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REGULATION OF DYNAMO ELECTRIC MACHINES.

APPLICATION FILED JULY 2, 1902.

910,649.

Patented Jan. 26, 1909.

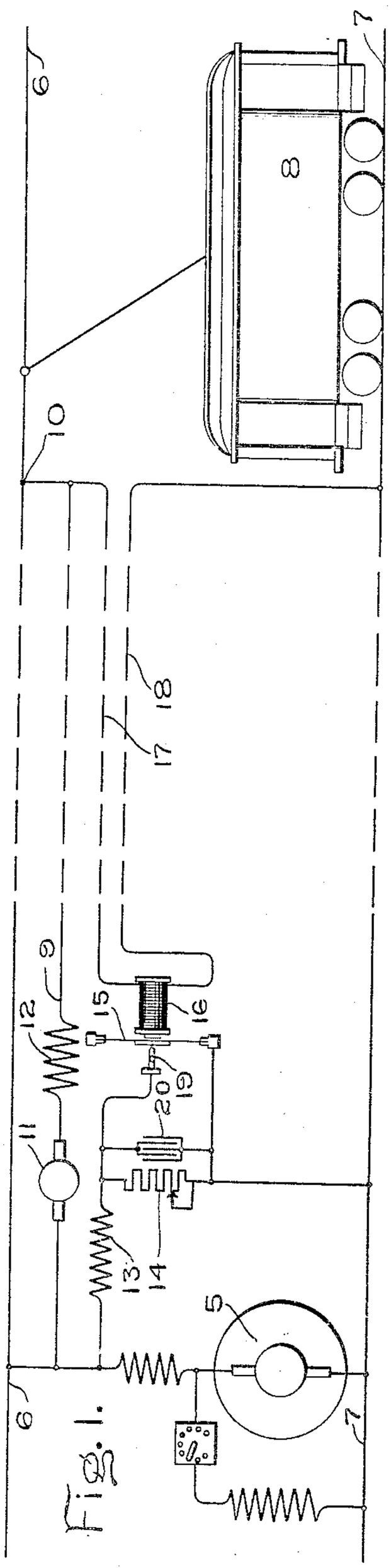

Fig. 1.

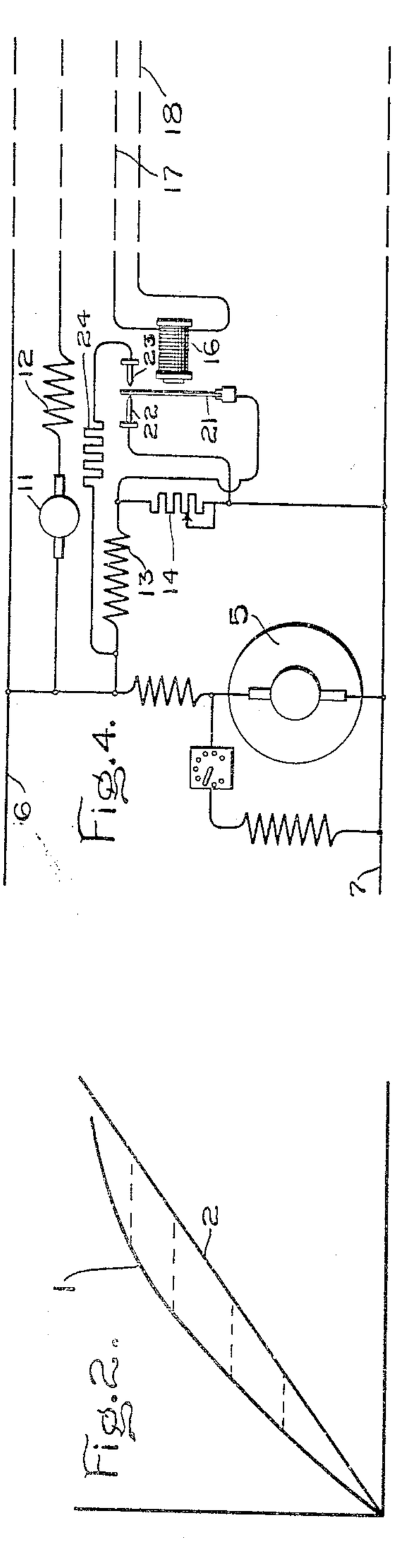

Fig. 4.

