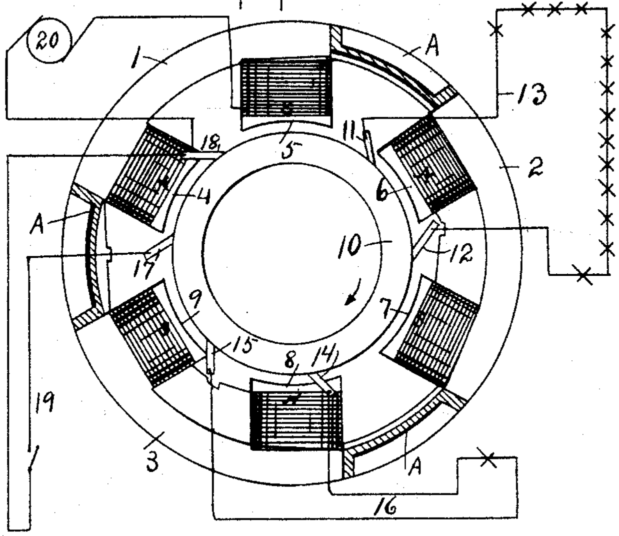
(No Model.) 2 Sheets—Sheet 1.

S. W. RUSHMORE.

DYNAMO ELECTRIC MACHINE.

No. 587,164. Patented July 27, 1897.

Fig. 1.



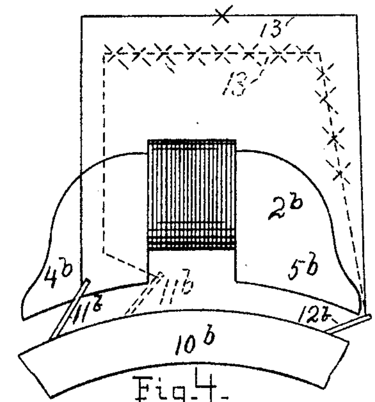


Fig. 4.

Fig. 7.

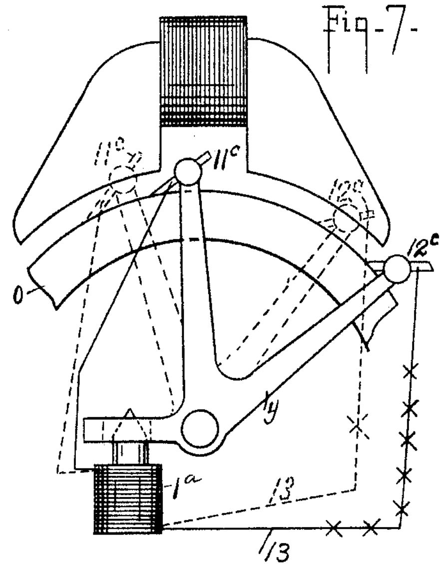


Fig. 2.

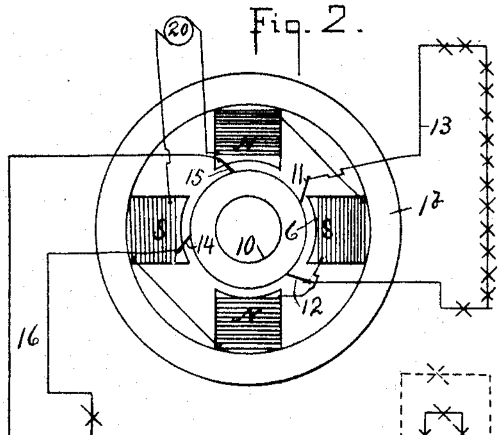
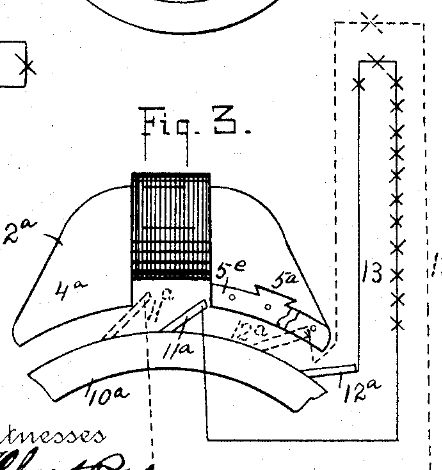


Fig. 3.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 6.

