Sept. 9, 1941. F. E. STRAUSS 2,255,475

PUMP-PROOF CIRCUIT BREAKER CONTROL SYSTEM

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Fig. 1.

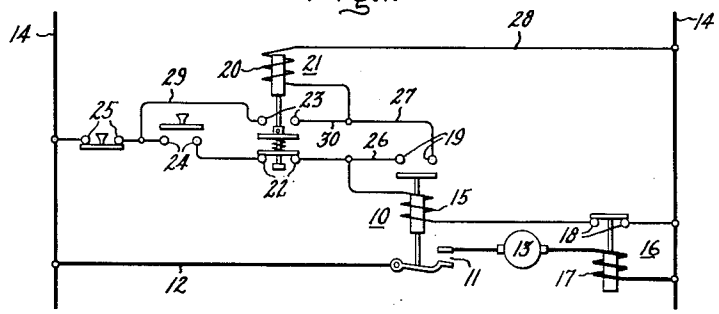
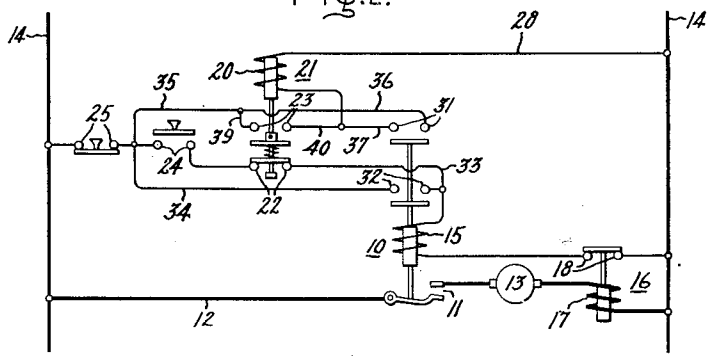


Fig. 2.



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PUMP-PROOF CIRCUIT BREAKER CONTROL SYSTEM

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6 Claims. (Cl. 175—294)

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

Circuit controlling switches of the automatic interrupting 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. The interrupting switch or circuit breaker is held in the closed position by continued energization of the operating winding or by a suitable latching means. In addition, control means responsive to abnormal electrical conditions of the circuit are provided either for de-energizing the normally energized operative winding, or for releasing the latching means to open the circuit breaker automatically.

In order fully to protect the electrical apparatus against injury due to the continuance of abnormal circuit conditions, means must be provided for preventing the automatic reclosure of the circuit interrupter after it has once opened. The reclosure of the circuit interrupter may occur by inadvertent energization of the operating winding upon the re-setting of the abnormal condition control responsive means which had previously caused the circuit interrupter to open.

To avoid energization of the operating winding and reclosure of the circuit breaker after it has once opened, lockout relays have been conventionally used in conjunction with normally open overload or undervoltage relay contacts, and connected to be energized at the time of occurrence of the abnormal circuit condition. This conventional circuit has the disadvantage of requiring normally open overload or undervoltage relay contacts which are inferior to normally closed contacts, in that, if the contacts become inoperative, the normally open type will not cause the circuit breaker to open. The circuit requires that the lockout relay operate at the time of abnormal circuit conditions. Such operation may become impossible if the value of the circuit voltage drops at this time, as it frequently does. Furthermore, the lockout relay contacts are required to interrupt the current of either a relay coil or the operating coil of the circuit breaker which current may be large in some switches.

It is therefore a further object of my invention to provide control means for a circuit controlling switch, which control means obviates the above mentioned disadvantages by using normally closed abnormal condition relay contacts together with normally closed lockout contacts that are opened as soon as the circuit breaker is closed, and which, by using only standard and reliable electrical switches and relay devices rather than specialized equipment, is simple and inexpensive to manufacture.

In carrying out my invention in one form, I provide, in connection with a suitable circuit controlling switch having an operating winding energizable to close the switch, a simple control switch which may be of the momentary-contact type, such as a push button, or of the maintaining-contact type, such as a float-operated or pressure-operated switch, a normally closed lockout switch and an abnormal condition responsive switch arranged to energize the operating winding of the main circuit controlling switch, relay means responsive to closure of the main switch for opening the lockout switch, additional switching means controlled by the relay means for establishing a holding circuit for the relay means, and switching means operable by closure of the main switch for energizing the relay means. Connections are also provided, when a momentary-contact type control switch is used, to interlock this switch either by the auxiliary switch operated by the closure of the circuit breaker, or by a separate auxiliary switch similarly operated.

