No. 613,209. Patented Oct. 25, 1898.

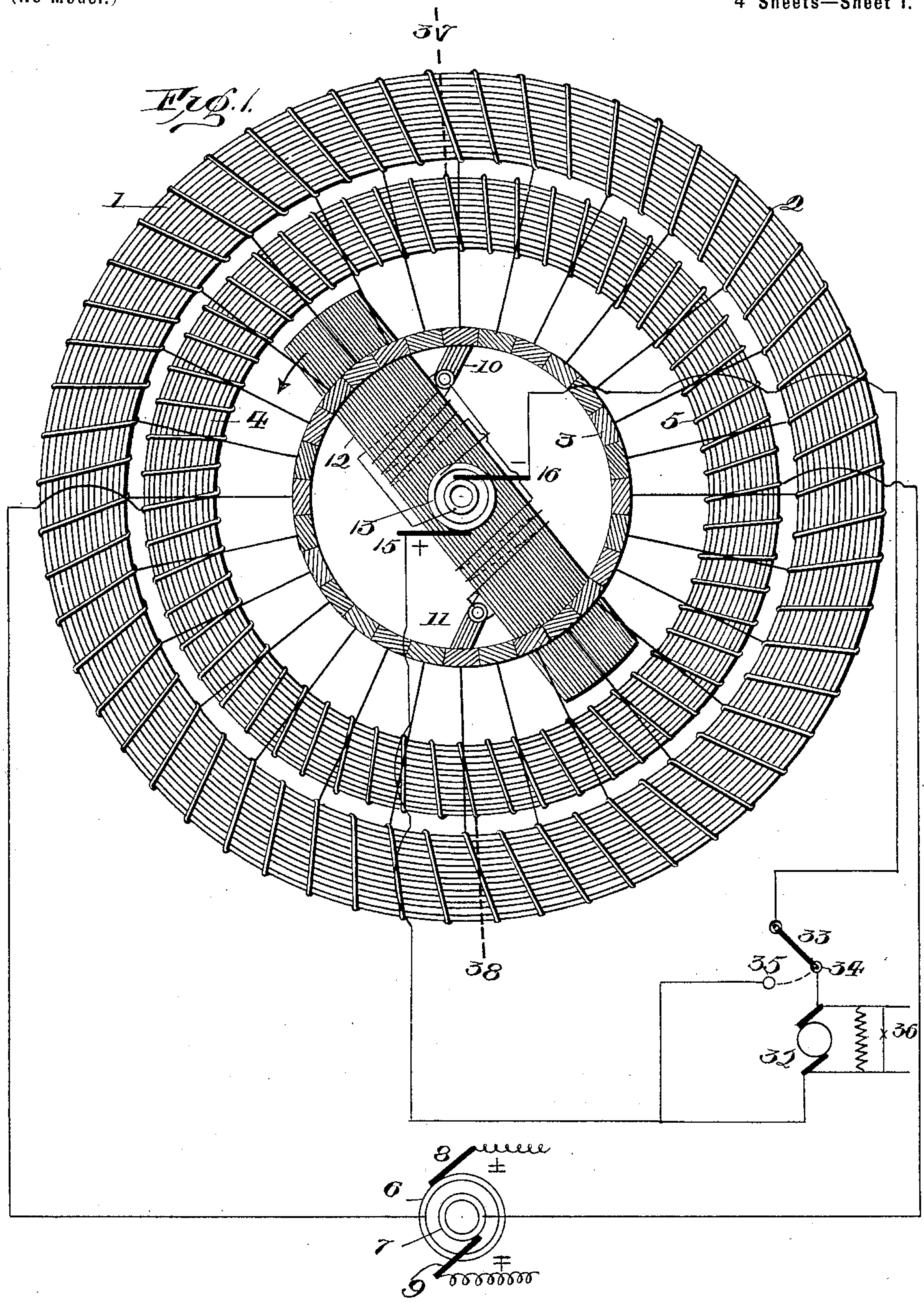
M. LEBLANC.

ALTERNATING CURRENT DYNAMO ELECTRIC MACHINE.

(Application filed Apr. 10, 1897.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.



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4 Sheets—Sheet 2.

Fig. 2.

