June 11, 1929. B. W. JONES 1,717,219

STEP BACK MOTOR CONTROL SYSTEM

Filed Nov. 1, 1926

Fig. 1.

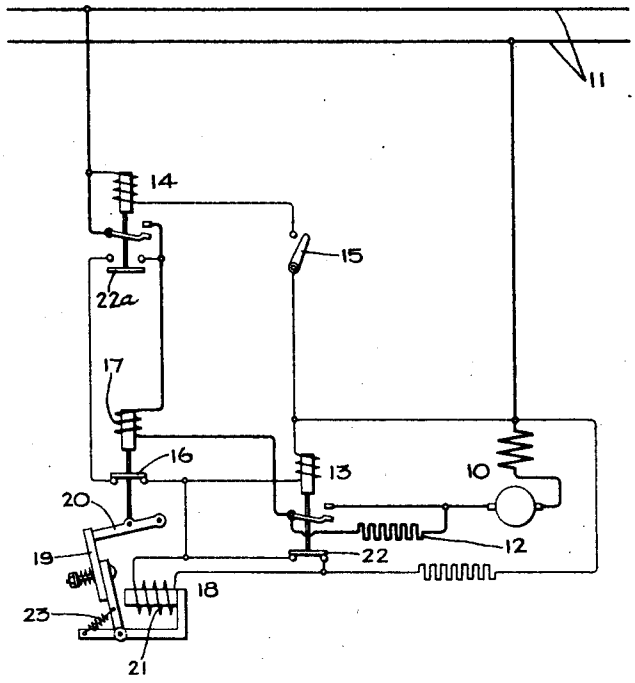
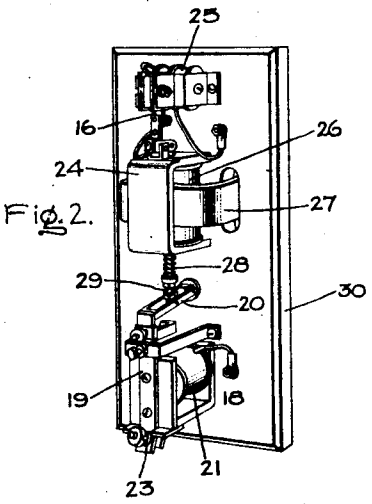


Fig. 2.



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UNITED STATES PATENT OFFICE.

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STEP-BACK MOTOR-CONTROL SYSTEM.

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Electric motors have heretofore been protected from temporary overloads by automatically re-inserting resistance in the motor circuit in response to the current taken by the motor so that a fly wheel or other mass in which energy has been stored may give up its energy and thus assist the motor to carry the load until the temporary condition has passed. Such systems are called "step-back" or "notch-back" systems. One of the difficulties encountered in such systems is that when the resistance is thus re-inserted in the motor circuit, the value of motor current drops and unless provision is made therefor, the device responsive to the motor current effects the immediate shunting of the resistance. The fly-wheel is thus unable to materially assist the motor in carrying the temporary overload. My invention is directed to the provision of simple, effective and reliable means whereby after the resistance is thus re-inserted in the motor circuit, a substantial and definite time interval must elapse before the resistor is again shunted. This gives the fly wheel an opportunity to give up its stored energy and the resistance will not be automatically shunted until the motor current has been stabilized at a predetermined safe value.

More specifically, the present invention is directed to improvements of the system of this general nature described and claimed in my Patent No. 1,614,198, dated January 11, 1927. In the system of said patent, electro-responsive means is provided for automatically preventing for a definite time interval the shunting of the resistor in the motor circuit after the resistor has been re-inserted therein in response to a temporary overload. The present invention is directed to the provision of a simpler, less expensive and equally effective arrangement whereby the said time interval is secured.

In carrying the invention into effect in the form which I now regard as the preferred form thereof, I provide an electromagnetic time element device which consists of an electromagnet having a winding and a magnetic movable member under the control thereof. The said winding is energized when the resistor in the motor circuit is shunted, and when the resistor is re-inserted in the motor circuit, the said magnetic member moves to a position to prevent the shunting of the resistor for a definite time interval and then releases to permit the shunting of the same. The definite time interval is obtained by the shunting of the winding of the electromagnetic device when the resistor has been re-inserted in the motor circuit, and the inductive effect of the winding prevents the flux set up thereby from decreasing immediately. This decreasing magnetic flux exerts a continuing holding effect on the said magnetic member that holds the same in the position to prevent the shunting of the resistor for a sufficient interval of time to permit the fly wheel to give up part of its stored energy.

