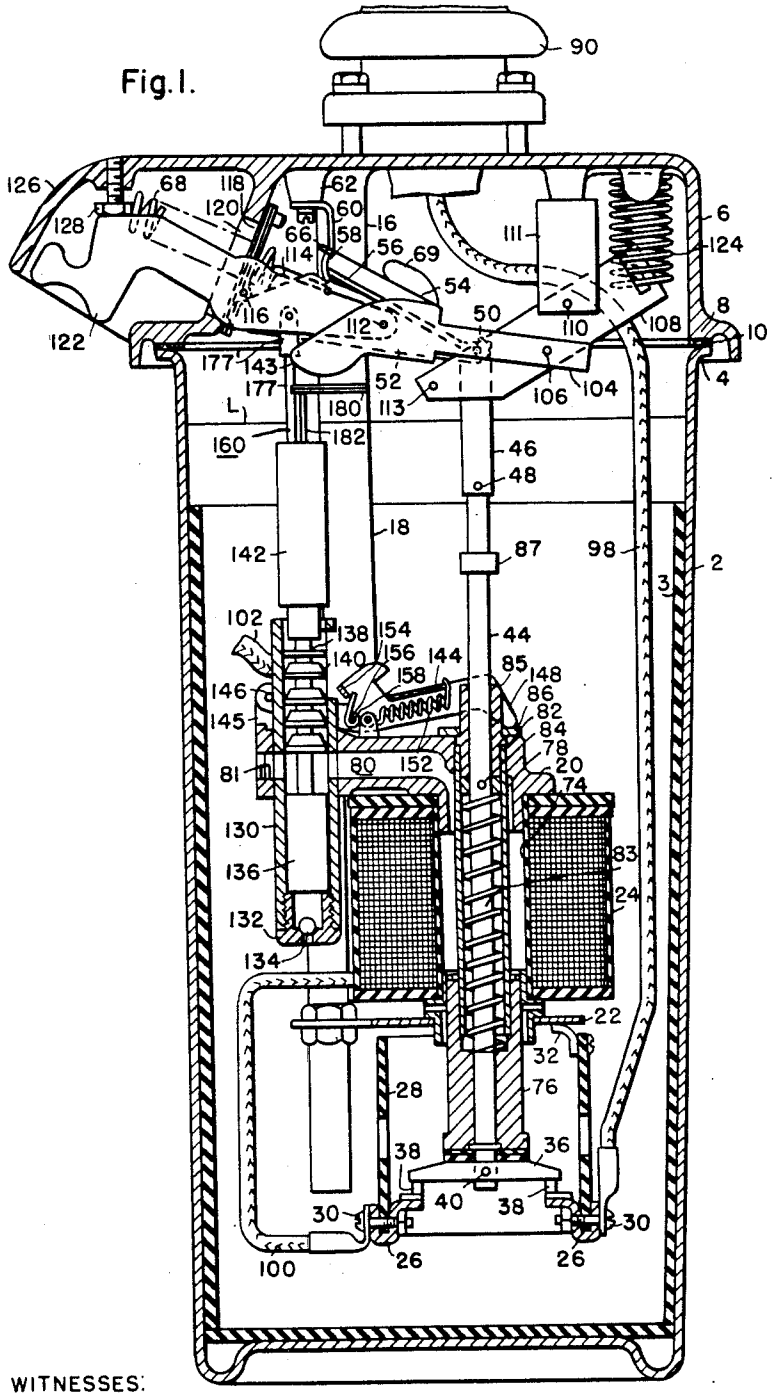
March 12, 1957 L. V. CHABALA 2,785,345

CIRCUIT INTERRUPTERS

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Fig. 1.



WITNESSES:

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CIRCUIT INTERRUPTERS

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Fig. 2.

