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CIRCUIT CONTROLLING MEANS

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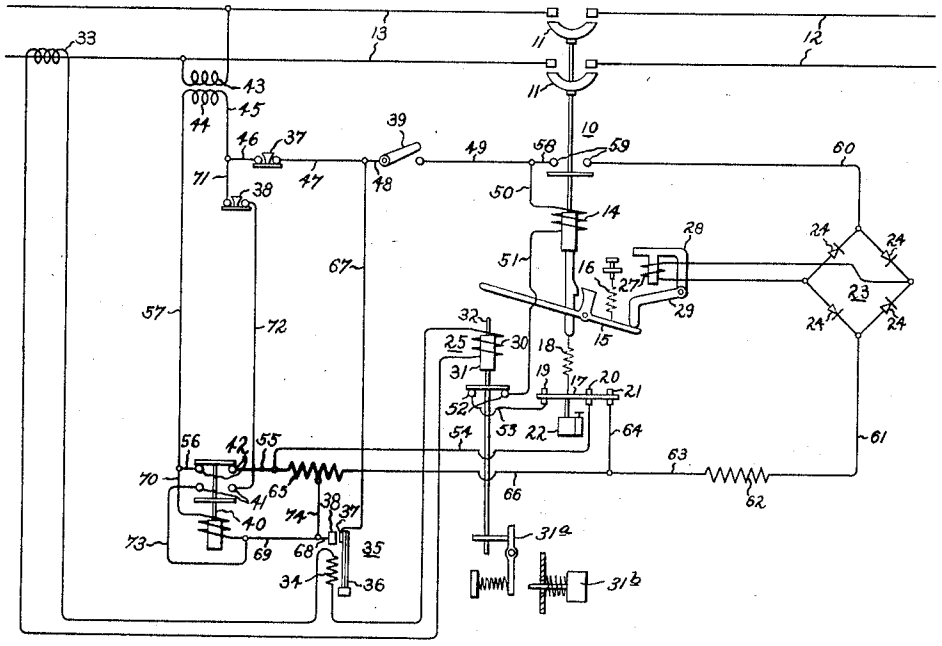

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CIRCUIT CONTROLLING MEANS

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My invention relates to circuit controlling means, more particularly to control means for circuit controlling switches of the latched closed type and has for an object the provision of improved control means of this character.

Circuit controlling switches of the latched closed type when applied to the control of electrical apparatus, such for example as electric motors, are usually provided with an operating winding for effecting closure of the switch, with latch means for latching the switch in its closed circuit position upon operation thereto, with interlock means for interrupting the energizing circuit of operating winding as soon as the switch is latched closed, and with control means responsive to various electrical conditions of the circuit such as overload or undervoltage conditions for releasing the latch means automatically to open the switch.

In order fully to protect the electrical apparatus against injury due to abnormal circuit conditions, the circuit controlling switch is usually provided not only with undervoltage means and with instantaneously operable electromagnetic means for releasing the latch, but also with thermal overload means responsive to prolonged overloads of less magnitude than are required to operate the electromagnetic overload. Such thermal overload means are ordinarily incapable of exerting a mechanical force of very great magnitude and accordingly the thermal means, being incapable of directly releasing the latch member, may be arranged to control the latch indirectly by controlling the energization of a special trip device or the deenergization of the undervoltage means.

The above arrangement of the thermal overload means is particularly desirable when the circuit controlling switch and its control means are immersed in a body of oil for operation therein, for in such cases it is desirable substantially to isolate the thermal element from the immersing body of oil, as set forth in my Patent 2,051,380 issued August 18, 1936. Various arrangements of the thermal overload means may advantageously be employed when the operating winding of the circuit controlling switch is controlled by means of a momentary-contact type control switch. When, however, it is desired to control the operating winding by means of a maintaining-contact type switch, for example a float operated or pressure operated switch, considerable difficulty may arise. Thus, if the overload device is arranged to deenergize the undervoltage means to effect release of the latch, a periodic opening and closing of the circuit controlling switch may result due to the fact that the energizing circuit for the operating winding is reestablished through the interlock contacts each time that the switch opens. Since the latch is held in its releasing position by the overload means, the circuit controlling switch will be caused to open and close periodically as the circuit for the operating winding is made and broken at the interlock contacts.

