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AUTOMATIC CIRCUIT BREAKER RECLOSING MECHANISM

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Fig. 1.

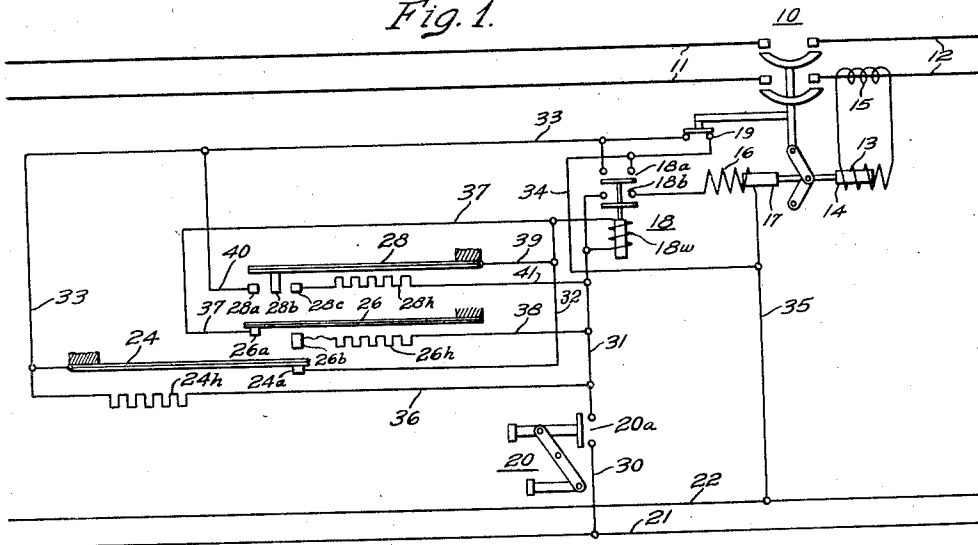


Fig. 2.

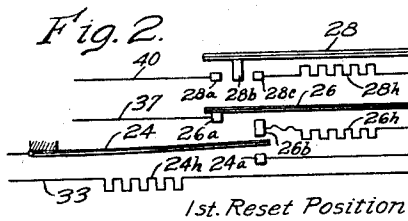


Fig. 3.

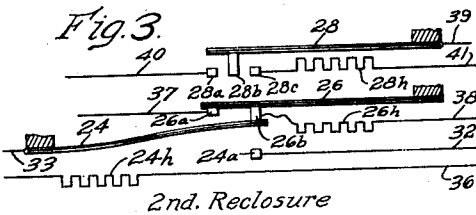


Fig. 4.

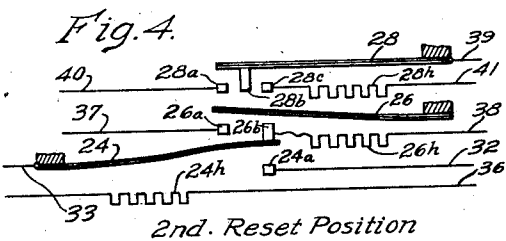


Fig. 5.

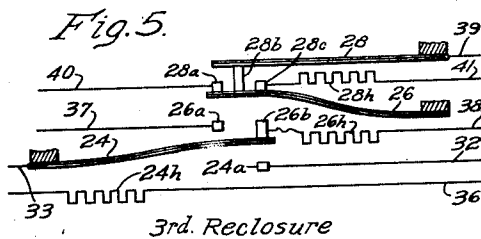
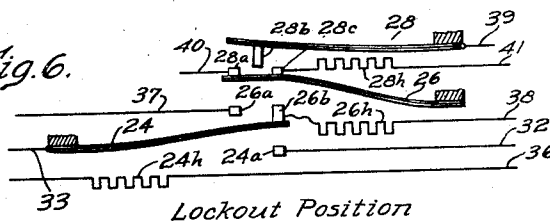


Fig. 6.



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AUTOMATIC CIRCUIT BREAKER
RECLOSING MECHANISM

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15 Claims. (Cl. 175—294)

My invention relates, generally, to electrical control systems, and it has particular relation to systems for automatically reclosing circuit breakers.

5 The object of my invention, generally stated, is to provide a reclosing system for circuit breakers which will be simple and efficient in operation, and which may be readily and economically manufactured and installed.

