(No Model.) 3 Sheets—Sheet 1.

R. J. SHEEHY.

DYNAMO ELECTRIC MACHINE.

No. 359,894. Patented Mar. 22, 1887.

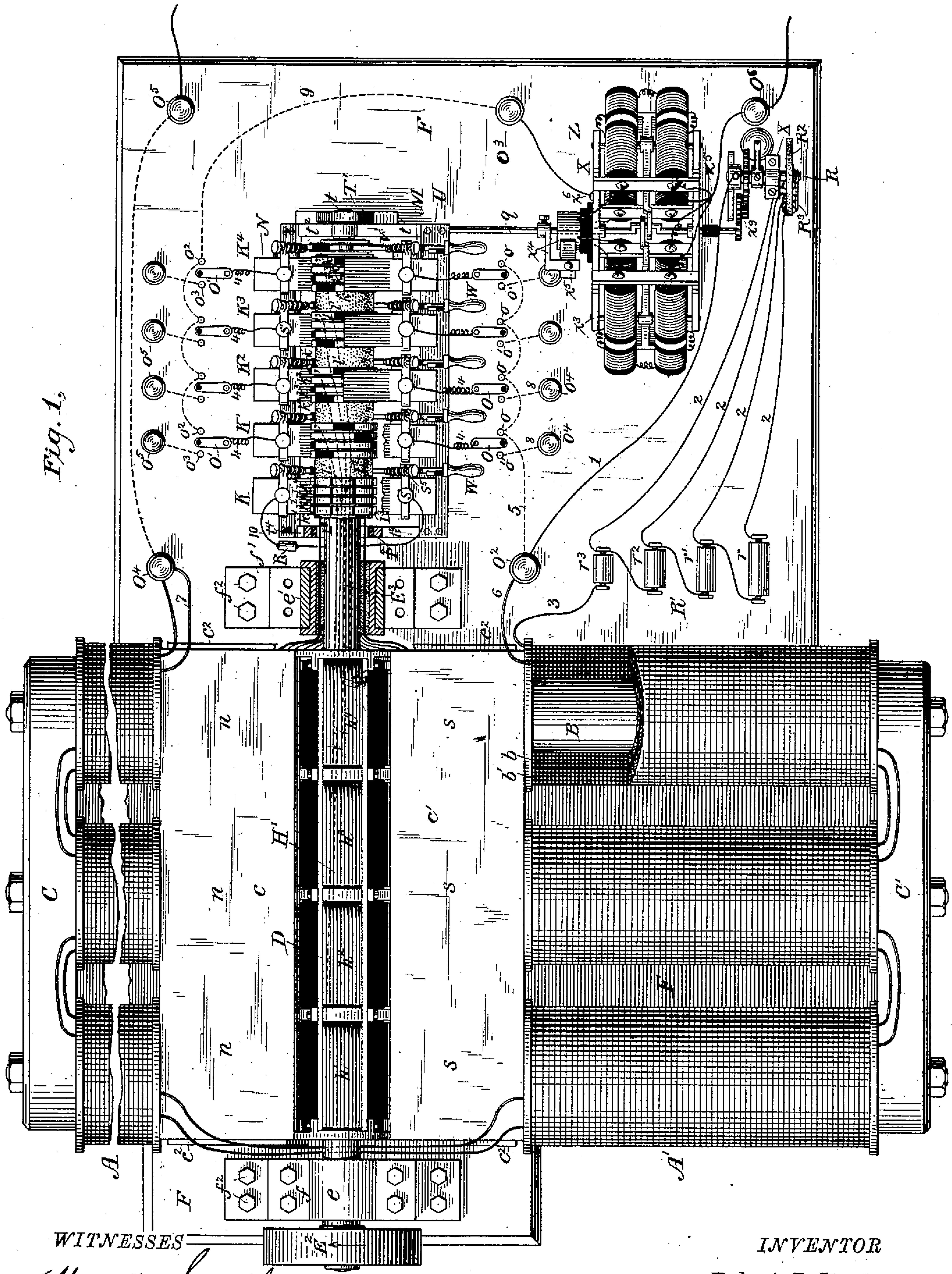

Fig. 1.

WITNESSES

Wm A. Skinkle

Geo W. Breck

INVENTOR

Robert J. Sheehy,

By his Attorneys

Pope Edgecomb & Butler

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 3 Sheets—Sheet 2.

R. J. SHEEHY.

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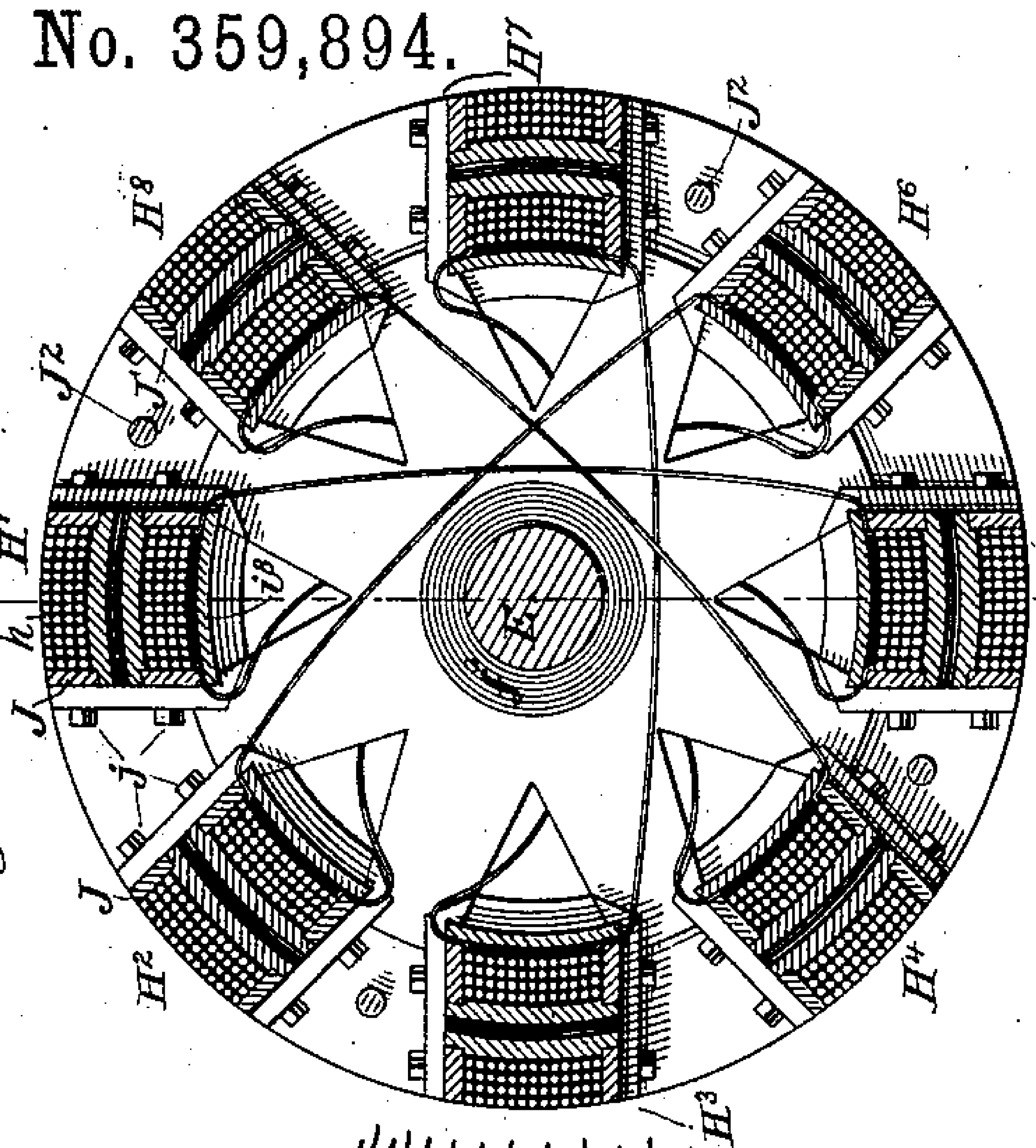

Fig. 4.