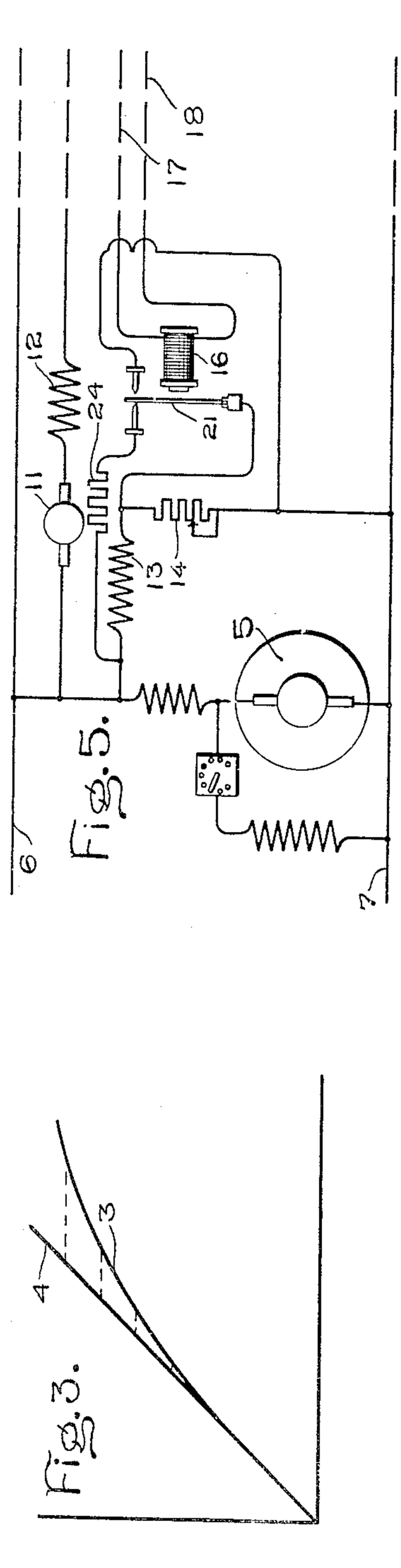

Fig. 5.

Fig. 2.

Fig. 3.

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UNITED STATES PATENT OFFICE.

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REGULATION OF DYNAMO-ELECTRIC MACHINES.

No. 910,649. Specification of Letters Patent. Patented Jan. 26, 1909.

Application filed July 2, 1902. Serial No. 114,103.

To all whom it may concern:

Be it known that I, WILLIAM F. DAWSON, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Regulation of Dynamo-Electric Machines, of which the following is a specification.

My invention relates to the distribution of electricity for railway, lighting and power purposes, and comprises certain improvements which, though capable of various applications, are particularly useful in connection with boosters used in such systems for compensating for the drop in feeder lines or other portions of the system. The main requirement for boosters employed for the purposes mentioned, is that they shall supply a voltage at their terminals proportional to the current flowing through them. This result is only approximately reached in practice and if the approximation be reasonably close it is only obtained by the use of an unduly costly design of machine.

Among the objects of my invention is the production of a booster which shall maintain a practically constant voltage at some point on the system regardless of the load, and which shall be economical in operation and not unduly costly in construction.

The means whereby I accomplish this result I have set forth with particularity as to its features of novelty in the appended claims and described in detail in the following specification which is to be taken in connection with the accompanying drawings which illustrate the invention in some of the various embodiments of which it is capable.

Figure 1 is a diagrammatic representation of a system embodying my invention; Figs. 2 and 3 are explanatory diagrams; and Figs. 4 and 5 are representations of certain modifications of the invention.

In the particular embodiments which I have chosen for illustrating my invention, I provide the booster, which is of the usual series wound construction, with an additional winding connected in shunt to the mains of the system or to any other source of current of moderately constant electromotive force. The current in this shunt winding is controlled automatically so as to cause the booster to maintain a constant electromotive force at a selected point of the system. The current in this shunt winding may be in a direction to assist the series winding of the booster or to oppose the same.

If the shunt winding acts in opposition to the series winding, then the condition of affairs may be explained by reference to Fig. 2 in which the curve 1 represents by its ordinates the voltage which, by the action of the series winding acting alone, will be produced at the terminals of the booster when current is flowing through the booster of a value represented by the corresponding abscissæ. It will be noted that this curve is by no means a straight line but is humped or bent in the region to which the numeral 1 is applied. By causing demagnetizing current to flow through the shunt winding of such values as represented by the horizontal dotted lines, the characteristic of the booster, or in other words the curve of voltage at the terminals of the booster plotted with respect to current flowing through the booster, becomes a straight line, as at 2. The means whereby the proper values of demagnetizing current are caused to flow in the shunt winding will be described below.

