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T. W. SLEBODNIK

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UNDervoltage TRIP CIRCUIT BREAKER

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Fig.1.

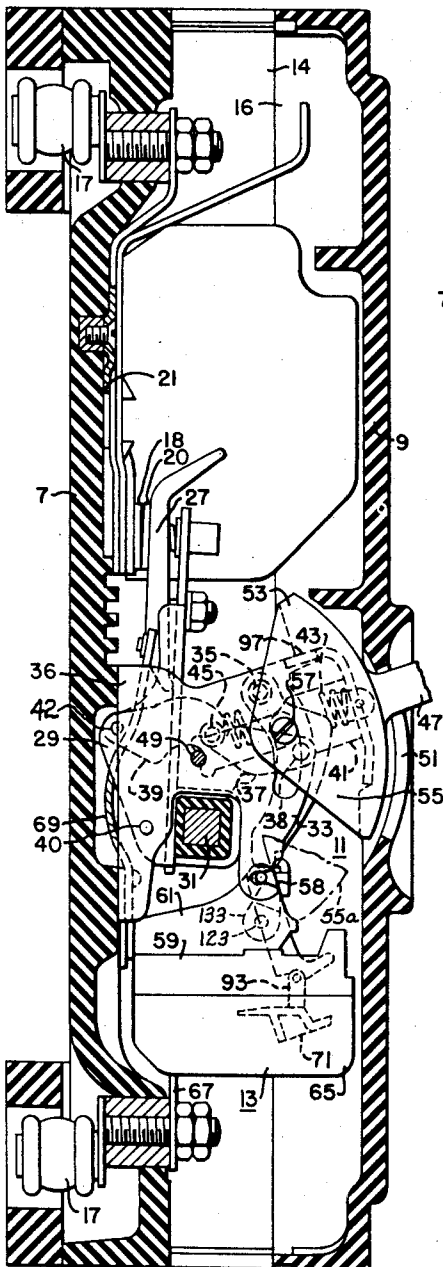


Fig.2.

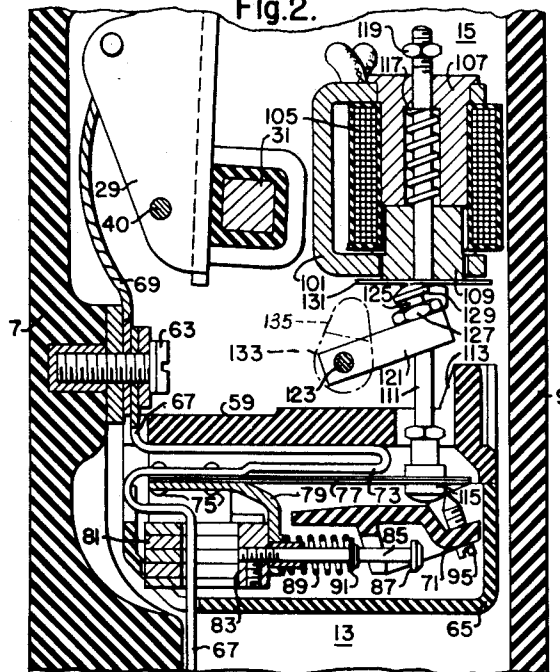
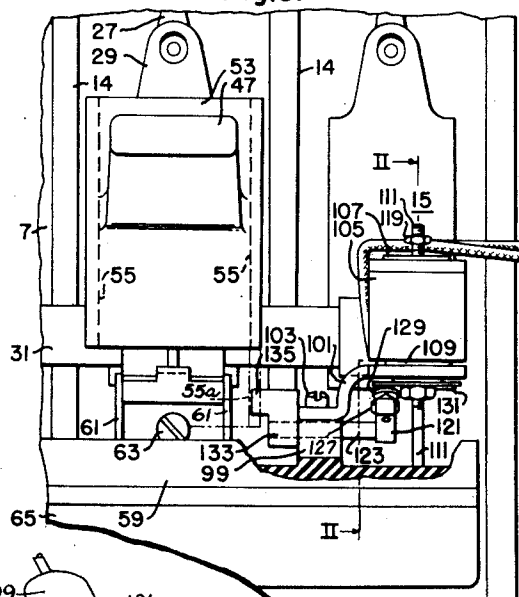


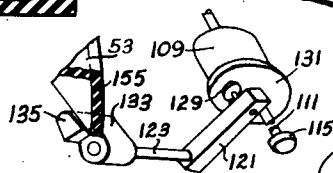
Fig.3.



