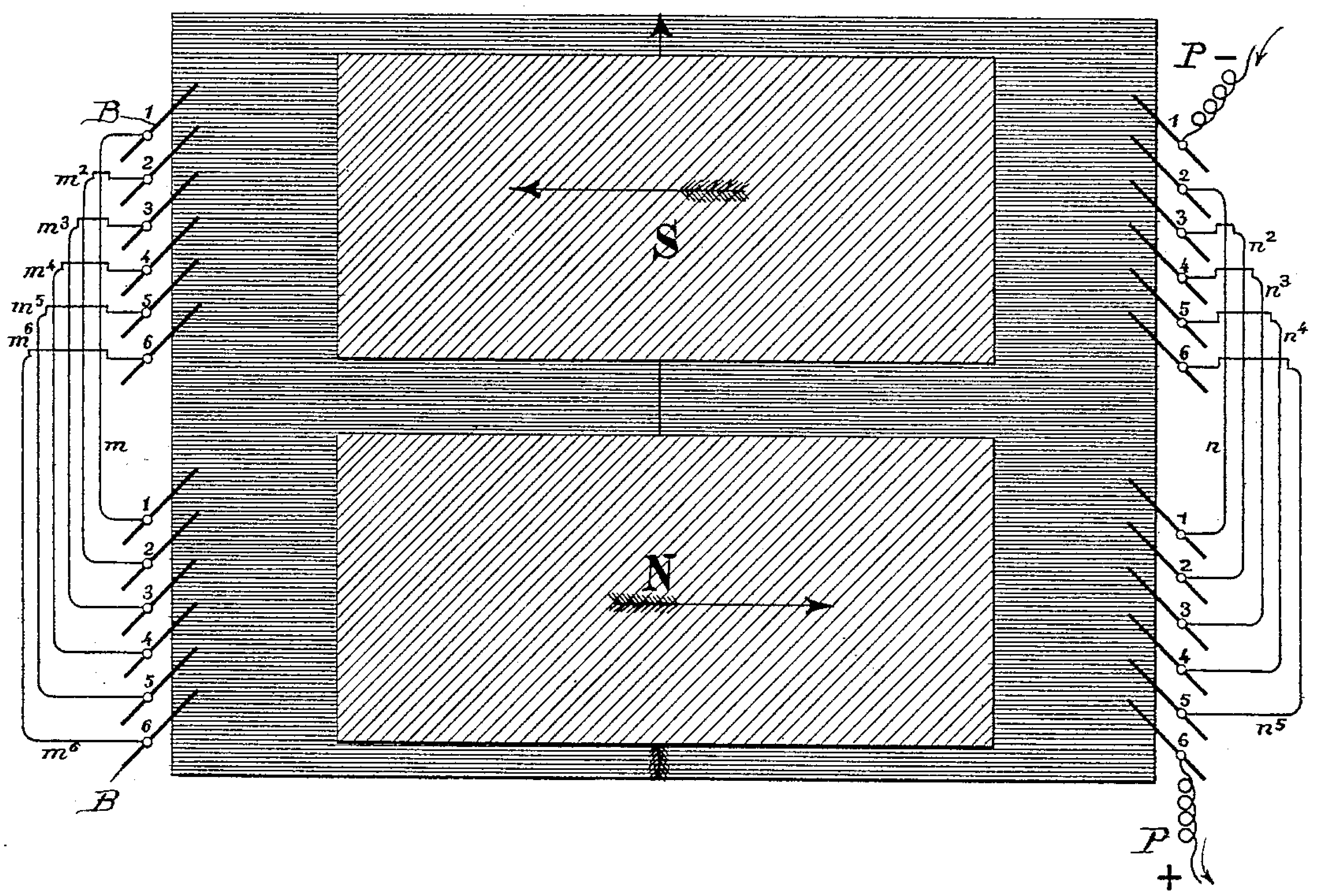
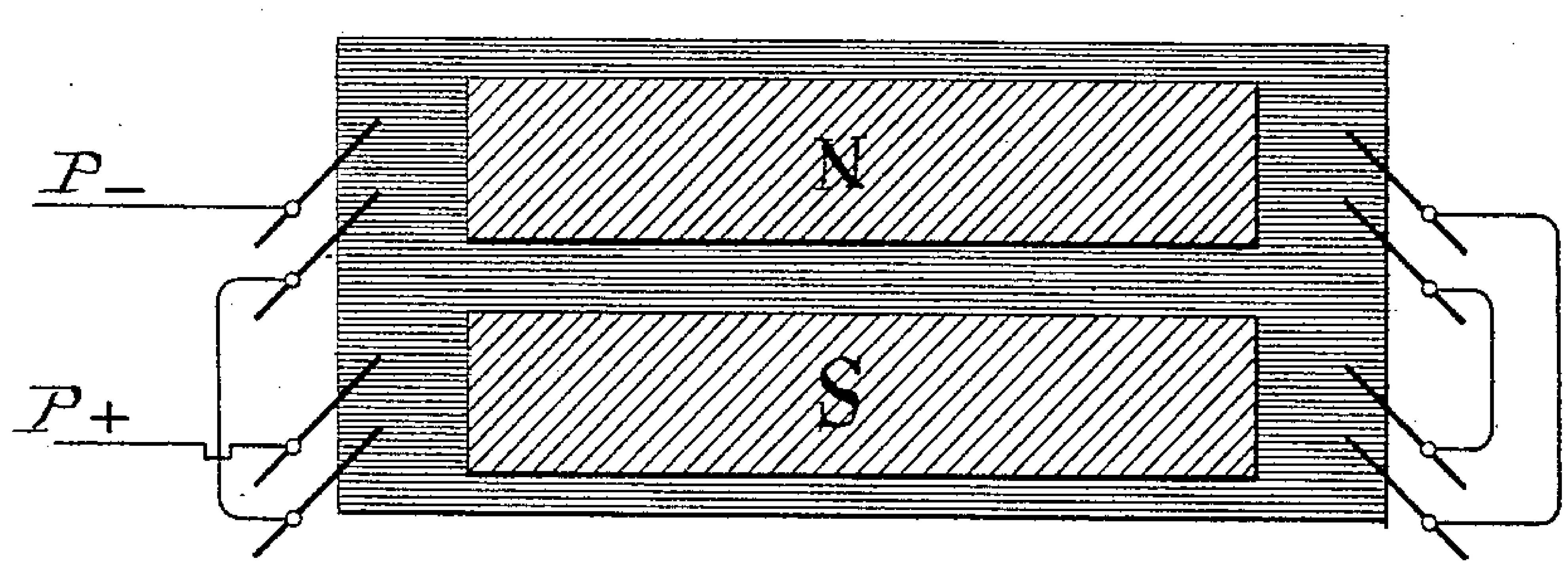


