

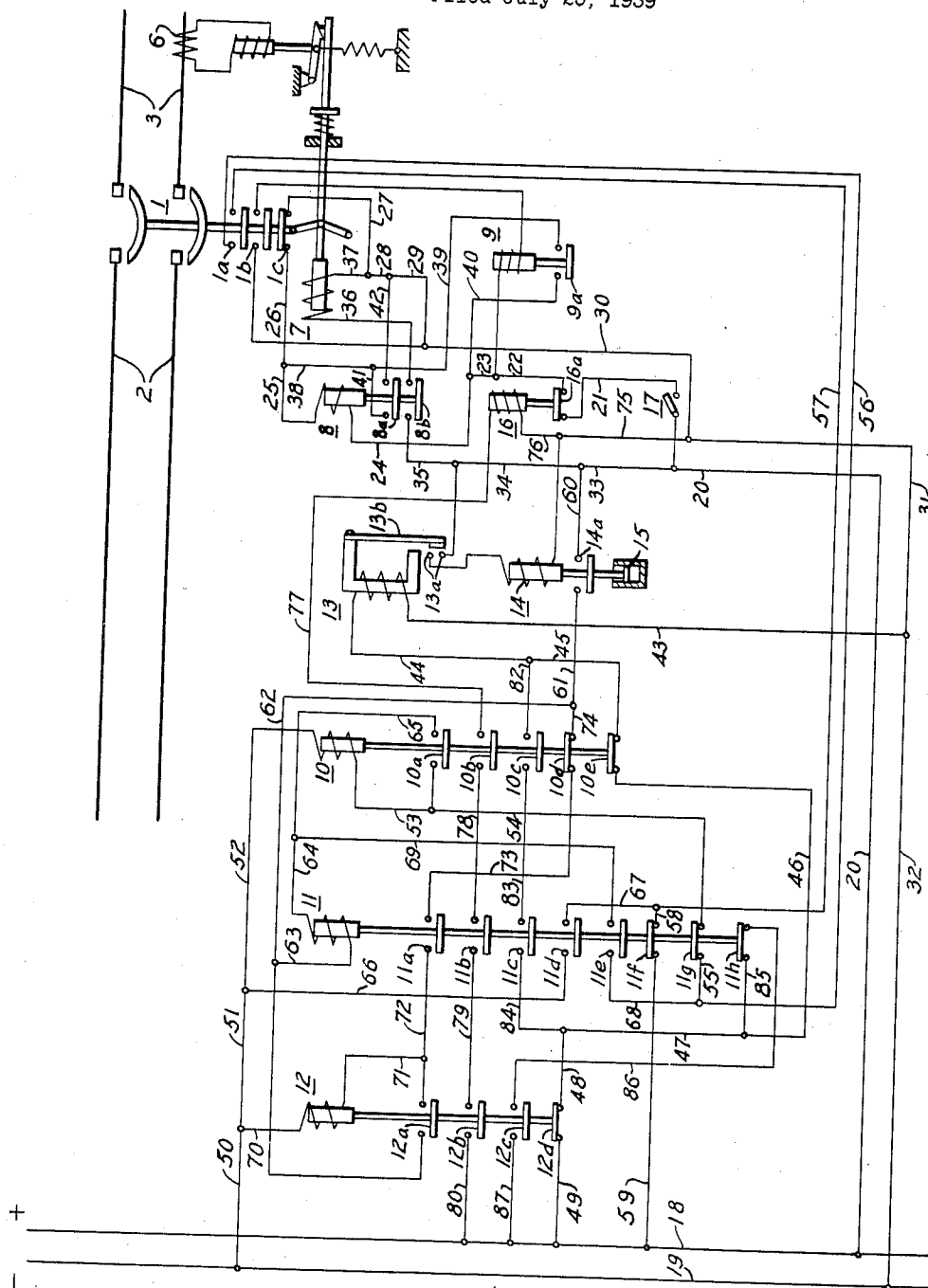
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CONTROL SYSTEM FOR CIRCUIT BREAKERS

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CONTROL SYSTEM FOR CIRCUIT BREAKERS

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Our invention relates in general to control systems, and in particular to a system for controlling the closing operation of circuit breakers to limit the attempts at closure to a predetermined number.

An object of our invention is to provide a circuit breaker control system which, in the event that the breaker fails to remain closed for a predetermined period of time, either upon the initial closure thereof or after the breaker has been opened by an overload or any other type of line fault to which the circuit breaker has been made responsive, will provide for a predetermined number of successive reclosing operations, after which the breaker will be locked out in an open position.