Instead of causing the shunt winding to act as a demagnetizing winding, current may be caused to flow through the same in such a direction as to assist the series winding, in which case the field of the booster is strengthened as the load comes on by just such an amount as will enable the booster to maintain the desired constant voltage at the selected point of the system. This condition of affairs is represented by Fig. 3 in which the voltage which would be produced by the series winding unassisted is represented at 3, and the resulting voltage produced by the increments of magnetization of the shunt winding at 4. The horizontal dotted lines in this figure represent magnetizing effect of the shunt winding corresponding to the various values of current indicated by the intersection of these dotted lines with the characteristic or curve 3.

Referring now to Fig. 1 which illustrates but one of the various embodiments of which my invention is capable, the main source of current for the system, which in this case is represented as a railway system, is indicated at 5. This source of current is represented as a compound wound direct current generator of a construction well known in the art and therefore requiring no special description. It is to be observed

that any other suitable source of current, either a single machine or a plurality of machines, may be used, as will be obvious to one skilled in the art. The main conductors extending from the source of current are shown at 6 and 7, and these conductors supply current to any suitable current-consuming devices such as an electric lighting system, electric cars or the like, a single electric car being indicated at 8 by way of example.

In order to prevent the voltage on parts of the system distant from the source from dropping as the load comes on, I may employ a feeder or a system of feeders, one of which is illustrated, for example, at 9. This feeder extends from the main generating source as shown to a point such as 10 distant from the generating source between which point and the generating source a drop of potential would occur under ordinary conditions of operation. In series with this feeder 9 is placed a booster having an armature 11 and a series winding 12, this booster being driven by any suitable source of power, such, for example, as a motor connected across the mains 6, 7.

It is evident that any other source of power may be employed, if desired, so that inasmuch as the means for driving the booster forms no essential part of my invention, I have considered it unnecessary to illustrate any particular driving means for the booster.

In addition to the series winding 12 of the booster I provide an auxiliary winding 13 thereon, which winding is connected in series with a relatively large and preferably adjustable resistance 14 across a suitable source of current such, for example, as the mains 6, 7. In shunt to the resistance 14 is a magnetically-controlled make-and-break contact device for alternately opening and closing a short circuit about the resistance. This device may assume various forms. One form which I find suitable consists of a stretched strip 15 of metal such as iron, or if not iron then a suitable armature of magnetic material is located at the middle point thereof. This stretched strip has a magnet 16 arranged so as to exert an attraction upon the middle or intermediate portion of the strip. This magnet is connected in a circuit with leads 17, 18, extending to and connected across the mains of the system at the point where it is desired to maintain a constant voltage. In Fig. 1 these leads extend to and are connected with a part of the system located at a distance from the generating source.

The magnet 16 in acting upon the stretched strip operates by variations in its attractive force to make and break contact between the strip and an adjustable fixed contact 19. The strip and the contact 19 are connected respectively to the ends of the resistance 14 so that when they are in engagement with each other the resistance is short-circuited and when the contact is broken the resistance is cut in circuit. To reduce the spark produced by the make-and-break of the contacts I may use a condenser 20 or some other suitable means.

In case the voltage at the end of the feeder line is too high, the magnet 16 will pull the stretched strip away from its coöperating contact 19, thereby cutting the resistance 14 in series with the winding 13, and so reducing the magnetizing force of this winding, which in the present instance is supposed to act in conjunction with the series winding 12. The voltage of the booster therefore falls, and as this fall in voltage is reflected back to the magnet 16, the reduced strength of the magnet permits the strip to recede and engage the contact 19, thereby short-circuiting the resistance 14, thus increasing the current in the winding 13, and so causing the voltage of the booster to rise. In actual service it is found that the armature of the magnet 16 keeps up a rapid and constant vibration, thereby maintaining a practically constant voltage at the end of the feeder.

In case the shunt winding 13 is connected so as to act in opposition to the series winding, which condition of affairs is represented in its results by Fig. 2, the contacts controlled by the magnet 16 should be such as to short-circuit the resistance 14 upon rise in voltage instead of opening the short circuit about the resistance. In this case the contact 19 should be placed on the opposite side of the strip 15 so as to be engaged by a portion of the strip when the latter is attracted by the magnet 16.