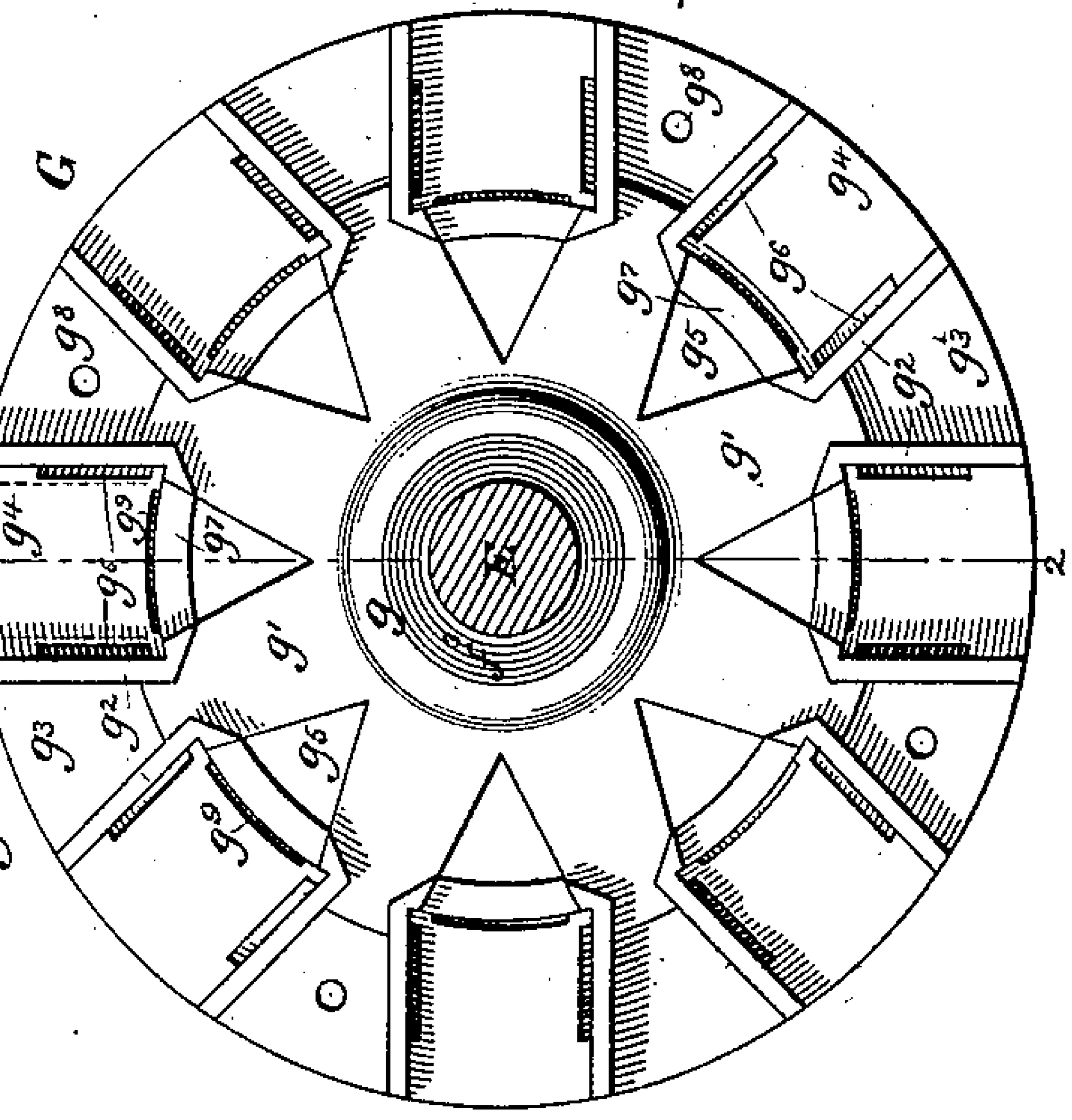

Fig. 5.

