(No Model.) 2 Sheets—Sheet 1.

C. S. BRADLEY.

DYNAMO ELECTRIC MACHINE.

No. 390,439. Patented Oct. 2, 1888.

Fig. 1.

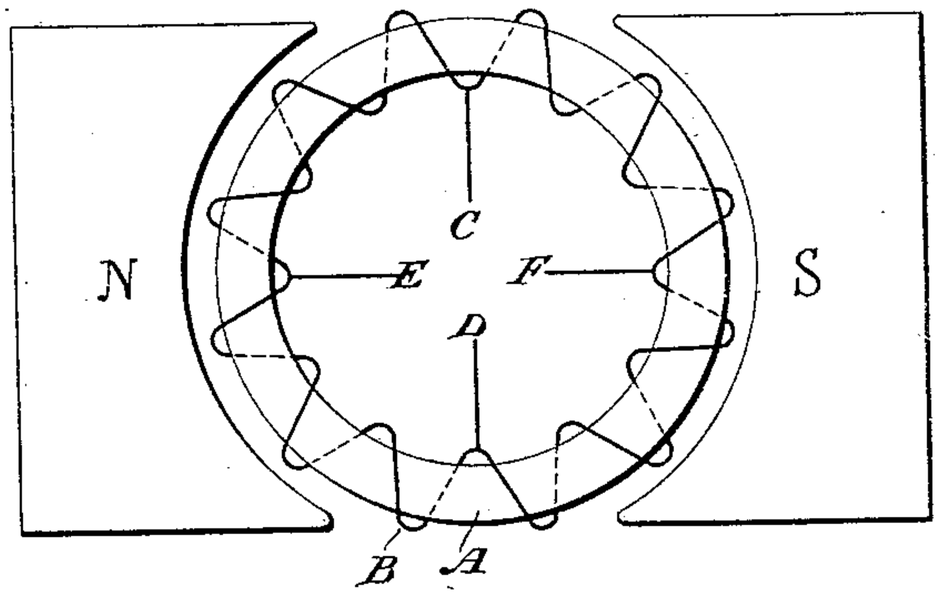


Fig. 2.

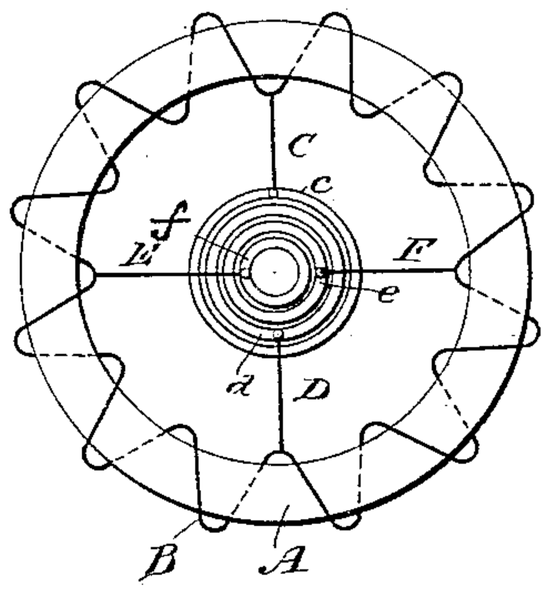


Fig. 3.