WITNESSES:

H. F. Sussner.
Paul O. Garber.

Fig.4.



INVENTOR

Thomas W. Slebodnik.

BY

Ralph W Swingle
BY
ATTORNEY

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UNDervOLTAGE TRIP CIRCUIT BREAKER

Thomas W. Slebodnik, Beaver, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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10 Claims. (Cl. 200—106)

This invention relates to circuit breakers and more particularly to circuit breakers of the type used for controlling light to moderate distribution circuits.

Undervoltage trip devices for circuit breakers usually comprise electromagnets having armatures which are held in attracted position by energization of the magnets in response to normal voltage. When the voltage on the coil of such an undervoltage magnet drops below a predetermined value, the armature is released and effects tripping of the breaker. Such undervoltage trip devices are usually mechanically reset and the mechanical reset means released during the contact closing operation. If, at this time, normal voltage has not been restored to the undervoltage coil, the undervoltage trip will act to trip the breaker free of the handle while the contacts are in motion in closing direction. This action causes high impact stresses on the breaker mechanism and may permit the contacts to momentarily close and then lock in a partially closed position. This could result in a dangerous condition particularly if an attempt is made to close the breaker on a short circuit with no voltage or low voltage on the undervoltage trip coil.

An object of the invention is to provide a circuit breaker having an undervoltage trip device with means for preventing closing movement of the breaker contacts when the voltage is below a predetermined value.

Another object of the invention is to provide a circuit breaker having an undervoltage trip device with novel means for resetting the undervoltage trip device.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description thereof when read in conjunction with the accompanying drawing.

In said drawing:

Figure 1 is a vertical longitudinal sectional view of a circuit breaker embodying the invention, the breaker being shown in the closed position.

Fig. 2 is an enlarged sectional view taken substantially on line II—II of Fig. 3 through the trip device showing the overcurrent trip means for one pole of the breaker and also the undervoltage trip device.

Fig. 3 is a fragmentary plan view, partly in section, showing the undervoltage trip device.

Fig. 4 is a perspective view of the undervoltage trip resetting device.

The present invention is illustrated as applied to a circuit breaker similar to that disclosed in Patent No. 2,047,739, issued July 14, 1936, to H. J. Lingal, and assigned to the assignee of the present invention.

Referring to Fig. 1 of the drawing, the three-pole circuit breaker comprises a base 7 and a cover 9 both of insulating material, an operating mechanism indicated generally at 11, an overcurrent trip device indicated generally at 13 and an undervoltage trip device indicated generally at 15. The casing formed by the base 7 and cover 9 is divided into three longitudinal compartments by partition walls 14 molded integral with the base and cooperating partition walls 16 molded integral with the cover. Each of the compartments is adapted to receive a stationary contact 18 and a cooperating movable contact 20 which, with the corresponding terminals and connecting conductors, collectively form the three poles of the breaker.

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Each pole of the circuit breaker is provided with terminals 17 disposed in suitable openings formed in the base 7 at each end thereof. The stationary contacts 18 for each of the poles of the breaker are mounted on the lower ends of conductors 21, the upper ends of which are connected to the respective terminals 17.

The movable contact structures for the several poles of the breaker are the same, for which reason only the one for the center pole will be described. The movable contact 20 (Fig. 1) for the center pole is secured to a contact arm 27 which is loosely supported for universal movement on a channel-shaped switch arm 29. The three channel-shaped switch arms, one for each pole, are rigidly secured together for unitary movement by means of a tie bar 31 which extends across all of the poles of the breaker. The tie bar 31 serves to mechanically interconnect all of the channel-shaped frames 29 so that all three frames are operated by a single operating mechanism.

