W. I. THOMSON.

VOLTAGE REGULATOR.

APPLICATION FILED APR. 15, 1905.

960,734. Patented June 7, 1910.

Fig. 1.

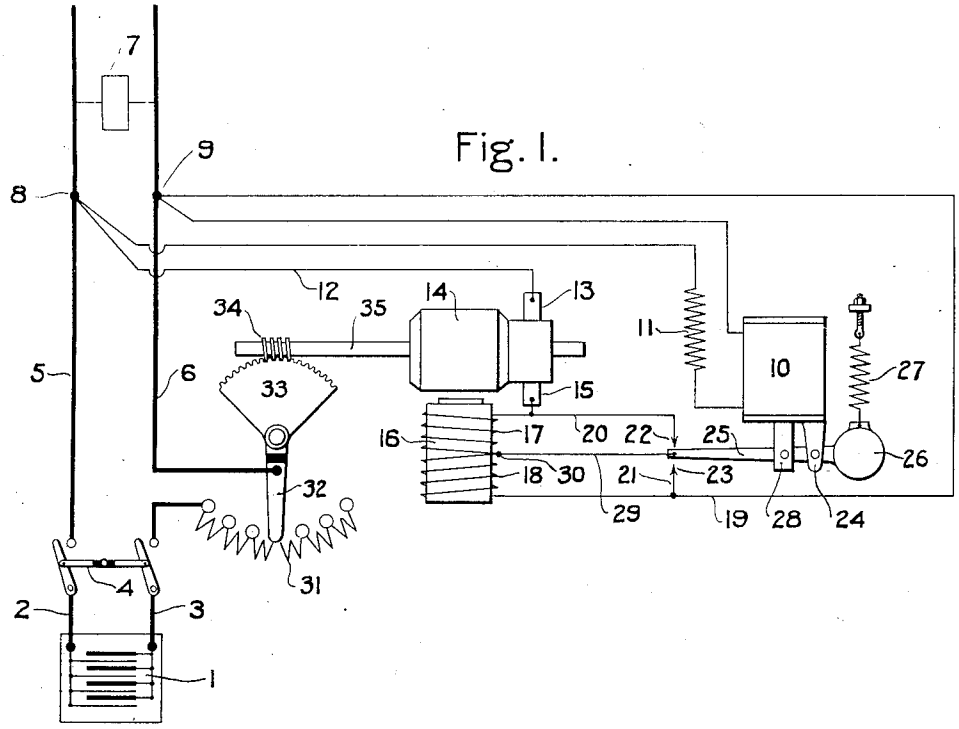
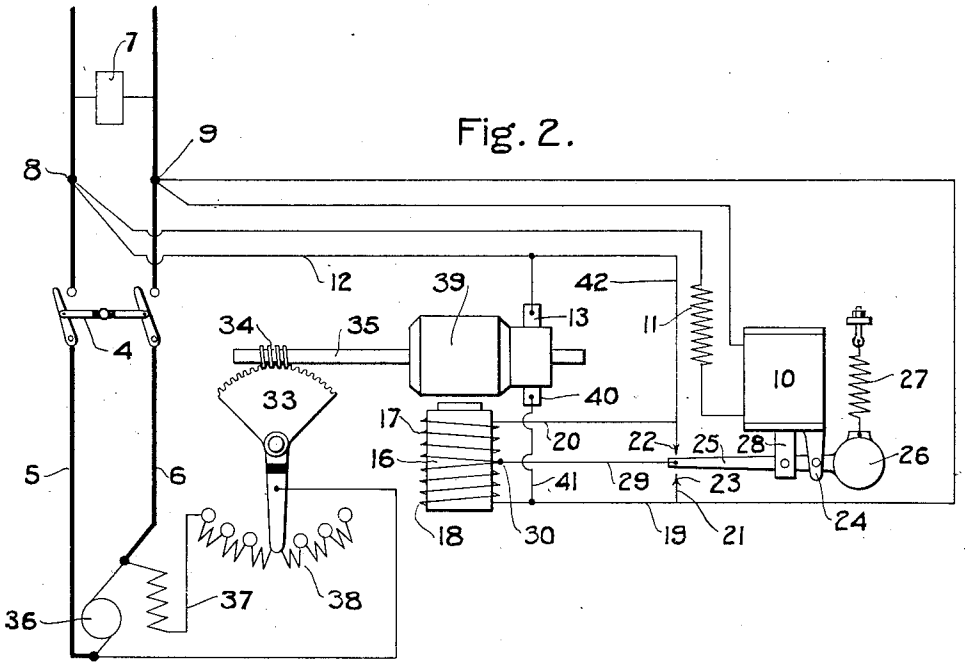


Fig. 2.



