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E. J. WALKER ET AL

2,989,606

CIRCUIT BREAKER

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2 Sheets-Sheet 1

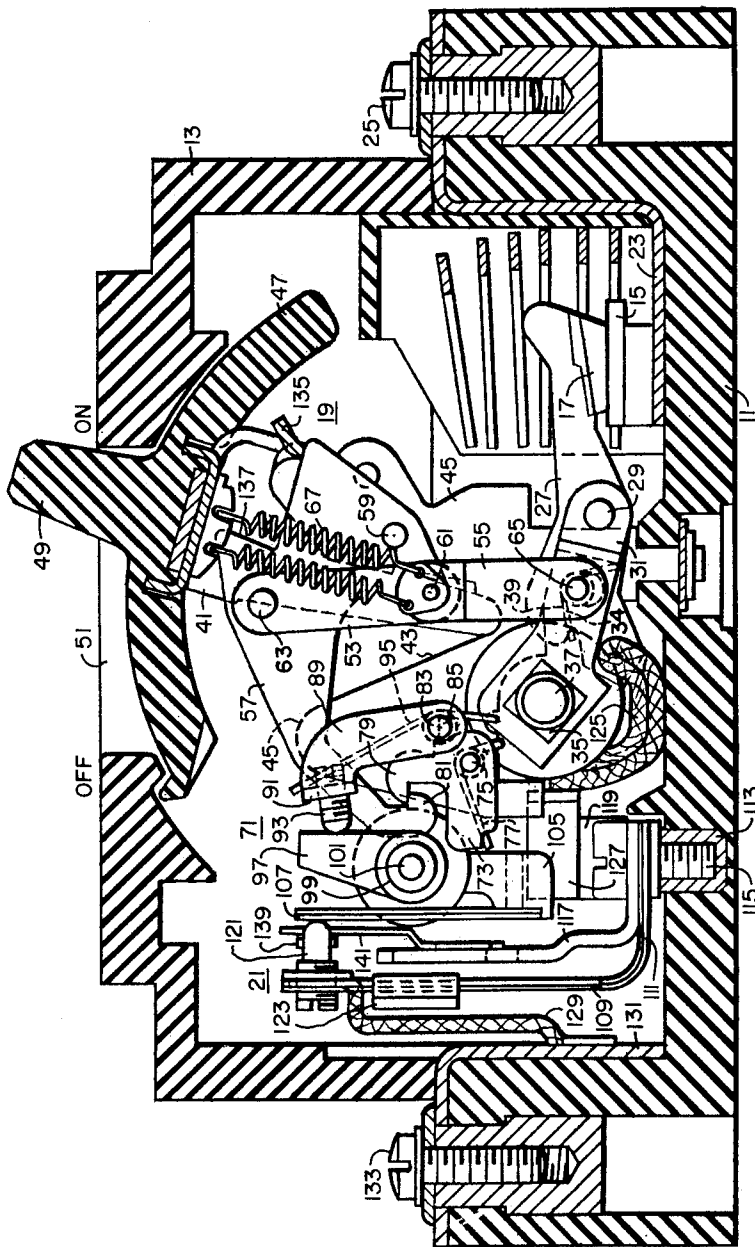


Fig. 1.

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2 Sheets-Sheet 2

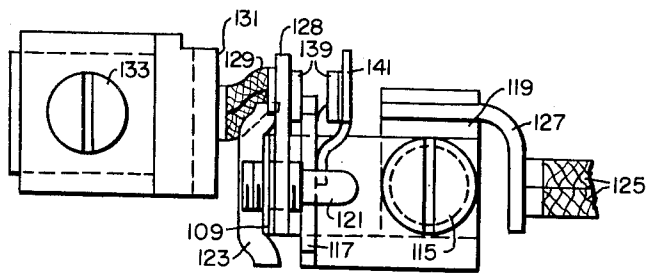


Fig. 2.

