Oct. 3, 1967 J. MAJCHER ETAL 3,345,481

CIRCUIT INTERRUPTER

Filed Oct. 16, 1964 4 Sheets-Sheet 1

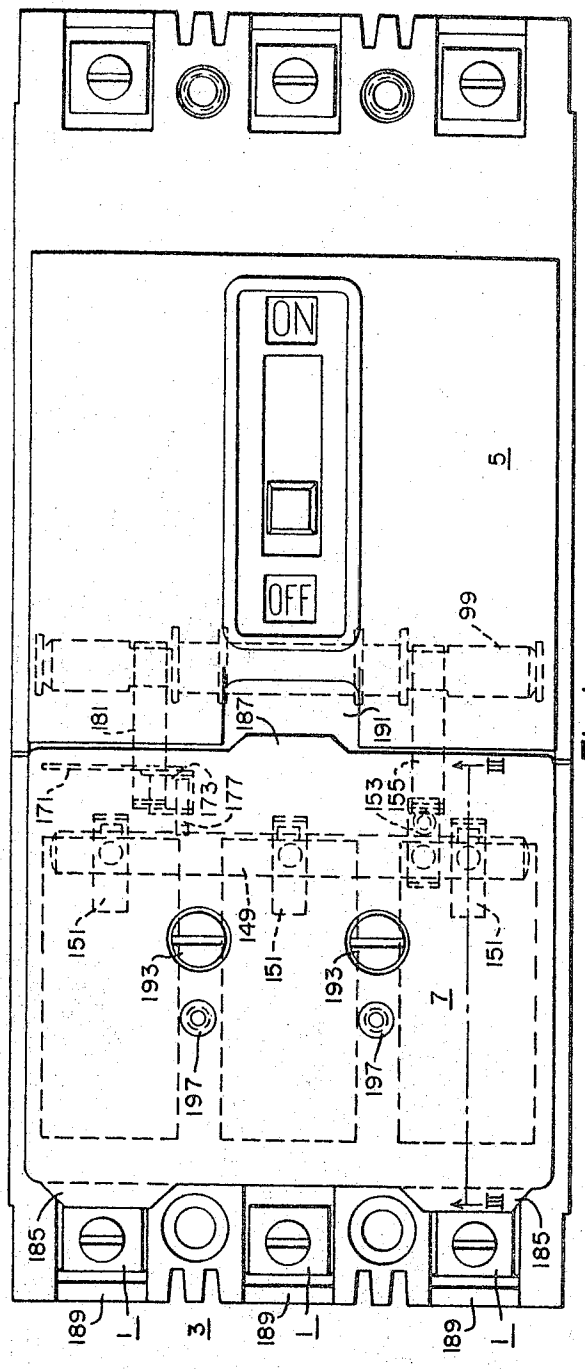

Fig. 1.

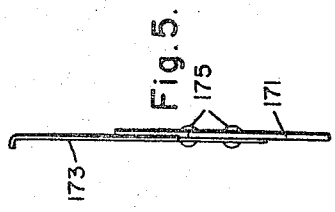

Fig. 5.

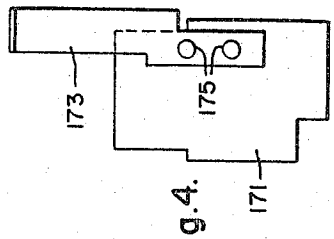

Fig. 4.

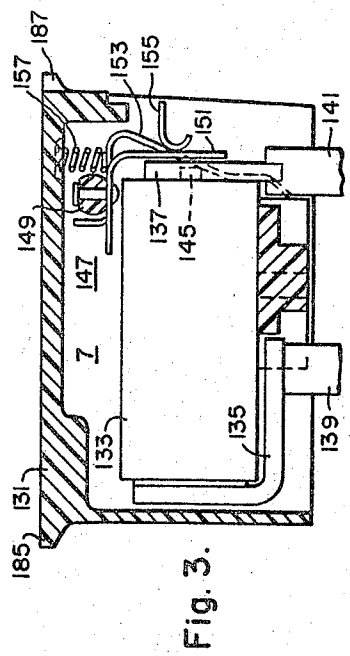

Fig. 3.