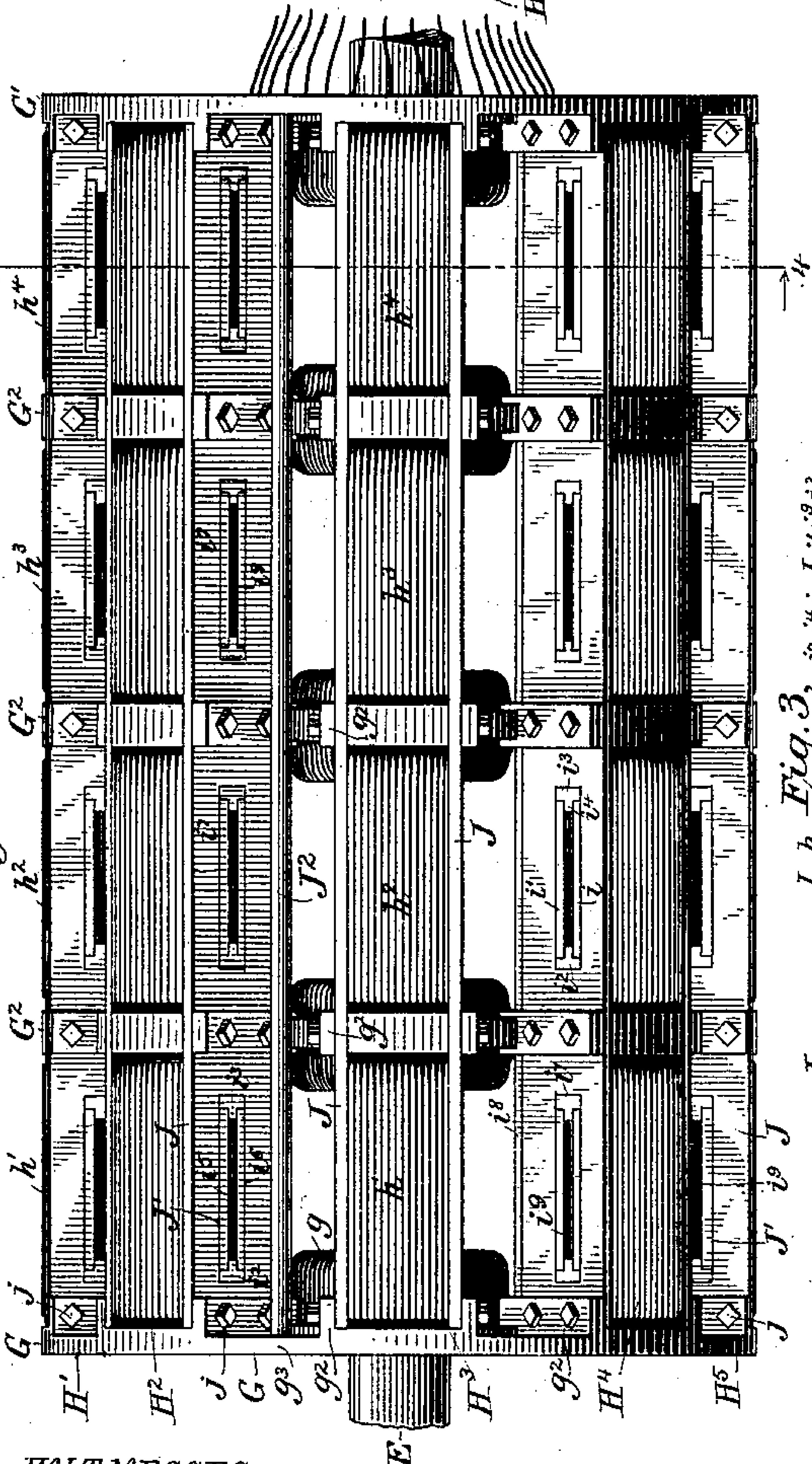

Fig. 2.

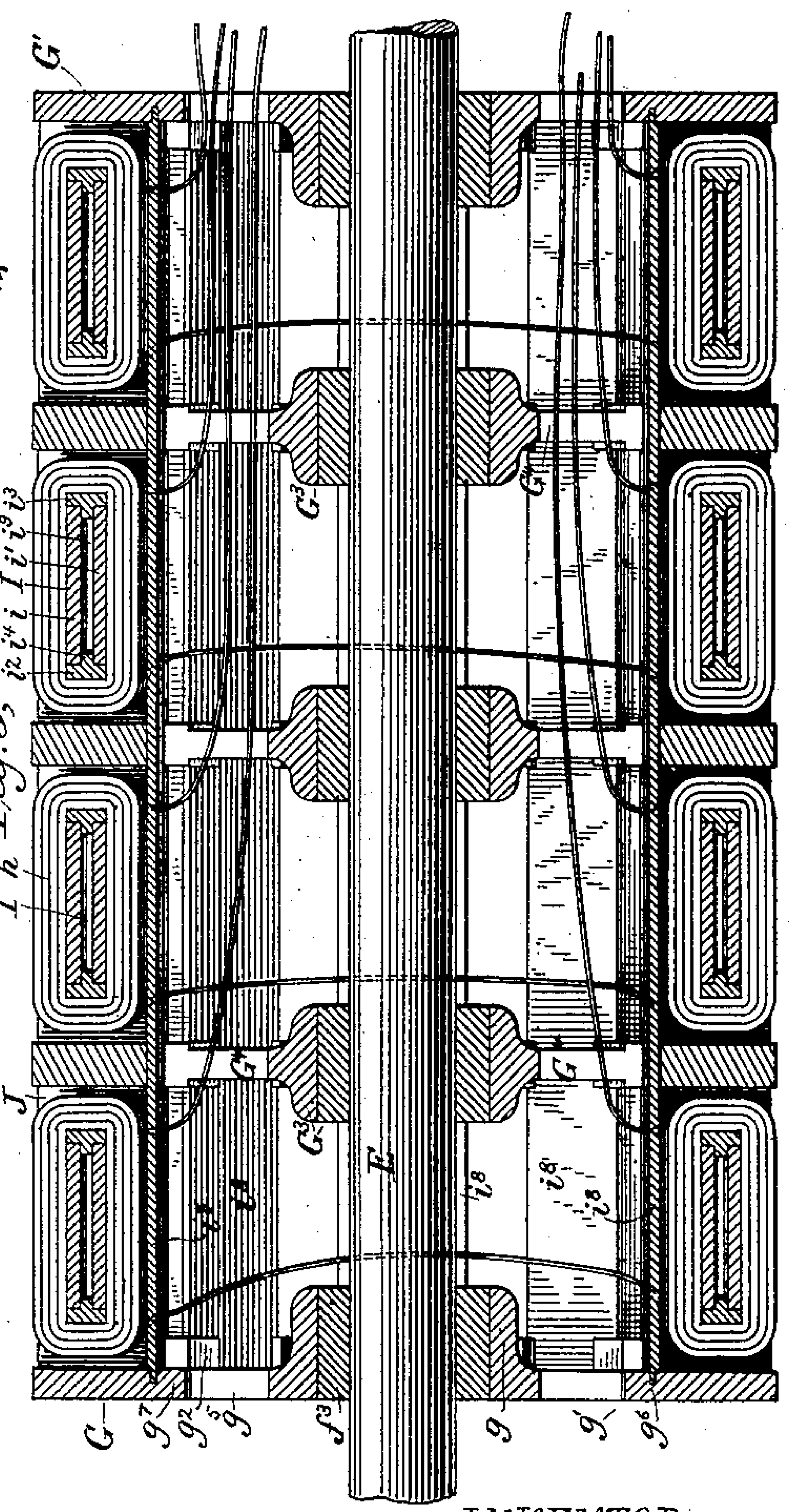

Fig. 3.

WITNESSES

Wm. A. Skinkle

Geo. W. Breck.

INVENTOR

Robert J. Sheehy,

By his Attorneys

Pope Edgecomb & Butler.

(No Model.) 3 Sheets—Sheet 3.