More specifically in the form of my invention shown, I provide a normally closed overload switch for deenergizing the operating winding of the circuit breaker or main switch in response to predetermined overload conditions. The operating winding of the main switch is energized through a normally closed lockout switch which is opened by the relay means upon closure of the main switch. In one case, the lockout switch and the control switch are shunted by a circuit including an auxiliary switch, which auxiliary switch is the same as is used to energize the relay means. Energization of the relay means operates an additional switch in a holding circuit to maintain the relay means energized. In another case, a pair of auxiliary switches are used, each being operated by closure of the main switch; one to complete the holding circuit for the relay means and the other in a circuit to shunt the momentary-contact type control switch if used and the lockout switch. Obviously, if a maintaining-contact type control switch is used, no shunt for the control switch need be provided.

For a more complete understanding of my invention, reference should now be had to the

drawing in which Fig. 1 is a diagrammatic representation of a circuit controlling switch for a motor provided with control means embodying my invention; and Fig. 2 is a diagrammatic representation of a circuit controlling switch similar to that shown in Fig. 1 provided with control means embodying my invention in another form.

Referring now to the drawing, I have shown my invention as applied to a circuit controlling switch 10 provided with the main circuit controlling contacts 11 arranged to control the connection of a load circuit, represented by a conductor 12 having in series circuit therewith an electric motor 13, to a supply circuit represented by a pair of conductors 14. 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 15 arranged when energized to effect movement of the circuit controlling contacts 11 to the closed circuit position for energizing the motor 13. Although the circuit interrupter 10 is shown to be of the type which is maintained in the closed circuit position only when its operating winding 15 is energized, I do not wish to be limited thereto since a circuit interrupter of the latched-closed type may be used without departing from the scope of my invention.

A suitable abnormal condition responsive means, such as an overload relay 16, is provided for causing the circuit interrupter 10 to open upon abnormal conditions in the load circuit 12. The overload relay 16 is of the magnetically operated type provided with a winding 17 in series with the load circuit 12 and arranged to operate a normally closed overload switch 18, which is connected in series with the operating winding 15, to the open position upon a predetermined overload in the load circuit 12. Obviously, the normally closed overload device 16 may be of the thermally operated type without departing from the scope of my invention.

In addition to the main circuit interrupting contacts 11, the circuit interrupter 10 is arranged to operate a normally open auxiliary switch 19 to the closed position when the circuit interrupter 10 is closed. Closure of the auxiliary switch 19 serves to energize an operating winding 20 of a lockout relay 21. The lockout relay 21 is provided with a normally closed lockout switch 22 and a normally open interlock switch 23, the switches 22 and 23 being provided with the so-called overlapping contacts, whereby when the locked relay 21 is energized, the normally open switch 23 closes shortly before the normally closed switch 22 opens. In addition to the various switches mentioned, I provide a suitable starting switch 24, here shown as of the momentary-contact type, and also a normally closed re-set and stop switch 25. The above described control circuits including the switches and relays may be energized from any suitable source and are shown connected to be supplied from the main supply conductors 14.

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 24, either manually or in response to a predetermined condition, an energizing circuit is established for the operating winding 15 of the main switch 10. This circuit may be traced from the left hand supply conductor 14 through the stop and reset switch 25, the start switch 24, the normally closed lockout switch 22, the operating winding 15 and through the normally closed overload contacts 18 to the right hand supply conductor 14.

Immediately upon energization of the operating winding 15 the contacts 11 of the circuit controlling switch 10 are operated to their closed circuit position and an energizing circuit is established for the lockout relay 21 by closure of the normally open switch 19 which is closed by closure of the circuit controlling switch 10. The energizing circuit for the lockout relay 21 extends through the previously mentioned switches 25, 24 and 22 to a conductor 26 and through the closed auxiliary switch 19 and a conductor 27 to the energizing winding 20 of the lockout relay 21 and thence by a conductor 28 to the right hand supply conductor 14. Operation of the lockout relay 21 closes the normally open auxiliary lockout contacts 23 and a short time after the closure of the contacts 23, opens the normally closed lockout switch 22. In this manner, a holding circuit is completed for the lockout relay 21, the holding circuit serving to maintain the lockout relay 21 in the energized condition irrespective of the operation of the circuit breaker 10 and the auxiliary switch 19. This holding circuit may be traced from the left hand supply conductor 14 through the stop re-set switch 25, a conductor 29, the switch 23, and through a conductor 30 to the energizing winding 20 of the lockout relay 21 and by the conductor 28 to the right hand supply conductor 14. Once the above described holding circuit for the lockout relay is established this relay can only be de-energized by opening the stop re-set switch 25, and thus the lockout switch 22 is maintained open until the lockout relay is de-energized or re-set. The stop switch 25 may be opened at any time to de-energize the load circuit 12 by operating the circuit controlling switch 10 and its contacts 11 to the open position.