A more specific object of our invention is to provide a simple and inexpensive relay system for controlling the closing operation of a circuit breaker, the relays of such system being operable in a novel interlocking arrangement, in accordance with successive opening and closing motions of the breaker, whereby the number of closing operations of said breaker are limited to a predetermined number.

A further object of our invention is to provide a control system for a circuit breaker which will limit the breaker closing operations to a predetermined number, and which will automatically reset itself to its initial position when the breaker remains closed for a predetermined time period on any one of the closing operations.

A further object of our invention is to prevent a circuit breaker from pumping in the event that the latching mechanism fails to hold the circuit breaker closed.

These and other objects of our invention will become more apparent from the following description when taken in conjunction with the accompanying drawing, the single figure of which diagrammatically illustrates a circuit breaker embodying our invention.

Referring to the drawing, the single figure of which illustrates a preferred embodiment of our invention, reference character 1 designates generally a circuit breaker of any suitable type which may be utilized, for example, to connect a source of power supply 2 and a load 3. The circuit breaker 1 may be provided with any suitable type of fault-responsive tripping means which are well known in the art. The particular means shown comprises an overload relay 4 which is operatively connected to spring biased latch member 5 which functions to hold the circuit breaker in a closed position under normal load conditions.

The breaker is tripped to an open position under overload conditions by energizing the winding of overload relay 4 from current transformer 6 in a well known manner.

The various electro-responsive devices of our invention may be energized through any suitable source of electric power and in the present embodiment of our invention, the source of power is represented by auxiliary power conductors 18 and 19.

The circuit breaker may also be provided with any suitable type of closing means such as a solenoid operated device 7 having a coil for moving the breaker to a closed position, which may be energized from conductors 18 and 19 of the auxiliary source of power through contact members 8b of control relay 8.

A cut-off relay 9 may also be provided to shunt the winding of the control relay 8, through its contact members 9a, when the circuit breaker has moved to a closed position and is effective to deenergize the closing coil of solenoid 7.

The interlocking relay system, in accordance with our invention, comprises relays 10, 11, and 12, each of which is provided with a plurality of make and break contact members, as shown, and their operation will be explained in detail hereinafter.

A timing device, such as pendulum relay 13, is also provided for timing the periods when the breaker 1 is in a closed position.

In the event that the circuit breaker 1 remains closed on any of its closing strokes beyond the predetermined time interval as measured or determined by the timing relay 13, we have provided a slow drop-out relay 14, the action of which may be retarded by any suitable means such as a dashpot 15, to automatically reset our device to its initial position.

The circuit breaker 1 may be locked in an open position after it has completed the predetermined number of closing operations which are permitted by our invention by any suitable lock-out means such as lock-out relay 16 which when energized opens the circuit between the control relay 8 and the auxiliary power conductors 18 and 19.

A hand switch 17, or any other well known switching means, may be utilized to initially close the breaker.

So that our invention may be better understood, a detailed description of the operation of the arrangement shown will now be given.

With the breaker in an open position, the winding of the timing relay 13 is energized from conductors 18 and 19 of the auxiliary power sup-

ply through a circuit which extends from conductor 19 through conductors 32 and 43, the winding of timing relay 13, conductors 44 and 45, contact members 10e of relay 10, conductors 46, 47 and 48, contact members 12d of relay 12 and conductor 49 to the other conductor 18 of the auxiliary power supply. When the timing relay 13 is thus energized, its pendulum member 13b closes contact members 13a. With the breaker in open position the retarded or slow drop-out relay 14 is also energized from the auxiliary power supply through closed contact members 13a of timing relay 13.

Under normal circuit conditions, when the hand switch 17 is closed, the coil of control relay 8 will be energized from conductors 18 and 19 of the auxiliary source of power, through a circuit which extends from conductor 18 through conductor 20, hand switch 17, conductor 21, contact members 16a of relay 16, conductors 22, 23 and 24, coil of control relay 8, conductors 25 and 26, breaker auxiliary contact members 1c, conductors 27, 28, 29, 30, 31 and 32 to conductor 19 of the auxiliary source of power supply.

