No. 870,029. PATENTED NOV. 5, 1907.

J. H. HALL.

SYSTEM OF MOTOR CONTROL.

APPLICATION FILED MAR. 19, 1906.

2 SHEETS—SHEET 1.

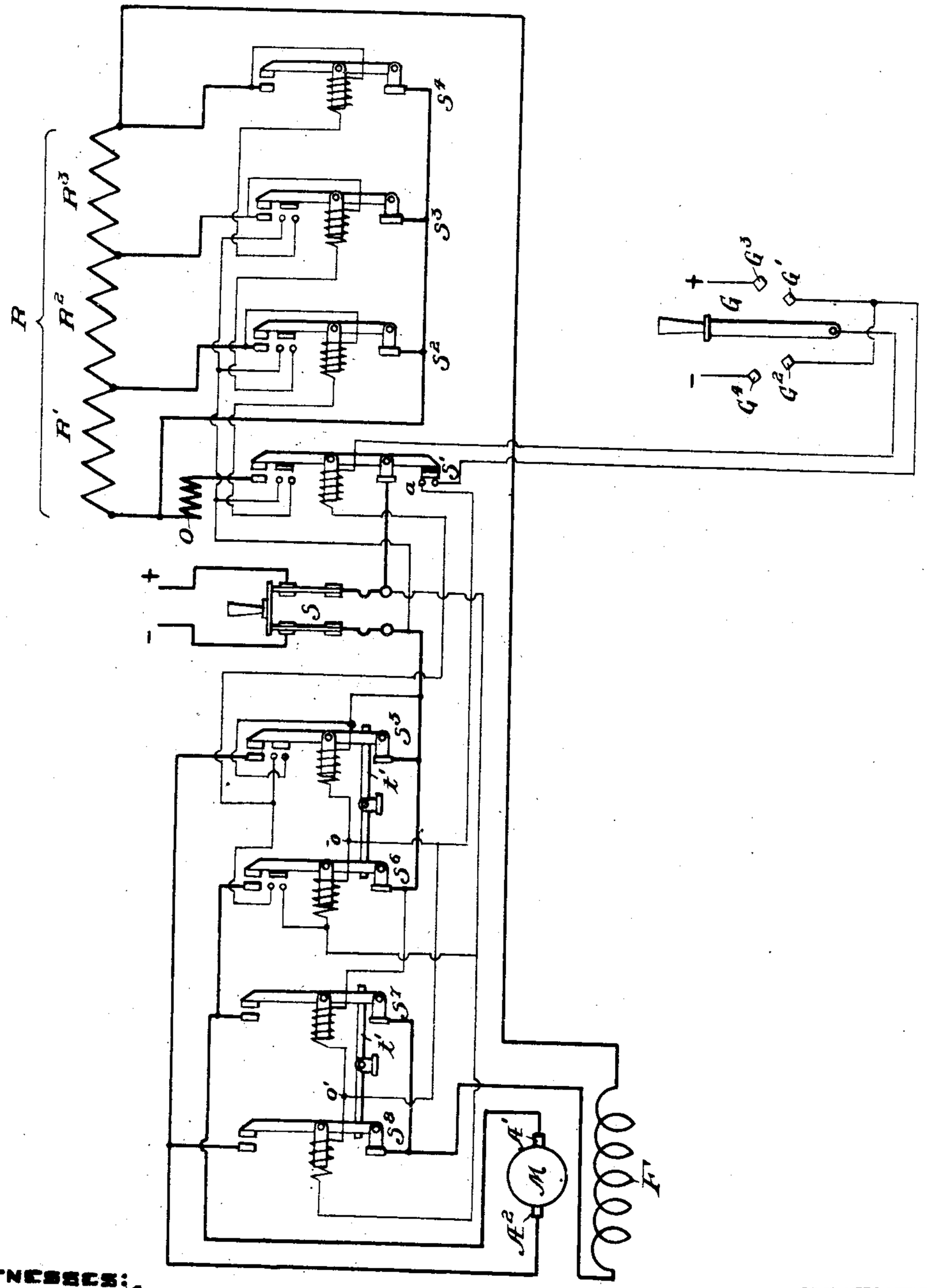

Fig. 1.