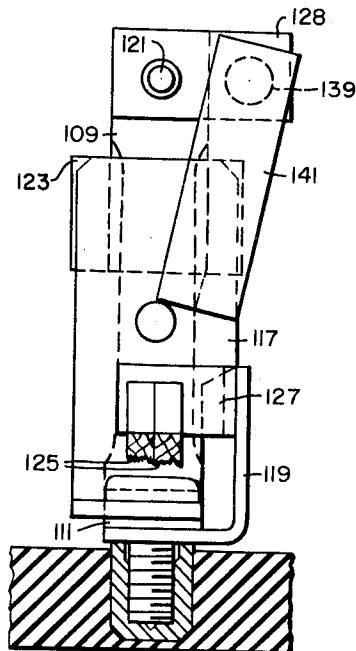


Fig. 3.

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CIRCUIT BREAKER

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11 Claims. (Cl. 200—88)

This invention relates to circuit breakers and, more particularly, to circuit breakers for controlling lighting and moderate power circuits.

An object of the invention is to provide a circuit breaker embodying a current-carrying thermally responsive trip element and an electromagnetic trip element, with means for limiting the current in the thermally responsive element under certain abnormal conditions.

Another object of the invention is to provide a circuit breaker embodying current-carrying thermally responsive trips means responsive to overload currents below a predetermined value to trip the breaker and electroresponsive trip means operable in response to overload currents above the predetermined value to trip the breaker, with means for limiting the current in, and preventing burn out of the thermally responsive means on excessive overload currents.

Another object of the invention is to provide a circuit breaker embodying a thermally responsive bimetallic tripping element and electroresponsive means for tripping the breaker, with simplified and lower cost means for limiting the current in the thermally responsive means upon operation of the electroresponsive means and thus preventing the bimetallic element from being excessively heated and taking a permanent set which would destroy the calibration of the breaker.

Another object of the invention is to provide a circuit breaker embodying thermally responsive means with electroresponsive means for protecting the thermally responsive means by limiting the current therein when the electroresponsive means is operated in response to excessive overload currents.

Another object of the invention is to provide a circuit breaker according to the preceding paragraphs wherein the protective means comprises cooperating contacts carried by the thermally responsive means and the electroresponsive means.

The invention, both as to structure and operation together with additional objects and advantages thereof, will be best understood from the following detailed description when read in conjunction with the accompanying drawing.

In said drawing:

FIGURE 1 is a vertical sectional view through the center pole of a three-pole circuit breaker embodying the principles of the invention;

FIG. 2 is an enlarged top plan view of the trip device for one of the poles of the breaker; and

FIG. 3 is an elevational view of the trip device shown in FIG. 2.

The invention is illustrated as applied to a circuit breaker of the type disclosed in application Serial No. 625,297, filed November 30, 1956, by Eugene J. Walker and Howard E. Reichert.

The circuit breaker is of the three-pole type, only one pole being shown, and comprises a base 11 and a cover 13 both of molded insulating material. A stationary contact 15 and a cooperating movable contact 17 are provided for each pole of the breaker. An operating mechanism 19 common to all of the poles is disposed in the center pole compartment (Fig. 1) and each pole is provided with a trip device indicated generally at 21.

The stationary contact 15 for each pole of the breaker

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is rigidly mounted on the inner end of a conducting strip 23, the outer end of which is secured by means of a line terminal connector 25 to a metal insert molded in the base 11. The movable contact 17 for each of the poles is mounted on a contact arm 27 which is pivotally mounted by means of a pin 29 on a switch arm 31. The switch arms 31 for the several poles are secured to an insulating tie bar 35 which is pivotally supported in brackets (not shown) by means of pins 37 in the ends of the tie bar. Springs 34 bias the contact arms 27 clockwise about the pins 29 to provide contact pressure in the closed position of the switch arm.

The operating mechanism 19 is disposed in the center pole and comprises a U-shaped operating lever 41 having its inner ends pivoted in V-shaped notches 43 in a pair of spaced metal frame members 45 that are mounted in the bottom portion of the base 11.