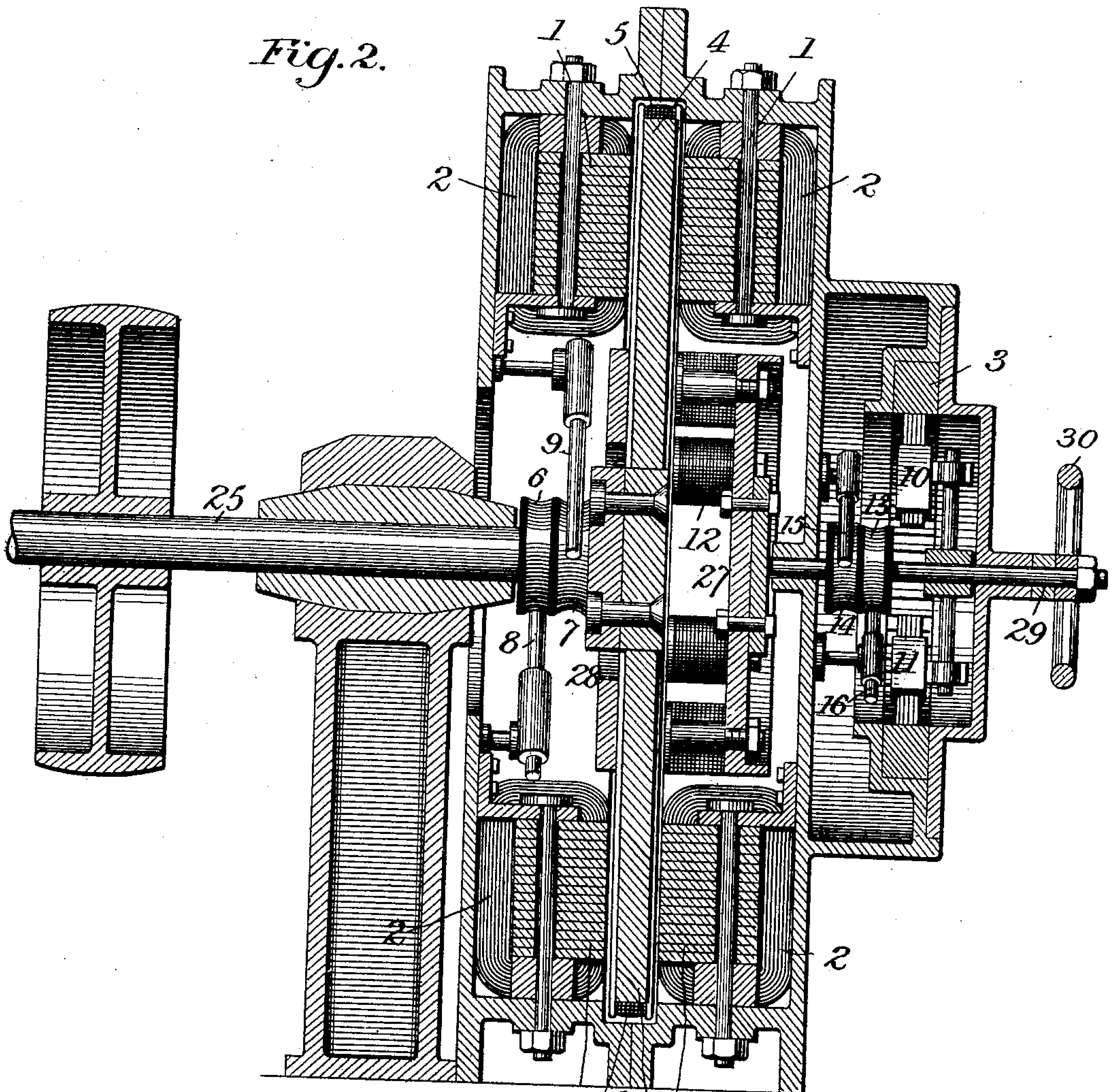
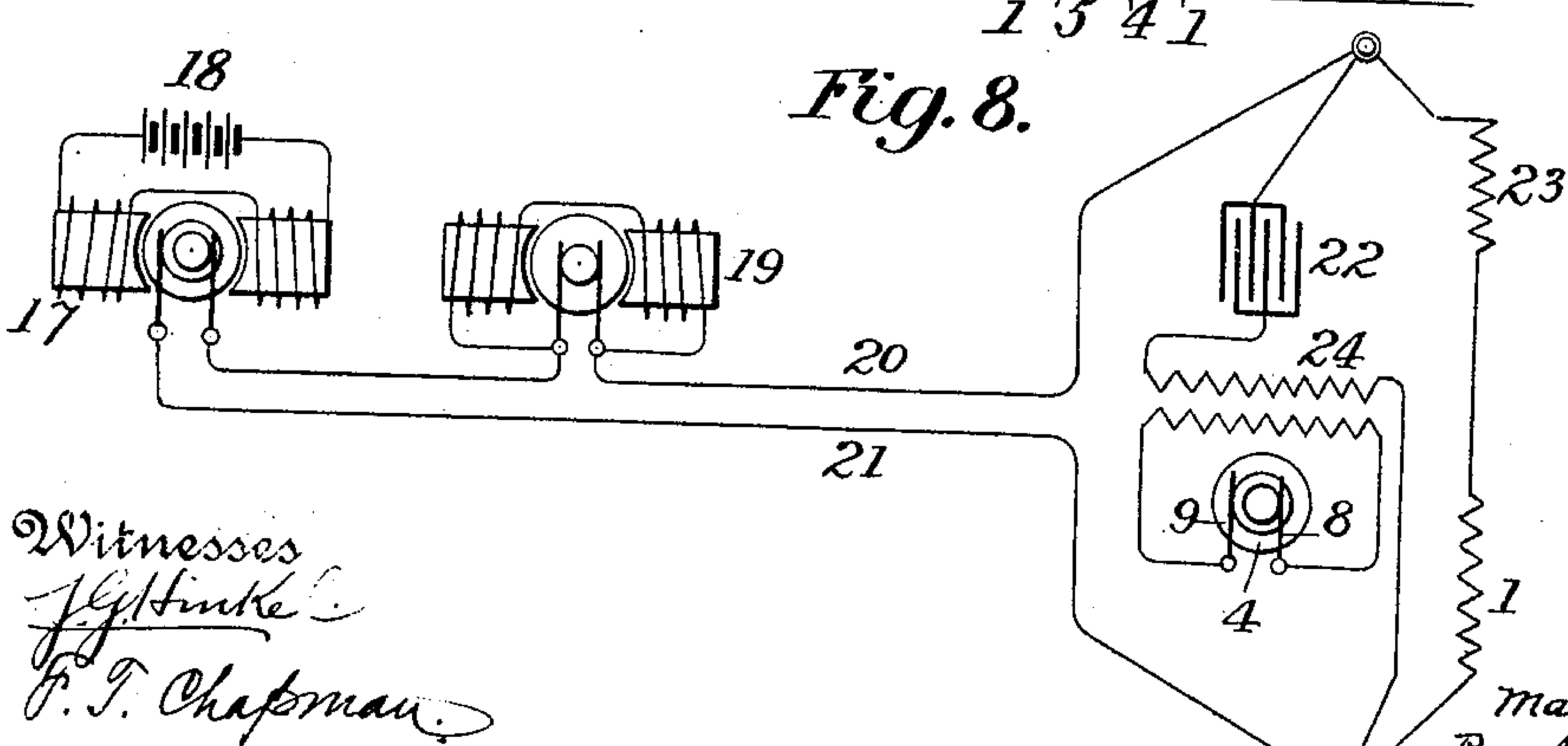


Fig. 8.



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(No Model.) 4 Sheets—Sheet 3.

Fig. 3.

