Dec. 30, 1930. A. YTTERBERG ET AL 1,787,028

EXCITING MEANS FOR DIRECT CURRENT GENERATORS

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Fig. 1.

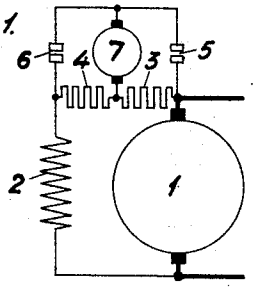


Fig. 2.

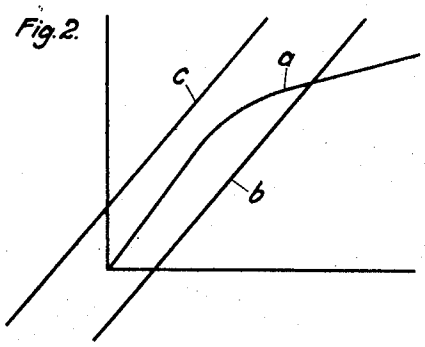


Fig. 3.

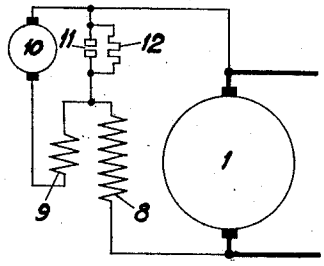


Fig. 4

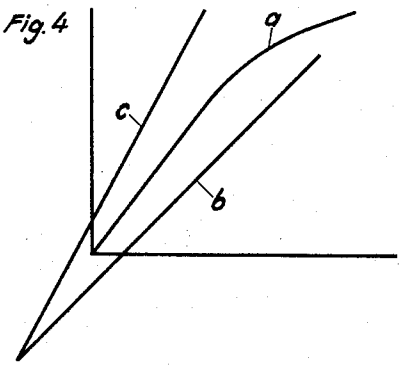


Fig. 5.

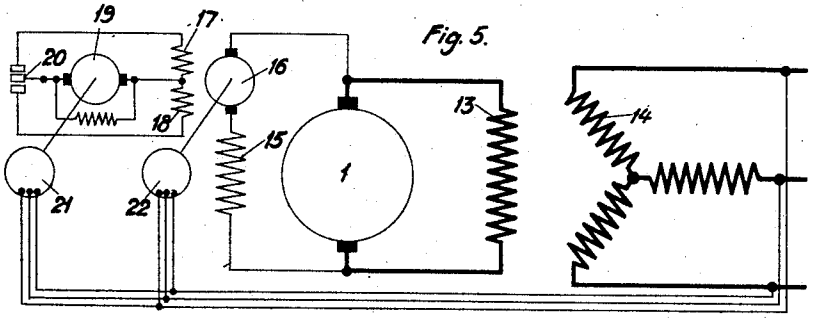
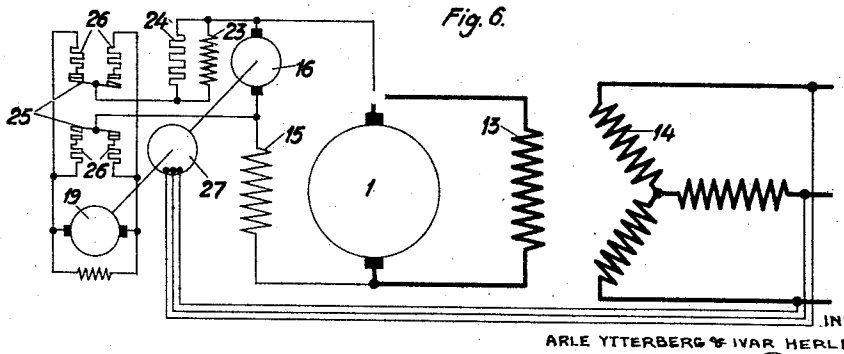


Fig. 6.