WITNESSES:

J. R. Hoffman,

Elva Stanick

INVENTOR

Jay H. Hall,

by Pierce & Barber,

ATTORNEYS

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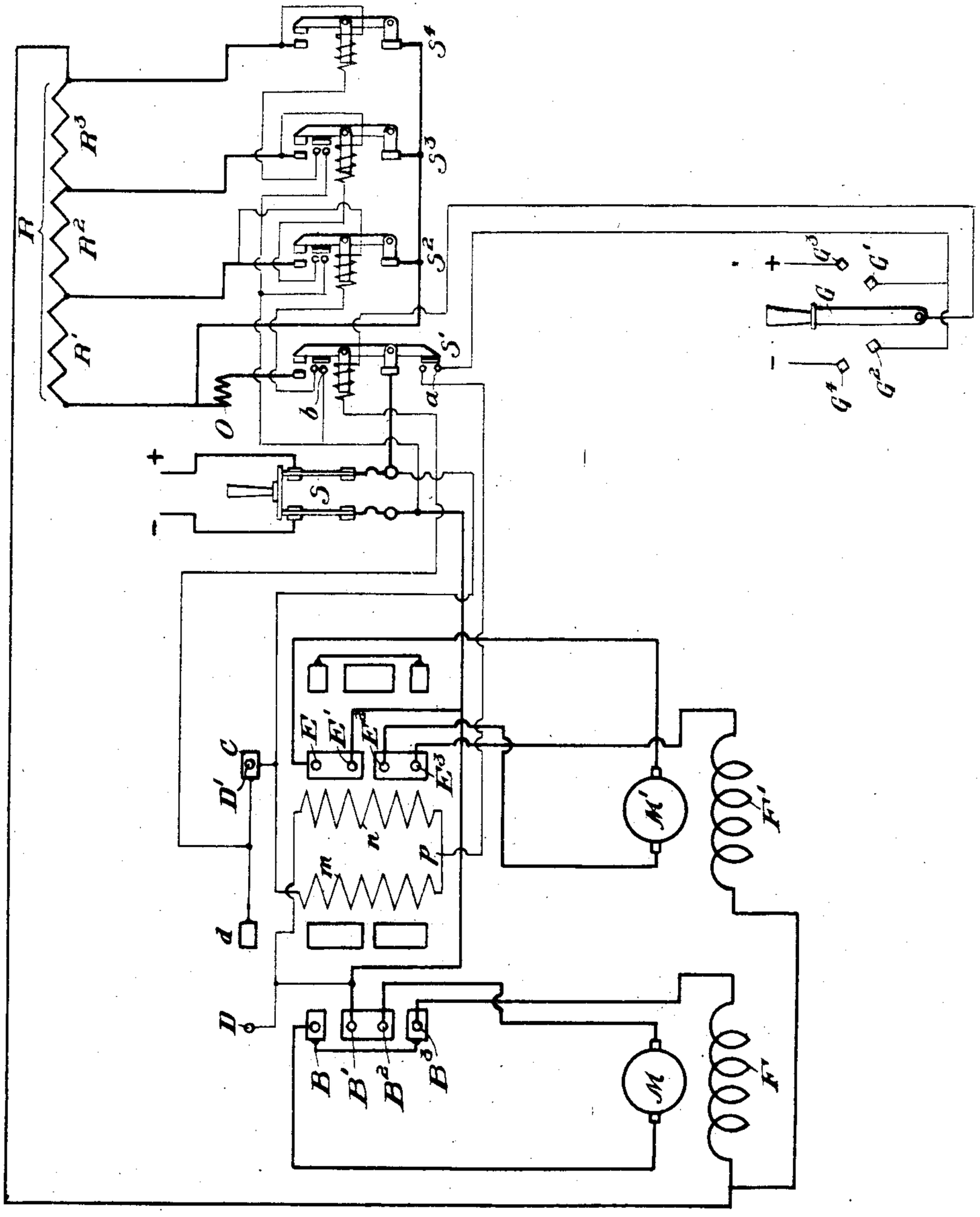

FIG. 2.