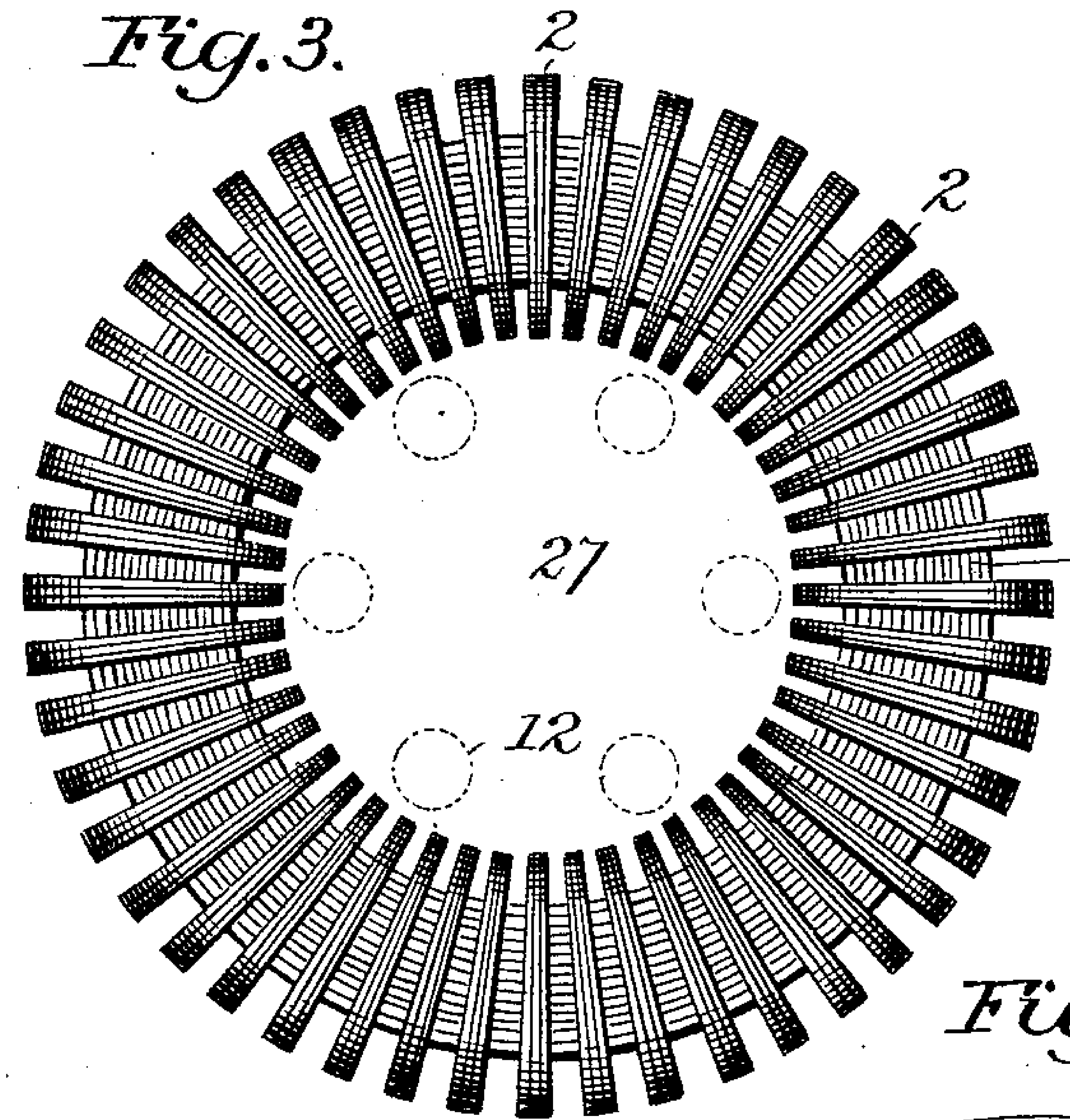


Fig. 4.

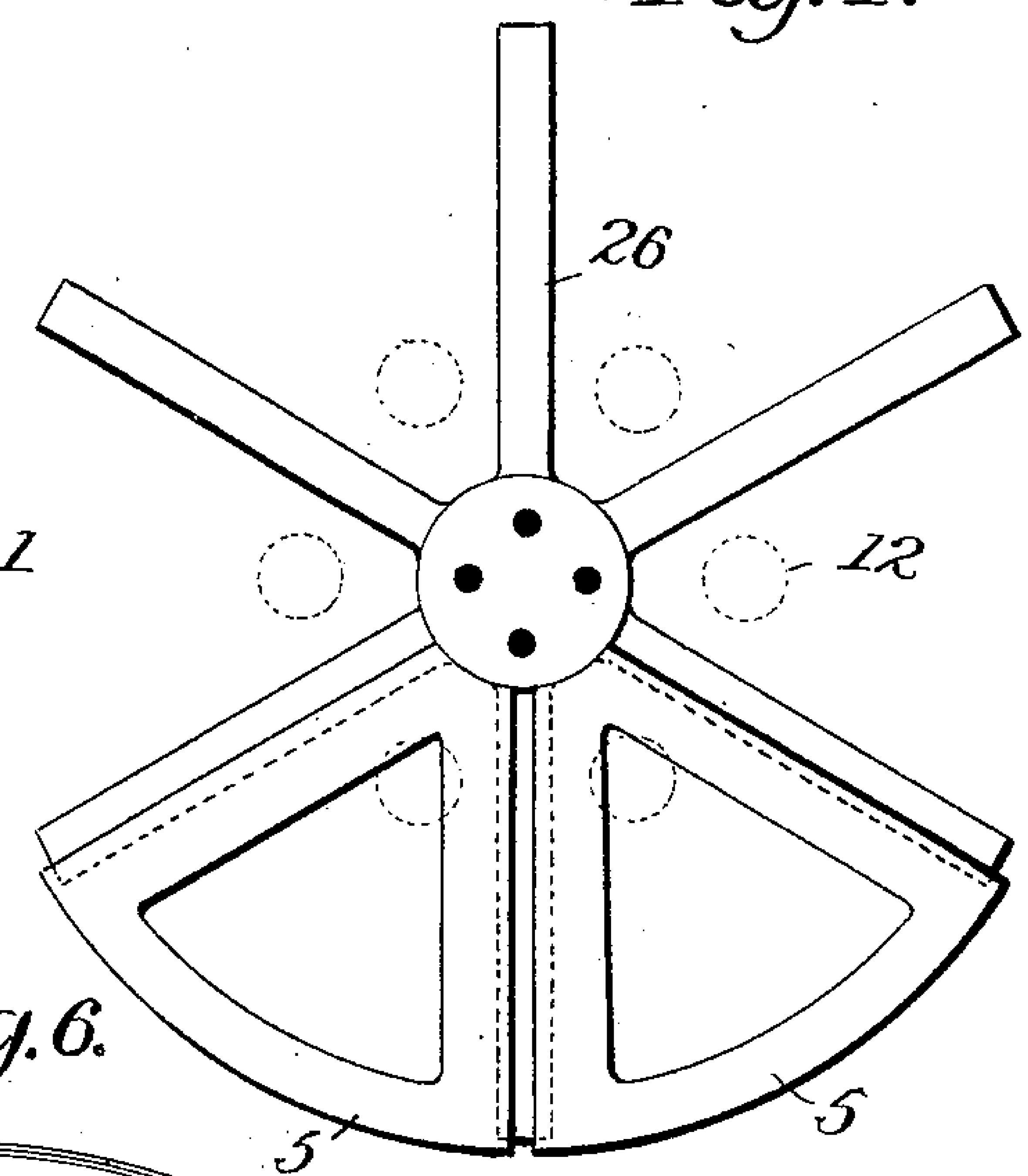
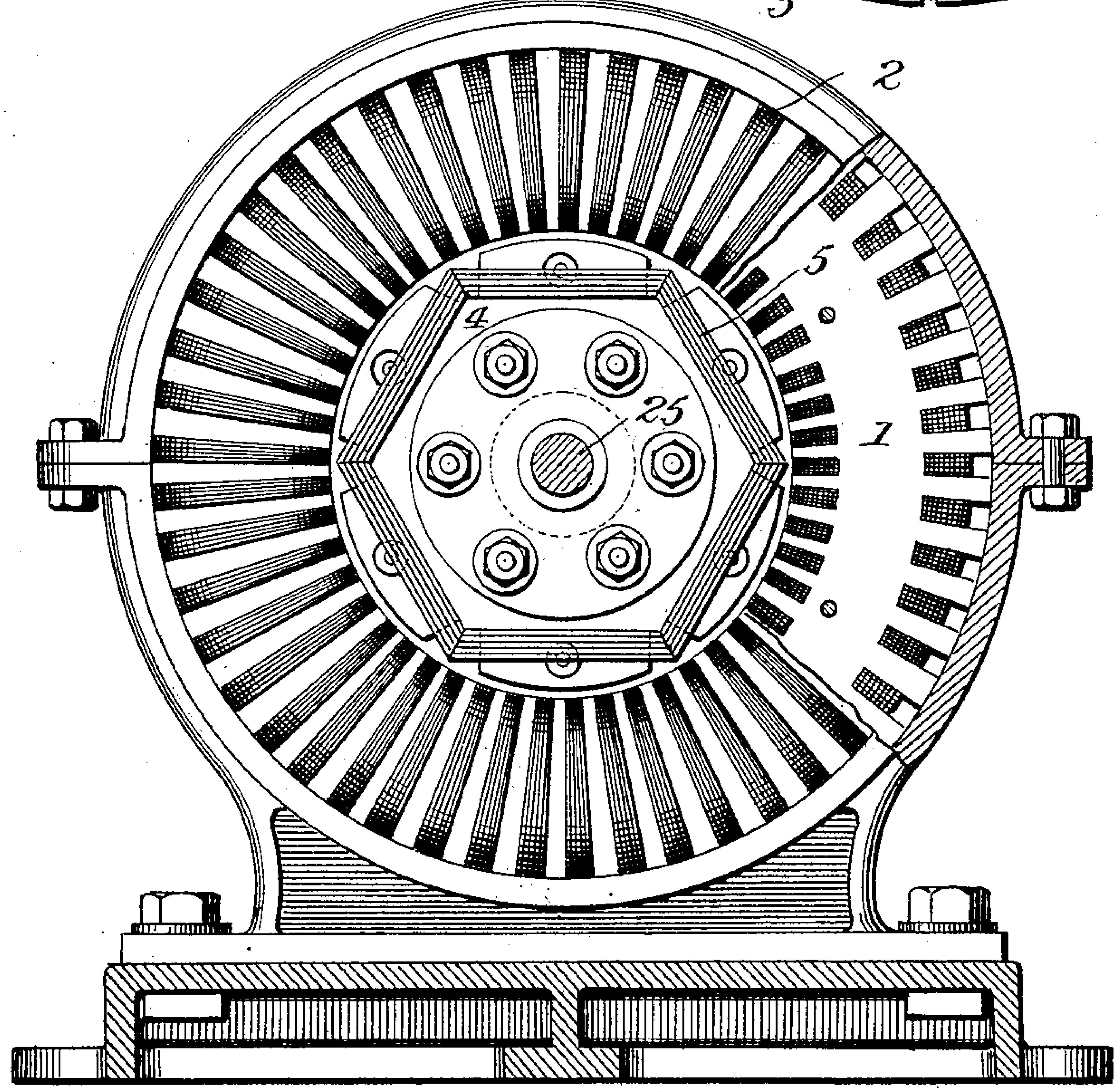