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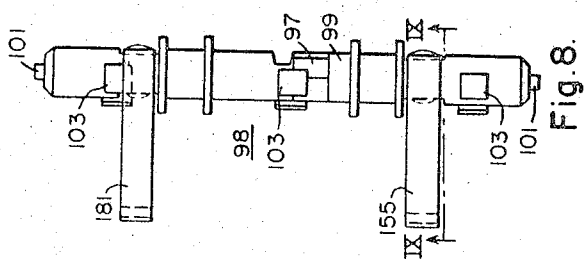


Fig. 8.

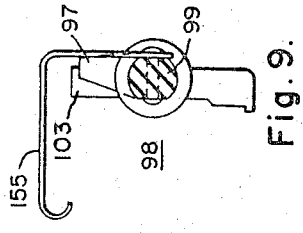


Fig. 9.

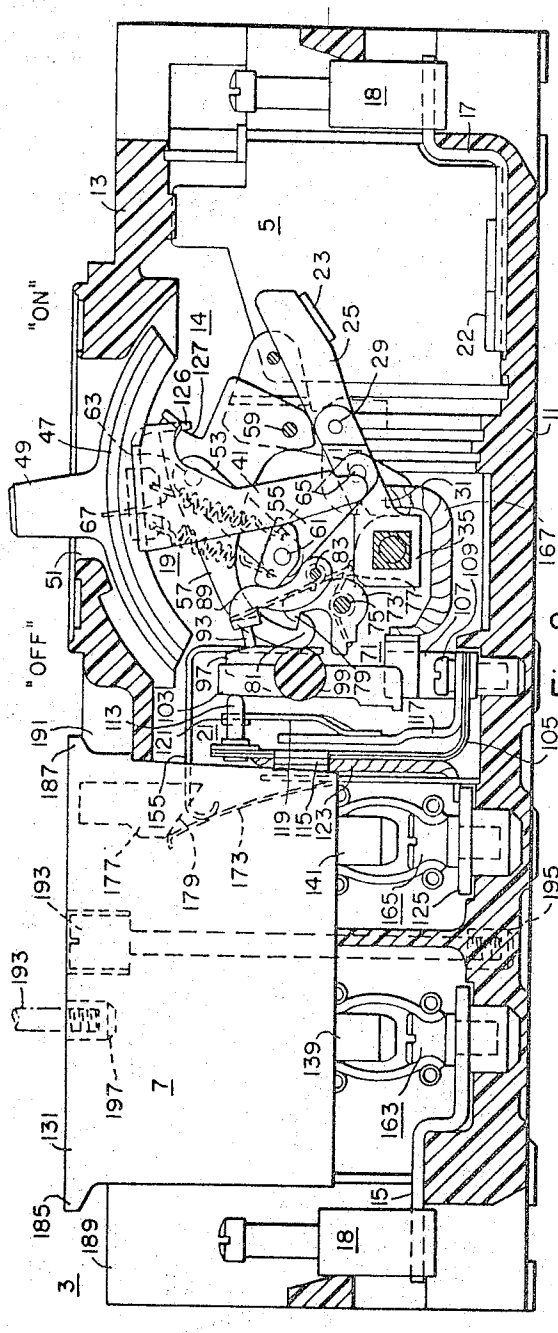


Fig. 2.

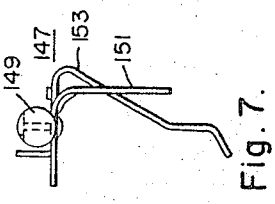


Fig. 7.

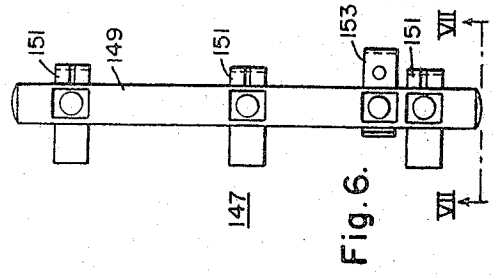


Fig. 6.

FIG. 10.