10 The principal object of my invention is to provide for automatically reclosing a circuit breaker.

A more specific object of my invention is to provide for effecting a predetermined number of timed reclosures of a circuit interrupter in response to successive openings thereof by means of a thermal switching device.

15 An important object of my invention is to provide for locking out a reclosing system to prevent reclosure of a circuit breaker after it has been reclosed a predetermined number of times.

20 A further object of my invention is to provide for automatically resetting a reclosing system for circuit breakers when the circuit breaker remains in the closed position.

25 A still further object of my invention is to provide for effecting either a single reclosure or a plurality of reclosures of a circuit breaker, and for restoring the reclosing system therefor to its initial non-operating condition when the circuit breaker remains in the closed position.

Other objects of my invention will, in part, be obvious and, in part, appear hereinafter.

30 My invention, accordingly, is disclosed in the embodiment hereof shown in the accompanying drawing and comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the appended claims.

35 For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description, taken in connection with the accompanying drawing, in which:

40 Figure 1 illustrates diagrammatically a concrete embodiment of my invention; and

45 Figs. 2 through 6 illustrate different positions of the thermal elements which are employed in practicing my invention.

50 When a circuit breaker which is used to connect two sections of an electric power system together is automatically tripped out, due to a fault, it is often desirable to immediately effect

its reclosure. Such operation is desirable in view of the fact that the fault may be of a momentary nature and may be immediately cleared as soon as the circuit breaker is opened. In some instances, however, it is desirable to re- 5 close the circuit breaker for more than one time, such, for example, as a predetermined number of times at predetermined intervals, in order to effect the clearing of the fault, or to maintain stability in the system.

10 In order to effect the reclosing of the circuit breaker, I have provided a thermal switching device comprising a plurality of sequentially-operable thermal devices. As soon as the circuit breaker is tripped, an energizing circuit is 15 completed through the first of the thermal devices for effecting an immediate reclosure of the circuit breaker. The heating element of the thermal device is energized in response to the opening of the breaker, which, after an interval 20 of time causes the thermal element to open the operating circuit, and at the same time, effecting the deenergization of the heating element. If the circuit breaker reopens immediately, the heating element is again energized or remains 25 energized and continues to heat or reheats the thermal element until it is effective to again complete the energizing circuit, whereupon the circuit breaker is again closed.

30 The foregoing cycle of operations continues until all of the thermal devices have been effective, or until the circuit breaker remains in the closed position. If the circuit breaker trips out after the last thermal device has operated, no further operation can take place, since the re- 35 closing system is automatically locked out at this point.

Referring now particularly to Fig. 1 of the drawing, the reference character 10 designates a circuit breaker which is disposed to connect two 40 sections of a power system which may be represented by conductors 11 and 12. For the purposes of illustration, the power system is illustrated as being an alternating-current power system, but it will be readily understood that this invention 45 may be also used in connection with a direct-current power system.

50 The circuit breaker 10 is provided with a trip winding 13 which is associated with an armature 14. The winding 13 is connected for energization to a secondary winding 15 of a current transformer, the primary winding of which comprises one of the conductors 12. It will be readily understood that a suitable relay may be inter- 55 posed between the secondary winding 15 and the

trip winding 13 if such an arrangement of apparatus is desired or that the circuit breaker may be tripped in response to any other circuit condition.

In order to operate the circuit breaker 10 to the closed position, an operating mechanism is provided therefor which comprises a closing winding 16 that is associated with an armature 17. The operating means also comprises an auxiliary relay, shown generally at 18, having an operating winding 18w and contact members 18a and 18b, the function of which will be set forth hereinafter. The circuit breaker 10 is also provided with an auxiliary switch 19, the contact members of which are bridged when the circuit breaker is in the open position. The contact members of the auxiliary switch 19 are connected in parallel circuit relation with contact members 18a of the auxiliary relay 18 for a purpose which will also be set forth hereinafter.

In order to manually control the operation of the circuit breaker 10, a control switch shown generally at 20, is provided, having contact members 20a which are disposed to connect the operating mechanism for energization to a control source, which may be represented by conductors 21 and 22.

In order to effect the automatic reclosing of the circuit breaker 10 in the event that it is tripped on energization of the trip winding 13, a plurality of sequentially-operable thermal devices are provided. The thermal devices comprise bimetallic strips or thermal elements 24, 26, and 28, respectively. It will be understood that the thermal elements 24, 26, and 28 are constructed of dissimilar metals having different thermal coefficients of expansion, so that they may be deflected on the application of heat thereto.

