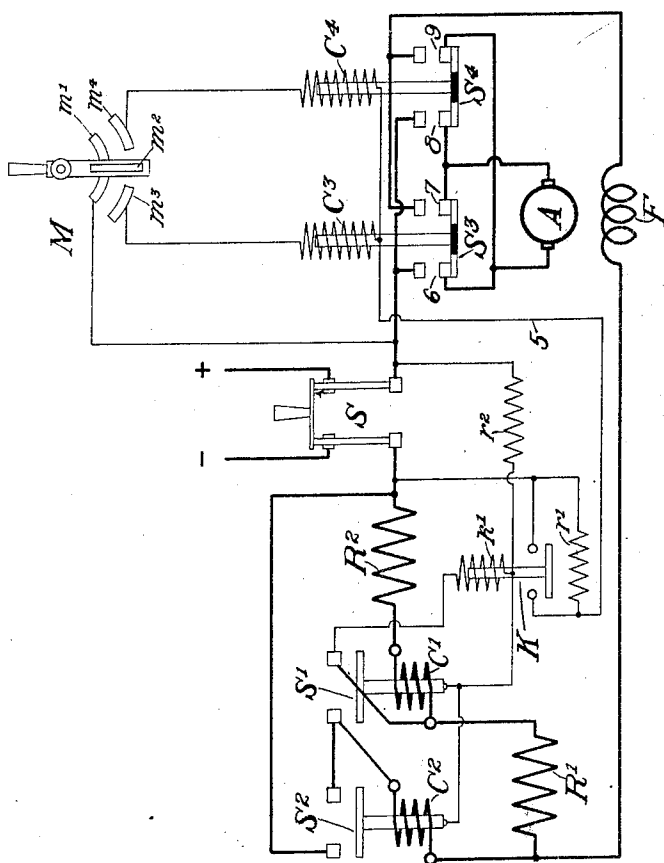


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J. H. HALL.
MOTOR CONTROL SYSTEM.
APPLICATION FILED DEC. 6, 1911.

1,060,082.

Patented Apr. 29, 1913.



WITNESSES

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

MOTOR-CONTROL SYSTEM.

1,060,082.

Specification of Letters Patent.

Patented Apr. 29, 1913.

Application filed December 8, 1911. Serial No. 864,253.

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 Motor-Control Systems, of which the following is a specification.

My invention relates to controllers for electric motors, particularly that type in which magnetically-operated switches are used to control the motor circuit.

One of the objects of my invention is to provide an interlock for preventing the closure of the main switch or the reversing switches when any of the main contacts of the accelerating switches is closed.

Another object is to provide an interlock to prevent further operation of the controller, if the interlocking apparatus should become deranged or injured.

Other advantages will be apparent from the following description.

Referring to the accompanying drawing which shows a wiring diagram of a motor-control system, the motor to be controlled has the armature A and the series field F. A service switch is shown at S. The resistance for controlling the motor is shown at R' and R^2 , which is controlled by the accelerating switches S' and S^2 , having their operating windings C' and C^2 arranged to be connected in the motor circuit. These switches I prefer to make of the type disclosed in Canfield's applications, Serial Number 583,000, filed September 21, 1910 and Serial Number 604,331, filed January 24, 1911, and Eastwood's patent, No. 1,040,292, granted October 8, 1912, which has the peculiar characteristic of being locked open when the current in its operating winding is above a predetermined value, and operating the switch to close its contacts when the current is reduced below that value.

The switches S^3 and S^4 are the usual form of reversing switches for reversing the direction of current through the motor armature to run the motor in one direction or the other. These switches are operated by the windings C^3 and C^4 , and are controlled by the master switch M. To prevent the closure of either of the reversing switches S^3 and S^4 when any of the accelerating switches S' , S^2 is closed, I employ the interlocking relay K, having the winding k' , which is normally energized, when the

switches S' and S^2 are open, by a circuit from the positive side of the switch S through the resistance r^2 and the winding k' to the negative side of the switch S through the winding C' and the resistance R^2 . From the lower terminal of the winding k' is a connection to the movable members of the switches S' and S^2 , so that upon the closure of the switch S' the winding k' will be short-circuited, or practically so, which will cause this winding to become de-energized sufficiently to drop the relay plunger. Likewise, upon the closure of the switch S^2 the circuit from the positive through the resistance r^2 will pass to the negative by a shorter path than through the winding k' , and, therefore, maintain this winding de-energized so long as either one of the switches S' , S^2 is closed.

