

W. STANLEY.
DYNAMO ELECTRIC MACHINE.
APPLICATION FILED FEB. 2, 1905.

933,399.

Patented Sept. 7, 1909.
2 SHEETS—SHEET 1.

Fig. 1.

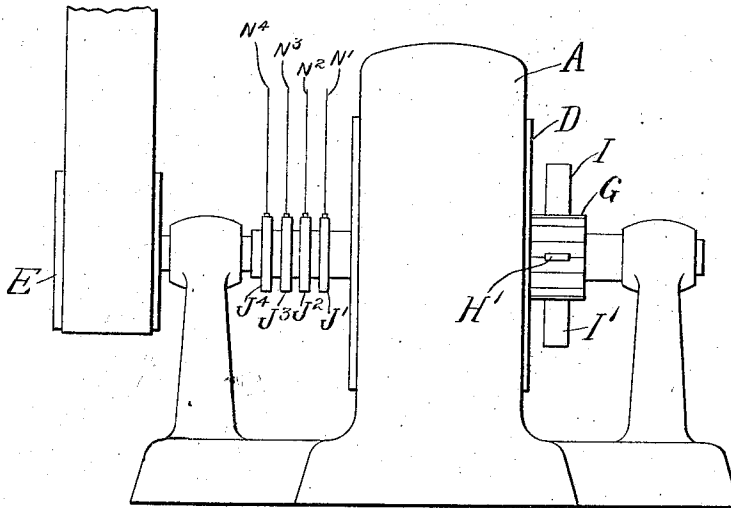
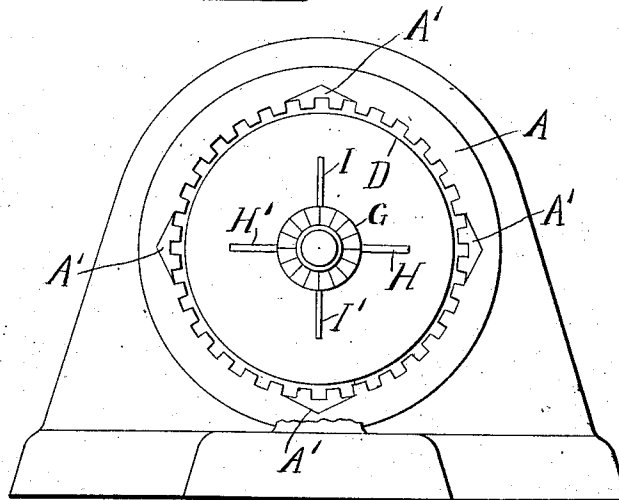


Fig. 2.



Witnesses
Chas. A. Baird
Geo. H. Mitchell

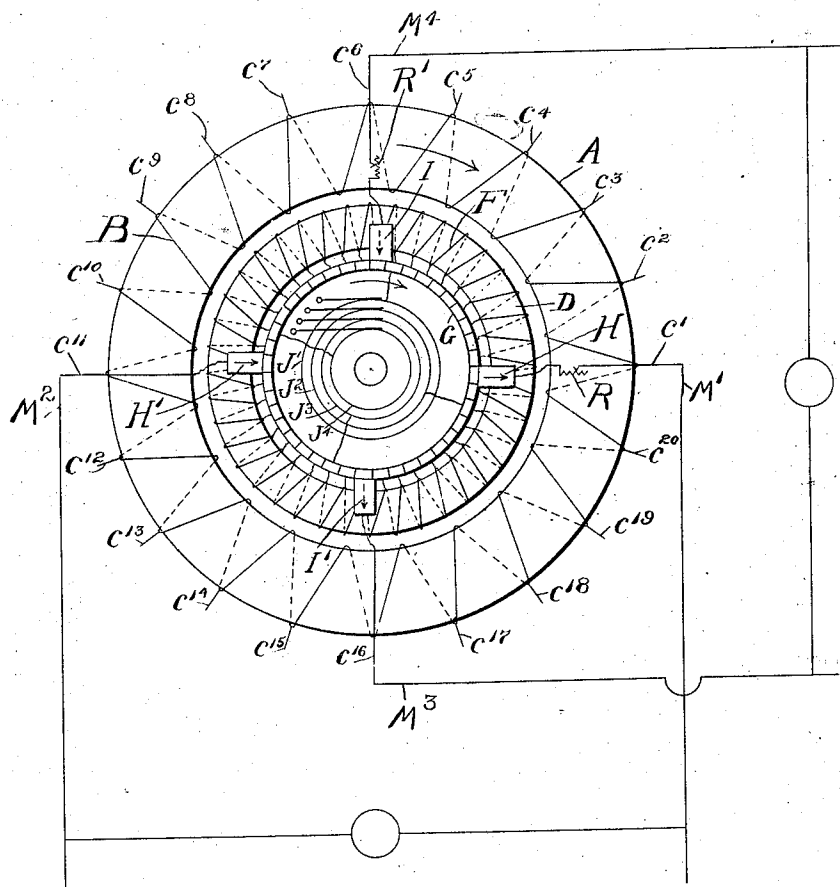
Inventor
William Stanley
By his Attorneys
Barth W. Brownell & Associates