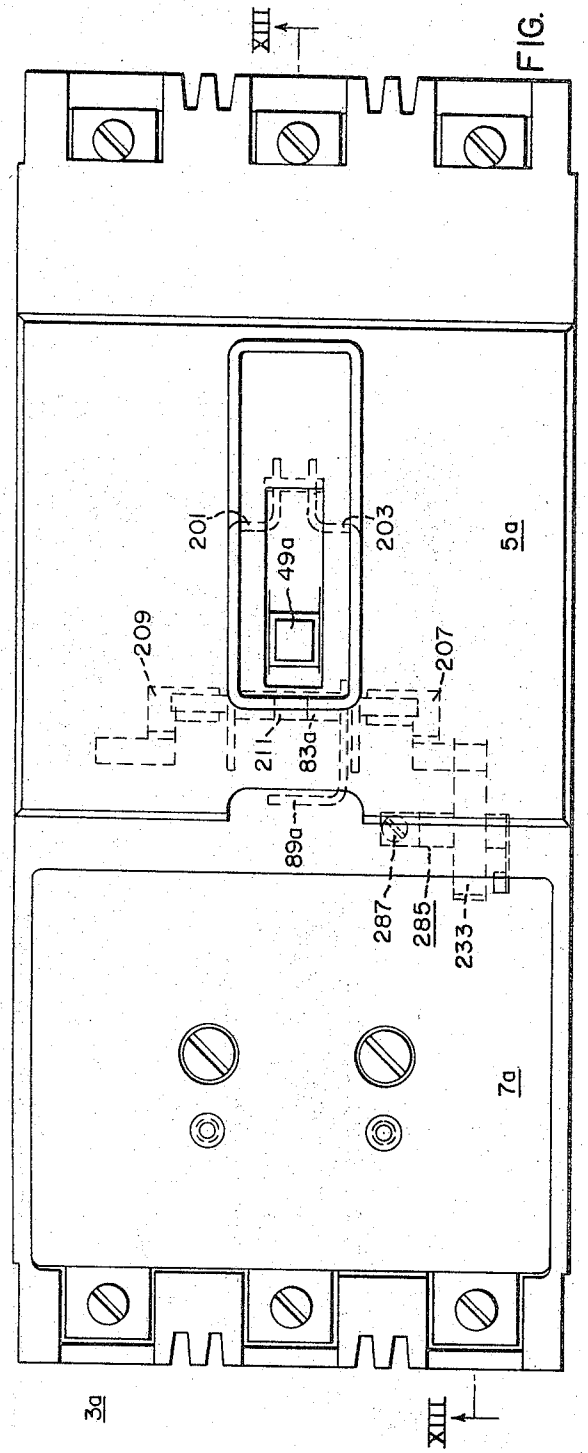


FIG. 12.

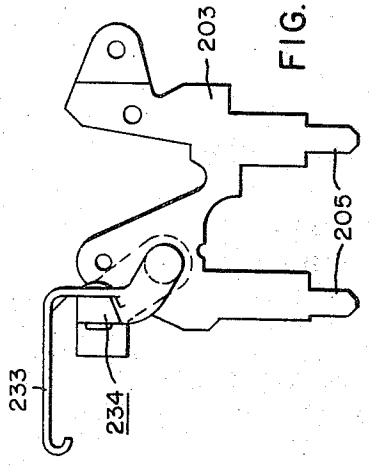
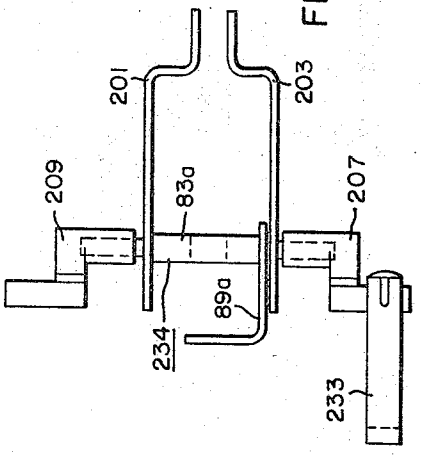


FIG. 11.



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CIRCUIT INTERRUPTER

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FIG. 13.

