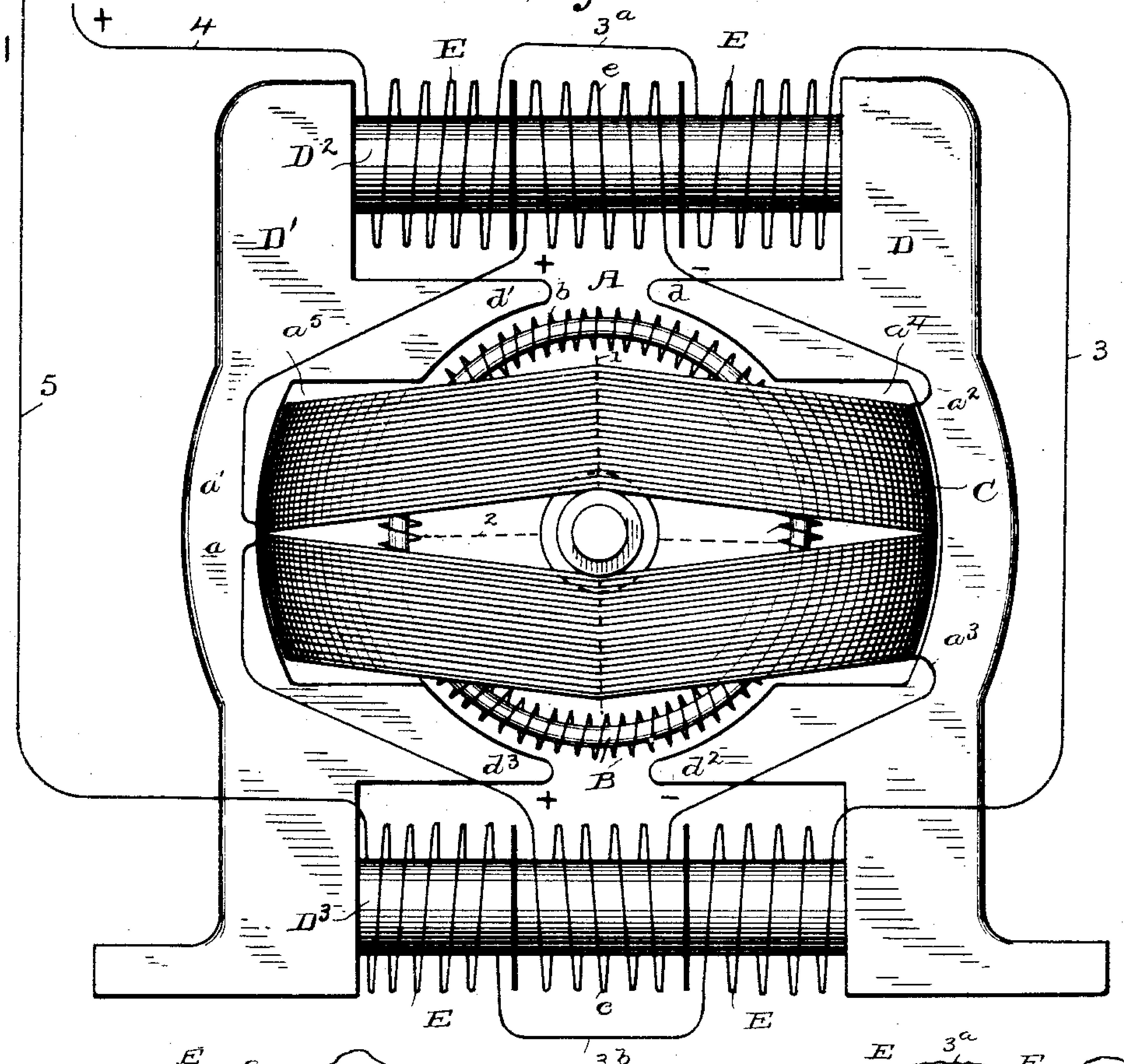
(No Model.) 5 Sheets—Sheet 1.

C. J. VAN DEPOELE.

ELECTRIC MOTOR.

No. 444,188. Patented Jan. 6, 1891.

Fig. 1.



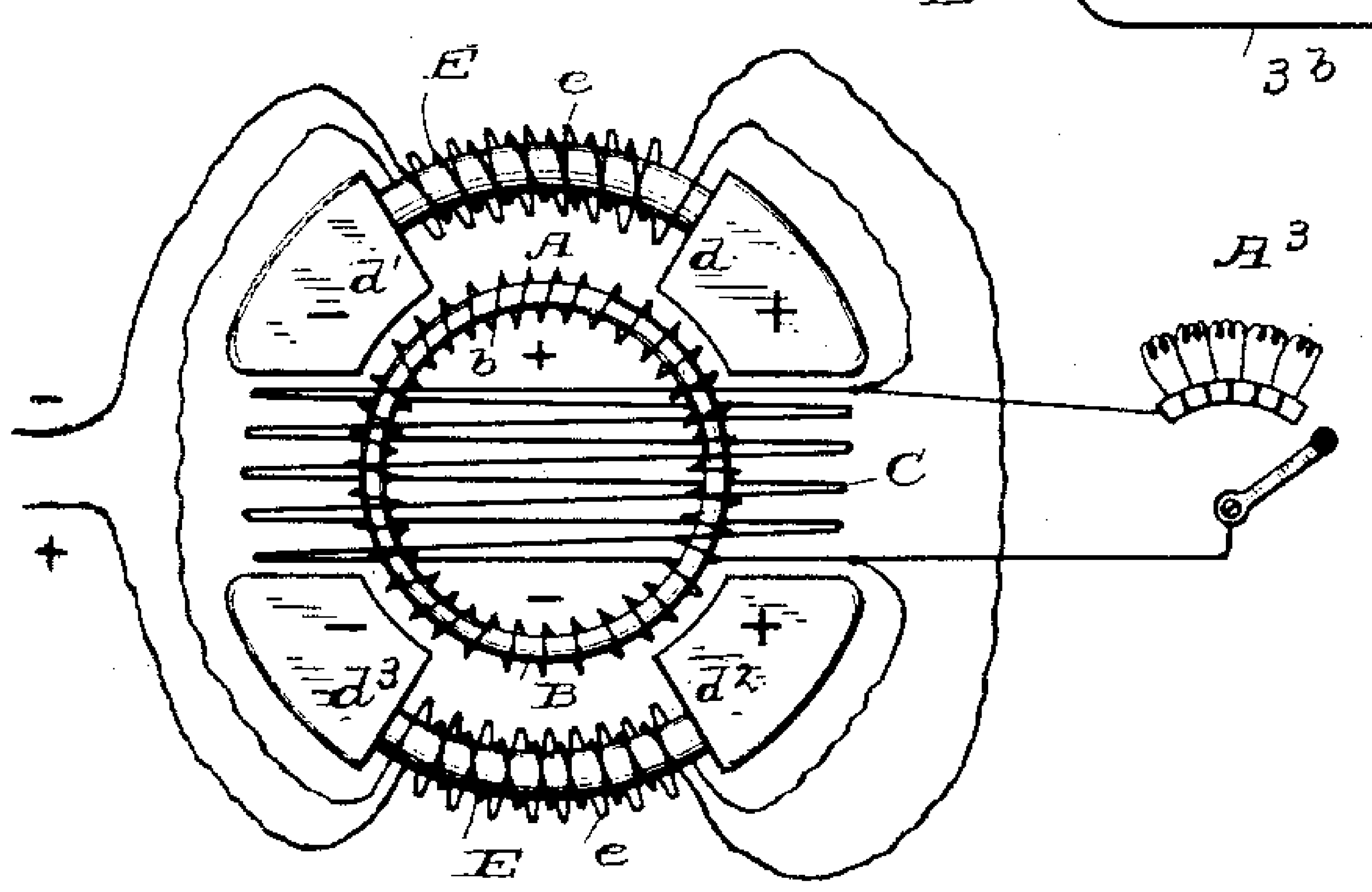


Fig. 2.