Furthermore, if the overload means is arranged to energize a special trip coil, difficulties may arise due to the fact that an adequate supply of energy is necessary to effect operation of the tripping device. Thus, the circuit voltage may be too low to effect operation of the tripping device and yet too high to effect release of the undervoltage means. Accordingly, the switch will remain closed even though a dangerous overload condition exists in the circuit.

It is therefore a further object of my invention to provide control means for a circuit controlling switch of the latched closed type, which control means is simple and inexpensive and which reliably effects release of the switch in response to predetermined overload and undervoltage conditions.

In carrying out my invention in one form, I provide, in connection with a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed position, and means responsive to closure of the switch for deenergizing the operating winding, control means comprising normally energized means operable when deenergized to release the latch means, relay means for controlling the normally energized means, and overload means for energizing the relay means to effect deenergization of the normal energized means so as to release the latch upon the occurrence of predetermined overload conditions. Connections are also provided by means of which the overload means short-circuits the normally energized device to effect release of the latch, even though the relay means fails to operate.

More specifically, I provide undervoltage means for releasing the latch in response to a predetermined decrease in the voltage of the circuit controlled by the circuit controlling switch and an auxiliary relay is arranged simultaneously to deenergize the undervoltage means and to interrupt the energizing circuit of the operating winding so as to prevent periodic opening and closing of the circuit controlling switch. The relay means and the operating winding have a definite

pick-up voltage which is greater than the drop-out voltage of the undervoltage means and the additional connections established by the overload means for short-circuiting the undervoltage means ensure release of the latch, even though circuit voltage may be less than the pick-up voltage of the relay and greater than the drop-out voltage of the undervoltage means.

For a more complete understanding of my invention, reference should now be had to the drawing in which the single figure is a somewhat diagrammatic representation of a circuit controlling switch provided with control means embodying my invention.

Referring now to the drawing, I have shown my invention as applied to a circuit controlling switch 10 of the latched closed type provided with circuit controlling contacts 11 arranged to control the connection of a load circuit represented by a pair of conductors 12 and a supply circuit represented by a pair of conductors 13. Although I have shown single phase circuits in order to simplify the drawing, my invention is obviously applicable as well to three phase supply and load circuits. As shown, the circuit controlling switch 10 is provided with an operating winding 14 arranged when energized to effect movement of the circuit controlling contacts 11 to their closed circuit position, with a pivoted latch 15 normally biased to its latching position by a spring 16 and with suitable interlock contacts which comprise a movable contact member 17 connected to the switch 10 by means of a resilient connection 18 and arranged to engage a plurality of stationary contacts 19, 20, and 21. The movable contact 17 is also connected, as shown, to suitable time delay means 22 represented as a conventional dash-pot for delaying operation of the contact 17 out of engagement with the stationary contacts 19, 20 and 21 for a predetermined time after the switch 10 is operated to its closed circuit position.

In order to control the latch 15 in response to predetermined undervoltage conditions, I provide undervoltage means of the type disclosed in my Patent 2,001,494, issued May 14, 1935, which undervoltage means may be described for the purposes of the present invention as comprising a full wave rectifier 23 which includes a plurality of asymmetric conducting units 24 for supplying direct current energy to an energizing winding 27 of an electromagnetic relay which includes a magnetizable core 28 and a pivoted magnetizable armature 29 biased by gravity to its unattracted position, in which position it effects the release of the latch 15. As more fully described in my above referred to Patent 2,001,494, the armature 29, when in its closed circuit position, provides in conjunction with the magnetizable frame 28 a substantially closed magnetic circuit and the full wave rectifier provides a closed local circuit winding 27, so that upon a decrease in the voltage supplied to the terminals of the rectifier, an induced current will flow through the closed local circuit comprising the winding 27 and the legs of the full wave rectifier, which current tends to prevent decay of flux in the closed magnetic circuit and thus retains the armature in its attracted position for a predetermined time after the voltage has decreased.