R. J. SHEEHY.

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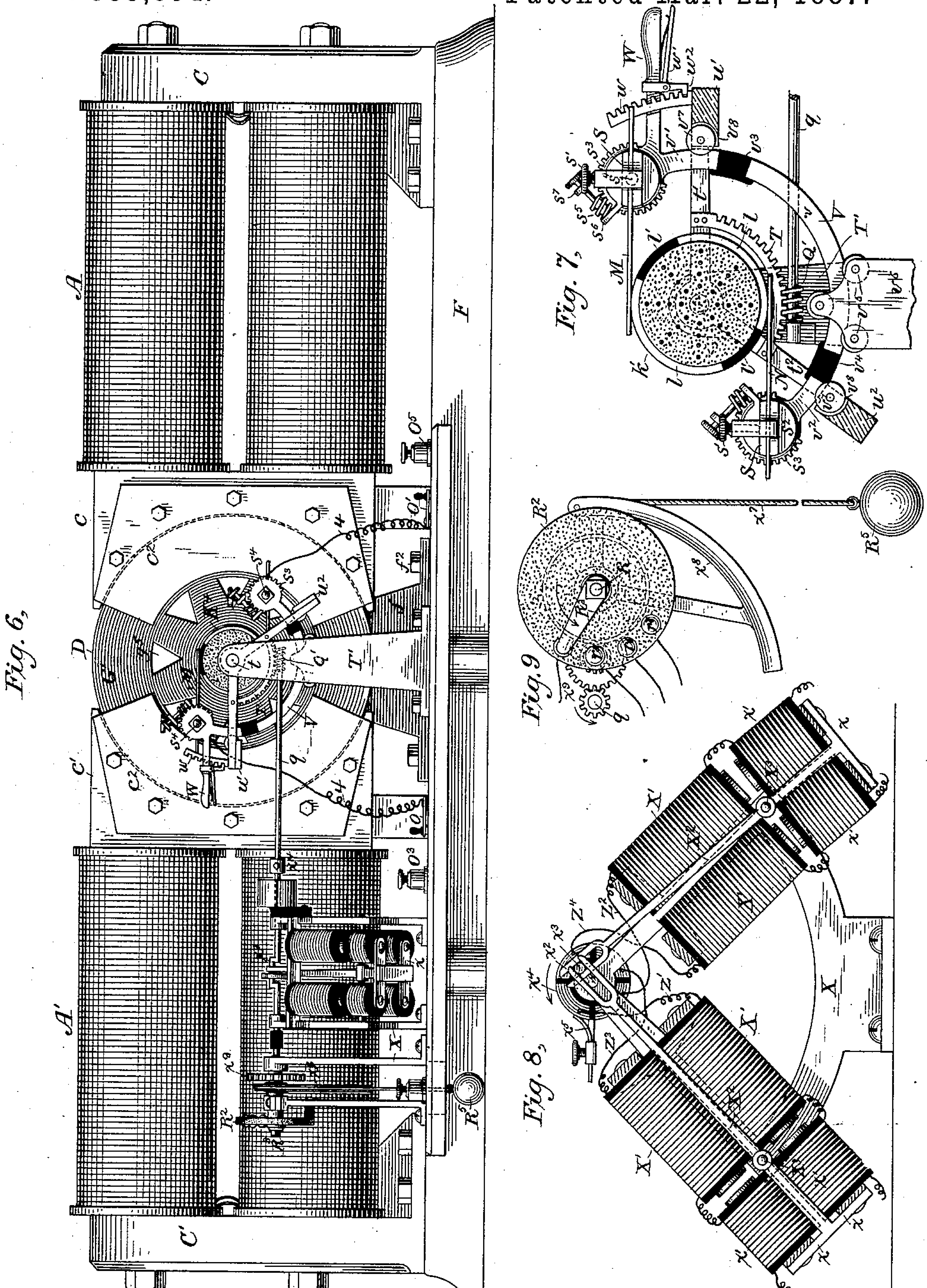

WITNESSES

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INVENTOR

Robert J. Sheehy,

By his Attorneys

Pope Edgecomb & Butler.

UNITED STATES PATENT OFFICE.

ROBERT J. SHEEHY, OF NEW YORK, N. Y.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 359,894, dated March 22, 1887.

Application filed November 7, 1882. Serial No. 76,138. (No model.)

To all whom it may concern:

Be it known that I, ROBERT J. SHEEHY, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Dynamo-Electric Machines, of which the following is a specification.

My invention relates to certain improvements in the construction of dynamo-electric generators, and in the application thereto of certain devices for determining the nature and regulating the strength of the currents generated thereby.

The objects of this invention are to improve the construction and efficiency of the so-called "dynamo-electric machine," to provide suitable means for determining the nature of the current or currents generated, and to automatically regulate the strength of said currents.

To this end one part of my invention consists in improvements in the armature, especially in the construction of the generating-coils and the metallic frame-work thereof. The frame is so constructed as to incase each of the said coils in metal upon all its faces, except that presented to the poles of the field-magnets, and to provide air-spaces in positions which it would be useless to occupy with metal; and, further, in employing, in conjunction with my improved armature, a commutator, through the agency of which only the currents of available strength are collected and transmitted to line, and at the same time sparks are prevented by automatically short-circuiting the coils when generating unavailable currents.

The invention also consists in an arrangement of circuits and switches in connection with the commutators, whereby the nature of the current or currents generated may be determined at will and the subdivision of the current into one or more circuits easily effected.

The invention also includes a method of and apparatus for maintaining a constant uniformity in the strength of current generated. To effect this regulation I make use of the variations in the strength of the current itself, employing said variations to more or less neutralize the field of force in which the armature is rotated. The field of force is established by the instrumentality of two series of confronting electro-magnets, each wound with two equal and opposing coils of insulated wire, one of said coils being included in the main or working circuit of the generator and serving to normally maintain the field of force by oppositely polarizing the confronting poles, while the other coil is included in a branch or neutralizing circuit. The strength of the current traversing the neutralizing-circuit is automatically controlled by means of an electro-magnetic motor actuated in accordance with the variations in the strength of the current traversing the main line. Thus when the current in the main line increases beyond a predetermined normal degree of strength the current traversing the neutralizing-circuit is increased in a corresponding ratio and the field of force proportionately decreased, or vice versa.

The invention also consists in applying to the commutator-brushes certain mechanical devices, first, for manually and independently adjusting the pressure of each; secondly, for manually and simultaneously adjusting the angular positions of contact of any pair of brushes; and, thirdly, of automatically adjusting a movable frame upon which the brushes are supported, and thus determining the precise positions of the arcs of the revolution of the armature within which the successive bobbins shall be disconnected from the collecting-brushes and connected with the short circuiting-brushes. These variations are closely correlated with the changes in the intensity of the magnetic field, and are therefore indirectly dependent upon the strength of the neutralizing-current. Availing myself of this principle, I give to the motor mentioned above, which governs the strength of the neutralizing-current, the additional function of varying the positions of contact of the brushes. Thus when the normal or standard intensity of the field is disturbed the motor simultaneously adjusts the commutator-brushes to suit the field, and operates to re-establish the said standard intensity.

The invention also consists in certain other improvements in construction of minor importance, the exact subject-matter being hereinafter specifically designated.

In the accompanying drawings, which illustrate my invention, Figure 1 is a plan view of the generator and motor, showing the relation of the latter to the commutator and resistance adjustments. Figs. 2, 3, and 4 are respectively a plan view, a longitudinal, and a transverse section, of the armature. Fig. 5 is a view of the inner face of one of the end disks of the armature detached. Fig. 6 is an elevation of the apparatus as appearing in Fig. 1, showing the commutator and its adjusting mechanism and the connection of the latter with the motor. Fig. 7 shows certain details of construction of the adjusting mechanism. Fig. 8 is a transverse section of the motor, and Fig. 9 shows certain details in the construction of the resistance-regulator.

Referring to the drawings, the field of force, within which the armature is caused to rotate, is created by means of two systems or groups of electro-magnets, A and A′. Each of the electro-magnets comprised in these systems consists of a soft-iron core, B, wound with two coils, b and b', of insulated wire. The two coils are constructed to have approximately equal but opposite magnetic effects upon the core B, when traversed by currents of equal strength. The inner coil, b, is included in the main or working circuit of the generator, while the outer coil, b', is included in a branch or neutralizing circuit, 1 2 3, in which is included an adjustable artificial resistance, the function of which is to determine the proportion of the total current which shall traverse the neutralizing-coils b'. The corresponding coils, b, of each electro-magnet of one series—for instance, A—are all wound or connected in the same direction, for the purpose of producing magnetism of a given polarity—say north—in the corresponding poles, n n, and likewise the coils b of the electro-magnets A′ are all wound or connected in the proper direction for producing magnetism of south polarity in the poles s, confronting the poles n of the electro-magnets A.