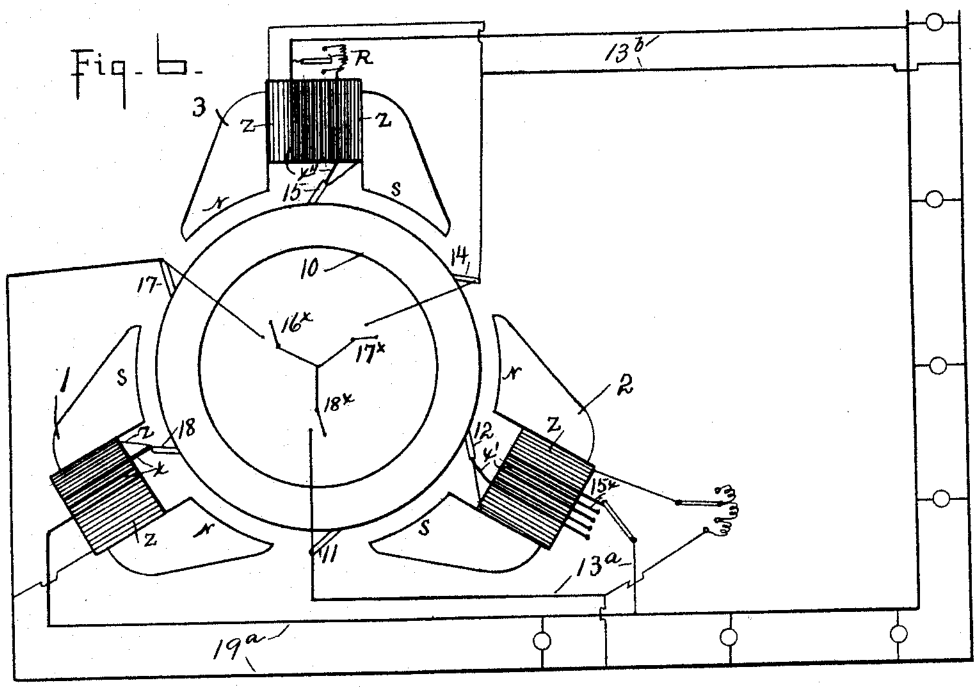
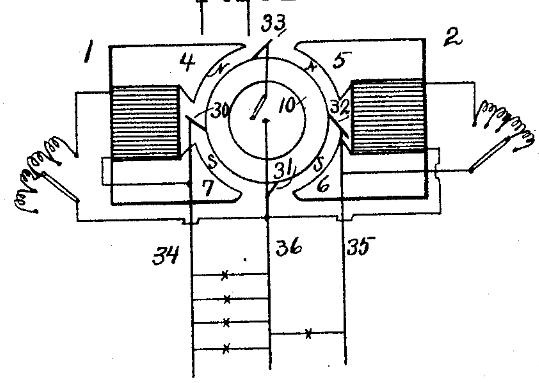


Fig. 5.



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UNITED STATES PATENT OFFICE.

SAMUEL W. RUSHMORE, OF BROOKLYN, NEW YORK.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 587,164, dated July 27, 1897.

Application filed May 14, 1897. Serial No. 636,518. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL W. RUSHMORE, a citizen of the United States, and a resident of Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Dynamos and Circuits, of which the following is a specification.

The present invention relates to dynamos adapted to deliver current to two or more circuits in varying volume or pressure, and has for its object to provide means whereby in the operation of such machine the variations in current generated in one section or part of the machine will not affect the working of the other section or sections which may be supplying current to another circuit or to other circuits.

The invention relates to the class of dynamos in which an armature is acted upon by a plurality of magnet-poles and current is collected from the sections of the armature under the different poles and is conducted to different circuits, as described in my application Serial No. 624,644, dated February 23, 1897.