Fig. 6.



Witnesses

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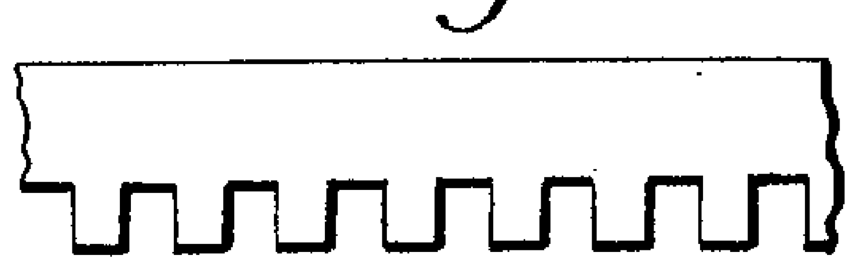
Fig. 5



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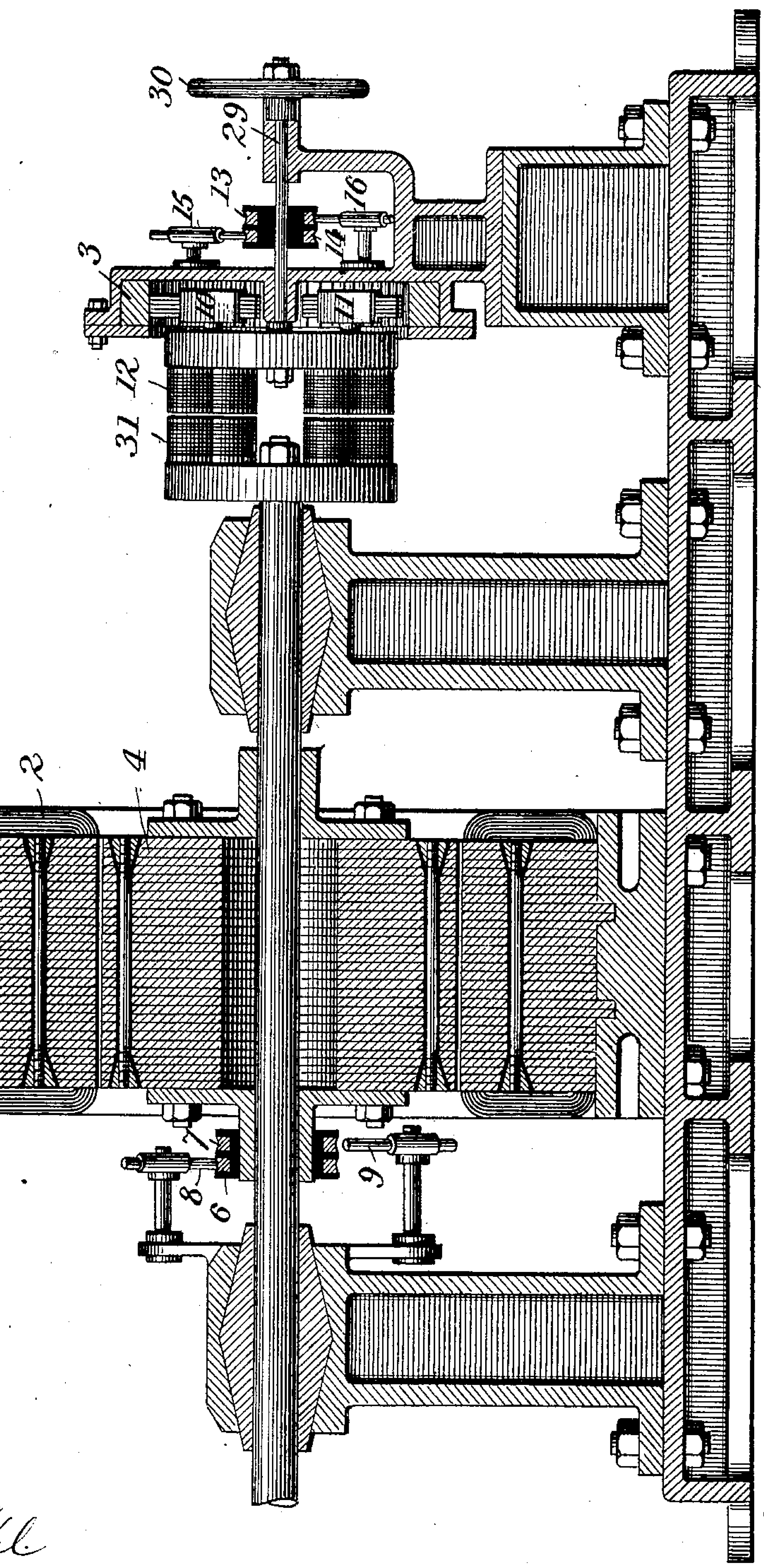

Fig. 7.