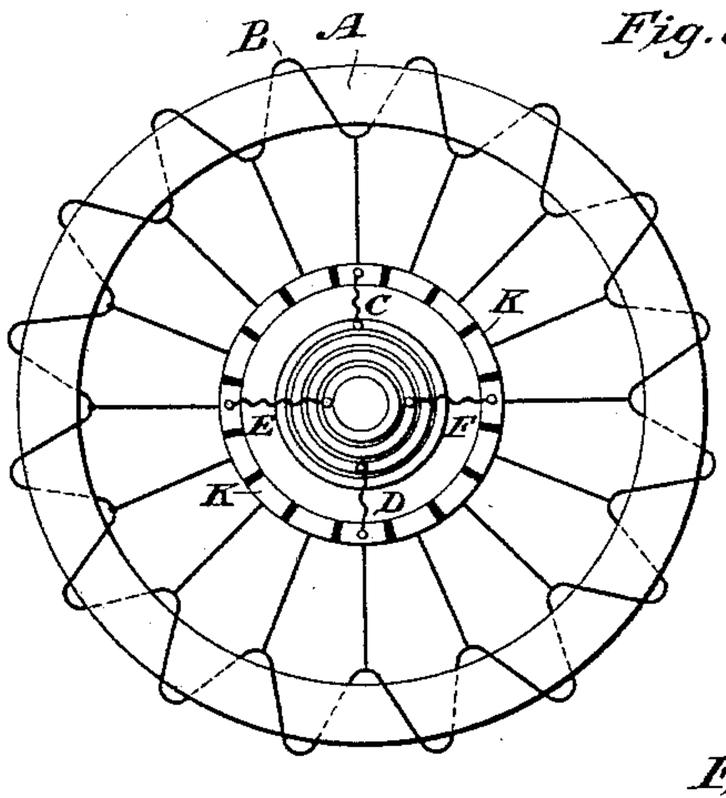


Fig. 4.

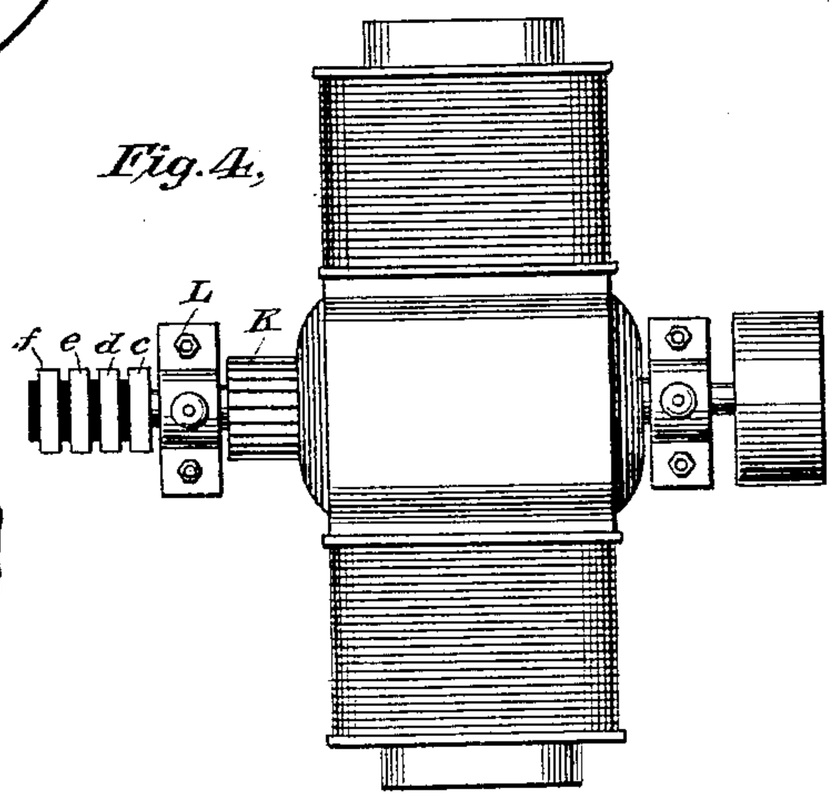
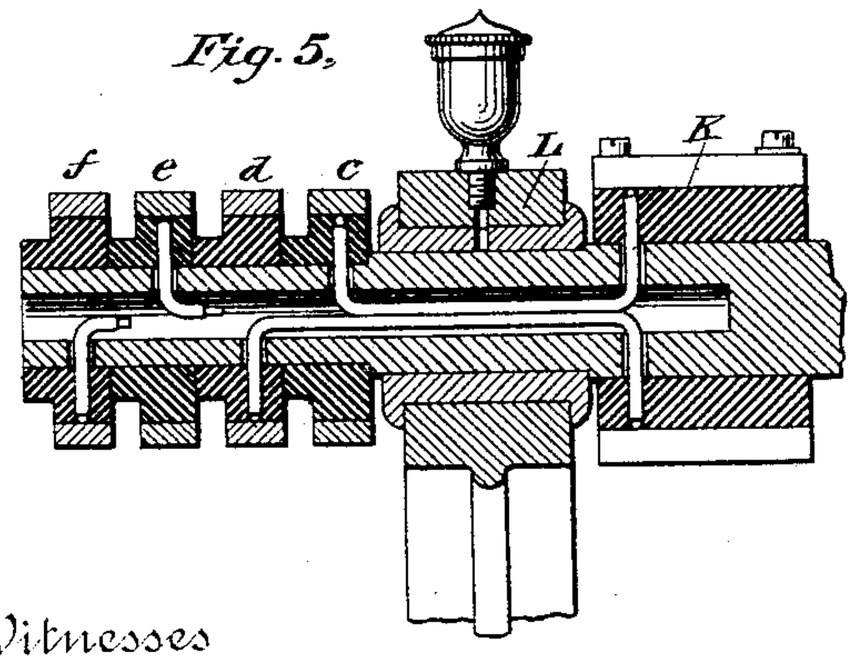


