

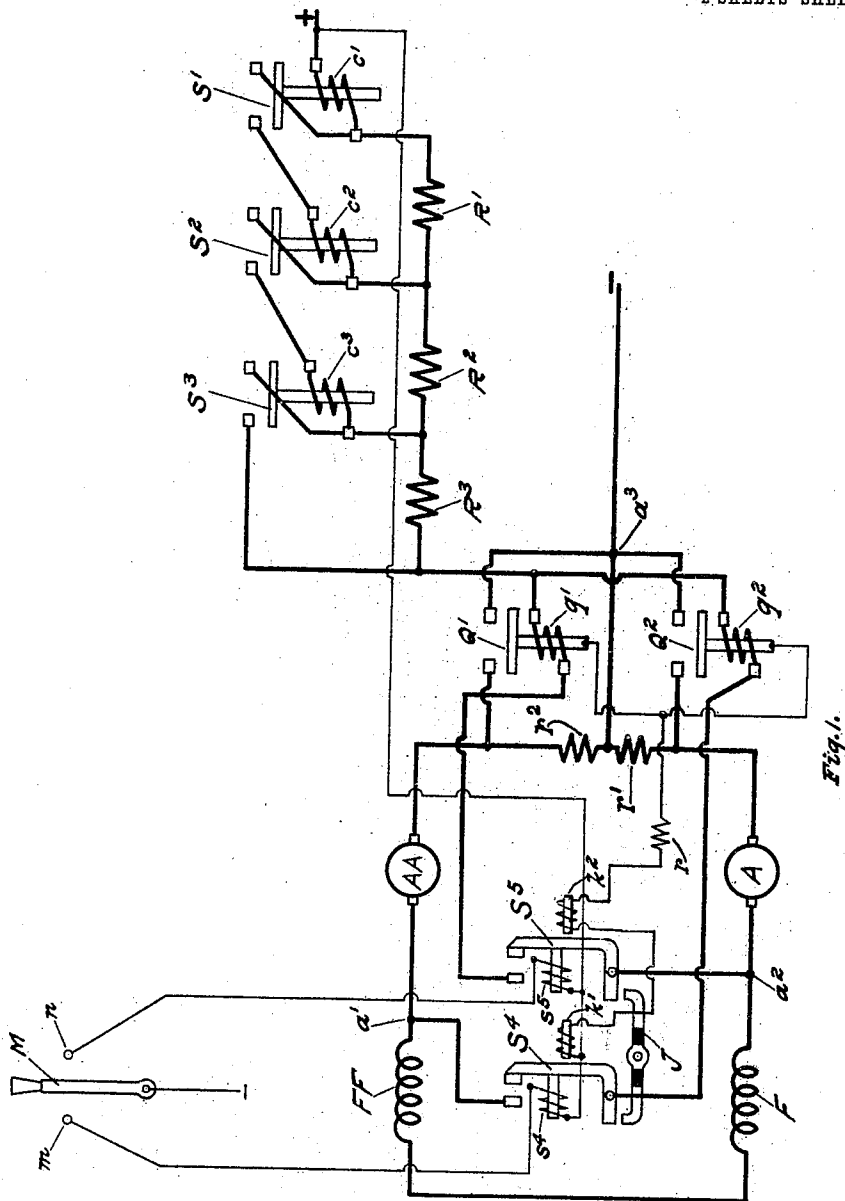
J. H. HALL.
ELECTRIC CONTROLLER.

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

1,053,500.

Patented Feb. 18, 1913.

2 SHEETS—SHEET 1.



WITNESSES

Abner C. Duff
Elmer Stanick.

INVENTOR

BY *Jay H. Hall*
F. N. Barber
ATTORNEY

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Ulice E. Duff
Ewa Staniek.

INVENTOR
BY *Jay H. Hall*
F. N. Barber
ATTORNEY

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.

1,053,500.

Specification of Letters Patent.

Patented Feb. 18, 1913.

Application filed July 27, 1911, Serial No. 640,927. Renewed October 19, 1912. Serial No. 726,807.