W. STANLEY.
DYNAMO ELECTRIC MACHINE.
APPLICATION FILED FEB. 2, 1905.

933,399.

Patented Sept. 7, 1909.
2 SHEETS—SHEET 2.

Fig. 3.



Witnesses
Charles A. Baird
Geo. H. Mitchell

Inventor
William Stanley
By his Attorneys
Barth H. Brown Mitchell

UNITED STATES PATENT OFFICE.

WILLIAM STANLEY, OF GREAT BARRINGTON, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

DYNAMO-ELECTRIC MACHINE.

933,399.

Specification of Letters Patent.

Patented Sept. 7, 1909.

Application filed February 2, 1905. Serial No. 243,842.

To all whom it may concern:

Be it known that I, WILLIAM STANLEY, a citizen of the United States, residing at Great Barrington, county of Berkshire, Massachusetts, have invented certain new and useful Improvements in Dynamo-Electric Machines, of which the following is a full, clear, and exact description.

My invention relates to improvements in alternating current dynamo electric machinery, such as alternating-current generators, motors, motor-generators and similar apparatus, employing novel methods for exciting or producing magnetic fields for the same and generating alternating currents.

One object of my invention is to provide in machines of the above-described type a magnetic field or fields of constant or nearly constant value, moving relatively to the structure producing them (known in the art as moving or rotating magnetic fields) by exciting currents produced within the machines themselves.

A further object of my invention is the application of moving or rotary fields upon the circuits generating the alternating currents producing them in such manner as to cause the machines to have novel characteristics of performance whereby energy is delivered from the stationary and moving windings of the machine.

A further object is to provide an alternating-current dynamo self-excited by alternating currents of low periodicity for generating alternating currents of either like periodicity, or of different periodicity, or both.

A further object is to produce a self-exciting alternating-current dynamo whose frequency can be controlled by other factors than its speed.

Heretofore in the art, the field or field magnetism of dynamo-electric machinery has been produced either by currents of constant value and given direction, known as continuous currents, or by alternating currents of one or more phases applied in such manner as to produce a field in a given polar line or fields periodically moving or revolving about the structure. Whenever alternating currents have been employed for such excita-

tion, it has been necessary to generate them by means of auxiliary apparatus, known as exciters, and in general such apparatus has consisted of a suitable rotor wound with conductors which pass through a field of constant value and fixed in space. Thus, it has been necessary to ultimately resort to the use of a magnetic field of constant value and fixed position for the initial production of all currents of electricity generated dynamically, while in the invention herein disclosed, no such procedure is necessary as the invention provides means for directly generating alternating currents by the passage of suitable conductors through a rotary magnetic field developed by the machine itself independently of any exterior or exciting device.

In the types of self-exciting machines, such as were developed by Gramme and Pacinotti, the currents induced in the rotor of the machine by the rotation of the armature conductors were so applied to the field-producing member of the machine as to reinforce the field which generated them.

In my invention, the currents generated by rotation of the rotor are applied to the stator of the machine in such manner as to develop a new field angularly displaced from the field generating them, and so that the total resulting field is of constant value but continuously varying in position. The importance of this method of excitation consists not only in the production of a field of constant value within the machine itself, but it is also of great value in that the field so produced possesses other dynamic properties than those which would accompany the production of a field produced by continuous currents. The magnetic field produced by the method herein described can be made to re-act upon the stator and rotor circuits in which are generated the currents producing it at a different frequency than the frequency of rotation of the machine. The circuits, therefore, may be subjected to the dynamic induction of the same field at the same or at different frequencies.