Fig. 5.



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(No Model.) 2 Sheets—Sheet 2.

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DYNAMO ELECTRIC MACHINE.

No. 390,439. Patented Oct. 2, 1888.

Fig. 1a

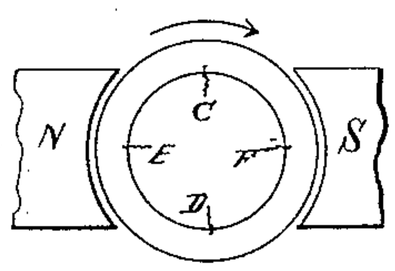

Fig. 2a.

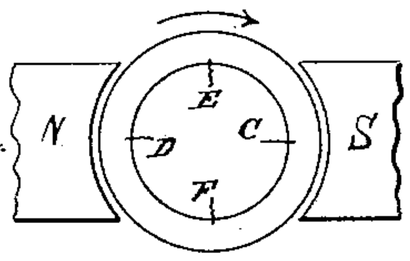

Fig. 3a.

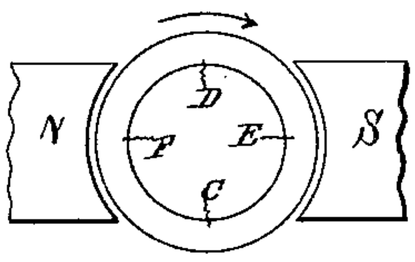

Fig. 4a.

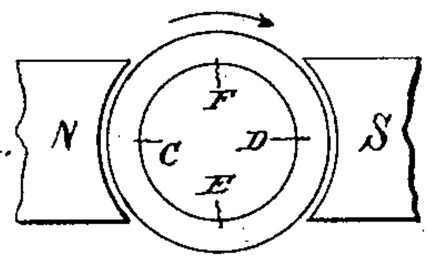

Fig. 5a.