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 control systems for electric motors having series fields operating in parallel, and particularly to the reversing of such motors. I connect the fields of both motors in series with one armature, the second armature being in parallel with the first. It is desirable to insert in the circuit of the second armature a resistance equal to that of the two fields in order to have the total current, and therefore the load, equally divided between the two motors.

It is one object of my invention to cause the reversal of two motors connected in parallel by the use of a single set of reversing switches.

It is another object of my invention to provide means whereby a resistance is automatically inserted in the circuit of the armature which is not connected in series with the field windings.

Figure 1 and Fig. 2 are diagrams showing different ways of obtaining these results.

Referring to Fig. 1, A and F indicate, respectively, the armature and the series field of one motor, AA and FF show, respectively, the armature and the series field of the other motor. S^1 and S^2 illustrate a set of reversing switches for the motors, provided with actuating windings s^1 and s^2 , respectively. One end of the winding s^1 is connected to the contact m of a master-controller while the other end is connected to the positive, and one end of the winding s^2 is connected to the contact n of the master controller while the other end is connected to the positive. The operating lever of the master controller is itself directly connected to the negative. A resistance r' , equal to the total resistance of the field windings F and FF is adapted to be connected in series with the armature not in series with the fields by means of the automatic relays Q' and Q^2 . Relay Q' , when operated, automatically short-circuits the resistance r' , leaving the resistance r' in series with the armature A and the relay Q^2 , when oper-

ated, short-circuits the resistance r' , leaving an equal resistance r^2 in series with the armature AA. The relays Q' and Q^2 are series relays, their operating windings q' and q^2 respectively being connected in the main circuit; they close their contacts as soon as their actuating windings are energized. These relays may be of the same construction as the switches S' , S^2 , S^3 described later, adjusted to close on any current which will be allowed to flow by the resistances R' , R^2 , R^3 . The reversing switches S^1 and S^2 are provided with a mechanical interlock J and also a locking circuit adapted to be energized when either of the relays Q' and Q^2 is closed. This circuit is traced from the positive through the locking magnets k' and k^2 , a limiting resistance r , and there it divides in two branches connected to the bridging pieces of the relays Q' and Q^2 , respectively. When energized each of the magnets k' and k^2 is strong enough to prevent the closure of its respective switch but cannot, owing to the increased air gap, force the said switch to the open position after it has operated. The object of this locking circuit is to prevent the reversal of the motors in case the relay Q' or Q^2 energized in the previous operation accidentally stays closed when the motors are stopped. A rheostat in series with both motors is further provided for starting the motors. It consists of the resistance sections R' , R^2 , R^3 adapted to be short-circuited by the switches S' , S^2 , S^3 , respectively. These switches are provided with the operating windings c' , c^2 , c^3 energized by the current in the motor circuit. The resistance controlling switches S' , S^2 , S^3 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 in their operating windings is reduced below said predetermined limit.

The operation of this controller is as fol-

lows: Assuming the master controller to be moved on the contact m , an operating circuit is completed from the positive through the winding s^4 and the contact m to the negative. The energization of the winding s^4 causes the switch S^4 to close its contact, whereupon current flows in the motor circuit thereby energizing the operating winding q^2 of the relay Q^2 which closes immediately its contacts. The motor circuit is established as follows: from the positive through the winding c' of the switch S' , the resistances R' , R^2 , R^3 , the winding q^2 of the relay Q^2 , and the contact of the switch S^4 to the point a' ; there it divides, one branch being traced through the field FF , the field F , the armature A , and the contacts of the switch Q^2 to the point a^3 ; and the other branch being traced through the armature AA and the resistance r^2 to the point a^3 . At the point a^3 the two branches unite and the circuit is connected to the negative. As the current in the motor circuit is limited only by the starting resistances, the first rush of current will lock the switch S' to the open position until, owing to the acceleration of the motors, the current in the winding c' diminishes 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 S^2 in the motor circuit. But the short-circuiting of the resistance section R' causes another rush of current which locks the switch S^2 to the open position until current in the motor circuit decreases to that value at which the switch S^2 is adjusted to operate, whereupon the said switch will close its contacts, short-circuit the resistance section R^2 and connect the operating winding c^3 of the switch S^3 in the motor circuit. Likewise, the switch S^3 will be locked to the open position until the current decreases to that value at which the said switch is adjusted to operate, whereupon the switch S^3 will close its contacts and short-circuit the last resistance section R^3 , the motor circuit being now traced from the positive through the winding c' , the contacts of the switch S' , the winding c^2 , the contacts of the switch S^2 , the winding c^3 , the contacts of the switch S^3 , the winding q^2 , the contacts of the switch S^4 to the point a' and thence as before. The two motors run now at full speed. Owing to the operation of the relay Q^2 , the resistance r' has been short-circuited, leaving the resistance r^2 connected in series with the armature AA , so that the two branches of the motor circuit may have an equal resistance, thereby insuring an equal division of the load between the two motors. The closure of the relay Q^2 completes the locking circuit from the positive through the magnets k' and k^2 ,

