No. 606,762. Patented July 5, 1898.

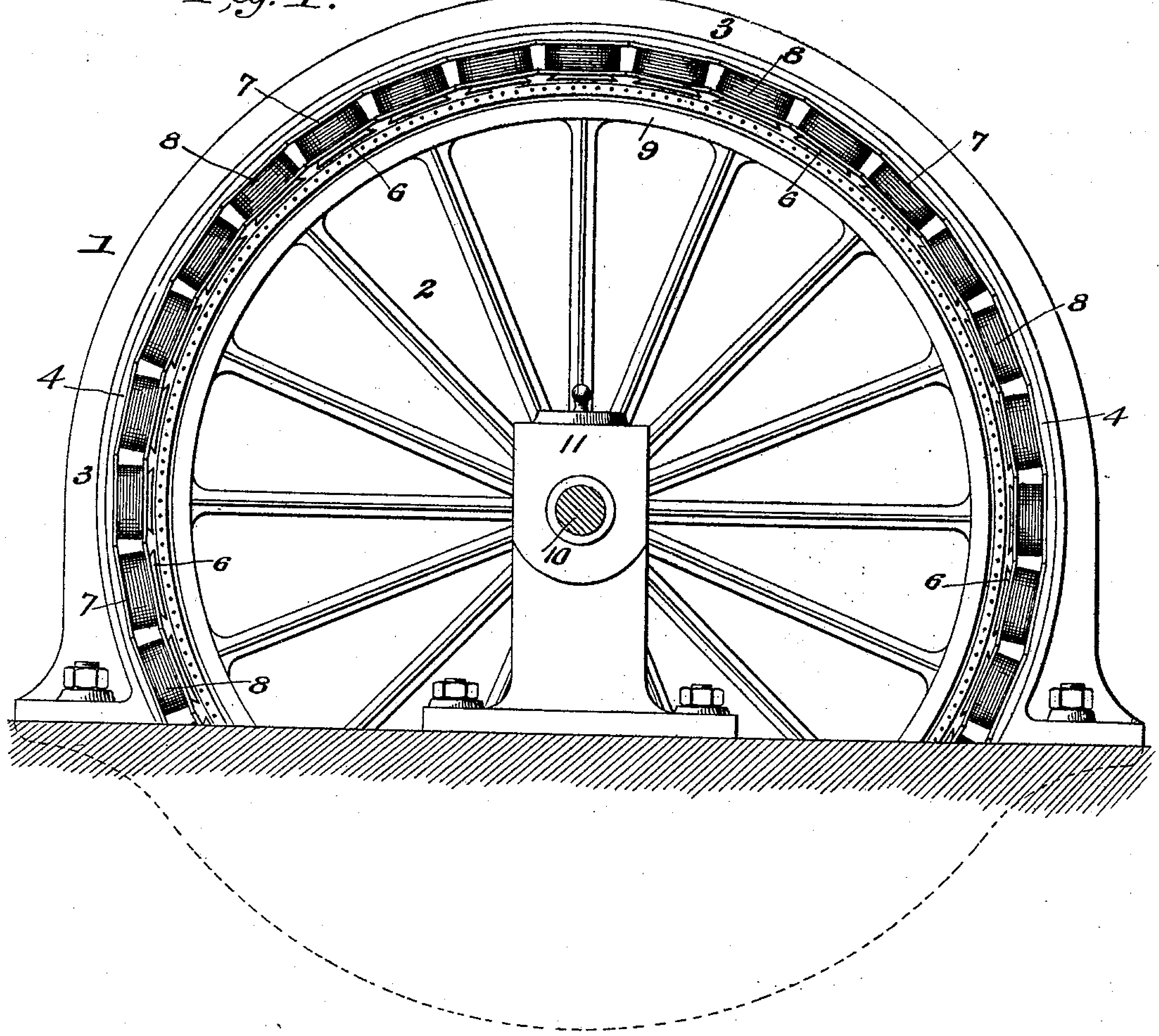
M. HUTIN & M. LEBLANC.

ALTERNATING CURRENT DYNAMO.

(Application filed Apr. 19, 1895.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

