(No Model.) 4 Sheets—Sheet 1.

C. J. VAN DEPOELE.

ALTERNATING CURRENT MOTOR.

No. 408,641. Patented Aug. 6, 1889.

Fig. 1.

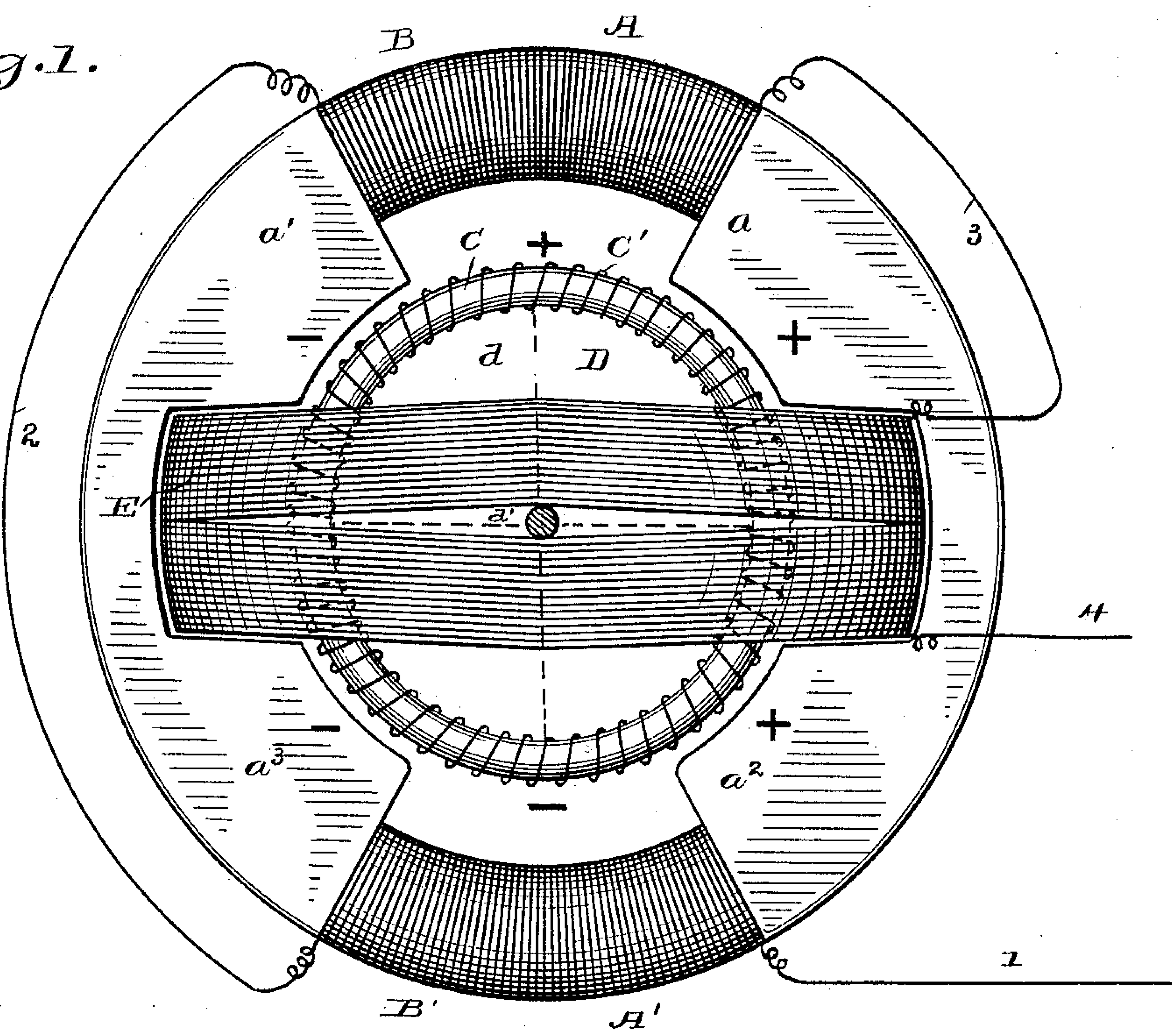


Fig. 2.