A portion of the holding circuit for the relay 21 also serves to shunt the momentary-contact type starting switch 24 and the lockout switch 22 so that, after this shunt circuit is completed, the start button 24 may be released without de-energizing the operating winding 15 of the circuit breaker 10. This circuit may be traced from the left hand supply conductor 14 through the re-set switch 25, the conductor 29, the switch 23, the conductors 20 and 27, the switch 19, and through the conductor 26, the energizing winding 15 and the overload contacts 18 to the right hand supply conductor 14.

If an overload occurs on the motor 13, this condition in the operating winding 17 of the overload relay 16 causes the relay plunger to move upwardly to open the normally closed overload switch 18 and thereby de-energize the operating winding 15 of the circuit breaker 10. Immediately, therefore, the circuit breaker 10 moves to the open position to open its contacts 11 and de-energize the motor 13. Also, the switch 19 is opened when the circuit breaker 10 opens. Obviously, when the circuit of the motor 13 is de-energized, the winding 17 of the overload relay 16 is also de-energized and the overload switch 18 recloses. Reclosure of the overload switch 18 is ineffective to energize the operating winding 15 of the circuit breaker 10, since the lockout switch 22 is held in the open position by the continued energization of the lockout relay 21. The sealing circuit for the winding 15 is also broken by the open

switch 19. Furthermore, inadvertent closure of the starting switch is ineffective to energize the circuit breaker winding 15, since the open lockout switch 22 is in series circuit with the starting switch 24, the operating winding 15 and the overload switch 18.

Before the circuit breaker 10 can be reclosed, it is first necessary to de-energize the lockout relay 21 by opening the reset switch 25 to permit the normally closed lockout switch 22 to close. Thereafter the re-set switch 25 may be closed without affecting the condition of the lockout relay 21 since the energizing circuit of the relay winding 20 has been opened at the switch 23. After the re-set switch 25 is again closed, the starting switch 24 may be closed to re-close the circuit breaker 10 as described above and again open the lockout switch 22 to prevent the reclosure of the circuit breaker 10, should it open due to overload.

Should it be desired to use a maintaining-contact type control switch in the circuit shown in Fig. 1, instead of the momentary-contact type control switch 24 shown, it is only necessary to remove the control switch 24 and substitute a circuit conductor in its stead to complete the circuit from the lockout switch 22 to a point between the auxiliary lockout switch 23 and the re-set switch 25. The maintaining-contact type control switch may then be connected in series with the re-set switch 25, the operating winding 15 and the overload switch 18 at a point outside of the parallel circuits, including the lockout switch 22 and the auxiliary lockout switch 23 preferably at a point between the left hand supply conductor 14 and the re-set switch 25. It will be noted also that I have shown a circuit breaker having an operating winding which must be energized to maintain the switch in its closed position. Obviously, a circuit breaker of the latched-in type may be substituted in a manner more fully described hereinafter in connection with Fig. 2 for the circuit breaker 10 shown, and therefore I do not wish to be limited in this respect.

Referring now to Fig. 2, I have shown my invention in another form wherein the operation of the control means is similar to that described in connection with Fig. 1 but wherein a pair of auxiliary switches are operated by the circuit controlling switch or circuit breaker, each auxiliary switch controlling a separate circuit, one auxiliary switch serving to energize the lockout relay means and the other switch serving to shunt the starting switch and the lockout switch, when the circuit breaker is operated to the closed position. In Fig. 2, the same reference numerals are used for elements common to both Fig. 1 and Fig. 2.

As shown in Fig. 2, the circuit controlling switch 10 is provided with the operating winding 15 arranged when energized to effect movement of the circuit controlling contacts 11 to the closed position for energizing the motor 13. However, instead of the single auxiliary switch 19 operated by the circuit breaker 10 when it is moved to its closed position, I provide a pair of auxiliary switches 31 and 32, each normally open and moved to a closed position when the circuit breaker closes.

