J. H. HALL.

ELECTRIC CONTROLLER.

APPLICATION FILED JULY 27, 1911. RENEWED OCT. 19, 1912.

1,053,501. Patented Feb. 18, 1913.

2 SHEETS—SHEET 1.

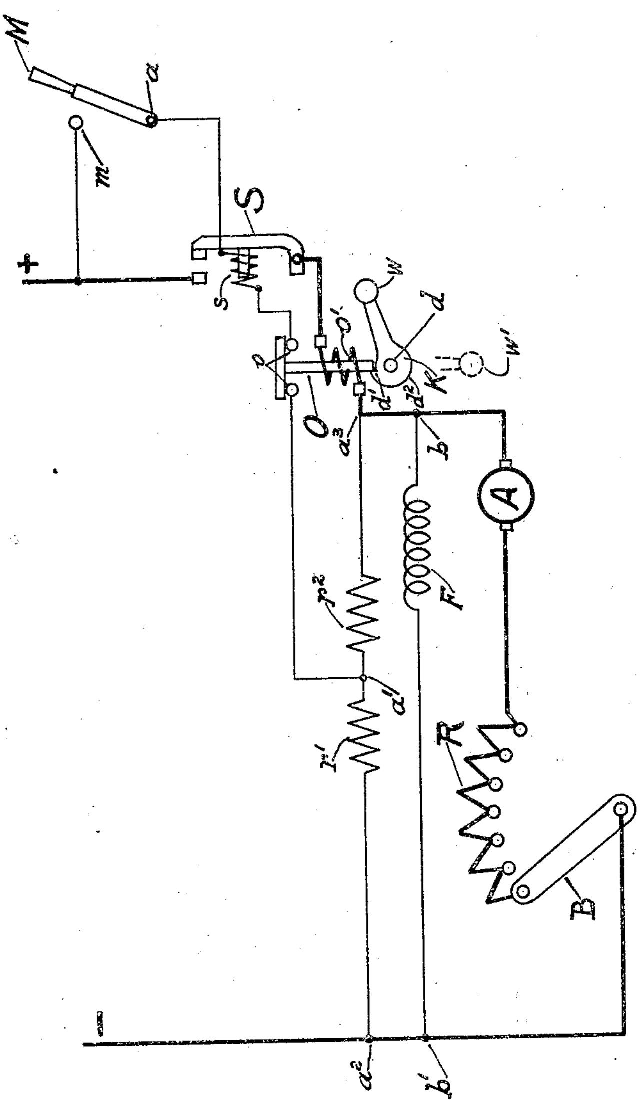

Fig. 1

WITNESSES

Alice E. Duff

Elva Stanick

INVENTOR

Jay H. Hall

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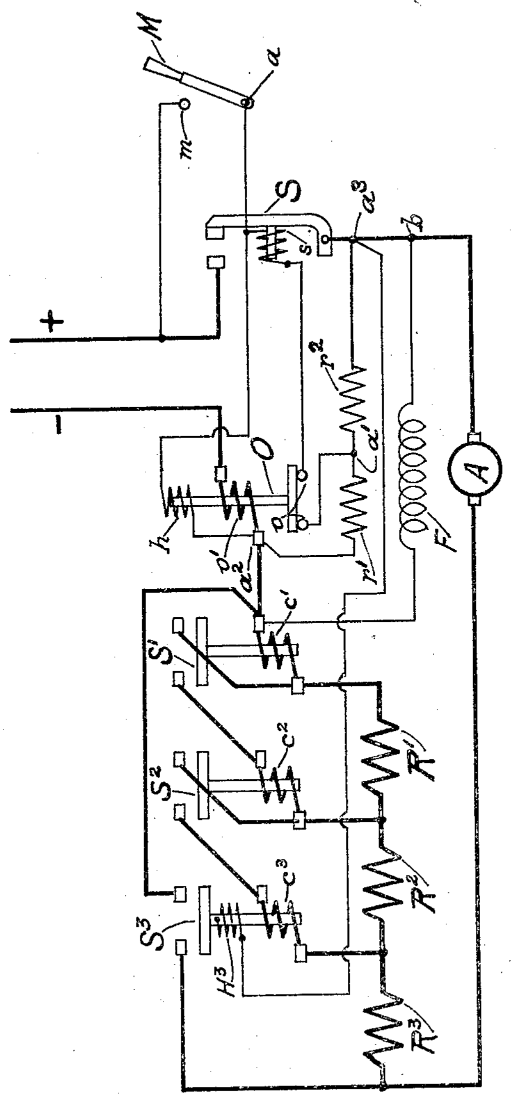

Fig. 2

WITNESSES

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UNITED STATES PATENT OFFICE.