the limiting resistance r , the bridging piece of the relay Q^2 , and the contacts thereof to the negative. This causes the magnets k' and k^2 to be energized, whereupon the magnet k^2 locks the switch S^5 to the open position and prevents its operation so long as the switch S^4 is closed. To reverse the motors, the master controller is first returned to the center and then moved on the contact n . The first movement of the master controller deenergizes the operating winding s^4 of the switch S^4 which causes the said switch to open its contact thereby opening the motor circuit and deenergizing the relay Q^2 and all the resistance controlling switches which will drop to the open position. The second movement of the master-controller closes the operating circuit of the switch S^5 from the positive through the winding s^5 , the contact n and the lever M to the negative. The switch S^5 closes its contacts, establishing the motor circuit, and then the relay Q' closes its contacts; but if the relay Q^2 has not dropped to the open position, the locking circuit will stay energized and the magnet k^2 will prevent the operation of the switch S^5 , and, consequently, the simultaneous closure of the two relays Q' and Q^2 which would short-circuit the resistance r' and r^2 .

The motor circuit is traced as follows: from the positive through the winding c' , the resistances R' , R^2 , R^3 , the winding q' of the relay Q' , the contact of the switch S^5 to the point a^2 ; there the circuit divides, one branch being traced through the field F , the field FF , the armature AA , and the contacts Q' to the point a^3 ; the other branch being traced through the armature A and the resistance r' to the point a^3 . At this point the two branches unite, the circuit being led to the negative. Examination of Fig. 1 shows that current flows in the two armatures in the same direction as before, but that the direction of the current in the two fields has been reversed. Therefore, the direction of rotation of the two motors is reversed. The resistance switches S' , S^2 , S^3 will operate as they did in the preceding case, that is, they will close their contacts in the order named, each switch being locked to the open position until the current in the motor circuit diminishes to that value at which the switch considered has been adjusted to operate. After the switch S^5 has operated, all the starting resistance is short-circuited and the two motors run at full speed. It will be noticed that the relay Q' in closing its contacts has short-circuited the resistance r^2 , leaving the resistance r' in series with the armature AA , thereby insuring that the two branches of the motor circuit are of equal resistance and that the load is equally divided between the two motors. It will be further noticed

that the locking circuit is established as soon as the relay Q' has closed its contacts, since the connection of the said circuit to the negative is made through the contacts of the said relay. The switch S^4 will then be locked to the open position by the magnet k' and cannot close its contact in case the relay Q' stays closed after the motors have been stopped. The mechanical interlock J prevents the two reversing switches S^4 and S^5 from closing at the same time and the consequent short-circuiting of the field windings. To stop the motors the operator brings the master controller to the center position which deenergizes the winding s^5 and causes the switch S^5 to open its contacts, thereby opening the motor circuit.

Referring to Fig. 2, the two reversing switches are shown at S^{40} and S^{50} . Each of these switches is provided with two sets of contacts; the lower contact of the switch S^{40} corresponds to the contacts of the relay Q^2 in Fig. 1, and the lower contact of the switch S^{50} corresponds to the contacts of the relay Q' in the same figure. The actuating windings s^{40} and s^{50} of the reversing switches are connected on one side directly to the positive and on the other to the contacts m' and n' , respectively, of a master controller M' . The upper contacts of the reversing switches are for the purpose of reversing the current in the field windings and the lower contacts of the said switches are for the purpose of connecting the resistance r' in series with the armature not connected in series with the fields. The resistance sections R' , R^2 , R^3 in series with the two motors are controlled by means of the switches S^{10} , S^{11} , S^{12} . The operating windings c^{10} , c^{11} , c^{12} , respectively, of these switches have one end connected to a common wire leading to the positive. The other end of the winding c^{10} is connected to the contacts n^2-m^2 on the master controller; that of the winding c^{11} , to contacts n^3-m^3 ; and that of the winding c^{12} , to contacts n^4-m^4 .