The present invention is intended chiefly for machines to supply two or more separate circuits of arc-lamps connected in series, but it may also be applied to machines for supplying currents at constant pressure for incandescent lighting and power transmission. In the preferred form I employ an armature of the ring type, surrounded by two or more magnets or pairs of magnet-poles, the magnets being preferably magnetically separated—that is, without any magnetic material joining them to the other magnets at any point; and my improvement is chiefly in the method of and means for collecting the current, so that the action of the current generated in each section of the armature shall not interfere with the action of other sections under other poles, thus making each section of the machine practically independent of every other section.

In my application Serial No. 624,644 I show a machine with separated magnets and brushes adapted to collect the current generated under each pair of poles of each magnet, and while that arrangement will work successfully when the loads on each of the separate circuits are nearly all alike I have found that the brushes of one section cannot be shifted to any great extent or the load thereon greatly varied from the other sections without serious sparking and falling off in the capacity of the machine. This is due to the fact that when the current is collected under all the poles alike the magnetic flux in the armature, due to the current therein, is so distributed that it passes from one section to another, even though the different magnets or pairs of magnet-poles be magnetically separated, and thus such machines as constructed heretofore have not been well adapted for arc-lighting, where each section must be entirely independent of every other section, although as applied to arc-lighting such machines will operate with a greater difference between the loads on the different sections if the magnets acting on the sections with lighter loads are correspondingly weakened. It is desirable in arc-lighting to keep the magnets of nearly maximum strength and to regulate the potential to circuits by shifting the brushes.

In my new method and machine I so place and adjust the commutator-brushes that the current is collected directly from the armature only under one pole of each magnet or pair of poles—that is, nearly all the current which goes to the external circuit is that generated under one pole, called the "working pole," only—although with closed-coil winding it is evident that a very small portion of the current generated under the other or idle pole will find its way around the armature under the other poles, although the volume of this current flowing in the section of the armature under the idle pole will be so small that it will not seriously distort the magnetism from the other sections. In other words, I propose to place commutator-brushes in such a way as to collect current practically under only one pole of each magnet or pair of poles and to leave one pole of each pair practically idle as to generating current, and serving chiefly to complete the magnetic circuit of its section and to keep the magnetic flux of its section from flowing to the other sections. Although it would appear that by this method I would obtain but half the maximum output of the armature as obtained with brushes to collect current generated under all the poles, I have found in practice that by reason of the field keeping in place in its section under all load I obtain an output greater than in collecting directly under both poles, although it would appear that as nearly all the current flows from one brush to the other over a single section of the winding instead of dividing and passing under each pole, as in all other machines, the armature would heat more with a given output; but I have found in machines I have constructed that the heating does not exceed that of machines operated in the usual way.

As applied to arc-lighting I prefer to employ for each magnet or pair of poles two brushes on the commutator, adapted to include between them the section—that is, the coils of the armature—acted upon by the leading pole of the pair—that is, the pole under which the armature-coils first pass in the rotation of the armature—and to shift these brushes backward or forward together as required to keep the volume of current constant, although I have found that I may shift the brushes and separate them at the same time to accomplish the same results; but this method has the objection that the current is caused to flow through and heat a larger section of the armature than when both brushes are shifted together and more complicated mechanism is required to shift the brushes unequally.

Referring to the drawings, Figure 1 shows a machine with magnetically-separated magnets arranged about an armature, with brushes adjusted to collect current required for different circuits at different pressures, the brushes of each pair being kept at a fixed distance from each other, but shifted together around the commutator as required. Fig. 2 shows a machine supplying two circuits at different loads, with brushes adapted to be shifted as in Fig. 1, but with field-magnets not magnetically separated. Fig. 3 shows by diagram the method of shifting the brushes together under varying pressure. Fig. 4 shows by diagram the method of regulating pressure by shifting one brush more than the other. Fig. 5 shows the improvement applied to supplying a three-wire system, with means for adjusting the pressure of one side of the system independently of the other side. Fig. 6 shows a machine with one section supplying a circuit at normally constant potential, with one section supplying feeders at higher potential connected to such circuit at points distant from the machine to maintain an equal potential throughout the length of such circuit. Fig. 7 shows a section of machine adapted to supply a circuit of constant current and varying pressure, with brushes carried upon a frame or segment and adapted to swing back and forth to shift the brushes along the commutator.