The characteristics of machines constructed in accordance with my invention differ widely from those of other machines in that

the electromotive force of the machine may be caused to automatically rise in value with an increase of output of the machine at any power factor and further these machines
 5 may be designed and arranged to produce currents of low power factor and given value at a higher potential than is obtained when the power factor of the circuit is unity.

My invention also involves features of construction which will be hereinafter particularly described in the specification and pointed out in the claims.

The following is a description of a dynamo embodying my invention, reference being had to the accompanying drawings which
 15 show the simplest form, namely a machine having a single field, by which I mean a machine having but one north pole and one south pole to be acted upon dynamically by the rotor. It is to be noted, however, that in these machines the functions of field and armature as ordinarily understood are pos-
 20 sessed by both the moving and stationary windings, for under certain conditions of operation the machine delivers current to the external circuit from both the rotor and stator circuits both of which thus constitute energy-giving windings by which I mean windings which supply work currents.

In the drawings Figure 1 is an end view of the dynamo, Fig. 2 is a side elevation of the same showing the stator with the windings removed, Fig. 3 is a diagram of circuit connections.

Referring more particularly to the drawings, A is the stator having the winding B, which is preferably of the ordinary distributed-winding type and from which taps C' to C²⁰, inclusive, are taken at equidistant
 40 points for the purpose of connecting them and the mains to the rotor windings through the commutator brushes, as hereinafter described.

D is the rotor rotatably mounted within the stator and driven by the pulley E. The rotor has the usual closed circuit distributed-winding F connected in the usual manner to a commutator G on which bear brushes H H' and I I'. The rotor winding is also connected to one or more sets of slip rings J' J² J³ J⁴ at equidistant points from which alternating currents may be taken, if desired, as hereinafter explained. Lying upon the commutator are the four brushes H H' and I I' placed 90° apart and in a position substantially opposite the taps C' C¹¹ C⁶ C¹⁶ to which they are respectively connected, the coils connected to the commutator segments on which the brushes bear being opposite to the segments. Thus it will be seen each
 60 brush is connected to the tap substantially opposite it so that the rotor and stator circuits consist on the one hand of a circuit from brush H to tap C' through the stator-winding to the diametrically opposite tap

C¹¹ and thence to the brush H' and the rotor-winding, and on the other hand of a circuit from the brush I' to tap C¹⁶ through the stator-winding to tap C⁶ and thence to the brush I and the rotor-winding.

If the machine be arranged as above described, and if there be a magnetic field existing in the machine due to the remanence of previous excitation, as, for instance, if residual magnetism passes from the stator to the rotor and vertically downward, and if the rotor of the machine be now rotated clockwise at some definite speed, such as, for example, 1000 revolutions per minute, then an electromotive force will be generated upon the commutator brushes H, H', placed at right angles to this residual field and consequently a current will begin to flow from these brushes to the taps or intake points of the stator windings in the direction shown by full line arrows, Fig. 3. Such a current will evidently magnetize the stator of the machine at right angles to the direction of the residual magnetism above mentioned and consequently the polar line of the machine will begin to move from the vertical direction, for example, toward the right, or clockwise, for the reason that the field produced by the generated currents combines with the residual field above mentioned to produce a resultant field in the well-known manner. But this development of the field at right angles to the residual field will cause an electromotive force to appear upon the brushes I, I' placed vertically upon the commutator and the direction of this electromotive force will be such as to cause current to flow from the brushes to the intakes or taps C⁶ C¹⁶ of the stator winding in the direction of the dotted arrows, Fig. 3, such as to destroy the vertical residual magnetism and thus having removed this magnetism will cause the magnetism generated by the currents flowing from the horizontal brushes to shift farther to the right or clockwise and to develop a higher electromotive force upon the vertical brushes I, I'. This action continuing will result in the production of an increased current from the vertical brushes and intake taps C⁶ C¹⁶ which will produce a magnetic field vertically again, but of opposite polarity to that of the original residual field, and such vertical field combining with the horizontal field above mentioned will produce again a resultant field distorted or rotated farther to the right and occupying a position advanced clockwise beyond that found when the currents from the horizontal brushes H, H' were alone operative. A continuous progression of the polar line thus results, the currents producing it being in this case two alternating currents of 90° phase difference. It is to be noted that the field which induces a cur-
 130

rent in the rotor is not reinforced by that current but another field is built up by that current which is angularly displaced from the inducing field.