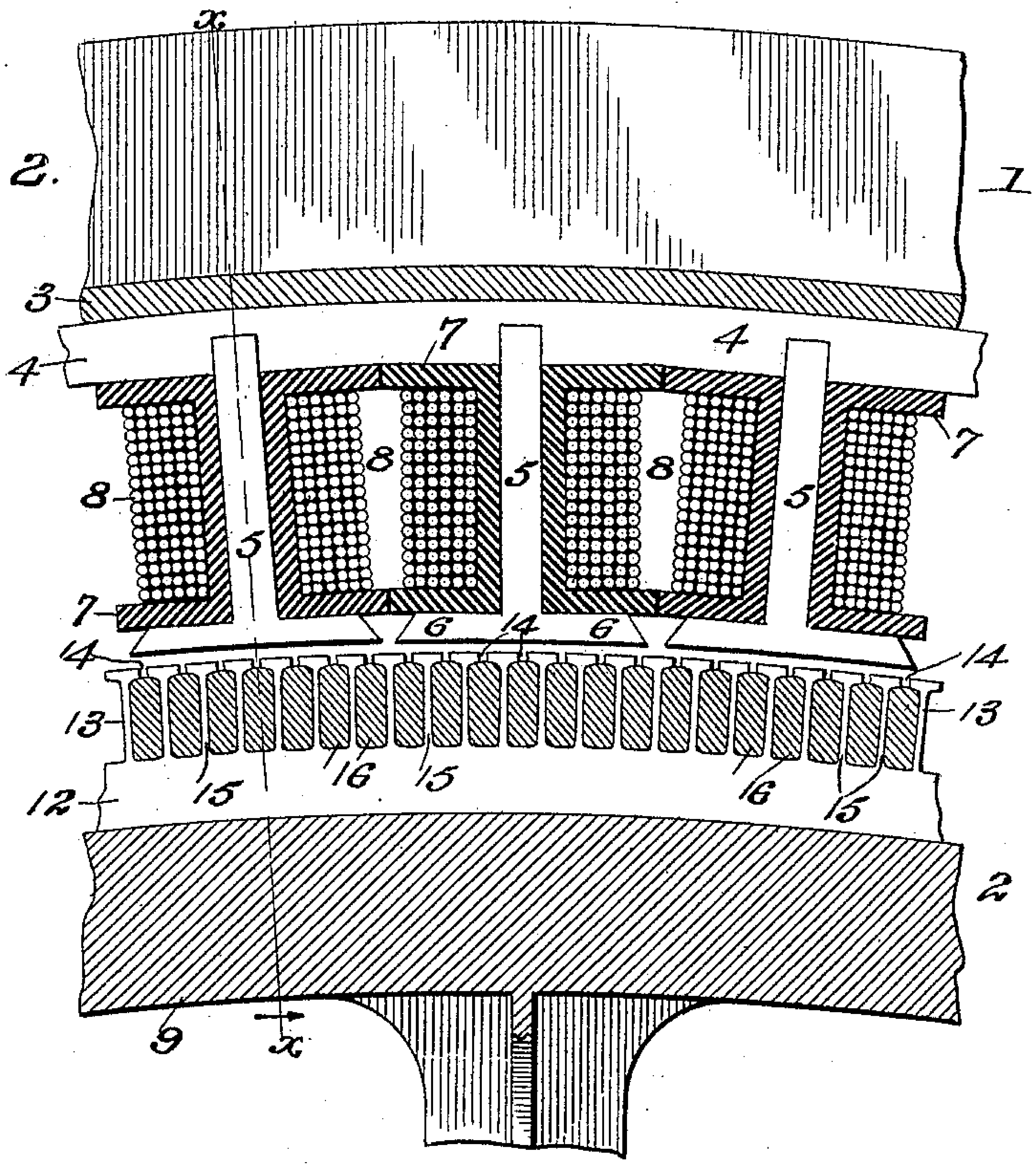

Fig. 3.

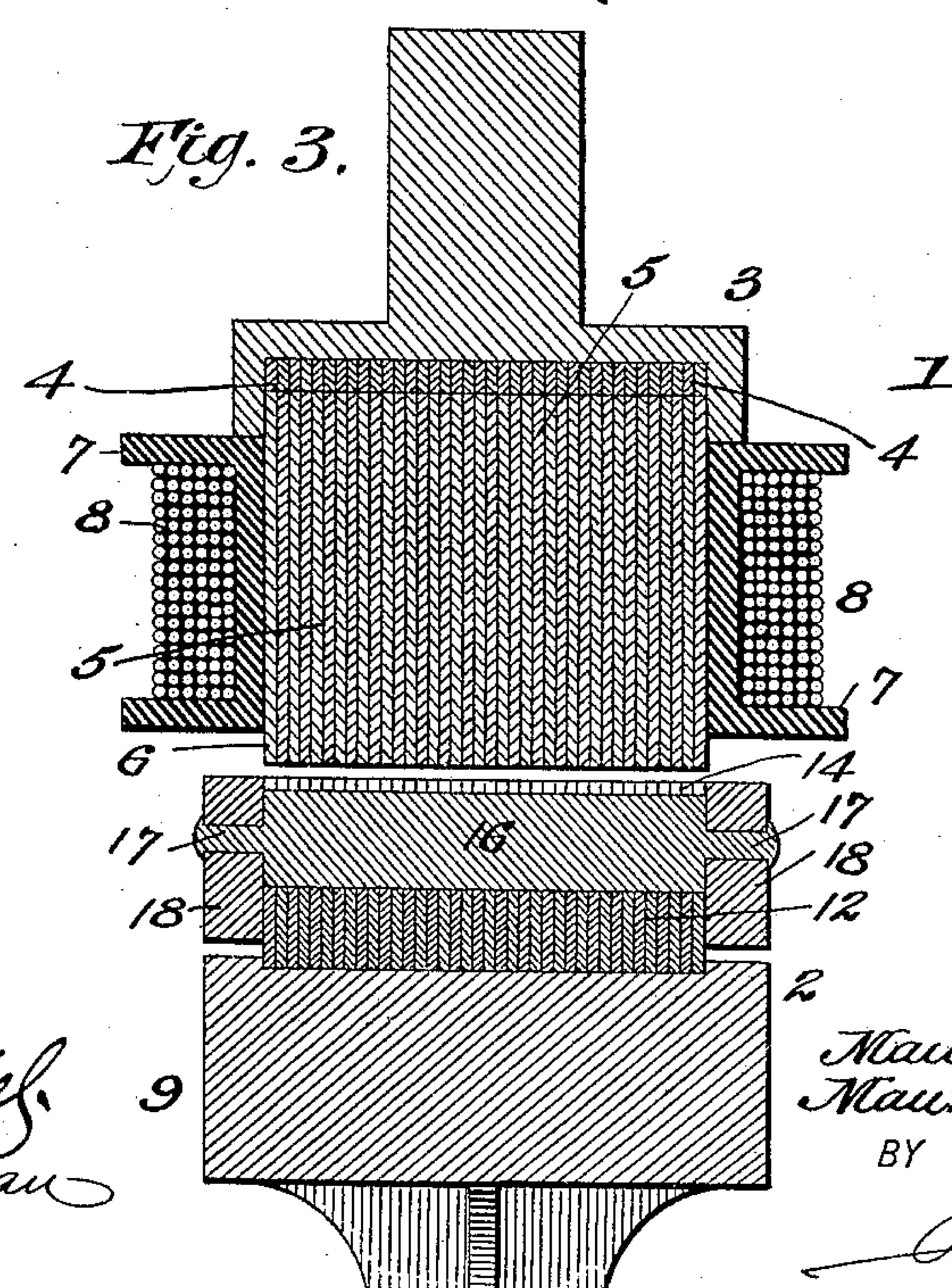

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Fig. 4.