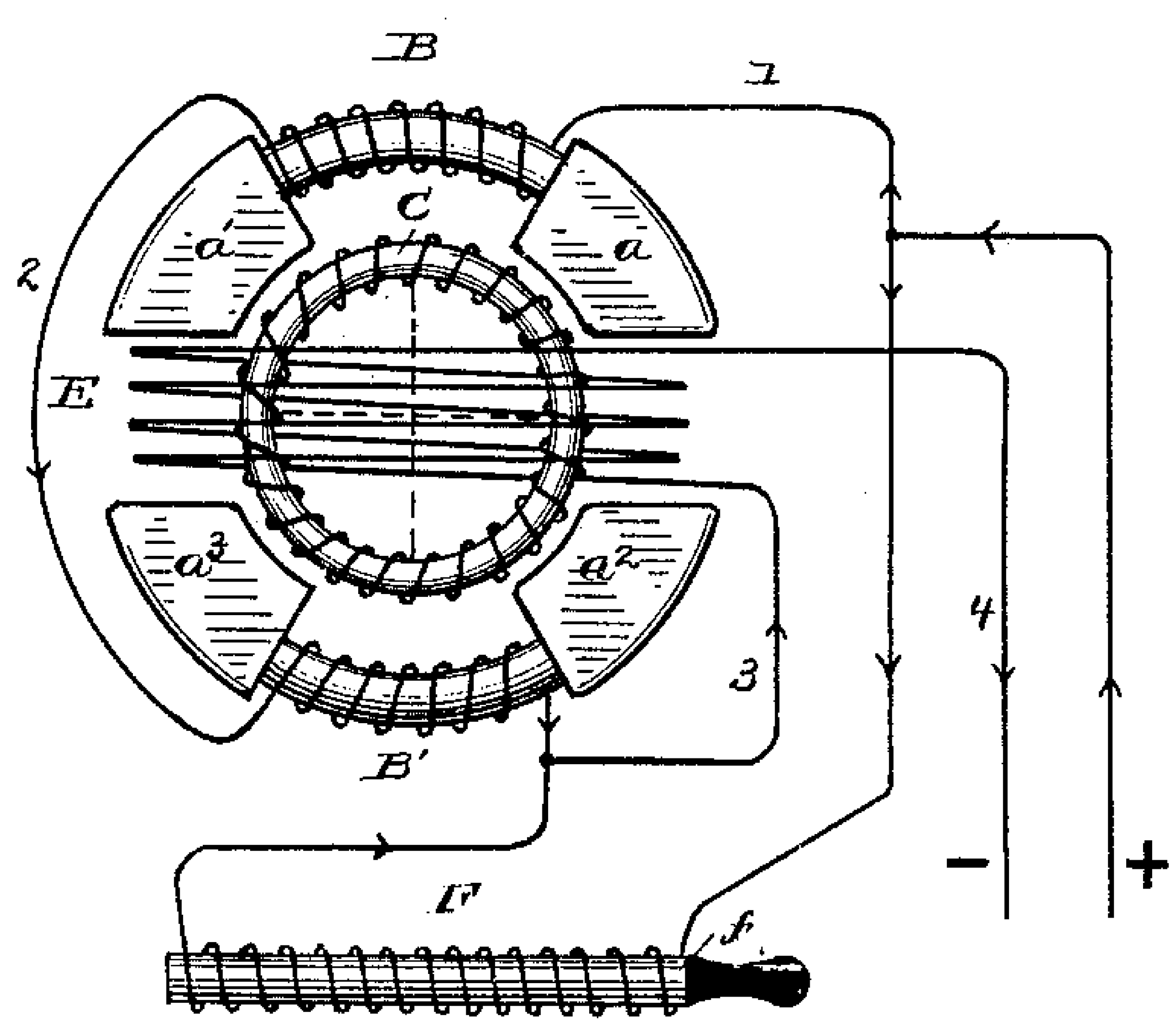
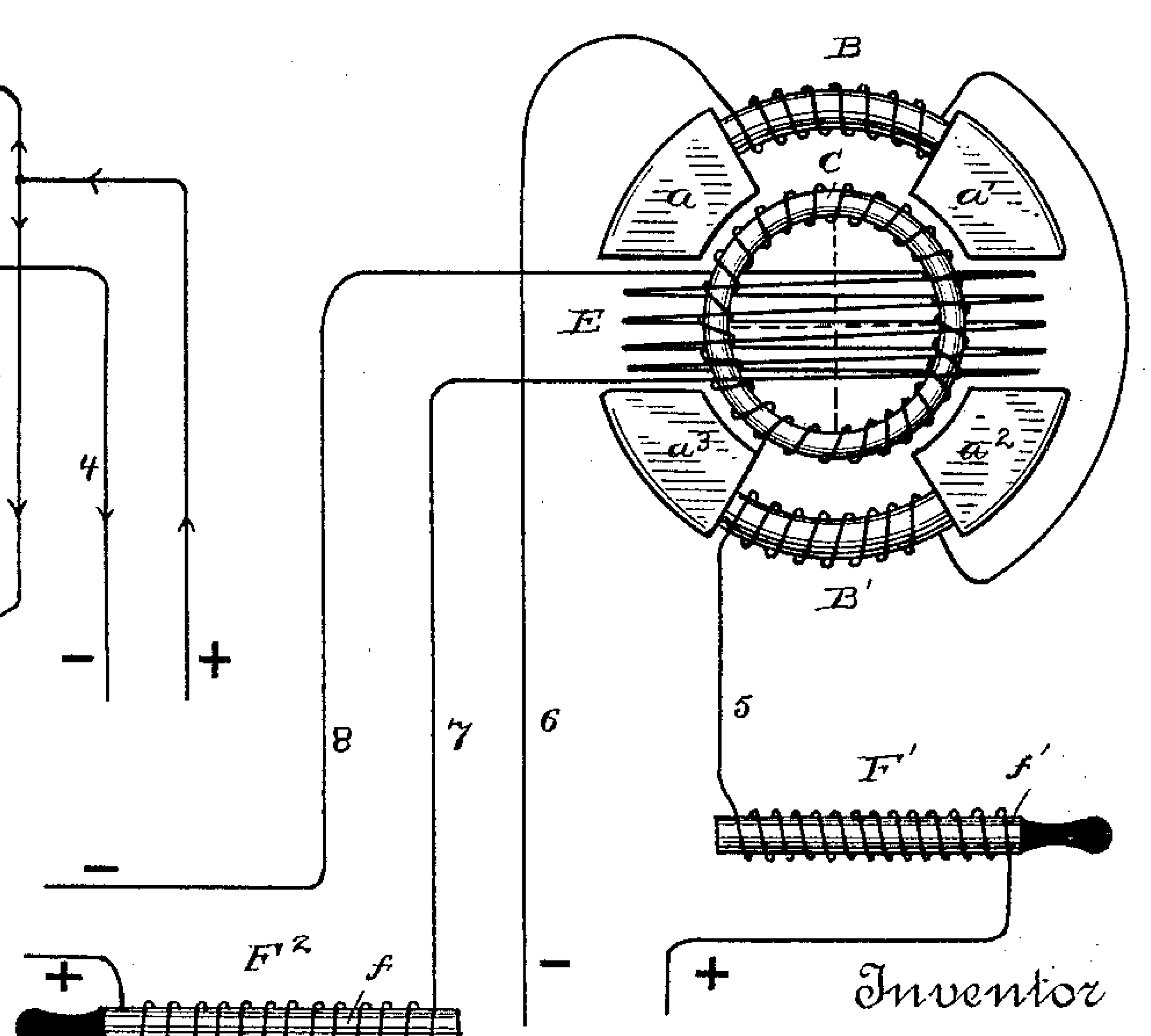


Fig. 3.



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4 Sheets—Sheet 2.

C. J. VAN DEPOELE.

ALTERNATING CURRENT MOTOR.

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Fig. 4.

