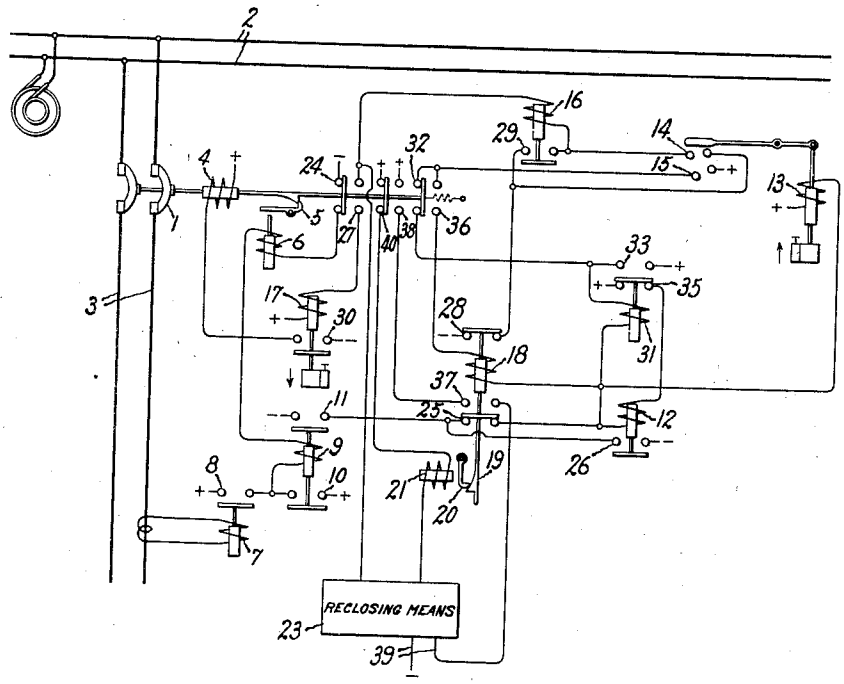
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AUTOMATIC RECLOSING CIRCUIT BREAKER SYSTEM

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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 the reclosing of the circuit breaker is controlled by two timing means one of which normally operates first to effect a predetermined number of reclosures, usually one, after which all subsequent reclosures, within a predetermined time interval, are effected by the other timing means. Heretofore it has been the practice to initiate the operation of both of the timing means simultaneously and to cause each timing means, after its operation has been initiated, to complete its respective timing operation irrespective of the position of the circuit breaker. Such arrangements result in an unnecessary operation of the timing means controlling the subsequent reclosures of the circuit breaker in cases where the circuit breaker remains closed in response to a reclosure effected by the timing means which normally controls the first reclosure.

One object of my invention is to provide an improved automatic reclosing circuit breaker system whereby such an unnecessary operation of one of the two timing means is prevented.

In accordance with my invention, I provide an improved arrangement of apparatus whereby the operation of one timing means is first effected and, when it has completed its timing operation, it effects the operation of a second timing means to effect further reclosures of the circuit breaker if the circuit breaker is open when the first mentioned timing means has completed its timing operation.

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 which may be of any suitable type, examples of which are well known in the art, for connecting a supply circuit 2 to a load circuit 3. As shown in the drawing, circuit breaker 1 is of the well known latched-closed type and comprises a closing coil 4 which, when energized, closes the circuit breaker, a latch 5 for holding the circuit breaker in its closed position, and a trip coil 6 which, when energized, releases latch 5 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 circuit breaker 1. As shown, an overcurrent relay 7 is provided for this purpose. This overcurrent relay is connected in series relation with load circuit 3 in any suitable manner so that the relay closes its contacts 8 in response to a predetermined abnormal current condition in load circuit 3. The closing of contacts 8 of relay 7 completes a series energizing circuit for a control relay 9 and trip coil 6. Relay 9, when energized, completes a locking circuit for itself and trip coil 6 so as to insure that the trip coil is energized for a sufficient length of time to effect the opening of circuit breaker 1 irrespective of the length of time contacts 8 of overcurrent relay 7 remain closed.