5 I have discovered that in a machine employing a commutator and embodying my invention the proper connections for the production of such a rotating field will be found when the connection between the rotor
10 brushes and the stator winding is such as to make the polar line of the field displaced from the diameter of commutation for each pair of brushes by 90° minus the angle of lag of the magnetizing currents. Thus if
15 the machine be constructed to have magnetizing currents lagging 80° behind their electromotive forces, the angular displacement of the intake taps of the stator circuits of the machine to the brushes to which these
20 taps are connected should be 90° minus 80° or 10° . If the magnetizing currents are to lag nearly 90° the angle between the brushes and the taps to which they are connected should be nearly zero as shown in Fig. 3.

25 The reason for displacing the intake taps on the stator winding from the brushes on the rotor windings above mentioned is, as follows:—The rotation of the flux or field of the machine through both the rotor and
30 stator circuits develops electromotive forces upon these circuits which are unbalanced or differ in phase by the angle of displacement above referred to, and as the circuits are connected together at the points C' C^s C''
35 C''' such phase-differing electromotive forces give rise to a resultant electromotive force and a consequent magnetizing current that flows internally through both the rotor and the stator circuits of the machine and causes
40 its magnetization. From this it will be seen that both the rotor and stator circuits of the machine contribute magneto-motive forces to the production of the rotating field produced, and therefore each possess the dual
45 properties of field and armature circuits. The two electromotive forces induced upon the rotor and stator circuits above mentioned have relatively opposite internal directions, and except for their very small
50 phase displacement are unable to produce a current flowing internally in the machine. They, however, cooperate to deliver work currents from both the rotor and stator circuits to the external circuit of the machine
55 and consequently whenever energy currents are required of the machine they are delivered from both the rotor and stator circuits which thus constitute energy-giving circuits. Such current delivered externally
60 to the machine must evidently flow through the rotor and stator circuits in opposite directions, and thus eliminate the magnetization that usually follows when the induced circuit of a machine of the usual type delivers energy to an external circuit. The

relatively opposite directions of these two electromotive forces is caused by the fact that the rotating field progresses, in the machine illustrated, clockwise with reference to the stator circuits and counterclockwise
70 with reference to the rotor circuits, as the rotor revolves at a greater speed than the electromagnetic rotation of the field.

By suitably proportioning the machine, it is not necessary to introduce energy consuming devices into its circuits for controlling the magnetization; that is to say; as the energy in these circuits is dependent in part upon their resistance such a waste
75 of energy or loss of energy in magnetization may be greatly reduced by making them of very low resistance as compared with those usually employed in the art, the inductance of the circuits serving as a controlling factor of the current.

85 The frequency of the currents in the exciting circuits (stator and rotor) and the consequent rate of rotation of the magnetic field produced thereby depends upon the ratio of the stator winding to the rotor
90 windings; that is, the number of turns in each. For a given rate of rotation of the rotor, neglecting the resistance of the circuits and their magnetic leakage, the frequency of the exciting currents would be
95 such that the electromotive forces induced in the stator windings will be equal to the rotor electromotive forces applied to the stator windings. The rotor electromotive forces are produced by the effective rotation of the
100 rotor circuits in the field produced by the exciting currents, while the stator electromotive forces are produced by the inductive action of the rotating stator upon the stator windings. Therefore, in order that these
105 electromotive forces shall be equal the frequency of the exciting currents must be equal to the frequency of revolution multiplied by the number of turns in the rotor winding and divided by the sum of the
110 number of turns in both rotor and stator windings. In the construction shown in the diagram the rotor has twice the number of turns of the stator circuit. The frequency
115 of the exciting currents would therefore be two-thirds of the frequency of rotor rotation. If the number of turns of the rotor and stator windings were the same, the frequency of excitation would correspond to
120 one-half the speed of revolution and the commutator would not change the frequency of the currents delivered through it from the rotor. In practice the resistance and magnetic leakage can be made so small by proper
125 designing that very nearly these results can be attained.

If external resistance or self-induction is interposed into the exciting circuits, the tendency will be in either case to reduce the frequency, since by such external resistance
130

or self-induction the effective electromotive force upon the stator windings is reduced so that the balancing electromotive force which must be produced in the stator-windings can be produced by a lower frequency provided the flux remains the same.

