The invention relates to circuit interrupters in general and more particularly to operating means for circuit breakers.

The present application is a division of my copending application entitled "Circuit interrupting apparatus," Serial No. 228,331, filed September 3, 1938, assigned to Westinghouse Electric & Manufacturing Company and which is now Patent No. 2,264,712, granted December 2, 1941.

Circuit breakers are usually provided with operating means including closing means, latching means or toggle devices for maintaining the breaker closed, and means for causing the breaker to be opened or closed of the breaker.

It is very important that the breaker closing means remain energized for a sufficient length of time to insure that the breaker is actuated to the fully closed position as otherwise the breaker may immediately return to open position. Under the last-mentioned condition the breaker mechanism will continue to try to close the breaker as long as the closing control switch is held in closed position. It is desirable, therefore, to provide some means for ensuring that the closing means will remain energized for a sufficient length of time to move the circuit breaker to the fully closed position.

An object of the invention is the provision of a circuit breaker and operating means therefor which will normally ensure that the circuit breaker is moved to the completely closed position before the operating means ceases to function.

Another object of the invention is the provision of a circuit breaker and operating means therefor which embodies a means for ensuring that the closing means will remain energized for a sufficient length of time to normally effect complete closing of the circuit breaker.

In accordance with the invention there is provided a capacitor or other electrical device which is energized on opening of the circuit breaker. When the breaker is being closed, the energy stored in the capacitor or device is discharged through a circuit which maintains the closing means energized until the circuit breaker has been moved to the fully closed position.

The novel features that are considered characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing, in which the single figure is a diagrammatic view showing an embodiment of the invention by the operation of which the complete closing of a circuit breaker is assured.

The apparatus shown in the drawing comprises a circuit interrupter 7 of the conventional construction equipped with a main contactor 9 and a latching arrangement 11 whereby it is latched in the closed position. Energy for actuating the circuit interrupter 7 is derived from a pair of direct current supply conductors 13 and 15 which may be supplied in any suitable manner as from a direct current source or through rectifiers from an alternating current source. The circuit interrupter is closed by the excitation of a solenoid 17 to the core 19 of which the actuating bar 21 for the interrupter is attached. The exciting coil 23 of the solenoid 17, which is customarily designated as the closing coil of the circuit breaker, is connected across the direct current supply conductors 13 and 15 through the contactor 35 of a closing relay 27 which is energized when the circuit breaker is to be closed.

For controlling closing of the interrupter, a control switch 29 is provided. The latter may be latched in the closed position after being manually moved to closed position, and opens under the action of gravity when after a closing operation, its latch 31 is released. It may be reset manually.

The closing control switch 29 maintains a circuit through the coil 33 of the closing relay 27 closed and the latter in energized condition. When the latch 31 of the control switch is released and the switch falls out, the closing relay would ordinarily be deenergized opening its contactor 25. If the circuit interrupter mechanism 7 has not been latched in closed position at the time that the control switch is opened, the circuit breaker would be opened because its associated closing coil 23 is deenergized.

To make certain that the circuit interrupter is moved to the fully closed position and latched before the termination of a closing operation there is provided, in accordance with the invention, a capacitor 35 which is charged quickly when the circuit interrupter 7 is opened and which slowly discharges through a resistor 37 and the exciting coil 33 of the closing relay 27 during closing of the circuit interrupter. The closing relay 27 is maintained energized by the discharge current from the capacitor 35 after the closing control switch 29 reopens and, therefore, at this time, the coil 23 of the circuit interrupter clos-
ing means if it is maintained excited and the circuit breaker, if it is not yet closed, continues to close in spite of the dropping out of the closing control switch, or opening of the auxiliary switch on the circuit breaker, which auxiliary switch is disposed in the control circuit of the closing relay.