Adjacent the pivoted latch 15 I also provide an electromagnetic overload device 25 which comprises a winding 33 for moving a magnetizable plunger 31, the upper end of which carries a projecting finger 32 arranged to engage the pivoted latch 15 and operate it to its releasing position against the bias of the spring 16 upon a predetermined degree of energization of the winding 30. The winding 30 is energized from a current transformer 33 so as to be responsive to overload conditions in the circuit represented by the conductors 13 and a heating winding 34 of a suitable thermal overload device 35 is connected in series with the current transformer 33 and the winding 30 of the electromagnetic overload device.

As shown, the thermal overload device 35 comprises in addition to the heating winding 34 a bi-metallic element 36, the free end of which carries a contact 37 arranged to engage a stationary contact 38.

In addition to the above described apparatus, my improved control means includes a pair of normally closed push-button switches 37 and 38, a control switch 39, which is of the maintaining contact type, and which may be either a manually operated or float operated switch for example, and an auxiliary relay 40 having a pair of normally open contacts 41 and a pair of normally closed contacts 42. Furthermore, in order to energize the undervoltage means in accordance with the voltage of the circuit controlled by the switch 10, I provide a potential transformer having a primary winding 43 connected across the supply circuit represented by the conductors 13 and a secondary winding 44 which supplies energy to the undervoltage means, and likewise supplies control energy for the operating winding 14 and the auxiliary relay 40.

With the above description of the principal elements in mind, it is believed that a complete understanding of my invention may now be had from a description of the operation. Upon closure of the control switch 39, either manually or in response to a predetermined condition if the switch is float operated or pressure operated, an energizing circuit is established for the operating winding 14 of the switch 10, which circuit may be traced from one side of the secondary winding 44 of the potential transformer through the conductors 45 and 46, the push-button switch 37, the conductors 47 and 48, the control switch 39, the conductors 49 and 50, the operating winding 14, a conductor 51, a pair of interlock contacts 52 carried by the plunger 31 of the electromagnetic overload device, the conductor 53, the cooperating contacts 19, 17, and 20, the conductors 54 and 55, the normally closed contacts 42 of the auxiliary relay 40 and by way of the conductors 56 and 57 to the opposite side of the secondary winding 44.

Immediately upon energization of the operating winding 14, the contacts 11 of the circuit controlling switch 10 are operated to their closed circuit position and an energizing circuit is established for the undervoltage means to attract the pivoted armature 29 and release the latch 15 for movement to its latching position. This energizing circuit for the undervoltage means extends from the previously energized conductor 49 through a conductor 58, a pair of interlock contacts 59 on the switch 10, a conductor 60, the rectifier 23, a conductor 61, a current limiting resistor 62, the conductors 63 and 64, the cooperating interlock contacts 21, 17, and 20, the conductors 54 and 55, the normally closed contacts 42 of the auxiliary relay 40, and by way of the conductors 56 and 57 to the secondary winding 44 of the potential transformer.

Operation of the switch 10 to its closed circuit

position is also effective to stress the resilient means 18 and accordingly the movable contact 17 tends to move out of engagement with the fixed contacts 19, 20, and 21. The time delay means 22, however, prevents movement of the contact 17 until after the undervoltage means has been energized and the latch 15 has moved to its latching position. As soon as the contact 17 is disengaged from the contacts 19, 20, and 21, the energizing circuit for the operating winding 14 is interrupted and accordingly the switch 10 is thereafter maintained in its closed circuit position solely by the latch 15. Likewise, disengagement of the contact 17 from the contacts 20 and 21 is effective to insert a second resistor 65 in the energizing circuit of the undervoltage means so as to reduce the energization of the rectifier 23 and the winding 27 of the undervoltage relay a predetermined amount. The energizing circuit for the undervoltage means now extends from the conductor 63 through a conductor 66 and the current limiting resistor 65 to the conductor 55 rather than through the conductors 54 and 64 and the contacts 17, 20, and 21.

So long as normal current conditions exist in the circuit represented by the conductors 12 and 13, the switch 10 will remain in its closed circuit position under the control of the switches 37 and 39. Whenever the switch 39 is open, the energizing circuit for the undervoltage means will be interrupted and accordingly the armature of the undervoltage relay will be released to move the latch 15 to its releasing position and open the switch 10. If the control switch 39 is a pressure operated or float operated switch, the push-button switch 37 may be used to open the switch 10 at will.