The outer ends of the cores of all the electro-magnets of the series A are united by means of a yoke, C, and likewise the outer extremities of the cores of the series A′ are connected by means of a corresponding yoke, C′. A common pole-piece, c, is used for the series of magnets A, and a similar pole-piece, c', for the series A′. The confronting surfaces of the pole-pieces c and c' are curved so as to form a cylindrical field-chamber, as shown in Fig. 6. This chamber is limited at each end by extension-pieces c^2 c^2, attached to the end surfaces of the pole-pieces c c'. The movable armature D is located within this cylindrical magnetic field-chamber. It is carried by a central shaft, E, supported at each end of the field in suitable bearings, e and e', formed within the standards f and f', respectively, which standards are secured to the base F of the machine by bolts f^2. The frame-work of the armature consists of two end plates and a suitable number of intermediate systems of radial braces, of which the figure shows three. The end plates are similar to each other, and each consists of a single casting. An inner face view of the plate G is shown in Fig. 5. It is provided with eight triangular air spaces or openings, g^5. Apart from these openings and the countersunk perforations g^8, for accommodating certain brace-bolts, the outer face of the plate is an uninterrupted smooth surface. The inner face of the plate is provided with an inwardly-projecting hub, g, (see also Fig. 2,) and also with projecting lugs g^2, arranged upon the inner face, as seen in the figure. The spaces g^3 of the plate metal, which are approximately triangular in shape, and which lie between the outer edges of adjacent lugs, are preferably of thinner metal than the remainder of the disk. The spaces between the inner edges of said lugs, which are approximately square, are provided with recesses, g^6 and g^9, the former to permit the entrance of the shoulders of the longitudinal girders which support the cores and bobbins, the latter to receive the shoulder of a curved plate of soft iron used for the purpose of magnetic induction.

The inner radial transverse braces, the sole office of which is to give greater strength to the armature than could be secured from the end plates alone, are each made up of a hub of soft iron, G^3, with radial projections G^4, each projection terminating in two flat pieces or lugs, which are attached by bolts to the said longitudinal girders, thereby holding them rigidly in place.

The bobbins h are supported between the longitudinal plates J, the ends of the cores being attached to said plates. The cores of these bobbins are preferably constructed in four sections, i, i', i^2, and i^3. The transverse sections of the plates i and i' are rectangular, and the plates are curved in the direction of their length, so as to coincide with circles concentric with the axis of the shaft E. The two sections i^2 and i^3 are constructed to fit upon the respective ends of the sections i and i', and are for this purpose correspondingly curved and provided with inwardly-projecting lugs i^4, which extend between the adjacent extremities of the sections. The compound cores thus formed are provided with extensions or tongues, forming a compound tenon, i^7, which fits tightly into mortises or apertures J′, formed in the longitudinal girders J′. These girders are parallel with the central shaft, E, (see Fig. 2,) and two are provided for each longitudinal series H of bobbins h, one girder being placed upon each side thereof.

Beneath the inner surface of each series of bobbins H is placed a longitudinal soft-iron inducing-plate, i^8, (see Figs. 3 and 4,) somewhat similar in its general construction to the core-sections i and i', but extending the entire length of the armature. The extremities of the plates i^8 enter the recesses g^9, as already explained. They completely underlie the inner surfaces of the bobbins h. The entire armature is securely bound together by means of soft-iron bolts or rods J^2, extending longitudinally between the two cylinder-heads G and G' and entering the openings g^8 therein. These rods may or may not be wound with coils of inductive wire.

The object of employing hollow cores with open ends and of providing the triangular openings g^5, as well as the openings which occur between the longitudinal girders, is to allow a free circulation of air throughout the entire armature. I prefer to distribute these openings in the manner shown, for if the same spaces were occupied by metal such metal would not be in the immediate proximity of the coils h of the insulated wire, and, therefore, while adding to the weight, would add nothing to the efficiency.

At one end, E', of the shaft E is keyed a suitable driving-wheel, E^2, by means of which motion may be communicated from any suitable source of power to the armature.

Upon an extension, E^3, at the opposite end of the shaft, is secured a suitable system of commutators, by means of which the successive alternating currents generated in the coils h of the armature D are collected, in accordance with their polarity, as hereinafter explained. The commutator comprises five distinct sections, K K' K^2 K^3 K^4, and each of these sections is subdivided into four segmental rings, k' k^2 k^3 k^4. The section K, hereinafter called the "short-circuiting" section, comprises thirty-two insulated conducting-segments arranged in eight axial series, L' L^2, &c., respectively corresponding to and parallel with the eight series H of coils h. Thus for every bobbin in the armature there is a corresponding segment in the section K, to which the outer terminal of said bobbin is connected. The inner terminals of the bobbins are connected each with that of the bobbin situated diametrically opposite it in the armature.

Each of the four segmental rings k', k^2, k^3, and k^4 of the remaining commutator-sections K', K^2, K^3, and K^4, hereinafter called the "collecting-sections," consists of two conducting surfaces or segments, l l, between the adjacent ends of which intervene short segments l' l' of non-conducting material, preferably compressed paper. The respective segmental rings k', k^2, k^3, and k^4 of each section K', K^2, K^3, and K^4 are so arranged that the non-conducting segments l' l' of each section succeed each other consecutively as regards their angular position, as is clearly shown in Fig. 1.

The terminals of the bobbins h are connected through the individual segments of the commutator-section with the conducting-segments l of the collecting-sections K', K^2, K^3, and K^4 in the following manner: The terminal of the bobbin h' of the series H', for instance, is united with that segment upon the short-circuiting commutator-section K which is situated in the vertical series k' and longitudinal series L', and through that segment with the particular conducting-segment of the vertical ring k' of the collecting-commutator K' which occupies a position with reference to the shaft E one-quarter of a revolution in advance of that coil. Likewise the corresponding terminal of the bobbin h^2 of the series H' is connected through the segment of the ring k^2 in the series L' with the corresponding conducting-segment l of the commutator-ring k' in the section K^2, and the coils h^3 and h^4 of the series H' are connected in the same manner through the segments of the rings k^3 and k^4 in the series L' with the corresponding segments l in the commutator-sections K^3 and K^4. The corresponding terminals of the coils h', h^2, h^3, and h^4, comprising the next succeeding series H^2, are in like manner connected through the next succeeding row, L^2, of commutator-segments in the short-circuiting section K with the corresponding segments of the sections K', K^2, K^3, and K^4, respectively.

By following out this construction it will be observed that the coils in the series H^4 will be connected with segments of the fourth segmental ring k^4 of the respective sections K', K^2, K^3, and K^4. The coils of the fifth series H^5, being the one diametrically opposite the first series, H', have their respective inner terminals connected with the inner terminals of that series. The remaining terminals of the series H^5 will therefore be connected through the segments of the commutator-section K, diametrically opposite those to which are connected the coils of the series H', with the conducting-segments l of the first segmental rings k', diametrically opposite those segments to which the coils of the series H' are connected. The same construction is followed out with respect to the remaining coils.