When relay 8 is energized, its contact members 8b are closed and a circuit for energizing the closing coil of solenoid 7 is established, which extends from conductor 18 through conductors 20, 33, 34 and 35, contact members 8b of control relay 8, conductor 36, the winding of closing coil of solenoid 7 and back to the other conductor 19 of the auxiliary power source through conductors 37, 28, 29, 30, 31 and 32.

In order that the circuit breaker may reach its fully closed position and be latched in such position by latch member 5 before the closing coil of solenoid 7 is deenergized, a holding circuit for keeping the control relay 8 energized until the circuit breaker is fully closed is provided through the closure of contact members 2a of the control relay.

When the circuit breaker 1 reaches a fully closed position and is latched in by the latching device 5, cut-off relay 9 will be energized from the auxiliary power supply conductors 18 and 19 through a circuit which is closed through auxiliary contact members 1b on the circuit breaker 1. Upon closure of contact members 9a, the coil of the control relay 8 is shunted through conductors 25, 38, 39, 40 and 24. It will be apparent that when the operating coil of the relay 8 is thus shunted, relay 8 will be deenergized and the breaker closing coil of solenoid 7 will also be deenergized since the contact members 3b of the relay 8 will be opened.

Should the latching mechanism 5 fail, for any reason, to latch the breaker in closed position on the initial closing stroke of the breaker, or should the breaker, for any reason, fail to remain closed for the predetermined time interval as determined by the setting of the timing relay 13, the circuit breaker 1 will be permitted to make a predetermined number of attempts at reclosure. If the breaker fails to remain closed for the period determined by the setting of timing relay 13 on the last of the predetermined number of closing operations, the lock-out relay 16 will be rendered effective to lock the breaker in an open position.

Likewise, should the circuit breaker be operating under normal conditions in a closed position and an overload or some other type of line fault to which the breaker has been made responsive causes the relay 4 to operate and trip the breaker to an open position, our device will permit the

breaker to make a predetermined number of attempts to reclose itself, after which the breaker will be locked in open position by relay 16.

On the initial or first closing stroke of the breaker, auxiliary contact members 1a of the circuit breaker 1 are closed and establish a circuit for energizing the winding of relay 10 from the auxiliary power source which extends from conductor 19 of the source through conductors 50, 51 and 52, the winding of relay 10, conductors 53 and 54, contact members 11g of relay 11, conductors 55 and 56, closed auxiliary contact members 1a of the circuit breaker, conductors 57 and 58, contact members 11f of relay 11 and conductor 59 to the other conductor 18 of the auxiliary power source.

It will be apparent that when the winding of relay 10 is thus energized on the closing stroke of the breaker, the timing relay 13 which, as hereinbefore explained, is energized when the breaker is in an open position, will now be deenergized through the opening of contact members 10e of relay 10. Deenergization of the timing relay 13 causes its pendulum member 13b to vibrate and intermittently open and close its contact members 13a for the predetermined time interval for which the relay 13 has been set. The retarded drop-out relay 14 which is energized when contact members 13a of the timing relay 13 are closed is so constructed, however, that it will remain closed and hence its contact members 14a will remain closed, so long as the vibrating element 13b of the timing relay 13 continues to intermittently open and close its contact members 13a.

If the circuit breaker fails to remain closed for the predetermined time interval as determined by the setting of the timing relay 13, and hence contact members 14a of relay 14 remain closed, the winding of relay 11 will also be energized in series with the already energized winding of relay 10 causing the relay 11 to close. The circuit for energizing windings of relays 10 and 11 in series from the auxiliary power source may be traced from conductor 18 of the source through conductors 20, 33 and 60, closed contact members 14a of relay 14, conductors 61, 62 and 63, the winding of relay 11, conductors 64 and 65, closed contact members 10a of relay 10, conductor 53, the winding of relay 10 and conductors 52, 51 and 50 back to conductor 19 of the auxiliary power source.

With both relays 10 and 11 energized, the circuit is again completed from the auxiliary supply source for energizing the winding of the timing relay 13, and may be traced from conductor 19 through conductors 32 and 43, the winding of relay 13, conductors 44 and 32, contact members 10c, conductor 83, contact members 11c, conductors 84 and 48, contact members 12d of relay 12, and conductor 49 to conductor 18. Reenergization of the timing relay 13 places it in readiness to time the period that the breaker remains closed on its second closing operation.

When the circuit breaker 1 moves to its full open position after its first attempt at closure, control relay 8 is again energized through the closed auxiliary contact members 1c of the circuit breaker. With relay 8 in closed position, the closing coil 7 of the breaker is now energized for the second time in the same manner as hereinbefore described.