The operating lever 41 has an arcuate shield 47 mounted on the outer end thereof. A handle portion 49 extends out from the shield 47 through an opening 51 in the cover 13. The switch arm 31 for the center pole is operatively connected by means of a toggle comprising links 53 and 55 to a releasable member or cradle 57 that is pivotally mounted on a pin 59 that is supported in the frames 45. The toggle links 53 and 55 are pivotally connected together by a knee pivot pin 61. The toggle link 53 is pivotally connected to the releasable cradle 57 by a pivot pin 63 and the toggle link 55 is pivotally connected by a pin 65 to the switch arm 31 for the center pole. Overcenter springs 67 are connected under tension between the knee pivot pin 61 of the toggle 53—55 and the yoke portion of the operating lever 41.

The contacts for all of the poles are manually opened and closed in a well-known manner by movement of the operating lever 41 to the "Off" position and then back to the "On" position. Movement of the lever 41 to the "Off" position causes collapse of the toggle 53—55 and opening of the contacts 15—17. Reverse movement of the handle back to the "On" position causes straightening of the toggle 53—55 and closing of the contacts 15—17.

The contacts are opened automatically in response to overload circuits occurring in any pole of the breaker by release of the releasable cradle 57. The cradle is normally releasably restrained in operative position by means of a latch mechanism indicated generally at 71 which is actuated by the trip device 21 to release the cradle 57. When released, the cradle 57 rotates clockwise about its pivot 59 under the influence of the overcenter springs 67 causing collapse of the toggle 53—55 and opening movement of the switch arms 31.

The latch mechanism comprises a main latch 73 pivoted on a pin 75 in the frame 45 and biased by a spring 77 in unlatching direction. The main latch 73 is provided with a latching portion 79 that engages a latch tip 81 on the free or latching end of the cradle 57 to releasably hold the cradle in operative position. The latch tip 81 is in-turned and faces generally in the direction toward the pivot 59 about which it moves. The latch 73 is of the slip-off type and is releasably held in latching position by a light-load cylindrical latch which comprises a rotary shaft 83 pivotally mounted in the frame 45 and having a cut-out portion 85 engaging a shoulder on the main latch 73. The latch 83 has an upwardly extending arm 89 secured thereto which, at its upper end, has an ear 91 formed thereon. An adjusting screw 93 is threaded into the ear 91 and is movable into engagement with a projection 97 on a trip bar 99. A spring 95 biases the arm 89 and the rotary shaft 83 to latching position where it is stopped by engagement of the screw 93 with the projection 97 on the trip bar.

The trip bar 99 is of molded insulating material and the projection 97 is molded integral therewith. The trip

bar 99 is pivotally supported by means of pins 101 molded in the ends thereof which are supported in brackets (not shown) in the end poles of the breaker adjacent the sidewalls of the housing. The trip bar 99 is provided with a downwardly extending projection 105 for each pole on which is rigidly mounted an ambient temperature compensating bimetal element 107 which is adapted to be mechanically actuated by the trip device 21 to operate the trip bar 99.

The trip device for each pole comprises a tripping bimetal element 109 having a mounting foot 111 formed thereon which is rigidly mounted on a metal insert 113 that is molded in the base 11 of the housing. The mounting foot 111 is rigidly secured to the insert 113 by a screw 115 which also secures a fixed magnetic member 117 and a terminal 119 to the base. At its upper or free end, the bimetal element 109 has an adjusting or calibrating screw 121 mounted thereon which, upon thermal bending of the bimetal element 109 in response to low overload currents, engages the free end of the compensating bimetal 107 to rotate the trip bar 99 gradually in a clockwise direction about its pivot 101. A movable magnetic member or armature 123 is rigidly secured to the tripping bimetal element 109 adjacent the upper end of the fixed magnetic member 117 and on the side of the bimetal 109 that is opposite the side that faces the magnetic member 117. The armature 123 is attracted to the fixed magnetic member 117 in response to excessive overload currents flowing in the bimetal and bends the tripping bimetal 109 to effect instantaneous operation of the trip bar 99.

The movable contact arm 27 for each pole is connected by means of a flexible conductor 125 to a portion 127 of the terminal 119. Mounted on the free end of the tripping bimetal 109 is a laterally extending tab 128 which is connected by a flexible conductor 129 to the inner portion of a conducting strip 131 which is provided at its outer end with a load terminal connector 133.