WITNESSES:

J. C. Hepleman,

Elva Stanicek

INVENTOR

Jay H. Hall,

by Pierce & Baldwin,

ATTORNEYS

UNITED STATES PATENT OFFICE.

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

SYSTEM OF MOTOR CONTROL.

No. 870,029. Specification of Letters Patent. Patented Nov. 5, 1907.

Application filed March 19, 1906. Serial No. 306,757.

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 or discovered new and useful Improvements in Systems of Motor Control, of which the following is a specification.

My invention relates to systems for controlling one or more electric motors from a point distant from them.

The objects of this invention are to provide a system of motor control, using preferably two wires to connect the master-controller with the magnetic controlling mechanism, in which system the motor current is always broken on the first of a series of resistance controlling switches; to cut down the number of operations of the reversing mechanism to a minimum; and to prevent the operation of the reversing mechanism when any current is flowing in the motor circuit. This system is applicable to the control of motors on one or more cars of an electric-railway train, in which all the motors may be controlled from one master-controller and in which but two wires are required to connect such master-controller to the controlling apparatus of each car.

Referring to the drawings which form a part of this specification, Figure 1 is a diagrammatic view of one form of my invention, wherein the reversing switches are of the clapper type; and Fig. 2, a similar view of a second form of my invention, in which the type of reverser is different from that of Fig. 1.

Referring first to Fig. 1, S^1, S^2, S^3, and S^4 represent a series of switches thrown in successively by automatic acceleration in accordance with the principles of Letters Patent No. 772,277, granted to Arthur C. Eastwood. These switches are shown with their fixed contacts connected with the different sections R^1—R^3 of the resistance R in the manner shown in said patent.

The resistance R is connected to one terminal of the field F of the motor M, the other terminal of said field being connected to the switches S^7 and S^8. The switch S^1 is connected to the positive main through the switchs S; and the switches S^2—S^4 are connected to a common wire leading from the wire which joins the resistance section R^1 to the fixed contact for the switch S^1. The switches S^5 and S^6 are connected to the negative main through the switch S. The fixed contacts of the switches S^5 and S^8 are connected to the brush A^2 of the motor M; and the fixed contacts of the switches S^6 and S^7, to the brush A^1 of said motor. It will thus be seen that the motor circuit is, when idle, open at three different groups of switches, one at the switches S^1 to S^4; one at the switches S^5 and S^6; and one at the switches S^7 and S^8. The switches S^5 and S^7 operate in pairs alternately with the switchse S^6 and S^8, the closing of one pair causing the rotation of the motor in one direction, and the other pair, in the opposite direction. An interlocking bar t' is provided between the switches S^5 to S^8 to prevent both members of either pair from closing at the same time. The solenoids of the switches S^5 and S^6 are in series and bridged across the mains; and the solenoids of the switches S^7 and S^8 are also in series and connected across the mains.

The switches S^1—S^3 are provided with a pair of auxiliary contacts, one being connected to the negative main, and the other to the fixed contact of the succeeding switch. The wire connecting the second of the said auxiliary contacts includes the actuating solenoid of said succeeding switch.

The switches S^5 and S^6 each have a pair of auxiliary contacts, one contact of each pair being connected to the solenoid of the switch S^1; the second contact of switch S^5 is connected to the negative main, and of the switch S^6, to the positive main.

O is a blow-out magnet provided for the switch S^1, which is the only switch requiring such a device.

G represents the switch of the master-controller connected to the remaining terminal of the solenoid of the switch S^1.

G^1 and G^2 are two fixed contacts connected to a single wire leading to one of the pair of auxiliary contacts *a* of the switch S^1, the other contact of said pair being connected at *o* to the wires connecting the solenoids S^5 and S^6, and at *o'* to the wire connecting the solenoids S^7 and S^8.

The two parts of auxiliary contacts controlled by the switch S^1 are on opposite sides of the pivot thereof, or otherwise so arranged to insure that both of said pairs will not be bridged at the same instant.