For effecting the reclosure of circuit breaker 1 after it is opened in response to the operation of overcurrent relay 7, I have shown an arrangement for effecting first a substantially instantaneous reclosure after each of a predetermined number of openings of the circuit breaker and then a time delay reclosure after each subsequent opening that occurs within a predetermined time interval. For effecting the substantially instantaneous reclosures of circuit breaker 1, control relay 9, when it closes its contacts 11, completes energizing circuits for a quick-acting relay 12 and a time relay 13. Relay 12 immediately completes a locking circuit for itself and time relay 13 irrespective of the length of time contacts 11 remain closed. Time relay 13 is arranged in any suitable manner so that after being energized a predetermined relatively short time interval, it closes its contacts 14 and, after being energized for a slightly longer time, it closes its contacts 15. Preferably, relay 13 is designed in any suitable manner so that these time intervals may be readily adjusted. If circuit breaker 1 is open when contacts 14 of relay 13 are closed, a series energizing circuit is completed for a control relay 16 and a hesitating control relay 17. Control relay 16 immediately closes a locking circuit for itself and relay 17, and the latter, in turn, completes an energizing circuit for closing coil 4 to reclose circuit breaker 1. The closing of circuit breaker 1 effects the immediate deenergization of relays 16 and 17.

If circuit breaker 1 fails to remain closed after its initial reclosure so that the circuit breaker is in its open position by the time that relay 13 closes contacts 15, an energizing circuit is completed for an operating coil 18 of a lock-out relay 19. This relay 19, when in its energized or lock-out position, interrupts the energizing circuit of relays 16 and 17, which is completed through contacts 14 of relay 13, so that relay 13 is rendered inoperative to effect further reclosures of circuit breaker 1. Lock-out relay 19 is arranged in any suitable manner so that it is held in its energized position after operating winding 18 thereof is deenergized. In the particular arrangement shown this result is accomplished by means of a latch 20 which holds the relay in its energized position and which is ar-

ranged to be released by a magnet 21, when it is energized.

In accordance with the specific embodiment of my invention, shown in the drawing, lock-out relay 19 also initiates the operation of additional reclosing means for effecting the reclosing of circuit breaker 1 a predetermined number of times with relatively long time intervals between successive reclosures in case circuit breaker 1 does not remain closed after the predetermined number of instantaneous reclosures has been effected. Since such 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 1,968,629, granted July 31, 1934, on an application filed by me and assigned to the assignee of this application, discloses the details of an arrangement which may be used in connection with my present invention to effect a predetermined number of successive energizations of control relay 17 with relatively long predetermined time intervals between successive energizations, if circuit breaker 1 opens a predetermined number of times within a predetermined time interval, and for effecting the energization of release magnet 21, if circuit breaker 1 is in its closed position, after the timing 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, circuit breaker 1 remains closed and the various control devices are in the position shown in the drawing. When an abnormal current condition occurs in load circuit 3, which effects the operation of overcurrent relay 7, the closing of contacts 8 of relay 7 completes through auxiliary contacts 24 on circuit breaker 1 a series energizing circuit for control relay 9 and trip coil 6. By closing its contacts 10, control relay 9 completes a shunt circuit around contacts 8 of relay 7. The energization of trip coil 6 effects the opening of circuit breaker 1.

By closing its contacts 11, control relay 9 also completes through contacts 25 of lock-out relay 19 energizing circuits for quick-acting relay 12 and time relay 13. By closing its contacts 26, relay 12 completes a shunt circuit around contacts 11 of relay 9 so that a locking circuit is completed for relays 12 and 13.