The high expansion sides of the tripping bimetal element 109 and the compensating bimetal element 107 are both on the left side of the bimetal elements as seen in FIG. 1, so that both of the bimetal elements will deflect in the same direction in response to changes in ambient temperature, thus compensating the tripping bimetal element for changes in ambient temperature.

The fixed magnetic member 117 is wider than either of the bimetal elements and is disposed between the bimetal elements 107 and 109 so as to shield the compensating bimetal 107 from the heat of the current-carrying tripping bimetal element 109.

When a low persistent overload current occurs, the bimetal element 109 becomes heated and when heated a predetermined amount bends toward the right. This movement through the screw 121 and the compensating bimetal 107 rotates the trip bar 99 in a clockwise direction, causing the projection 97 to gradually rotate the arm 89 and the rotary latch shaft 83 clockwise until it reaches the point where it frees the main latch 73. The latching point of the main latch 73 and the latch portion 81 of the cradle 57 is to the left of the pivot 75, hence, the main latch 73 is biased in unlatching direction by a component of the force exerted by the overcenter springs 67 as well as by the spring 77. When the main latch 73 is released by the lightload trigger latch 83, it is immediately snapped to the unlatching position, releasing the cradle or releasable member 57 to effect opening of the contacts in the manner previously described.

Means is provided to limit the current in the thermally responsive tripping bimetal element 109 when an excessive overload current or a short circuit current occurs. Excessive currents flowing in a current-carrying bimetal cause undue heating thereof which causes the bimetal to take a permanent set, thus destroying its calibration. Even heavier short-circuit currents could melt through or burn out the bimetal. In order to prevent undue heating

of the bimetal 109 on excessive overload currents and to thereby preserve the functioning and calibration of the bimetal means, means is provided to shunt part of the current around the bimetal 109. This means comprises a pair of contacts 139 (FIG. 2) one of which is mounted on the tab 128 to which the flexible conductors 129 are secured, the other contact 139 being mounted on a resilient member 141 that is secured to the fixed magnetic member 117.

Upon the occurrence of an excessive overload current or a short circuit current, the armature 123 is attracted to the fixed magnetic member 117 bending the bimetal 109 to effect instantaneous tripping of the breaker. This bending of the bimetal 109 closes the contacts 139, thus forming a parallel shunt path for the current. Since the resistance of the shunt path through the resilient member 141, the fixed magnetic member 117 and the contacts 139 is less than the resistance through the bimetal 109, the major part of the current will be shunted around the bimetal, thus preventing overheating of the bimetal. By proper adjustment of the magnetic air gap and the distance between the contacts 139, the contacts 139 will close only on magnetic tripping and the breaker will trip on thermal tripping without closing the contacts 139, so that the thermal trip calibration is not affected by the contacts 139. The use of the leaf spring member 141 to carry one of the contacts 139 provides a cushion, maintaining contact pressure and not forcibly stopping the movement of the bimetal. At the same time the leaf spring 141 provides the shunt current path to the contacts.

It is a feature of this invention that the current flows in the same direction in the shunt path as in the main path in the bimetal. Thus at an instant when the contacts 139 have closed and the current flow from the flexible conductor 129 is downward in the bimetal 109, the current flow through the contacts is also downward in the leaf spring member 141 and the magnetic member 117. Since these two paths are close together, the current flow in them in the same direction causes a magnetic attraction between the two current paths and holds the contacts 139 together, rather than tending to blow them apart. This assures good contact and protects the short-circuiting contacts from unnecessary arcing.

The design of the short-circuiting arrangement disclosed herein takes very little space in the breaker and is of low cost, since the only added elements are the spring member 141 and the contacts 139. The arrangement is so compact that it may be used in a 480 or 600 volt breaker, where the invention is particularly needed, with the over-all size of the breaker not being substantially greater than was formerly used for 250 volt breakers.