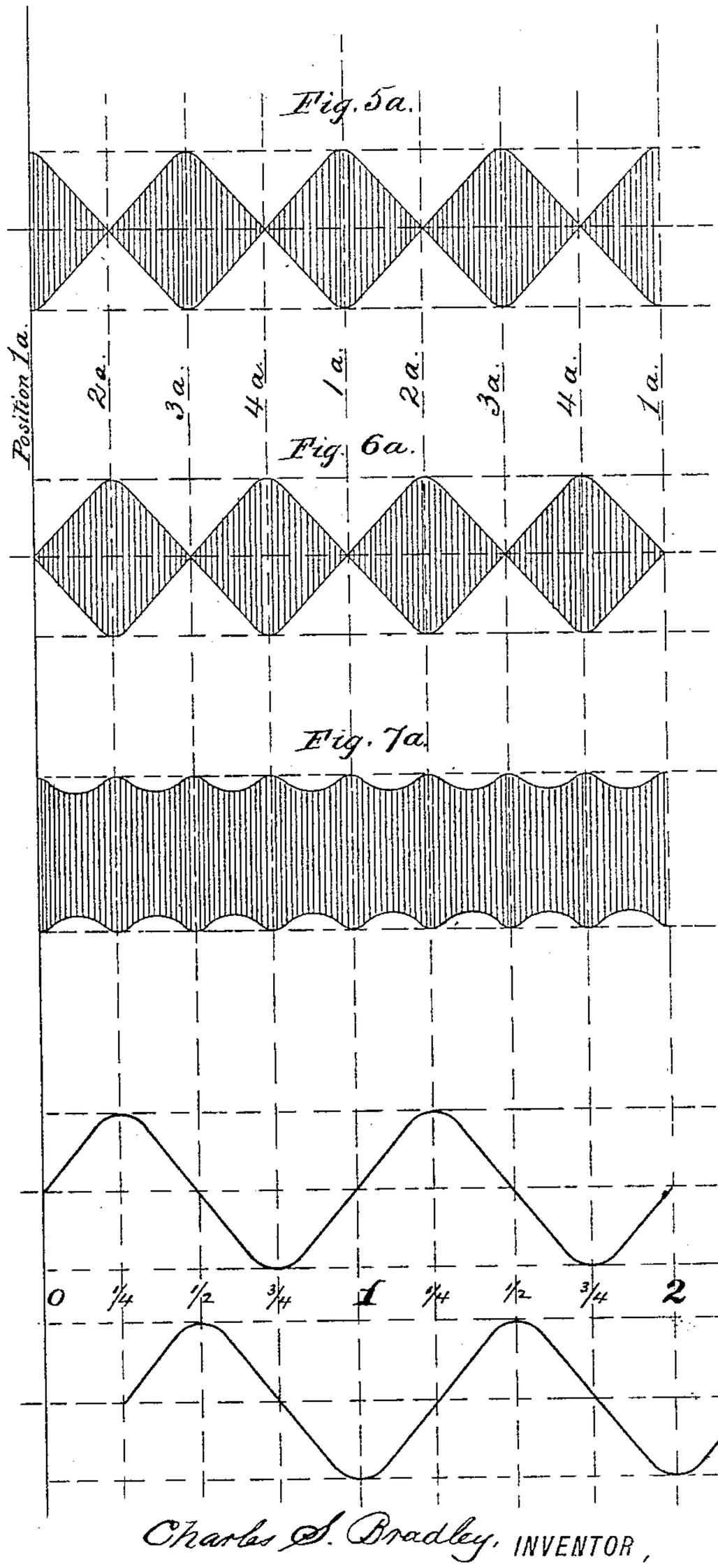

Fig. 6a.

Fig. 7a.

Fig. 6.

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UNITED STATES PATENT OFFICE.

CHARLES S. BRADLEY, OF YONKERS, NEW YORK.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 390,439, dated October 2, 1888.

Application filed May 9, 1887. Serial No. 237,515. (No model.)

To all whom it may concern:

Be it known that I, CHARLES S. BRADLEY, of Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Dynamo-Electric Machines, of which the following is a specification.

In alternating-current machines as heretofore constructed the generation of current occurs for practically half the time only, as there are certain points in the revolution of the armature at which the maximum potential is generated, but between these points of maximum there are an equal number of points of zero potential. This fact arises from the modern construction of alternating-current machines wherein a multipolar field-magnet is ordinarily used with a drum-armature having windings or coils laid on its external surface. These coils and their arrangement on the drum must bear a definite relation to the number and angular separation of the pole-piece of the field-magnet, and the result is that there are a number of blank spaces on the surface of the armature not occupied by coils and therefore not utilized for the production of current, as will be more clearly understood further on.

For some purposes it is desirable that the machine should be capable of giving off either a continuous or an alternating current, or both, at will, and give the maximum amount of either or both kinds of current with the maximum efficiency.

The objects of my invention are therefore, among others, to overcome the described difficulties and limitations, to increase the capacity of output of alternating-current dynamos, and to construct a machine which will generate either an alternating current or a continuous current, or both, as desired, and will give either or both with the maximum efficiency and output.