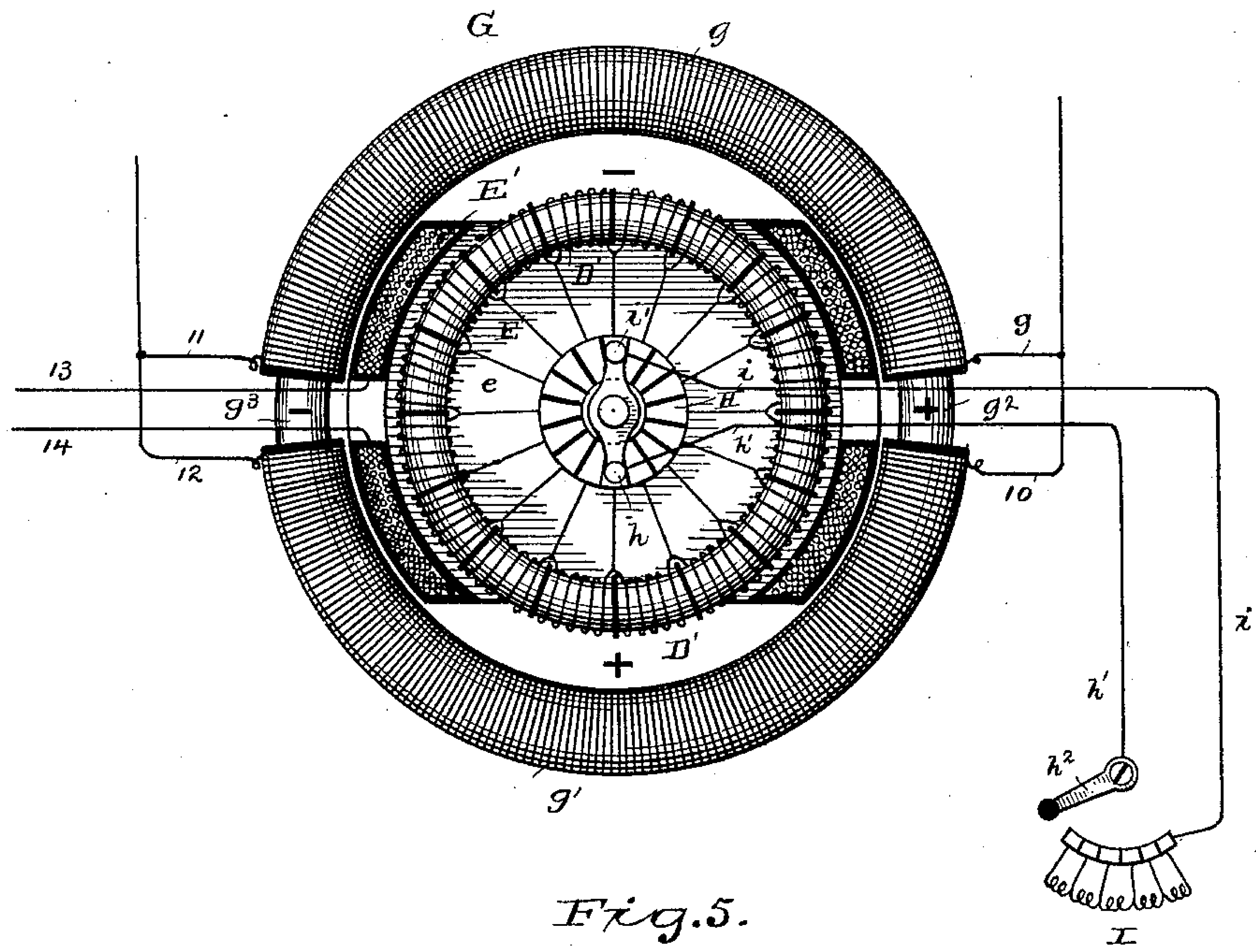
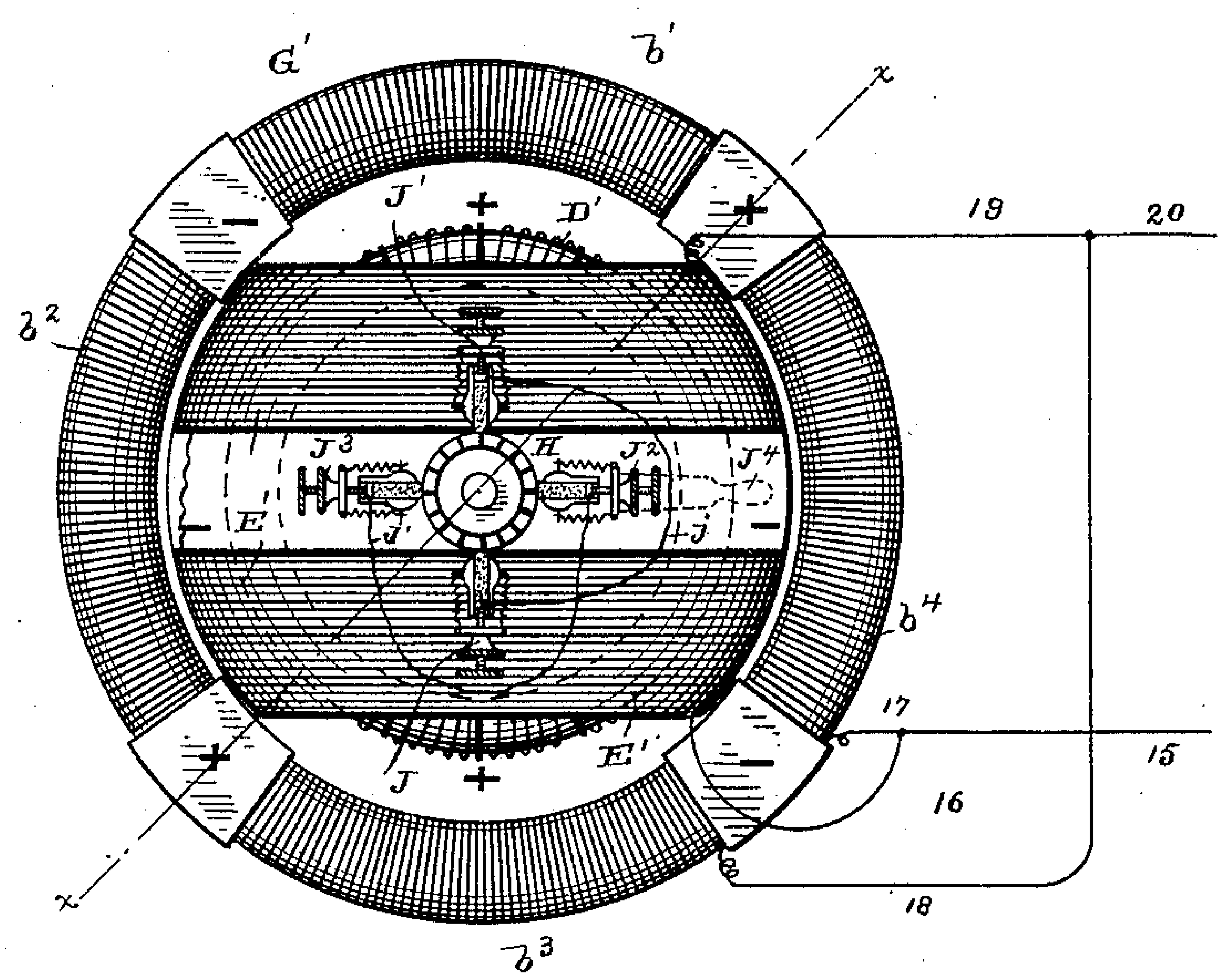


Fig. 5.



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C. J. VAN DEPOELE.

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Fig. 6.

