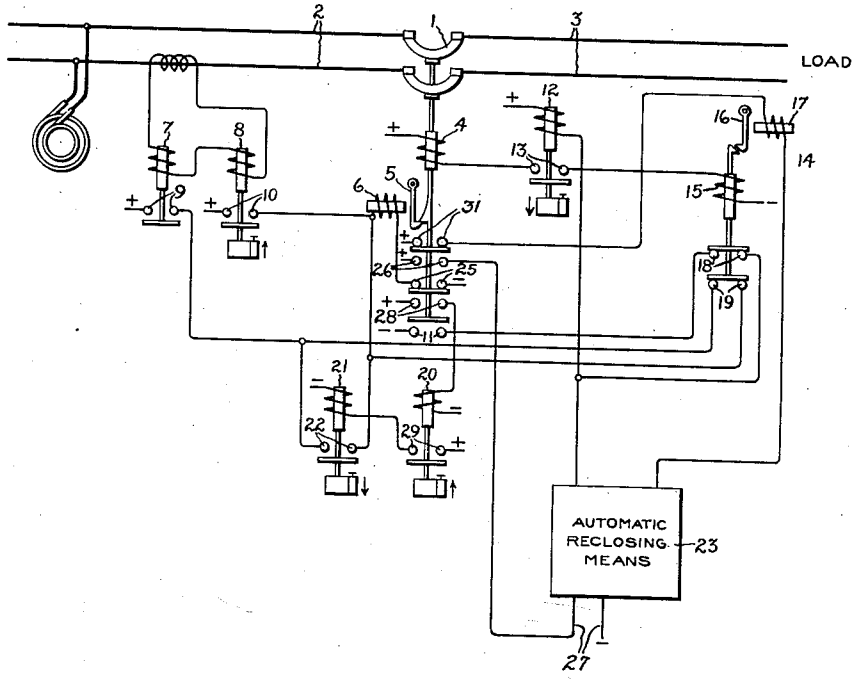
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AUTOMATIC RECLOSING CIRCUIT BREAKER SYSTEM

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AUTOMATIC RECLOSING CIRCUIT BREAKER SYSTEM

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My invention relates to automatic reclosing circuit breaker systems and particularly to such systems in which a circuit breaker is arranged to be opened in response to a predetermined abnormal condition on the circuit controlled by the circuit breaker and the circuit breaker is arranged to be reclosed automatically after each opening thereof which occurs within a predetermined time interval after the first opening, and its object is to provide an improved arrangement for controlling the manner of opening the circuit breaker in accordance with the number of times the circuit breaker has been opened and reclosed.

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 any suitable circuit breaker, examples of which are well-known in the art, for connecting a supply circuit 2, which may be supplied from a suitable source of current, to a load circuit 3. As shown in the drawing, the circuit breaker 1 is of the well-known latched-in type and comprises a closing coil 4, which, when energized, closes the circuit breaker 1, a latch 5 for holding the circuit breaker in its closed position, and a trip coil 6, which, when energized, releases the latch 6 and allows the circuit breaker to open.

Any suitable fault responsive means, examples of which are well-known in the art, may be provided for effecting the opening of the circuit breaker 1. As shown in the drawing, two over-current relays 7 and 8 are provided, which are respectively connected in series relation with the supply circuit 2 in any suitable manner so that they will close their respective contacts 9 and 10 in response to a predetermined abnormal current condition in the supply circuit 2. Each of these over-current relays, when it closes its respective contacts, is normally arranged to complete an energizing circuit for the trip coil 6 of the circuit breaker 1. The over-current relay 7 is arranged so that it closes its contacts 9 instantly when the predetermined abnormal condition occurs in the supply circuit 2, whereas the relay 8 is designed so that it does not close its contacts 10 until after the predetermined abnormal condition has existed for a predetermined time.