The operation of the apparatus is briefly as follows: Immediately the circuit breaker opens, the capacitor 35 is quickly charged in a circuit which extends from the positive supply conductor 13 through a conductor 39, a rectifier 41, the capacitor 35, a conductor 43, an auxiliary switch 45 which is closed when the circuit breaker opens, a conductor 47 to the negative supply conductor 16. The rectifier 41 is provided in circuit with the capacitor 35 to prevent its discharge through any circuits or portions of circuits which happen to be connected to the direct current supply 13—16. It is preferably of the dry type such as a copper-oxide rectifier. It is to be noted that in the charging circuit just traced there are no resistances other than the resistance of the rectifier 41 and of the conductors 39, 43 and 47. Because of this situation, the time constant of the circuit is small and the capacitor 35 charges quickly.

When the circuit interrupter 7 opens, a current is induced through the exciting coil 33 of the closing relay 27. The circuit extends from the positive supply conductor 13 through a conductor 49, the lowest auxiliary switch 51 of the circuit interrupter which is closed when the circuit breaker opens, a conductor 53, the control switch 29, another dry rectifier 55, the exciting coil 33 of the closing relay 27, the central auxiliary switch 45 of the circuit interrupter, the conductor 47 to the negative supply conductor 16. To close the circuit breaker, the control switch 29 is manually closed. This completes the prepared circuit just described effecting energization of the closing relay 27. The closing relay 27 closes its contactor 25 causing energization of the closing means 17. Since the electromagnetic action involved in the excitation of the closing relay 27 is slow compared to the time constant of the charging circuit for the capacitor 35, the capacitor has time to charge substantially before the relay is actuated.

On the actuation of the closing relay 27 its contactor 25 is closed and closes the circuit through the exciting coil 33 of the closing relay 27, and also a circuit through the latching coil 57 of the closing control switch 29. The latter circuit extends from the positive line conductor 13 through the conductor 39, the contactor 25 of the closing relay, the latching coil 57, a conductor 59 to the negative line conductor 16. The latch 31 is, therefore, released simultaneously with the energization of the closing means 17 and both are operated together. The circuit interrupter 7, however, requires some time for complete operation, since it must be latched in the closed position. To provide the necessary time, the capacitor 35 is now discharged through the exciting coil 33 of the closing relay 27. The discharge circuit for the capacitor 35 extends from its left-hand plate 61 through the discharge resistor 37, a third rectifier 53, a fourth rectifier 55, the exciting exciting coil 33 of the auxiliary switch 43 to the right-hand plate 61 of the capacitor. The resistor 37 is of such magnitude that the current flow through the exciting coil 33 of the auxiliary relay 27 continues at a substantial value for a long enough time to enable the circuit interrupter 7 to completely close. After the interrupter is latched in the closed position, the capacitor 35 is discharged such the auxiliary relay coil, the relay 27 opens, and the system continues to operate in the normal manner. The closing control switch 29 may be closed at any convenient time by the operator. If the fault producing the actuation of the circuit breaker happens to be permanent, the circuit interrupter 7 is again reopened.

The upper auxiliary switch 69 of the circuit interrupter is provided for the purpose of preventing undesired operation of the closing relay 27 by reason of current flow in a circuit through exciting coil 33 of the relay and through the discharge resistor 37 which happens to be closed by mere coincidence when the interrupter 7 is opened. The circuit extends from the positive supply conductor 13 through the conductor 39, the rectifier 41, the resistor 37, the rectifier 65, the exciting coil 33 of the closing relay 27, the central auxiliary switch 45 of the circuit breaker, the conductor 47 to the negative line conductor 16. The operation of the relay 27 is prevented because the exciting coil 33 is short circuited by the upper auxiliary switch 69 of the circuit interrupter and, therefore, diverts the current flow from the closing relay control circuit.

The function of the rectifiers 63, 65 and 55 is the same as that of the rectifier 41 to prevent the undesired discharge of the capacitor 35 through extraneous circuits. For example, the rectifier 55 in series with the closing control contactor 29 prevents the discharge of the capacitor 35 in a circuit extending through the conductor 39, the rectifier 41, the capacitor 35, the exciting coil 33 of the closing relay 27, the closing control switch 29, the lowest auxiliary switch 51 of the circuit interrupter, the conductor 47 and the portion of the positive line conductor 13 connecting the conductors 39 and 49.