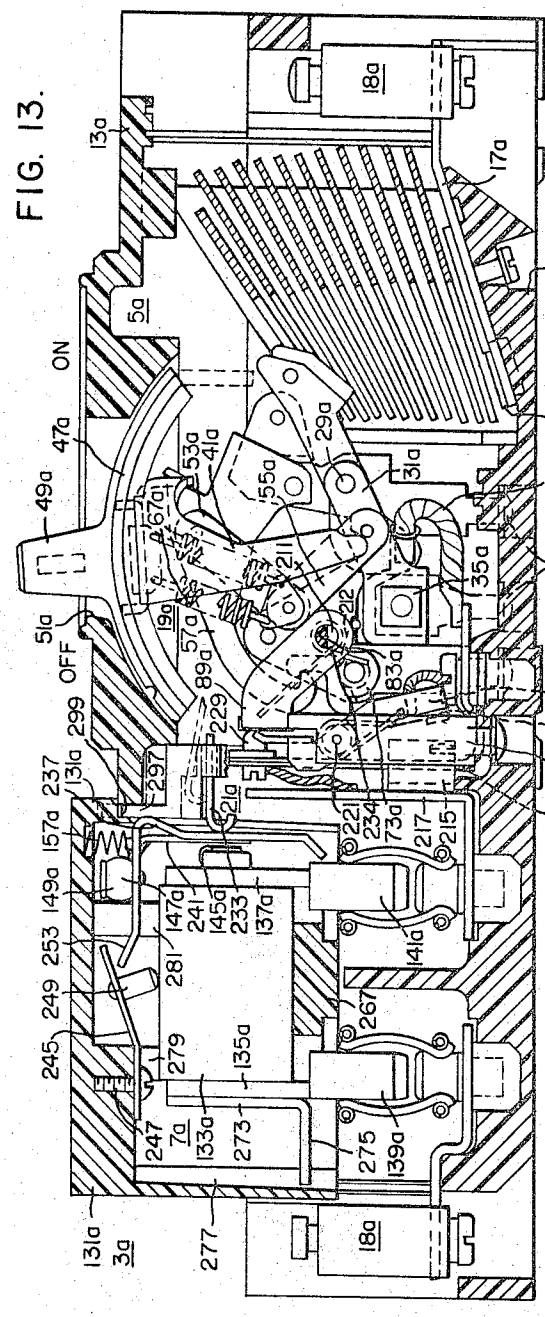


FIG. 15.

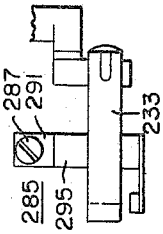


FIG. 14.

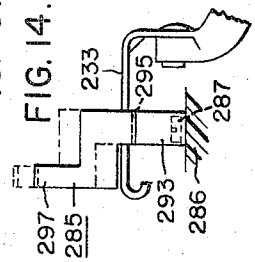


FIG. 17.

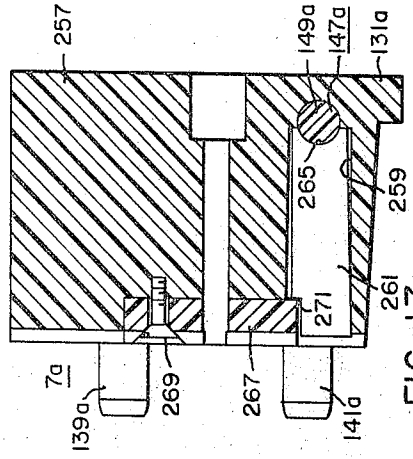
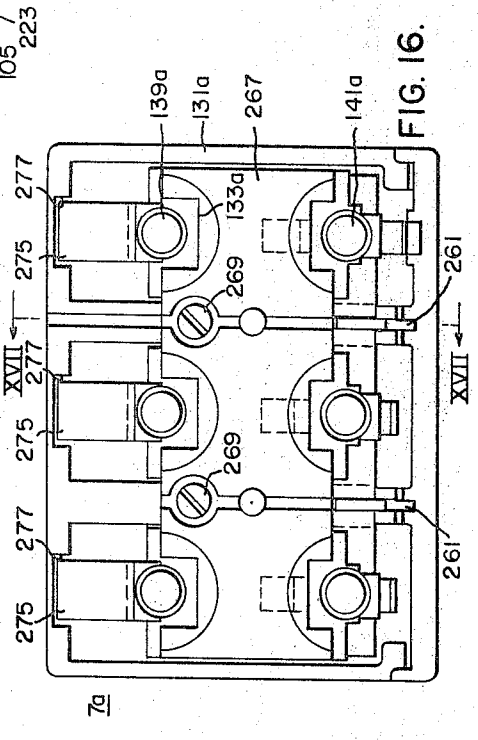


FIG. 16.