FIG. 8.



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UNITED STATES PATENT OFFICE.

THOMAS L. WILLSON, OF BROOKLYN, NEW YORK.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 495,538, dated April 18, 1893.

Application filed March 8, 1890. Serial No. 343,120. (No model.)

To all whom it may concern:

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

This invention relates to that class of "open coil" dynamo machines wherein the armature is constructed with a cylindrical core overlaid with a layer of conducting bars insulated from each other and from the core, and connected at one or both ends with collecting brushes which take off the currents generated in the bars by their movement through successive magnetic fields of alternately contrary polarities. A dynamo of this type is illustrated in my patent No. 403,630, dated May 21, 1889.

My present invention aims to increase the electro-motive force attainable by machines of this type with a given number of pole pieces to the field-magnet, or to enable the field-magnet to be made with fewer pole-pieces without necessarily thereby reducing the electromotive force.

Instead of providing one collecting brush to bear upon the ends of the bars coincident with each field of force through which the bars are passing, my present invention provides two or more brushes to each field of force, so that the bars passing through one field may be connected serially instead of being necessarily in multiple. Thus by applying, for example, six brushes to each field of force the electromotive force derivable therefrom is increased six times. The conductivity of the armature conductors, and consequently the quantity of current obtainable from a given electromotive force is, with a given width of field, decreased in the same proportion, but this may be avoided wholly or in part by making the magnetic fields of greater width. At the same time the number of magnetic fields may be reduced, thereby simplifying the winding of the field-magnet and reducing also the leakage of the magnetic lines of force from pole to pole outside of the armature.