JAY H. HALL, OF CLEVELAND, OHIO, ASSIGNOR TO THE ELECTRIC CONTROLLER AND MANUFACTURING COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

ELECTRIC CONTROLLER.

1,053,501. Specification of Letters Patent. **Patented Feb. 18, 1913.**

Application filed July 27, 1911, Serial No. 640,929. Renewed October 19, 1912. Serial No. 726,808.

To all whom it may concern:

Be it known that I, JAY H. HALL, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented new and useful Improvements in Electric Controllers, of which the following is a specification.

My invention relates to electric controllers in which magnetically-operated switches are used to control electric circuits.

More particularly, it relates to such controllers in which an overload device is used to cause the circuit to be opened at one of these magnetically-operated switches when the current in the circuit becomes too large.

It is well known that the amount of current in the winding of a magnetically-operated switch must be greater to operate the switch than to hold it in its operated position; and it is, therefore, desirable to decrease the amount of current in the winding after the switch has operated, as this reduces the heating of the winding and also reduces the consumption of current.

One of the objects of my invention is to cause automatically the decrease in current in the winding of a magnetic switch upon the closure of the main contacts of the switch.

Another object of my invention is to provide an overload device which shall cause the opening of the motor circuit when the current therein reaches a dangerous value, and necessitates the intervention of the operator to restart the motor after the device has operated.

In the accompanying drawings, Figures 1 and 2 are diagrams showing two ways of obtaining the above mentioned results.

Referring to Fig. 1, A indicates the armature of the motor to be controlled, and F the shunt field thereof; R is any suitable starting resistance which is gradually cut out by the movement of an arm B. The motor circuit is completed by the operation of the main switch S actuated by the energization of the winding s. The circuit of the winding s extends from the point a on the master switch M through the winding s, the contacts o of the overload relay O to the point a' between the two resistances r' and r^2. There the circuit divides, one branch extending from the point a' through the resistance r' to the negative; the other branch extending through the resistance r^2 to the point a^3 in the motor circuit between the winding o' of the overload relay O and the armature A. The overload relay is shown at O operated by the winding o' which is in the motor circuit and responds to an excess of current therein. In normal operation, the contacts o are closed; and when an excess of current occurs the relay O opens said contacts. K is a detent normally held in the position shown in Fig. 1 by the tooth or shoulder d' which engages the lower end of the plunger of the relay O. When released, the detent rotates freely around the stud d under the action of a weight w. The plunger when released rests on the surface d^2 of the detent which is farther from the stud d than that portion of the detent on which the plunger normally rests.

The operation of this controller is as follows: To start the motor the operator closes the master switch M, thus establishing an actuating circuit from the positive through the contact m, through the point a, the winding s of the switch S, and the contacts o on the overload relay O to the point a'; there the current follows two parallel paths, one of which leads through the resistance r' to the negative and the other of which leads through the resistance r^2 to the point a^3, the armature A, the resistance R, and the arm B to the negative. The current in this circuit causes the main switch S to close its contacts, whereupon the motor circuit is established from the positive, through the switch S, the winding o', the armature A, the starting resistance R, and the arm B to the negative. Current flows through the shunt field from the point b through the field F to the negative at b'. The motor then starts at minimum speed and is accelerated by gradually cutting out the starting resistance R. The operation of the switch S also changes the relation of the winding s to the resistance r' and r^2, because the point a^3 being now positive, it follows that s and r^2 are connected in parallel and both in series with r'. From the positive the current follows two paths: one through the coil s and one from the point a^3 through the resistance r^2; the two paths reunite at a' and the circuit extends to the negative through the resistance r'. The effect of this change is to reduce the current through the coil s. It is not necessary that the circuit from the point a^3 be completed to the negative through the motor armature for the winding s to close the switch S. In this case the current through the winding s and the resistance r' must be great enough to close the switch. As soon as the contacts of the switch close, however, the resistance r^2 is connected as a shunt around the winding s, thereby reducing the current therein. The relay O is adjusted to operate whenever the current in the motor circuit reaches a certain value which is the maximum that should be permitted to flow in the motor circuit. The energization of the winding o' is then sufficient to lift the relay O, which has two effects; first it opens the contacts o, thereby breaking the circuit through the coil s and causing the main switch to drop to the open position, whereupon the motor is cut off from the source of supply and stops; second, it releases the detent K which is rotated by the weight w falling to the position w', whereby the relay O is positively prevented from closing its contacts o after its operating winding o' is deënergized. This in turn prevents further operation of the main switch S by manipulation of the master switch M. Before the motor can be started again it is necessary that the operator restore the detent K to its running position, whereupon the relay O will drop and bridge the contacts o, making everything ready for another operation of the controller.