United States Patent Office 3,345,481 Patented Oct. 3, 1967

3,345,481

CIRCUIT INTERRUPTER

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Filed Oct. 16, 1964, Ser. No. 404,414
4 Claims. (Cl. 200—114)

This application is a continuation-in-part of the copending application Ser. No. 197,971, filed May 28, 1962.

This invention relates generally to circuit interrupters and more particularly to circuit interrupters of the type comprising a low-cost circuit breaker and a fuse unit electrically connected in series relation with the circuit breaker to interrupt fault currents that exceed the interrupting capacity of the circuit breaker.

An object of this invention is to provide an improved compactly constructed circuit interrupter comprising a circuit breaker and a fuse unit connected in electrical series with the circuit breaker.

Another object of this invention is to provide a multi-pole circuit interrupter comprising a multi-pole circuit breaker and a multi-pole fuse unit connected in electrical series with the circuit breaker with improved means for tripping the circuit breaker upon removal of the fuse unit.

Another object of this invention is to provide a multi-pole circuit interrupter comprising a multi-pole circuit breaker and a multi-pole fuse unit connected in electrical series with the circuit breaker with improved means for tripping the circuit breaker when one of the fuses of the fuse unit blows.

Another object of this invention is to provide a multi-pole circuit interrupter comprising a multi-pole circuit breaker and a multi-pole fuse unit connected in electrical series with the circuit breaker with improved means for preventing operation of the circuit interrupter if one of the fuses is not in place in the fuse unit.

Another object of this invention is to provide an improved fuse unit comprising improved means for positioning the fuses in the fuse unit housing.

A more general object of this invention is to provide an improved circuit interrupter which largely retains the advantages of circuit breakers over fuses and at the same time embodies the desirable current-limiting function of current-limiting fuses when there is a heavy short circuit, without requiring the use of an expensive circuit breaker of high interrupting capacity.

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 drawings.

In said drawings:

FIGURE 1 is a top plan view of a circuit interrupter embodying principles of this invention;

FIG. 2 is a side elevational view, with parts broken away, of the circuit interrupter seen in FIG. 1;

FIG. 3 is a sectional view of the removable fuse unit taken generally along the line III—III of FIG. 1;

FIGS. 4 and 5 are elevational and end views, respectively, of the barrier and tripping spring seen in FIGS. 1 and 2;

FIG. 6 is a top plan view of the tripping bar seen in FIG. 1;

FIG. 7 is an end view of the tripping bar seen in FIG. 6 looking in the direction of the arrows;

FIG. 8 is a top plan view of the trip bar seen in FIG. 1;

FIG. 9 is a sectional view taken along the line IX—IX of FIG. 8;

FIG. 10 is a view similar to FIG. 1 of a circuit breaker embodying a modified form of the invention;

FIG. 11 is a top plan view of the two support plates and trip bar that are shown in broken lines in FIG. 10;

FIG. 12 is a side elevational view of the parts seen in FIG. 11 with the parts being shown prior to the mounting thereof in the circuit interrupter;

FIG. 13 is a sectional view taken generally along the line XIII—XIII of FIG. 10;

FIG. 14 is a side sectional view illustrating certain parts of the circuit interrupter of FIGS. 10 and 13;

FIG. 15 is a top plan view of some of the parts seen in FIG. 14;

FIG. 16 is a bottom plan view of the trip unit seen in FIGS. 10 and 13; and

FIG. 17 is a sectional view taken generally along the line XVII—XVII of FIG. 16.