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VOLTAGE-REGULATOR.

960,734. Specification of Letters Patent. Patented June 7, 1910.

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To all whom it may concern:

Be it known that I, WILLIAM I. THOMSON, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Voltage-Regulators, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to electrical apparatus.

One of the objects thereof is to provide simple and practical means adapted to maintain a substantially constant potential difference between two points in an electric circuit.

Another object is to provide means of increased efficiency and durability adapted to reverse the direction of rotation of a motor armature with a constant direction of current in an external circuit connected therewith, or to reverse the direction of current in an external circuit connected with a generator having a constant direction of rotation of the armature thereof.

Another object is to provide durable and practical means for reversing the field of a dynamo.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements and arrangement of parts which will be exemplified in the apparatus and devices hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, wherein are shown two of various possible embodiments of certain features of my invention: Figure 1 is a diagrammatic view of one of the same in connection with a series wound dynamo. Fig. 2 is a similar view showing another of the same applied to a shunt wound dynamo and showing the use of another form of current-supplying means. Similar reference characters refer to similar parts throughout the several views.

As tending to conduce to a better understanding of certain features of my invention, it may here be noted that the regulation of voltage across the mains of an electric circuit is difficult of practical accomplishment, as, on account of the tendency of certain regulating devices to over-regulate and the necessity of providing apparatus which will be automatic in action, in order to do away with constant supervision, and of simple and durable construction so as to stand the almost constant action to which they are subjected without injury to or derangement of the several parts. It may also here be noted that I have found that if it be attempted to regulate voltage by means of an intermittently operative electro-motor, it is difficult to reverse the same without harmful arcing at the point at which the circuit is broken. The above and other defects are remedied in constructions of the nature of that hereinafter described.

Referring now to the drawings, there is shown in Fig. 1 a battery 1, herein represented as of the secondary or storage type, having its leads 2 and 3 respectively connected, as by means of the double-pole switch 4, with the mains 5 and 6. Between these mains are bridged any desired form of current-utilizing devices 7, the same not being shown in detail, as they form no part of the present invention. At certain points 8 and 9 upon these mains between which it is desired that a constant voltage be maintained, is bridged a magnet 10 in series with a resistance 11 of such proportions as to cause the field of the magnet to vary in strength substantially in accordance with the variations in potential difference between these points. Leading from point 8 is a conductor 12, which terminates upon a brush 13 of a dynamo, in this case motor, 14. It may here be noted that the term "dynamo" is used throughout this specification and the following claims in its generally accepted broad sense as denoting either a generator or a motor. The opposite brush 15 of the motor 14, assuming the same to be a bi-polar machine, is connected with a series-wound field magnet diagrammatically represented at 16. This magnet is provided with two windings 17 and 18, so formed as to be differential in magnetic effect when serially traversed by an electric current. Winding 18 terminates in a conductor 19 leading to the point 9 upon the main 6. A pair of short conductors 20 and 21 lead respectively from the conductor 19 and brush 15 to the spaced contacts 22 and 23 for a purpose hereinafter explained.

Pivotally mounted as upon a lug 24 formed

adjacent magnet 10 is a lever 25 counterbalanced at 26 and flexibly held in its desired normal position as by means of an adjustable spring 27. Jointed to this lever at a point adjacent lug 24 is a movable core 28 controlled in position by the field of magnet 10. Lever 25 is positioned at its free end between the contact points 22 and 23 and is in electrical connection, as by conductor 29, with the point 30 upon the field magnet at the junction of the two windings thereof.

Positioned within the main 6 is a variable resistance 31, the circuit through which is completed by means of a pivotally mounted arm 32 having formed thereon a toothed sector 33 intermeshing with a worm 34 fixed upon the shaft 35 of the motor.

It may here be noted that the term "disturb" is used throughout this specification and the following claims in connection with a balanced condition to denote an action by reason of which one of the previously balanced factors exceeds the other.