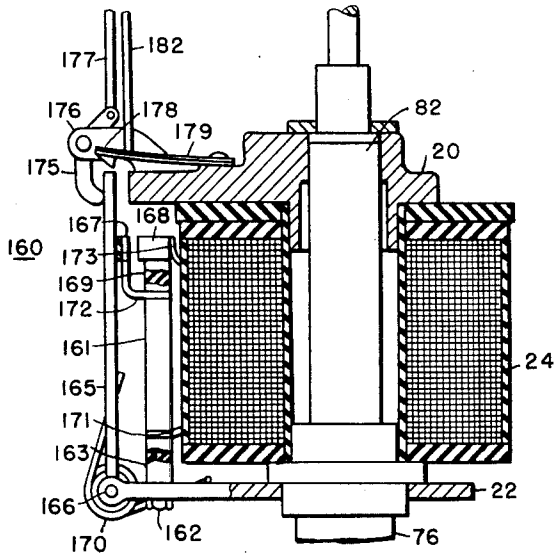


Fig. 3.

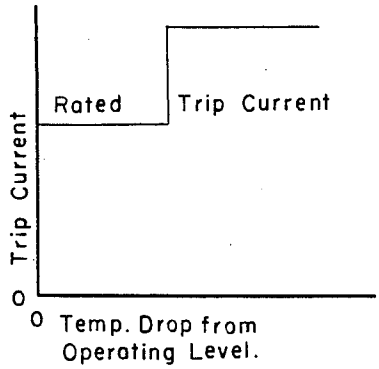
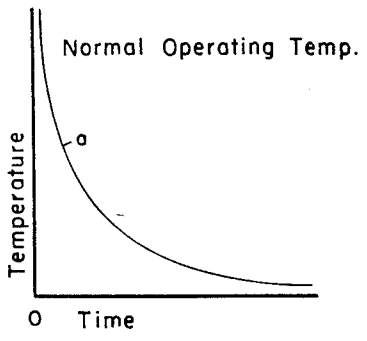


Fig. 4.



United States Patent Office 2,785,345 Patented Mar. 12, 1957

2,785,345

CIRCUIT INTERRUPTERS

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Application November 27, 1953, Serial No. 394,814

14 Claims. (Cl. 317—22)

My invention relates generally to circuit interrupters, and it has reference in particular to automatic reclosing circuit breakers.

Generally stated, it is an object of my invention to provide for increasing the current rating of a reclosing circuit breaker when it has been open for a predetermined time, to permit it to handle increased currents upon reclosing, such as may be due to loss of diversity of demand on the system.

More specifically, it is an object of my invention to provide for changing the effective ampere turns of the operating coil of a recloser when the recloser is reclosed after it has been open for a predetermined time.

Another object of my invention is to provide for decreasing the effective ampere turns of the operating coil of a recloser when it opens, and for maintaining such decreased condition when the recloser recloses, only if the recloser remains open for a predetermined time.

Yet another object of my invention is to provide for shunting a portion of the ampere turns of the operating coil of a recloser when it opens, and using a thermal latch for maintaining said shunted condition if the temperature of the recloser falls below a predetermined level.

It is an important object of my invention to provide for shunting the series operating coil of a reclosing circuit breaker when it locks open, and for utilizing a latch having a bimetallic member responsive to the temperature of the oil to maintain such shunt in the event that the breaker remains open for a sufficient time for the temperature thereof to drop to a predetermined value.

Other objects will in part be obvious, and will in part be explained hereinafter.

In practicing my invention in accordance with one of its embodiments, an auxiliary switch is disposed to be actuated from the lockout toggle linkage of a reclosing circuit breaker to connect a resistor in shunt with the solenoid coil of the breaker to increase its effective trip rating. So as to enable the breaker to attain this increased rating when reclosed after a relatively long delay of twenty minutes or so, a bimetallic latch is provided that becomes effective only when the breaker is open for a relatively long interval, otherwise the switch opens and removes the shunt when the recloser is reclosed.

For a more complete understanding of the nature and scope of my invention, reference may be made to the following description which may be read in connection with the drawings in which:

Fig. 1 is a substantially central vertical section view of a circuit breaker embodying the invention in one of its forms;

Fig. 2 is an enlarged vertical sectional view in part of the breaker shown in Fig. 1 taken to the rear of the counter and at an angle to the section of Fig. 1;

Fig. 3 is a characteristic temperature-current curve for the breaker shown in Fig. 1; and

Fig. 4 is a characteristic time-temperature curve for the same breaker.