The operation of this controller is as follows: Assuming the master controller arm M' to be moved to the left and to make contact with the contact m' , an actuating circuit is completed from the positive through the winding s^{40} , the contact m' , and the strip m^5 to the negative. The switch S^{40} then closes its contacts, whereupon the motor circuit is established as follows: from the positive through the resistances R' , R^2 , R^3 , through the upper contact of the switch S^{40} to the point a' where it divides, one branch being traced through the field FF , the field F , and the armature A to the point a^1 ; the other branch being traced through the armature AA and the resistance r' to the point a^1 . At this point the two branches unite again, the circuit being further traced through the lower contact of the switch S^{40} to the negative.

Moving the arm M' one step farther closes a circuit from the positive through the winding c^{10} and the contact m^2 to the negative. The energization of the winding c^{10} causes the switch S^{10} to close its contacts and short-circuit the resistance section R' , thereby increasing the speed of the motors. Moving the arm M' to the next contact m^3 energizes the winding c^{11} of the switch S^{11} , which closes its contacts and short-circuits the resistance section R^2 . Finally, when the arm M' comes on the last contact m^4 , the winding c^{12} is energized and the switch S^{12} closes its contacts and short-circuits the last resistance section R^3 . The two motors will then run at full speed. The operation of the switch S^{40} connects the resistance r' in series with the armature AA and the two branches of the motor circuit have an equal resistance, thereby insuring an equal division of the load between the two motors. To reverse the motors, the master controller is first returned to off position and then moved to the right. This causes all the resistance switches to be deenergized and to open their contacts and lastly the switch S^{40} to be deenergized and also to open its contacts, thereby opening the motor circuit. When the arm M' comes on the contact n' , a circuit is established from the positive through the winding s^{50} and the contacts $n'-m^5$ to the negative. The switch S^{50} then closes its contacts and establishes the motor circuit as follows: from the positive through the resistances R' , R^2 , R^3 , the upper contact of the switch S^{50} to the point a^2 ; there the circuit divides, one branch being traced through the field F , the field FF , the armature AA to the point a^2 ; the other branch being traced through the armature A and the resistance r' to the point a^2 . There the two branches unite and the motor circuit is further traced through the lower contact of the switch S^{50} to the negative. The resistance switches are operated as in the preceding case by further movement of the arm M' to the contacts n^2 , n^3 , and n^4 until all the starting resistance is short-circuited and the motors run at full speed. It will be noticed that the switch S^{50} in closing its contacts has connected the resistance r' in series with the armature AA , thereby insuring that the two branches of the motor circuit are of equal resistance and that the load is equally divided between the two motors. To stop the motors, the operator brings the master controller to off position which deenergizes all the switches and causes the switch S^{50} to open the motor circuit.

It is possible to operate the motors in parallel as here shown without the use of the resistance r' or r^2 , but the motors would divide the load unequally due to the resistance of both the field windings in one armature

circuit. It would be practical to operate the motor in this way, if they were not called upon to carry their full load, in which case the resistances r' , r'' and the switches Q' , Q'' can be omitted from the system shown in Fig. 1, leaving only the two switches S^4 and S^5 for reversing the motors. If the character of the load is such that the motors will be fully loaded in one direction of motion and only partially loaded in the opposite direction, the resistance r' can be left permanently in the circuit of say, the armature A, omitting the switches Q' , Q'' and the resistance r'' . Then, in running in one direction when the switch S^5 is closed, the resistance r' will be in the circuit of the armature A balancing the circuit of the armature AA containing the two field windings. The motors will then divide the load equally. When running in the opposite direction with the switch S^4 closed the armature A will have in its branch of the divided circuit the two field windings and the resistance r' , while the other branch of the circuit will contain only the armature AA. This will of course cause one armature to assume more of the load than the other, but if the current in the motor which takes the greater amount in this direction of motion is less than full load, or if operation in the reverse direction is only seldom, the fact that the two motors are slightly unbalanced will not be objectionable.