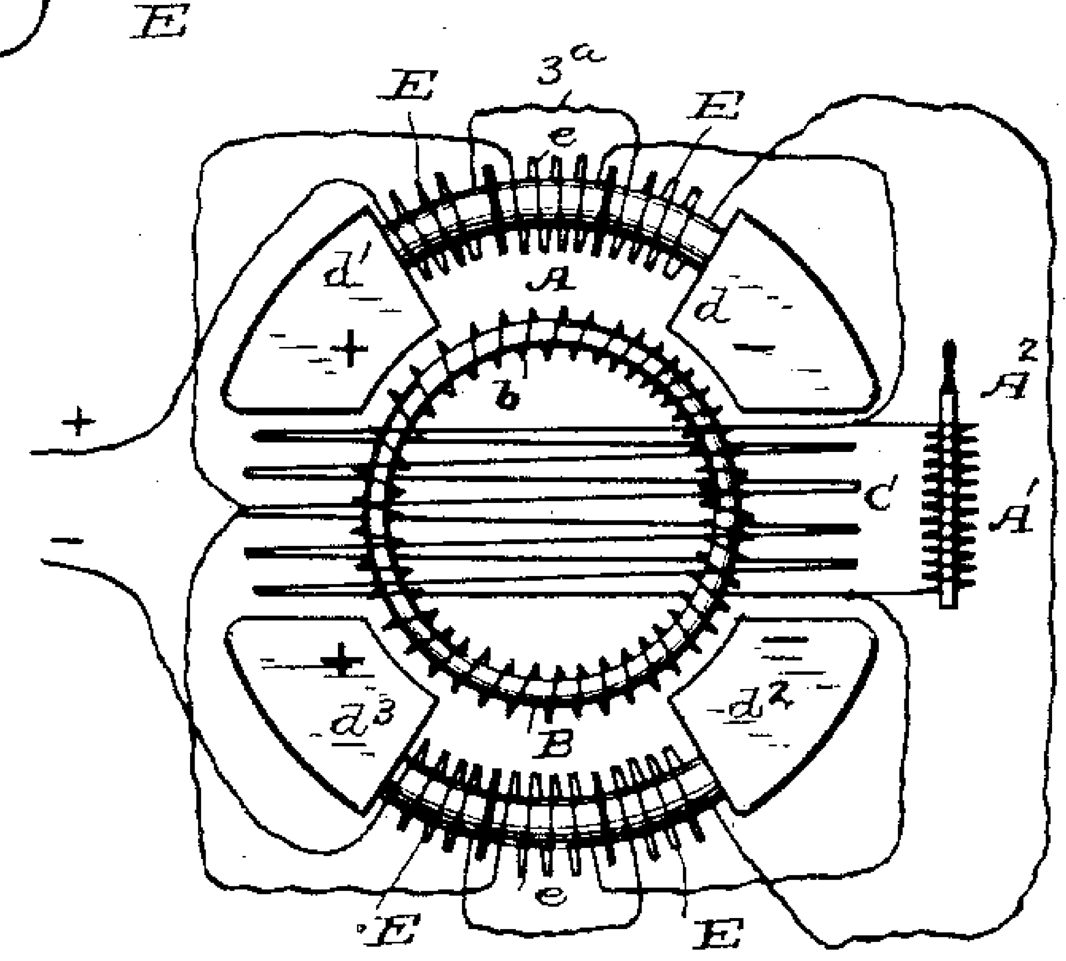


Fig. 3.

Witnesses

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Fig. 4.

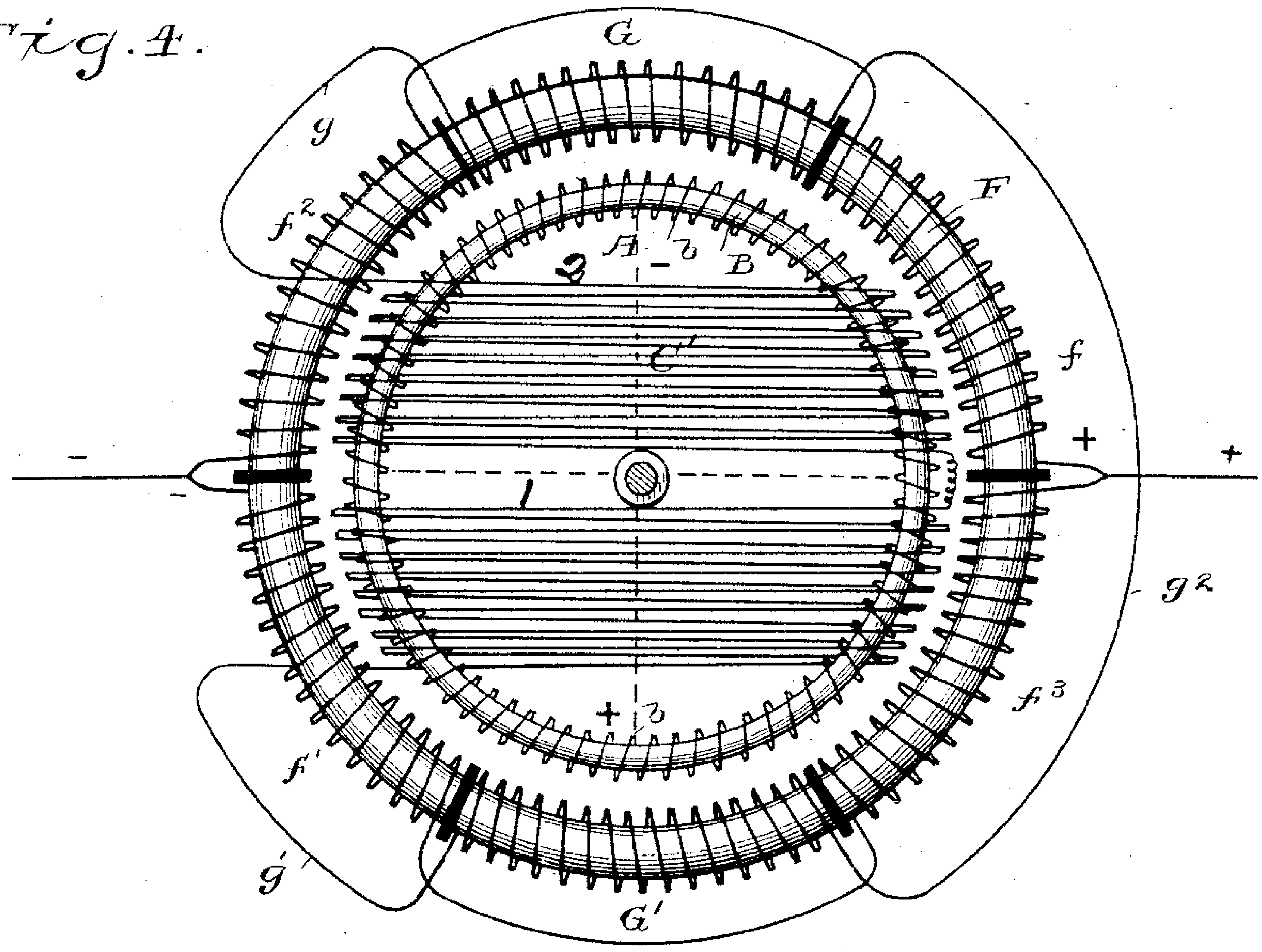

Fig. 5.