The major part of the breaker shown on the drawings

is substantially the same as that described in Patent No. 2,622,167 of H. L. Rawlins et al. except that the dashpot is modified as shown in Patent No. 2,626,329 and is as shown therein mounted in a metal tank 2 having a closed bottom wall and an open top. Preferably, the tank is adapted to be lined at least over the bottom wall and up to a point adjacent the open top of the container with a liner 3 of insulating material such as fiber, or the like, and is filled up to the level L with liquid, preferably a liquid having arc extinguishing ability such as oil. The upper end of tank 2 is provided with an outwardly extending flange 4 on which the flange 8 of a cover casting 6 is adapted to be seated, preferably, with a gasket 10 interposed therebetween. Cover casting 6 may be secured to the tank in any desired manner, such for example, as by bolts (not shown) secured to suitably formed brackets on the tank.

The breaker contacts and certain of the contact actuating mechanism are adapted to be supported in tank 2 from cover casting 6 by means of a pair of integral supporting lugs 16 (only one of which is shown) depending from the top wall of the cover casting and adapted to engage insulating spacer rods 18 having threaded studs (not shown) engaging threaded openings in the rods, lugs 16 and a supporting casting 20. A supporting plate 22 may be supported in a similar manner from casting 20, so that a solenoid coil 24 may be mounted between casting 20 and supporting plate 22, which act as pole pieces with the central opening in the coil aligned with openings provided in casting 20 and plate 22.

Spaced stationary contacts 26 of the breaker are each supported from plate 22 by a support tube 28 of insulating material, such as fiber, with the stationary contacts being mounted on support 28, by means of screws 30 and with the upper end of the support 28 having brackets 32 by means of which the support is secured to supporting plate 22.

Stationary contacts 26 are adapted to be closed by engagement therewith of a bridging contact 36 having contact tips 38 at opposite ends thereof for engagement with the stationary contacts, respectively. Bridging contact 36 is supported substantially centrally thereof on a slidable contact actuating rod 44 by pivot pin 40 for limited pivotal movement about a transverse axis on contact actuating rod 44. Contact rod 44 should be of an insulating material such as fiber or a molded insulating material.

The upper end of contact actuating rod 44 has a pair of connecting links 46 positioned one at each side thereof and pivoted thereon as by a pivot pin 48, with the upper ends of these connecting links mounted on a common pivot pin 50 for a pair of toggle levers 52 and 54. Toggle levers 52 and 54 are both formed of sheet material, with lever 54 being bent to substantially channel form with outwardly extending flanges 56 adapted to be received at the free ends thereof in recesses 58 provided in the spaced downwardly depending fingers of an angled supporting bracket 60 which, in turn, is secured to a lug 62 integral with the cover casting. Preferably, the base of the channel part of toggle lever 54 is extended at 66 through the space between the supporting fingers of bracket 60, and the other end of lever 54 the sides of the channel formation thereof are extended to be mounted on pivot pin 50. Lever 52 has a hooked extension 69 extending through lever 54 to limit separation therefrom. A coil tension spring 68 has one end hooked into an opening provided in toggle lever 52, and has the opposite end thereof hooked over a spring support on the cover casting.

Solenoid coil 24 previously mentioned is adapted to be energized under certain conditions for automatically opening the circuit breaker contacts. The central open-

ing through coil 24 preferably is provided with a cylindrical sleeve 74 in which a solenoid core 76 is adapted to be slidably mounted in a piston-like manner. The sleeve 74 communicates with an annular passage 78 in the casting, which connects with a passage 80 having a threaded end opening 81 for receiving a plug (not shown) if all time delay operation of the breaker is desired.

A contact actuating sleeve 82 is telescoped over contact actuating rod 44 and its lower end is received in core 76 and preferably threadably mounted therein. A coil compression spring 83 is provided within actuating sleeve 82 on contact actuating rod 44 and is adapted to react between a shoulder in the core and a pin 84 extending transversely through actuating rod 44. A bushing 85 surmounts the sleeve 82 and is provided with a flange 86.

