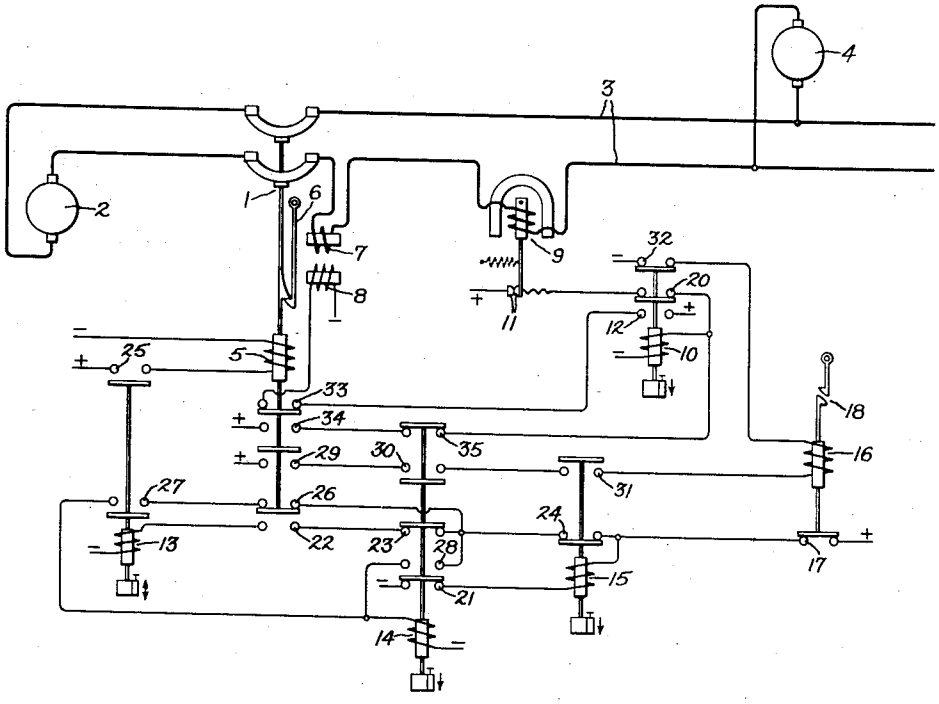
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AUTOMATIC RECLOSING CIRCUIT BREAKER EQUIPMENT

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AUTOMATIC RECLOSING CIRCUIT BREAKER EQUIPMENT

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My invention relates to automatic reclosing circuit breaker equipments, and one of its objects is to provide an improved arrangement of apparatus for preventing further automatic reclosures of a circuit breaker in case it fails to remain closed for a predetermined time interval after a reclosure.

Another object of my invention is to provide an improved arrangement of apparatus whereby the number of automatic reclosures is unlimited when the opening of the circuit breaker is in response to an abnormal condition of a predetermined character such, for example, as in response to a reverse flow of power through the circuit breaker, and the number of automatic reclosures is limited to a predetermined number in case the circuit breaker fails to remain closed for a predetermined time interval after any reclosure following an opening thereof effected by an abnormal condition of a different predetermined character.

My invention will be better understood from the following description when taken in connection with the accompanying drawing, the single figure of which diagrammatically illustrates an automatic reclosing circuit breaker system embodying my invention, and the scope of my invention will be pointed out in the appended claims.