For a better understanding of the invention, reference is had to the acompanying drawing, in which Fig. 1 shows a very simplified diagram of a system of control for an electric motor in acordance with the invention, and Fig. 2 is a perspective view of an overload relay provided with an electromagnetic time element device for preventing operation of the relay contacts to effect the short-circuiting of the resistor in the motor circuit for a definite interval of time after the resistor has been reinserted therein.

In Fig. 1 the electric motor 10 to be controlled is indicated as of the direct current series type arranged to be energized from the direct current source of supply 11. The resistor 12 is included in the armature circuit of the motor for protecting the motor from temporary overloads and the electromagnetic switch or contactor 13 is provided for shunting this resistor. The motor is connected to the source of supply by means of the line contactor 14, the winding of which is controlled by the master switch 15. The resistor shunting contactor 13 is controlled by means of the relay shown in Fig. 2 and this relay is indicated more or less diagrammatically in Fig. 1.

The relay comprises a switch member 16 which is biased to its closed position and is operated to its open position by means of the series coil 17. When the switch member is thus operated to its open position, it effects the deenergization of the resistor shunting contactor 13 so as to cause the main contacts of this contactor to open and reinsert the resistor 12 in the armature circuit of the motor. The reinsertion of this resistance effects a temporary reduction in the motor current and I have, therefore, provided a simple and effective electromagnetic time element device to prevent the reclosure of the switch member 16 for an interval of time after this switch

member has been operated to its open position.

This time interval is provided by means of the electromagnet 18 which has a movable magnetic member or armature 19 serving as a stop to arrest the return of the lever 20 associated with the switch member 16 when the switch member 16 has been operated to its open position. The winding 21 of this electromagnet is controlled by an auxiliary switch 22 associated with the resistor contactor 13.

In general, the arrangement shown in Fig. 1 is such that when the line switch 14 is closed and the resistor contactor 13 is also closed, the winding 21 will be energized so that when an overload occurs and the switch member 16 is operated to its open position, the armature 19 will move clockwise to its attracted position, so as to thereby serve as a stop for the lever 20. The opening of the circuit through the switch member 16 will effect the deenergization of the resistor contactor 13 so that this contactor will automatically open and reinsert the resistor 12 in the armature circuit of the motor. The auxiliary switch member 22 associated with resistor contactor 13 will be returned to its normal closed position by reason of the opening of contactor 13 and the winding 21 will thus be included in a local circuit. Although this winding is disconnected from the source of supply by the opening of the contacts of the overload device, the armature 19 will not immediately return to its biased or unattracted position because of the inductive effect of the winding 21. Since this winding is in a short-circuited condition at this time, the flux in the electromagnet 18 will persist for a definite and substantial interval of time. When the attractive effect of this flux has decreased to such a value that the spring 23, which biases the armature 19 to its unattracted position, overpowers the magnetic holding effect of the decreasing flux, the armature will return to its position indicated in Fig. 1, thereby permitting the switch member 16 of the overload device to return to the closed position thereof, in case the current taken by the motor has dropped to the predetermined value.

It will be understood by those skilled in the art that the motor is connected to the source of supply by the closing of the master switch 15 which effects the closing of the line contactor 14. When this line contactor closes, the auxiliary switch 22^a associated therewith also closes and the winding of resistor contactor 13 is energized through the contacts of the overload device. It will be understood that I have not shown any acceleration controlling means for the motor, since systems for accelerating electric motors are in themselves quite old. The resistor 12 may be used to not only protect the motor when the current taken thereby is in excess of a certain value after the motor has been started, but also may be used for protecting the motor during the starting interval.

It will also be understood that while I have shown my invention in a system for the control of a direct current motor, the invention is not necessarily limited thereto, since the invention is equally applicable to other types of motors.

It will be appreciated by those skilled in the art that I have provided a very simple system incorporating therein a very simple, inexpensive and thoroughly reliable time element device which prevents the shunting of the protective resistor in the motor circuit for a definite interval of time after this resistance has been included in the motor circuit to protect the motor.