It is believed that a complete understanding of the form of my invention shown in Fig. 2 may readily be had from the description of operation which follows: Upon closure of the control switch 24, an energizing circuit is established for the operating winding 15 of the switch 10. This circuit may be traced from the left hand supply conductor 14 through a re-set switch 25, the momentary start button 24, the normally closed lockout switch 22 and by a conductor 33 through the operating winding 15 and the normally closed overload contacts 18 to the right hand supply conductor 14. Thus upon energization of the energizing winding 15, the contacts 11 of the circuit breaker 10 are moved to the closed position to energize the motor 13. Simultaneously, the auxiliary switches 31 and 32, which are normally open, are moved to their closed positions. The auxiliary switch 32 completes a shunt circuit for both the starting switch 24 and the lockout switch 22 and maintains the operating winding 15 energized irrespective of the position of the start button 24 or the lockout contacts 22. This energizing circuit for the operating winding 15 may be traced from the left hand supply conductor 14 through the stop re-set switch 25, a conductor 34, the auxiliary switch 32 to the operating winding 15 and through the normally closed overload contacts 18 to the right hand supply conductor 14.

Closure of the auxiliary contact 31 with the closure of the circuit breaker 10 serves to energize the winding 20 of the lockout relay 21 whereupon the auxiliary lockout contacts 23 are closed and thereafter the lockout contacts 22 are opened. This circuit may be traced from the left hand supply conductor 14 through the stop re-set switch 25, the conductors 35 and 36, the switch 31, a conductor 37 and through the energizing winding 20 of the lockout relay 21 by a conductor 28 to the right hand supply conductor 14.

Closure of the auxiliary lockout contact 23 upon operating of the lockout relay 21 establishes a holding circuit to maintain the energizing winding of the lockout relay 21 in the energized condition irrespective of subsequent operation of the circuit breaker 10 and the auxiliary switches 31 and 32. This maintained energizing circuit through the lockout relay 21 may be traced from the live conductor 35 through a conductor 39, the switch 23, and a conductor 40 to the energizing winding 20 and by the conductor 28 to the right hand supply conductor 14. The circuit breaker 10 may be opened at any time by opening the stop re-set switch 25.

If thereafter an overload occurs on the motor 13, the overload relay 16 operates to open the switch 18. This serves to de-energize the energizing winding 15 of the circuit breaker 10 to open the main switch 11 and the auxiliary switches 31 and 32. At this time, the lockout switch 22 is open and is maintained open because of the continued energization of the lockout relay winding 20 through the holding circuit including the closed switch 23. Before the circuit breaker 10 can be reclosed, the lockout switch 22 must be closed by de-energizing the winding 20. This is done by opening the stop re-set switch 25. After re-setting of the lockout switches 22 and 23, the stop re-set switch may be closed and closure of the circuit breaker 10 obtained by pressing the start button 24. Should a latched-type circuit breaker be used instead of the energized breaker 10 shown, the holding circuit including the conductor 34 and the switch 32 is dispensed with and a suitable tripping means for the latch provided which will trip the

circuit breaker upon operation of the overload relay 16. In any case, the lockout relay 21 is energized upon closure of the circuit breaker and thereafter is maintained in its operated position irrespective of the later operation of the circuit breaker and its auxiliary switching means.

While I have shown particular embodiments 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 main switch having an operating winding energizable to close the switch, said control means comprising an abnormal condition responsive means including a switch for opening the circuit controlling main switch, means including a control switch and a lockout switch in series circuit with said condition responsive switch for energizing said operating winding to close said main switch, relay means responsive to each closure of the main switch for opening said lockout switch, an auxiliary switch operable by the closure of the main switch for energizing said relay means, additional means controlled by said relay means for establishing a holding circuit for said relay means when said relay means is energized whereby said lockout switch is maintained open irrespective of the operation of said auxiliary switch, circuit means connecting said auxiliary switch and said additional means in a parallel circuit, said last mentioned parallel circuit being connected in series with said relay means and in parallel with said condition responsive switch, and means for de-energizing said relay means to re-set said lockout switch.

2. Control means for a circuit controlling main switch having an operating winding energizable to close the switch, said control means comprising an abnormal condition responsive means including a switch for opening the circuit controlling main switch, means including a control switch and a lockout switch in series circuit with said condition responsive switch for energizing said operating winding to close said main switch, relay means responsive to each closure of the main switch for opening said lockout switch, an auxiliary switch operable by the closure of the main switch for energizing said relay means, additional means controlled by said relay means for establishing a holding circuit for said relay means when said relay means is energized whereby said lockout switch is maintained open irrespective of the operation of said auxiliary switch, circuit means connecting said auxiliary switch and said additional means in parallel with each other, said circuit means also connecting said relay means in shunt with said lockout switch and said condition responsive switch for energizing said relay means independently of the operation of said lockout switch, said condition responsive switch and said auxiliary switch being connected in shunt with said lockout switch after said additional means has been operated to the closed position by the energization of said relay means, and means for de-energizing said relay means to re-set said lockout switch.