The circuit through the circuit breaker thus far described may now be traced from the point where it enters tank 2 through one of a pair of terminal bushings 90 (only one being shown), each being provided with a conductor element which extends through the bushing seated in an opening provided in the top wall of cover casting 6, and proceeds by conductor 98 directly to one fixed contact 26 of the breaker. When the contacts are in engagement, the circuit then proceeds through bridging contact 36 to the other fixed contact 38, and then by way of a conductor 100 to one terminal of solenoid coil 24. The other terminal of coil 24 is adapted to be connected by a conductor 102 to the conducting means in the other terminal bushing 90. It will be apparent that solenoid coil 24 in this embodiment of the invention is connected in series in the circuit through the circuit breaker so as to be energized at all times when the circuit breaker is closed, an amount dependent upon the value of current flowing in the circuit.

For any given rating of circuit breaker, solenoid coil 24 is designed to become sufficiently energized when the load current in the circuit exceeds its rating sufficiently to attract core 76 and move it upwardly within sleeve 74. Core 76 will move upwardly relatively rapidly if the passage 80 is open, and slowly if it is closed, since it is necessary to displace the liquid in sleeve 74 above the core either through the opening 81 or through relatively small clearance between the core and sleeve 74. Accordingly if the opening 81 is open, as shown, opening movement of the core will not be slowed up appreciably by the aforesaid dashpot action, and opening movement thereof may be relatively rapid. When core 76 commences its upward travel, bridging contact 36 being engaged by toggle spring 68 does not move, so that spring 83 is compressed until it is substantially solid, at which point the upper end of bushing 85 strikes a collar 87 secured to rod 44. Thereupon, actuating rod 44 moves upwardly, and the force exerted by toggle spring 68 begins to decrease and in a very short distance has substantially no value at all, so that the remaining major part of the circuit opening movement of bridging contact 36 occurs extremely rapidly due to expansion of spring 83.

Accordingly, it will be apparent that the maximum energy available from the solenoid coil 24 will be stored in compression spring 83 and will thus be available to overcome the closing bias of toggle spring 68, preferably at some point during initial movement of core 76 before bushing 85 engages collar 87 on actuating rod 44. However, collar 87 is provided to obtain a positive contact separation in the event there is any sticking or welding of the bridging contact to stationary contacts 26. In either case, it is apparent that toggle levers 52 and 54 will be moved to their on-center position in the manner previously described, and bridging contact 36 will be moved by spring 83. When the breaker contacts have attained their full open circuit position, the parts associated therewith are biased to return by gravity.

In order to limit the number of operations of the circuit breaker in close succession upon the occurrence of a continuing overload on the circuit, and to provide for manual operation, means are provided for holding the breaker contacts open in response to the occurrence of a predetermined number of closely succeeding circuit interrupting operations, which means can be manually actuated. This means comprises a toggle lever 104 pivoted at one end as at 106 on a U-shaped spring lever 108 which, in turn is pivotally supported as at 110 between the legs of a U-shaped supporting bracket 111 secured to cover casting 6. The other end of toggle lever 104 is pivoted, as by a pivot pin 112, to the adjacent end of a second toggle lever 114, and this, in turn, is mounted on a pivot pin 116 intermediate its ends, with the pin 116 being mounted in a bracket 118 secured to the adjacent wall of cover casting 6. A slot 120 is provided through the cover casting 6 for receiving the other end of toggle lever 114, which acts as a manual operating handle at the exterior of the circuit breaker casing, being provided with an angled hook end 122. A coil compression spring 124 is mounted to react between the bight of lever 108 and cover casting 6. Normally, toggle levers 104 and 114 are held by spring 124 with pivot 112 below the center line connecting pins 106 and 116, with the outer end of lever 114 positioned in and beneath an integral hood 126 on cover casting 6, in engagement with an adjustable stop screw 128 mounted in the hood.

In the position of toggle levers 104 and 114 illustrated, they have no effect on operation of the circuit breaker as previously described, being normally inactive in this respect. However, lever 108 has a connecting pin 113 extending beneath toggle levers 52 and 54. Accordingly, if it is desired to manually open the circuit breaker contacts, a hook stick or similar operating member may be engaged with the upper side of angle hook 122 of toggle lever 114 and pulled downwardly to rotate the toggle lever in a counter-clockwise direction about its supporting pivot 116 to move toggle levers 104 and 114 overcenter in an upward direction, and in doing this, pin 113 engages toggle levers 52 and 54 and moves them upwardly in a counter-clockwise direction, thus carrying contact actuating rod 44 upwardly to separate bridging contacts 38 from stationary contacts 26. The contacts will be held open by spring 124, which maintains toggle levers 104 and 114 in their upper over-center position.