Upon this second closure of the circuit breaker, the winding of relay 10 is now shunted out due to the closing of the auxiliary contact members

1a on the breaker causing relay 10 to open. The shunting circuit for the winding of relay 10 may be traced from one side thereof through conductors 52 and 66, closed relay contact members 11d of relay 11, conductors 67 and 57, closed auxiliary contact members 1a of the circuit breaker, conductors 56 and 68, closed contact members 11e of relay 11, conductors 69 and 65, closed contact members 10a of relay 10 and conductor 53 to the other side of the winding of relay 10.

As relay 10 now opens, relay 12 is energized from the auxiliary power source through contact members 11a of relay 11 and contact members 10d of relay 10. The circuit for thus energizing the winding of relay 12 may be traced from conductor 19 of the power source through conductors 50 and 70, winding of relay 12, conductors 71 and 72, contact members 11a of relay 11, conductor 73, contact members 10d of relay 10, conductors 74 and 61, contact members 14a of relay 14 and conductors 60, 33, and 29 back to conductor 19 of the auxiliary power source.

Also when the circuit breaker closes for the second time, the timing relay 13 will be deenergized substantially at the same time that relay 10 is shunted to its open position. With the timing relay 13 now deenergized, drop-out relay 14 will remain closed for the predetermined time interval for which the timing relay 13 has been set as heretofore explained.

If the breaker fails to remain closed on its second closing stroke for a period longer than that for which the timing relay 13 has been set, and again moves to an open position, provision is made for effecting a third and final closing operation of the breaker. As the breaker again moves to its open position, relay 11 will now be deenergized by the opening of auxiliary contact members 1a of the breaker. When relay 11 becomes deenergized and moves to its open position, the energizing circuit for the timing relay 13 is again established from the auxiliary power source to prepare it for timing the period that the breaker remains closed on its third closing operation. This circuit may be traced from conductor 19 of the auxiliary source through conductors 32 and 43, the winding of relay 13, conductors 44 and 45, relay contact members 10e, conductors 46 and 35, relay contact members 11h, conductor 36, relay contact members 12c, and conductor 37 to source conductor 19.

With the breaker now in its open position for the second time and auxiliary contact members 1c on the circuit breaker closed, the control relay 8 is again operated to energize the closing coil of solenoid 7, as hereinbefore described, and the breaker moves to a closed position for the third time. As the breaker reaches its closed position, auxiliary contact members 1a of the breaker are again closed and relay 10 is again energized from the auxiliary source of power in the same manner as it was energized when the breaker auxiliary contact members 1a were closed on the initial closing stroke of the breaker. With relay 10 now energized, the circuit for the timing relay 13 is again opened.

Should the breaker fail to remain closed on its third closing operation for a period longer than that for which the timing of the pendulum relay has been set, our relay system will now function to operate the lockout relay 16 and prevent any further attempts at closing the breaker. As the breaker moves to its open position for the third time, relays 11 and 10 are energized in series

from the auxiliary supply conductors 18 and 19 in the same manner as hereinbefore described. At this time, relays 10, 11 and 12 are all energized for the first time and the lock-out relay 16 will now be energized from the auxiliary power supply conductors 18 and 19 through the contact members of all three relays. This circuit may be traced from conductor 19 of the source of supply through conductors 32, 31, 75, 76, the winding of lock-out relay 16, conductor 77, closed contact members 10b of relay 10, conductor 78, closed contact members 11b of relay 11, conductor 79, closed contact members 12b of relay 12, and conductor 80 to the other conductor 18 of the auxiliary supply source.

Once the lock-out relay 16 has been operated, the circuit for energizing the control relay 8 is opened through relay contact members 16a of the lock-out relay 16, and it will be apparent that such an open circuit will prevent further energization of the closing coil 7 of the circuit breaker 1, thereby rendering the closing mechanism of the circuit breaker ineffective for further closing operations.

In the foregoing description it has been assumed, for purposes of explanation, that the circuit breaker failed to remain closed for a predetermined time on each of its closing operations. However, should the breaker remain closed for a longer period than that for which the timing relay 13 has been set, on any of its predetermined number of closing strokes, the intermittent operation of contact members 13a of relay 13, as hereinbefore described, will cease and cause contact members 13a to remain open. Contact members 14a of relay 14 will then open, since relay 14 is now deenergized because contact members 13a are open, and the relays 10, 11 and 12 will reset themselves to the initial position which they occupied when the hand switch 17 was closed to effect the initial closing stroke of the breaker.