3. Control means for a circuit controlling main switch having an operating winding energizable to close the switch, said control means comprising an abnormal condition responsive means including a switch for opening the circuit controlling main switch, means including a control switch and a lockout switch in series circuit with said condition responsive switch for energizing said operating winding to close said main switch, relay means responsive to each closure of the main switch for opening said lockout switch, an auxiliary switch operable by the closure of the main switch for energizing said relay means, additional means controlled by said relay means for establishing a holding circuit for said relay means when said relay means is energized whereby said lockout switch is maintained open irrespective of the operation of said auxiliary switch, circuit means connecting said auxiliary switch and said additional means in series circuit, said last mentioned series circuit being connected in shunt with said lockout switch to energize said main switch through said auxiliary switch and said additional means when the main switch is in the closed position, and means for de-energizing said relay means to re-set said lockout switch.

4. An electrical control system for a circuit interrupter having a movable contact operable to circuit opening and closing positions comprising a control switch, a normally closed lockout switch, a solenoid winding and a normally closed overload switch electrically connected together in series circuit, means operable by said solenoid winding upon energization thereof to effect movement of said movable contact of the circuit interrupter to the closed position, a relay winding and a normally open interlock switch connected in series circuit, circuit means connecting said last mentioned series circuit in shunt with said lockout switch, said solenoid winding and said overload switch, said relay winding when energized causing said lockout switch to open and said normally open interlock switch to close, means including a normally open auxiliary switch operable to the closed position by closure of the circuit interrupter, said auxiliary switch being connected in series circuit with said relay winding and in shunt with said interlock switch for energizing said relay winding upon closure of said auxiliary switch thereby to close said interlock switch to maintain said lockout switch in the open position irrespective of the position of said auxiliary switch, and means for de-energizing said relay winding to re-set said lockout switch.

5. An electrical control system for circuit interrupter having a movable contact operable to circuit opening and closing positions comprising a control switch, a normally closed lockout switch, a solenoid winding and a normally closed overload switch electrically connected together in series circuit, means operable by said solenoid winding upon energization thereof to effect movement of said movable contact of the circuit interrupter to the closed position, a relay winding and a normally open interlock switch connected in series circuit, circuit means connecting said last mentioned series circuit in shunt with said control switch, said lockout switch, said solenoid winding and said overload switch, said relay winding when energized causing said lockout switch to open and said normally open interlock switch to close, means including a normally open auxiliary switch operable to the closed position by closure of the circuit interrupter, means connecting said auxiliary switch in series circuit with said relay winding and in shunt with

said interlock switch for energizing said relay winding upon closure of said auxiliary switch thereby to close said interlock switch to maintain said lockout switch in the open position irrespective of the return of said contactor to said open position, said interlock switch and said auxiliary switch being series connected in shunt across said control switch and said lockout switch for interlocking said switches when the circuit interrupter is in said closed position, and means for de-energizing said relay winding to re-set said lockout switch.

6. An electrical control system for a circuit interrupter having a movable contact operable to circuit opening and closing positions comprising a control switch, a normally closed lockout switch, a solenoid winding and a normally closed overload switch electrically connected together in series circuit, means operable by said solenoid winding upon energization thereof to effect movement of said movable contact of the circuit interrupter to the closed position, a relay winding and a normally open interlock switch connected in series circuit, circuit means connecting said last mentioned series circuit in shunt with said lockout switch, said solenoid winding and said overload switch, said relay winding when energized causing said lockout switch to open and said normally open interlock switch to close, means including a pair of normally open auxiliary switches operable to the closed position by closure of the circuit interrupter, one of said auxiliary switches being connected in series circuit with said relay winding and in shunt with said interlock switch for energizing said relay winding upon closure of said auxiliary switch thereby to close said interlock switch to maintain said lockout switch in the open position irrespective of the position of said one of said auxiliary switches, the other of said auxiliary switches being connected in shunt with said lockout switch for energizing said solenoid winding after the circuit interrupter has closed said last mentioned auxiliary switch, and means for de-energizing said relay winding to re-set said lockout switch.

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