In thus manually opening the circuit, after toggle spring 68 is moved to its on-center position, it will be observed that the spring 124 is only required to maintain the contacts of the breaker open against the relatively light closing bias due to gravity, and such light bias as may be due to toggle spring 68 in the event that toggle levers 52 and 54 are stopped just prior to reaching their on-center position. With the breaker contacts maintained at their open circuit position following the manual circuit opening operation described above, it will be apparent that the outer end of toggle lever 114 projects below hood 126 of cover casting 6 so as to provide a readily visible indication that the breaker contacts are maintained at open circuit position. It will further be apparent that the breaker contacts may then be closed only by manual operation of toggle lever 114 in the opposite direction, that is, by exerting an upward force on the outer end of the toggle lever by engagement of a hook stick or the like with the underside of hook 122, to rotate lever 114 in a clockwise direction to move it and toggle lever 104 back over-center to the full line position illustrated on the drawings.

An integrating mechanism is provided for automatically moving toggle levers 104 and 114 upwardly over-center and thus preventing reclosure of the circuit breaker in response to a predetermined number of closely successive circuit interrupting operations, comprising a cylindrical tube 130 clamped or otherwise secured in a lateral extension of casting 20 at the top of solenoid coil 24, and this tube has a plug 132 threaded into the lower end thereof, with the plug having a small central opening con-

trolled by a ball check valve 134, which permits flow of fluid into the lower end of tube 130 but prevents outflow. An integrating piston 136 is mounted in tube 130 and normally rests on the upper end of plug 132, being provided with a reduced extension 138 at the upper end thereof having a plurality of spaced circular flanges 140 forming rack teeth thereon, and having an elongated extension 142 of insulating material on the extreme outer end thereof which is positioned below an extension 143 on toggle lever 104. A pawl lever 144 is pivotally mounted at one end as at 146, this end of pawl lever 144 being split, with legs located at each side of tube 130 and with pivot 146 supported on spaced supporting flanges 145 integral with casting 20. Pawl lever 144 has a connecting web intermediate its ends, and at the other end thereof the sides of the lever are extended outwardly and laterally as at 148, to normally be in engagement with flange 86 of actuating tube 82 adjacent the outer end of this tube. Pawl lever 144 is normally biased into engagement with flange 86 by a coil tension spring 152 hooked over the remote edge of the web of the pawl lever at one end and anchored to an ear integral with casting 20 at its other end. Pawl lever 144 is provided with a pawl member 154 pivoted thereon as at 156, and biased by a spring 158 in a counterclockwise direction to a position wherein a portion of pawl member 154 engages the connecting web of pawl lever 144.

The tube 130 intersects the passage 80 of the dashpot, and the piston 136 acts as a valve to control venting thereof, so that with the piston as shown the dashpot vents freely and operation of the breaker is rapid. When the piston 136 is moved upwardly by the pawl 154, it first partially and then completely blocks the passage 80 so as to delay operation of the armature 76 slightly, and then with an inverse time current characteristic.

In order to permit the breaker to be reclosed and handle the additional load which accumulates due to loss of diversity of load after an extended outage, such as will occur when the breaker is reclosed after having locked open for a relatively long time of, say, twenty minutes or more, recalibrating means may be provided, designated generally by the numeral 160. As best shown in Fig. 2, a resistor 161 may be mounted adjacent coil 24, being, for example, secured to the lower plate 22 by a bolt 162 and insulating spacer 163. An arm 165 may be pivotally mounted on plate 22 as by a pivot 166, having a contact 167 for engaging a fixed contact 168 mounted on the upper end of resistor 161 and spaced therefrom by insulation 169. A spring 170 biases arm 165 away from casting 20.

The lower end of resistor 161 may be connected to the lower terminal of coil 24 by connector 171, while the upper end is connected by a flexible connector 172 to contact 167. Connector 173 connects fixed contact 168 to the upper terminal of coil 24, so that resistor 161 is connected in shunt with coil 24 when the switch arm is actuated to the closed position.