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UNITED STATES PATENT OFFICE.

MAURICE LEBLANC, OF PARIS, FRANCE, ASSIGNOR TO THE SOCIÉTÉ ANONYME POUR LA TRANSMISSION DE LA FORCE PAR L'ÉLECTRICITÉ, OF SAME PLACE.

ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 613,209, dated October 25, 1898.

Application filed April 10, 1897. Serial No. 631,614. (No model.) Patented in France May 17, 1889, No. 198,289; in Germany June 9, 1889, No. 53,332; in Austria August 10, 1889, No. 34,987; in Hungary August 10, 1889, No. 64,927; in Switzerland December 2, 1889, No. 1,689; in England December 3, 1889, No. 19,450; in Belgium December 7, 1889, No. 88,767, and in Italy December 12, 1889, No. 26,665/286.

To all whom it may concern:

Be it known that I, MAURICE LEBLANC, a citizen of the Republic of France, and a resident of Paris, France, have invented certain new and useful Improvements in Alternating-Current Dynamo-Electric Machinery, (for which Letters Patent have been granted in France, dated May 17, 1889, No. 198,289, and certificate of addition of October 23, 1891; in Germany, dated June 9, 1889, No. 53,332; in Austria, dated August 10, 1889, No. 34,987; in Hungary, dated August 10, 1889, No. 64,927; in Belgium, dated December 7, 1889, No. 88,767; in Switzerland, dated December 2, 1889, No. 1,689; in Italy, dated December 12, 1889, No. 26,665/286, and in England, dated December 3, 1889, No. 19,450,) of which the following is a specification.

My invention relates to alternating-current dynamo-electric machinery, and comprises a single-phase motor capable of running either at synchronous speed or at speeds below synchronism with full torque and good efficiency.

It also comprises a single-phase lag or induction motor of a new type.

The construction and mode of operation are such that the self-induction in the field-magnets of my improved motors is either entirely absent or negligibly small.

My invention also comprises a new electric generator capable of furnishing direct or unidirectional current and also capable of furnishing alternating currents, either single phase or multiphase, of any frequency desired, and a new rotary transformer for changing single-phase alternating into continuous current, and vice versa, with or without change of voltage, a new system of distribution, and certain less important details, as will be hereinafter more particularly described and claimed.

For a clearer understanding of my invention reference is had to the accompanying drawings, in which—

Figure 1 is a simple ideal diagram showing my invention in its skeleton form. Fig. 2 is a vertical cross-section of my improved motor in its preferred form. Figs. 3 and 4 are detail views of the same. Fig. 5 is a view showing a part of one of the laminæ which form the field-magnet core. Figs. 6 and 7 are views of a modification, and Fig. 8 is a diagrammatic representation of the whole system.

Like letters and numerals refer to like parts throughout the various figures of the drawings.

In Fig. 1 is shown a Gramme-ring core 1, wound with a continuous winding of insulated wire 2, tapped at equidistant points to the segments of a commutator 3. 4 is a similar core wound in the same way with the continuous winding 5, which is connected at diametrically opposite points to collector-rings 6 7 on the main shaft of the machine. The brushes 8 9 bear on these collector-rings and lead in the alternating current. There is thus formed across the core 4 an alternating polar line, joining the points at which the wires from the rings 6 7 connect with the winding 5. This polar line is stationary with reference to the core 4, but alternates at a speed equal to the frequency of alternation of the alternating current, as is well understood. The ring-core 1, which may be called the "field-core," is preferably fixed, and the ring-core 4 is mounted to rotate on a shaft, though it is evident that in this, as in other respects, the machine is reversible. Now if the winding 2 on the core 1 be supplied with direct current, as by the exciter 32, through the brushes 10 11, and if these brushes are held stationary while a single-phase alternating current is fed to the collector-rings 6 7, it is evident that we have a very simple synchronous motor which will run with great efficiency at synchronous speed, which speed will of course depend on the frequency of the alternating current supplied and on the number of poles in the two cores 1 and 4. Such a machine, however, is not self-starting, and if overloaded will "break" from synchronism and stop altogether. To avoid these troubles, I place inside the ring-core 4 and in inductive relation with it the small iron piece 12, mounted to turn freely on a separate shaft. This part carries the collector-rings 13 14, with the fixed brushes 15 16 bearing upon them. From the ring 13 a wire runs to the brush 10, while to the brush 11 a wire is connected which takes a few turns around the iron piece 12 and is then connected to the ring 14. The iron piece 12 constitutes, with its winding, what I call the "auxiliary" field-magnet, and which, with respect to the rotating armature, may be called an "auxiliary" rotor. Suppose now that the field-core 1 and the armature 4 are each at rest, that the armature 4 is supplied with alternating current at a frequency $\frac{W}{2\pi}$, and that the auxiliary rotor 12 is supplied with direct current through the brushes 15 and 16. It is evident that this auxiliary rotor will constitute, with the armature 4, a small synchronous motor. As it carries no load, it may be readily started by hand. Let us then start the auxiliary rotor by hand. It is evident that it will thereupon at once run up to a speed which is synchronous with the alternating current supplied at a frequency $\frac{W}{2\pi}$ to the stationary armature 4—that is to say, the auxiliary rotor will rotate with a velocity of W. From the connections it will be seen that the field-magnet 1 is supplied with direct current in series with the auxiliary rotor 12. The brushes 10 11 are therefore carried about the commutator 3 at a speed W, corresponding to synchronism. The poles in the core 1 are always under the brushes 10 11. There is thus set up in the core 1 a rotary field which turns with the speed W. I repeat, therefore, to fix ideas, that when we assume the field-core 1 and the armature 4 each at rest and the rotor 12 moving at a speed of synchronism W that we have a rotary field in the field-core 1 moving at a speed W, that the auxiliary rotor 12 is moving in the same direction at the speed W, and that the alternating polar line of the armature 4, being fixed with relation to the armature, is stationary on a stationary diameter, but is alternating back and forth across the diameter at a frequency of $\frac{W}{2\pi}$.