It will now be assumed that with the switch 10 in its closed circuit position, a predetermined decrease in the voltage of the circuit represented by the conductors 12 and 13 occurs. Consequently, the magnetic flux in the frame 28 and the armature 29 of the undervoltage device tends to decrease, but is maintained for a predetermined time by the induced current flowing in the winding 27 and the rectifier 23. If the voltage does not return to its normal value within a predetermined time, the armature 29 will be released and will move to the position shown in the drawing to release the latch and open the switch 10. Although the energizing circuit for the operating winding 14 will be reestablished as soon as the movable contact 17 reengages the contacts 19 and 20, the switch 10 will not be operated to its closed circuit position until the voltage returns to normal, because the pick-up voltage of the switch 10 is considerably greater than the drop-out voltage of the undervoltage device. As soon as the voltage returns to normal, however, the switch will again be closed and the undervoltage device energized to attract its armature 29 and permit the latch 15 to move to its latching position.

If a severe overload occurs in the circuit represented by the conductors 12 and 13, a current will be induced in the current transformer 33 which will energize the winding 30 of the electromagnetic overload device 25 sufficiently to move the plunger 31 upwardly and operate the latch 15 to its releasing position. Since the energizing circuit for the operating winding 14 of the switch 10 is interrupted at the contacts 52 upon operation of the plunger 31, the switch 10 will not be reclosed, even though the contact 17 reengages the contacts 19 and 20 until the plunger 31 of the overload device returns to its normal position. In order to prevent the plunger 31 of the overload device 25 from returning to its normal position as soon as the switch 10 opens, and thereby reestablishing an energizing circuit for the switch 10, the overload device 25 is preferably provided with suitable latch means, shown as a pivoted spring pressed latch 31*a* for retaining the plunger 31 in its uppermost position upon operation thereto. The latch 31*a* may be withdrawn by pressing a button 31*b* to release the plunger 31 and permit it to drop and close the circuit through the contacts 52.

It will now be assumed that an overloaded condition exists in the circuit represented by the conductors 12 and 13 which induces in the current transformer 33 a current which is insufficient to operate the plunger 31 of the overload device 25, but which is sufficiently large to cause the heating winding 34 of the thermal overload relay 35 to generate considerable heat. If this overload continues for a predetermined time, the bimetallic element 36 of the thermal relay 35 will flex in a direction to effect engagement of the contacts 37 and 38 and establish an energizing circuit for the energizing winding of the auxiliary relay 40.

This energizing circuit may be traced from the secondary winding 44 of the potential transformer through the conductors 45 and 46, the push-button switch 37, the conductors 47 and 67, the contacts 37 and 38, the conductors 68 and 69, the winding of the auxiliary relay 40, and by way of the conductors 70 and 57 to the other side of the secondary winding 44. If the voltage existing on the circuit represented by the conductors 12 and 13 is sufficiently high to induce in the secondary winding 44 of the potential transformer a control voltage which is above the pick-up voltage of the relay 40, the relay will immediately be operated to interrupt at the contacts 42 both the energizing circuit for the undervoltage means and the energizing circuit for the operating winding 14. Consequently, the armature 29 of the undervoltage relay will operate with a slight time delay to the position shown in the drawing to release the latch 15, whereupon the circuit controlling switch 10 is immediately opened. As hereinbefore mentioned, the energizing circuit for the operating winding 14 is likewise interrupted at the relay contacts 42 and accordingly the circuit controlling switch 10 does not reclose.

Consequent to operation of the relay 40 to its uppermost position, a holding circuit is established for the energizing winding of the relay 40, which circuit may be traced from the secondary winding 44 of the potential transformer through conductors 45 and 71, the push-button switch 38, a conductor 72, the contacts 41 of the relay 40, a conductor 73, and by way of the energizing winding for the relay 40 and the conductors 70 and 57 to the secondary winding 44. Thus, it will be seen that the relay 40 will be maintained in its operating position to prevent reestablishment of an energizing circuit for the operating winding 14 until such time as the push-button switch 38 is operated to deenergize the relay 40 and reestablish energizing circuits for the operating winding 14 and the undervoltage means.