In order to localize the flux produced by the distributed exciting winding so as to produce points analogous to neutral points to improve the commutation, I form the core of the stator with recesses opposite which the brushes are placed. These recesses reduce the flux cut by the coils as they pass the brushes so that the difference in potential in adjoining coils is at that time small resulting in a reduction of the sparking. They may be filled with blocks A' of wood or similar material in which notches for the stator windings are formed.

When mains M' M² and M³ M⁴ are connected to the diametrically opposite taps phase differing currents derived from both stator and rotor windings of a frequency corresponding to the exciting currents are taken off and may be used for such purpose as desired, the taps used being selected according to desired characteristics.

When mains N' N² N³ N⁴ are connected by brushes to the slip rings J' J² J³ J⁴ phase differing currents may be taken off having a frequency determined by the frequency of the exciting currents and the rate of rotation.

The characteristics of the machine change materially as the angle between the brushes and the intakes is changed. The angular change may be produced by shifting the brushes, though in the embodiment shown any considerable shifting would cause sparking. I therefore prefer to let the brushes remain stationary and shift the points of connection to the taps.

As shown by Fig. 3 taps may be brought out from the stator windings at points intermediate between the taps connected to the brushes of the rotor. The external circuit connections, either single or multiphase, may be connected to the taps to which the brushes are connected (in which case the rotor and stator windings are in parallel connection with each other and in series connection with the mains), or the external circuit may be connected to taps intermediate between those connected to the brushes, as at C³ C¹³ and C⁸ C¹⁸. In case the mains are connected to intermediate taps the electromotive force characteristic of the machine differs widely from that found when the service wires are connected to the taps to which the brushes are directly connected, and depends upon which intermediate taps are used. In case the same taps are directly connected to the brushes and to the service wires, the electromotive force of the generator is higher on lagging than on unity

power factor currents. Thus, for instance, when so connected the machine has the remarkable characteristic of supplying a potential which is higher when the power factor is .8 than when it is .9 or unity. In the case of the connection with intermediate taps as C³ C¹³ C⁸ C¹⁸ the electromotive force of the machine is greater when supplying unity power factor currents than when supplying currents of low power factor, thus the characteristics of the machine may be widely varied by simply connecting the service wires to stator winding taps displaced by different angles from the point of the brush connection.

My invention is not limited to machines having distributed windings or possessing but a single magnetic field or to machines producing two-phase exciting currents or two-phase work currents, but can be embodied in various forms of machines and various types of machines both as to windings, number of poles and number of phases.

What I claim is:

1. In a dynamo-electric machine, the combination of a stator element and a rotor element, said elements each having windings, a commutator and collecting rings connected to the windings of one of said elements, brushes bearing upon said commutator, brushes bearing on said collecting rings and connections between said commutator brushes and points on said stator windings, said points being angularly displaced relatively to said commutator brushes so as to produce an energizing field of definite frequency rotating in the same direction as the relative rotation of said rotor windings.

2. In a dynamo-electric machine, the combination of a stator and windings thereon, a rotor and windings thereon, a commutator connected to said rotor windings, brushes bearing on said commutator connections between said brushes and said stator windings such as to produce a rotating energizing field of definite frequency, said stator being recessed and said brushes being located at neutral points caused by said recesses.

3. In a dynamo electric machine, the combination of a stator element and a rotor element, said elements each having windings, a commutator and collecting rings connected to the windings of one of said elements, brushes bearing upon said commutator, brushes bearing on said collecting rings and connections between said commutator brushes and points on said stator windings, said points being angularly displaced relatively to said commutator brushes so as to produce an energizing field of definite frequency rotating in the same direction as the relative rotation of said rotor windings, and a work circuit electrically connected to said windings.

4. In a dynamo electric machine, the com-

5 bination of a stator and windings thereon, a rotor and windings thereon, a commutator connected to said rotor windings, brushes bearing on said commutator, connections between said brushes and said stator windings such as to produce a rotating energizing field of definite frequency, said stator being recessed and said brushes being located at neutral points caused by said recesses, and a work circuit electrically connected to said 10 windings.

WILLIAM STANLEY.

Witnesses:

H. B. BROWNELL,
L. VREELAND.