Any suitable means for effecting the reclosure of the circuit breaker 1 after it is opened in response to the operation of either of the over-current relays 7 and 8 may be provided. In the drawing, I have shown an arrangement for effecting a substantially instantaneous reclosure after each of a predetermined number of openings of the circuit breaker and a time delay reclosure after each subsequent opening that occurs within a predetermined time interval after the initial opening. For effecting the initial instantaneous reclosure of the circuit breaker 1, the circuit breaker when it opens completes through its auxiliary contacts 11 are energizing circuit for the hesitating control relay 12 which in turn, by closing its contacts 13, completes an energizing circuit for the closing coil 4 of the circuit breaker 1.

In order to limit the number of instantaneous reclosures of the circuit breaker 1 to a predetermined number, which in the particular arrangement shown in the drawing is one, a lock-out relay 14 is provided which is arranged so that after the initial reclosure it maintains the instantaneous reclosing circuit for the hesitating control relay 12 open for a predetermined time interval, if the circuit breaker 1 remains closed, and permanently open, if the circuit breaker is open at the expiration of this predetermined time interval. As shown in the drawing, the operating coil 15 of the lock-out relay 14 is connected in series with the closing coil 4 of the circuit breaker 1. The operating coil 15, when energized, opens the contacts 18, which are connected in series with the contacts 11 so that the subsequent closing of the contacts 11 does not effect an immediate energization of the relay 12. The lock-out relay 14 is arranged in any suitable manner so that it is held in its energized position after the operating winding 15 thereof is de-energized. In the particular arrangement shown, this result is obtained by means of a latch 16 which holds the relay in its energized position and which is arranged to be released by a magnet 17 when it is energized.

In accordance with my invention, the lock-out relay 14 also is arranged to remove the opening of the circuit breaker 1 from the control of the instantaneous over-current relay 7 and place it under the control of the time delay over-current relay 10 when the circuit breaker 1 has been reclosed a sufficient number of times to effect the operation of the relay 14. As shown in the drawing, contacts 9 of the instantaneous over-current relay 7 are connected in series with the normally closed contacts 19 of the lock-out relay 14 so that

the opening of the circuit breaker 1 is controlled by the instantaneous over-current relay 7 until the relay 14 is operated. Then the opening of the circuit breaker 1 is controlled by the time delay over-current relay 8, the contacts 10 of which are arranged to complete an energizing circuit for the trip coil 6 of the circuit breaker 4 after the relay 8 has been energized for a predetermined time by the abnormal current condition.

In accordance with my invention, after the time delay over-current relay 8 has effected a predetermined number of openings of the circuit breaker 1, which in the particular arrangement shown in the drawing is one, the subsequent openings of the circuit breaker 1 are effected by the instantaneous over-current relay 7. This result is accomplished by means of the relay 20, which is connected and arranged so that it closes its contacts in case the circuit breaker 1 remains open for a predetermined length of time. The relay 20, in turn, completes an energizing circuit for relay 21, which has a time delay drop-out. The normally open contacts 22 of the relay 21 are connected in parallel with the contacts 19 so that when the contacts 22 are closed, the closing of the contacts 9 of the instantaneous over-current relay 7 effects the instantaneous opening of the circuit breaker 1.

I also provide additional automatic reclosing means for effecting the reclosing of the circuit breaker 1 a predetermined number of times with relatively long time intervals between successive reclosures in case the circuit breaker 1 does not remain closed after the predetermined number of instantaneous reclosures has been effected. Since such automatic reclosing means are well-known in the art and the detailed circuits thereof form no part of my present invention, I have represented such reclosing means by a rectangle 23. United States Patent 1,784,651, granted December 9, 1930, on an application filed by me and assigned to the assignee of this application, discloses the details of an automatic reclosing circuit breaker arrangement which may be used in connection with my present invention to effect a predetermined number of successive energizations of the control relay 12 with relatively long predetermined time intervals between successive energizations, if the circuit breaker opens a predetermined number of times within a predetermined time interval, and for effecting the energization of the release magnet 17 if the circuit breaker 1 is closed after the automatic reclosing means 23 has been in operation for a predetermined time.