To actuate arm 165, a bellcrank 175 is pivotally mounted on projection 176 of casting 20, and connected to toggle lever 114 by link 177 and clevis 177' (Fig. 1), so as to be operated to close switch arm 165 each time the toggle relation of levers 114, 104 is broken. A latch 178 having a bimetallic actuating portion 179 is mounted on casting 20 so as to be actuated downwardly to a position to retain arm 165 in the closed position, if the interrupter has been open for a predetermined time of say, about twenty minutes or more, and has cooled down sufficiently below the normal operating temperature. Temperature compensation may be effected by connecting a reversely disposed bimetal element 180 (Fig. 1) positioned on support rod 18 above the oil L to latch 178, as by link 182, so that changes in ambient temperature will not affect the operation of the latch.

When the circuit breaker operates to open the circuit, flange 86 will be carried upwardly with actuating sleeve 82 and thus carry the free end of pawl lever 144 upwardly with it to move pawl member 154 into engagement with the upper one of flanges 140 on integrating piston 136, to thus carry the piston upwardly a predetermined distance. When the breaker recloses following such a first circuit interrupting operation, integrating piston 136 is left at the position to which it was advanced, since pawl member 154 is free to disengage circular flanges 140, and if the breaker remains closed, integrator piston 136 will slowly reset to the position shown in Fig. 1 due to leakage of liquid in cylinder 30 below piston 136 through the relatively small clearance between the cylinder and piston. However, if the breaker immediately reopens after a first opening and reclosing operation, pawl member 154 this time will engage the next lower circular flange 140 on the integrator piston and raise the piston a further amount. Subsequent reclosing will result then in leaving piston 136 at this further advanced position from which it eventually will reset if the breaker remains closed. However, in the event of a continuing overload, the breaker will again open and reclose, and the pawl member 154 advances integrator piston 136 an amount sufficient to cause the upper extension 142 thereof to engage the extension 143 of toggle lever 104 and move this lever upwardly over-center, so that toggle spring 124 will maintain the contacts separated in the manner previously described. It is thus apparent that toggle levers 104 and 114 will be automatically moved upwardly over-center to maintain the breaker contacts separated, only in response to a predetermined number of closely successive circuit opening and closing operations, usually four such operations. However, in the event a lesser number of closely successive opening and closing operations occurs, the integrating mechanism will reset and the breaker contacts will be automatically held open only when the aforesaid predetermined number of opening and closing operations occurs in close succession. Obviously, after the breaker contacts have been automatically actuated to a position where they are held open by toggle spring 124, they can be reclosed only by manual operation of toggle lever 114 in the manner previously described.

When toggle levers 104 and 114 are moved over-center, link 177 actuates bellcrank lever 175 counterclockwise to close switch arm 165. Resistor 161 is thereby placed in shunt with coil 24 so as to require a greater value of current to effect a subsequent trip operation.

Should the recloser be reclosed shortly after such locking open, and before the usual diversity of load is lost, the operating temperature of the recloser, which will run on the order of 25 to 30 degrees centigrade above ambient, will not have dropped sufficiently for latch 178 to become effective, and spring 170 will open switch arm 165 as bellcrank 175 is rotated clockwise by handle 122. The interrupter will therefore have its normal trip rating.

Should the recloser remain open for about twenty minutes or more, so that the usual diversity of load is lost, the temperature of the recloser will drop as shown by curve (*a*) of Fig. 4, and latch 178 will be actuated downwardly by bimetal 179 so as to be effective to latch arm 165 closed. Thus when the recloser is reclosed, switch arm 165 will remain closed, and coil 24 will be shunted by resistor 161, thus reducing the effective ampere turns thereof. Accordingly, the trip current rating of the recloser will be increased, as shown by curve (*b*) of Fig. 3, and the recloser will be able to handle the increased load current due to loss of diversity.

From the above description and the accompanying drawings it will be apparent that I have provided a reclosing circuit breaker with increased cold load pickup, which means that the normal trip current may be much closer to the normal rating, while still permitting greater overcurrents to be handled if the breaker has been open for some time so as to permit load to accumulate. By making the arm 165 of a magnetic material, the magnetic

attraction between arm 165 and casting 20 may be utilized to prevent interrupting excessively heavy currents at the switch arm contacts, such as might occur should latch 173 be released during an overload. Existing breakers may be readily modified according to my invention with a minimum of labor and expense.