As soon as circuit breaker 1 opens so that its auxiliary contacts 27 are closed and time relay 13 closes its contacts 14, a series energizing circuit is completed for control relay 16 and hesitating control relay 17 through contacts 28 of lock-out relay 19. By closing its contacts 29, control relay 16 completes a shunt circuit around contacts 14 of relay 13 so that a locking circuit is completed for relays 16 and 17. By closing its contacts 30, hesitating control relay 17 completes an energizing circuit for closing coil 4 to effect the closing of circuit breaker 1. By opening its auxiliary contacts 27, circuit breaker 1 interrupts the locking circuit of relays 16 and 17 so that these relays become deenergized because time relay 13 is designed so that it maintains its contacts 14 closed only momentarily, and, therefore, the original energizing circuit for these two relays is now open.

If the fault is still connected to load circuit 3 when circuit breaker 1 recloses, overcurrent relay 7 again closes its contacts 8 to effect the opening of circuit breaker 1 in the manner heretofore described.

If circuit breaker 1 remains closed after its initial reclosure so that it is in its closed position when time relay 13 completes its timing operation and closes its contacts 15, an energizing circuit is completed for relay 31 through auxiliary contacts 32 on circuit breaker 1, contacts 25 of lock-out relay 19, and contacts 26 of quick-acting relay 12. Preferably the time interval between the closing of contacts 14 and 15 of relay 13 is made longer than the sum of the reclosing and opening times of circuit breaker 1. By closing its contacts 33, relay 31 completes a shunt circuit around contacts 32 of circuit breaker 1 and contacts 15 of relay 13. By opening its contacts 35, relay 31 interrupts the holding circuit of relay 12 which, in turn, by opening its contacts 26, effects the deenergization of relays 12, 13 and 31 so as to restore these relays to their normal positions.

If circuit breaker 1 is open when time relay 13 completes its timing operation and closes its contacts 15, an energizing circuit is completed for operating winding 18 of lock-out relay 19 through contacts 36 on circuit breaker 1, contacts 25 of lock-out relay 19, and contacts 26 of relay 12. The opening of contacts 25 and 28 of lock-out relay 19 effects the deenergization of relays 12 and 13 so as to prevent further instantaneous reclosures from being effected by these relays. Lock-out relay 19 is held in its energized position by a latch 20 after the energizing circuit for the winding 18 is interrupted by the opening of contacts 25. By closing its contacts 37, lock-out relay 19 completes through contacts 38 on circuit breaker 1 a starting circuit 39 for reclosing means 23 which then functions in a manner well known in the art to effect the completion of an energizing circuit for hesitating control relay 17 a predetermined number of times within a predetermined time interval and with predetermined time intervals between successive energizations if circuit breaker 1 is open at the expiration of each of the last mentioned predetermined time intervals. Each time that relay 17 is energized, it completes an energizing circuit for closing coil 4 to reclose circuit breaker 1.

If circuit breaker 1 is open at the expiration of a predetermined time interval after the first completion of starting circuit 39 of reclosing means 23, this timing means is rendered inoperative in a manner well known in the art to effect further reclosures of the circuit breaker. If, however, circuit breaker 1 is closed at the expiration of this predetermined time interval, timing means 23 is arranged to effect through contacts 40 of circuit breaker 1 an energizing circuit for release magnet 21 to restore lock-out relay 19 to its normal position so that the instantaneous reclosing means is again rendered operative to control the next reclosure 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. An arrangement for reclosing a circuit

breaker comprising means normally operative to reclose said circuit breaker, other means for reclosing said circuit breaker, and means controlled by said first reclosing means for rendering said first reclosing means inoperative to effect further reclosures of said circuit breaker and for initiating the operation of said other reclosing means only if said circuit breaker is open after said first reclosing means has been in operation for a predetermined time.

2. An arrangement for reclosing a circuit breaker comprising means normally operative to reclose said circuit breaker a predetermined number of times within a predetermined time interval, other means for reclosing said circuit breaker a predetermined number of times within a predetermined time interval, and means controlled by said first mentioned reclosing means for initiating the operation of said other reclosing means only if said circuit breaker is open at the expiration of said first mentioned time interval.