Figure 1 of the accompanying drawings is a side elevation of one suitable construction of dynamo embodying my present invention, the view being partly in vertical mid-section. Fig. 2 is a vertical transverse section in two planes, the right-hand half being cut on the line 2—*x* in Fig. 1, and the left-hand half on the line 2—*y*, the brushes being omitted. Fig. 3 is a vertical section on the line 3—3 showing the pole-pieces, armature and commutator brushes. Fig. 4 is an end elevation partly in vertical section on the line 4—4 in Fig. 1, showing the preferred method of supporting the commutator brushes. Fig. 5 is a fragmentary elevation partly in section on the line 5—5 in Fig. 1, showing how the brush-holders are electrically connected in pairs at one end of the machine. Fig. 6 is a similar view in section on the line 6—6 in Fig. 1, showing how the brush-holders are connected at the opposite end of the machine. Fig. 7 is a diagrammatic view, the armature conducting bars being developed in a plane, the field-magnet poles shown over them in section, and the electric connections between the commutator brushes being indicated. Fig. 8 is a similar diagram showing a machine of the simplest construction of which my invention admits.

Referring especially to Figs. 1 to 4, let F designate the field-magnet as a whole, and A the armature as a whole. B B are the commutator brushes, C is the armature shaft, D D are the supporting frames in which the shaft has its bearings, and E is the base-plate of the machine.

In the construction shown the field-magnet F is of horse-shoe shape, having two pole pieces N S mounted on vertical cores which are fastened to the base-plate E, the latter being formed to constitute the neutral portion *f* of the magnet. The upper cores are wound with exciting coils *c c* which may be connected with a separate exciting machine, or if the dynamo be self-exciting they may be connected either serially in the line circuit or in a shunt between the commutator brushes, or according to the method of compound winding, partly in series and partly in shunt, or by any other known method of connecting field-magnet coils in order to excite the field-magnet under any desired conditions.

The armature A is mounted on the axial shaft C, and rotates between the field-magnet poles. It is of barrel form, being cylindrical, or approximately so, and its ends project beyond the field-magnet to form commutators. The armature is constructed with a core a of soft iron and an exterior "winding" consisting of a single layer of longitudinal conducting bars b b surrounding the core and fastened thereto by wire bands h h or otherwise. The soft iron core may be made in any way in which armature cores are made, being preferably laminated in large machines to prevent eddy currents. In the construction shown it consists of a supporting spool or drum d of cast iron or other material constructed with a portion of its length, equal approximately to the length of the field-magnets, reduced in diameter sufficiently to admit of winding therein a suitable depth of varnished iron wire e to constitute the soft iron core. The end portions d' of this drum are made of larger diameter to come against and support the ends of the bars b b which project to constitute the commutator. The spool or drum d is keyed or otherwise fastened to the shaft C.

The conducting bars b b are preferably of copper, their sides being tapered to form radii from the axis of rotation in order to make them as compact as possible. The bars are separated by placing thin sheets of mica or other insulating material between them, and they are insulated from the core a by an intervening layer g of suitable insulating material which extends from end to end and thus insulates them also from the end portions d' of the supporting drum.

The lines of force extending between the pole pieces N S pass through the armature, traversing the soft iron core a thereof. They thus cross the armature bars b b, and as the armature is rotated these bars cut the lines of force, whereby an electromotive force is generated in the bars during their passage through the magnetic fields. These electromotive forces are taken off from the opposite ends of the bars where they project beyond the field-magnet by the commutator brushes B B in the manner best shown in Fig. 3. In this figure the arrows marked on the brushes show the direction of the currents passing between the brushes and the bars. The brushes in contact with the bars which are passing through one field receive a negative current, or, in other words, conduct a current into the bars, while the brushes in contact with the bars which are passing through the other field receive a positive current, or conduct a current away from the bars. It is essential that the brushes at opposite ends of the armature shall be arranged in exactly coincident positions in order that they may make contact simultaneously with the same bars, so that while one end of a bar is in contact with one brush its other end shall be in contact with a corresponding brush. The bar is thus connected in closed circuit and the electromotive force generated within it is made effective to institute a current through this circuit. The armature bars are normally open-circuited, that is, they are cut out of circuit at both ends during their passage between the magnetic fields and while passing between the successive brushes.