As illustrated, each of the thermal elements 24, 26, and 28 has associated therewith respectively a heating element 24h, 26h, and 28h. In addition, the thermal element 24 has associated therewith a contact member 24a which is normally in engagement therewith. Thermal element 26 has a contact member 26a with which it is normally in engagement, and a contact member 26b, which is normally out of engagement therewith, but which may be moved into engagement therewith by means of the thermal element 24. The thermal element 28 has associated with it fixed contact members 28a and 28c, and a contact member 28b which is movable therewith.

In the event that it is desired to only provide for a single reclosure of the circuit breaker 10 when it has been automatically tripped, the thermal element 24 and associated heating element 24h, and contact member 24a need only be used. However, if it is desired to reclose the circuit breaker 10 more than a single time, then the additional thermal devices are required, the number corresponding to the number of times that it is desired to reclose the circuit breaker 10.

In operation, the switch 20 is closed to effect the operation of the auxiliary relay 18 which, in turn, completes a circuit for energizing the closing winding 16. The circuit breaker 10 is then operated to the closed position connecting the conductors 11 to the conductors 12 in the usual manner.

The circuit for energizing the operating winding 18w may be traced from the energized conductor 21 through conductor 30, contact members 20a, conductor 31, operating winding 18w, conductor 32, contact member 24a, thermal element 24, conductor 33, the contact members of aux-

iliary switch 19 and conductors 34 and 35 to the energized conductor 22.

At contact members 18b, an obvious energizing circuit for the closing winding 16 is completed. At contact members 18a, the contact members of the auxiliary switch 19 are shunted, thereby maintaining intact the energizing circuit for the operating winding 18w, after the contact members of the auxiliary switch 19 are opened, on closure of the circuit breaker 10.

As long as the thermal element 24 remains in contact engagement with the contact member 24a, the energizing circuit for the operating winding 18w will be maintained. At the same time that the operating winding 18w is energized, it will be observed that the heating element 24h is also energized. The temperature of the thermal element 24 is then increased as a result of the heat generated by the heating element 24h, which causes it to deflect to a position which may be termed the first reset position as is illustrated in Fig. 2 of the drawing. It will be understood that the energizing circuit for the operating winding 18w is then opened, since the thermal element 24 no longer remains in contact engagement with the contact member 24a.

The circuit for energizing the heating element 24h may be traced from the energized conductor 21 through conductor 30, contact members 20a, conductors 31 and 36, heating element 24h, conductor 33, contact members 18a, and conductors 34 and 35 to the energized conductor 22.

The opening of the energizing circuit for the operating winding 18w of the auxiliary relay 18 causes it to be restored to the normal position, and at contact members 18a the energizing circuit for the heating element 24h is opened. It is deenergized and no longer applies heat to the thermal element 24. If the circuit breaker 10 remains in the closed position, the thermal element 24 will be restored to the normal position shown in Fig. 1.

Assuming, however, that only a single thermal element 24 is provided, and that the circuit breaker 10 immediately trips out as soon as it has been closed, it will be observed that the heating element 24h will be immediately reenergized through the contact members of the auxiliary switch 19, and will continue to apply heat to the thermal element 24. Since the thermal element 24 will not, as yet, have been restored to the normal position, it will not be possible to complete the energizing circuit for the operating winding 18w, and as a result, the circuit breaker 10 cannot be again reclosed until the system is manually reset.

However, if the additional thermal elements 26 and 28 are provided, as illustrated, the circuit breaker 10 may be reclosed two more times. Assuming that the circuit breaker 10 is automatically tripped again, the heating element 24h will be reenergized by the closing of the contact members of the auxiliary switch 19 and the thermal element 24 will be deflected to engage the contact member 26b and to move it into engagement with the thermal element 26. The relative positions of the thermal elements and contact members, as thus described, are illustrated in Fig. 3 of the drawing. Circuits are now completed for energizing the operating winding 18w to effect the second reclosure of circuit breaker 10 and for energizing the heating element 26h to increase the temperature of the thermal element 26.