The operating mechanism comprises a releasable carrier 33 pivotally mounted by means of a pin 35 on a main frame 36, a pair of toggle links 37 and 39 interconnecting the carrier 33 and the center pole switch-arm frame 29, a U-shaped operating lever 41, overcenter springs 43 connecting the operating lever 41 to the knee pivot pin 45 of the toggle links 37—39, and an insulating operating handle 47 for the operating lever.

The toggle link 37 is pivotally connected to the carrier 33 by means of a pivot pin 38 and the toggle link 39 is pivotally connected by means of a pivot pin 42 to the channel-shaped frame 29 for the center pole of the breaker which is pivotally mounted on a pin 40. The two legs of the operating lever 41 lie adjacent the inner sides of the main frame members and are pivotally supported on pins 49 projecting therefrom. The operating handle 47 projects through a slot 51 in the cover 9 and has an arcuate protective portion 53 and integral side plates 55. The side plates 55 of the handle straddle the main frame and are secured to the legs of the operating lever 41 by means of screws 57 which extend through slots (not shown) in the frame members and threadedly engage the respective legs of the operating lever. The carrier 33 is normally held in latched position as shown in Fig. 1 by the free end thereof engaging a latch 58 which forms a part of the tripping mechanism.

With the parts in the closed position, as shown in Fig. 1, the circuit breaker is manually opened by clockwise movement of the handle 47 to the opposite end of the slot 51 to rotate the operating lever 41 in a clockwise direction. During this movement of the operating lever 41 the line of action of the overcenter spring 43 moves overcenter below the center line of the toggle link 37 causing the toggles 37—39 to collapse and causing simultaneous movement of all of the channel-shaped frames 29 and the movable contacts 20 to the open position.

To close the breaker, the operating handle 47 is moved in the opposite direction back to the position shown in Fig. 1. This movement of the handle causes the overcenter spring 43 to move over in the opposite direction, and move the toggle to the in-toggle position, thereby simultaneously moving the channel-shaped frames 29 and the movable contacts 20 to the closed position.

The circuit breaker is tripped open automatically in response to overload currents occurring in any pole of the breaker by operation of the trip device 13. The trip device comprises a base 59 mounted on a U-shaped bracket 61 which is rigidly secured by means of a screw 63 to the base 7 of the breaker. A cover 65 is provided to enclose the trip device. The screw 63 also serves to secure to the base 7 one end of a conductor 67 which has its other end suitably connected to the lower terminal 17. The upper end of the conductor 67 is connected to the movable contact arm 27 by means of a flexible conductor 69. Thus the circuit for the center pole, and also for the two other poles, may be traced from the upper terminal 17, conductor 21, stationary and movable contacts 18—20, movable switch arm 27, flexible conductor 69, and conductor 67 to the lower terminal 17. Pivotally mounted (by means not shown) on the base 59 is a trip bar 71 which extends across all of the poles of the breaker. Thermal and electromagnetic trip means are provided for each pole of the breaker to actuate the

trip bar 71 but since the trip means for each of the poles are alike, only one (Fig. 2) will be described.

The conductor 67 just below the base 59 for the trip device is formed into a loop 73 to the lower leg of which is secured by means of rivets 75 a bimetal element 77 extending to the right above the trip bar 71. The rivets 75 also serve to secure to the conductor 67 a bracket 79 which supports the electromagnetic trip means. A U-shaped magnet yoke 81 is rigidly supported on the bracket 79. A movable armature 83 is secured to the left-hand end of a trip rod 85 extending through a guide opening in the bracket 79. The right-hand end of the rod 85 is provided with a head 87 for engaging and actuating the trip bar 71. The armature 83 and the rod 85 are biased to unattracted position by means of a spring 89 compressed between the bracket 79 and a collar 91 on the rod 85.