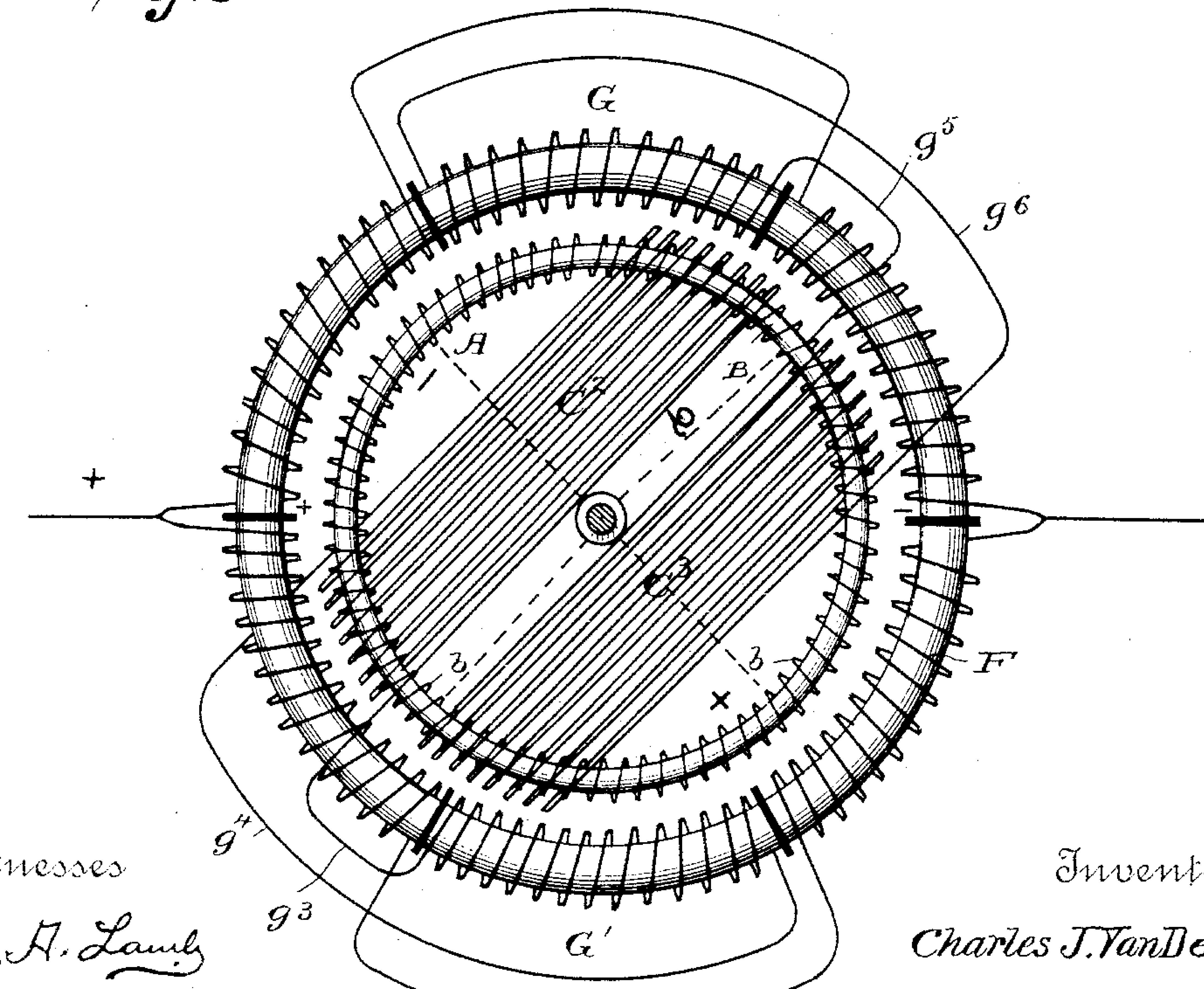

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Fig. 6.

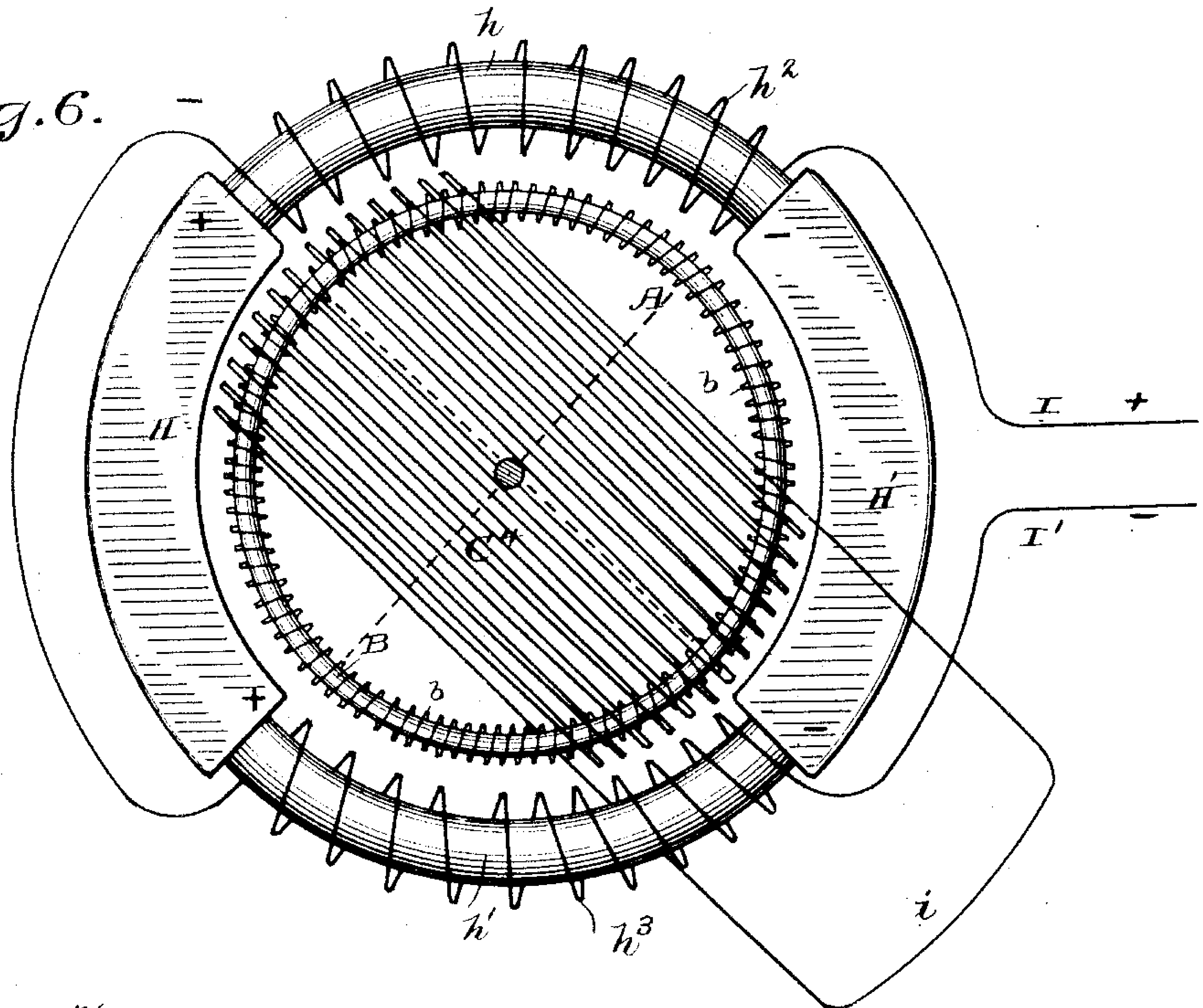
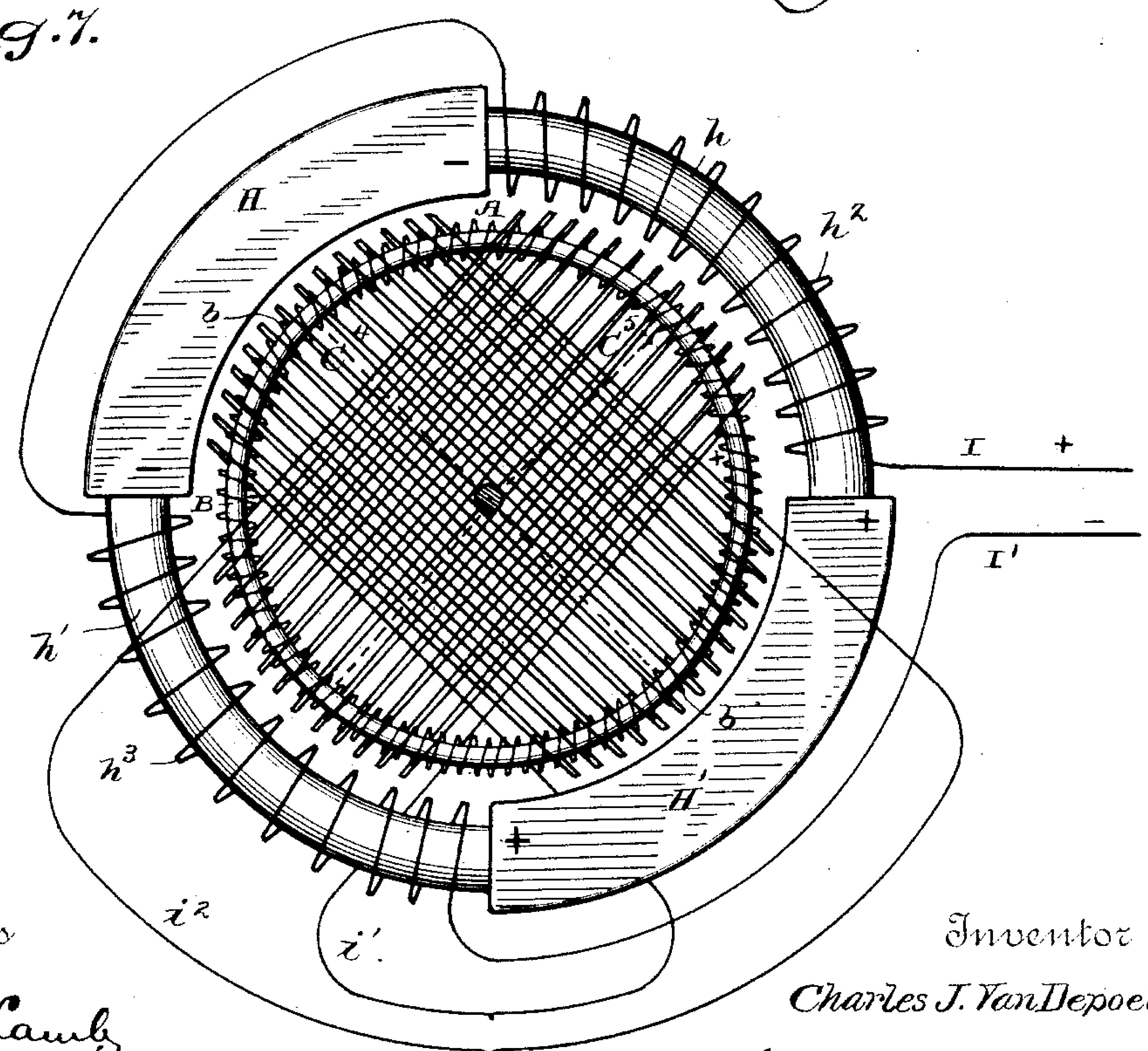