Before the breaker contacts can be closed following an automatic opening operation, it is necessary to reset and relatch the mechanism. This is accomplished by moving the handle 49 counterclockwise to the "Off" position. During this movement a projection 135 on the operating lever 41 engages a shoulder 137 on the cradle 57 and moves the latter counterclockwise about its pivot 59. Near the end of this movement the lower rounded portion of the latch end 81 of the cradle 57 engages the outwardly extending arm of the bell-crank shaped latch member 73 and moves it to its latching position. As soon as the shoulder (not shown) of the latch 73 clears the corner of the partially cylindrical portion of the latch 83, the spring 95 restores the arm 89 to its normal position, moving the latch 83 to its latching position. The latching portion 79 of the latch 73 is then above the latch end 81 and it engages the latch end 81 of the cradle. Thereafter, the contacts are closed in the previously described manner by movement of the handle to the "On" position.

The invention provides a circuit breaker embodying an improved thermal and magnetic trip device including ambient temperature compensating means and means

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for limiting the current flow in the thermal tripping means on the occurrence of excessive overload currents or short circuit currents to prevent undue heating of and damage to the thermal element.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details and arrangement of parts thereof may be made without departing from the spirit of the invention.

We claim as our invention:

1. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a member movable to effect release of said releasable means, current-carrying thermally responsive means operable to move said movable member, an electromagnetic device operable to actuate said thermally responsive means to cause said thermally responsive means to move said movable member, and means operated by said thermally responsive means when said thermally responsive means is actuated by said electromagnetic device to limit the current flow in said thermally responsive means.

2. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a member movable to effect release of said releasable means, current-carrying thermally responsive means operable in response to low overload currents to move said movable member, electromagnetic means operable in response to excessive overload currents to actuate said thermally responsive means and cause said thermally responsive means to move said movable member, current shunting means disposed substantially between said thermally responsive means and said movable member, said current shunting means being operated by said thermally responsive means when said thermally responsive means is actuated by said electromagnetic means to limit the current flow in said thermally responsive means to thereby prevent damage to said thermally responsive means.

3. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, trip means comprising current-carrying thermally responsive means operable to effect release of said releasable means, an electromagnetic device operable to actuate said thermally responsive means to effect release of said releasable means, and means operated by said thermally responsive means only when said thermally responsive means is actuated by said electromagnetic device to thereby limit the current flow in said thermally responsive means.

4. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, trip means comprising a current-carrying bimetal element heated by the current therein and when heated a predetermined amount bending in a direction to effect release of said releasable means, an electromagnetic device operable when energized in response to excessive overload currents to bend said bimetal element to effect release of said releasable means, contact means closed by said bimetal element upon the bending of said bimetal element by said electromagnetic device to limit the current flow in said bimetal element to prevent damage to said bimetal element, and said contact means remaining open when said bimetal element is bent by the heat therein to effect release of said releasable means.

5. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a trip member movable to effect release of said releasable means, a trip device comprising a current carrying bimetal element having one end mounted and the other end free, an ambient temperature responsive bimetal element having one end mounted on said trip member and the other end free, said ambient temperature responsive bimetal element extending along one side of said current-carrying bimetal element and spaced therefrom, thermal bending of said current-carrying bimetal element causing the free end thereof to engage the free end of said am-

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bient temperature responsive bimetal element to move said trip member, electromagnetic trip means comprising a magnetic member fixedly mounted at one end and extending between said bimetal elements to shield the ambient temperature responsive bimetal element from the heat of the current-carrying bimetal element, said electromagnetic trip means comprising an armature mounted on said current-carrying bimetal element operable upon energization of said electromagnetic trip means to bend said current-carrying bimetal element to instantaneously move said trip member, and means comprising a pair of contacts closed upon bending of said current-carrying bimetal element upon energization of said electromagnetic trip means to thereby limit the current flow in said current-carrying bimetal element.

6. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts to open an electric circuit, trip means comprising a current-carrying bimetal element heated by the current of said circuit and when heated a predetermined amount bending in a direction to effect release of said releasable means, electromagnetic means comprising a magnetic member fixedly mounted at one end and extending along one side of said current-carrying bimetal element, an armature mounted on said current-carrying bimetal element operable upon energization of said electromagnetic means to bend said current-carrying bimetal element to effect instantaneous release of said releasable means, and means comprising a pair of open contacts closable to limit the current flow in said current-carrying bimetal element, one contact of said pair of contacts being carried by the free end of said bimetal element and the other contact of said pair of contacts being supported on said fixed magnetic member, said pair of contacts remaining open when said bimetal element bends in response to the heat therein to effect release of said releasable means, and said pair of contacts closing when said bimetal element is bent by actuation of said electromagnetic means.

7. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts to open an electric circuit, trip means comprising a current-carrying bimetal element heated by the current of the circuit and when heated a predetermined amount bending in a direction to effect release of said releasable means, electromagnetic means comprising a magnetic member fixedly mounted at one end and extending along one side of said current-carrying bimetal element, a leaf spring mounted at one end thereof on said magnetic member, an armature mounted on said current-carrying bimetal element and being operable upon energization of said electromagnetic means to bend said current-carrying bimetal element to effect instantaneous release of said releasable means, and means comprising a pair of contacts for limiting the current flow in said current-carrying bimetal element, one contact of said pair of contacts being carried by the free end of said bimetal element and the other contact of said pair of contacts being supported on the free end of said leaf spring on said fixed magnetic member, said pair of contacts being closed upon bending of said bimetal element when said electromagnetic means is energized to thereby provide a current path shunting part of the current around the bimetal element.

8. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a trip member movable to effect release of said releasable means, a current-carrying thermally responsive member movable in response to low overload currents therein to move said trip member to effect release of said releasable means, electromagnetic means energized by heavy overload currents to move said thermally responsive member to effect release of said releasable means, a leaf spring having a short-circuiting contact surface adjacent one end thereof, a second short-circuiting contact surface adjacent one end of the current-carrying thermally responsive member, means electrically connecting said leaf spring to

provide a shunt path around at least a major part of the current-carrying thermally responsive member, and said electromagnetic means when energized by said heavy overload currents operating to move said short-circuiting contact surfaces together to complete said shunt path.

9. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a trip member movable to effect release of said releasable means, trip means comprising a current-carrying bimetal element heated by the current therein and when heated a predetermined amount bending in a direction to move said trip member to effect release of said releasable means, electromagnetic means energized by high overload currents to bend said bimetal element to effect release of said releasable means, a leaf spring carrying a short-circuiting contact, a second short-circuiting contact carried on and electrically connected to said bimetal element, means electrically connecting said leaf spring to provide a shunt path around at least a major part of said bimetal element when said short-circuiting contacts are closed, said short-circuiting contacts being positioned to remain apart when said bimetal element bends in response to the heat therein to effect release of said releasable means, and said electromagnetic means when energized by said high overload currents operating to move said short-circuiting contacts together.

10. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a trip member movable to effect release of said releasable means, a current-carrying thermally responsive member movable in response to low overload currents therein to move said trip member to effect release of said releasable means, electromagnetic means energized by heavy overload currents to move said thermally responsive member to effect release of said releasable means, a resilient leaf spring having a short-circuiting contact surface adjacent one end thereof, a second short-circuiting contact surface adjacent one end of the current-carrying thermally responsive member, means electrically connecting said leaf spring to provide a shunt path around at least a major part of the current-carrying thermally responsive member with the current flowing in the same general direction in a substantial part of the shunt path

as in the current-carrying thermally responsive member whereby there is magnetic attraction between the shunt path and the current-carrying thermally responsive member after closure of the short-circuiting contacts, and said electromagnetic means when energized by said heavy overload currents operating to move said short-circuiting contact surfaces together to complete said shunt path.

11. A circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a trip member actuated during a tripping operation to effect release of said releasable means, tripping means comprising a current-carrying bimetal member heated by the current therein and when heated a predetermined amount bending in a direction to actuate said trip member to effect a thermal tripping operation, electromagnetic means operable when energized in response to excessive overload currents to bend said bimetal member in the direction to actuate said trip member to effect a magnetic tripping operation, current shunting means actuated by the movement of said bimetal member upon the occurrence of a magnetic tripping operation to limit the current flow in said bimetal member, said current shunting means being positioned in relation to said bimetal member and said trip member so that the movement of said bimetal member which is required to actuate said trip member is not as great as the movement of said bimetal member which is required to actuate said current shunting means whereby said current shunting means is not actuated upon the occurrence of a thermal tripping operation.

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