The trip bar 71 has a projection 93 (Fig. 1) which normally engages the tail of the latch 58 to restrain the latch in latching position to thereby restrain the carrier 33 in operative position. Upon the occurrence of an overload current below a predetermined value of, for instance 1000% of normal rated current, the bimetal is heated by the excessive current flowing in the loop 73, and, when heated a predetermined amount, deflects downwardly to engage an adjusting screw 95 on the trip bar and rotate the trip bar in a clockwise direction about its pivot (not shown). This movement of the trip bar 71 effects release of the latch 58 which, in turn, releases the carrier 33 whereupon the overcenter spring 43 acting through the toggle link 37 rotates the carrier 33 counterclockwise to carry the center line of the toggle link 37 above the line of action of the overcenter spring. This causes collapse of the toggles 37-39 and movement of the switch arms 29 to the open position regardless of the position of the handle.

Before the breaker can be closed following an automatic tripping operation, it is necessary to reset and relatch the mechanism. This is accomplished by movement of the handle 47 in a clockwise direction as far as it will go to a "reset" position beyond the normal "off" position. During this movement a projection 97 on the operating lever engages and moves the carrier 33 back to its normal latched position. Thereafter the breaker can be closed in the previously described manner.

The circuit breaker is tripped instantaneously in response to overload currents above the predetermined value of, for instance, 1000% of normal rated current, or in response to short circuit currents. When an overload current above the predetermined value or a short circuit occurs, the electromagnetic trip means is energized by the current flowing through the conductors 67 which passes through the U of the magnet yoke 81. Energization of the electromagnet attracts the armature 83 and causes the head 87 of the rod 85 to engage and rock the trip bar 71 clockwise to effect instantaneous tripping of the breaker. The breaker mechanism is reset and the contacts closed following an instantaneous tripping operation in the previously described manner.

The undervoltage trip device 15 (Figs. 2 and 3) is mounted on the trip device base 59 by means of a block 99 and a bracket 101 secured to the base 59 by screws 103 (only one being shown). The undervoltage trip includes a voltage coil 105 connected across the circuit ahead of the breaker contacts, a fixed core member 107 and a movable armature 109. Attached to the armature 109 is a trip rod 111 which extends through an opening in the core member 107 and also extends downwardly through a clearance opening 113 in the base 59 where it carries a head 115 adapted to engage and operate the trip bar 71. The trip rod 111 is biased in tripping direction by means of a spring 117 disposed in an opening in the core member 107 and compressed between the bottom of the opening and the movable armature.

As long as normal voltage is applied across the coil 105, the armature 109 will be held in its attracted position as shown. When the voltage drops to a predetermined value, however, the armature 109 will be released and the spring 117 will move the armature and the trip rod 111 downward with sufficient force to cause the head 115 to engage and actuate the trip bar 71 to thereby effect automatic opening of the breaker in the manner previously described. A nut 119 threadably engaging the upper end of the trip rod 111 limits the downward movement thereof.

Heretofore most conventional undervoltage trip de-

vices have been reset and the reset mechanism released during a closing operation of the breaker operating mechanism. If an attempt was made to close the breaker with no or low voltage on the undervoltage coil, the undervoltage trip device will, upon release of the reset means, immediately function to actuate the trip bar and effect release of the operating mechanism during the closing operation. This results in high impact stresses on the breaker operating mechanism and, at times, causes the contacts to momentarily close and then lock in a partially closed position. This latter condition could result in a very dangerous condition if an attempt was made to close the breaker in against a short circuit with no voltage on the undervoltage release coil.

An important feature of the present invention is the provision of means for resetting the undervoltage trip means during the resetting and relatching operation of the breaker mechanism so that the resetting means for the undervoltage trip will be released as soon as the operating handle is started in the closing direction and before the closing movement of the contacts is started. With this arrangement if an attempt is made to close the breaker with no voltage on the undervoltage coil, the breaker mechanism will be immediately released and any movement of the contacts in closing direction will be prevented.