Fig. 7.



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(No Model.) 5 Sheets—Sheet 4.

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Fig. 8.

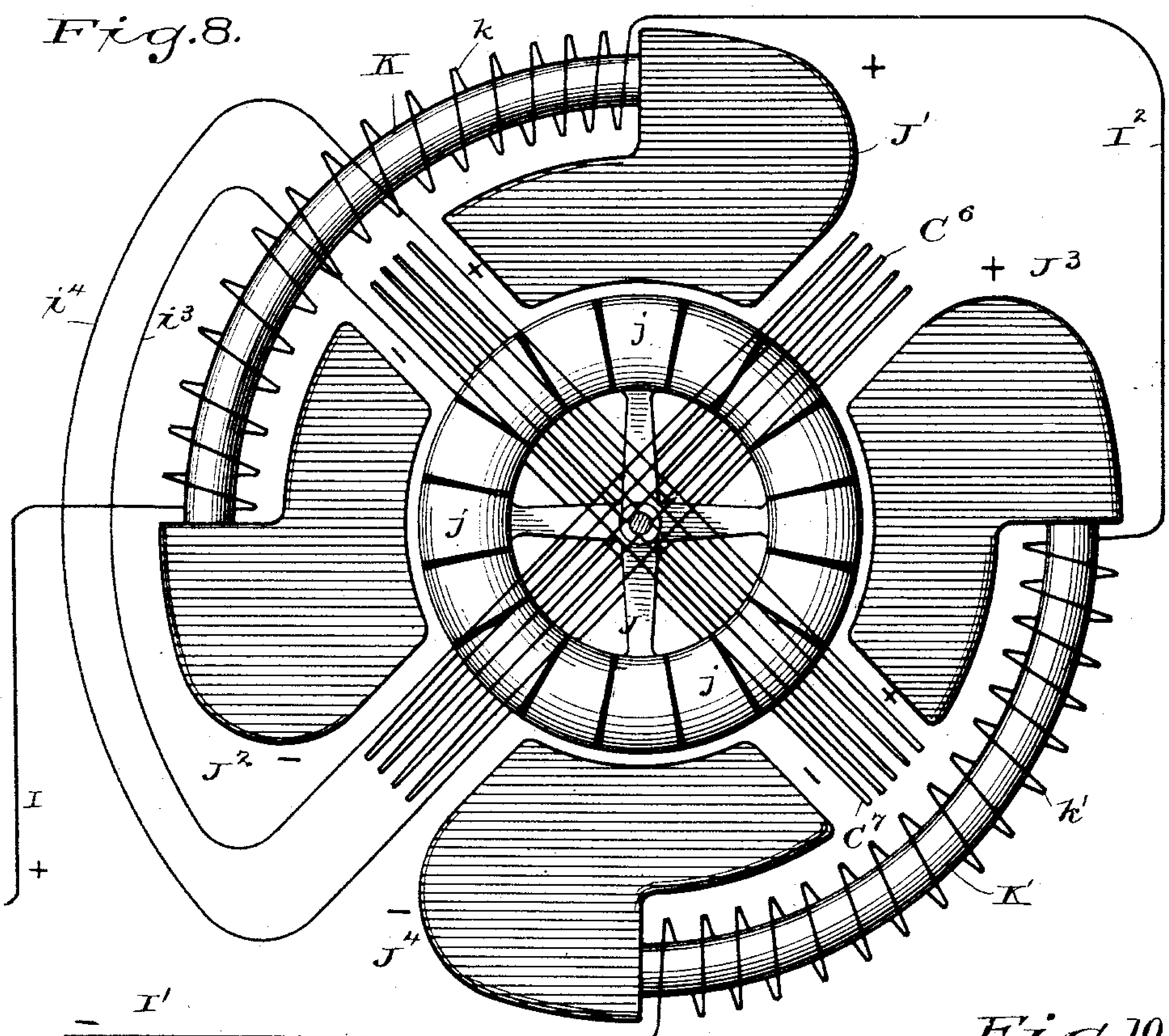


Fig. 9.