To this and other ends my invention consists in the machine and its arrangement and combinations of circuits and devices, as hereinafter fully described and claimed.

In the accompanying drawings, which illustrate my invention and form a part of this specification, Figures 1ª, 2ª, 3ª, 4ª, 5ª, 6ª, and 7ª represent the characteristics of my invention diagrammatically. Fig. 1 is a simple diagram representing my principle of increasing the capacity for output of alternating-current dynamos as applied to a simple two-pole machine. Fig. 2 is a diagram representing the manner of connecting a closed-circuit armature to give alternating currents according to my invention. Fig. 3 is a diagram representing the manner of connecting an armature to give both continuous and alternating currents while adhering to my fundamental principle. Fig. 4 is a plan view of a dynamo constructed according to my invention. Fig. 5 is a detail view in section showing the continuous-current commutator and the alternating-current contact-rings, and the manner of connecting the same. Fig. 6 is a set of diagrams of the two curves produced by Fig. 1, illustrating the relative periods of alternation produced by the machine constituted according to my invention, and making clear the effect of such on the total capacity of the machine itself.

N and S represent, respectively, the north and south pole pieces of the field-magnet, which may be excited by a separate current or in any suitable manner.

A is the armature-core, and B the winding of a simple Gramme ring, which will serve for my illustration. Connections are assumed as being made to the winding at four equidistant points by the terminals C, F, D, and E, arranged in the order named, so that C and D will be at diametrically-opposite points, and E and F similarly, but on a line at right angles to the line of C and D.

Assuming the armature to be revolving, and considering the successive actions therein according to the well-known laws of induction, the terminals C and D are, in the position of Fig. 1ª, at the maximum difference of potential, and if they be connected together directly or through any external resistance current will flow and will be maximum for the resistance of the said circuit. The terminals E and F on the contrary at this moment are each at a common potential and of like sign, and consequently as there is no difference of potential existing between them no current would flow through any circuit connecting them together.

Fig. 2 represents the same armature, with the terminals C, F, D, and E connected to four different contact-rings *c f d e*, respectively. For the sake of clearness these rings are shown as concentrically arranged one within the other

in the same plane. Two brushes applied to the contact-rings *c* and *d*, respectively, will take off an alternating current from the armature. This current when the armature is in the position indicated in the figure would be at a maximum in one direction, or, say, above zero; when the armature has revolved through ninety degrees, this current from C D would be zero; at one hundred and eighty degrees it would be at a maximum in the opposite direction, or, say, below zero; at two hundred and seventy degrees it would again be zero, and so on through each revolution of the armature. If now two other brushes be applied to the rings *e* and *f*, respectively, a similar and equal alternating current will be taken from them; but this second current will differ from the first in time by exactly a quarter of a phase or wave-length—that is, when the first current or C D is at a maximum the second or E F will be zero, and, conversely, when the first is zero the second will be at a maximum. This will be clearly understood by inspection of Figs. 1ª to 7ª, inclusive.

Figs. 1ª to 4ª show the armature at four different positions, each ninety degrees from its predecessor. In Fig. 1ª the terminals C D are at a maximum difference of potential in one direction—say positive—while E F are each of the same potential and the same sign, and are therefore at zero so far as concerns the delivery of current externally In Fig. 2ª, C D are of the same sign and potential, and therefore at zero, while E F are now at a maximum difference of potential positive. At Fig. 3ª, C D are at a maximum difference of potential in the opposite direction or negative, while E F are at zero, and in Fig. 4ª, E F are now at a maximum difference of potential negative, while C D are at zero. The resulting diagrams of output may be graphically shown, and Fig. 5ª represents the periodic phases of output from the terminals C D, while Fig. 6ª shows the corresponding phases of output from the terminals E F, the dotted vertical lines indicating each one-quarter of a phase or wave-length, while in the particular relations of winding and pole-pieces shown they will also be indicative of each one-quarter revolution. Thus in the case of any given armature I can effect the generation of two independent currents, each supplementing the other in the manner above described, and thus the time wasted during the generation of one is utilized for the generation of the other, and therefore two currents are obtained from the same machine, each of which is practically as great as the machine would generate if used in the ordinary way. These two currents can be employed for any purpose to which alternating currents are applicable, and they may be used separately, one being used to feed one circuit and the other to supply another circuit.