For the purpose of collecting the successive currents of alternating polarity generated in the coils h by the revolutions of the armature through the field of force, I employ two series of commutator-brushes, M and N, constructed to press upon the upper and lower surfaces of the commutator-section, respectively. One pair of brushes is provided for each section of the commutator.

In practice I find that there is with every revolution of any coil a certain fraction or arc of the revolution during which the coil generates little or no current, rendering it advisable that it should be withdrawn from the working-circuit, so as to relieve that circuit of its resistance. With this in view I have given to the insulating commutator-sections l' such angular positions and length in every instance that during these intervals they (the insulating-sections) will be in contact with the brushes. At the same time, to prevent sparks, the coils thus withdrawn are short-circuited through the short-circuiting section K, the brushes of which are, during the same intervals, in contact with the segments respectively connected with the coils thus opened at the collecting-section of the commutator. The brushes M and N of the short-circuiting section of the commutator are accordingly connected together by conductor 10, in the circuit of which may be included an adjustable resistance. In this manner each line of coils will be short-circuited during that portion of its revolution in which the currents generated are changing from a given polarity to the opposite.

The currents collected upon the brushes M are of opposite polarity to those collected by brushes N, and the currents collected by the several sections of the commutator may be employed independently or in conjunction both for maintaining the field of force and for performing outside work. To readily accomplish this end, I connect each of these commutator-brushes M with a corresponding switch, O, and each of the brushes N with corresponding switches, O′, by means of flexible wires 4 4. The several switches O and O′ are each provided with two contact-points, o o' and o^2 o^3, respectively, and may be placed at will upon either of these. The contact-points o are all in electric connection with each other and with a binding-post, O^2, through a wire, 5, and the binding-post O^2 is connected by a conductor, 6, with one terminal of the working-coil b of the field-magnets A′. After traversing both series of field-magnets A′ and A, the connection is continued by a conductor, 7, to a binding-post, O^4, and thence to a binding-post, O^5. The contact-points o' are each connected by conductors 8 with separate binding-posts o^4. Likewise the contact-plates o^2 of the switches O′ are connected with each other and with a binding-post, O^3, by a conductor, 9, and the plates o^3 with individual binding-posts o^5.

By placing the switches O and O′ in contact with their connected contact-plates o and o^2, respectively, a circuit will be completed from all the collecting commutator-brushes through the field-magnets to the binding-posts O^3 and O^5, and thus through any desired circuit, including electric lights or other apparatus connected therewith. This arrangement would be preferable for multiple-arc lighting, electroplating, or other purposes requiring currents of considerable quantity.

When it is desired to employ only a portion of the current generated for maintaining the field of force and to connect with one or more distinct circuits, the switches O and O′ of one or more commutator-sections, K′, K^2, K^3, and K^4 may be placed upon their respective contact-points o' and o^3, and the terminals of that circuit connected with the corresponding binding-posts, o^4 and o^5. By the proper manipulation of these switches, quantity or intensity currents may be derived from the machine at will, or the currents may be subdivided and supplied to a number of different circuits.

As the resistance of the external circuit connected with a generator is usually subject to a continual fluctuation, the intensity of the field of force, and consequently the amount of current generated in the armature, will vary in inverse proportion thereto. Thus, if for any cause the resistance of the external circuit be suddenly diminished, as by the short-circuiting of an electric light included therein, the strength of the current traversing the coils of the field-magnets will be increased and the current generated will also be increased, and vice versa. For the purpose of compensating for the effect thus produced by any sudden change in the external resistance, and to maintain the strength of the current traversing the external circuit as constant as possible, I make use of a neutralizing shunt or branch circuit and a motor, Z, which is preferably included in the external circuit of the generator, and which is so constructed as to automatically determine the proper amount of artificial resistance to be included in the neutralizing-circuit. One terminal of the branch or neutralizing circuit 1 2 3 is connected with the binding post O^2. The shunt-circuit passes then through an automatic-switch mechanism; thence by one or other of conductors 2 and the artificial resistance therein included, and thence by conductor 3 to the series of opposing or neutralizing coils b' of the field-magnets A and A′, again uniting with the main line at the binding-post O^4. Any portion of the current which traverses this circuit will, it is evident, act in opposition to that traversing the main circuit of the field-magnets. If, therefore, the strength of the current generated be increased from any cause, the portion traversing the opposing coils b' will also be increased, and will tend to neutralize or reduce the intensity of the field of force and thus react upon the armature.

The opposing or neutralizing coils will not of themselves exactly compensate for the fluctuations in the resistance of the external circuit, and I therefore employ in addition thereto a series of graduated artificial resistances, R′, a greater or less number of which are included in the shunt or neutralizing circuit, according as it is desired to cause a smaller or greater portion of the current generated to traverse the opposing or neutralizing coils.

The graduated resistance R′ consists of a series of artificial resistances, r r', &c., of different capacities. These are respectively included in the branch circuits 2 2 of the neutralizing-circuit. One terminal of each of the branches is connected with an insulated contact-plate, r^5 r^6, &c., (see Fig. 9,) mounted upon the face of a disk, R^2, into contact with either one of which a switch-arm, R^3, connected with the conductor l, may be placed.

I prefer to control this device, and thus automatically regulate the amount of resistance included in the branch circuit, by means of the motor Z, in the following manner: The switch-arm R^3 is attached to a shaft, R, mechanically controlled by the motor, and the disk R^2, carrying the contact-plates r^5 r^6, &c., is secured to the frame X of the motor in such a position that the contact-arm R^3 will be placed, by the revolution of the shaft R, in successive contact with the contact-plates r^5 r^6, &c. As the increasing currents in the main line cause the motor-shaft q to revolve in the direction indicated by the arrow, the shaft R will also be revolved in the same direction and close the circuit successively through the respective resistances. The positions of the contact-plates r^5 r^6, &c., with reference to the arm R are such that the action of the motor under the influence of a current of increased strength will cause a resistance, r' r^2, &c., of a given quantity to be replaced by one of less quantity. The strength of the current traversing the neutralizing-circuit will thereupon be increased, and the intensity of the field of force decreased proportionately.

The relations of the resistances to each other and to the electric devices may be variously adapted to the circumstances under which the generator is to be employed. Thus, if fifty electric lamps, for instance, are to be included in circuit with the generator, I prefer to employ forty-eight contact-points, each succeeding one being connected with the neutralizing-coils through an artificial resistance differing from the preceding by an amount proportionate to the resistance of one lamp. If, therefore, the switch-arm R^3 normally be in a position to leave the neutralizing-circuit open, and the full number of lamps be included in circuit, the entire current will traverse the coils b of the field-magnets and also the electro-magnets of the motor. The latter is, however, so adjusted that it will remain inactive so long as the resistance offered by the fifty lamps is in circuit. When, however, one or two lamps, for instance, are cut out of circuit, the strength of the current will be increased sufficiently to actuate the motor, and thus cause the switch-arm R^3 to be moved to the first contact-point, r'. This movement will close the neutralizing-circuit through a resistance of sufficient magnitude to allow only so much current to traverse the neutralizing-coils b' as is required to reduce the strength of the field of force, and consequently the electro-motive force of the current generated in the armature sufficiently to compensate for the decrease in the resistance of the main circuit. The motor will remain in this position so long as the resistance of the main circuit remains proportionate to the remaining forty-eight or forty-nine lamps, the strength of current being insufficient to operate the motor in opposition to the increased retractile force which is now exerted upon the shaft R, in a manner hereinafter to be described. When, however, one or more additional lamps are cut out of circuit, the resistance of the main circuit will be decreased and the strength of current increased sufficiently to again actuate the motor Z, and cause the shaft R to be further rotated in the direction indicated by the arrow. The neutralizing-circuit will thereupon be closed through a resistance sufficiently less than the preceding one to compensate for the decrease in the resistance of the main circuit, thereby decreasing the strength of the current generated.