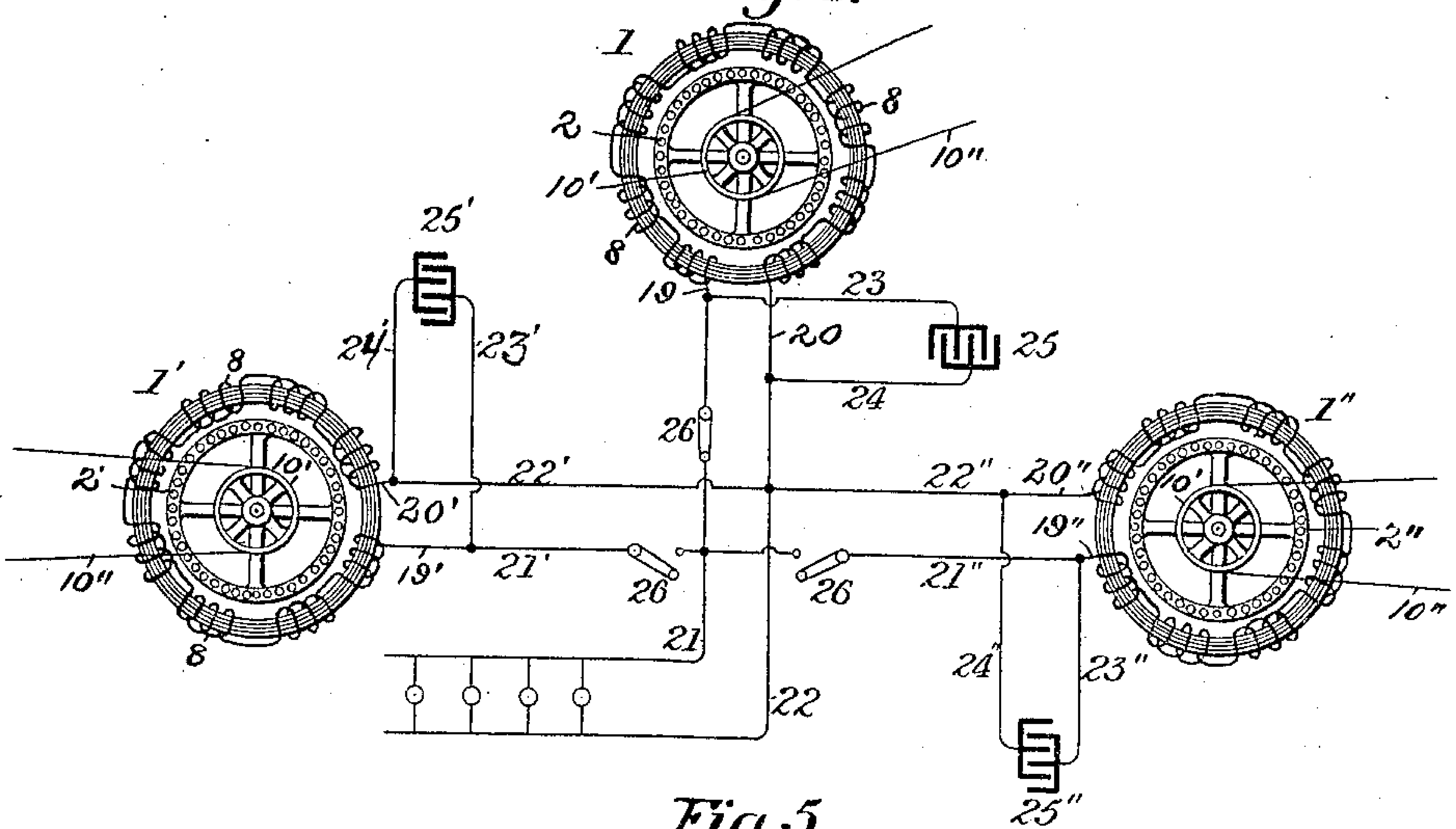
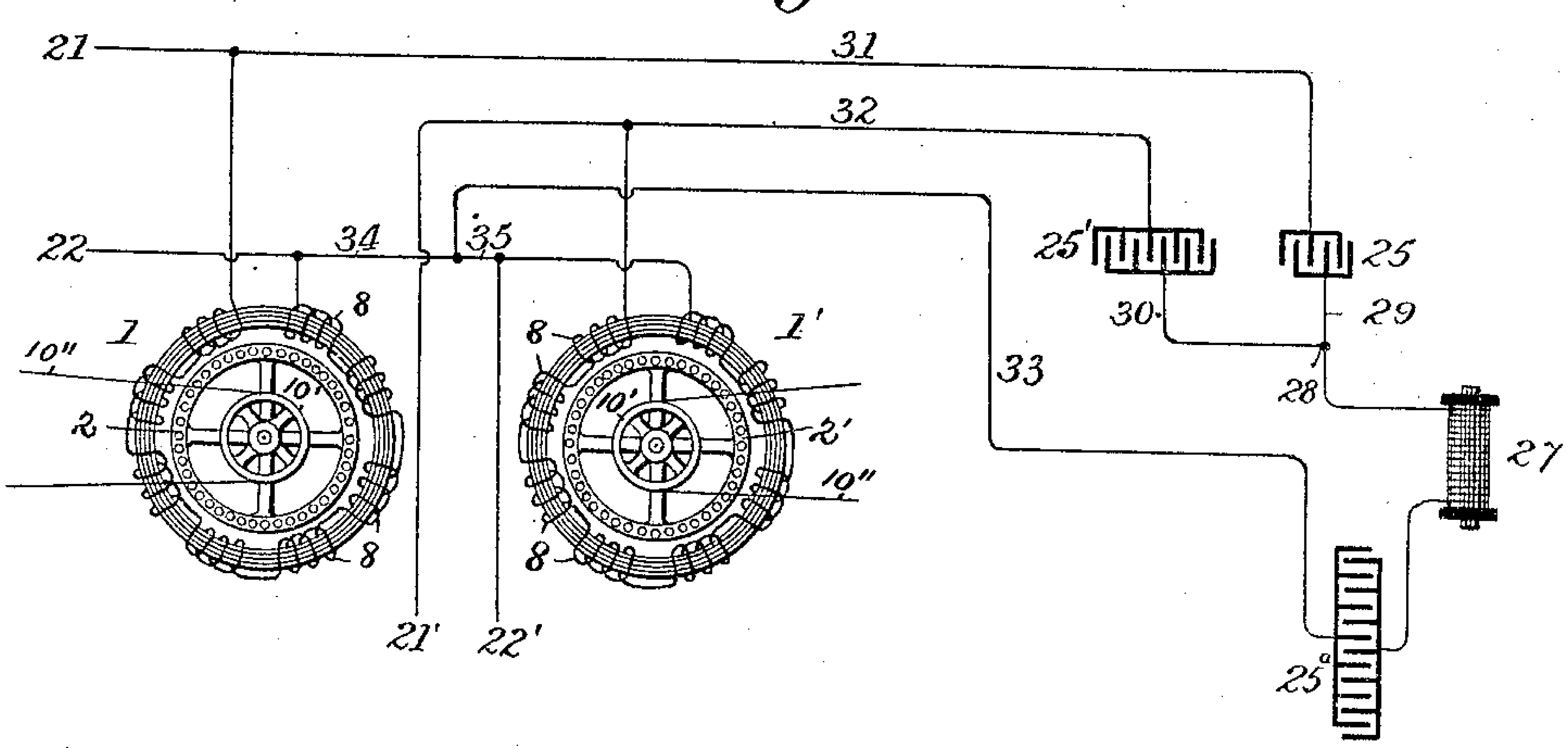