In Fig. 3 the armature is represented as connected to a rectifying-commutator, K, in the usual manner, and the same winding or armature conductor is connected to contact-rings, precisely as in Fig. 2.

Fig. 4 shows in complete form a dynamo constructed and connected in this way, K being the rectifying-commutator, and *c d e f* being the four contact-rings. I prefer to place the contact-rings *c d e f* beyond the bearing L, as represented in Figs. 4 and 5, in order that the bearing shall not be placed too far out on the shaft. In this case the ring C is connected to one commutator-strip, while the ring D is connected to the commutator-strip diametrically opposite; and the rings E and F are connected, respectively, to the two commutator-strips occupying positions ninety degrees either way from the strips to which the rings C and D are connected. The connections from the commutator-strips to the rings are carried through the shaft, which is made hollow for that purpose, as shown in Fig. 5. With such construction and arrangement, on revolving the armature of the machine a continuous current may be taken from the commutator K by suitable brushes in the usual manner, one alternating current may be taken from the rings C and D, and another alternating current may be taken from the rings E and F; but, as hereinbefore explained, this second alternating current will be a quarter of a phase behind the current taken from the rings C D. These currents may all be taken at the same time, if desired, and their relative proportions to each other will depend upon the external resistances in the three circuits, in accordance with well-known laws.

The advantage of a dynamo constructed according to my invention is that it may be used either as a continuous current machine, or as an alternating-current machine, or both. When used as a continuous-current generator, it is just as good as if specially made for continuous currents. If used as an alternating-current generator, it is much better than the machines now generally employed on account of the large increase of output possible with a given size of machine. I thus have a dynamo which can be used for either purpose; and at any time the owner or user desires to change the alternating-current system to the continuous, or vice versa, he can do so without any trouble whatever.

Another advantage from the foregoing construction lies in the fact that when the machine is used as an alternating-current generator a continuous current for energizing the field-magnets can be taken from the continuous-current commutator—or, in other words, the machine is in that event self-exciting.

Any approved form of armature can be connected up according to my invention. For example, a drum-armature may be connected in a manner precisely similar to that which I have shown and described for a Gramme ring. The form of armature and its winding, described by H. Muller in United States Patent No. 331,726, is also well adapted for connec-

tion and use in this manner. I prefer to employ those forms of armature in which the winding is so constituted as to form what is known as a "closed circuit" in preference to an armature whose winding is in the form of one or more open-ended coils, because the former are generally of higher efficiency and output, and are, besides, much more conveniently applicable to my purpose.

It is obvious from inspection of Figs. 3 and 4 that my machine may be used as a motor as well as a generator, and that it may, when so used, be fed or actuated either by continuous or alternating currents, or both, the continuous currents being fed through the brushes of the rectifying-commutator K and the alternating currents being supplied through the contact-rings *c d e f*. It is also obvious that my machine may be used as a device for changing a continuous current to an alternating current, or vice versa, or one alternating current into another of different time phase. The former would be accomplished by feeding the machine with a continuous current by the brushes on the rectifying-commutator, and an alternating current or two alternating currents can be taken from the machine through the brushes in contact with the rings *c*, *d*, *e*, and *f*. Where alternating currents are to be delivered to the machine and by it commutated into continuous currents, the alternating currents will be delivered in the first instance through the rings *c*, *d*, *e*, and *f* and the rectified continuous current will be taken off by the ordinary bearing on the commutator K. Where it is desired to use the machine to change one alternating current into another of different time phase, the primary current is sent into the machine through the rings *c d*, for example, and from the rings *e f* there can be collected an alternating current whose time period will differ by one-quarter phase from the original or primary current. When it is desired to use the machine so constructed for any purpose which does not involve the simultaneous use of both sets of brushes, the set which is not wanted is simply lifted out of contact with its rings or commutator, as the case may be. For example, if the machine is to be used as a continuous-current generator only the brushes are applied to the rectifying-commutator K, and all brushes bearing on contact-rings *c d e f* are lifted out of contact with such rings, so that there will be no circuit except the external circuit from the commutator K through its own brushes. Conversely, when the machine is used as a generator for alternating currents alone the corresponding brushes are placed in contact with their rings *c d e f*, and the brushes, bearing on the rectifying-commutator K, are lifted out of contact therewith if the field-magnets are energized from another source; but if the machine is to be self-exciting the brushes are left on the commutator K and connected in the usual manner with the energizing-coils of the field-magnet, and in this case the resistance in the field-magnet circuit will be made high enough to absorb only the percentage of the total current proper for the purpose of charging the fields.