As will be well understood by those skilled in the art, certain types of overloads may cause a considerable decrease in the voltage of the circuit and I have found in actual practice that over-

load conditions will often arise in which the voltage of the circuit represented by the conductors 12 and 13 may be of such a value that the control voltage induced in the secondary winding 44 of the potential transformer will be less than the pick-up value of the relay 40 and greater than the drop-out value of the undervoltage means. Under such voltage conditions, closure of the contacts 37 and 38 does not effect operation of the auxiliary relay 40 and since the control voltage is of sufficient magnitude to maintain the undervoltage device in its energized position, the circuit controlling switch 10 will not be opened, even though a dangerous overload condition exists in the circuit represented by the conductors 12 and 13.

In order to provide for operation of the switch 10 to its open circuit position under such conditions, the contacts 37 and 38 controlled by the overload relay 35 are arranged upon closure to short-circuit the undervoltage means and thereby ensure release of the latch 15, even though the auxiliary relay 40 does not pick up. This short-circuit extends from the conductor 47 in the energizing circuit of the undervoltage means through the conductor 67, the contacts 37 and 38, and the conductors 68 and 74 to a midpoint on the current limiting resistor 65. As soon as this short-circuit is completed, the undervoltage means will be substantially deenergized and the latch 15 will be released to open the switch 10. Under these conditions, it is not necessary to interrupt the energizing circuit of the operating winding 14 since the control voltage available is below the pick-up voltage of the switch 10 and accordingly a periodic opening and closing of the switch 10 cannot occur.

It will thus be seen that I have provided improved control means which will reliably effect operation of the switch 10 to its open circuit position under all dangerous conditions of overload or undervoltage.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising normally energized means operable upon deenergization thereof to release said latch means, relay means for controlling said normally energized means, overload means for energizing said relay means to effect deenergization of said normally energized means and thereby release said latch means upon the occurrence of predetermined overload conditions, and connections controlled by said overload means for short-circuiting said normally energized means to effect release of said latch means upon the occurrence of said overload conditions even though said relay means fails to operate.

2. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising means normally energized from the circuit controlled by said switch and operable when deenergized to release said latch means, relay means energizable from said circuit for controlling the energization of said normally energized means, overload means responsive to predetermined overload conditions for energizing said relay means to effect deenergization of said normally energized means and thereby release said latch means, and connections controlled by said overload means for short-circuiting said normally energized means to effect release of said latch means even though the voltage of said circuit is insufficient to effect operation of said relay means.

3. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising means normally energized from the circuit controlled by said switch and operable when deenergized to release said latch means, relay means energizable from said circuit for controlling the energization of said normally energized means, overload means responsive to predetermined overload conditions for energizing said relay means to effect deenergization of said normally energized means and thereby release said latch means, means controlled by said relay means for preventing reenergization of said operating winding upon movement of said switch means to its open circuit position, and connections established by said overload means for short-circuiting said normally energized means to effect release of said latch means even though the voltage of said circuit is insufficient to operate said relay means.

4. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising undervoltage means energizable from the circuit controlled by said switch for releasing said latch means upon a predetermined decrease in the voltage of said circuit, an auxiliary relay energizable from said circuit, overload means responsive to predetermined overload conditions for establishing an energizing circuit for said relay, means responsive to operation of said relay for deenergizing said undervoltage means to release said latch means and for preventing reenergization of said operating winding upon operation of said switch to its open circuit position, and connections established by said overload means for short-circuiting said undervoltage means to release said latch means even though the voltage of said circuit is insufficient to operate said relay.

5. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising undervoltage means energizable from the circuit controlled by said switch for releasing said latch means upon a predetermined decrease in the voltage of said circuit, an auxiliary relay energizable from said circuit, overload means responsive to predetermined over-

load conditions for establishing an energizing circuit for said auxiliary relay, means responsive to operation of said relay for deenergizing said undervoltage means to release said latch means and for preventing reenergization of said operating winding upon operation of said switch to its open circuit position, said switch and said relay having a pick-up voltage greater than the drop-out voltage of said undervoltage means, and connections established by said overload means for short-circuiting said undervoltage means to release said latch even though the voltage of said circuit is greater than said drop-out voltage and less than said pick-up voltage.

6. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising means for deriving from the circuit controlled by said switch a control voltage proportional to the voltage of said circuit, undervoltage means energizable in accordance with said control voltage for releasing said latch means upon a predetermined decrease in the voltage of said circuit, an auxiliary relay, overload means responsive to predetermined overload conditions for energizing said auxiliary relay from said voltage deriving means, means responsive to operation of said relay for deenergizing said undervoltage means to release said latch means and for preventing reenergization of said operating winding upon operation of said switch to its open circuit position, said switch and said relay having a pick-up voltage greater than the drop-out voltage of said undervoltage means, and connections established by said overload means for short-circuiting said undervoltage means to release said latch means even though said control voltage is greater than said drop-out voltage and less than said pick-up voltage.

7. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for reenergizing the operating winding, said control means comprising undervoltage means energizable from the circuit controlled by said switch for releasing said latch means upon a predetermined decrease in the voltage of said circuit, electromagnetic means for releasing said latch substantially instantaneously in response to overload currents of predetermined magnitude, an auxiliary relay energizable from said circuit, thermal overload means responsive to prolonged overload currents of less than said predetermined magnitude for controlling the energization of said relay, means responsive to operation of said relay for deenergizing said undervoltage means to release said latch and for preventing reenergization of said operating winding upon operation of said switch to its open circuit position, and connections established upon operation of said thermal overload means for short-circuiting said undervoltage means to release said latch independently of said auxiliary relay.

8. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising means for deriving from the circuit controlled by said switch a control voltage proportional to the voltage of said circuit, undervoltage means energizable in accordance with said control voltage for releasing said latch means upon a predetermined decrease in the voltage of said circuit, electromagnetic overload means for releasing said latch means substantially instantaneously in response to overload currents of predetermined magnitude, an auxiliary relay, thermal overload means responsive to prolonged overload currents of less than said predetermined magnitude for energizing said auxiliary relay from said current deriving means, means responsive to operation of said relay for deenergizing said undervoltage means to release said latch means and for preventing reenergization of said operating winding upon operation of said switch to its open circuit position, said switch and said relay having an effective pick-up voltage greater than the drop-out voltage of said undervoltage means, and connections established upon operation of said thermal overload means for short-circuiting said undervoltage means to insure release of said latch means even though said control voltage is less than said pick-up voltage and greater than said drop-out voltage.

9. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising undervoltage means energizable from the circuit controlled by said switch for releasing said latch means upon a predetermined decrease in the voltage of said circuit, an auxiliary relay energizable from said circuit, overload means responsive to predetermined overload conditions for completing an energizing circuit for said relay, means responsive to operation of said relay for deenergizing said undervoltage means to release said latch means and for preventing reenergization of said operating winding upon operation of said switch to its open circuit position, additional means responsive to operation of said relay for completing a holding circuit therefor, manual means for interrupting said holding circuit to deenergize said relay to permit reenergization of said operating winding and said undervoltage means, and connections established upon operation of said overload means for short-circuiting said undervoltage means to release said latch means even though the voltage of said circuit is insufficient to effect operation of said relay.

10. Control means for a circuit controlling switch having an operating winding energizable to close the switch, means for latching the switch in its closed circuit position upon operation thereto and means responsive to closure of the switch for deenergizing the operating winding, said control means comprising means for deriving from the circuit controlled by said switch a control voltage proportional to the voltage of said circuit, means for energizing said operating winding from said voltage deriving means, undervoltage means energizable in accordance with said control voltage for releasing said latch means upon a predetermined decrease in the voltage of said circuit, electromagnetic overload means for releasing said latch means substantially instantaneously in response to overload currents of predetermined magnitude, a relay,

thermal overload means responsive to prolonged overload currents of less than said predetermined magnitude for energizing said relay from said current deriving means, means responsive to operation of said relay for deenergizing said undervoltage means to release said latch means and for preventing reenergization of said operating winding upon operation of said switch to its open circuit position, additional means controlled by said relay for establishing a holding circuit therefor, manually operable means for interrupting said holding circuit to effect deenergization of said relay to permit reenergization of said operating winding and said undervoltage means, said switch and said relay having an effective pick-up voltage greater than the drop-out voltage of said undervoltage means, and connections established upon operation of said thermal overload means for short-circuiting said undervoltage means to insure release of said latch means even though said control voltage is less than said pick-up voltage and greater than said drop-out voltage.

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