Fig. 5.



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UNITED STATES PATENT OFFICE.

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

ALTERNATING-CURRENT DYNAMO.

SPECIFICATION forming part of Letters Patent No. 606,762, dated July 5, 1898.

Application filed April 19, 1895. Serial No. 546,407. (No model.) Patented in France June 13, 1894, No. 239,283; in Germany June 26, 1894, No. 82,217; in Austria July 4, 1894, No. 45,201; in Hungary July 14, 1894, No. 1,627; in Belgium November 9, 1894, No. 112,648; in Switzerland November 9, 1894, No. 9,636; in England November 12, 1894, No. 21,827; in Italy November 12, 1894, No. 37,622/448, and in Spain November 12, 1894, No. 21,827.

To all whom it may concern:

Be it known that we, MAURICE HUTIN and MAURICE LEBLANC, citizens of the Republic of France, and residents of Paris, in the Department of the Seine, Republic of France, have invented certain new and useful Improvements in Constant-Potential Alternating-Current Dynamos, (for which Letters Patent have been obtained in France, No. 239,283, dated June 13, 1894; in Great Britain, No. 21,827, dated November 12, 1894; in Germany, No. 82,217, dated June 26, 1894; in Austria, No. 45,201, dated July 4, 1894; in Hungary, No. 1,627, dated July 14, 1894; in Belgium, No. 112,648, dated November 9, 1894; in Switzerland, No. 9,636, dated November 9, 1894; in Italy, No. 37,622/448, dated November 12, 1894, and in Spain, No. 21,827, dated November 12, 1894,) of which the following is a specification.

Our invention has reference to improvements in constant-potential alternating-current dynamos in which an initial field of force is produced by currents or electrical discharges derived from an exterior source and which field of force is reinforced by the inductive action thereon of a rotary armature the circuit or circuits of which move in inductive proximity and with reference to the poles of said field of force.

The invention is an improvement upon and an amplification of the system of generating alternating currents of high frequency set forth in our application, Serial No. 503,524, filed March 13, 1894. It embraces a new mode of generating constant-potential monophase or polyphase alternating currents and also a general system of distribution of alternating currents in which any number of generators may be coupled for quantity without requiring the several generators to run in synchronism. Thereby it becomes practicable to connect to the system of distribution any number of generators at a moment's notice without the observance of any particular precaution, so that at any time additional generators may be inserted in the line or may be withdrawn from the same even with greater ease than in the case of ordinary straight-current dynamos and without shock to or disturbance in the system.

In the said application, Serial No. 503,524, we have shown and described a system of generating alternating currents of high frequency, and in said system we employ a generator having a rotary field and an armature closed upon itself rotating with reference to said field. This requires at least two alternating currents or alternating electrical discharges properly dephased for the production of the rotary field, and in such machines there are produced by the generator directly at least two alternating currents equally dephased, which currents are or may be united upon the line as a monophase alternating current.

The fundamental invention upon which the present improvement is based may be stated in broad terms to be the generation of alternating currents by causing electrical oscillations of any desired frequency and reinforcing the same to any desired volume. The electrical oscillations are preferably produced by condensers and constitute the initial currents upon the line and produce an initial magnetic field of force, both of which are exceedingly faint. This initial field of force and these initial alternating currents are reinforced by the inductive action of an armature having circuits closed upon themselves and which is rotated within the initial field of force with a speed that exceeds a certain minimum speed.