Another important feature of the invention is that the undervoltage trip device is operative to release the operating mechanism while the breaker contacts are open. That is, if the breaker is manually opened in order to disconnect the load from the line, and is left in the open position for a period of time, the undervoltage trip device will function in response to a predetermined loss of voltage occurring while the breaker is standing open and cause release of the operating mechanism. The mechanism must then be reset and relatched before the contacts can be closed. This condition serves as a warning to the operator that a dangerous condition has occurred and may still exist, and makes it impossible to close the breaker contacts if the low voltage condition still exists.

The undervoltage reset device comprises an arm 121 (Figs. 2, 3 and 4) secured to a shaft 123 mounted for rotation in the block 99. The arm 121 adjacent its free end carries a stud 125 threaded into the arm and locked in position by a lock nut 127. The stud 125 is provided with a rounded head 129 for engaging a disc 131 secured to the armature 109 of the undervoltage trip device. Secured to the shaft 123 on the opposite side of the block 99 from the arm 121 is a lever or cam member 133 having an offset portion 135 adapted to be engaged by the adjacent side plate 55 of the operating handle.

Following an automatic tripping operation by the undervoltage trip device in response to a loss of voltage, it is necessary to reset and relatch the breaker operating mechanism before the contacts can be closed. This is effected, as previously described, by movement of the operating handle as far as it will go in a clockwise direction from the "on" position shown in Fig. 1. As the handle nears the extreme clockwise or reset position, the side plate 55 nearest the undervoltage trip device engages the cam member 133, as shown by dot and dash lines at 55a in Figs. 1 and 3 and rotates the shaft 123 and the arm 121 in a counterclockwise direction as viewed in Fig. 2. This movement causes the head 129 of the stud 125 to engage the disc 131 and raise the armature 109 together with the trip rod 111 closing the air gap between the armature and the core member 107.

The parts remain in this position until the handle is released or is moved to close the contacts. If the handle is released when in the reset position it will be automatically moved to the "off" position. When the handle is released or is moved in closing direction, the side plate 55 releases the cam member 133 during the movement of the handle from the "reset" to the "off" position. If, at this time normal voltage has been restored to the coil 105, the armature 109 will be attracted and held in its attracted position and the contacts may be closed in the normal manner. However, if there is no voltage on the coil 105 or the voltage is below a predetermined value, the armature 109 will not be held and, as soon as the handle is moved far enough in closing direction to release the cam member 133, the spring 117 will drive the armature 109 and the trip rod 111 downward and actuate the trip bar 71 to effect immediate release of the carrier 33. Since, at this time, the handle has not moved far enough to carry the

overcenter spring 43 overcenter, the toggle 37—39 remains in collapsed condition and release of the releasable carrier 33 maintains the toggle 37—39 in collapsed position, thus preventing any movement of the movable contact structure in closing direction. The force applied to the handle to close the contacts, under this condition, merely moves the handle idly to the closed position.

Before the contacts can be closed, it is necessary to again move the handle in order to reset and relatch the operating mechanism and to reset the undervoltage trip device. If the normal voltage has been restored to the coil 105, the armature 109 and the trip rod 111 will be held in their attracted positions and the handle may then be operated to close the breaker contacts as previously described.

Having described the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made therein without departing from some of the essential features of the invention.

I claim as my invention:

1. A circuit breaker comprising relatively movable contact means, a movable switch member operable to open and close said contact means, operating mechanism releasable to effect automatic opening of said contact means, an operating handle movable to open and closed positions to open and close said contact means, trip means responsive to overload currents to effect release of said operating mechanism and automatic opening of said contact means, an undervoltage trip device responsive to a predetermined loss of voltage to effect release of said operating mechanism and automatic opening of said contact means free of said operating handle, said operating handle being movable to a reset position different from said open and closed positions to reset said operating mechanism, and means engageable by said handle when said handle only is moved to said reset position to effect resetting of said undervoltage trip device.