The circuit for energizing the operating winding 18w may now be traced from the energized conductor 21 through conductor 30, contact mem-

bers 20a, conductor 31, operating winding 18w, conductor 37, contact member 26a, thermal element 26, contact member 26b, thermal element 24, conductor 33, contact members of the auxiliary switch 19 and conductors 34 and 35 to the energized conductor 22. The circuit for energizing the heating element 26h may be traced from the energized conductor 21 through conductor 30, contact members 20a, conductors 31 and 38, heating element 26h, to the contact member 26b and thence over the circuit which has just been traced for energizing the operating winding 18w.

It will now be observed that both heating elements 24h and 26h are energized in order to maintain the thermal elements 24 and 26 in a heated condition. The continued heating of the thermal element 26 causes it to open the energizing circuit for the operating winding 18w, which had been bridged between contact members 26a and 26b by the thermal element 26. This condition is illustrated in Fig. 4 of the drawing, in what may be termed a second reset position. The operating winding 18w is then deenergized and at contact members 18a the energizing circuits for the heating elements 24h and 26h are opened, thereby permitting the thermal elements 24 and 26 to be restored to their normal positions, as illustrated in Fig. 1 of the drawing.

In the event that the circuit breaker 10 again immediately trips out, it will be observed that the energizing circuits for the heating elements 24h and 26h will be completed at the contact members of the auxiliary switch 19. Since the thermal elements 24 and 26 have not, as yet, been restored to their normal positions, they will continue to be heated and finally the thermal element 26 will assume the position illustrated in Fig. 5 in order to effect the third reclosure of the circuit breaker 10. In this position, the thermal element 26 bridges the contact members 28a, 28b, and 28c, in order to again effect the energization of the operating winding 18w and to energize the heating element 28h.

The circuit for now energizing the operating winding 18w may be traced from the energized conductor 21 through conductor 30, contact members 20a, conductor 31, operating winding 18w, conductors 37, 32, and 39, thermal element 28, contact members 28b and 28a bridged by the thermal element 26, conductors 40 and 33, contact members of the auxiliary switch 19 and conductors 34 and 35 to the energized conductor 22. The circuit for energizing the heating element 28h may be traced from the energized conductor 21 through conductor 30, contact members 20a, conductors 31 and 41, heating element 28h, contact member 28c, and thence through thermal element 26 and contact member 28a over the same circuit which has just been traced for energizing the operating winding 18w.

The energization of the heating element 28h increases the temperature of the thermal element 28 and causes it to move to what may be termed the lock-out position, which is illustrated in Fig. 6 of the drawing. When the thermal element 28 is operated to the position there shown, the energizing circuit for the operating winding 18w is opened, and the auxiliary relay 18 is restored to its normal position.

In the event that the circuit breaker 10 is immediately tripped out, the heating elements 24h, 26h, and 28h will be reenergized and will be effective to maintain their corresponding thermal elements 24, 26, and 28 in the positions illustrated in Fig. 6 of the drawing. It will then be necessary

to manually reset the system. This may be accomplished by operating the switch 20 to the open position, thereby deenergizing all of the heating elements and restoring the system to the condition illustrated in Fig. 1 of the drawing.

Although three thermal elements 24, 26, and 28 have been illustrated, it will be readily understood that a greater or a lesser number may be employed, without departing from the scope of this invention. Since certain further changes may be made in the foregoing construction, and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all matter shown in the accompanying drawing or described in the foregoing specification shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a thermal device having a normal and an operated position, means responsive to the opening of the circuit breaker for initiating the functioning of said thermal device to energize said operating means for reclosing the circuit breaker, and means for maintaining said thermal device in the operated position on the immediate reopening of the circuit breaker.

2. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a thermal device, means for effecting the energization of said thermal device and the operating means through said thermal device thereby in turn deenergizing the operating means, and means responsive to the immediate opening of the circuit breaker for continuing the energization of said thermal device to effect the reclosure of the circuit breaker.

3. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a thermal device having a normal and an operated position, means for effecting the energization of said thermal device and the operating means through said thermal device thereby in turn deenergizing the operating means, means responsive to the immediate opening of the circuit breaker for continuing the energization of said thermal device to effect the reclosure of the circuit breaker, and means for maintaining said thermal device in the operated position on the immediate reopening of the circuit breaker and permitting said thermal device to reset when the circuit breaker remains in the closed position.

4. A reclosing system for a circuit breaker provided with operating means and an auxiliary switch comprising, in combination, a thermal device disposed to complete an energizing circuit through the auxiliary switch for the operating means when the circuit breaker is in the open position, and a heating element disposed in operative relation to said thermal device for energizing it to open the circuit to the operating means subsequent to the energization of the operating means.