It is evident that the rotating field in the field-core 1 will tend to set the armature 4 in rotation, either in the same or in the opposite direction, according as the brushes 10 11 are in advance of or lag with respect to the auxiliary rotor. By setting the brushes so as to lag with respect to the auxiliary rotor, as indicated in Fig. 1, the armature 4 will start to rotate in a direction opposite to that of the auxiliary rotor. Let us suppose that the velocity of rotation of this armature 4 at any given moment is w. Since the alternating polar-line of the armature is fixed with reference to the armature, it is evident that this alternating polar line is at that moment moving in space with the same velocity w. It is furthermore apparent that since it is this alternating polar line which determines the movement of the auxiliary rotor the auxiliary rotor will tend to keep the same space relation with respect to this alternating polar line when the armature 4 is rotating as it does when the armature 4 is at rest; but in order that the alternating polar line of the armature 4, which is now moving in a given direction with a velocity w, may maintain the same relation with respect to the auxiliary rotor 12, which is moving in the opposite direction, it is evident that this auxiliary rotor may no longer move with the speed W, as it did when the armature 4 was at rest, but must, on the contrary, move with a speed W w. It follows, therefore, that as the armature 4 increases its speed w the auxiliary rotor decreases its speed correspondingly, so that when the armature 4 is running at a synchronous speed W the auxiliary rotor is at rest. In fact, the sum of the velocities of the armature and of the auxiliary rotor is always constant. Since, however, the speed of rotation of the rotary field in the field-magnet 1 is exactly equal to the speed of rotation of the auxiliary rotor 12, it follows that the sum of the velocity of the rotary field in the field-magnet 1 and of the velocity of the armature 4 is always constant; but this is another way of stating that the relative speed of the rotary field with respect to the armature or with respect to the polar line of the armature is constant. There is therefore always maintained a sensibly constant angular displacement between the polar line of the field-magnet 1—in this case the stator—and the polar line of the armature 4—in this case the rotor.

The direct current required may be supplied in any convenient way; but I prefer to supply it by my improved system of distribution. (Shown in Fig. 8.) In that figure, 17 is an ordinary alternating-current generator, excited in any known way, as from the source of electricity 18. In series with it is placed the continuous-current generator 19, and lines 20 21 lead to the motor. It is well known that an alternating current will pass with great readiness through a condenser. In fact, a condenser in series with a motor is advantageous, as it tends to bring the current more nearly in phase with the electromotive force. A direct current, however, will not pass through a condenser. On the other hand, a direct current will pass through a coil of great self-induction, but low resistance, with great ease, while the same coil will practically shut off an alternating current. I therefore place in the circuit that conveys current to the armature of my motor, either directly or indirectly, a condenser 22 and in series with the field-magnet 1 a choking-coil 23. The field is in multiple with the circuit that conveys current to the armature. In this way each part is supplied with its proper current and only one system of lines is necessary. It is obvious that by inserting a condenser and self-induction coil in series with the alternating and continuous generator, respectively, these two generators may be placed in multiple instead of in series. I may, and preferably do, interpose a transformer of some ordinary form in the armature-circuit, in order that high voltages may be used on the line. This transformer is shown in the figure and numbered 24.

My motor in its practical and preferred form is shown in Figs. 2 to 5, inclusive, while another modification which presents some advantages is shown in Figs. 6 and 7.

Fig. 2 shows a motor with a disk-armature 4 mounted on the shaft 25 between the two field-magnets 1 1. The field-magnets are built up of laminæ of the form shown in Fig. 5, preferably stamped out of sheet-iron. In the slots are wound the coils 2 2, connected in series and tapped at equidistant points to the commutator in the ordinary way and as in the form shown in Fig. 1. If the field-magnet is bipolar, the brushes will be diametrically opposite; if multipolar, there may be as many brushes as there are poles, or two brushes may be used in a manner well known in the armatures of continuous-current multipolar generators. The field-rings are so wound that the two poles opposite each other in the two magnets are of opposite signs, creating a flux through the armature. In the form shown this flux is assumed to be sextipolar. The armature is composed then of six bobbins 5 5. A simple form is shown in Fig. 4, in which a six-armed star-shaped metal carrier 26 supports six V-shaped coils. The coils overlap the arms of the carrier in such a way as to prevent lateral displacement, and the whole is completed by fastening the coils in place with exterior binding-wires. The coils are wound alternately in opposite directions and connected in series, while the terminals are connected, as in Fig. 1, to the collector-rings 6 7, on which bear the brushes 8 9, connected, as in Fig. 8, to the secondary of the transformer 24 or to the source of alternating current directly, as was assumed in connection with Fig. 1. It will be noticed that the points of the V-shaped coils project toward the center of the machine more than would be necessary if they were only to embrace the flux of the field. These six points may be considered as forming a second armature in inductive relation to the auxiliary field-magnet 12. This latter consists of six cores wound with wire and fastened to a plate 27, while a plate 28 on the other side of the armature closes the magnetic circuit. The coils on the pole-pieces are connected in series and wound to produce poles in line on the same radii with those of the main field-magnet, and the terminals are connected one to the brush 11 and one to the ring 14. It will be seen that the connections in this structure are the same as those in the skeleton form shown in Fig. 1. The shaft 29, which supports this auxiliary armature, is mounted on the frame of the machine and turns independently of the main shaft 25. The hand-wheel 30 is sufficient to give this shaft the initial rotation required. The brushes 10 11 are carried on this shaft, as are also the rings 13 14. It is obvious that this machine is electrically the equivalent of the form shown in Fig. 1, and its action will be obvious. The armature is in inductive relation to both field-magnets, as in the skeleton form, and the two machines differ only in number of poles and mechanical construction, the disk-machine being adapted for practical work on a large scale with good efficiency. The auxiliary rotor is started by hand should it refuse to start itself on being supplied with current and carries no load except the friction of the brushes 10 11. This field-magnet after being started would, if the armature remained at rest, attain and maintain the speed of synchronism; but since by the movement of the auxiliary field the polar line of the field-magnet proper is shifted the armature starts in a direction opposed to that of the rotation of the auxiliary field-magnet; but the relative speed of the armature and auxiliary field-magnet will always remain the same, and this relative speed will be that of synchronism. From this it follows that if the armature accelerates the field-magnet will slow down, and if the armature slows down the field-magnet will accelerate. When the armature attains synchronous speed, the rotary field will be at rest; but even then the relative speed of the two will be that of synchronism. This machine can therefore run at synchronism and at all speeds below synchronism, as above set forth. It is not necessary that the auxiliary rotor be at rest when the armature comes to synchronism, since the same result is attained by so setting the brushes that the auxiliary rotor tends to start in the same direction as the armature, in which case when the machine comes to full speed the auxiliary rotor will turn at twice the velocity corresponding to synchronism. For this purpose the brushes must be set to lead the auxiliary field-magnet, or, what is the same thing, the auxiliary field-magnet is started in a direction opposite to that of the arrow indicated in Fig. 1, in which case the brushes set as there shown will be leading; but the operation as indicated in Fig. 1 is preferable, as the auxiliary rotor is then less subject to wear and the hysteresis is a minimum.