The invention which we have thus broadly outlined and which forms the subject-matter of our aforesaid application, Serial No. 503,524, is fully explained and properly claimed in the said application.

In our present improved system we dispense with the production of a rotary field—

that is, a field that rotates even when the armature is at rest—and we produce by the generator directly monophase currents, and if polyphase currents are required we use a number of our improved machines, each generating a monophase current, but each having its phase displaced with reference to the other.

Our machines are so constituted that their electromotive force is independent or practically independent of the speed of rotation of the rotary member as soon as the same has exceeded a certain critical speed. Any further acceleration of the speed of the machine only increases the volume of the current generated, so that if a number of machines of this kind are driven with speeds exceeding that critical speed they may be compared to a number of electrolytic cells of the same type, but having electrodes of different sizes. Such electrolytic cells, as is well known, may be connected in quantity to a system of distribution without short-circuiting each other, and any number of them may at any time be inserted into or withdrawn from the system without in any way or manner affecting the system, except to increase or diminish the current in the same. Our generators behave exactly in this manner, always supposing that they are driven beyond the critical speed.

All this will more fully appear from the following detail description with reference to the accompanying drawings, in which our system is illustrated as follows:

Figure 1 is a side view of the constant-potential alternating-current dynamo, partly in section. Fig. 2 is a vertical section at right angles to the shaft, through a portion of the field-magnets and the armature, upon an enlarged scale. Fig. 3 illustrates a section on the line *x x* of Fig. 2. Fig. 4 is a diagram illustrating the manner of coupling a number of our dynamos for quantity with a system of distribution. Fig. 5 is a diagram illustrating the production of two dephased currents in accordance with our invention.

Like letters and numerals of reference indicate like parts throughout the drawings.

The constant-potential monophase alternating-current generator has the general form represented in Fig. 1, the details of which are shown in Figs. 2 and 3. Referring to these figures of the drawings, it will be seen that the generator is composed of a stationary member 1 and a rotary member 2. By reason of the peculiar mode of action of our machine the conventional nomenclature usually applied to these two parts is perhaps not quite applicable, but in order to facilitate the description we shall hereinafter speak of the stationary member as the "field" magnet or magnets and of its circuit or circuits as the "field" circuit or circuits, and similarly we shall call the rotary member the "armature" and its circuits the "armature-circuits," without, however, thereby implying the notion that the currents for the system of distribution are derived from the armature. On the contrary, these currents are derived from the field circuit or circuits, as will presently appear.

The stationary member is an annular casting 3, to the inner face of which is fitted and properly secured a ring 4, composed of laminæ of sheet-iron insulated from each other by any of the well-known means, and in this ring are embedded the ends of laminated-iron cores 5, having polar extensions 6. These cores extend radially from the inner face of the ring 4, and each of these cores has upon it a bobbin 7 of insulating material, with a coil 8 of insulated wire wound thereon. In the drawings the cores and bobbins are shown rectangular in shape; but this is by no means essential, since all that is required is that a series of electromagnets be arranged closely together, projecting radially from the laminated ring 4, which constitutes the common yoke to all these electromagnets. Another condition is that there be an even number of electromagnets. These electromagnets are wound alternately in opposite directions, and they are all connected in one series, so that an electric current or impulse passing through them will give to the successive polar extensions opposite polarities. The faces of these polar extensions are slightly curved, so as to define the surface of a cylinder concentric with the ring 4.

The rotary member is in the shape of a spoked wheel 9, mounted on a shaft 10, supported in bearings 11. On the periphery of this wheel there is a laminated ring 12, of sheet-iron, securely fixed to the rim of the wheel and having a series of slots 13, extending parallel to the shaft and opening into the outer face of the said ring 12. These openings 14 are much narrower than the slots proper, which latter are shown in the drawings somewhat approaching the form of a rectangle with the corners rounded off; but this form is not essential and has only been selected because it admits of a great number of slots of considerable size with a narrow web 15 between them. In these slots are inserted closely-fitting copper rods 16, each terminating at each end in a pin 17. To each side of the ring 12 is applied a copper ring 18, provided with perforations corresponding to the pins 17 and fitting over the same. The ends of these pins are upset, whereby the two copper rings are riveted to the copper rods 16, so as to make good electrical connection with the same. Instead of riveting these copper rods to the copper rings they may be screwed to the same or otherwise secured, the only condition being that a great number of circuits of low resistance be formed and as much as possible embedded in the laminated ring 12. The number of copper rods 16 should be as great as possible, but never less than two rods for each polar extension of the field-magnets. The greater the number of these rods the better it is.

In Figs. 4, 5, and 6 a number of generators constructed and operated in accordance with our invention are represented in a conventional manner, the field-magnets being shown simply as ring-cores with the field-coils wound directly thereon instead of being wound upon cores projecting radially therefrom. This is done for the sake of simplicity of illustration only.

Referring now more particularly to the generator 1 2, (shown in Fig. 4,) it will be seen that the series winding of the field-magnets terminates at 19 and 20, from which points the two line-wires 21 and 22 extend to the system of distribution, by which any suitable translating devices may be fed. From these same terminals 19 20 extend the conductors 23 24, which are connected with the terminals of a condenser 25, as indicated.