Referring to the drawings, and particularly to FIGS. 1 and 2, there is shown therein a circuit interrupter **3** comprising a multi-pole circuit breaker **5** and a removable multi-pole fuse unit **7** connected in electrical series with the circuit breaker **5**. The circuit breaker **5** comprises a housing comprising an insulating base **11** and an insulating cover **13** suitably connected to the base **11**. A circuit breaker mechanism **14**, of the type disclosed in Patent No. 2,989,606, issued June 20, 1961, to E. J. Walker et al., is supported within the housing **11, 13**.

Each pole unit of the circuit interrupter **3** comprises a line terminal **15** and a load terminal **17** to enable connection of the circuit interrupter in an electrical circuit. A solderless terminal conductor **18** is disposed at the cutter end of each of the terminals **15, 17** in a manner well known in the art.

The circuit breaker **5** is of the three-pole type, only the center pole being shown in FIG. 2. An operating mechanism **19** common to all of the poles, is disposed in the center pole compartment. Each pole is provided with a trip device **21** similar to that seen in FIG. 2.

A stationary contact **22** is rigidly mounted on the inner end of each of the terminal conductors **17**. A movable contact **23** is provided to cooperate with each of the stationary contacts **22**. Each of the movable contacts **23** is secured to a movable contact arm **25** that is pivotally mounted by means of a pin **29** on a switch arm **31**. The switch arms **31** for the three pole units are secured to a common insulating tie bar **35** that is rotatably supported in the circuit breaker housing **11, 13**. Springs (not shown) bias the contact arms **25** clockwise about the pins **29** to provide contact pressure in the closed position of the contact arms.

The operating mechanism **19** is disposed in the center pole unit and comprises a U-shaped operating lever **41** having its inner end portions pivoted on a suitable frame (not shown) that is mounted on 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 unit 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 frame that supports the lever **41**. 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 member **57** by a pivot pin **63**, and the toggle link **55** is pivotally connected by means of 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 U-shaped operating lever **41**.

The contacts for all of the poles are manually closed and opened in a well-known manner by movement of the operating lever **41** to the "on" and "off" positions. Movement of the lever **41** to the "on" position straightens the

toggle 53, 55 to move the switch arm 31 for the center pole unit to the closed position. Since the switch arm for the center pole unit is connected to the tie bar 35, this movement rotates the tie bar 35 clockwise (FIG. 2) to move all of the switch arms 31 to the closed position. Reverse movement of the operating lever 41 to the "off" position causes collapse of the toggle 53, 55 to rotate the tie bar 35 counterclockwise and move all of the switch arms 31 to the open position.

The contacts are opened automatically, in response to an overload current above a predetermined value in any pole of the circuit breaker, by release of the cradle or releasable member 57. The cradle 57 is normally releasably held in an 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 influnce of the overcenter springs 67 causing collapse of the toggle 53, 55 to move all of the switch arms 31 to the open position.

The latch mechanism 71 comprises a main latch 73 that is pivoted on a pin 75 that is supported in the frame that supports the lever 41. The main latch 73 is biased by a spring 77 in a clockwise unlatching direction. The main latch 73 is provided with a latching portion 79 that engages a latch portion 81 on the free or latching end of the cradle 57 to releasably hold the cradle in the operative position. The latch portion 81 is in-turned and faces generally toward the pivot 59 about which it moves. The main latch 73 is releasably held in latching position by a latch that comprises a rotary shaft 83 that is pivotally mounted on the supporting frame. The main latch 73 is held in the latching position by the engagement of a part thereof with the shaft 83. This engagement is at a point on the cylindrical surface of the shaft 83 adjacent a notch (not shown) in the shaft 83. The purpose of the notch will be hereinafter specifically described. The latch 83 has an upwardly extending arm portion 89. An adjusting screw 93, which is threaded on the arm 89, is movable into engagement with a projection 97 on a common trip bar structure 98. The arm 89 and rotary shaft 83 are biased by spring means to the latching position seen in FIG. 2.

The trip bar structure 98 comprises a trip bar 99 that is of molded insulating material. The projection 97 is molded integral with the trip bar 99 at a position adjacent the adjusting screw 93. The trip bar 99 is rotatably supported in the housing 11, 13 by means of pins 101 (FIG. 8) molded in the ends thereof. Three projections 103, one for each pole unit, are molded integral with the trip bar 99.