This feature of our invention permits the circuit breaker to make two reclosing operations in the event that either a fault occurs subsequently in the latching mechanism for holding the breaker closed, or the breaker is tripped out at some later time because of an overload or because some other type of line fault, to which the circuit breaker has been made responsive, trips the breaker out.

While we have shown and described a system wherein provision is made for limiting the number of successive attempts at reclosure to two, it is to be understood that any desired number of attempts at reclosure may be provided for by utilizing the principle of our invention.

In conclusion, it may be stated that while the foregoing description and diagrammatic illustration constitutes one practical embodiment of our invention, we do not wish to be limited thereby, inasmuch as changes and modifications will be obvious to those skilled in the art, and we desire therefore that only such limitations be placed thereon as are necessary in the light of prior art.

We claim as our invention:

1. In combination, a circuit breaker, means for closing said breaker, lock-out means to lock said breaker in an open position, and a device for limiting said closing means to a predetermined number of substantially instantaneous closing operations when said breaker does not remain closed for a predetermined time interval on any one of said closing operations, said device

comprising timing means for measuring said time interval, and a plurality of electro-responsive devices actuated in predetermined sequence in accordance with successive opening and closing operations of said circuit breaker, said electro-responsive devices being operable upon opening of said breaker following the last of said predetermined closing operations of said breaker to render effective said lock-out means.

2. In combination, a circuit breaker, closing means for said breaker, latching means for holding said breaker closed when said breaker is moved to a closed position, lock-out means to lock said breaker in open position, and means, operable upon failure of said latching means to hold said breaker closed for a predetermined time interval, to permit said breaker closing means to effect a plurality of successive substantially instantaneous reclosing operations of said breaker, said means comprising means for timing said predetermined time interval, and a first, second and third electro-responsive means actuated in predetermined sequence in accordance with successive opening and closing operations of said circuit breaker, said electro-responsive means being effective upon opening of said breaker following the last of said predetermined number of reclosing operations of said breaker to render effective said lock-out means.

3. In combination, a circuit breaker, closing means for said breaker, means for opening said circuit breaker in response to predetermined circuit conditions, lock-out means for locking said breaker in an open position, and means for limiting said breaker to a predetermined number of substantially instantaneous closing operations when said breaker does not remain closed for a predetermined time interval upon any of said breaker closing operations comprising timing means operable in response to a closed position of said circuit breaker for timing the period when said breaker is closed, and a plurality of electro-responsive devices arranged for operation in predetermined sequence upon successive opening and closing operations of said breaker, said electro-responsive means being effective upon opening of said breaker following the last of said predetermined closing operations of said breaker to render said lock-out means effective.

4. In combination, a circuit breaker, closing means for said breaker, lock-out means for locking said breaker in an open position, means for opening said breaker in response to predetermined circuit conditions, and means operable when said breaker is opened for limiting said breaker closing means to a predetermined number of substantially instantaneous reclosing operations when said breaker does not remain closed for a predetermined time interval upon any reclosing operation thereof comprising timing means operable in response to the closed position of said circuit breaker for timing the period of closed position of said breaker, and a system of at least three electro-responsive devices arranged for operation in predetermined combinations in accordance with successive opening and closing operations of said breaker, said devices being operable upon opening of said breaker following the third closing operation of said breaker to render effective said lock-out means.

5. In combination, a circuit breaker, closing means for said breaker, lock-out means for locking said breaker in an open position, means for opening said breaker in accordance with pre-

determined circuit conditions, and means operable when said breaker is tripped out by said opening means for effecting two successive substantially instantaneous reclosing operations of said breaker in the event said breaker does not remain closed for a predetermined period of time upon any reclosing operation thereof, comprising a timing relay operable in response to a closed position of said circuit breaker for timing said period when said breaker is closed and a system of three electrically-interlocked relays arranged for operation in predetermined sequence upon successive opening and reclosing operations of said breaker, said relays being effective upon opening of said breaker following the second reclosing operation thereof to render effective said lock-out means.