The machine which I have so far described is of the disk type and is the preferred form; but it is obvious that the principle is applicable to other known forms, and Figs. 6 and 7 show a motor of the drum type on this principle. The field-magnet 1 is built up, as before, of laminæ, as is also the armature 4. The coils of the field-magnet are connected, as before, like the coils of the armature of a continuous-current generator, and tapped to a commutator 3. The armature is wound with six coils, connected reversely in series, and the terminals are carried to the rings 6 7. The auxiliary rotor 12 is arranged as in the preferred form, but is now in inductive relation to an auxiliary armature 31, connected in series or in multiple with the main armature. The parts 12 and 31 form together a small synchronous motor and act together just as do the coils 5 and the auxiliary rotor 12 in the form shown in Figs. 1 to 5. Direct current is supplied to the rings 13 14 and alternating current to the rings 6 7. The auxiliary rotor is first started and runs as the direct-current member of a synchronous motor, its alternating-current member being the part 31. When the auxiliary rotor has reached synchronism, a torque is produced between the main armature 4 and the field-magnet 1, as explained above, with the result that the armature 4 starts and runs up to synchronism.

If in any of the forms described the brushes 15 16 are put on short-circuit—that is to say, if no continuous current is supplied from an external source—the action is different. I have shown means for accomplishing this result, consisting of the switch 33 and its connections in Fig. 1. When the machine is to be run as a synchronous motor, the switch 33 rests on the contact-point 34 and direct current is supplied from the exciter 32 or otherwise, as already described; but when the machine is to be run as a lag-motor, as will now be described, the switch 33 is thrown to the contact 35, short-circuiting the brushes 15 16. When under these conditions the alternating current is first applied through the rings 6 7, the armature 4 acts as a primary and induces electromotive force in the winding 2 of the field-magnet 1. This causes a current to pass through the winding on the auxiliary field-magnet 12, which starts or is started and runs at a speed corresponding to synchronism. While it is thus running, the electrical conditions will be the same as in the ordinary single-phase induction-motor. As soon as the auxiliary rotor 12 reaches synchronism with respect to the pole in the ring 4 the alternating currents induced in 2 will be rectified to unidirectional currents in the winding of 12, thus permanently magnetizing 12 and enabling it to retain synchronism. Moreover, by the tapping of the ring 1 around the commutator 3 the poles of the ring 1 will always be in line with the brushes 10 and 11 and will rotate with these brushes. A torque will thereby be established between the poles in the armature 4 and the field-ring 1, either forward or backward, according to the setting of the brushes. It is preferable to set the brushes in such a manner as to cause the armature to start against the auxiliary rotor, as above explained. As the armature accelerates in obedience to the torque the auxiliary rotor will slow down until, if the armature reached synchronous speed, the auxiliary rotor would come to rest, so that with a frequency of one hundred periods per second in the armature-circuit the speed of the armature would be one hundred revolutions per second and the auxiliary rotor would be at rest. It is impossible, however, for this to occur, for at synchronous speed the armature-poles would be fixed in space and would fail to induce appreciable currents in the field-winding, so that the torque would disappear. Therefore the armature approaches synchronous speed until its magnetic torque is less than the mechanical load torque. The slip or deficit of speed below synchronism corresponds to the slip which occurs in an induction-motor and increases with the load. The auxiliary rotor must therefore acquire the speed of slip in a direction opposite to that of the armature. If the slip were two per cent. and the frequency one hundred periods, then with a bipolar motor, as represented in Fig. 1, the speed of the armature would be ninety-eight revolutions per second in one direction and the speed of the auxiliary rotor two revolutions per second in the opposite direction. This means that the frequency of rotation of the poles of ring 4 in space is two revolutions per second and the frequency of the induced currents in winding 2 of ring 1 is two periods per second. By this means the reactance of the field-winding is fifty times less than if the currents in it were externally supplied or had a frequency of one hundred periods. The self-induction excited successively in the separate coils of the winding 2 of ring 1, as they are successively shifted from one branch to the other, would excite injurious sparking at the brushes if the magnetic poles of the ring 4 did not advance in such a relative position and at such a rate that the electromotive force of self-induction is neutralized directly by the advancing pole. The armature will therefore start and run at a speed which will depend on the frequency of the current supplied, the self-induction and resistance of the windings, the load on the shaft, &c. The machine thus becomes a self-starting single-phase lag-motor. In other respects the action is as before.

The motors above described are capable of important uses besides those above set forth. For example, it has been shown above that with the switch 33 in the position opposite to that shown in Fig. 1 the machine will act as a lag-motor exciting the auxiliary rotor 12 with unidirectional current. It is evident that this unidirectional current may be taken off and used to feed translating devices without interrupting the action of the machine as a motor. We now have a combined motor and rotary transformer taking single-phase alternating current at the rings 6 7 and furnishing mechanical work on the shaft and at the same time furnishing from the winding 2 on the induced member 1 an alternating current which is commutated by the action of the brushes 10 11, rotating with the auxiliary rotor 12 into a unidirectional current. This is illustrated in Fig. 1, in which 32 may now be considered as a direct-current motor and 36 a lamp or other translating device. The current induced in 2 by the action of the alternating poles in 4 passes through the commutator 3, brushes 10 and 11, winding on 12, and brushes 15 and 16 to the translating devices of the external circuit. If now we fix the armature 4, we have a simple rotary transformer taking single-phase alternating current and delivering unidirectional current. This is evidently similar to the last application, as it is simply the case in which the mechanical power taken off becomes zero; but the result evidently affords a simple means of changing single-phase alternating current into unidirectional, or vice versa.

In either of the uses above set forth it is evident that the unidirectional current will be of a voltage which depends on the voltage of the alternating current supplied at the rings 6 7, and also on the ratio of turns in the windings 2 and 5, so that the rotary transformer or the combined rotary transformer and motor may furnish unidirectional current of any desired tension. The self-induction of the circuits will tend to smooth out the variations of the unidirectional current referred to without affecting its mean value; but in order to obtain true direct current it is only necessary to supply the ring 4 with multiphase currents fed to bobbins at points displaced from each other, as in the inducing member of an ordinary multiphase motor. In Fig. 1 the two additional leads for the alternating current are indicated in dotted lines at 37 and 38. In this form the machine acts as a multiphase motor delivering at the same time mechanical work and direct current in a manner very similar to that above explained. As before, the armature 4 may be fixed in space, when the effect is to convert all of the energy of the multiphase currents, neglecting certain small losses, into direct current.