Having described a preferred embodiment of the invention in accordance with the patent statutes, it is desired that this invention be not limited to this particular construction inasmuch as it will be apparent, particularly to persons skilled in this art, that many modifications and changes may be made in this particular structure without departing from the broad spirit and scope of this invention. Accordingly, it is desired that the invention be interpreted as broadly as possible and that it be limited only as required by the prior art.

I claim as my invention:

1. A circuit interrupter comprising, separable contacts, an operating mechanism therefore, electroresponsive means operable to actuate said mechanism to effect separation of said contacts, lockout means actuated by a predetermined number of operations of the electroresponsive means to maintain said contacts separated, switch means actuated by the lockout means operable to vary the effectiveness of said electroresponsive means when the contacts are maintained separated, and releasable means operable in accordance with a predetermined temperature condition of the interrupter to maintain said switch means operated.

2. In a circuit interrupter, separable contacts, an operating mechanism for said contacts, a solenoid having an armature movable to actuate said mechanism to separate the contacts in response to a predetermined value of current, lockout means operable to hold said contacts separated, switch means operable in response to said lockout means to decrease the effective ampere turns of said solenoid, and releasable means for retaining said switch means operated when the temperature of the interrupter is below a predetermined value.

3. A circuit interrupter comprising, separable contacts, an operating mechanism for said contacts, electroresponsive means having an armature movable in response to a current above a predetermined value to actuate said operating mechanism to effect separation of said contacts, lockout means actuated by a predetermined number of closely consecutive operations of said electroresponsive means to maintain said contacts separated, means operable to reduce the effectiveness of the electroresponsive means actuated by operation of the lockout means, and releasable means operable in accordance with the temperature of the interrupter for maintaining the aforesaid means operated if the contacts are maintained separated for more than a predetermined time.

4. In a circuit interrupter, separable contacts, an operating mechanism therefor, electroresponsive means for actuating said mechanism to effect separation of said contacts in response to an overcurrent, lockout means actuated by a predetermined number of separations of said contacts operable to maintain said contacts separated in response to a predetermined number of closely consecutive separations, recalibrating means actuated by operation of said lockout means to recalibrate said electroresponsive means and increase the value of overcurrent required to operate the electroresponsive means, and latch means operable in response to said contacts remaining open for a predetermined time to retain the recalibrating means operative when the contacts are closed.

5. A circuit interrupter comprising, separable contacts, an operating mechanism for said contacts, electroresponsive means operable to actuate said mechanism to effect separation of said contacts, lockout means operated by a predetermined number of closely successive operations of the electroresponsive means in response to overcurrent conditions, recalibrating means operated by the lockout means when it operates to maintain said contacts separated to reduce the effectiveness of said electroresponsive means, biasing means for rendering the recalibrating means non-operative, and thermally responsive latch means for retaining the recalibrating means operated after the temperature of the interrupter reaches a predetermined minimum value.

6. In a circuit interrupter, separable contacts, an operating mechanism for said contacts, electroresponsive means operable to actuate said mechanism for separating said contacts, lockout means operated by a predetermined number of contact separations to maintain said contacts separated, recalibrating means operated by the lockout means when it acts to maintain separation of said contacts to reduce the effectiveness of the electroresponsive means, biasing means normally making the recalibrating means inoperative when the contacts are closed, and thermoresponsive releasable means operable to retain the recalibrating means operative against the effect of said biasing means when the temperature of the interrupter reaches a value a predetermined amount below the operating level.

7. In a circuit interrupter, separable contacts, operating means therefor including a solenoid having a movable armature for separating the contacts, lockout means operated by closely successive contact separations to maintain the contacts separated, switch means connected in circuit relation with the solenoid operable to reduce the effective ampere turns of the solenoid, actuating means operated by operation of the lockout means to effect operation of the switch means, biasing means normally effective to open the switch means when said contacts are closed, and releasable means maintaining the switch means operated when the contacts remain open for greater than a predetermined time.