2. A circuit breaker comprising relatively movable contact means, a switch arm movable to open and close said contact means, operating mechanism for said switch member including a member releasable to effect automatic opening movement of said switch member, an operating handle movable to open and closed positions to effect opening and closing movements of said switch member, trip means responsive to overload currents to effect release of said releasable member, an undervoltage trip device comprising an electromagnet having an armature movable in response to a predetermined loss of voltage to effect release of said releasable member free of said handle, said operating handle being also movable to a reset position different from said open and closed positions to reset said releasable member, resetting means operable by said handle only when said handle is moved from said open position to said reset position to engage and reset said armature, and said operating handle when moved from said reset position to effect closing movement of said switch member causing said resetting means to release said armature and permit said undervoltage trip device to trip said operating mechanism free of said operating handle before said switch member is moved in closing direction.

3. A circuit breaker comprising relatively movable contact means, a switch member movable to open and close said contact means, operating mechanism for said switch member including a member releasable to effect automatic opening movement of said switch member, an operating handle movable to open and closed positions to effect opening and closing movement of said switch member, trip means responsive to overload currents to effect release of said releasable member, an undervoltage trip device comprising a coil and an armature responsive to predetermined voltage conditions to effect release of said releasable member free of said handle, said operating handle also being movable to a reset position different from said open and closed positions to reset said releasable member, resetting means for said undervoltage trip device comprising a shaft, an arm on said shaft for engaging said armature, a member on said shaft disposed to be engaged by said operating handle only when said handle is moved from said open position to said reset position to cause said arm to engage and reset said armature, and said operating handle when moved from said reset position to said open position causing said resetting means to release said armature to permit said armature to effect release of said releasable member before said switch member is moved in closing direction upon movement of

said handle from said open position in closing direction when the voltage on said coil is below a predetermined value.

4. A circuit breaker comprising relatively movable contact means, a switch member movable to open and close said contact means, operating mechanism for said switch member including a member releasable to effect automatic opening movement of said switch member, a trip member normally restraining said releasable member and operable to effect release of said releasable member, support means for said trip member, an operating handle movable to open and closed positions to effect opening and closing movements of said switch member, trip means mounted on said support means and responsive to overload currents to actuate said trip member, said handle being also movable to a reset position different from said open and closed positions to reset said releasable member, an undervoltage trip device comprising a voltage coil and an armature movable in response to predetermined voltage conditions to actuate said trip member and release said releasable member free of said handle, means mounting said undervoltage trip device on said support means, resetting means for said undervoltage trip device comprising a shaft mounted for rotation on said mounting means, an arm on said shaft for engaging said armature and a member also mounted on said shaft and disposed to be engaged by said handle only when said handle is moved from said open position to said reset position to actuate said shaft and cause said arm to engage and reset said armature, and said handle when moved from said reset position to said open position causing said arm to release said armature to permit said armature to actuate said trip member and effect release of said releasable member before said switch member is moved in closing direction upon movement of said handle in closing direction when the voltage on said coil is below a predetermined value.

5. A circuit breaker comprising relatively movable contact means, a movable switch member movable to open and close said contact means, operating means releasable to effect automatic opening of said contact means, an operating handle movable to open and closed positions to open and close said contact means, an undervoltage trip device responsive to predetermined loss of voltage to effect release of said operating means and automatic opening of said contact means free of said operating handle, said operating handle being movable to a reset position different from said open and closed positions to reset said operating means, resetting means operable only upon movement of said operating handle from said open position to said reset position to reset said undervoltage trip device, and said operating handle when moved from said reset position to said open position causing said resetting means to release said undervoltage trip device and permit said undervoltage trip device to effect release of said operating mechanism before said contact means is moved in closing direction upon movement of said handle in closing direction.