I claim—

1. In a motor control system, two motors having their armature and field windings connected in a closed loop, a switch for operating the motors in one direction, and a second switch for operating them in the opposite direction.

2. In a motor control system, two motors having their armature and field windings connected in a closed loop, one side of a source of supply connected to a point on the loop, a switch for connecting the other side of the source to a second point on the loop to run the motors in one direction, and a second switch for connecting it to a third point on the loop to run the motors in the reverse direction.

3. In a motor control system, two motors having their armatures arranged to be connected in parallel paths, means for connecting the fields of both motors in the path containing one armature to operate the motors in one direction, and means for connecting the said fields in the path containing the other armature to operate the motors in the reverse direction.

4. In a motor control system, two motors, a switch for connecting the armature of the first motor in one branch of a divided circuit, the other branch containing the armature of the second motor and the fields of both motors, and a second switch for con-

necting the armature of the second motor in one branch of a divided circuit, the other branch containing the armature of the first motor and the fields of both motors.

5. In a motor control system, two motors, a switch for connecting the armature of the first motor in one branch of a divided circuit, the other branch containing the armature of the second motor and the fields of both motors, and a second switch for connecting the armature of the second motor in one branch of a divided circuit, the other branch containing the armature of the first motor and the fields of both motors, the current through both fields being reversed.

6. In a motor control system, two motors, the armatures of which are arranged to be connected in parallel, a pair of contacts for causing the current to flow through the fields of the motors in one direction for operating the motors in one direction, and a second pair of contacts for causing the current to flow through the fields in the opposite direction to reverse the motors.

7. In a motor control system, two motors, the armatures of which are arranged to be connected in parallel, a switch for connecting the fields of both motors in series with one armature, and a switch for connecting the fields in series with the other armature and reversing the current in the fields.

8. In a motor control system, two motors, their armatures arranged in parallel, a field for each armature, the fields being arranged in series with each other, means for connecting the fields in series with one or the other of the armatures, a resistance, and means for connecting the resistance in series with the armature not in the circuit with the fields.

9. In a motor control system, two motors, their armatures arranged in parallel, a field for each armature, said fields being arranged in series with each other, means for connecting the fields in series with one or the other of the armatures, means for reversing the direction of current through the series fields to reverse the direction of rotation of the armatures, a resistance, and means for connecting the resistance in series with the armature not in the circuit with said fields.

10. In a motor control system, two motors having series windings and having their armatures connected to operate in parallel, a set of reversing switches for reversing the direction of current flow through the series fields of both motors and for connecting the fields in series with one or the other of the armatures, and means compensating the circuit containing the armature not in circuit with the fields, for the resistance of the fields in circuit with the other armature.

11. In a motor control system, two motors

having series windings and having their armatures connected in parallel, a set of reversing switches for reversing the direction of current flow through the series fields of both motors and for connecting the fields in series with one or the other of the armatures, means compensating the circuit containing the armature not in circuit with the fields, for the resistance of the fields in circuit with the other armature, a variable resistance in series with the two motors, and magnetically-operated switches for controlling the resistance.

12. In a motor control system, two motors, armatures therefor arranged in parallel, a field for each armature, said fields being arranged in series with each other, switches for connecting the fields in series with one or the other of the armatures, a resistance, relays for connecting the resistance in series with the armature not in the circuit with the fields, and a locking circuit containing magnets for preventing the operation of one or

all of the switches and adapted to be energized when any of the relays is closed.

13. In a motor control system, two motors, their armatures arranged in parallel, a field for each armature, the fields being arranged in series with each other, switches for connecting the fields in series with one or the other of the armatures and for reversing the direction of current through the series fields, a resistance, relays energized by the current in the motor circuit for connecting the resistance in series with the armature not in the circuit with the fields, and a locking circuit containing magnets for preventing the operation of the switches and adapted to be energized when any of the relays is closed.

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

JAY H. HALL.

Witnesses:

HENRY L. ASSET,
H. M. DIEMER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."