We have discovered that if in a machine of this kind an alternating current no matter how faint and of the frequency $\frac{1}{T}$ is passed from the conductors 23 24 by the binding-posts 19 20 through the coils of the field-magnets, and if the armature is rotated by external power, as indicated by pulley 10′ and belt 10″, with a speed exceeding the quantity $\frac{1}{n\,T}$, (the number of poles of the machine being $2\,n$) then, first, the field of the machine will be rapidly reinforced and the machine will furnish to the line an alternating current of the frequency $\frac{1}{T}$; second, after a very short time a constant difference of potential will be established between the binding-posts, and, third, this effective difference of potential will be practically independent of the output in amperes. This latter phenomenon we explain by the fact that to every increase of current traversing the field-circuit corresponds in these machines a proportional increase of currents generated in the armature-circuits. These latter currents developing a magnetizing force opposed to that produced by the currents in the field-circuit, it is clear that the total flux developed in the machine will not vary with the output of its field-circuit. The phenomenon, therefore, of building up the field terminates in these machines when the speed of the armature exceeds the critical speed $\frac{1}{n\,T}$, and any further increase of that speed only adds to the volume of the currents generated.

The initial current for the initial excitation of the field we derive either from an ordinary condenser or any other suitable equivalent apparatus which furnishes alternating electrical impulses of the desired frequency $\frac{1}{T}$. In the case of a condenser, as in the present instance, its capacity must be such that, joined to the machine, its alternating discharges will have the frequency $\frac{1}{T}$. We have found that this capacity Γ is given by the formula:

$$\Gamma = \frac{T^2}{4\,\pi^2\,L} \times 10^6 \text{ microfarads,}$$

wherein T represents the duration of the period of the discharges to be obtained expressed in seconds, and L the coefficient of self-induction of the field expressed in henrys. Circuits the capacity and self-induction of which are proportioned in this manner for a definite frequency are known in the art as "resonant" circuits.

It will now be evident that any number of such machines running at any desired and variable speeds above the critical speed $\frac{1}{n\,T}$ may be connected in multiple arc with or disconnected from the line without any precaution and without any skilful manipulation or observance, precisely the same as if these machines were each an electrolytic cell of the same type, but each having a different internal resistance from the others. Nor is the frequency of the current generated affected in any way or manner by the coupling of several of these machines for quantity, because when the machines are thus connected the existing condensers also become connected for quantity and then form in effect only a single condenser having a capacity equal to the sum of the capacities of the coupled condensers and at the same time the exterior circuit into which this battery of condensers now discharges—that is to say, the circuits of the field-magnets of the different machines connected in multiple arc—has now a coefficient of self-induction that is equal to the coefficient of self-induction of one of these field-circuits divided by the number of field-circuits connected in multiple arc. Now, since, as we have seen above,

$$\Gamma = \frac{T^2}{4\,\pi^2\,L} \times 10^6,$$

there is also

$$T = \frac{2\,\pi}{10^3}\sqrt{\Gamma L}.$$

This being the case, it is evident that, if any number of these machines—say, for instance, k machines—be coupled for quantity the coefficient of self-induction would be divided by k, while the static capacity would be multiplied by k, so that the period of the current generated will remain unchanged and the combined exciting-circuits form a resonant system of the original frequency. Such arrangement of several machines connected for quantity with a line of distribution is represented by the diagram Fig. 4, in which three such machines are shown thus connected. The field-coils of the machines are designated, respectively, by $l\ l'\ l''$, the condensers by 25 25′ 25″, respectively, and the conductors connecting the condensers with the terminals of the field-coils by 23 24 23′ 24′ 23″ 24″, respectively. The main line is marked 21 22 and the conductors by which the two auxiliary machines are or may be connected to the main line are marked 21′ 22′ and 21″ 22″, respectively.

It will now be seen that if the machine with the field-coils l were feeding the line 21 22, and if a greater number of translating devices were required to be loaded onto the line than could be supplied with current by this one machine, all that is necessary is to close the circuit of any one or both of the auxiliary machines by the switches 26 after their armatures have attained a speed exceeding $\frac{1}{n\,T}$. The electromotive force of each of these machines being the same, so long as the armatures exceed the critical speed there can be no short-circuiting of any one machine or machines by any other machine or machines. What has here been said of three machines is equally true of any other number of machines.

We have so far considered the charging of a line with monophase currents either by one or by several generators; but our method of generation is also applicable to the production of polyphase currents by using as many machines of the kind described as there are to be dephased currents. It is evident that the currents or discharges from the exciters must be dephased by the same fraction of a period as the currents to be obtained from the generators, since the period of the current generated is the same as the period of the exciting-currents, and the phase of the current generated depends upon the phase of the exciter-currents. If therefore k currents dephased with reference to each other by $\frac{1}{k}$ of a period are required, the exciter currents or discharges for the k field-circuits must also be dephased with reference to each other by $\frac{1}{k}$ of a period. This can be done in a variety of ways, some of which we have indicated in the drawings.

In Fig. 5 an arrangement for the production of two currents dephased by one-quarter of a period is diagrammatically illustrated. The field-coils of the two machines are designated by l and l', and from the terminals of the same the lines 21 22 and 21′ 22′ proceed, either for joinder to the same translating device or devices or for independent use. The exciting organ in this case is represented as a condenser 25^a and a reaction-coil 27, connected in series. The free end of the reaction-coil is carried to a point 28, from which wires 29 and 30 lead to one of the terminals of each of the condensers 25 25′, respectively, the other terminals of which are connected by conductors 31 32 to the points from which the outgoing lines 21 21′ proceed from the respective terminals of the field-coils l l'. The free terminal of the condenser 25^a is connected by the common return-conductors 33 and 34 35 to the points where the incoming lines join the field-coils l and l', respectively. If the currents desired are intended to have the frequency $\frac{1}{T}$, the coefficient of self-induction $\mathit{\Lambda}$ of the coil 27 and the capacity Γ of the condenser 25^a must be so chosen as to satisfy the relation

$$\Gamma=\frac{T^2}{4\,\pi^2\,\mathit{\Lambda}}\times 10^6 \text{ microfarads.}$$