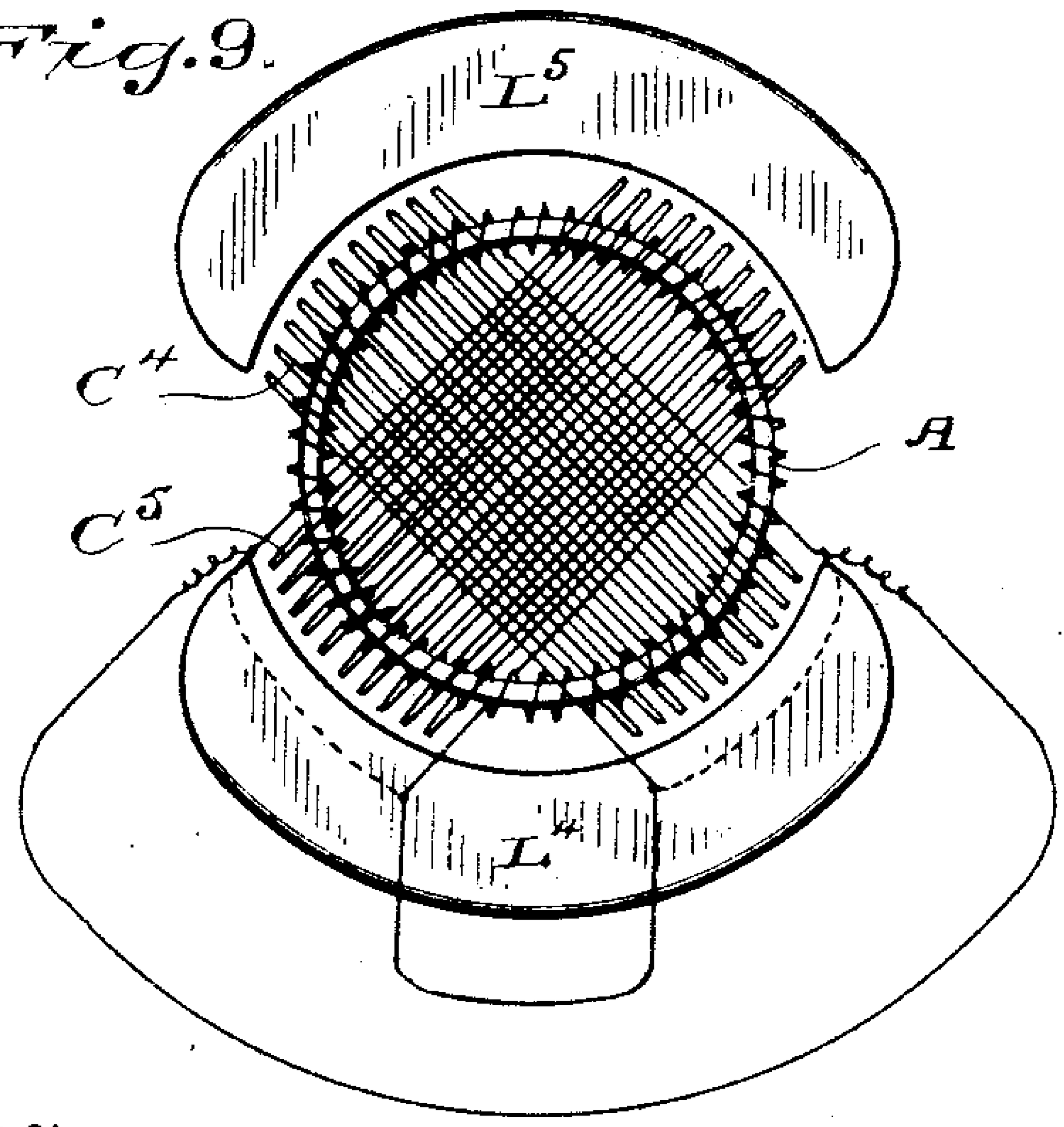
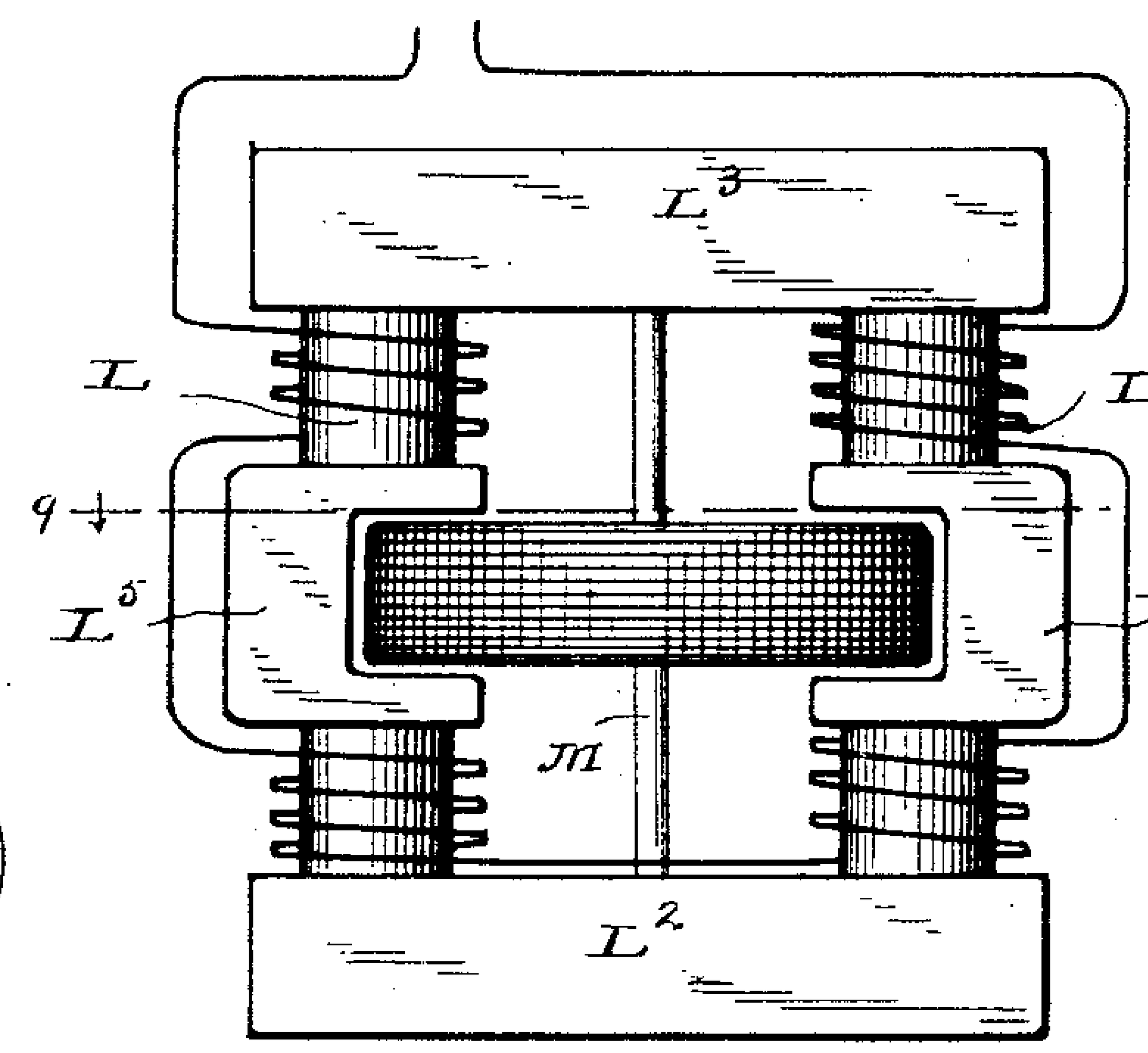


Fig. 10.



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5 Sheets—Sheet 5.

C. J. VAN DEPOELE.

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Fig. 11.