The operation of Fig. 1 is as follows the parts being as shown thereon: If the switch G be moved to bridge the contacts G^1 and G^3, the current from the positive contact G^3 passes in parallel to the solenoid of the switch S^1 and through the auxiliary contacts *a*. From the contacts *a* the current passes to the points *o* and o^1 and through the solenoids of the switches S^5 and S^7 to the negative main, causing these switches to close their contacts. The closing of the switch S^5 also bridges its auxiliary contacts, by which the remaining terminal of the solenoid of the switch S^1 is connected to the negative main and said switch S^1 moved to open the contacts *a* and close its main and other pair *b* of auxiliary contacts. The motor circuit is now closed and may be traced as follows: from the positive pole of the switch S through the switch S^1, the whole of resistance R, the field F, the switch S^7, the brush A^1, the motor M, the brush A^2, and the switch S^5 to the negative pole of the switch S. The other resistance controlling switches will be thrown in automatically as the motor speeds up in a manner well known. If the mas-

ter-controller switch G be now thrown to the off-position, the switch S^1 opens breaking the motor circuit where the blow-out magnet O is provided, and the switches S^2—S^4 immediately open. The switches S^5 and S^7 do not operate because their solenoid windings are connected in series with the solenoid windings of the switches S^6 and S^8, respectively, and the switches S^5 and S^7 remain closed by virtue of the small air-gap in the magnetic circuit, while the air-gap of the switches S^6 and S^8 is comparatively large. If the master-controller switch be moved again to bridge the contacts G^1 and G^3, the switches S^1 to S^4 close by automatic acceleration, starting up the motor in the same direction as before with no movement of the reversing mechanism. If the master-switch G be moved from the off-position so as to bridge the contacts G^2 and G^1 the current flows from the positive main through the switch S, the solenoids of the switches S^6 and S^8, the points O and O′ to the auxiliary contact *a*, the contact G^2, and the switch G to the negative contact G^4. The switch S^1 will be actuated as before, its solenoid circuit being closed through the auxiliary contact of S^6 but the current will flow through the armature M in the opposite direction, the current through the field F not being changed. The motor accordingly rotates in the opposite direction from what it did when the master-switch closed the contacts G^1 and G^3. Whenever the motor is reversed the switch S′ cannot close until the reverser has completed its movement closing the auxiliary contacts which complete the circuit of the solenoid of switch S′. The making of the circuit is therefore confined to the contacts of the switch S′, which is provided with a blowout. If the master-switch be thrown quickly from the contacts G^2 and G^4 to the contacts G^1 and G^3 and the switch S^1 should not for any reason open, the current could not pass to the reversing switch solenoids on account of the auxiliary contacts *a* being open, thereby preventing the possibility of the current being broken on the reversing switch contacts.

Referring now to Fig. 2, the master-controller and the resistance controlling mechanism are the same as in Fig. 1, but the reversing mechanism is of a different type, which I will now describe.

The contact of the pair *a* not connected to the master-controller leads to a point *p* between the solenoids *m* and *n* which, in a well known manner, cause the contact fingers D and B to B^3, and the contact fingers D′ and E to E^3 to contact with certain contact plates as shown, or to contact with certain other contacts, as those to the right of the ones now in contact with the contact fingers.

The solenoid *m* has its remaining terminal connected to the positive main through the switch S and the solenoid *n* has its remaining terminal joined to the negative main through the switch S. The contact finger D is connected to the negative main and the contact finger D′, to the positive main. These are arranged to contact with the plates *d* and *c*, which are connected through a common wire to the solenoid of the switch S^1. The solenoids *m* and *n* are connected in series across the mains.

If the master-switch G be moved to bridge the contacts G^2 and G^4, the current from the positive main will pass through the switch S, the solenoid *m*, the point *p*, and the contacts *a*, to the negative main through the switch G. The solenoid will actuate the reverser so as to move the contact plate into contact with the contact fingers, as shown. As soon as the plate *c* and the finger D′ contact, the circuit through the solenoid of the switch S^1 is closed, the said switch closing its main contacts and its previously open auxiliary contacts *b*, and opening the contacts *a*. The motor circuits are now closed and the switches S^2 to S^4 will be thrown in automatically as in Fig. 1.