If now we designate by L the coefficient of self-induction of the field-coils l and by L_1 the coefficient of self-induction of the field-coils l', also by R the total resistance of the exciter-circuit, then in order that the phases of the exciting discharges be shifted with reference to each other by one-quarter of a period the capacities c and c_1 of the condensers 25 and 25′ are determined by the two relations

$$\frac{2\,\pi}{T}\left(L-\frac{T^2}{4\,\pi^2\,c}\right)=R$$

and

$$\frac{2\,\pi}{T}\left(L_1-\frac{T^2}{4\,\pi^2\,c_1}\right)=-R.$$

These analytical deductions we have verified in practice, which demonstrated not only that under the conditions stated do the two dynamos automatically build up their field of force jointly, but also that the currents furnished by the same are dephased with reference to each other by one-quarter of a period.

We have now shown how two machines may be excited jointly for the production of two-phase currents; but it is evident that any greater number of machines may be joined in accordance with the same principles for the production of multiphase currents. In each case it is practicable and indeed preferable to start with a monophase exciting-current and to decompose the same into a two, three, or poly phase current, and in each case it is practicable and indeed preferable to use as the means for the production of the monophase exciting currents or discharges a condenser and a reaction-coil, constituting an electric resonator, and then to dephase the currents or discharges. While this is the preferable mode of obtaining the dephased exciting-currents, it is not by any means indispensable, since an ordinary small alternating-current machine with the requisite number of shifted generating-circuits may be employed, as will be readily understood by by those skilled in the art.

Any group of dynamos connected and operated as described for the production of polyphase currents may be treated as a unit—that is, as a single polyphase machine—and if an increase of the current in the distributing system is required one or more additional polyphase machines may be added in quantity to the system, as is quite evident.

While we have particularly emphasized the use of our machines in multiple-arc connection with a system of distribution, it is quite clear that they may also be used coupled for tension, in which case the initial exciters must also be connected in series. The exciters thus connected then constitute, in effect, one exciter common to all machines.

In our machines the field-magnets, or what we here call "field-magnets," are shown as fixed. Consequently their pole-pieces are also fixed, and the resulting magnetic fluxes have definite locations with reference to the pole-pieces. Now we desire it to be understood that when we speak of "fixed" poles or a "fixed" magnetic field or fields we refer solely to the structure of the machine and to the phenomenon directly observable in the same when the armature is at rest, but that we do not thereby desire to convey the idea that the current derived from the windings of the field-magnets is due to magnetic fluxes which have a fixed location with reference to the field-magnets. On the contrary, we understand that by the rotation of the armature the fixed alternating magnetic fluxes are decomposed into two rotary magnetic fluxes, one of which is consumed in the generation of currents in the armature and the other acts upon the field-winding to reinforce the initial current in the same. While this is our understanding of the *modus operandi* of our reinforcing-machine, it is unnecessary to enlarge here upon this theory, and in the appended claims we shall speak of a "magnetic" field or fields and of "magnetic" poles as if they were fixed with reference to the field magnet or magnets, thereby referring only to the mechanical structure of the machine and to the phenomenon directly observable therein when the armature is at rest, as above explained. Similarly, when we speak of an "oscillating" magnetic field or an "alternating" magnetic field we thereby only mean to define the nature of the magnetic field as the same is produced directly by single-phase alternating currents and when the armature is at rest.

Having now fully described our invention, we claim and desire to secure by Letters Patent—

1. The method of generating alternating electric currents, which consists in producing periodically alternating magnetic poles, fixed with reference to a field-magnet, reinforcing the same by the movement of a closed circuit or circuits with reference and in inductive relation thereto, and inducing by the reinforced field or fields alternating currents, in a circuit or circuits traversing the said reinforced fields, substantially as described.

2. The method of generating and utilizing alternating electric currents, which consists in producing by single-phase initial alternating electric currents or discharges an initial alternating magnetic field or fields, reinforcing the said field or fields and initial currents or discharges by the movement within said field or fields of a closed electric circuit or circuits, and conveying the reinforced currents to a line of distribution, substantially as described.

3. The method of generating alternating electric currents, by rotating an armature circuit or circuits, closed upon themselves, within inductive proximity to a circuit traversing an alternating magnetic field or fields, with a speed exceeding the frequency of alternations of the field, divided by half the number of poles of the same, substantially as described.

4. The method of generating periodic alternating currents, which consists in producing, in suitable field-magnets, alternating magnetic poles fixed with reference to said magnets, reinforcing said poles by moving a closed circuit or circuits with reference and in inductive relation thereto, with a speed exceeding the frequency of the alternations divided by half the number of poles, and inducing, by the reinforced poles, alternating currents in a circuit or circuits in the magnetic field of said poles, substantially as described.

5. The method of generating alternating electric currents, which consists in producing, by initial alternating electric currents or discharges, an initial alternating magnetic field or fields fixed with reference to a field magnet or magnets, reinforcing the said field or fields and initial currents or discharges, by moving within said field or fields a closed electric circuit or circuits with a speed exceeding the frequency of the initial alternating currents divided by half the number of field-poles, and conveying the reinforced currents to a line of distribution, substantially as described.

6. The method of generating and distributing two or more alternating currents of like periods and tension, which consists in simultaneously charging the field-coils of two or more independent generators from the same initial source of alternating currents or discharges, reinforcing the field-currents by rotating, independently of each other, within the field of each generator, a closed circuit or circuits, with any speed exceeding the frequency of the exciting currents or discharges divided by half the number of poles of the field, and conveying the reinforced currents each directly to the same system of electrical distribution, substantially as described.