While the invention is obviously susceptible of many modifications, I prefer the particular construction shown in Fig. 2 for the relay which controls the resistor contactor 13. Referring to this figure, it will be seen that the switch member 16 is pivotally mounted on the magnetic frame 24 so that the contacts of this relay may be vertically disposed. The magnetic blow-out device 25 of customary form is provided for interrupting the arcs formed at the relay contacts. The switch member 16 is connected to be operated by the plunger (not shown) of an electromagnet which includes the magnetic frame 24, the hollow core 26 within which the plunger operates, and the series winding 27 which partially embraces core 26. This winding 27 is indicated as a single electrical conductor of relatively large cross-section and this conductor may form a part of the main motor circuit. The switch member 16 is biased to its closed position by the weight of the previously mentioned plunger and by means of the biasing spring 28 which surrounds a rod 29 secured to the lower end of the plunger. The lower end of this rod 29 is pivotally connected with the lever 20, as indicated in both Figs. 1 and 2. The timing electromagnet is preferably as indicated in Fig. 2, which is essentially the same as the corresponding electromagnet in Fig. 1. It will be understood from what has been said previously, that the armature 19 of this electromagnet is intended to move to its attracted position and serve as a stop for the lever 20 so as to hold the relay contact member 16 in its open position after this contact has been operated thereto in response to an overload in the motor circuit. The armature prevents the contact member from moving from its full open position until the armature is released. This is an advantage since the overload device can be calibrated exactly for a certain pick up and drop out value. If the plunger of the overload device were permitted to move at once from its full operated position after the occurrence of an overload, the reluctance of the magnetic circuit would have changed

and calibration difficulties would be encountered. As before explained, the timing action of the electromagnet 18 is secured by disconnecting the winding 21 from the source of supply and including this winding in a local circuit when the resistor 12 has been reinserted in the motor circuit. The various parts of the relay which control the resistor contactor 13 are preferably mounted on a slate or other insulating base 30, as shown in Fig. 2.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination in a system of motor control, a motor circuit, a resistor therein, a switch member operable between an open position and a closed position for effecting the short-circuiting of said resistor and the reinsertion thereof in the motor circuit, means for effecting operation of said switch member, an electromagnet operably associated with said switch member so as to hold said switch member in one position and means operated by said switch member in moving to said position for controlling the energization of said electromagnet to release said switch member after a time interval.

2. In combination in a system of motor control, a motor circuit, a resistor therein, a contactor for shunting said resistor, means for controlling said contactor responsively to the motor current so that when the motor current is above a predetermined value said means moves to a position to effect a deenergization of said contactor whereby said resistor is reinserted in the motor circuit, an electromagnet operably associated with said control means so as to hold said control means in said position, and means operated by said contactor in moving to reinsert said resistor for controlling the energization of said electromagnet to release said control means after a time interval.

3. In combination in a system of motor control, a motor circuit, a resistor included therein, electroresponsive means for shunting said resistor, a switch having a switch member for controlling said means, the said switch member being normally in a position to effect the shunting of said resistor by said means while the motor current is less than a predetermined value and operative to another position to effect operation of said means to reinclude said resistor in the motor circuit when the motor current rises above said predetermined value, a normally energized electromagnet operably associated with said switch member so as to hold said switch member in said other position and means operated by said electro-responsive means in operating to reinclude said resistor in the motor circuit for controlling the energization of said electromagnet to release said switch member after a time interval.

4. In combination in a system of motor control, a motor circuit, a resistor therein, a contactor which when closed shunts said resistor, a relay energized responsively to the motor current and having a switch member normally in the closed position which is operated to the open position thereof to effect the opening of said contactor when the motor current is above a predetermined value, a normally energized electromagnet operably associated with said switch member so as to hold said switch member in its open position, said electromagnet being connected to be shunted by the opening of said contactor so as to delay the closing of said switch member during the interval in which the motor current is temporarily reduced by reason of the reinsertion of said resistor.

5. In combination in a system of motor control, a motor-circuit, a resistor therein, a contactor for shunting said resistor, a relay energized responsively to the motor current and having a switch member normally in the closed position which is operated to the open position thereof to effect the opening of said contactor when the motor current is above a predetermined value, and an electromagnet having a normally energized winding and a magnetic movable member which moves to the attracted position so as to hold said switch member in its full open position, the said winding being connected so as to be shunted by the opening of said contactor to thereby provide a time interval for the release of said magnetic member and the return of said switch member to the closed position thereof.

In witness whereof, I have hereunto set my hand this 29th day of October 1926.

BENJAMIN W. JONES.