The operation of the above-described embodiment of my invention is as follows: Assuming that switch 4 is closed and that the potential difference between the points 8 and 9 is of the desired magnitude, the resistances and parts are so proportioned as to cause the field of magnet 10, together with the weight of counterbalance 26 exactly to neutralize the effect of the spring 27 and the combined weight of core 28 and pivoted lever 25, thus holding the free end of the lever positioned at a point intermediate the contacts 22 and 23. In this condition of affairs the current passes from point 9 through conductor 19 and the two windings of the field of motor 14 in series, each winding thus neutralizing the effect of the other, thence through the armature of the motor and by means of the conductor 12 to the point 8. In this condition, the motor armature is stationary owing to the fact that the strength of the field is practically zero. Assuming now that there is a tendency to a drop in voltage between the points 8 and 9, there will be a consequent decrease in the field strength of magnet 10, permitting the lever 25 to swing into engagement with the contact 23. Winding 18 of the motor field is thus shunted through the conductors 21 and 29 and, on account of the marked excess of current thus thrown through the winding 17, the field of the motor is excited to such an extent as to cause the rotation of the armature thereof in a direction determined by the polarity of this field. It may be here noted that the starting of the motor is rendered more certain with the series winding here shown, owing to the substantial cutting out of the resistance of winding 18 with a consequent increase in current flow through the armature. The starting of the motor 14, caused as above-described, is in such direction as to cut down the variable resistance 31 with a consequent decrease in the potential drop along main 6 between the switch 4 and the point 9, thus increasing the voltage between points 8 and 9. When this state of affairs has been reached, the field of magnet 10 is built up to such an extent as to draw the lever 25 away from contact 23, thus breaking the shunt about winding 18 and again neutralizing the field of the motor and cutting down the current through the armature thereof. If, on the other hand, the voltage across the mains becomes excessive, the increase in field strength of magnet 10 will cause the shunting of winding 17 with a consequent starting of the motor in a direction opposite to that above-described, on account of the opposite polarity of the field, and result in the cutting in of additional resistance 31 and the reduction of the voltage between the points 8 and 9 to the desired standard. It will thus be seen that I have provided apparatus well adapted to accomplish the objects of my invention and that this apparatus is of simple and inexpensive construction and yet is positive and efficient in action. The motor 14 is driven only during the abnormal condition of the voltage across the mains and is instantly and automatically stopped upon this voltage being brought to the desired standard, thus avoiding any tendency to over-regulation. Moreover, as the motor is reversed without any complete break of an electric circuit, the sparking at the contact points is insignificant and the attention required to maintain the same in a state of the highest efficiency correspondingly small.

In Fig. 2 is shown a slightly different embodiment of certain features of my invention in which the mains are supplied by a generator 36 having serially connected with its field winding 37 a variable resistance 38 controlled by means similar to those above-described. Across the points at which regulation is desired is bridged a voltage-controlled switch substantially identical with that previously set forth. The motor 39, however, controlling the position of the pivotally mounted resistance varying arm is of the shunt type and the brush 40 is consequently connected directly to conductor 19 by means of conductor 41, whereas the winding 17 has a direct connection, as by conductor 42, with the conductor 12.

The operation of this embodiment of my invention is similar to that above-described, the reversing of motor 39 being accomplished by the shunting of one of the differential windings of the fields thereof and the direction of rotation being determined by the field-winding shunted. Arm 32, by cutting in or out the variable resistance, weakens or strengthens the field of generator 36, with a consequent decrease or increase of the

output thereof, thus bringing the potential across the mains to the desired point.

Many of the advantages of the embodiment first described are inherent in that later set forth.

As many changes could be made in the above construction and many apparently widely different embodiments of my invention could be made without departing from the scope thereof, I intend that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I desire it also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein-described and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is:—

1. In voltage regulating apparatus, in combination, a source of current, a current utilizing device bridged across the mains of said source of current, a voltage-controlled magnet bridged across said mains in parallel with said current utilizing device, a variable resistance device operatively related to said source of current to vary the voltage across said mains, a motor having a rotary armature connected to said variable resistance device to operate the same, said motor being constantly connected across said mains and having a pair of opposing field windings, a movable contact connected to said field between said windings and provided with means controlling its position in accordance with the field strength of said voltage-controlled magnet, and a pair of contacts respectively connected with the outer ends of said windings and normally free from said movable contact and adapted alternatively to make connection therewith whereby said field windings are alternatively short-circuited in accordance with variations in the field strength of said voltage-controlled magnet.

2. In voltage regulating apparatus, in combination, a source of current, a current utilizing device bridged across the mains of said source of current, a voltage-controlled magnet bridged across said mains adjacent said current utilizing device, a variable resistance device operatively related to said source of current to vary the voltage across said mains, a motor having a rotary armature connected to said variable resistance device to operate the same, said motor being constantly connected across said mains and having a pair of opposing field windings, a movable contact connected to said field between said windings and provided with means controlling its position in accordance with the field strength of said voltage-controlled magnet, and a pair of contacts respectively connected with the outer ends of said windings and normally free from said movable contact and adapted alternatively to make connection therewith whereby said field windings are alternatively short-circuited in accordance with variations in the field strength of said voltage-controlled magnet, said movable contact being pivotally mounted and counter-balanced to eliminate the effect of jarring.

In testimony whereof I affix my signature, in the presence of two witnesses.

WILLIAM I. THOMSON.

Witnesses:
A. C. MOORE,
C. H. MCCORMICK.