Each pair of brushes arranged to simultaneously make contact with one bar might be connected in a separate circuit, so that the machine would feed as many circuits as there were pairs of brushes, but by this arrangement, unless the armature were made of inordinate length, the electromotive force would be too low to be ordinarily available for practical use. To secure a sufficient electro motive force I connect the pairs of brushes in a circuit serially with one another. The method and effect of this connection can be best understood by reference to Fig. 7. In this figure the armature bars are shown developed in a plane as though spread out flat, and the two field-poles N S are shown over them in section in order to indicate their relative positions. The armature is supposed to be revolving in such direction as to cause the bars to pass the poles N S in the direction indicated by the upright arrow. In this and the other figures, except Fig. 8, six pairs of brushes are shown to each field-magnet pole. The six brushes of each set are numbered 1, 2, 3, 4, 5 and 6 respectively. The brushes in connection with the S-pole I will designate as S-brushes and those in connection with the N-pole as N-brushes. Those brushes through which the current enters the armature bars I will designate as "negative" brushes and those by which it leaves the bars as "positive" brushes. The negative pole or terminal P— of the machine is in connection with the negative S-brush No. 1, whence the current flows through the bars and past the S-pole to positive S-brush No. 1. From this brush it passes through a connecting conductor m to negative N-brush No. 1, and across through the armature bar past the N-pole and out through the positive N-brush No. 1. From this brush it passes through a conductor n to brush No. 2 of the first set. The course of the current is then continued through the four brushes No. 2, then through the four brushes No. 3, and so on, until the current emerges from positive N-brush No. 6 which is connected to the positive pole P+. The course of the current is thus approximately the same as in a Siemens drum armature, passing longitudinally along the sides of the drum and crossing spirally at its ends, with this difference, however, that the armature in this case is wound with but one layer of conducting bars or wires, and the current passes around solely in one direction instead of dividing into two paths flowing around opposite halves of the drum. At one end of the armature the like-numbered brushes of the two sets are connected by the conductors m m^2 m^3, &c., while at the other end of the armature the conductors n n^2, &c., connect the respective negative brushes Nos. 1, 2, 3, 4 and 5 with the positive brushes of one set in advance, namely, Nos. 2, 3, 4, 5 and 6 respectively. It is thus that the spiral arrangement of the current in the armature is secured.

The preferred construction for connecting the brushes is shown best in Figs. 5 and 6, Fig. 5 showing the brushes that are indicated at the right in Fig. 7, and Fig. 6 showing those indicated at the left. Both these views are transverse sections looking in the same direction. In the construction shown each brush B is clamped in a brush-holder H having a metallic stud I which passes through a corresponding hole in an arc-shaped supporting frame or yoke J, and is fastened firmly thereto by nuts, but is insulated therefrom. The projecting end of this stud I on the opposite side of the frame J is connected to an eye in one end of a bar or plate *m* or *n* as the case may be, a good electrical connection being made therewith by screwing a nut on the threaded end of the stem against the eye in the plate. The plates *m n* in these views constitute the connecting conductors *m n* shown in Fig. 7. The studs I I are numbered from 1 to 6 in these figures to correspond with the numbers of the brushes in Fig. 7. The plates *m n* are simply flat metal bars curved laterally at their middle part to avoid the shaft C. The plates *m* in Fig. 6 connect at their opposite ends with studs I I which are diametrically opposite, while the plates *n* in Fig. 5 are somewhat shorter since they connect with studs which are somewhat closer together. The successive plates m m^2 m^3, &c., and n n^2 n^3, &c., connecting the successive pairs of brushes are arranged in different planes, and are insulated from each other either by a sufficient intervening air space or by interposing any suitable insulating plates or otherwise. The yokes J J are conveniently mounted on standards J′ which are fixed on base-plates J^2, but fit into transverse grooves in the top of the base-plate E, and are secured thereto by bolts or nuts, by moving which the standards may be moved laterally outward to carry the entire set of six brushes away from the end of the armature in order to gain access thereto.

With the arrangement of six pairs of brushes to each field, as shown in the drawings, the electromotive force generated will be twelve times that which is induced in each armature bar. Thus, for example, if at a given speed a single bar exhibits a difference of potential at its opposite ends of, say, four volts, the total electromotive force generated at that speed will be forty-eight volts.

The brushes may be made of greater or less width so as to make contact with one, two or more armature bars at a time, whereby the conductivity of the armature conductors may be made greater or less as may be desired up to the limit imposed by the proximity of the brushes to one another, it being essential that at least one open-circuited armature bar shall intervene between each two successive brushes, as otherwise the bars would be short-circuited from brush to brush.

My improved dynamo is well adapted for the generation of a considerable current under comparatively low electro-motive force, such currents, for example, as are useful for incandescent electric lighting, electric smelting, electro-plating, &c. By increasing the number of brushes connected in series the electromotive force may be increased to any desired number of volts up to the limit that convenience may dictate for the number of connections *n n* or *m m* between the sets of brushes at the ends of the armature. These connections have the advantage of being stationary and readily accessible.