The same method of operation is continued throughout the series, the strengths of the currents traversing the two opposing systems of coils b and b' becoming more nearly equal at each reduction in the resistance of the external circuit. When all the lights are out of circuit, the resistance of the external and the neutralizing circuits will be approximately equal.

The intensity of the field of force is, as heretofore stated, varied by changes in the magnetization of the field-magnets, and accordingly the positions of the arcs of the revolution of the armature within which it is expedient that the successive coils should remain in connection with the external circuit, for the purpose of obtaining a current of the greatest volume, must also be varied; hence it becomes essential to readjust the positions of the commutator-brushes for every change in the strength of the current traversing the neutralizing-circuit. The means whereby I accomplish this result consist in combining, with the motor Z, before referred to, the device, hereinafter described, for moving the commutator-brushes forward or backward upon the peripheries of their respective commutator-sections.

When the motor Z is set in motion, either by an increase or decrease in the normal strength of the current traversing its coils, it turns a shaft, q, carrying an endless screw or worm, Q', at its extremity, in one direction or the other. This motion is communicated to the commutator-brushes by means of a toothed segment, T, with which the worm Q' engages. The segment T is attached to two arms, t' and t^2, which are supported by and turned upon a stud or pivot, t, on the standard T', at a point in line with the axis of the commutator-sections K. The extremity of the arm t' is secured to a plate, u', of dry wood or other non-conducting material, which extends beneath the commutator-brushes M, parallel with the axis of the commutator. The arm t^2 is likewise secured to a strip, u^2, extending upon the opposite side of the commutator, beneath the brushes N. The opposite extremities of the strips u' and u^2 are respectively attached to the extremities of two arms, t^3 and t^4, corresponding to the arm t' and t^2, and constructed to revolve upon a collar, T^2, surrounding the commutator-shaft E'. Thus the two strips u' and u^2, together with the arms t', t^2, t^3, and t^4, constitute a rectangular frame, U, movable upon an axis coincident with the axis of the commutator-shaft, the angular position of which frame is controlled by the worm S' and rack T, through the instrumentality of the motor Z.

The position of the frame U is made to govern the positions of the commutator-brushes M and N by means of a series of semicircular rockers, V, upon the opposite extremities of which the respective sets of commutator-brushes M and N are carried. One of these rockers V is provided for each pair M N of commutator-brushes, and each consists of a circular segment, v, concentric with the commutator and carrying at its respective ends the extensions v' and v^2. The extensions v' and

v^2 are respectively insulated from the section v by intervening blocks, v^3 and v^4. The semicircular rockers V are each movably supported by means of three small wheels, v^5, within the grooves formed in the peripheries of which the edge of the rocker is constructed to move. The wheels v^5 are each mounted upon a suitable arbor, v^6, projecting from a standard, V^6, secured to the base F of the machine. One wheel engages the inner edge of each rocker V, and the remaining two support the same upon the lower or outer edge. The rockers V are further supported at their respective ends by grooved guide-wheels v^7, similar in their construction to the wheels v^5, and carried in suitable brackets, v^8, extending from the nonconducting bars u and u'.

Each of the rockers V is adjustably united to the frame U through the medium of a lever, W, secured to the extremity v', and a spring-lever, w', constructed to engage a ratchet, w, consisting of a notched segment of a circle secured to the plate u' of the frame U. Each spring-lever w' carries a dog, w^2, which engages in the notches upon the periphery of the ratchet w. By means of this dog and ratchet the angular position of each rocker V with reference to the frame U may be manually adjusted.

To further facilitate the adjustment of the individual commutator-brushes M and N, I prefer to attach each brush to the extremity v' or v^2 of its corresponding rocker, V, by means of an adjustable clamp, S, to which they are secured by suitable set-screws, s'. The clamps S each form a part of a disk, s^2, and are mounted by means of a stud, s^4, projecting from the disk through the enlarged end s^3 of the rocker V. The stud s^4 constitutes an arbor upon which the clamp may be revolved in either direction. An endless screw or worm, s^5, carried in fixed bearings formed in two lugs, s^6 and s^7, extending from the disk s^2, engages a serrated segment of the periphery of the extension s^3 of the rocker V. By turning the worm s^3 in one direction or the other, the disk s^2 and clamp holding the brush may be revolved correspondingly, thereby causing the particular commutator-brush supported thereby to press with more or less force against the periphery of its corresponding commutator-section.

The form of motor which I prefer to employ for actuating the contact-arm R^3 and worm Q', and thus regulating the strength of current in the neutralizing-circuit and the positions of the commutator-brushes M and N, is illustrated in Figs. 1 and 8. Its essential construction is similar to that described in a patent issued to me on May 29, 1877, No. 191,478; but it differs therefrom in certain details.

Within a frame, X, are placed four electro-magnets, X', which are preferably arranged in pairs, the cores of the two pairs being placed at an angle of about ninety degrees. Between the electro-magnets of each pair extends a lever, X^2, supported upon an arbor, X^3, which has its bearings in the frame X. At one end of each of the levers X^2 are two arms, x, extending therefrom in opposite directions and supporting the armatures x' of the corresponding electro-magnets. The armatures x' each consist of an electro-magnet included in the same circuit with its corresponding electro-magnet, and so wound that a current traversing both the electro-magnet and armature simultaneously will produce magnetism of opposite polarity in their confronting poles. The armatures x' are placed at a sufficient distance from the poles of their respective electro-magnets to permit the supporting-lever X^2 to be vibrated upon their arbors X^3 under the influence of the successive magnetizations and demagnetizations of the same.

The extremities of the levers X^2, which are remote from the armature x', are forked, as shown at x^2. The prongs of these forks embrace a crank, x^3, which forms a part of the horizontal shaft q, upon one extremity of which is carried the worm Q'. If an electric current be caused to traverse the various electro-magnets X' in the proper succession, the armatures x' will be caused to oscillate, thereby communicating a vibratory movement to the forked ends of the levers X^2. This vibratory movement will be converted into a rotary motion of the crank x^3, in a manner well understood.

For the purpose of closing a circuit through the electro-magnets X' at the proper intervals and in the required succession, I provide a commutator, X^4, rigidly supported upon the frame X, but insulated therefrom. The periphery of the commutator is divided into four segments, against which presses a contact-brush, x^5, rigidly attached by clamp x^4 to the shaft q, and in electrical connection therewith through the frame X. The successive segments of the commutator X^4 are in electrical connection through the conductors Z', Z^2, Z^3, and Z^4, respectively, with the alternate electro-magnets X'.

The electric motor Z is, as before stated, preferably included in the main circuit of the generator, which enters the motor at a point, x^6, of the frame X, and leaves by conductor z^5, passing to binding-post O^6.