In Fig. 1, 1, 2, and 3 are magnets with poles 4, 5, 6, 7, 8, and 9 arranged about the ring-armature 10. A A are magnetically-insulating sections between the magnets. 11 and 12 are brushes adapted to collect the current generated in a section of armature under pole 6, and connected to these brushes is a circuit 13 of translating devices in series. 14 and 15 are the brushes adapted to collect the current under pole 8 and connected to a circuit 16, such circuit having a smaller load than circuit 13, and the brushes are shown shifted together to the position required to maintain a constant current. 17 and 18 are brushes adapted to collect current generated under pole 4 and connected to circuit 19, which circuit is shown interrupted and carrying no load.

Fig. 2 is practically the same as Fig. 1, except that but two pairs of N and S magnet-poles are shown, and these not magnetically separated, but connected by ring 1^b.

In Fig. 3, 2^a is one of several magnetically-separated field-magnets with poles 4^a 5^a, and 10^a is a section of the armature under the poles. 11^a and 12^a are brushes adapted to collect the current generated under leading or working pole 5^a and connected to circuit 13 of arc-lamps. The brushes are shown in dotted lines as shifted toward pole 4^a to keep the current constant when the load or resistance of the circuit is reduced, for example, to that of one light, as indicated by the dotted circuit 13.

In Fig. 4, 2^b is a magnetically-independent magnet; 4^b and 5^b, poles thereof; 10^b, a section of armature under the poles; 11^b and 12^b, brushes connected to circuit 13 and adapted to collect current generated under pole 5^b. In dotted line is shown the position of brush 11^b when adjusted to maintain constant current in circuit 13 with an increased load or resistance.

In Fig. 5, 1 and 2 are magnetically-independent magnets arranged about an armature 10. 4, 5, 6, and 7 are poles of the separate magnets arranged in the order north, north, south, south. 30 and 31 are brushes adapted to collect current generated under pole 7. 32 is a brush adapted to collect current generated under pole 6. 33 is a brush adapted to collect the current under either pole 4 or 5. 34 is a wire connected to brush 30. 35 is a wire connected to brush 32, and 36 is a wire connected to brush 31, the three wires forming the three-wire system.

The operation is as follows: In Fig. 1 the magnets are shown all separately excited from the source 20, and I prefer to separately excite all machines constructed on the principle embraced in this invention, for the reason that the magnetic pull on the armature will then be nearly all balanced and the machines respond more quickly to changes in load. I might excite all the magnets from a single section of the machine or set of brushes, but the failure of that section would then interrupt the working of all other sections. When the machine is in operation, a current will be generated under pole 6, assumed to be in the direction of brush 11, through which brush it will flow out over circuit 13, through arc-lamps, and return to brush 12. As the magnetic flux from pole 7 will be practically the same as of pole 6, there will be an electric motive force generated under pole 7, but as there are no brushes to collect such current no current will flow through that section of the armature except the very small amount which may find its way around the entire armature, past all other sections, to brush 11, and while the small amount of current which will pass through the winding under pole 7 will contribute to the circuit 13 its volume is relatively so small that there is very little flux in the armature-core due to the armature-current under pole 7, and thus, there being no disturbing influence, pole 7 will hold the flux or lines of force circulating through pole 6, yoke-piece, pole 7, and armature-core between poles 6 and 7 practically without distortion, and practically none of the magnetic flux due to poles 6 and 7 or current in armature between brushes 11 and 12 will extend beyond that section of the machine and will not disturb the working of the sections of the armature under poles 4 and 5 or 8 and 9. Thus by my method of placing brushes and collecting the current directly from only one pole of each pair I make each section of the machine or armature supplying each separate circuit practically independent of all the other sections. Should a brush be placed between poles 7 and 8 and connected to brush 11, the same electromotive force would be generated at no load with one-half the armature resistance, but the armature-flux due to the current which would thus pass beyond pole 7 and extend fully or in part to and mingle with that of pole 8, and thus the sections would be more or less dependent upon one another and the different sections could not be operated at a widely-differing range of loads. I have shown brushes 14 and 15 collecting current generated under pole 8, but shifted forward a certain amount to maintain a constant current in circuit 16 with but a single arc-lamp. Brushes 17 and 18 are shown in position when circuit 19 is open and carries no current.