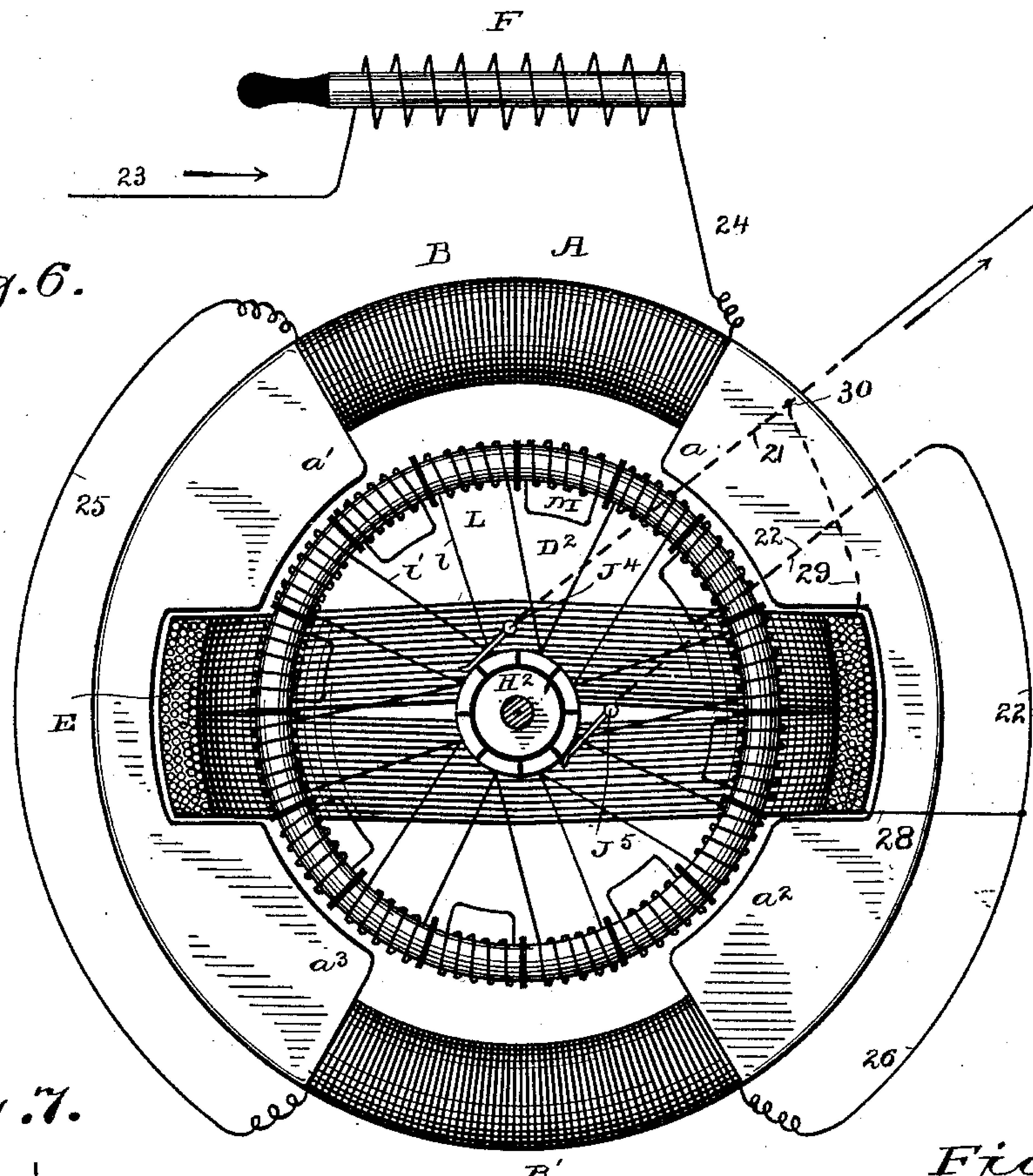

Fig. 7.

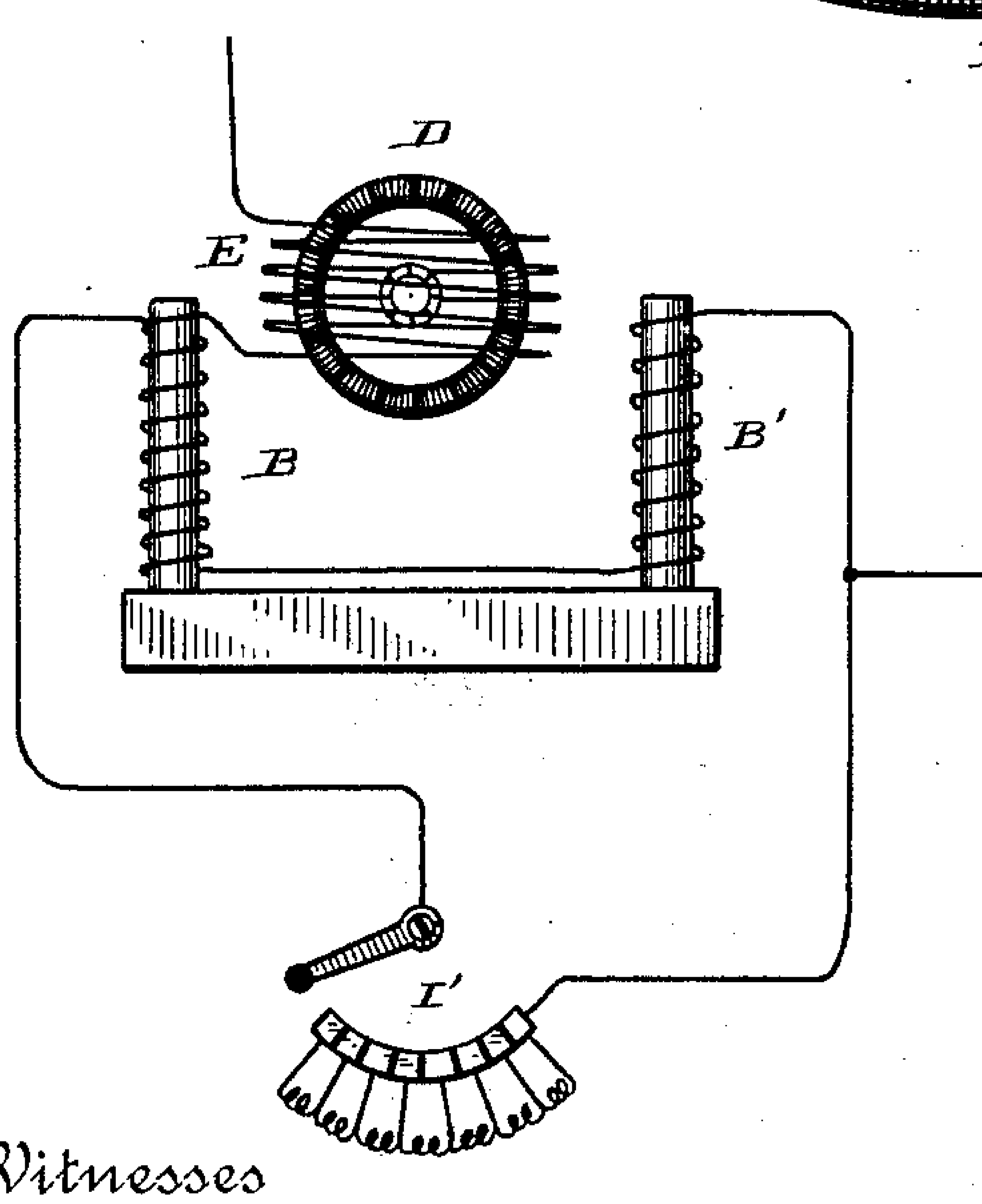

Fig. 8.