6. A circuit breaker having an enclosing housing divided into a plurality of compartments, relatively movable contact means in at least two of said compartments, operating mechanism disposed in one of said compartments and releasable to effect automatic opening of said contact means, an operating handle in said one compartment movable to an open position and to a closed position to effect opening and closing of said contact means, an undervoltage trip device disposed in another of said compartments, said undervoltage trip device being operable in response to a predetermined loss of voltage to effect release of said operating mechanism and automatic opening of said contact means free of said handle, said operating handle being movable to a reset position different from said open and closed positions to reset said operating mechanism, resetting means for said undervoltage trip device comprising a member extending from said one compartment to said other compartment, an element operated by said member and disposed in said other compartment to engage and reset said undervoltage trip device, and a part operatively connected to said member and disposed in said one compartment to be engaged by said operating handle only when said handle is moved from said open position to said reset position to actuate said member and cause said element to engage and reset said undervoltage trip device.

7. A circuit breaker having an enclosing housing divided into a plurality of compartments, relatively movable contact means in at least two of said compartments, oper-

ating mechanism disposed in one of said compartments and releasable to effect automatic opening of said contact means, an operating handle in said one compartment movable to an open position and to a closed position to effect opening and closing of said contact means, an undervoltage trip device disposed in another of said compartments, said undervoltage trip device being operable in response to a predetermined loss of voltage to effect release of said operating mechanism and automatic opening of said contact means free of said handle, said operating handle being movable to a reset position different from said open and closed positions to reset said operating mechanism, resetting means for said undervoltage trip device comprising a shaft extending from said one compartment to said other compartment, an arm on said shaft disposed in said other compartment to engage and reset said undervoltage trip device, a member on said shaft disposed in said one compartment to be engaged by said operating handle only when said handle is moved from said open position to said reset position to actuate said shaft and cause said arm to engage and reset said undervoltage trip device, and said operating handle when moved away from said reset position to effect closing of said contact means causing said resetting means to release said undervoltage trip device and permit operating said undervoltage trip device to effect release of said operating mechanism free of said handle before said contact means is moved in closing direction.

8. A circuit breaker having line and load terminals, stationary and movable contacts, said stationary contacts being connected to said line terminals, operating mechanism releasable to effect automatic opening of said contacts, an operating handle movable to an open position and to a closed position to open and close said contacts, an undervoltage trip device connected across the line terminals ahead of said stationary contacts and operative in both the open and closed positions of said operating handle in response to a predetermined loss of voltage to effect release of said operating mechanism, resetting means operable to reset said undervoltage trip device, said handle being movable to engage and actuate said resetting means to reset said undervoltage trip device while said contacts are open.

9. A circuit breaker having line terminals and load terminals thereon, stationary and movable contacts, said stationary contacts being connected to said line terminals,

operating mechanism releasable to effect automatic opening of said contacts, an operating handle movable to an open position and to a closed position to open and close said contacts, an undervoltage trip device connected across the line terminals ahead of said stationary contacts and operative in both the open and closed positions of said operating handle in response to a predetermined loss of voltage to effect release of said operating mechanism, resetting means operable to reset said undervoltage trip device, said handle being movable to engage and actuate said resetting means to reset said undervoltage trip device while said contacts are open, said handle moving to an indicating position different from said open and closed positions when said undervoltage trip device operates to release said operating mechanism when the contacts are open.

10. A circuit breaker having line terminals and load terminals, stationary and movable contacts, said stationary contacts being connected to said line terminals, operating mechanism releasable to effect automatic opening of said contacts, an operating handle movable to an open position and to a closed position to manually open and close said contacts, said handle being movable to a reset position to reset said releasable operating mechanism, an undervoltage trip device connected to the line terminals ahead of said stationary contacts and operable in response to a predetermined loss of voltage while said contacts are open to effect release of said operating mechanism while said contacts are open, resetting means operable by said handle only when said handle is moved from said manually open position to said reset position to reset said undervoltage trip device while said contacts are open, said handle when moved from said reset position to said manually open position causing said resetting means to free said undervoltage trip device to permit its operation.

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