Referring to the drawing, 1 represents a circuit breaker connecting a generator 2 to a load circuit 3 which is supplied from another source 4. As shown, the circuit breaker 1 is of the well-known latch-closed type and comprises a closing coil 5, a latch 6 for holding the circuit breaker in its closed position, an overcurrent trip coil 7 connected in sreies relation with the source 2 when the circuit breaker 1 is closed and arranged to release the latch 6 when the current through the trip coil 7 exceeds a predetermined value, and a second trip coil 8 which, when energized, also effects the release of the latch 6. Preferably the circuit breaker 1 is of the well-known trip-free type. As shown in the drawing, the energization of the trip coil 8 is controlled by a reverse power relay 9 which is responsive to the direction of the flow of power through the circuit breaker 1 and by an associated control relay 10 which is so controlled by the reverse power relay 9 that the trip coil 8 is energized when power flows from the load circuit 3 to the source 2. Under normal operating conditions, the relay 10 is energized and maintains the circuit of the trip coil 8 open, but when a reverse power flows through circuit breaker 1, the reverse power relay 9 opens its contacts 11 and effects the deenergization of the control relay 10 which, after being deenergized for a predetermined time, closes its contacts 12 and completes an energizing circuit for the trip coil 8. It will be evident, however, that the relay 10 does not have to have a time delayed drop out in order to obtain proper operation.

For effecting an automatic reclosure of the circuit breaker 1 after each opening thereof, I provide a reclosing relay 13 which is normally arranged to be energized in response to each opening of the circuit breaker and which, when energized, effects the completion of an energizing circuit for the closing coil 5 of the circuit breaker 1. As shown the relay 13 has a time delayed pick up but it will be evident however that it can have an instantaneous pick up in case an instantaneous reclosure is desired. The reclosing relay 13 is also arranged to effect the energization of a control relay 14 as soon as the circuit breaker 1 closes. The control relay 14, in turn, interrupts the original energizing circuit of the control relay 13 so that it cannot be reenergized to effect another reclosure until after the relay 14 has returned to its deenergized position. The relay 14, when energized, also completes a locking circuit for itself through the contacts of a time relay 15 which, in turn, is arranged to open its contacts in the holding circuit of the relay 14, a predetermined time after the relay 14 becomes energized. When the relay 14 returns to its deenergized position, an energizing circuit is completed thereby for the control relay 15 to restore it to its normally energized position.

In accordance with the embodiment of my invention shown in the drawing, I provide an arrangement of connections so that if, after any reclosure, the circuit breaker 1 again opens before the control relay 14 returns to its deenergized position, an energizing circuit is completed for a lockout relay 16 so that it opens its contacts 17 and interrupts the energizing circuit of the reclosing relay 13 and thereby prevents any further automatic reclosures as long as the lockout relay 16 is held in its energized position by the latch 18.

Since it is desirable not to lock out the circuit breaker 1 in response to momentary reversals of power through the circuit breaker produced by fluctuating load conditions, I also provide an arrangement whereby the lockout relay 16 is prevented from being operated to its lockout position in response to an immediate reopening of

the circuit breaker when the reopening is due to a reversal of power through the circuit breaker. This result is accomplished by having the reverse power relay 9, when it operates to effect an opening of the circuit breaker 1, also effect the opening of the energizing circuit of the lockout relay 16 so that it cannot be completed by the relay 15 closing its contacts 31 while the circuit breaker is open.

The operation of the embodiment of my invention shown in the drawing is as follows: When the circuit breaker 1 is closed and the source 2 is supplying normal current to the load circuit 3, the various control devices are in the positions in which they are shown in the drawing. The control relay 10 is energized by a holding circuit which includes the contacts 20 of the relay 10 and the contacts 11 of the reverse power relay 9, and an energizing circuit is completed for the control relay 15 through the contacts 17 of the lockout relay 16 and the contacts 21 of the control relay 14.