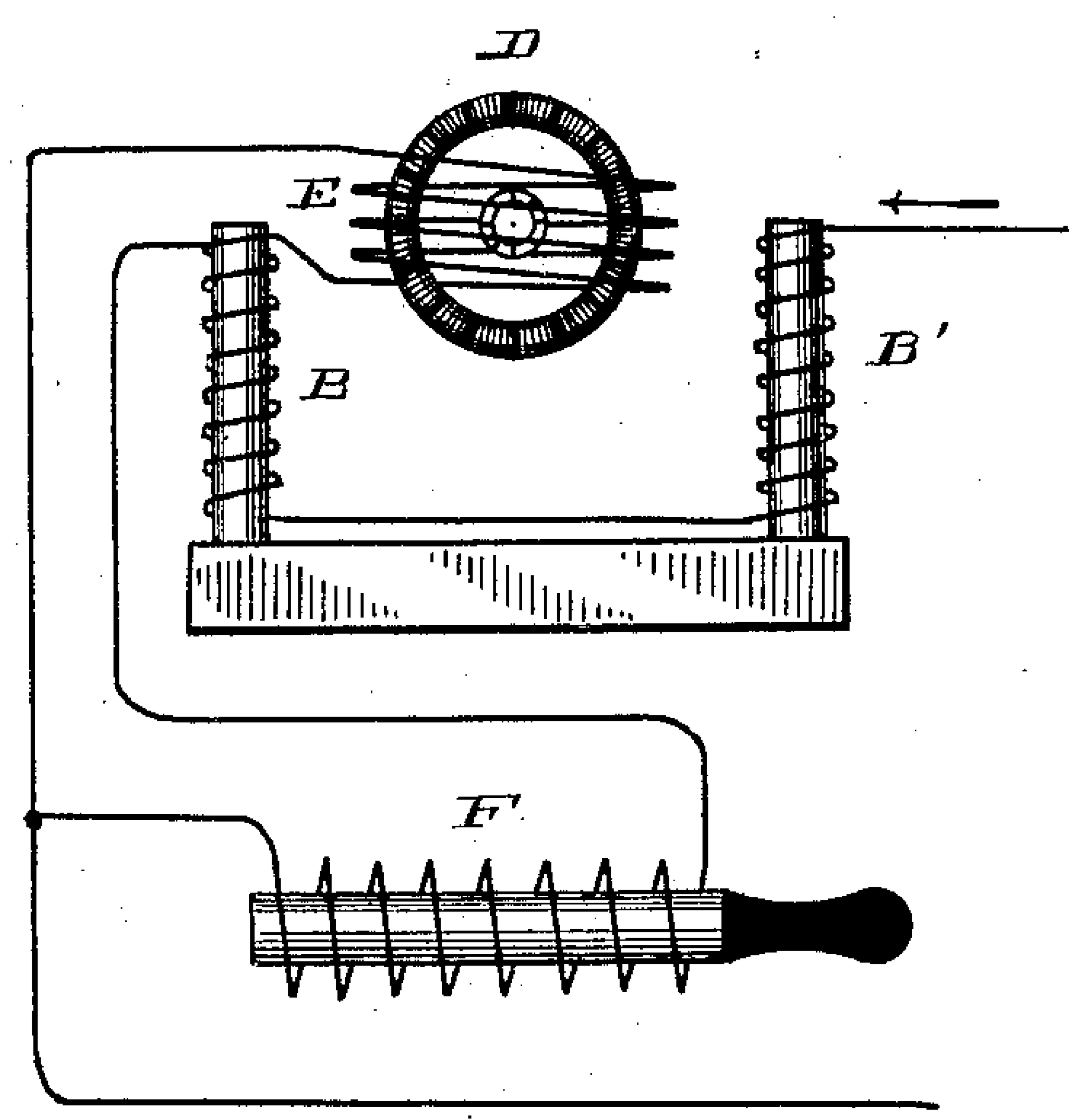

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Fig. 9.