Many other modifications in the manner of use of such a machine will readily suggest themselves to one skilled in the art to which this invention appertains, and the same need not be more specifically referred to herein. In order to avoid confusion I use the term "current-leading device" as expressive of either rings and brushes or commutator and brushes, or both, according to the use and manner of use of the machine.

I claim as my invention—

1. An alternating-current dynamo-electric machine having generative conductor, in combination with two pairs of current-leading devices, said pairs being respectively connected to the generative conductors, so as to collect two independent alternating currents, one of which has its time phase substantially one-fourth of a wave length or period behind the other.

2. An alternating-current dynamo-electric machine constructed with its generating-circuit closed, in combination with two pairs of current-leading devices, the pairs being respectively connected to said generating-circuit, so as to collect two currents independent of each other and substantially one-fourth of a phase apart in their relative time-periods.

3. An alternating-current dynamo-electric machine constructed with its generating-conductor constituting a closed circuit, and having two pairs of independent current-leading devices, one pair connected into said closed generating-circuit at mutually opposite points, and the other pair connected into said generating-circuit at intermediate points also mutually opposite each other.

4. A dynamo-electric machine having an armature provided with a current-rectifying commutator and brushes therefor, and two pairs of current-leading devices, the pairs being respectively connected to the armature winding at alternating points of the same, so as to lead off two alternating currents independent of each other, and substantially one-fourth of a phase apart in their respective time-periods.

5. An electro-motive device consisting of a field-magnet and a rotating armature provided with a rectifying-commutator and brushes therefor, through which current is received into the armature and rotation produced, in combination with two pairs of current-leading devices respectively connected to the armature winding at alternating points, and so arranged relatively as to lead off two independent alternating currents substantially one-fourth of a phase apart in their relative time-periods, whereby a continuous current may be transformed into two independent alternating currents.

6. An electro-motive device consisting of a

field-magnet and a rotating armature provided with a rectifying-commutator and brushes therefor, in combination with two pairs of current-leading devices, each pair independently connected to said commutator at respectively alternating points, and the two pairs adapted to receive and deliver to said armature two independent alternating currents of different phase from corresponding external circuits.

7. An electro motive device consisting of a field-magnet and a rotating armature provided with a rectifying-commutator and brushes therefor in circuit with the field-magnet coils, in combination with two pairs of current-leading devices—such, for instance, as contact rings and brushes—each pair independently connected to the armature winding at alternating points of the same, substantially as described, whereby the two pairs of current-leading devices are adapted either to receive and deliver to said armature two independent alternating currents of differing phase from corresponding external circuits or to receive from one external circuit a single alternating current, change its time-period, and deliver the same into another external circuit.

8. A self-exciting alternate-current dynamo-electric generator having a rectifying-commutator and brushes connected to its field-magnet circuit and having two pairs of collecting rings and brushes adapted to deliver two independent alternating currents externally, the generating-circuit being common to both the commutator and collecting rings.

9. A rotary electric motor consisting of a field magnet and armature and two pairs of current-leading devices—such, for instance, as contact rings and brushes—the respective pairs being independently connected into the armature winding at alternating points of the same and arranged for connection with two independent external circuits.

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