The operation of the machine of Fig. 2 will be practically the same as in that of Fig. 1, although it is evident that the variations in load in one section of the armature will affect the other sections; but as applied to arc-lighting it is possible that the automatic regulators in each circuit will compensate for this interference.

In Fig. 3 when the brushes are in full-line position the machine will give its greatest voltage with constant current, as the brushes are so placed that the armature-coils in the space between them are subject to the maximum flux from magnet-pole 5^a. As the resistance of circuit 13 diminishes the brushes are shown shifted forward to the position 11^a and 12^a, and while the current remains constant the voltage will be diminished, as the flux from pole 5^a will be distorted and thus weakened. By this method the brushes may be set an equal distance apart on a single rocker, as y, Fig. 7, and automatically shifted to keep the current constant, 1^a being a magnet in circuit 13 to move the rocker forward and to allow it to recede as required to shift the position of the brushes 11^c 12^c on the commutator to maintain a constant current with a variable load.

In Fig. 4 brushes 11^b and 12^b are capable of adjustment independently of each other and the regulation is effected by moving brush 11^b toward or away from brush 12^b. In the position shown in full lines, with one lamp in circuit, brush 11^b extends under pole 4^b, although the current flowing from it through the circuit is generated mostly under pole 5^b. The magnet-flux from poles 4^b and 5^b being distorted and some of the flux from pole 4^b acting on some of the coils between the brushes sets up an electromotive force opposing that due to pole 5^b, and thus further keeps down voltage to maintain a constant current in the circuit under a light load. As load is increased brush 11^b is shifted to dotted position, thus lessening the distortion and lessening the flux from pole 4^b, acting to create an electromotive force in opposition to that under pole 5^b. This method of regulation I consider inferior to that shown in Figs. 1 and 3, as on light loads a larger portion of the armature is thrown into the circuit, thus increasing the heating, and as in practice it is found necessary to shift brushes 12^b in the same direction as 11^b, but to a lesser extent, the mechanism to effect this shifting will be more complicated and difficult of adjustment.

In Fig. 5 the machine as shown is, in effect, two constant-potential dynamos connected in series and to a three-wire system. The current generated under pole 7 will flow through brushes 30 and 31 and circuit 34 and 36, but when lights are connected to wires 36 and 35 current will flow through brushes 31 and 32, and when the loads between 34 and 36 and 36 and 35 are equal no current will flow through brush 31, and brush 31 will carry current only when the resistance on one side of the system is greater than on the other, as in the regular three-wire system. I have shown a brush between magnets 4 and 5 with a switch connected to brush 33, which may be closed, if desired, but I prefer to operate with the neutral wire connected only to brush 31. It is evident that by reversing the polarity of poles 5 and 6 and making proper connection from the brushes the machine may be used to supply a single circuit or two independent circuits.

I am aware that others have tried with more or less success to operate a three-wire system with but a single machine; but they have not, so far as I am aware, employed magnetically-separated magnets, and as tried by all others the current has been collected under all the poles at all times, and their failure is largely or entirely due to the fact that when collecting under all the poles the voltage from one section or set of brushes cannot be be changed without changing that of all the other or adjacent sections, for the reasons already explained.