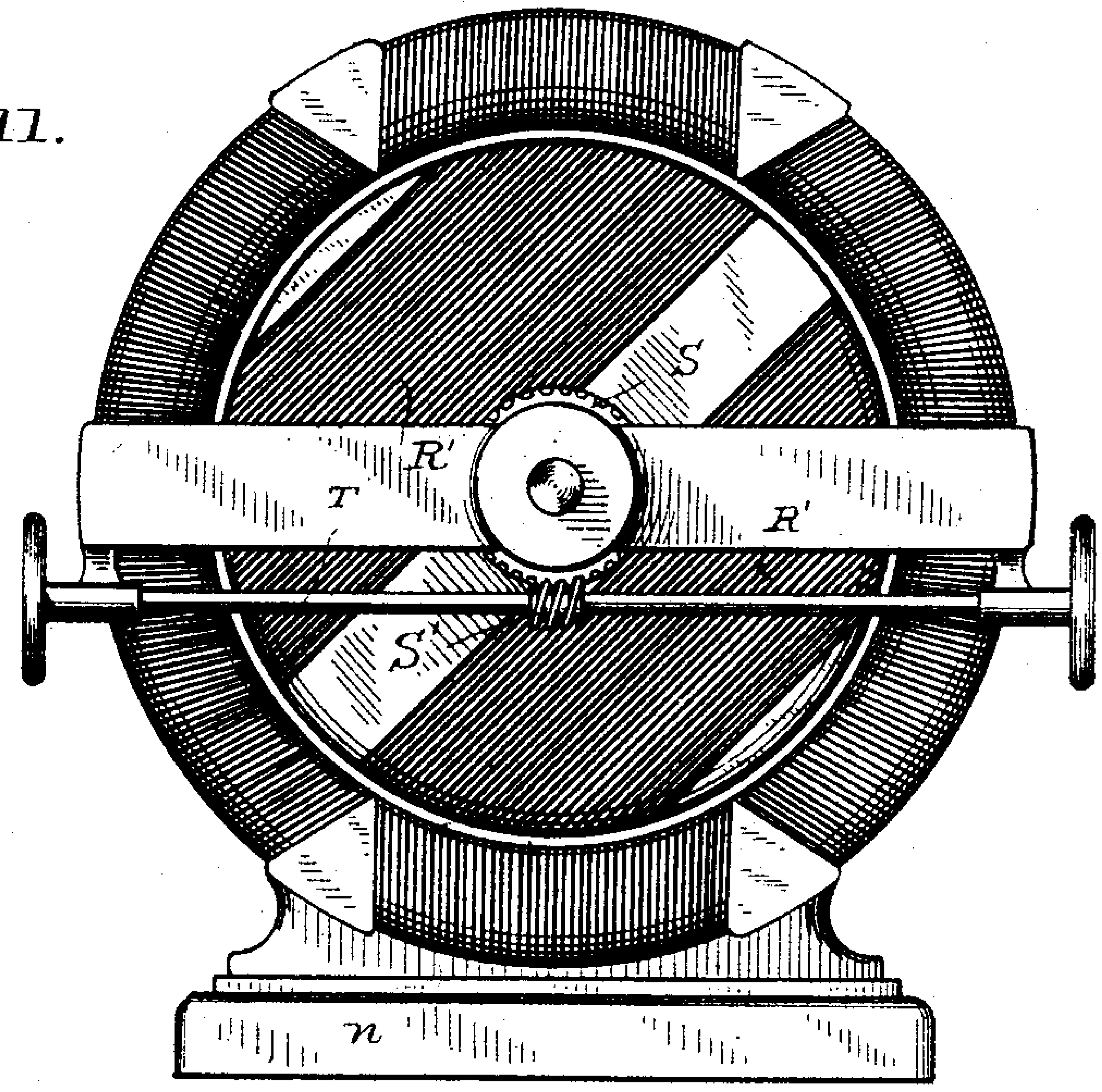
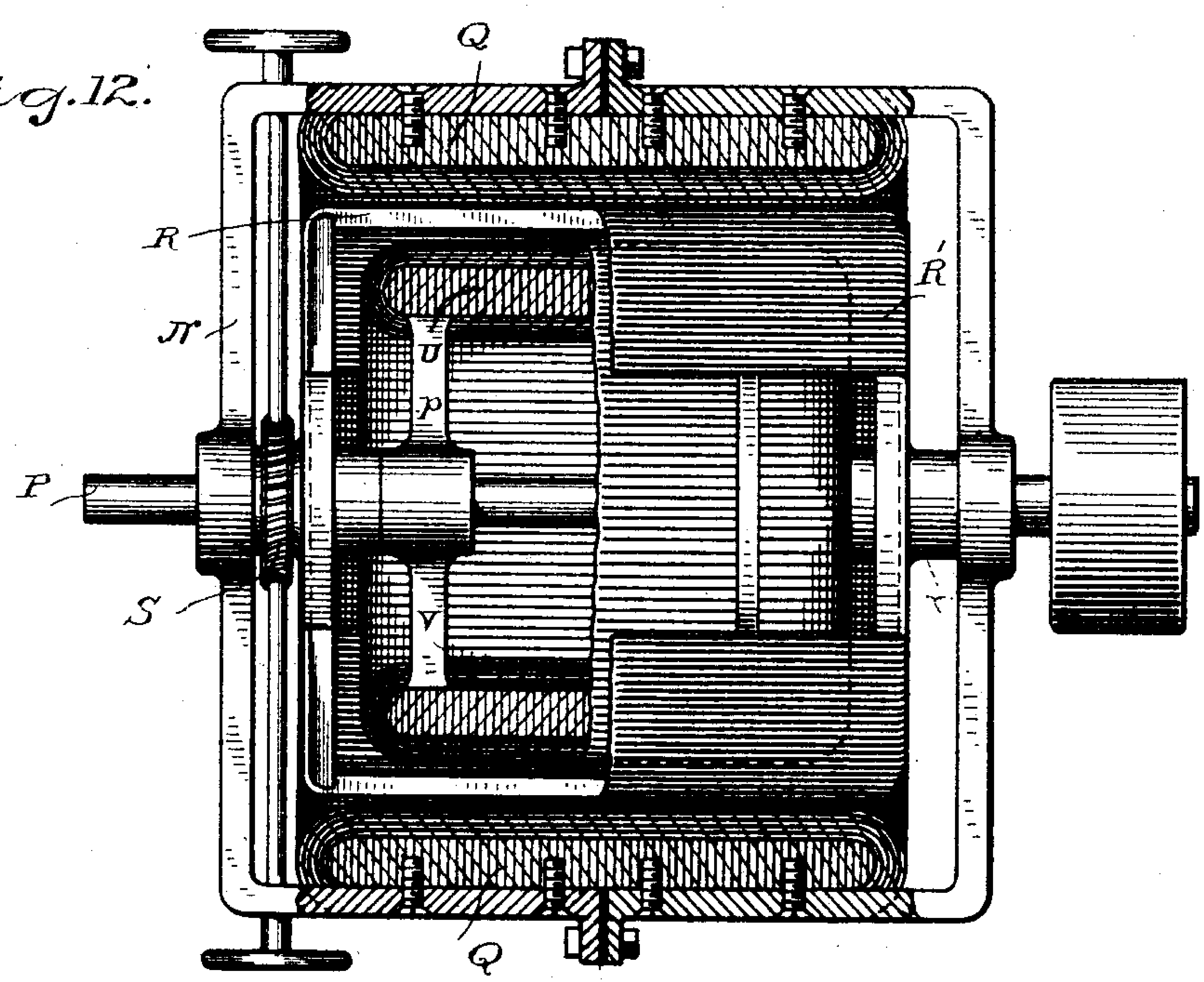


Fig. 12.



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UNITED STATES PATENT OFFICE.

CHARLES J. VAN DEPOELE, OF LYNN, MASSACHUSETTS.

ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 444,188, dated January 6, 1891.

Application filed March 22, 1889. Serial No. 304,234. (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 Electric 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.

The present invention relates to improvements in electro-dynamic motors of the type of which an alternating, pulsating, or intermittent electric current is used to energize the field-magnet and armature thereof. In an application filed March 8, 1889, Serial No. 302,544, I have shown, described, and claimed an alternating-current motor comprising a wire-wound armature having one or more closed circuits thereon, a field-magnet therefor, and an induction coil or coils between the field-magnet and the armature for acting inductively upon said armature to produce secondary currents therein for magnetization. In said application the induction-coil was indicated as a primary coil and received a portion of the main supply-current. In the present instance the motor includes the three elements above referred to; but instead of the induction-coil for the armature being the primary circuit of an inducting system it is arranged and connected to occupy a secondary relation to the field-magnet, and consequently the armature becomes a tertiary induction system—that is to say, the current circulating in the coils of the field-magnet produces secondary currents sent to the induction-coil surrounding the armature, and the flow of said secondary currents in the induction-coil induces tertiary currents in the armature, which serve to magnetize the same and establish the necessary poles. The positions of the poles in the armature are located by affording a definite path or paths for the currents circulating therein, substantially as described in my said prior application.

The principles of construction and operation may be applied in a great variety of ways, many specific modifications and changes being possible without departing from the invention. It will be understood in all cases where iron is employed in machines of this class that the same must be laminated or subdivided in order to respond with sufficient rapidity to the changes or reversals of the supply and induced currents.

The arrangement and operation of applications embodying my invention will be hereinafter fully described, and referred to in the appended claims.

Figure 1 is a view in elevation showing a motor embodying my invention. Figs. 2 and 3 are diagrammatic views illustrating different modes of arranging the circuits of the motor. Fig. 4 shows a diagrammatic view of a form of motor also embodying my invention, but differing from that shown in Fig. 1 principally in having the induction-coil wholly arranged within the field-magnet and capable of being moved to different positions. Fig. 5 is also a diagrammatic view similar to Fig. 4, except that the induction-coil is differently placed with regard to the poles in the field-magnets. Fig. 6 is a diagrammatic view of a form of my improved motor in which the induction-coil is acted upon directly instead of receiving current from secondary coils upon the cores of the field-magnets. Fig. 7 is a diagrammatic view showing an arrangement in which two induction-coils are used. Fig. 8 is a diagrammatic view showing a form of motor in which induction-coils are arranged to extend partly between polar extensions of the field-magnets. Fig. 9 is a top plan view partly in diagram showing an arrangement in which two induction-coils are used, the same being disposed between the polar extensions of the field-magnets and the armature. Fig. 10 is a view in elevation of the motor shown in Fig. 9. Fig. 11 is a view in elevation showing the exterior of a complete motor. Fig. 12 is a transverse partly-sectional view of the motor seen in elevation in Fig. 11.