6. In combination, a circuit breaker, closing means for said breaker, lock-out means for locking said breaker in an open position, means for opening said breaker in accordance with predetermined circuit conditions, and means operable when said breaker is tripped out by said opening means for effecting at least two successive substantially instantaneous breaker reclosing operations in the event said breaker does not remain closed for a predetermined time interval upon any of the said successive reclosing operations thereof, comprising at least three electrically-interlocked relays operable in predetermined sequence in accordance with successive opening and reclosing operations of said breaker, said interlocked relays being effective upon an opening of said breaker following the second reclosing operation of said breaker to render effective said lock-out means, and including timing means operable when the breaker is in closed position, for timing the closed period of said breaker upon each of said reclosing operations, and means responsive to said timing means to reset said interlocked relays to their initial position when said breaker remains closed longer than the said predetermined time interval on any of said reclosing operations thereof.

7. In combination, a circuit breaker, closing means for said breaker, lock-out means to lock said breaker in an open position, means for opening said breaker in response to predetermined circuit conditions and means operable when said breaker is opened for effecting a predetermined number of substantially instantaneous reclosing operations of said breaker in the event that said breaker does not remain closed for a predetermined time interval on any reclosing operations thereof, comprising a first, second and third relay, energized in predetermined interlocked arrangement in accordance with successive opening and reclosing operations of said breaker, said relays being simultaneously energized upon an opening of said breaker following the second reclosing operation of said breaker to render effective said lock-out means, and including timing means responsive to the closure of the breaker for timing the reclosed period of said breaker upon each of said reclosing operations and means controlled by the said timing means to reset said relays to their initial position when said breaker remains closed for a period longer than said predetermined time interval on any of said reclosing operations of said breaker.

8. In combination, a circuit breaker, closing means for said breaker, latching means for holding said breaker closed when said breaker is moved to a closed position, lock-out means to

lock said breaker in an open position, and means operable upon the failure of said latching means to hold said breaker closed for a predetermined time interval on the initial closing operation of said breaker to effect a predetermined number of substantially instantaneous reclosing operations of said breaker comprising a system of at least three relays arranged for operation in predetermined sequence upon successive opening and reclosing operations of said breaker, said relays being effective upon an opening of said breaker following the second reclosing operation of said breaker to render effective said lock-out means and including timing means operable in response to the closure of the breaker for timing said predetermined time intervals and means controlled by said timing means to reset said relay system to its initial condition when said breaker remains closed upon either the first or second reclosing operations thereof.

9. A reclosing device for effecting a plurality of substantially instantaneous reclosing operations of a circuit breaker when the breaker does not remain closed for a preselected time interval on any closing operation thereof comprising, a timer for measuring the closed period of the breaker, means for initiating operation of said timer whenever said breaker is closed, first, second and third control relays, means operable upon the initial closure of the breaker to energize the first relay, means for energizing the second relay and for retaining the first relay energized upon the first opening of the breaker, means for energizing the third relay and for shunting out the first relay upon the first reclosure of the breaker, means for deenergizing the second relay upon the second opening of the breaker, means for reenergizing the first relay upon the second reclosure of the breaker, means for reenergizing the second relay upon the third opening of the breaker, all of said control relays being then energized, lockout means for preventing further reclosing operations of said breaker, means operable when all of the control relays are energized to actuate said lockout means, a reset relay operable when deenergized to reset said control relays to their initial position, and means to deenergize said reset relay when the breaker remains closed for a period longer than that for which the timer has been set.

energizing the second relay upon the third opening of the breaker, all of said control relays being then energized, lockout means for preventing further reclosing operations of said breaker, and means operable when all of the control relays are energized to actuate said lockout means.

10. A reclosing device for effecting a plurality of substantially instantaneous reclosing operations of a circuit breaker when the breaker does not remain closed for a preselected time interval on any closing operation thereof comprising, a timer for measuring the closed period of the breaker, means for initiating operation of said timer whenever said breaker is closed, first, second and third control relays, means operable upon the initial closure of the breaker to energize the first relay, means for energizing the second relay and for retaining the first relay energized upon the first opening of the breaker, means for energizing the third relay and for shunting out the first relay upon the first reclosure of the breaker, means for deenergizing the second relay upon the second opening of the breaker, means for reenergizing the first relay upon the second reclosure of the breaker, means for reenergizing the second relay upon the third opening of the breaker, all of said control relays being then energized, lockout means for preventing further reclosing operations of said breaker, means operable when all of the control relays are energized to actuate said lockout means, a reset relay operable when deenergized to reset said control relays to their initial position, and means to deenergize said reset relay when the breaker remains closed for a period longer than that for which the timer has been set.

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