The operation of the arrangement shown in the drawing is as follows: Under normal load conditions, the circuit breaker 1 remains closed and the control devices are in the position shown in the drawing. When the abnormal condition occurs which is arranged to effect the operation of the relays 7 and 8, the relay 7 closes its contacts 9 and completes through the contacts 19 of the lock-out relay 14 and the auxiliary contacts 25 on the circuit breaker 1 an energizing circuit for the trip coil 6 to effect the opening of the circuit breaker 1. As soon as the circuit breaker 1 opens, its auxiliary contacts 11 complete through the contacts 18 of the lock-out relay 14 an energizing circuit for the hesitating control relay 12. By closing its contacts 13, the hesitating control relay 12 completes a series energizing circuit for the closing coil 4 of the circuit breaker 1 and the operating winding 15 of the lock-out relay 14. The energization of the closing coil 4 closes the circuit breaker 1 so as to reconnect the load circuit 3 to the supply circuit 2. The energization of the operating winding 15 of the lock-out relay 14 causes this relay to open its contacts 18 and 19. The opening of the contacts 18 prevents the subsequent closing of the auxiliary contacts 11 of the circuit breaker 1 from completing an energizing circuit for the hesitating control relay 12 and the opening of the contacts 19 prevents the trip coil 6 from being energized by the subsequent closing of the contacts 9 of the instantaneous over-current relay 7.

The closing of the auxiliary contacts 26 on circuit breaker 1 in response to the initial opening thereof completes a starting circuit 27 for the automatic reclosing means 23. If the fault is still connected to the load circuit 3 at the time the circuit breaker 1 is reclosed, the abnormal current condition again effects the operation of the over-current relays 7 and 8. The closing of the contacts 9 of the instantaneous over-current relay 7, however, does not effect the opening of the circuit breaker 1 at this time, because the contacts 19 of the lock-out relay 14 are open. Therefore, the trip coil 6 is not energized until after the over-current relay 8 has been energized by the abnormal current condition for a sufficient length of time to effect the closing of the contacts 10.

After the second opening of the circuit breaker 1, a relatively long time interval elapses before the automatic reclosing means 23 completes a closing circuit for the hesitating control relay 12. When this closing circuit is completed, relay 12, by closing its contacts 13, completes, in the manner above-described, an energizing circuit for the closing coil 4 to effect another closing of the circuit breaker 1.

Although the closing of the auxiliary contacts 28 of the circuit breaker 1 in response to the initial opening thereof completes an energizing circuit for the relay 20, this relay does not close its contacts 29 because a sufficient length of time does not elapse between the initial opening and initial reclosure of the circuit breaker 1. However, sufficient time elapses between the second opening and the second reclosure of the circuit breaker 1 to allow the relay 20 to close its contacts 29 and complete an energizing circuit for the relay 21. The relay 21 then immediately closes its contacts 22 so as to complete a shunt circuit around the open contacts 19 of the lock-out relay 14. Therefore, if the fault is still connected to the load circuit after the second reclosure of the circuit breaker, the reopening of the circuit breaker is effected by the instantaneous over-current relay 7 since the closing of its contacts 9 completes through the contacts 22 of the relay 21 an energizing circuit for the trip coil 6. This same circuit is completed for the trip coil 6 in case any subsequent opening of the circuit breaker is effected while the contacts 22 are closed.