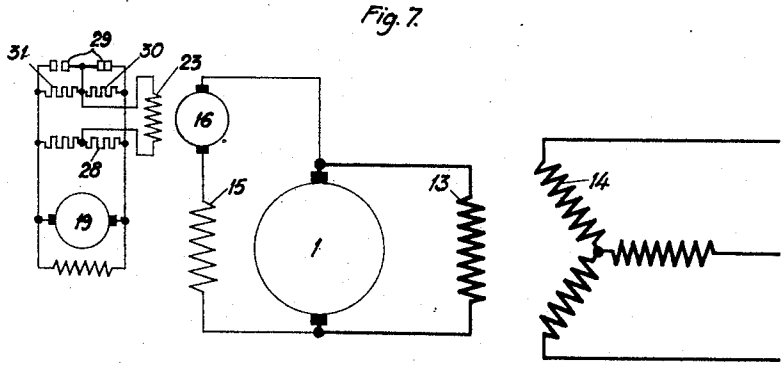
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EXCITING MEANS FOR DIRECT CURRENT GENERATORS

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Fig. 7.



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UNITED STATES PATENT OFFICE

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EXCITING MEANS FOR DIRECT-CURRENT GENERATORS

Application filed February 29, 1928, Serial No. 257,799, and in Sweden March 5, 1927.

In electrical machines, including those having automatic voltage regulation, it is sometimes necessary to lower the voltage considerably below the normal value or even to reverse its direction, for instance in machines serving as exciters for alternating current generators which operate with highly condensive load, for instance on extensive high-tension systems. In self-exciting machines having voltage regulators of the type which intermittently short-circuit resistances in the exciting circuit, such a regulation down to low or negative values is not practicable. The operation of such a regulator may be appropriately illustrated in such manner, that in the excitation diagram are drawn two so-called resistance lines representing the relation between terminal voltage and exciting current for short-circuited and inserted resistance, respectively. The regulator can only operate within the region where the voltage characteristic of the machine lies between these two lines. The latter both pass through the origin and thus lie close to each other for low values. As the voltage characteristic is no sharply defined line, but on account of hysteresis in the iron has somewhat different positions for increasing and for decreasing voltage and further is influenced by the unavoidable speed variations, it will tend to intersect the resistance lines for low voltages, whereby the range of regulation is limited. Further the speed of regulation is considerably reduced with the voltage, which is a great inconvenience.

The present invention has for its object to provide a possibility for causing an intermittently acting voltage regulator to operate at low values of the voltage and even at negative values. This is accomplished by causing the regulator to connect a voltage source independent of the machine alternately in different relations to the proper voltage of the machine, whereby the resistance lines will either be parallel or intersect each other below the origin.

Five different forms of the invention are diagrammatically illustrated in the accompanying drawing in Figs. 1, 3, 5, 6, and 7, while Figs. 2 and 4 are voltage diagrams corresponding to Figs. 1 and 3, respectively.

Referring to Fig. 1, 1 is the armature of a D. C. generator, the voltage of which is to be regulated, and which is assumed to be for instance the exciter of a large A. C. generator. 2 is the exciting winding of the D. C. generator, said winding being connected to the generator's own terminals over a double resistance 3, 4. By contacts 5, 6 which are alternately opened and closed by a mechanism of well-known kind, an auxiliary generator 7 is alternately connected in parallel to the one or other half 3 or 4 of the resistance. As one terminal of the generator 7 is permanently connected to a point between the two halves 3 and 4, this implies that the voltage of the generator 7 will be alternately added to and subtracted from that of the main generator 1.

The mode of operation of this connection is illustrated in Fig. 2. When the voltages of the two generators are added, the resistance line b is obtained, and when they are subtracted the line c parallel to the former. The voltage characteristic a of the main machine lies between the two lines within the operating range of the machine and even below the origin at considerable distance from both, whence the voltage regulator can operate safely and rapidly at all desired voltages.

The machine illustrated in Fig. 3 has two exciting windings 8, 9 and an auxiliary machine 10 connected in series with both of them. The point of connection between the two exciting windings is connected to the other terminal of the machine 10 over the regulator contacts 11. When the latter are closed, the main machine 1 and auxiliary machine 10 energize substantially one exciting winding each, said windings then cooperating. When on the contrary the contacts are open, the two machines are connected against each other and the difference of voltage is impressed upon the series-connected exciting windings, which moreover counteract each other. The result will be the two resistance lines shown in Fig. 4, which intersect one another below the origin at a distance depending on the proportion between the number of turns in the two exciting windings. This connection has thus

the desired properties for low voltages and for a portion of the negative side.

For facilitating the contact-breaking, a resistance 12 may be connected in parallel to the contact point 11 whereby of course the illustrated manner of operation is somewhat modified.