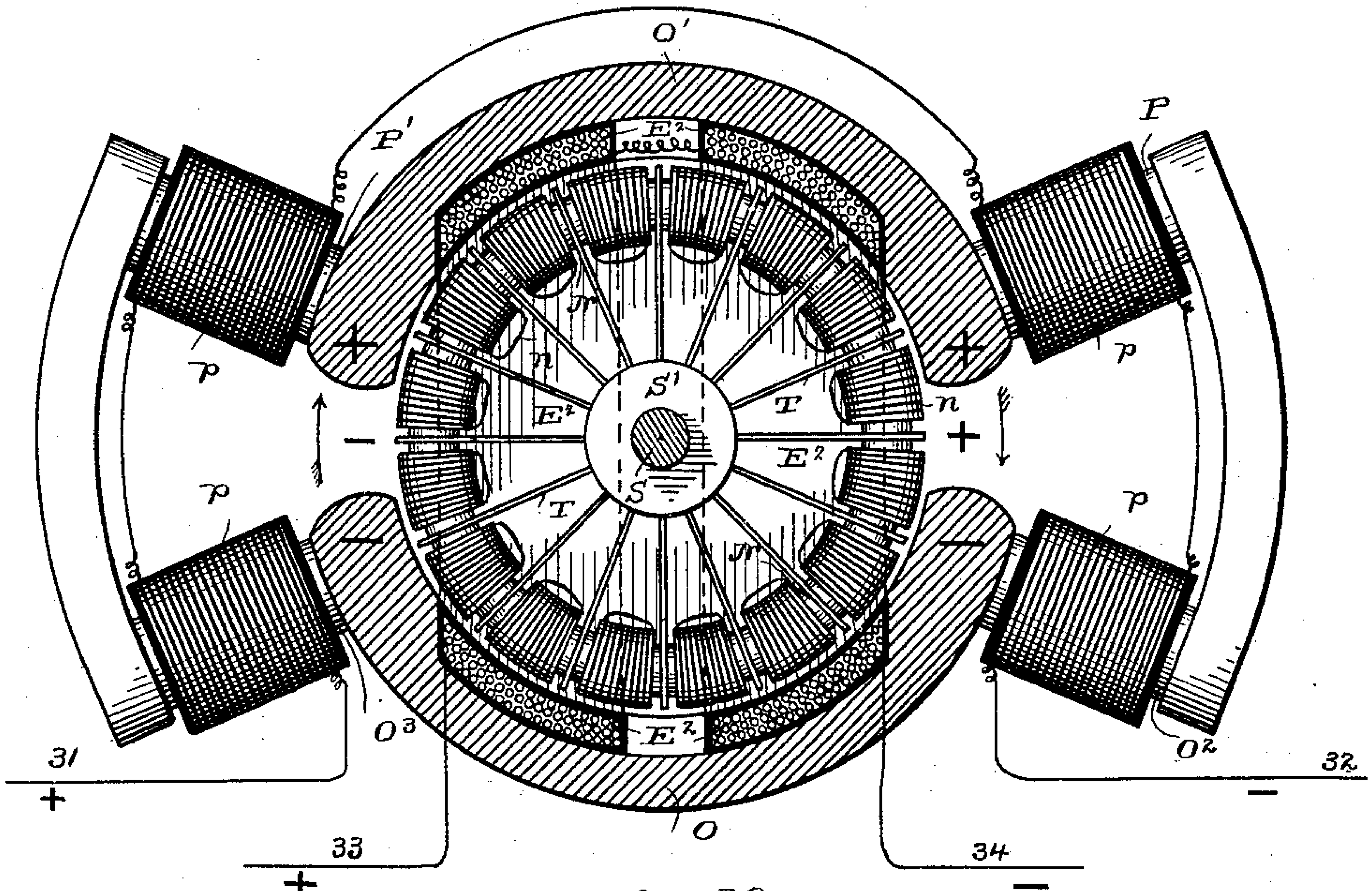
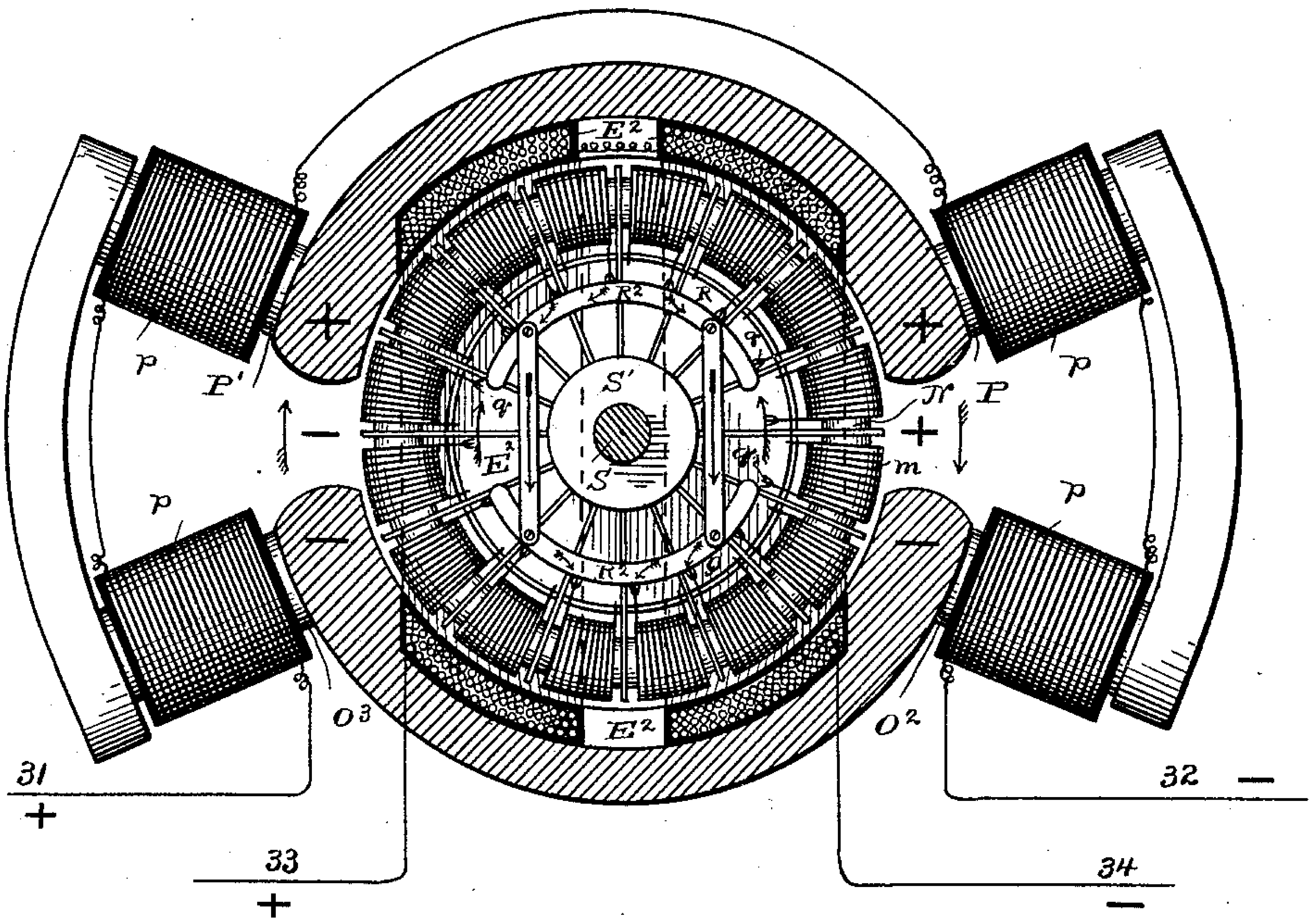


Fig. 10.



Witnesses.

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UNITED STATES PATENT OFFICE.

CHARLES J. VAN DEPOELE, OF LYNN, MASSACHUSETTS.

ALTERNATING-CURRENT MOTOR.

SPECIFICATION forming part of Letters Patent No. 408,641, dated August 6, 1889.

Original application filed March 8, 1889, Serial No. 302,544. Divided and this application filed July 5, 1889. Serial No. 316,578. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. VAN DEPOELE, a citizen of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Alternating-Current Motors, of which the following is a description, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon.

This application is a division of case filed March 8, 1889, Serial No. 302,544.

My invention relates to an improvement in electro-dynamic motors, and comprises a rotating electro-magnetic motor or engine applicable to any form of work and capable of being operated in some of its forms by any species of current, whether pulsating or intermittent. Since many forms of electric motors are capable of operation with continuous currents, I will describe the invention more particularly with reference to its operation under the influence of alternating, intermittent, or pulsating currents. It is well known that almost any form of dynamo-electric machine having its iron parts sufficiently subdivided to respond to rapid reversals of polarity is capable of being set in motion by alternating electric currents; but such machines are not capable of efficient action until the armature speed corresponds with or is in synchronism with that of the generator supplying the current. Therefore the torque of such a motor is very feeble at starting, and it has been hitherto found impracticable to apply alternating currents to motors where they were required to run at low speed or start a load—as, for example, in electric-railway work, where the motors are frequently stopped and started with the full load.

My improved motor comprises an armature, which may be of any of the well-known types including a wire-wound iron core; but I prefer to use a Gramme ring the terminals of the sections of which may be connected in various ways, as will appear. The armature rotates under the action of a field of force in the usual manner. In addition to the armature and field-magnets, I use a third element in the form of a non-rotating coil or coils of insulated wire, the said coils enveloping or partially enveloping the armature and acting inductively thereon to produce in the armature a definite and concentrated polarity—that is, true poles adapted to cause the rotation of the armature under the influence of the field-magnet. It has been proposed to cause the rotation of an armature by currents induced therein while rotating in its field of force; but while this may produce practical results when the armature is rotating at high speed, its effect is almost *nil* at starting, and various extraneous means have been proposed for creating magnetism in the armature-core at starting. By my invention, however, these difficulties are entirely overcome, and the motor is rendered as efficient at low speed and at starting as any continuous-current machine, and without any reference whatever to the rate of the phases of supply-current.

The invention may of course be applied and modified in a great variety of ways, some of which are shown in the accompanying drawings, and set forth and referred to in the following description and the claims appended thereto.

In the drawings, Figure 1 is a view in elevation of a motor embodying my invention. Fig. 2 is a diagrammatic view of the motor, showing circuits and regulator. Fig. 3 is a diagrammatic view similar to Fig. 2, but showing a different arrangement of circuits. Fig. 4 is a view in elevation, partly in section, showing a somewhat different arrangement of the moving parts. Fig. 5 is an elevation showing a construction and arrangement differing in some respects from that seen in Fig. 4. Fig. 6 is a view in elevation, partly in section, of another arrangement of parts of the motor also embodying the invention. Figs. 7 and 8 are diagrammatic views illustrating different modes of regulating and controlling the action of the motor. Fig. 9 is a view in elevation, partly in section, showing a motor of the same general form, the connections and manner of energizing the armature being somewhat different. Fig. 10 is also a view in elevation, partly in section, but showing a somewhat different arrangement of the armature winding.