In the controller disclosed in Fig. 2, the starting resistance is shown divided in sections R′, R², R³, respectively, short-circuited by the switches S′ S², and S³. The operating windings c' c^2, c^3 of these switches are energized by the current in the motor circuit. The resistance controlling switches S′, S², S³ are of that type of switches described in H. R. Canfield's applications, Serial Number 583,000, filed September 21, 1910, and Serial Number 604,331, filed January 23, 1911, and in Eastwood's Patent, No. 1,040,292, granted October 8, 1912. In these applications and in this patent particularly in Fig. 2, the switches have the peculiar characteristic of locking to the open position when the current in their operating windings is above a certain predetermined limit and of closing their contacts when the current is reduced below said limit. The motor circuit is established by the operation of a main switch S which is provided with an actuating circuit extending from the point a on the master switch M through the coil s, and the contacts o normally bridged by the overload relay O to the point a' where it divides, one branch leading through the resistance r' to the negative at the point a^2, the other branch leading through the resistance r^2 to the point a^3 between the main switch and the armature A. O is the overload relay provided with the operating winding o' in the motor circuit and the holding winding h, the purpose of which is to keep the overload relay lifted after it has operated and the motor is cut off from the source of supply.

The operation of this controller is as follows: To start the motor, the operator closes the master switch M, establishing an actuating circuit from the positive through the master switch M, the winding s, and the contacts o on the overload relay to the point a', where the circuit divides, one branch extending through the resistance r' to the point a^2, the other branch extending through the resistance r^2 to point a^3, and thence through the armature A, the resistances R³, R², R′, and the winding c' to the point a^2, where the two branches reunite and are connected to the negative through the winding o'. The energization of the winding s causes the switch S to close its contacts, whereupon the motor circuit is completed, current flowing from the positive through the switch S, the armature A, the resistances R³, R², R′, the operating winding c' of the switch S′, and the operating winding o' of the overload relay O to the negative. The current in the motor circuit being limited only by the starting resistance, the first resistance switch S′ is locked to the open position until, due to the acceleration of the motor, the current in the winding c' decreases to that value at which the switch S′ is adjusted to operate. Then the switch S′ will close its contacts, short-circuit the resistance section R′ and connect the operating winding c^2 of the switch S² in the motor circuit. The short-circuiting of the resistance section R′ causes a rush of current which locks the switch S² to the open position till the speed of the motor increases sufficiently for the current to diminish to that value at which the switch S² is adjusted to operate. At that moment the switch S² will close its contacts, short-circuit the resistance section R², and connect the operating winding c^3 of the switch S³ in the motor circuit. Likewise the last resistance switch S³ will first lock out and then close its contacts and short-circuit the last resistance section R³. The motor now runs at full speed and its circuit is traced from the positive through the switch S, the armature A, the contacts of the switch S³, and the winding o' to the negative. It will be seen that the operation of the switch S³ short-circuits the windings c', c^3, and c^3. Consequently, the switches S′ and S² drop to the open position, and the switch S³ would drop too, were it not for the holding winding H³ which is energized as soon as the switch S³ has closed its contacts, the holding circuit being traced from the point a^3 through the holding winding H^3, the bridging piece of the switch S^3, and the contacts thereof to the negative. The switch S^3 is, therefore, held closed by the energization of the winding H^3. As soon as the switch S closes its contacts the resistance r^2 is connected in parallel with the coil s, current flowing from the positive through the master switch M, the coil s, the contacts o to the point a', and from the point a^3 through the resistance r^2 to the point a', where the two branches unite and the circuit further extends through the resistance r' and through the winding o' to the negative. As in the case of Fig. 1, this reduces the current in the winding s and the heating therein. The shunt field circuit is traced from the point b through the field F and through the winding o' to the negative. When an overload occurs the overload relay O is operated and opens its contacts o, thereby deënergizing the winding s of the main switch S and causing the said switch to open its contacts, which in turn opens the motor circuit. The holding winding H^3 of the switch S^3 is also deënergized and the said switch drops to the open position, but the overload relay is maintained in the open position by the holding circuit which extends from the positive through the contact m on the master switch, the winding h of the relay O, and the operating winding o' thereof to the negative. The winding h is not strong enough to operate the overload relay, but it is able to hold the said relay in the open position after it has been operated. Consequently, the operator must open the master switch M in order to deenergize the winding h, thus allowing the overload relay O to again close its contacts o, in order that the controller may be ready for another operation. To stop the motor the operator opens the switch M, whereupon the coil s, is deënergized and the switch S drops to the open position, thereby opening the motor circuit.

I have shown my invention applied to the control of a shunt wound motor, but it will be evident to those skilled in the art that it may be as readily applied to the control of a series or compound wound motor, and, that with the addition of reversing switches, a reversible motor may be controlled by the means disclosed in this specification. My invention may also be applied to any circuit which it is desired to control.