As indicated in the drawings, A is a wire-wound armature, preferably of the Gramme type, although other forms may be used, if desired, since any wire-wound armature having an iron core may be arranged to be used in connection with the other parts of my improved motor. The core B of the armature A is wound with a continuous conductor b, which is divided into two or more sections by conductors 1 2, connected to the coils b at opposite points upon the armature, thereby affording a defined path or paths for the circulation or flow of currents induced in the coils *b*. The armature is enveloped by or inclosed within an exterior coil or coils C, which may be made in two or more parts, as convenient, and for some purposes the said coils are permanently secured in fixed relation to the core of the field-magnets and armature, as will appear.

D D′ are the pole-pieces of a surrounding field-magnet frame, said pole-pieces being provided with polar extensions $d\ d'\ d^2\ d^3$, arranged in proximity to the armature. For convenience the induction-coil C is shown as being fitted into recesses formed between the polar extensions of the field-magnets.

$D^2\ D^3$ are the field-magnet cores proper, upon which is wound a suitable number of coils E. The said coils are united by conductors $3\ 3^a\ 3^b$ and connected to a source of alternating, intermittent, or pulsating currents by suitable conductors 4 5. A second series of coils *e* are wound upon the field-magnet cores $D^2\ D^3$ in inductive relation to the field-magnet coils proper, and said coils *e* are connected to the induction coil or coils C, forming a single closed circuit. The field-magnet coils E receive current from an exterior source, and not only energize the field-magnets to produce rotation of the armature by reacting upon the poles therein, but the coils *e*, being in inductive relation to the coils E, constitute a secondary circuit in which currents are produced by induction. The currents produced in the secondary coils *e* flow through the induction-coil C. Owing to the proximity of the induction-coil to the coils of the armature-currents, flowing of the former will react inductively upon the coils of the latter and produce tertiary currents therein, which, flowing along the lines provided by the connections 1 2, will form true poles in the armature, upon which the field-magnets will react. The phases of the secondary currents, by which the induction-coil is energized will, however, lag somewhat about one-half phase behind the phases of the main current by which the field-magnets are engergized. This will enable the said coil to produce its effects upon the armature at a proper time with respect to the reversals of the main current, and this without regard to the rotation or speed of rotation of the armature. When, however, the retardation of the phases in the secondary coils is not adjusted to produce the best effects upon the armature, I employ a reactive coil in derivation from the secondary circuit, the iron core of which being adjustable will enable me to vary or time the current phases in the respective coils, as may be found desirable. Such an arrangement is indicated in Fig. 3, A′ being the reaction-coil or inductional regulator, and A^2 the movable iron core.

An adjustable resistance A^3 may be used instead of the coil A′, an organization embodying such features being seen in Fig. 2. It will also be understood that the secondary coils *e* may be wound in many different ways with respect to the field-magnet (primary) coils E—as, for instance, in said Fig. 2, where the coils *e* are shown as wound over or between the field-magnet coils E instead of in separate sections, as in Fig. 1.

As described with reference to Fig. 1, the induction-coils over the armature for producing magnetizing-currents therein are fitted into recesses in the magnetic yokes or polar extension of the field-magnet, and are thus rendered practically immovable, the desired control or regulation of the motor being effected by artificial means provided for that purpose. Some adjustment sufficient for ordinary purposes is provided by making the said recesses $a^4\ a^5$ somewhat wider than the ends of the coil *c*. The invention is not, however, limited to any specific form, since a great number of different dispositions of the parts are contemplated, some of which are shown and will be described.

In Figs. 4 and 5 I employ an annular field-magnet core F. The core F is divided into six sections, four of which $f\ f'\ f^2\ f^3$ are wound with suitable conductors, which produce positive and negative poles, as indicated by the signs. The armature A is suitably mounted within the annular field-magnet so formed and is provided with a suitable closed-circuit winding *b* upon its core B. The armature A is partially enveloped by an induction coil or coils C′, the function of which is to induce what I have called "tertiary currents" in the coils of the armature for magnetizing it. The armature being provided with cross-conductors 1 2, the said tertiary currents will flow along said conductors to establish poles in suitable relation to the poles in the field-magnet by which said armature is rotated. As here shown, the inducing-coils C′ are located between the armature and the interior of the field-magnet, so that the said inducing-coils may be placed upon a movable support and capable of adjustment with reference to the poles of the field-magnet for purposes of regulation. The fifth and sixth coils G G′ are wound upon the core F in inductive relation to the field-magnet coils proper. When energized by an alternating, pulsating, or intermittent current said field-magnet coils constitute the primary of an induction system, of which the coils G G′ are the secondary. The secondary coils are in circuit with the induction-coils C′, being connected thereto by conductors $g\ g'\ g^2$. Currents generated in the secondary coils G G′ will flow through the induction-coils C′ and by induction generate tertiary magnetizing-currents in the coils of the armature A upon the line of the magnetic axis of the inducing-coil C′. Coil C′ being adjusted or adjustable will enable me to locate or maintain the poles in the armature in the desired relation to the fixed poles in the field-magnet. Additional effects may be produced by connecting the induction-coils C′ to form two separate inducing systems C^2 C^3. For example, the coil C^2 is connected by conductors g^3 g^4 with the coil G′, forming a closed circuit thereon. The coil C^3 is similarly connected with the coil G by conductors g^5 g^6. The coils G C^3 will therefore act upon one half of the armature and the coils G′ C^2 upon the other half, producing two poles in the armature, as with the arrangement shown in Fig. 4 and indicated by the signs.

Instead of employing a separate secondary circuit for energizing the induction coil or coils, they may be arranged under the influence of the lines of force of the field-magnets, when they will constitute secondary circuits and be energized by induction.

As indicated in Figs. 6 and 7, a field-magnet may be employed having polar extensions H H′ united by cores h h' to form an annular field-magnet, within which an armature A is rotatively mounted. The cores h h' are wound with suitable conductors h^2 h^3 in circuit with a suitable source of alternating or intermittent currents through conductors I I′. An inducing-coil C^4 surrounds the armature A and is disposed between the periphery of said armature and the interior of the annular field-magnet, substantially as in Figs. 4 and 5; but said coil C^4 constitutes a closed circuit, its terminals being united by a conductor i. The coil C^4 being upon the interior of the field-magnet is acted upon thereby as a secondary coil and currents are induced therein, which, flowing around the armature, induce tertiary currents in the coils upon the armature, magnetizing the core of the latter and establishing fixed poles therein upon the line of the magnetic axis of the induction coil or coils C^4, the armature-poles being then reacted upon by the stationary poles in the field-magnet. Additional effects may be produced by the use of more than one induction-coil upon the armature, and such an arrangement is indicated in Fig. 7, in which, the other parts remaining the same, an induction-coil C^5 is added at right angles to the coil C^4. The coils C^4 C^5 are connected to form a single circuit by way of conductors i' i^2. With this arrangement the polarities established in the armature will be as indicated by the signs, but, being produced by the resultant of both coils, can be made to appear where desired by shifting the connections.

With the universally-adjustable induction-coils indicated in Figs. 4, 5, 6, and 7, and clearly shown in Figs. 11 and 12, interposed between the interior of the field-magnet and the exterior of the armature, some space is necessarily occupied thereby and the armature placed a trifle farther away from its field-magnet poles, thereby necessitating the use of a somewhat larger field-magnet than with the arrangement seen in Fig. 1, where the extremities of the induction-coils are disposed in recesses in the field-magnets and the armature may occupy its usual relation—that is, be as close to the poles of the field-magnets as is mechanically practical. While I have described the coil C in Fig. 1 as being immovable, I wish to be understood as saying that it is simply not universally movable or has no great range of movement. It will be apparent that the recesses in the field-magnet yokes within which it is sustained may be sufficiently larger than the mass of the said coils to permit sufficient adjustment for practical purposes.