When the current supplied by the source 2 to the load circuit 3 exceeds a predetermined value, the overcurrent trip coil 7 releases the latch 6 and effects the opening of the circuit breaker 1. The closing of the auxiliary contacts 22 of the circuit breaker 1 completes an energizing circuit for the reclosing relay 13 through the contacts 17 of the lockout relay 16, the contacts 24 of the control relay 15, and the contacts 23 of the control relay 14. After being energized for a predetermined time, the reclosing relay 13 closes its contacts 25 and completes an energizing circuit for the closing coil 5 to effect the reclosing of the circuit breaker 1. The closing of the auxiliary contacts 26 of the circuit breaker 1 completes through the contacts 17 of the lockout relay 16, the contacts 24 of the control relay 15, and the contacts 27 of the reclosing relay 13, an energizing circuit for the control relay 14 which, in turn, completes a locking circuit for itself through its contacts 28, the contacts 24 of the control relay 15, and the contacts 17 of the lockout relay 16. The opening of the contacts 21 of the relay 14 interrupts the energizing circuit of the control relay 15 which, after being deenergized for a predetermined time, opens its contacts 24 in the holding circuit of the control relay 14. After being deenergized for a predetermined time, the control relay 14 returns to its normally deenergized position and closes its contacts 21 thereby reestablishing the energizing circuit of the control relay 15 so that the control devices are restored to their normal positions.

If when the circuit breaker 1 is reclosed the over-current trip coil 7 operates immediately to effect another opening of the circuit breaker before the relay 14 is restored to its deenergized position, the closing of the auxiliary contacts 29 of the circuit breaker 1 completes through the contacts 30 of the control relay 14, the contacts 31 of the control relay 15, and the contacts 32 of the control relay 10, an energizing circuit for the lockout relay 16 so that it opens its contacts 17 in the energizing circuit of the reclosing relay 13 and thereby prevents any further automatic reclosures of the circuit breaker. It will be seen, however, that if the circuit breaker 1 is not opened until after the control relay 14 has been restored to its deenergized position, the above described energizing circuit of the lockout relay 16 cannot be completed in response to the next opening of the circuit breaker.

When the circuit breaker 1 is closed and power flows from the load circuit 3 to the source 2, the reverse power relay 9 opens its contacts 11 and interrupts the holding circuit of the control relay 10. The closing of the contacts 12 of the control relay 10 completes through the auxiliary contacts 33 of the circuit breaker 1 an energizing circuit for the trip coil 8 so as to effect the opening of the circuit breaker 1. The opening of the circuit breaker 1 effects an automatic reclosure of the circuit breaker in the same manner as above described, and the closing of the auxiliary contacts 34 of the circuit breaker 1 completes through the contacts 35 of the control relay 14 an energizing circuit for the control relay 10 so that it completes a holding circuit for itself through the contacts 11 before the circuit breaker 1 is reclosed.

If a reversal of power occurs immediately after the circuit breaker 1 is reclosed, the control relay 10 is operated in the manner above described to effect another opening of the circuit breaker 1. Furthermore, the opening of the contacts 32 of the control relay 10 interrupts the heretofore described energizing circuit of the lockout relay 16 so as to prevent this relay from being energized by the closing of the auxiliary contacts 29 of the circuit breaker 1 while the control relay 14 is energized and the control relay 15 is deenergized.

While I have, in accordance with the Patent Statutes, shown and described my invention as applied to a particular system and as embodying various devices diagrammatically indicated, changes and modifications will be obvious to those skilled in the art, and I therefore aim in the appended claims to cover all such changes and 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. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to predetermined abnormal conditions on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, timing means, a control device, means responsive to the closing of said circuit breaker by said second mentioned means for effecting the operation of said control device, means responsive to the operation of said control device to its operated position for initiating the timing operation of said timing means, means responsive to said timing means completing its timing operation for effecting the restoration of said control device to its normal position, and means jointly controlled by said timing means and said control device for preventing a subsequent operation of said reclosing means if said circuit breaker is open while said control device is in its operated position after said timing means has completed its timing operation.

2. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to predetermined abnormal conditions on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, timing means, a control device, means responsive to the closing of said circuit breaker by said second mentioned means for effecting the operation of said control device, means responsive to the operation of said control device to its operated

position for initiating the timing operation of said timing means, means responsive to said timing means completing its timing operation for effecting the restoration of said control device to its normal position, a lockout device for rendering said reclosing means inoperative, and means jointly controlled by said timing means and control device for effecting the operation of said lockout device if said circuit breaker is open while said control device is in its operated position after said timing means has completed its timing operation.

3. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to predetermined abnormal conditions on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, two control devices, means responsive to the closing of said circuit breaker by said second mentioned means for effecting the operation of one of said control devices, means responsive to the operation of said one of said control devices for effecting the operation of the other control device, means responsive to the operation of said second control device for effecting the restoration of said one of said control devices to its normal position, and means jointly controlled by said control devices for preventing a subsequent operation of said reclosing means if said circuit breaker is open when both of said control devices are simultaneously in the operated position.

4. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to predetermined abnormal condition on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, two control devices, means responsive to the closing of said circuit breaker by said second mentioned means for effecting the operation of one of said control devices, means responsive to the operation of said one of said control devices for effecting the operation of the other control device, means responsive to the operation of said second control device for effecting the restoration of said one of said control devices to its normal position, a lockout device for rendering said reclosing means inoperative, and means jointly controlled by said control devices for effecting the operation of said lockout device only when both of said control devices are simultaneously in their operated positions and the circuit breaker is open.

5. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuit, means for opening said circuit breaker in response to predetermined abnormal conditions on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, means for rendering said automatic reclosing means inoperative to effect another reclosure of said circuit breaker if it is opened within a predetermined time interval after any automatic reclosure, and means responsive to an abnormal condition of a predetermined character on one of said circuits for preventing said last mentioned means from rendering said automatic reclosing means inoperative when said circuit breaker is opened by such a fault within said predetermined time interval.

6. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to predetermined abnormal conditions on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, means for rendering said automatic reclosing means inoperative to effect another reclosure of said circuit breaker if it is opened within a predetermined time interval after any automatic reclosure, and means responsive to the flow of power through said circuit breaker in a predetermined direction for preventing said last mentioned means from rendering said automatic reclosing means inoperative when said circuit breaker is opened by such a flow of power.

7. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to predetermined abnormal conditions on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, two control relays, a lockout relay, an energizing circuit for one of said control relays including contacts of the other control relay which are closed when said other control relay is deenergized and contacts of said lockout relay which are closed when said lockout relay is in its normal position, means responsive to the operation of said reclosing means for energizing said other control relay to effect an interruption in said first mentioned energizing circuit, and an energizing circuit for said lockout relay controlled by said control relays and said circuit breaker so that said energizing circuit for said lockout relay is completed when said one of said control relays is in its deenergized position and the other control relay is in its energized position and said circuit breaker is open.

8. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to predetermined abnormal conditions on one of said circuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, two control relays, a lockout relay, an energizing circuit for one of said control relays including contacts of the other control relay which are closed when said other control relay is deenergized and contacts of said lockout relay which are closed when said lockout relay is in its normal position, means responsive to the operation of said reclosing means for energizing said other control relay to effect an interruption in said first mentioned energizing circuit, an energizing circuit for said lockout relay controlled by said control relays and said circuit breaker, so that said energizing circuit for said lockout relay is completed when said one of control relays is in its deenergized position and the other control relay is in its energized position and said circuit breaker is open, means responsive to the direction of power flow through said circuit breaker, and means controlled by said power direction responsive means for interrupting the energizing circuit of said lockout relay when the power flow through said circuit breaker is in a predetermined direction.

9. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to two different predetermined abnormal conditions on one of said cir-

cuits, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, means for limiting the number of automatic reclosures of the circuit breakers when the breaker is tripped in response to one of the predetermined abnormal conditions, and means for permitting an unlimited number of reclosures when the breaker is tripped under the other predetermined abnormal condition.

10. In an automatic reclosing circuit breaker system, two circuits, a circuit breaker interconnecting said circuits, means for opening said circuit breaker in response to overcurrent above a predetermined value and also in response to a reverse current through said circuit breaker, means responsive to the opening of said circuit breaker for effecting the automatic reclosing thereof, means for limiting the number of automatic reclosures of the circuit breakers when the braker is tripped in response to an overcurrent, and means for permitting an unlimited number of reclosures when the breaker is tripped in response to a reversal of current.

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