In Fig. 6 is shown a generator with magnetically-independent magnets 1, 2, and 3, arranged around an armature 10. 17 and 18 are brushes adapted to collect current generated under the working pole S of magnet 1. 11 and 12 are brushes adapted to collect current generated in section under pole S of magnet 2. 14 and 15 are brushes adapted to collect current generated in section under pole S of magnet 3. Brushes 17 and 18 are shown connected through a series coil x of magnet 1 to a circuit 19^a, containing translating devices in parallel. Brushes 11 and 12 are shown connected through series coil x' on magnet 2 to a feeder-circuit 13^a, which feeds into circuit 19^a at a distant point. Brushes 14 and 15 are shown connected through a series coil x'' on magnet 3 to a feeder-circuit 13^b, which feeds into the circuit 19^a at a still farther distant point. The series winding on magnet 2 is so proportioned or adjusted as to increase the strength of the magnet as the current in feeder 13^a increases, thus increasing the pressure on such feeder to a predetermined amount to make up for the loss in transmission and to keep the pressure on circuit 19^a at a desired amount at the point where the feeder joins it. In like manner the series coil on magnet 3 is proportioned or adjusted to increase the pressure on the feeder 13^b to compensate for the loss in transmission and keep the pressure on circuit 19^a at the desired amount at the point where it joins with feeder 13^b. Thus the generator may be employed to supply a circuit of constant potential from one or more sections of the machine, while the other sections may supply feeders to such circuits at higher pressures to maintain a constant potential through the length of the main circuit, and, as is accomplished in practice to-day, by employing a separate machine at higher pressures on the feeders.

On magnet 3 I have shown resistance R, adapted to shunt the current around the series winding for regulating the amount of increase of pressure with increased load, and on magnet 2 I show connections $15^\times$, leading from different points in the series winding with a switch adapted to short-circuit or cut out some of the series turns for the purpose of regulating the increase of pressure or compounding.

At a point central with the brushes I have shown switches $16^\times$, $17^\times$, and $18^\times$, which may be closed at will, thus cross-connecting brushes 17, 11, and 14, and I propose to operate the machine with the switches closed when the potentials generated in the several sections of the machine are nearly all alike and thus the current is distributed throughout the armature; but in practice I have found where the potentials taken from the different sections differ greatly from each other it is desirable, and in some cases necessary, to collect the current directly from each section from under only one pole of each magnet for the reason already explained.

The machine is shown with each section excited with the shunt-winding z from its own brushes; but I prefer to separately excite all the magnets from an outside source for the reason given.

It is evident that the feeders 13^a and 13^b may be connected to the circuits independent of circuit 19^a, and in railroad-work these feeders would in some cases be connected to certain independent sections of the line, and the compounding of the section of the machine would be adjusted to keep the potential constant along the section of the line to which it is connected and to accomplish the results now obtained with "boosters" or separate specially-compounded dynamos.

Having described my invention, I claim—

1. The method of operating a dynamo having a plurality of pairs of N and S poles which consists in collecting current under but one pole only of each pair, using the second pole of each pair to keep the magnetic flux of its section from flowing to other sections.

2. The method of operating a dynamo having a plurality of poles which consists in collecting the current from brushes including directly between them the coils of an armature acted upon by one pole only, and an adjacent pole of opposite sign with no brushes to collect current directly under it, such poles serving chiefly to complete the magnetic circuit of the pole under which current is directly collected.

3. The method of operating a dynamo having a plurality of pairs of N and S poles which consists in collecting current under but one pole only of each pair, using the second pole of each pair to keep the magnetic flux of the section from flowing to other sections, and separately adjusting the different pairs of brushes.

4. The combination in a dynamo of two or more pairs of N and S poles, an armature, a commutator, and commutator-brushes arranged to collect current under one pole of each pair, said brushes being independently adjustable.

5. The combination in a multipolar dynamo of a field having a plurality of pairs of N and S poles, an armature, a commutator, and commutator-brushes arranged in pairs

to include between the brushes of each pair armature-coils carrying current generated under poles of one sign or one pole of each pair, of separate or independent circuits connected to the separate pairs of brushes, so that the current delivered from the brushes will not be equally divided through the winding of the armature but will be of greater volume under some of the poles than under other poles, whereby the magnetic flux due to current in the armature will be greater under some of the poles than under other poles.

6. The combination in a multipolar dynamo having two or more separated magnets arranged around an armature, a commutator and commutator-brushes arranged to collect current under one pole of each pair, said brushes being independently adjustable.