8. A circuit interrupter comprising, separable contacts, operating means for said contacts, electroresponsive means for actuating said operating means and separating said contacts including a solenoid having an armature responsive to a predetermined value of current, lockout means for biasing the operating means and maintaining the contacts separated, a counter having a member advanced by closely successive operations of the electroresponsive means to effect operation of the lockout means to eventually lock said contacts open, an impedance device, means including a switch actuated by the lockout means connecting the impedance device in circuit relation with the solenoid, and releasable means operable when the temperature of the interrupter falls below a predetermined temperature to maintain said switch in the actuated position.

9. In a circuit interrupter, separable contacts, means including a solenoid having an armature for effecting separation of said contacts, lockout means for maintaining said contacts open, a counter operated by closely successive separations of said contacts to effect operation of the lockout means, a resistor, a switch, operating means operable in response to operation of the lockout means to effect operation of the switch to connect the resistor in circuit with the solenoid to reduce the effective ampere turns of the solenoid, said switch being normally disposed to open when the interrupter is closed, and a latch having a bimetallic member for retaining the switch closed when the temperature of the oil drops below a predetermined value while the interrupter is open.

10. A circuit interrupter comprising, separable contacts, operating mechanism therefore, a solenoid having an armature operable in response to a predetermined value of current to operate said mechanism to separate said contacts, said contacts being biased to reclose, lockout means operable to maintain said contacts separated against the reclosing bias, a counter operable in response to closely successive operations of the armature to effect operation of the lockout means, a resistor, a switch actuated by operation of the counter to connect the resistor in shunt with at least a portion of the solenoid,

and latch means including a temperature responsive member retaining said switch closed, only if the interrupter remains open for sufficient time for the temperature thereof to fall below a predetermined level.

11. A circuit interrupter comprising, separable contacts, an operating mechanism for said contacts, electroresponsive means for operating said mechanism and separating said contacts in response to a current above a predetermined value, a lockout mechanism for locking said contacts open, a counter operated by a predetermined number of closely successive operations of the electroresponsive means, a switch actuated by the lockout mechanism to reduce the effectiveness of the electroresponsive means, and a bimetallic latch for engaging a portion of the switch and retaining the switch actuated when the contacts are closed, provided the temperature of the interrupter has dropped below a predetermined value.

12. In a circuit interrupter, separable contacts, an operating mechanism for said contacts, electroresponsive means including a solenoid having an armature for operating said mechanism and effecting separation of said contacts, lockout means for maintaining said contacts separated, a counter actuated by a plurality of contact separations to effect operation of the lockout means, a resistor, a switch actuated by the lockout means to connect the resistor in shunt with at least a portion of the solenoid, a bimetallic latch element for engaging a portion of and retaining the switch closed if the temperature of the interrupter is below a predetermined value, and a bimetallic element opposing said latch element to compensate for changes in ambient temperature.

13. In a circuit interrupter, separable contacts, means including a solenoid having an armature movable to effect separation of said contacts, a magnetic circuit for said solenoid including pole pieces of magnetic material, lockout means for maintaining said contacts separated, a counter operated by a predetermined number of closely successive separations to effect operation of the lockout means, means shunting said solenoid including a switch having an armature of magnetic material extending between said pole pieces so as to be held closed for excessive currents by magnetic attraction to at least one of the pole pieces, actuating means for closing said switch only when the lockout means operates, and latch means including a bimetallic element for holding the switch closed so long as the temperature is below a predetermined level.

14. A circuit interrupter comprising, a container having insulating oil therein, a cover for said container, separable contacts supported in said oil from said cover, means for separating said contacts including a solenoid supported from the cover in said container responsive to current above a predetermined value, means biasing said contacts closed, lockout means operable to maintain said contacts separated, a counter actuated by closely successive separations of the contacts for operating the lockout means to maintain said contacts separated after a predetermined number of such operations, a resistor, a switch connecting the resistor in shunt with the solenoid, actuating means for said switch operated by the lockout means, a spring biasing the switch open, and a latch having a bimetallic operating member mounted adjacent the solenoid disposed to engage and latch the switch closed when the temperature of the solenoid and oil falls a predetermined amount below a normal operating temperature.

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