In the circuit 5, which forms the common line to negative for the reversing switch windings C^3 , C^4 , I place the resistance r' , which is short-circuited by the contacts of the relay K when the winding k' is energized. This resistance r' is sufficient to prevent the operation of either reversing switch when the relay contacts are open, and it is, therefore, necessary that the contacts of the relay K be closed before either reversing switch can close. After a reversing switch has closed, however, the insertion of the resistance r' in the circuit of its winding will not cause the reversing switch to open, because, as it is well known, a smaller amount of current is required to hold a magnetically-operated switch closed than to cause it to close.

The operation of the controller is as follows: Upon the closure of the switch S, a circuit is established through the resistance r^2 and the winding k' , which causes the relay K to close its contacts. Upon the movement of the master controller so that the brush m^2 connects the contacts m' and m^3 , a circuit is established from the positive, through the contacts m' , m^2 , m^3 , of the master controller, the winding C^3 , the conductor 5, and the relay K to the negative. The switch S^3 then closes and establishes the motor circuit from the positive through the contacts 6, the armature A from left to right, the contacts 7, the field winding F, the resistance R' , the operating winding C' of the switch S' , and the resistance R^2 to the negative. This circuit causes the motor

to start and run at its slowest speed. The value of current in the motor circuit which is allowed to pass at this time may be large enough in the winding C' to lock the switch S' open, but as soon as the value of current decreases to the value at which the switch S' is adjusted to operate, this switch will close its contacts, short-circuit the resistance R' , and energize the winding C^2 of the switch S^2 . As soon as the switch S' closes its contacts the winding k' is short-circuited, the relay opens its contacts, thereby inserting the resistance r' in series with the winding C^3 . The switch S^2 , however, is maintained in its closed position, the amount of current allowed to pass after the insertion of the resistance r' being sufficient to hold the switch closed. The short-circuiting of the resistance R' by the switch S' causes the motor current to increase to a value which locks the switch S^2 open, the winding C^2 now being included in the motor circuit, and as soon as the motor has further increased in speed and the current reduced to the value at which the switch S^2 is adjusted to operate, this switch will close its contacts and short-circuit the resistance R^2 and the winding C' , leaving its own winding C^2 in the motor circuit. All of the starting resistance has now been removed from the motor circuit and the motor will operate at its normal speed. The closure of the switch S^2 maintains the winding of the relay K short-circuited, even though the switch S' has opened its contacts, so that the relay K will have its contacts open as long as the switch S^2 remains closed. If the operator wishes to suddenly reverse the motor, he moves the master controller quickly to the position connecting the contacts m' and m^4 , whereupon the winding C^3 is deenergized and the motor circuit opened at the contacts 6 and 7, and the winding C^4 of the switch S^4 is energized. The circuit through the winding C^4 includes the contacts m' , m^2 , m^4 of the master controller, the conductor 5, and the resistance r' . So long as the switch S^2 remains closed provided it is sluggish in opening, or should it remain closed for any reason, such as the sticking of its contacts, the relay K will have its winding deenergized and the resistance r' will remain in the circuit of the winding C^4 . The current allowed to pass in this circuit as long as the resistance r' remains in the circuit will not be sufficient to close the switch S^4 , but as soon as the switch S^2 falls open, the winding of the relay K becomes energized through the circuit including the resistance r' and the winding k' , and the relay K will close its contacts, short-circuit the resistance r' , and allow the winding C^4 to close the switch S^4 . The motor circuit is traced from the positive through the contacts 8 of the switch S^4 , the armature A from right to left,

the contacts 9, the field windings F , the resistance R' , the winding C' , and the resistance R^2 to the negative. The amount of current allowed to pass in the motor circuit will be limited by the resistances R' and R^2 to a value which will cause the motor, if it is still running in the forward direction, to be brought quickly to rest and started in the opposite direction. As soon as the motor current is decreased below the value at which the switch S' is adjusted to operate, this switch closes and cuts out the resistance R' . The relay winding k' is again short-circuited upon the closure of the switch S' , and the resistance r' is inserted in the circuit of the winding C^4 . As soon as the motor current, which has been increased by cutting out the resistance R' , has decreased to the value at which the switch S^2 will operate, this switch closes and short-circuits the resistance R^2 and the winding C' of the switch S' , connecting the motor directly across the line and allowing the switch S' to drop open. The motor now runs at its normal speed in the reverse direction. To stop the motor the operator moves his master controller to the central or off-position, whereupon the switch S^4 opens and ruptures the motor circuit at its contacts 8 and 9. The cessation of current in the motor circuit allows the switch S^2 to again open; and the relay winding k' being reenergized closes the relay contacts and short-circuits the resistance r' , so that a reversing switch can be closed as soon as the operator moves the master controller in either direction.