Although I have shown and described one embodiment of the invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination, a circuit breaker, operating means which is energized to cause closing of said breaker and which is deenergized upon closing of said breaker, charge storing means, means actuated upon opening said breaker, said charge storing means and a path including said operating means for discharging said charge storing means to maintain said operating means energized for a sufficiently long time to completely close said breaker.

2. In combination, a circuit breaker, operating means, a circuit for energizing said operating means to cause closing of said breaker, said circuit being opened upon closing of said breaker, charge storing means, means actuated upon opening said breaker for charging said charge storing means to a substantial potential in an interval of time that is short compared to the time required for said breaker to carry through one complete closing operation, and a path including said operating means for discharging said charge storing means, said path being of such character and said potential being of such magnitude that said operating means is maintained energized by the discharge sufficiently long to completely close said breaker.
3. In combination, a circuit breaker, operating means therefor, a circuit for energizing said operating means to cause closing of said breaker, said circuit being opened upon closing of said breaker, charge storing means, means actuated upon opening of said breaker for charging said charge storing means to a substantial potential in an interval of time that is short compared to the time required for said breaker to carry through one complete closing operation, a path including said operating means for discharging said charge storing means, said path being of such character and said potential being of such magnitude that said operating means is maintained energized by the discharge sufficiently long to completely close said breaker, and means for preventing the discharge of said capacitor through portions of said energizing circuit.

4. In combination, a circuit breaker having means for latching it in the closed position, operating means and a circuit for energizing said operating means to cause closing of said breaker, said circuit being opened upon closing of said breaker, charge storing means, means actuated upon opening of said breaker for charging said charge storing means to a substantial potential in an interval of time that is short compared to the time required for said breaker to carry through one complete closing and latching operation, and a path including said operating means for discharging said charge storing means, said path being of such character and said potential being of such magnitude that said operating means is maintained energized by the discharge sufficiently long to cause said breaker to be moved to the fully closed and latched position.

5. In combination, a circuit breaker, means operable to cause opening of said breaker, closing means for closing said breaker, an energy storing device, means operable upon opening of said breaker for storing energy in said device, and means for discharging the energy stored in said device during a closing operation to cause said closing means to remain energized a sufficient length of time to completely close said breaker.

6. In combination, a circuit breaker, operating means therefor including closing means for closing the breaker, a closing relay having contacts and an operated winding operable when energized to close the relay contacts and thereby cause said closing means to close the breaker, a source of electric energy, a control circuit including a pair of control contacts operable when closed to cause energization of said relay operating winding by said source of energy, additional circuit means including an electrical energy storage device independent of said closing means automatically operable during a closing operation of the breaker to maintain said relay operating winding energized independently of the control circuit and for a sufficient length of time to normally cause complete breaking of the breaker.

7. In combination, a circuit breaker, operating means therefor including closing means for closing the breaker, a source of electric energy, a closing relay having contacts and an operating coil for closing said contacts to thereby energize said closing means, a control circuit having a pair of control contacts operable when closed to effect energization of said relay operating winding by said source of energy to cause said closing means to close the relay contacts and thereby move the breaker toward closed position, additional circuit means including an electrical energy storage device independent of said closing means automatically operable during a closing operation of the breaker to maintain said relay operating winding energized independently of said control circuit and for a sufficient length of time to normally cause complete closing of said breaker.

8. In combination, a circuit breaker, operating means therefor including closing means for closing said breaker, a source of electrical energy, a closing control device operable when energized to close an energizing circuit for said closing means, a control circuit including control contacts operable when closed to energize said device from said source to cause energization of said closing means, said control circuit including auxiliary contacts on said breaker which are open when said breaker is in closed position to de-energize said device and means including an electrical energy storage device independent of said closing means and said closing control device automatically operable during closing operation of the breaker to maintain said closing control device independently of said source for a predetermined length of time sufficient to normally effect complete closing of the breaker.

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