As indicated in the drawings, with reference to Fig. 1 and other similar figures not specifically mentioned, A A′ represent oppositely-located field-magnets, the polar extensions $a\ a'\ a^2\ a^3$ of which are magnetized by coils B B′ wound upon laminated iron cores extending between and connecting the polar extensions. C is an iron ring constituting the core of the armature D, which is wound with a continuous conductor C′. As shown, the coils of the armature D are connected by conductors *d d′*, extending across at right angles with each other and electrically uniting diametrically-opposite portions of the armature-conductor to form two closed circuits therein. In large armatures it will frequently be desirable to use more cross-connections than the two here shown, but they will serve to illustrate the principle. The armature is partly inclosed within a non-rotating exterior induction-coil E, which is placed about its transverse axis, the normal position of the coil E being at right angles to the axis of the field-magnets. For convenience, as here shown the induction-coil E is sustained within recesses formed at the neutral points of the field-magnet; but it may also be entirely within the field-magnet and movably sustained in the desired position. As shown, the coils of the field-magnets A A′ and of the coil E are connected in series, the current entering coil B′ by conductor 1, passing thence by conductor 2 to coil B, thence by conductor 3 to solenoid E, and from thence to line by conductor 4. Current flowing through said coils will magnetize the polar extensions as indicated by the signs thereon, while the coil E will, when an alternating or pulsating current is employed, act inductively upon the armature, causing secondary currents to flow therein, which secondary currents, having a defined path, by reason of the cross-connections *d d′*, will concentrate their magnetizing effect and form true poles along the lines represented by said cross-conductors, and, whether the armature be held stationary or be in motion, the poles so established in the armature will be strongly attracted by their opposite poles on the field-magnets and repelled by like ones.

Thus it will be seen that the action of my motor, while depending upon the magnetization of the armature from currents induced therein, is not dependent upon the rapid rotation of said armature for its efficiency, since the same inductional effects will take place when the armature is forcibly prevented from rotating.

In Fig. 2 an arrangement similar to the foregoing is represented diagrammatically; but I have shown a regulator, in the form of reactive coil F, included in a derivation from the series circuit.

In Fig. 3 I have shown a view similar to Fig. 2, except that the circuit 7 8 of the coil E and of the field-magnets A A′, by conductors 5 6, are entirely separate and each one provided with a reactive coil F′ F^2 for controlling the flow of current in their respective circuits. The reactive coils can be solenoids provided with movable iron cores *f*, which, when entirely inserted in the coils, create a reaction therein, which, by creating a counter electro-motive force in said coils, opposes the flow of the main current therethrough. As the cores *f* are withdrawn, the reactions are diminished and a convenient means for controlling the flow of current is thus afforded. When two such circuits are placed in parallel, either one or the other can be made to predominate to produce the desired effects.

In Fig. 4 is seen an annular exterior field-magnet G, having two energizing-coils *g g′*, which are separated at their extremities to expose the positive and negative poles $g^2\ g^3$ in the iron core. The armature D′ is mounted within the field-magnet, and the induction-coil E′ is located between the exterior of the armature and the interior of the field-magnet. In this case, also, the armature is shown as an ordinary Gramme ring; but each section is provided with a terminal *e*, connected to a corresponding section of a commutator H. A pair of oppositely-mounted and adjustable commutator-brushes are held in any desired position with respect to the commutator, and when electrically connected serve to close the commutator-circuit upon itself, thereby causing currents flowing in the armature to traverse a defined path and to establish true poles therein upon the line occupied by the commutator-brushes. It may be desirable, for more thorough regulation and control, to connect an adjustable resistance between the commutator-brushes. As shown, the positive commutator-brush *h* is connected by conductor *h′* with the switch-lever h^2 of an adjustable resistance I, the other extremity of the resistance I being connected by conductor *i* to commutator-brush *i′*. The induction-coil E′ acts inductively upon the coils of the armature D′, generating currents therein, which, flowing around said armature and along the line established by the commutator-brushes and circuit-connections, will establish a polarity in the said armature, which, being at an angle from the poles of the field-magnet, will be attracted thereby and the armature thus set in motion. By changing the position of the commutator-brushes the polar axis of the armature can be moved as desired to secure the best working effect under varying circumstances, the normal position being, however, at right angles to the polar axis of the field-magnet, as indicated.

I have referred to the coils acting upon the armature as an induction-coil. It will be understood, however, that the said coil may be formed in two or more parts, according to the mechanical exigencies of the case. Wherever movable commutator-brushes are used it will also be desirable that the position of the induction-coil be movable—that is to say, that although it must not rotate as does the armature, the best effect will be secured by keeping its axial line always at right angles with the desired polar axis of the armature. The form shown in Fig. 4 may be readily subdivided to produce a four or more pole machine.

As seen in Fig. 5, the field-magnet G′ is provided with four oppositely-located polar extensions between which the magnetizing-coils b' b^2 b^3 b^4 are wound. The armature D′ is similar to that seen in the preceding figure, as also is its induction-coil E′. Since, however, the field-magnet is provided with four poles, a double set of poles must also be formed in the armature, which is accomplished by providing the commutator H′ thereof with two sets of commutator-brushes J J′ and J^2 J^3. The said brushes are attached at right angles and are movably mounted upon a stationary part of the machine and provided with an operating-lever J^4, by which they may be adjusted about the commutator as desired. The induction-coil E′ is also sustained by a stationary portion of the machine and connected or attached to the commutator-brush carrier, so that both move together, thus insuring symmetrical relationship between the magnetic axis of the induction-coil and the polar lines it is desired to establish in the armature. Opposite commutator-brushes are connected by conductors j j', thus forming two closed circuits in the armature, and consequently two polar axes therein, which, as indicated, are at right angles to each other. It will be understood that the induction-coil as an entirety can be connected so as to produce four poles in the armature; but the better way is to arrange the connections to form two inducing-circuits to maintain the four armature-poles. With this form the most economical action will take place when the axis of the induction coil or coils and of one pair of commutator-brushes is upon the line x x'. Although desirable for purposes of regulation, it is not necessary that any exterior resistance be placed in the short circuit connecting the commutator-brushes.

In Fig. 4 the coils of the field-magnet and of the induction-coils are in separate circuits. 9 and 10 represent one set and 11 12 the other set of terminals of the field-magnet coils g g', which, being united with their line-conductors, place the coils g g' in multiple arc. The induction-coil E′ receives current through conductors 13 14, either from a separate circuit or from a source local to the motor. In Fig. 5 the coils of the field-magnets and of the induction coil or coils E′ are all connected in multiple arc, the current entering at 15 divides through conductors 16 17, passing to the field-magnet coils and to the solenoid, traversing same, and passing out by conductors 18 19, and thence to line-conductor 20.

Various different methods of regulating the flow of supply-current in the field-magnet circuit and induction-coil may be adopted.