The motor circuits may be traced as follows: from the positive main through the switch S, the switch S^1, the resistance R, the field F, the contact fingers B^3 and B, the armature M, and the contact fingers B^2 and B^1 to the negative main. The current also flows from the resistance R through the field F^1, and the contact fingers E^3 and E^2, the armature M^1, and the contact fingers E and E^1 to the negative main.

If the master-switch be moved to close the contacts G^1 and G^3, the current will flow from the master-controller through the contacts *a*, and the point *p*, the solenoid *n*, to the negative main. The solenoid *n* will now cause the contact fingers to contact with the plates to their right. The motor circuits will then be as follows: from the positive main, through the switch S, the resistance R, the field F, the contact fingers B^3 and B^2, the armature M, and the contact fingers B and B^1 to the negative main. The current through the other motor will flow through the field F^1, the contact fingers E^3 and E, the armature M^1, and the contact fingers E^2 and E^1 to the negative main. It is seen that the current through the armature has been reversed, causing a reverse rotation thereof.

If the reverser is as shown in Fig. 2 and the master-switch is moved to the off-position as shown, the reversing mechanism will not move as the solenoids carry equal currents. As in Fig. 1, the reverser cam cannot be actuated until the switch S^1 is open, and when the reverser is operated the switch S^1 cannot close until the operation of the reverser is complete.

By the words main switch, I do not refer to a hand-operated switch, such as the switch S, but to the automatic switch S′ or its equivalent.

I do not restrict myself to the details shown, but include with my invention all mechanism containing the spirit thereof.

I claim—

1. In a system for controlling electric motors, a motor, a magnetically operated main switch therefor, a magnetically controlled reversing mechanism for said motor and an auxiliary switch mechanically opened by the closure of said main switch and mechanically closed by the opening of said switch for preventing the operation of said reversing mechanism while the main switch is closed.

2. In a system for controlling electric motors, a motor, a main magnetically operated switch therefor, a magnetically controlled reversing mechanism for said motor, a master controller, a connecting wire from said master controller to said reversing mechanism, and means whereby the circuit through said wire is broken on the closure of the said main switch and remains broken as long as the main switch is closed and remains closed as long as the main switch is open.

3. In a system for controlling electric motors, a reversing mechanism, a pair of electro-magnets for operating said reversing mechanism, the windings of said pair of electro-magnets being normally connected in series across the supply mains, a magnetically operated main switch, an auxiliary switch opened by the closure of said main switch and closed by the opening of said main switch, and a mas-

ter switch, the connections being such that when the master switch is operated to start the motor in either direction the winding of one of said pair of electro-magnets will be short circuited and the other winding of said pair will be connected directly across the supply mains until said magnetically operated main switch is closed, the closure of the main switch mechanically opening the auxiliary switch and thereby opening the short circuit and disconnecting said winding from the master controller.

4. In a system for controlling electric motors, a motor reversing mechanism, electro-magnets for operating said reversing mechanism, a magnetically operated main switch, and a master switch, said master switch being connected to one end of the winding of the operating coil of said main switch and through an auxiliary switch to the windings of the electro-magnets which operate said reversing mechanism, said auxiliary switch being mechanically interlocked with said main switch in such manner that it is opened by the closure of said main switch and is closed by the opening of said main switch, thus preventing actuation of the reversing mechanism when the main switch is closed.

5. In a system for controlling electric motors, a motor, a main switch therefor, a magnetically controlled reversing mechanism for said motor, a master controller entirely disconnected from the controlling magnets of said reversing mechanism when said main switch is closed, and an auxiliary switch mechanically closed by the opening of said main switch whereby the master controller is connected to said reversing mechanism when the main switch is open.

6. In a system for controlling electric motors, a motor, a main switch, an electro-magnet for closing the same, an electro-magnetically controlled reversing mechanism for said motor, a master controller, two wires leading from the same, one being in circuit with the winding of the electro-magnet of the main switch and the other in circuit with the winding of the electro-magnets of the reversing mechanism when said main switch is open, and means mechanically controlled by the closure of said main switch for entirely opening the circuit between the master controller and the electro-magnets of the reversing mechanism.

Signed at Cleveland, O., this 14th day of March, 1906.

JAY H. HALL.

Witnesses:
A. C. EASTWOOD,
J. E. WELLMAN.