7. The method of generating and distributing two or more alternating currents of the same period and tension, but dephased with reference to each other, which consists in simultaneously charging the field-coils of two or more independent generators from the same initial source of dephased alternating currents or discharges, reinforcing the field-currents by rotating, independently of each other, within the field of each generator, a closed circuit or circuits, with any speed exceeding the frequency of the dephased exciting currents or discharges divided by half the number of poles of the field, and convey-

ing the reinforced currents to a multiphase system of distribution, substantially as described.

8. An alternating-current dynamo-electric generator, consisting of a field-magnet having initial alternating poles fixed with reference to the field-magnet and excited by alternating currents or discharges from an exterior source, an armature having one or more circuits, each closed upon itself, and adapted to be rotated by external power in inductive proximity to the poles, and a line or lines of conductors receiving currents from the field-circuit, substantially as described.

9. An alternating-current dynamo-electric generator, consisting of a number of field-magnets having alternating oppositely-wound coils connected with a distributing system, a source of alternating exciting-currents or electrical discharges connected with the field-coils in a branch derived from the line, charging the coils with single-phase currents, and an armature having one or more circuits, each closed upon itself, adapted to be rotated by external power in inductive proximity to the field-poles, substantially as described.

10. An alternating-current dynamo-electric generator, consisting of a number of field-electromagnets, the polar faces of which are circularly arranged, so as to define the curved surface of a cylinder, the coils of the alternate magnets being oppositely wound and all connected in a single series with a line of distribution, a source of alternating exciting-currents or electrical discharges also connected with the coils, in a branch derived from the line, and an armature having circuits, each closed upon itself, adapted to be rotated by external power in inductive proximity to the pole-faces, substantially as described.

11. An alternating-current dynamo-electric generator, consisting of a field-magnet having circularly-arranged pole-pieces, each with a coil wound in opposition to the next adjacent coils and all excited by single-phase alternating currents or electrical discharges from an exterior source, a rotatable armature composed of two parallel metal rings connected by metal bolts embedded in laminated iron, and adapted to be rotated by external power, and a distributing line or lines of conductors connected with the field-circuit in multiple arc with the exciting-circuit, substantially as described.

12. An alternating-current dynamo-electric generator, consisting of a field-magnet having circularly-arranged pole-pieces, each with a coil wound in opposition to the next adjacent coils and all excited by alternating currents or electrical discharges through alternately oppositely wound coils, an armature composed of a ring of laminated iron having a copper annulus on each side and copper rods traversing the iron ring and connecting the copper rings, and a distributing line or lines of conductors connected with the field-circuits in multiple arc with the exciting-circuit, substantially as described.

13. A system of generation and distribution of alternating electric currents, composed of a number of dynamo-electric generators, each consisting of a field magnet or magnets and an armature having circuits closed upon themselves; means for connecting the field-circuits of the different dynamos in multiple-arc connection with a line or lines of distribution, a single ultimate source of faint initial alternating exciting currents or discharges for the field-circuits in a shunt or shunts around the line or lines of distribution, and means for rotating the armature, by external power, with a speed exceeding the frequency of the exciting currents or discharges divided by half the number of poles of the field, substantially as described.

14. A system of generation and distribution of multiphase alternating currents, composed of a series of dynamos each having its field-circuit excited by a current properly dephased with reference to the exciting-current of the other or others, and each having an armature with circuits closed upon themselves, rotatable by external power with a speed exceeding the frequency of the exciting currents or discharges divided by half the number of poles of the field, and lines of distribution proceeding from the field-windings, substantially as described.

15. The method of generating alternating electric currents, by rotating an armature circuit or circuits closed upon themselves, within inductive proximity to a resonant circuit traversing an alternating magnetic field or fields, with a speed exceeding the frequency of electrical oscillations in the resonant circuit, divided by half the number of poles of the field, substantially as described.

16. An alternating-current generator composed of a series of field-magnets having alternately oppositely wound coils, all included in and forming part of a resonant exciting-circuit adjusted to a definite frequency of electrical oscillation, an armature having circuits closed upon themselves within inductive proximity to the field-poles, means for rotating the armature with reference to the field-poles with a speed exceeding the frequency of the exciting-current divided by one-half the number of poles of the field, and a line of distribution connected with the field-winding, substantially as described.

17. An alternating-current dynamo-electric generator consisting of a field-magnet having initial alternating poles, fixed with reference to the field-magnet and excited by the electrical oscillations in a resonant circuit, an armature having one or more circuits, each closed upon itself, and adapted to be rotated by external power in inductive proximity to the poles, and a line or lines of conductors receiving currents from the field-circuit, substantially as described.

18. A system of electrical generation and

distribution which consists in a number of alternating-current generators, each having a magnetic field formed by alternating magnetic poles fixed with reference to its field-magnet and each excited by a resonant circuit; an armature with circuits closed upon themselves for each generator; means for rotating each armature with a speed exceeding the frequency of the exciting-currents divided by one-half the number of poles of the machine, a working circuit proceeding from each field-circuit, means for coupling the resonant circuits in multiple, and means for coupling the working circuits in multiple, substantially as described.

19. As a means of exciting a number of alternating-current generators independently and jointly with alternating currents or discharges of the same frequency, the combination of electrical resonant circuits, one for each generator, and each tuned for the same frequency, with means for coupling the resonator-circuits in multiple, substantially as described.

20. As a means of exciting a number of alternating-current generators jointly with alternating currents or discharges of the same frequency, the combination of a resonant exciting-circuit for each generator, with means for coupling the resonator-circuits in multiple, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

MAURICE HUTIN.
MAURICE LEBLANC.

Witnesses:
CLYDE SHROPSHIRE,
BOVY.