In Fig. 7 the apparatus is indicated diagrammatically, and an artificial resistance I′ is shown in a derivation from the field-magnet circuit. It will be clear, however, that the adjustable resistance might be connected in a derivation from the induction-coil, or a separate resistance be used in connection with both the field-magnet circuit and the induction coil or coils.

In Fig. 8 I show a reactive coil F in derivation from the field-magnet circuit. The field-magnet coils and those of the induction-coil are connected in series. Instead of connecting all the coils of the armature into one or more circuits closed upon themselves, I may employ the arrangement shown in Fig. 6, in which the field-magnet circuit and induction-coils are similar to that seen in Fig. 1. The coils of the armature D^2 are, however, somewhat differently connected. Alternate sections L are connected by conductors 1 1′ to separate sections of a commutator H^2 in the same manner as the sections of a Gramme ring. Commutator-brushes J^4 J^5 bear upon opposite sides of the commutator and are provided with conductors 21 22, connected in derivation from the main supply-circuit of the machine. A reactive coil F is connected in series with the supply-circuit, the course of which is as follows: The current enters by conductor 23, passing through reactive coil F, and thence by conductor 24 to the field-magnet coil B. From said coil current passes by conductor 25 to the other field-magnet coil B′, thence by conductor 26 to point 27, from where the main current passes by conductor 28 to the coil E, leaving the said coil by conductor 29, which is connected to the other side of the circuit at 30. The conductor 22, (representing one of the commutator-brushes,) is connected to the conductor 26 at the point 27, and the return-conductor 21 from the other commutator-brush is connected to the other side of the circuit at point 30. The field-magnet coils and those of the induction-coil are therefore connected in series, with the armature-circuit in derivation therefrom. Coils M are placed between each of the coils L on the armature and each coil M is closed upon itself. The induction-coil E will act inductively upon the coils M, and thereby add to the magnetizing effect of the coils L, which are connected in the main circuit. It will be obvious that by disconnecting the conductors 21 and 22 from the main circuit and uniting them the same effects would be produced as described with reference to Fig. 4, with the addition of the magnetizing effect upon the core of the armature B^2 produced by the additional coils M.

Fig. 9 represents a modification of the specific forms, already referred to, in the matter of connecting the armature-coils. Instead of bringing all or part of the terminals of the successive coils to a commutator, as in a Gramme or Pacinotti armature, thus connecting all the sections in one continuous circuit, I wind the core N with a number of separate coils n, or even a single copper ring, according to the size of the armature, each coil being closed upon itself and well insulated from its neighbors. By this disposition the action of the inducing-coil E^2 upon the coils n will produce currents flowing on the right side of the armature—say from bottom to top in the said coils—and on the left side from top to bottom. This is due to the fact that the coils on the right side, say, present all their inner closed terminals upward and their outer terminals downward, the reverse being the case with the coils upon the other side of the armature, so that under these conditions the current induced by the solenoid will produce a north pole on the top of the armature and a south pole on the bottom, and these conditions will obtain whether the armature be at rest or rotating at any speed. The field-magnets of my motor may be constructed of forms and arranged differently from those heretofore described. As, for example, in said Fig. 9 the polar extensions O O′ are semicircular in form and envelop the induction-coil E^2, and most of the armature being separated at their extremities. From the extremities of the pole-pieces O O′ extend cores O^2 and P and O^3 P′, each of which is provided with a magnetizing-coil p, acting to produce north poles at each extremity of the pole-piece O′ and south poles at the extremity of the pole-piece O. With this arrangement the positive pole at the top of the armature will be repelled by the adjacent north pole in the field-magnet and attracted toward the adjacent south pole of the field-magnet, while the south pole at the bottom of the armature will be repelled by the adjacent south pole, thus establishing and maintaining rotation in the armature so long as the same is magnetized by the inductional effects upon its coils of the induction-coil E^2. The field-magnet coils and the induction-coil seen in Figs. 9 and 10 may be conected in any of the different ways hereinbefore referred to. As seen, however, they are provided with separate circuits represented by terminals 31 32 and 33 34.

As indicated in Fig. 9, the coils of the armature are almost entirely enveloped by the inducing-coils E^2. There will still be, however, some current developed in the coils passing between the poles of the field-magnets by the action of the field-magnets thereon, and these currents, being in an opposite direction from the currents induced by the induction-coil, will tend to diminish the desired magnetizing effect. This will not amount to very much where the induction-coil is of the proportions indicated in said figure; but whatever their quantity the production of said opposing currents may, when desired, be entirely prevented by cutting out the coils passing between the field-magnet poles, allowing them to pass those points in an entirely inactive condition. This may be accomplished in many different ways—for example, as indicated in Fig. 10, where the coils m are each provided with a free terminal Q, provided with a contact device or brush q, the other extremities of all the coils being connected to and united by a conductor R. Fixed segments R′ R^2 are arranged to engage and thereby connect in multiple arc the terminals q of the coils on each side of the armature which are under the influence of the induction-coil E^2, but not to engage the terminals of the coils passing under the influence of the poles of the field-magnet, they being open-circuited and entirely inactive. The segments R′ R^2 are electrically connected by conducting-strips r r', and currents induced in the coils under the influence of the induction-coil on one side of the armature flow in multiple arc to the segment R^2, for example, thence by conductors r r' to the segment R′, thence by the terminals q of the corresponding coils upon that side of the armature, and out of said coils into the conductor R, and by said conductor to the inner terminals of the coils upon the opposite side of the armature, substantially as indicated by the arrows. Any kind of commutation will answer, the form shown being by way of illustration.

As indicated in Figs. 9 and 10, the armature-shaft S is provided with a hub S′, from which extend non-metallic spokes or arms T, which, being mechanically attached to the core N between the coils m or n, forms a strong and symmetrical support therefor.

This case being a division of a prior application, it will of course be understood that many matters are herein shown and described, but not claimed, and that whatever is not herein claimed continues to form part of the parent case.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An electro-dynamic motor comprising a wire-wound armature, means for connecting the armature-conductor into one or more closed circuits, an adjustable resistance in the circuit or circuits across the armature, a stationary coil for inducing currents in the armature, and a suitable field-magnet for reacting upon the resultant armature-poles, substantially as described.

2. In an electro-dynamic motor, a wire-wound armature, a commutator to which sections thereof are connected, adjustable commutator-brushes therefor, a stationary field-magnet, a non-rotating coil inclosing the armature and adjustable relatively with respect to the poles of the field-magnet and acting inductively upon the armature to produce magnetizing-currents therein upon the line of the axis of the said coil, and connections for maintaining a fixed relation between the inducing system and the commutator-brushes, substantially as described.

3. In an electric motor, an armature-core

with a plurality of circuits all independent of each other and closed upon themselves, a stationary induction system therefor, a field-magnet for the armature, a single source of current, and means for adjusting the phases of the divided circuit with relation to each other, substantially as described.

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

CHARLES J. VAN DEPOELE.

Witnesses:
JOHN W. GIBBONEY,
FRANKLAND JANNUS.