3. An arrangement for reclosing a circuit breaker comprising means normally operative to reclose said circuit breaker a predetermined number of times within a predetermined time interval, other means for reclosing said circuit breaker a predetermined number of times within a predetermined time interval, and means controlled by said first mentioned reclosing means and said circuit breaker for initiating the operation of said other reclosing means and for rendering said first mentioned reclosing means inoperative to effect further reclosures of said circuit breaker only if said circuit breaker is open at the expiration of said first mentioned time interval.

4. In combination, a circuit breaker, means for opening said circuit breaker, timing means, means for initiating the operation of said timing means when said circuit breaker is opened, means controlled by said timing means for effecting the reclosure of said circuit breaker after said timing means has been in operation a predetermined time interval, a second timing means, means controlled by said first mentioned timing means for initiating the operation of said second timing means a predetermined time interval after the operation of said first mentioned timing means is initiated and for rendering said first timing means inoperative to effect further reclosures of said circuit breaker, and means controlled by said second timing means for reclosing said circuit breaker.

5. In combination, a circuit breaker, means for opening said circuit breaker, timing means, means for initiating the operation of said timing means when said circuit breaker is opened, means controlled by said timing means for effecting the reclosure of said circuit breaker after said timing means has been in operation a predetermined time interval, a second timing means, means controlled by said first-mentioned timing means for initiating the operation of said second timing means a predetermined time interval after the operation of said first mentioned timing means is initiated and for rendering said first timing means inoperative to effect further reclosures of said circuit breaker, and means controlled by said second timing means for reclosing said circuit breaker a predetermined number of times within a predetermined time interval and with predetermined time intervals between successive reclosures.

6. In combination, a circuit breaker, means for opening said circuit breaker, timing means, means for initiating the operation of said second timing means when said circuit breaker is opened, means controlled by said timing means for effecting the reclosure of said circuit breaker after said timing means has been in operation a predetermined time interval, a second timing means, means controlled by said first mentioned timing means for initiating the operation of said second timing means a predetermined time interval after the operation of said first-mentioned timing means is initiated and for rendering said first timing means inoperative to effect further reclosures of said circuit breaker, means controlled by said second timing means for reclosing said circuit breaker a predetermined number of times within a predetermined time interval and with predetermined time intervals between successive reclosures, and means controlled by said second timing means for rendering said first timing means again operative to control the reclosure of said circuit breaker if said circuit breaker is closed after said second timing means has been in operation a predetermined time.

7. In combination, a circuit breaker, means for opening said circuit breaker, timing means having an operating winding, means for completing an energizing circuit for said winding when said circuit breaker is opened, means controlled by said timing means for effecting the reclosure of said circuit breaker after said winding has been energized for a predetermined time, a lock-out relay controlling normally closed contacts in series with said winding, a second timing means having a starting circuit, means controlled by said first timing means and said circuit breaker for effecting the operation of said lock-out relay to open said normally closed contacts if said circuit breaker is open after said winding has been energized for a predetermined time, means responsive to the operation of said lock-out relay for initiating the operation of said second timing means, and means controlled by said second timing means for reclosing said circuit breaker.

8. In combination, a circuit breaker, means for opening said circuit breaker, timing means having an operating winding, means for completing an energizing circuit for said winding when said circuit breaker is opened, means controlled by said timing means for effecting the reclosure of said circuit breaker after said winding has been energized for a predetermined time, a lock-out relay controlling normally closed contacts in series with said winding, a second timing means having a starting circuit, means controlled by said first timing means and said circuit breaker for effecting the operation of said lock-out relay to open said normally closed contacts if said circuit breaker is open after said winding has been energized for a predetermined time, means responsive to the operation of said lock-out relay for initiating the operation of said second timing means, and means controlled by said second timing means for reclosing said circuit breaker a predetermined number of times within a predetermined time interval, and means controlled by said second timing means for restoring said lock-out relay to its normal condition if said circuit breaker is closed after said second timing means has been in operation a predetermined time.

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