In any of the forms above described my improved motor will also act as a generator. If, for example, armature 4 be driven mechanically, the conditions being otherwise as above set forth and one or more alternating currents be supplied to the winding 5, a unidirectional or direct current may be taken off from the brushes 10 11 or 15 16, as preferred. If the current supplied to the winding 5 is single phase, the resulting current will be unidirectional, but pulsating. If multiphase current be supplied, the result will be true direct current. If now the armature 4 be still driven mechanically and a direct current be supplied to the fixed ring—as, for instance, at two diametrically opposite points in the form shown in Fig. 1—it is evident that the machine is a simple alternating generator, supplying single-phase currents at the rings 6 7, whose frequency depends only on the rate of rotation of the armature 4. This result could be obtained by the connections shown in Fig. 1 by simply fixing the auxiliary rotor and supplying the exciting-current from the exciter 32. If, further, the brushes 10 11 be driven by the auxiliary rotor 12 or otherwise, the poles of the ring 1 will rotate and the frequency of the alternating current supplied will be equal to the speed of rotation of the armature 4, plus or minus the speed of rotation of the brushes 10 11, according to the direction in which they are rotated. In the forms shown in Figs. 2 to 7 the frequency will be greater in proportion as the number of poles of those forms is greater. The machine is then, used in this way, a generator of alternating current whose frequency may be made anything desired without altering the driving speed by simply changing the speed of rotation of the brushes 10 11.

In this specification and in the claims thereto attached I use the term "dynamo-electric machine" to include any apparatus, as generators, motors, or transformers, in which a useful result is produced by the mutual action between lines of force and electric conductors.

I do not limit myself to the specific forms shown and described, as it is evident that they may be greatly varied without departing from the spirit of my invention; but

I claim as my invention and desire to secure by Letters Patent—

1. The method of operating an electric motor which consists in supplying its field-magnet windings with direct current and its armature with alternating current through the same line.

2. The method of starting and running an alternating-current motor which consists in supplying its armature with alternating currents and rotating the points of entrance of the field-current.

3. The method of starting an alternating-current motor which consists in supplying its armature with alternating currents and rotating the points of entrance of the field-current and gradually reducing such rotation as the armature attains speed.

4. The method of starting an alternating-current motor which consists in supplying one member with alternating currents, and the other member with continuous currents, and progressively shifting the points of connection of the said continuous currents.

5. The method of starting an alternating-current motor which consists in supplying one member with alternating currents, and the other member with continuous currents, and progressively shifting the points of supply of the said direct currents and gradually reducing the progressive shifting as the armature attains speed.

6. The method of transmitting, transforming and utilizing electrical energy which consists in conveying alternating currents to the

primary member of an induction-motor comprising relatively-movable primary and secondary members, deriving continuous unidirectional currents from the secondary member and utilizing the same, substantially as described.

7. The method of maintaining synchronous relative speed between the rotor and the field-poles of the stator of a single-phase alternating-current motor at all speeds of the rotor, which consists in rotating the polar line of the stator from moment to moment by currents conveyed therefrom or thereto, so as to maintain a sensibly constant angular displacement between the polar line of the stator and the polar line of the rotor, substantially as described.

8. The method of maintaining synchronous relative speed between the rotor and the field-poles of the stator of an alternating-current motor, at all speeds of the rotor, which consists in rotating the polar line of the stator by an auxiliary field-magnet in magnetic inductive proximity to the rotor, so as to maintain a sensibly constant angular displacement between the polar line of the stator and the polar line of the rotor, substantially as described.

9. The method of maintaining synchronous relative speed between one element and the magnetic poles of the other element of an alternating-current motor, at all speeds of the rotor element, which consists in rotating the polar line of one of these elements, from moment to moment by currents conveyed therefrom or thereto, so as to maintain a sensibly constant angular displacement between the polar line of the stator and the polar line of the rotor, substantially as described.

10. The method of maintaining a synchronous relative speed between one element and the magnetic poles of the other element of an alternating-current motor, at all speeds of the rotor element, which consists in rotating the polar line of one of these elements by an auxiliary field-magnet in magnetic inductive relation to the element which receives the alternating current, so as to maintain a sensibly constant angular displacement between the polar line of the stator and the polar line of the rotor, substantially as described.

11. In an alternating-current motor the combination of an element receiving alternating currents, and an element receiving a continuous current; with means for shifting the poles of the latter element by an auxiliary rotor in magnetic inductive relation with the former element; whereby the motor is capable of running at synchronous speed and at all speed below synchronism, substantially as described.

12. An alternating-current single-phase induction-motor having a primary member receiving the alternating currents and a secondary member in which electromotive forces are induced by the currents in the primary, in combination with means for starting the motor from rest under load by the energy of continuous current derived from the secondary member, substantially as described.

13. An alternating-current single-phase induction-motor having a primary member receiving the alternating currents and a secondary member in which electromotive forces are induced by the currents in the primary, and means for establishing and shifting a magnetic polar line or lines in the induced member by the energy of continuous currents derived from the electromotive forces induced therein, whereby the motor will start from rest under load, substantially as described.

14. An alternating-current single-phase induction-motor having a primary member receiving the alternating currents and a secondary member in which electromotive forces are induced by the currents in the primary, and means for establishing a magnetic polar line or lines in the induced member by continuous currents derived from the electromotive forces therein and maintaining a constant angular displacement between such polar line or lines and the virtually-rotating polar line or lines in the inducing member; whereby the machine will start under load and maintain constant torque at all speeds, substantially as described.

15. In a system of electrical distribution, the combination of main conductors, a source of alternating current and a source of direct current connected to said conductors, an alternating-current-translating device and a direct-current-translating device, both in multiple with said conductors, means for preventing the flow of direct current through the alternating-current-translating device, and means for preventing the flow of alternating current through the direct-current-translating device.

16. In a system of electrical distribution, the combination of a source of direct current and a source of alternating current, both connected to a pair of mains, and an electric motor whose field-magnet winding is connected to the said mains, and whose armature-winding is also connected to the said mains, through a condenser.

17. In a dynamo-electric machine, the combination of a field-magnet, a commutator, connections from the field-magnet to the commutator, brushes bearing on the commutator, a rotary armature, and an auxiliary rotary field-magnet for rotating said brushes, substantially as described.

18. In a dynamo-electric machine, the combination of an armature composed of a number of V-shaped coils, a field-magnet in inductive relation to a portion of each of said coils, and an auxiliary field-magnet or rotor in inductive relation to another portion of each of said coils.

19. An induction-motor transformer comprising relatively-movable primary and sec-

ondary members, means for feeding alternating currents to the primary member, and means for deriving unidirectional currents from the electromotive forces induced in the secondary member, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

MAURICE LEBLANC.

Witnesses:
EDWARD P. MACLEAN,
PAUL BOUR.