7. The combination in a multipolar dynamo having two or more magnets or pairs of N and S poles, an armature, a commutator, and commutator-brushes arranged to collect current under one pole of each pair, said brushes being independently adjustable, and separate circuits connected to different pairs of brushes.

8. The combination of a dynamo having a field with a plurality of pairs of adjoining N and S poles, an armature, a commutator, commutator-brushes for one pole of each pair, and an exciting-generator for the field, the brushes adjoining such poles being connected or adapted to be connected to separate circuits.

9. The combination, in a dynamo adapted to supply a plurality of separate circuits, of a field with a plurality of pairs of adjoining N and S poles, an armature, a commutator, pairs of commutator-brushes adapted to directly collect current generated under one pole only, means for holding the brushes, and means controlled by the currents in the working circuits to suitably shift the brushes to separately regulate the currents in said circuits.

10. The combination in a dynamo adapted to supply a plurality of circuits of a field with a plurality of N and S poles, an armature, a commutator, pairs of commutator-brushes adapted to include between them directly armature-coils under one pole only, a brush-holder for each pair of brushes, and means controlled by the current adapted to shift the brushes toward or away from the idle pole or poles under which no current is directly collected to maintain a constant current in the working circuit or circuits.

11. The combination of a dynamo having a field with a plurality of N and S poles, an armature, a commutator, two or more pairs of brushes adapted to include between them directly the sections of armature under poles of one sign, the poles of opposite sign having no brushes to collect current under them, and independent circuits connected to the different pairs of brushes, and means for shifting the different brushes singly or in pairs to vary the electromotive force to maintain a constant current in each of the independent circuits.

12. A multipolar dynamo adapted to supply two or more independent circuits with currents of constant volume having a field with a plurality of pairs of N and S poles, an armature, and commutator with brushes arranged in pairs to collect current directly from sections of the armature under alternate poles, or under poles of one sign, only, so that but a small proportion of the current will flow through the sections of armature under the other poles, so that the flux due to the armature-current under such poles will be less than that due to the current in the armature between the brushes and under the other poles.

13. The combination with a multipolar dynamo having a number of magnetically-separated magnets surrounding a ring-armature, a commutator and commutator-brushes arranged in pairs, each pair adapted to collect current generated under one pole only of each of the separate magnets, of separate or independent circuits containing translating devices in series connected to different pairs of brushes, and means for shifting the pairs of brushes independently of the other pair or pairs to maintain a constant current in each of the circuits.

14. The combination with a multipolar dynamo having two or more magnets or pairs of N and S poles, an armature, commutator and commutator-brushes arranged in pairs so that each pair shall collect directly from the armature current generated under one pole only of each magnet, a main circuit supplied with current from some of the pairs of brushes at normally constant potential, feeders connected at distant points to such circuit, such feeders being supplied with current from other pairs of brushes, and means for varying the magnetism to vary the voltage between brushes connected to the feeders for the purpose of maintaining a constant potential throughout the length of the main circuit.

15. The combination with a dynamo having four or more poles, an armature, commutator, commutator-brushes arranged in pairs so that each pair shall collect from the armature current generated under only the poles of one sign, one or more constant-potential circuits connected to the brushes or pairs of brushes, means for varying the strength of the different poles to vary the potential between the different pairs of brushes, and means for cross-connecting at will two or more of the brushes, so that the brushes will, when so connected, collect current generated under poles other than those of one like sign only.

16. The combination in a dynamo adapted to supply a plurality of separate circuits and having two or more magnetically-separated magnets around an armature, a commutator,

commutator-brushes arranged in pairs and adapted to directly connect the current generated under only one pole of each of the separate magnets, coils for exciting the separate magnets, and other coils around one or more of the magnets, such latter coils being connected in series with the circuits supplied from the brushes collecting current generated under the magnet having such coils so that the magnetism of each of the separate magnets will automatically increase with an increase of current flowing from the brushes under each separate magnet.

Signed this 8th day of May, 1897.

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