In Fig. 8 is seen a modified form of the arrangement shown in Fig. 1. In this instance a field-magnet having four separate polar extensions J′ J^2 J^3 J^4 surrounds an annular space within which is rotatively mounted the armature J, the periphery of which is arranged to move as near to the faces of the said polar extensions as is practicable. The extensions J′ J^2 are united by a core K, and the extensions J^3 J^4 by a similar core K′. The said cores are wound with energizing-coils k k', receiving current from a suitable exterior source through conductors I I′ and connected by a conductor I^2. Inducing-coils are placed over the armature in this instance also; but instead of their end portions being sustained within recesses at the neutral points of the field-magnet extensions the coils C^6 C^7 are placed between the field-magnets at right angles to each other, their end portions being located between the extremities of the polar extensions, so that lines of force passing between the said polar extensions must act upon the wire of the inducing-coils located between them and cause secondary currents to flow in the coils C^7, which are between the plus and minus poles of the field-magnets K K′. The coils C^6 C^7 are connected by conductors i^3 i^4 to form a single closed circuit through which the secondary currents flow and produce a magnetizing-current in the armature-winding. No current is generated in C^6, as it is located between two poles of similar name. The armature A, previously referred to, is desirably of the Gramme type and wound and connected to form a continuous closed circuit. In many instances, however, I prefer to wind the armature with separate coils, each one closed upon itself. A desirable form of this type is indicated in Fig. 8, in which the sections j of the armature J are each composed of a single coil or flat ring of copper conductor, the ends of which, being united, constitute a closed-circuited section.

In Figs. 9 and 10 an arrangement similar to that shown in Fig. 8 will be seen, except that the field-magnets are somewhat differently constructed and disposed, thereby rendering the inducing-coils universally adjustable, and here both coils 4 and 5 by their position become the seat of induced currents induced by the poles plus and minus. As indicated, vertical cores L L′, united by magnetic yokes L^2 L^3, carry polar extensions L^4 L^5, partially surrounding an annular space, within which is rotatively mounted an armature A of any desired type. Inducing-coils C^4 C^5 are placed over the armature A between its periphery and the interior of the field-magnet polar extensions. The coils C^4 C^5 may be connected by conductors i' i^2 to form a single circuit, and when both are between the poles of the field-magnets, as shown, they will react upon each other. It will be evident that by displacing either or both of said coils a number of electrical combinations may be made for purposes of regulation and economy. The coils C^4 C^5 may be mounted upon supports M M between the legs of the field-magnet and be thus rendered universally adjustable.

In Fig. 11 is seen an exterior view of a motor embodying an annular field-magnet and universally-adjustable inducing-coils between its field-magnet and armature, means being there shown for adjusting the induction-coil to bring their magnetic axis into the desired relation with the stationary poles of the field-magnet. The internal arrangement of the machine shown in Fig. 11 is seen in Fig. 12, in which an exterior separable yoke N, of iron, is suitably attached to a supporting-base n, and is provided with journals along its central line, within which is mounted the armature-shaft P. Upon the interior of the yoke N are secured annular cores Q, desirably built up of thin laminæ of sheet-iron, each layer being suitably insulated from the adjoining ones. The core Q is preferably annular, and, as indicated in Fig. 11, it is provided with six coils, substantially as indicated in Figs. 4 and 5, although so far as the cores are concerned they may be of any of the types hereinbefore shown and described. The core or cores Q, however constructed, are suitably wound with conductors, as described. Within the annular space on the interior of the field-magnet and extending into close proximity thereto is placed a frame R, upon which are wound the induction coil or coils. The frame R may be of copper or iron, and is mounted concentric with the armature-shaft, being desirably supported on short sleeved extensions r, carried by the yoke N. The axis of the frame R is provided with a worm-wheel S, which is in engagement with a worm-pinion S′ upon a shaft T, by which the same may be rotated and the position of the frame R and induction-coils thereon adjusted as desired.

The armature-shaft P passes through the hollow frame R, and is provided with suitable spiders p p, which support the core U, which is also of laminated iron and is wound with a suitable conductor V. The armature-coils V may be of any desired type of conductor, whether flat or round, and may be in a single or in separate closed circuits, as hereinbefore set forth.

The yoke N, being of iron and its mass considerable, will serve to concentrate the effects of the magnetism at the desired point, and the parts of the machine should be located with reference to its magnetic effect. The yoke or frame of the induction-coil can be of iron or copper. If of iron, it will be magnetized by the coils thereon, and if copper a current will be induced therein which will coact with the other inducing-coils in their reactions upon the armature, so that there is no space lost in the center of the induction-coil.

All the iron parts of the machine, except possibly the yoke N, should be of subdivided or laminated material, the fineness of the subdivision or lamination, however, depending upon the rapidity of the reversals or interruptions of the current employed.

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

1. An electric motor comprising a closed-circuited armature having a coil in inductive relation thereto, a field-magnet and a single external source of current therefor, and coils in secondary relation to the coils of the field-magnet and connected to the induction-coil of the armature.

2. In an electric motor for alternating or pulsating currents, an armature wound with a copper conductor or conductors connected in one or more closed circuits, an induction-coil placed over the armature, and a field-magnet having a primary and a secondary circuit or circuits, the said secondary circuit being connected to and energizing the induction-coil of the armature, substantially as described.

3. An electro-dynamic motor having a closed-circuited armature, an induction coil or coils over said armature, a primary circuit upon the core of the field-magnets arranged to receive current from an alternating or pulsating source, and a secondary circuit upon the field-magnets, the said secondary circuit being closed through the induction-coil, which under the influence of the secondary currents induces tertiary magnetizing-currents in the armature, substantially as described.

4. An electro-dynamic motor comprising a stationary field-magnet, a stationary inducing system within the field-magnet and provided with coils arranged in inductive relation to the coils of the field-magnet and with coils in circuit therewith and in inductive relation to the armature, and an armature comprising one or more closed circuits rotatively mounted within the inducing system, whereby currents are produced in the armature to form poles therein, substantially as described.

5. In an electro-dynamic motor, a stationary field-magnet, a wire-wound armature, and a closed-circuit induction system surrounding the armature between the armature and field-magnet, part of its coils being wound in secondary relation to the field-magnet coils, whereby said inducing system is energized by secondary currents under the influence of primary currents of alternating or intermittent currents flowing in the field-magnet coils and acts inductively upon the armature to pro-

duce tertiary magnetizing-currents therein, substantially as described.

6. An electro-dynamic motor, a stationary field-magnet wound with magnetizing-coils in circuit with a source of alternating, pulsating, or intermittent currents, a wire-wound armature for said field-magnets, and a secondary inducing system surrounding the armature and arranged in inductive relation thereto, whereby the alternating or intermittent current traversing the coils of the field-magnets will produce secondary currents in the stationary inducing system, causing the latter to act inductively upon the armature to form tertiary magnetizing-currents therein, substantially as described.

7. An electro-dynamic motor comprising a stationary field-magnet, a closed-circuited armature rotatively mounted within the field of force, an inducing system comprising a secondary circuit in inductive relation to the field-magnet, energizing-coils surrounding the armature, and means for regulating the phases of current induced in the inducing system under the influence of the field-magnets when supplied with alternating or intermittent currents, substantially as described.

8. An electro-dynamic motor comprising a stationary field-magnet, a closed circuited armature rotatively mounted within the field of force, an inducing system surrounding the armature, a secondary circuit in inductive relation to the field-magnet and energizing the coils surrounding the armature, and means for regulating the phases of current induced in the inducing system under the influence of the field-magnets when supplied with alternating or intermittent currents, substantially as described.

9. An electric motor comprising a closed-circuited armature having a coil in inductive relation thereto, a field-magnet and a single external source of current therefor, coils in secondary relation to the coils of the field-magnet and connected to the induction-coil over the armature, and a regulating device placed in circuit between the secondary coils upon the field-magnets and the induction-coil over the armature.

10. An electro-dynamic motor comprising a stationary field-magnet, an armature rotatably mounted with respect thereto and having magnetizing-conductors upon its core, said conductors arranged to form one or more closed circuits thereon, an inducing system composed in part of an inducing-coil adjustably mounted between the poles of the field-magnet and the periphery of the armature, and means for adjusting the induction-coil with respect to the field-magnet poles.

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

CHARLES J. VAN DEPOELE.

Witnesses:

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CHAS. L. OECHSNER.