In Fig. 5, an auxiliary machine 16 is permanently connected in series with the exciting winding 15 of the D. C. generator 1. The machine 16 has two exciting windings 17, 18 acting in opposite directions and adapted to be alternately connected to a generator 19 by means of an oscillating contact 20 which of course may be replaced by two separate, mechanically cooperating contact systems, as in Fig. 1. The connection according to Fig. 5 of course like that of Fig. 1 will give parallel resistance lines. For facilitating the breaking, resistances may be connected in parallel to the contacts, or they may be connected in series with the contacts and the reconnection effected without interruption.

To prevent the voltage characteristic of the generator rising above the resistance line representing the upper limit of regulation, if the machine should increase its speed rapidly on being relieved of its load, the arrangement may be such that the voltage of the auxiliary machine simultaneously rises in a suitable proportion. If the generator 1 forms the directly coupled exciter of a three-phase generator 13, 14, the exciter 19 may for instance be driven by a motor 21 connected to the system fed by said generator so that its speed will increase with that of the main machine. The auxiliary machine 16 may also be driven by the same motor or by another motor 22 whereby the voltage thereof will increase with the square of the speed. Of course the machines 16, 19 may also be coupled directly to the main machine.

In Fig. 6, an auxiliary machine 16 is also permanently connected in series with the exciting winding 15 of the D. C. generator 1. The machine 16 has an exciting winding 23 which is fed from a small generator 19 alternately in either direction by means of a pair of oscillating contacts 25 which may be operated simultaneously or mechanically connected together. The two machines 16 and 19 may for instance be driven by a motor 27 connected to a generator 13, 14 excited from the generator 1. A resistance 24 is connected in parallel to the exciting winding 23 for facilitating the change-over, if one contact of the system 25 opens before the corresponding one closes, and resistances 26 are connected in series with the contacts for preventing short-circuit, if both of the cooperating contacts should remain closed at the same time. For facilitating the reversal of the flux in the auxiliary machine its own armature voltage is in series with the voltage of the generator 19, both acting on the exciting winding 23. The resistance of the latter and the resistances 24 and 26 may preferably be so adapted that the voltage of the machine 16 will be sufficient to cover the entire ohmic drop, that is, that the whole of the voltage of the generator 19 will be available for equilibrating the counter-voltage excited in the winding by the variation of the flux. This connection, as those of Figs. 1 and 5, will give parallel resistance lines.

The connection according to Fig. 6 may also be modified in such manner that the generator 19 is provided with a potentiometer to the mid-point of which one end of the exciting winding 23 is connected while the other by means of an oscillatory contact is connected to one or the other of the terminals of the machine. The second oscillating contact will in that case be superfluous.

In Fig. 7 such a modification of Fig. 6 is shown in which the generator 19 is connected to the terminals of a potentiometer 28 to the mid-point of which one terminal of the exciting winding 23 is connected, while the other terminal of said winding is connected to the one or other terminal of the machine 19 by means of an oscillating contact 29. The second oscillating contact may in this case be omitted. Resistances 30 may be connected in parallel to the contact gaps.

Although the independent source of voltage has been illustrated in all the modifications as a machine it may in certain cases consist for instance of a battery.

We claim as our invention:

1. Exciting means for D. C. generators comprising a D. C. generator, a self-energized exciting winding therefor, an auxiliary independent voltage source of excitation, and oscillatory contact means for shifting the connections of said source to affect the said exciting winding fed thereby, so as to cause the said source to alternately cooperate with and counteract the self-energization of said exciting winding.

2. Exciting means for D. C. generators comprising a generator, an independently excited auxiliary machine, an exciting winding connected to the generator terminals in series with said auxiliary machine, and oscillatory contact means for reversing the voltage of said auxiliary machine.

3. Exciting means for D. C. generators comprising a generator, an auxiliary machine, an exciting winding connected to the generator terminals in series with the auxiliary machine, an exciting winding on said auxiliary machine, an independently excited machine for feeding said exciting winding, and oscillatory contact means for reversing the connection between said winding and machine.

4. Exciting means for D. C. generators comprising a generator, an auxiliary machine, an exciting winding connected to the generator terminals in series with said auxiliary machine, an exciting winding on said machine connected to one terminal thereof, a third independently excited machine connected between said winding and the other terminal of said auxiliary machine, and oscillatory contact means for reversing the connection of said third machine.

In testimony whereof we have signed our names to this specification.

ARLE YTTERBERG.
IVAR HERLITZ.