5. A reclosing system for a circuit breaker provided with operating means and an auxiliary switch comprising, in combination, a thermal device disposed to complete an energizing circuit through the auxiliary switch for the operating means when the circuit breaker is in the open position, and a heating element connected to be energized on opening of the circuit breaker and disposed in operative relation to said thermal device for heating it to open the circuit to the operating means and to maintain said thermal

device energized on the immediate reopening of the circuit breaker.

6. A reclosing system for a circuit breaker comprising a plurality of sequentially-operable thermal devices disposed to successively effect the reclosure of the circuit breaker a predetermined number of times, and means for effecting the sequential operation of said thermal devices in response to the successive automatic opening of the circuit breaker.

7. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a plurality of sequentially operable thermal devices, and means responsive to the opening of the circuit breaker for initiating the functioning of said thermal devices for successively effecting the energization of the operating means in response to the successive automatic opening of the circuit breaker.

8. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a plurality of sequentially-operable thermal devices, means responsive to the opening of the circuit breaker for initiating the functioning of said thermal devices for successively effecting the energization of the operating means in response to the successive automatic opening of the circuit breaker, and means for preventing further energization of the operating means after the circuit breaker has been closed a predetermined number of times and is then opened.

9. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a plurality of sequentially-operable thermal devices, and means for sequentially effecting the energization of said thermal devices and the operating means through said thermal devices thereby in turn deenergizing and energizing the operating means for a predetermined number of times in response to the successive opening of the circuit breaker.

10. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a plurality of sequentially-operable thermal devices, means for sequentially effecting the energization of said thermal devices and the operating means through said thermal devices thereby in turn deenergizing and energizing the operating means for a predetermined number of times in response to the successive opening of the circuit breaker, and means for maintaining the last operated thermal device in the operated position on the immediate reopening of the circuit breaker and permitting said thermal devices to reset when the circuit breaker remains in the closed position.

11. A reclosing system for a circuit breaker provided with operating means and an auxiliary switch comprising, in combination, a plurality of sequentially-operable thermal devices each disposed to complete an energizing circuit through the auxiliary switch for the operating means when the circuit breaker is in the open position, and a heating element disposed in operative relation to each of said thermal devices for heating them to open the circuit to the operating means

subsequent to the energization of the operating means.

12. A reclosing system for a circuit breaker provided with operating means and an auxiliary switch comprising, in combination, a plurality of sequentially-operable thermal devices each disposed to complete an energizing circuit through the auxiliary switch for the operating means when the circuit breaker is in the open position, and a heating element disposed in operative relation to each of said thermal devices and connected to be successively energized on successive opening of the circuit breaker for heating said thermal devices to open their respective circuits to the operating means and to maintain said thermal devices energized on the immediate reopening of the circuit breaker.

13. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a plurality of sequentially-operable thermal devices disposed to be successively energized, means for effecting the sequential operation of said thermal devices on successive opening of the circuit breaker for effecting the energization of the operating means to reclose the circuit breaker, and means for preventing further operation of the circuit breaker after it has been reclosed a predetermined number of times.

14. A reclosing system for a circuit breaker provided with operating means and an auxiliary switch comprising, in combination, a plurality of sequentially-operable thermal devices, the first of said devices being provided with normally closed contact members and the remainder with normally open contact members, said contact members being connected in parallel circuit relation and in series circuit with the operating means and auxiliary switch, and a heating element individual to each thermal device, said circuit breaker on opening completing an energizing circuit for the operating means and heating element of the first thermal device through the auxiliary switch, thereby effecting a reclosure of the circuit breaker and energization of the first thermal device to open the energizing circuit for the operating means, successive opening of the circuit breaker causing the successive energization of the remaining thermal devices to effect the reclosure of the circuit breaker for a number of times corresponding to the number of thermal elements.

15. A reclosing system for a circuit breaker provided with operating means comprising, in combination, a thermal device having a normal and an operated position, means responsive to the opening of the circuit breaker for initiating the movement of said thermal device to said operated position and for energizing said operating means to reclose the circuit breaker before said thermal device leaves said normal position, and means for maintaining said thermal device in the operated position on the immediate reopening of the circuit breaker to prevent a second immediate reclosure thereof by the same means whereby the first reclosure was effected.

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