It is impossible to close either of the switches S^3 and S^4 when any of the starting resistance is cut out by the closure of either of the switches S' and S^2 . If any injury, such as the breaking of a wire, occurs in the relay winding k' and its associated resistance r^2 , the relay will immediately open its contacts and prevent further operation of the switches S^3 and S^4 . In like manner, any injury to the winding C^3 or C^4 , or the limiting resistance r' , will prevent proper operation of these switches. It is, therefore, necessary that all the controlling apparatus, both operating and interlocking, shall be in perfect order before any operation of the control system can proceed.

It will be understood by those skilled in the art that for a non-reversing controller the reversing switches S^3 and S^4 can be replaced by a single main switch for connecting the motor circuit to the positive side of the switch S , and by the use of the interlocking relay K it will be impossible to close this main switch when any of the accelerating switches is closed.

The starting resistance can be subdivided into as many sections as desirable, each controlled by an accelerating switch, and as far as the application of the interlocking relay

to the closure of these switches is concerned, it does not matter whether these switches are operated by windings connected in the motor circuit or by shunt windings controlled from a master controller or otherwise.

I have used the term "deenergize" with respect to the winding of the relay K to include a sufficient reduction of current in the winding k' to cause the relay plunger to drop. Methods for deenergizing the winding k' other than that shown in the drawing will readily suggest themselves to those skilled in the art.

15 I claim—

1. A main circuit, a switch for closing the same, a winding for actuating the switch, an actuating circuit and a maintaining circuit for the switch, the last circuits including the said winding, a second switch for controlling the main circuit, means for making the actuating circuit ineffective with respect to the first switch, the said means including a relay and a winding therefor, and means for deenergizing the second winding when the second switch is closed.

2. A main circuit, a switch for closing the same, a circuit including a winding for actuating the switch, a resistance in the actuating circuit, contacts for short-circuiting the resistance, a second winding, means actuated by the second winding for closing the contacts, a second switch in the main circuit, and means for deenergizing the second winding when the second switch is closed.

3. In an electric control system, a circuit, one or more switches for controlling the circuit, a main switch for closing the circuit, a relay for preventing the closure of the main switch, a winding for the relay, and means to short-circuit the winding upon the closure of any of the controlling switches.

4. In an electric control system, a circuit, a circuit closer therefor, a switch having contacts in the circuit, a relay for preventing the operation of the circuit closer, a winding for the relay, and means to deenergize the winding upon the closure of the contacts of the switch.

5. In an electric control system, a circuit, two switches in the circuit, a relay, a winding therefor, means whereby the relay prevents the closure of one of the switches when

the relay winding is deenergized, and means whereby the winding is deenergized when the other switch is closed.

6. In an electric control system, a circuit, a circuit closer therefor, a resistance in the circuit, means for cutting out the resistance, a relay having a winding for preventing the closure of the circuit closer when the winding is deenergized, and connections by which the relay winding is short-circuited when the resistance is cut out of the circuit.

7. In an electric control system, a motor, a circuit therefor, reversing switches for the motor, resistance in the motor circuit, accelerating switches for cutting out the resistance, a relay for preventing the closure of the reversing switches when any of the accelerating switches is closed, an operating winding for the relay, and means for deenergizing the winding when any of the accelerating switches is closed.

8. In a motor control system, a motor, a circuit therefor, a reverser for the motor, an actuating circuit therefor, a resistance in the motor circuit, a series of switches for controlling said resistance, means to prevent the reverser from closing the motor circuit when any of the resistance switches is closed, the said means comprising a relay whose winding when energized causes its contacts to close the reverser actuating circuit, and means to deenergize the winding when any of the resistance-controlling switches is closed.

9. In a motor control system, a motor, a circuit therefor, a reverser for the motor, an operating winding for the reverser, a resistance in the circuit, one or more switches for controlling the resistance, means to prevent the reverser from closing the motor circuit when any of the resistance-controlling switches is closed, the said means comprising a relay which when its winding is deenergized causes the current in the operating winding of the reverser to be reduced below the value for operating the reverser, and means to deenergize the relay winding when any of the resistance-controlling switches is closed.

Signed at Cleveland, Ohio, this 29th day of November 1911.

JAY H. HALL.

Witnesses:

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H. M. DIEMER.