In some instances I find it desirable to vary the operation somewhat from that described. Thus in Fig. 4, which represents only such a portion of the system as may be necessary to explain the arrangement, the vibrating armature, which may consist of a flexible strip of magnetic material 21 fixed at one end and free to vibrate at the other, operates in conjunction with two fixed but adjustable contacts 22, 23. The armature 21 is connected to the junction between the shunt winding 13 and the resistance 14, while the two contacts 22 and 23 are connected respectively to the remaining terminals of the resistance 14 and the winding 13. If the winding 13 be arranged to act in conjunction with the series winding 12, then the armature 21 and the contact 22 are arranged to engage each other when the voltage of the system is below normal. When the voltage rises above normal, the armature 21 is attracted by the magnet 16, thereby engaging the other contact 23, thus opening the circuit about the resistance 14 and closing a shunt circuit across the winding 13. This

shunt circuit contains a resistance 24 and diverts current from the winding, thus still further weakening its magnetizing effect. This arrangement permits the use of a smaller amount of resistance 14 than in the arrangement in Fig. 1, and also is subject to less sparking at the contacts.

Fig. 5 differs from Fig. 4 only in that it represents the arrangement of parts when the auxiliary or shunt winding 13 acts in opposition to the series winding 12. In this case the shunt circuit containing the resistance 24 is closed about the winding 13 when the voltage of the system is below normal. The lesser opposition of the shunt winding therefore permits the series winding to bring the voltage of the booster immediately up, whereupon the controlling magnet 16 operates, thereby opening the shunt circuit about the winding and closing the short circuit across the resistance 14, the effect of which is to produce an immediate and vigorous increase in the demagnetizing effect of the winding 13, thereby checking the rise in voltage of the booster and causing it to decrease until it is again below normal. This operation takes place so rapidly and the range of variation of voltage is so small that no perceptible variation of voltage is observed upon the system, the voltage being maintained practically constant regardless of the load.

Though I have described my invention in connection with boosters for electric circuits, it will be readily understood that as to many of its features it is in no wise limited to use in this one connection, but is capable of many and diverse applications.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The combination of a source of current, mains extending therefrom, a feeder also extending therefrom, a series-wound booster in said feeder, and means for regulating the voltage of the feeder, controlled by the voltage of the feeder, by controlling the field-excitation of the booster.

2. The combination of a source of current, mains extending therefrom, a feeder also extending therefrom, a series-wound booster in said feeder, an auxiliary winding on said booster, and means controlled by the voltage of the feeder to be regulated for varying the magnetizing force of said winding.

3. The combination of a source of current, mains extending therefrom, a feeder also extending therefrom, a series-wound booster in said feeder, an auxiliary winding on said booster, and means controlled by the voltage to be regulated for varying the current in said winding.

4. The combination of a series wound booster, an auxiliary winding on said booster, a resistance associated with said winding, a make-and-break contact device connected to said resistance, and a magnet for actuating said make-and-break contact device.

5. The combination of a series wound booster, a supplemental winding thereon, a resistance in series with said winding, and means for rapidly making and breaking a shunt circuit about said resistance.

6. The combination of a source of current, mains extending therefrom, a feeder also extending therefrom, a series wound booster in said feeder, an auxiliary winding on said booster, and means for regulating the flow of current in said winding in response to variation of the voltage at some point of the system from normal.

7. The combination of a source of current, mains extending therefrom, a feeder also extending from said source of current, a series wound booster in said feeder, an auxiliary winding on said booster, and means for regulating the current flowing through said winding so as to cause the booster to preserve a substantially constant electromotive force at some point of the system.

8. The combination of a dynamo-electric machine, a resistance in series with the field winding of said machine, and means for alternately shunting said resistance and said field winding.

9. The combination of a dynamo-electric machine, a resistance in series with a field winding thereon, and a vibrating contact device for alternately shunting said resistance and said winding.

10. The combination of a source of current, a booster or regulating generator in circuit therewith so as to combine its voltage with that of said source to produce a resultant voltage, a winding on said booster, a resistance in circuit with said winding, and means responsive to said resultant voltage for rapidly opening and closing a shunt circuit about said resistance.

In witness whereof I have hereunto set my hand this first day of July, 1902.

WILLIAM F. DAWSON.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.