I claim—

1. In an electric controller, a resistance, a magnetically-operated switch, means connecting the winding of the switch to a source of supply in series with the resistance, a second resistance, means including the contacts of the switch when it closes for connecting the second resistance in parallel with the winding and in series with the first resistance, and means for opening the circuit of the winding when the current through the switch is too large.

2. In a controller, a circuit, a magnetically-operated switch in the circuit, a resistance, means connecting the winding of the switch in series with the resistance, means connecting a shunt around the winding to control the current therein upon closure of the switch, and an overload device for opening the circuit of the winding.

3. In a controller, a circuit, a magnetically-operated switch in the circuit, a resistance, means connecting the winding of the switch in series with the resistance, means connecting a shunt around the winding to control the current therein upon closure of the switch, an overload device for opening the circuit of the winding, and means for holding the said device in its operated position.

4. In an electric controller, a resistance, a magnetically-operated switch, means for connecting the winding of the switch to a source of supply in series with the resistance, a shunt connected around the winding upon closure of the switch thereby controlling the current in the winding, an overload device for deënergizing the winding of said switch, and means for maintaining said winding deënergized.

5. In an electric controller, two resistances, a magnetically-operated switch, a winding therefor, means for connecting the winding in series with the two resistances in parallel for closing the switch, and for subsequently connecting one of the resistances in parallel with the winding.

6. In an electric controller, two resistances, a magnetically-operated switch, a winding therefor, means for connecting the winding in series with the two resistances in parallel for closing the switch, and for connecting one of the resistances in parallel with the winding upon closure of the switch, and an automatic switch for deënergizing said winding.

7. In an electric controller, a resistance, a circuit a magnetically-operated switch for closing the circuit, means connecting the winding of said switch in series with the resistance for closing the switch, a second resistance adapted to be connected in shunt with the winding to control the current therein when the switch is closed, and means for decreasing the current in said winding when the current in said circuit is above a predetermined value.

8. In a motor control system, a motor, a circuit therefor, a magnetically-operated switch in the circuit, two resistances, means connecting the winding of the switch in a circuit containing the two resistances in parallel, a crcuit including one of the resistances and the contacts of the switch for reducing the current in the winding, and contacts in

the circuit of the winding opened when the current in the motor circuit exceeds a predetermined value.

9. In a motor control system, a motor, a circuit therefor, a magnetically-operated switch in the circuit, two resistances, means connecting the winding of the switch in a circuit containing two resistances in parallel, a circuit including one of the resistances and the contacts of the switch for reducing the current in the winding, contacts in the circuit of said winding opened when the current in the motor circuit exceeds a predetermined value, and means for maintaining the contacts open.

10. In a motor control system, a motor, a circuit therefor, a magnetically-operated switch for the circuit, a winding therefor, two resistances associated with the winding, and means connecting the winding in a circuit with the two resistances in parallel to close the switch, the closure of the switch causing one of the resistances to be connected in circuit with the winding and the other resistance in parallel therewith.

11. In an electric motor control system, a motor, a circuit therefor, a magnetically-operated switch for the circuit, a winding therefor, two resistances associated with the winding, means connecting the winding in a circuit with the two resistances in parallel to close the switch, the closure of the switch causing one of the resistances to be connected in a circuit with the winding and the other resistance in parallel therewith, and an automatic switch for deënergizing the winding of the switch upon an abnormal condition in the motor windings.

12. In a motor control system, a motor, a circuit therefor, a main switch for closing the circuit, an operating winding therefor, an actuating circuit including the winding and divided into two branches, a resistance in each branch, one of the resistances being adapted to be connected in parallel with the operating winding upon closure of the main switch, a master switch for controlling the actuating circuit, contacts in the actuating circuit, and means responding to an excess of current in the motor circuit for opening the contacts.

13. In an electric motor control system, a motor, resistances therefor, means for controlling the resistances, a main switch, an operating winding therefor, an actuating circuit including the winding and divided into two branches, a resistance in each branch, one of the latter resistances being adapted to be connected in parallel with the operating winding to control the current therein upon closure of the main switch, a master switch for controlling the actuating circuit, contacts in the actuating cricuit, an overload relay adapted to open the contacts upon an excess of current in the motor, and means for preventing the overload relay from closing the contacts after it has operated.

14. In an electric motor control system, a motor, a circuit therefor, resistances therefor, switches for controlling the resistances, operating windings for the switches energized by current in the circuit, a main switch, an operating circuit therefor, a master switch for controlling the circuit, contacts in the circuit, means responding to an excess of current for opening the contacts, and a holding winding for holding the contacts in the open position.

Signed at Cleveland, Ohio, this 21st day of July, A. D. 1911.

JAY H. HALL.

Witnesses:
HENRY L. ASSET,
H. M. DIEMER.