After the third opening of the circuit breaker, the automatic reclosing means 23 again effects the energization of the hesitating control relay 12 and the reclosing of the circuit breaker 1 after a predetermined time. This automatic reclosing means is arranged, in the manner well-known in the art, to effect a predetermined number of reclosures of the circuit breaker 1 within a predetermined time interval and with predetermined time intervals between successive reclosures. If the circuit breaker 1 is open at the expiration of a predetermined time interval after the initial

opening of the circuit breaker, the automatic reclosing means 23 is rendered inoperative, in the manner well-known in the art, to effect further reclosures of the circuit breaker. If, however, the circuit breaker 1 is closed at the expiration of this predetermined time interval, the automatic reclosing means 23 is arranged to effect, through auxiliary contacts 31 on the circuit breaker 4, the energization of the release magnet 17 to restore the lock-out relay 14 to its normal position so that the instantaneous reclosing means is again rendered operative to control the initial reclosure of the circuit breaker 1 when it is opened again and the instantaneous over-current relay 7 can effect the initial opening of the circuit breaker 1.

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 combination, an electric circuit, a circuit breaker in said circuit, means responsive to a predetermined abnormal condition of said circuit, means for effecting the reclosing of said circuit breaker when it is open, and means controlled by said abnormal condition responsive means for effecting the opening of said circuit breaker in one predetermined manner prior to a predetermined opening of said circuit breaker and in a different manner after said predetermined opening and prior to a predetermined subsequent opening and in said first-mentioned predetermined manner after said subsequent opening when all of said circuit breaker openings occur within a predetermined time interval.

2. In combination, an electric circuit, a circuit breaker in said circuit, means responsive to a predetermined abnormal condition of said circuit, means for effecting the reclosing of said circuit breaker when it is open, and means controlled by said abnormal condition responsive means for effecting the initial opening of said circuit breaker in a predetermined manner and the second opening of said circuit breaker in a different manner and the subsequent openings of said circuit breaker in said first-mentioned predetermined manner when all of said circuit breaker openings occur within a predetermined time interval.

3. In combination, an electric circuit, a circuit breaker in said circuit, means responsive to a predetermined abnormal condition of said circuit, means for effecting the reclosing of said circuit when it is open, and means controlled by said abnormal condition responsive means for effecting the opening of said circuit breaker prior to a predetermined opening thereof substantially instantaneously upon the occurrence of the abnormal condition and for effecting the subsequent opening of the circuit breaker a predetermined time after the occurrence of the abnormal condition and for effecting any subsequent openings of the circuit breaker substantially instantaneously upon the occurrence of the abnormal condition when all of said circuit breaker openings occur within a predetermined time interval.

4. In combination, an electric circuit, a circuit breaker in said circuit, means responsive to a predetermined abnormal condition of said circuit, means for effecting the reclosing of said circuit breaker when it is open, and means controlled by said abnormal condition responsive means for effecting the initial opening of said circuit breaker substantially instantaneously after the occurrence of the abnormal condition, and the second opening of said circuit breaker a predetermined time after the occurrence of the abnormal condition, and the subsequent openings of said circuit breaker substantially instantaneously after the occurrence of the abnormal condition when all of said circuit breaker openings occur within a predetermined time interval.

5. In combination, an electric circuit, a circuit breaker in said circuit, means responsive to a predetermined abnormal condition of said circuit, means for effecting a substantially instantaneously initial reclosure followed by a predetermined number of time delayed reclosures when said circuit breaker is opened a predetermined number of times within a predetermined time, and means controlled by said abnormal condition responsive means for effecting the initial opening of said circuit breaker substantially instantaneously after the occurrence of the abnormal condition, and the second opening of said circuit a predetermined time after the occurrence of the abnormal condition, and all of the other openings of said circuit breaker within said predetermined time substantially instantaneously after the occurrence of the abnormal condition.

6. In combination, an electric circuit, a circuit breaker in said circuit, means responsive to a predetermined abnormal condition of said circuit, means for effecting a substantially instantaneously initial reclosure followed by a predetermined number of time delayed reclosures when said circuit breaker is opened a predetermined number of times within a predetermined time, and means controlled by said abnormal condition responsive means for effecting the initial opening of said circuit breaker in one manner and the second opening of said circuit in a different manner and all of the other openings of said circuit breaker within said predetermined time in the same manner as the initial opening.

ARVID E. ANDERSON.