The improved dynamo provided by my invention has the simplest possible construction of field-magnet, and I believe the simplest possible construction of revolving armature, the latter consisting solely of a cylindrical core and a single layer of longitudinal conductors.

Fig. 8 is a view corresponding to Fig. 7, and showing but two pairs of brushes to each field of force. The connections are obvious. This figure shows the simplest application of my invention.

The same dynamo machine might be used to feed two or more circuits either by alternating the brushes of the second circuit with the brushes of the first circuit, or by utilizing a portion of the brushes for feeding one circuit and the remaining brushes for feeding one or more additional circuits. Thus the brushes numbered 1, 2 and 3 might be used for feeding one circuit, and 4, 5 and 6 for feeding a separate circuit.

My invention is not necessarily limited in its application to the precise construction of armature shown, as any armature of the "open coil" type, the coils of which terminate in sufficiently numerous commutator segments to admit of the application of the desired number of brushes in commutation with the coils which are passing each magnetic field may be utilized in connection with my invention.

I claim as my invention the following defined novel features and combinations, substantially as hereinbefore specified, namely:

1. The combination of an armature consisting of a cylindrical iron core overlaid with insulated longitudinal conducting bars, a field-magnet having a plurality of poles exterior to and facing the armature, so that as the armature turns its bars pass through successive fields of alternately contrary polarity, two or more pairs of commutator brushes to each field, the two brushes of each pair arranged to make simultaneous connection with the opposite ends of the armature bars passing them, and the successive pairs of brushes arranged to make successive connection with the armature bars, whereby the bars in their passage through each successive field are successively included in two or more brush-cir-

cuits, and conducting connections from brush to brush adapted to join the armature bars while in the respective magnetic fields serially in one or more external circuits.

2. The combination of an armature consisting of a cylindrical iron core overlaid with insulated longitudinal conducting bars, a field-magnet having a plurality of poles exterior to and facing the armature, so that as the armature turns its bars pass through successive fields of alternately contrary polarity, two or more pairs of commutator brushes to each field, the two brushes of each pair arranged to make simultaneous connection with the opposite ends of the armature bars passing them, and the successive pairs of brushes arranged to make successive connection with the armature bars, whereby the bars in their passage through each successive field are successively included in two or more brush circuits, and conducting connections from brush to brush adapted to join the armature bars in one or more external circuits, and the conducting connections extending between a negative brush of one field and a positive brush of another field, whereby the brushes are connected serially and the circuit is completed spirally around the armature.

3. The combination of an armature consisting of a cylindrical iron core overlaid with insulated longitudinal conducting bars, a field-magnet having a plurality of poles exterior to and facing the armature, so that as the armature turns its bars pass through successive fields of alternately contrary polarity, two or more pairs of commutator brushes to each field, the two brushes of each pair arranged to make simultaneous connection with the opposite ends of the armature bars passing them, and the successive pairs of brushes arranged to make successive connection with the armature bars, whereby the bars in their passage through each successive field are successively included in two or more brush circuits, stationary brush-holders for the respective brushes, supporting frames for the brush-holders at opposite ends of the armature, and connecting conductors between the brush-holders, each connecting a negative brush of one field at one end with the corresponding or successive positive brush of another field at the same end, whereby the armature bars are joined serially in a circuit traversing a bar in one direction through one field, then a bar in the opposite direction through a contrary field, and so on.

4. The combination of an armature A consisting of core *a* and insulated conducting bars *b b*, a field magnet F having contrary poles N S facing said armature, so that as the armature turns its bars pass through successive fields of alternately contrary polarity, a plurality of pairs of commutator brushes B B for each field, the two brushes of each pair arranged to touch simultaneously opposite ends of the bars passing them, and the successive pairs of brushes arranged to make successive connection with the armature bars, brush-holders for said brushes, having conducting studs I I, conducting bars *m m*, connecting at one end of the armature the studs of the negative brushes of one field with those of the corresponding positive brushes of the contrary field, and conducting bars *n n*, connecting at the other end the studs of the positive brushes of one field with those of the respective negative brushes of the contrary field.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

THOMAS L. WILLSON.

Witnesses:
ARTHUR C. FRASER,
JNO. E. GAVIN.