The tendency of any electric current traversing the shunt-circuit will be to actuate the motor and rotate the shaft x^3 in the direction indicated by the arrow.

For the purpose of controlling and graduating the motion of the shaft R, I provide a counterpoise, R^5, acting in opposition to the motor. The weight R^5 is suspended by a cord, x^7, from one extremity of a grooved cam, x^8, adjustably secured to a shaft, R, by a set-screw. The shaft R is connected with the motor-shaft q through a train of gear-wheels, x^9. The wheels x^9 are arranged to rotate the shaft R, and therefore the cam x^8, in the direction indicated by the arrow when the motor is actuated by increases of current. The point of suspension of the weight x^6 will thereby be carried farther from the center of the shaft R and its leverage thereon proportionately increased. It is evident thus that the longer the motor Z continues to operate under the influence of the current traversing the shunt-circuit the greater will be the strength of current required to actuate it in opposition to the counterpoise. When the current traversing the main circuit is of the normal or standard strength, the motor will remain at rest.

From the above description it will be seen that the motor simultaneously and automatically performs two functions—namely, first, that of adjusting the commutator-brushes to suit the intensity of the magnetic field, and, secondly, that of re-establishing the standard or normal strength of field when for any reason it is disturbed.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, of a bobbin, a hollow core of rectangular cross-section curved in the direction of its length in conformity with the cylindrical field-chamber in which it revolves, and longitudinal girders to which the ends of said core are attached.

2. The combination, substantially as hereinbefore set forth, of a bobbin, a hollow core of longitudinal cross-section curved in conformity with the cylindrical field in which it revolves, tongues upon either end of said core, and longitudinal girders for supporting said core, provided with openings to receive said tongues.

3. The combination, substantially as hereinbefore set forth, of bobbins arranged in longitudinal series, the curved hollow cores of rectangular cross-section and provided with the end tongues, longitudinal girders on each side of the series of cores and extending the entire length of said series, and a succession of openings in said girders for receiving said tongues.

4. A hollow core provided with open ends and end tongues and the frame-work of an armature provided with openings to receive said tongues.

5. The combination, substantially as hereinbefore set forth, of two longitudinal girders, the bobbins arranged in longitudinal series between said girders, and a plate of soft iron placed beneath said longitudinal series and extending its entire length for the purpose of enhancing the inductive action of said bobbins.

6. The combination, substantially as hereinbefore set forth, of longitudinal girders provided with tongues at either end, plates of soft iron underlying the longitudinal spaces between said girders, also provided with tongues at either end, and end disks provided with recesses for receiving the tongues of said girders and underlying plates.

7. The combination, substantially as hereinbefore set forth, of the horizontal shaft, the end plates provided with recesses, the longitudinal girders, and the underlying magnetizing-plates fitted into said recesses, the cores held in place by said girders, and the systems of transverse braces, the whole constituting the skeleton frame-work of the armature of a dynamo-electric machine.

8. In an electric generator, the combination, substantially as hereinbefore set forth, of one or more field-magnets, two or more series of armature-coils, the inner terminal of each of which coils is electrically connected with the inner terminal of the diametrically-opposite coil, a commutator for each series of coils, commutator-brushes for collecting the currents generated in each series of coils independently, and means, substantially such as described, for electrically connecting each pair of brushes to separate conductors or to a common conductor.

9. In an electric generator, the combination, substantially as hereinbefore set forth, of the series of commutators, the series of commutator-brushes, the independent rockers supporting said brushes, and the longitudinal supports to which said rockers are independently and adjustably attached.

10. The combination, substantially as hereinbefore set forth, of a commutator, two or more commutator-brushes pressing upon the surface of said commutator, means for independently adjusting the angular positions of said commutator-brushes, and mechanism, substantially such as described, for automatically changing the angular adjustment of all of said brushes simultaneously.

11. In an electric generator, the combination, substantially as hereinbefore set forth, of an armature, a series of commutator-segments, a series of commutator-brushes, and an adjustable frame for supporting said brushes, consisting of a series of rockers carrying at their respective extremities adjustable clamps for supporting the brushes, and two longitudinal non-conducting bars, to which each of said rockers are adjustably attached.

12. The combination, substantially as hereinbefore set forth, of a shaft, two or more annular series of coils of insulated wire placed longitudinally upon said shaft, the inner ends of the diametrically-opposite coils of said series being connected, a commutator having a series of conducting contact-segments for each series of coils, to the diametrically-opposite segments of each of which commutator-sections the outer terminal of each of the corresponding coils of insulated wire are connected, two commutator-brushes resting upon the surface of each commutator-section and simultaneously electrically connecting the outer terminals of the opposite coils of two or more of the series with an external circuit.

13. The combination, substantially as hereinbefore set forth, of an armature having one or more longitudinal series of coils, the inner terminals of diametrically-opposite coils being joined, a commutator divided into two divisions, each embracing a series of contact-segments, respectively corresponding to each coil, opposite segments in both divisions being connected to the remaining terminals of said coils, and brushes for connecting the seg-

ments in one division at times to the line-conductor, and brushes for connecting the segments in the other division with each other when not connected to line.

14. The combination, substantially as hereinbefore set forth, of an armature, a commutator divided into two divisions, one division for collecting and transmitting to line the available currents generated in the several working-circuits of said armature, and the remaining division for successively short-circuiting said working-circuits when generating currents of unavailable strength, brushes applied to said short-circuiting division, an electric circuit connecting said brushes, and an adjustable resistance in said electric circuit.

15. The combination, substantially as hereinbefore set forth, of one or more field-magnets, each constructed with a magnetizing and neutralizing coil, an armature constructed with two or more annular series of inductive coils, a commutator having an independent segment for each of said coils, commutator-brushes for collecting the currents from each annular series of inductive coils independently, means for connecting said brushes in pairs or in series, an external circuit connected with one or more pairs of said brushes, a branch conductor including in its circuit the neutralizing-coils of the field-magnets, and an electric motor actuated in response to the variations in the strength of the current traversing said external circuit to control the strength of the current traversing the said branch circuit.

16. The combination, substantially as hereinbefore set forth, of the field-magnets of an electric generator, each constructed with a magnetizing and an equal and opposing or neutralizing coil, an armature revolving within the field of said magnets, the external circuit of said generator, a branch circuit including the neutralizing-coils of said field-magnets, a graduated artificial resistance included in said branch circuit, an electric motor operated by and responding to the changes in the strength of the currents traversing said external circuit, and a device simultaneously actuated by said motor for adjusting the position of the commutator-brushes of said generator.

17. The combination, substantially as hereinbefore set forth, in a dynamo-electric generator, with the field-magnet helices, of a system of generating-coils arranged in different series, independent commutators receiving the currents from the different series, commutator-brushes applied thereto, and switches applied to the commutator-brushes, whereby one or more of the series of coils may be connected in circuit with the field-magnet helices, while the remaining coils are connected in circuit with the external circuit.

In testimony whereof I have hereunto subscribed my name this 6 h day of November, A. D. 1882.

ROBERT J. SHEEHY.

Witnesses:

DANIEL W. EDGECOMB,

MILLER C. EARL.