The trip device 21 for each pole unit comprises a bimetal 105 that is supported on a conducting tab 107 by means of a screw 109. An adjusting screw 113 is threaded in a tab that is attached to the free end of the bimetal 105, and a generally U-shaped magnet member 115 is secured to the bimetal 105 intermediate the ends of the bimetal. A magnet member 117 is also connected to the conducting tab 107 by means of the screw 109. A leaf spring 119 having a contact 121 thereon is secured to the member 117 for a purpose to be hereinafter specifically described. A flexible conductor 123 is secured at one end to the bimetal 105, and at the other end to a terminal 125.

When a low persistent overload current occurs in any pole unit, the current carrying bimetal 105, for that pole unit, becomes heated and when heated a predetermined amount bends to the right. This movement, through the adjusting screw 113 and projection 103, rotates the trip bar 99 in a clockwise direction causing the projection 97 thereon to rotate the arm 89 and the rotary latch 83 clockwise until the latch 83 reaches a point where a portion of the main latch 73 snaps into the notch in the main latch 83 under the force of the springs 67. This movement releases the cradle or releasable member 57, whereupon the member 57 is rotated clockwise by means of the springs 67 to cause collapse of the toggle 53, 55 and opening of all of the contacts 22, 23.

The circuit breaker is trip-free in that the mechanism will operate to open the contacts when a tripping overload occurs even if the handle 49 is held in the closed position.

Upon the occurrence of an excessive overload current or a short circuit current, the magnet member 115 is attracted to the magnet member 117 bending the bimetal 105 to rotate the trip bar 99 to effect instantaneous tripping of the breaker. This bending of the bimetal 105 closes a contact (not shown) near the top of the bimetal 105 with the contact 121 that is supported on the leaf spring 119 forming a parallel shunt path for the current through the breaker. Since the resistance of the shunt path through the members 119 and 117 is less than the resistance through the bimetal 105, 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 shunting contacts, these contacts will close only on magnetic tripping and the breaker will trip on thermal tripping without closing the shunting contacts so that the thermal trip calibration is not affected by the shunting contacts.

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 a position slightly past the full "off" position. During this movement, a projection 125 on the operating lever 41 engages a shoulder 127 on the cradle 57 to move the cradle 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 an outwardly extending portion of the bell-crank type main latch 73 to move the main latch 73 to the latching position. As soon as the latching shoulder of the main latch 73 clears the corner of the notch (not shown) of the cylindrical latch 83, a torsion spring restores the arm 89 and latch 83 to the normal 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 57 to hold the cradle in the operative latched position seen in FIG. 2. Thereafter, the contacts can be closed and opened by operation of the handle 49 in the same manner previously described.

The multi-pole fuse unit 7 (FIGS. 1–3) comprises a housing 131 of molded insulating material which housing comprises three compartments. A fuse 133 is removably mounted in each of the fuse compartments. Each of the fuses 133 has a conducting member 135 connected to one end thereof and a conducting member 137 connected to the other end. A plug-in type connector 139 is connected to the conductor 135, and a plug-in type connector 141 is connected to the conductor 137. A spring-loaded plunger or actuator 145 is disposed at one end of each of the fuses 133. The plunger 145 is biased to move toward the right when the fuse blows. This plunger and biasing means for operating it may be in one of the forms disclosed, for example, in the patent to Rawlins et al., Patent No. 2,435,844, issued Feb. 10, 1948.

The fuse unit 7 also comprises a tripping bar structure 147 (FIGS. 1–3, 6, and 7), that is rotatably supported in the fuse unit housing 131 and is common to all three poles of the fuse unit. The tripping bar structure 147 is rotatably supported in notches in barriers (not shown) that separate adjacent poles in the fuse unit. Referring to FIGS. 6 and 7, the tripping bar structure 147 comprises an insulating tripping bar 149 having three arms 151 riveted thereto. An actuating arm 153 is riveted to the tripping bar 149 in a position adjacent an arm 155 (FIGS. 1 and 8) of the trip bar structure 98. As is seen in FIG. 3, a spring 157 is supported between the housing 131 and the arm 153 to bias the tripping bar structure 147 in a clockwise (FIG. 3) direction. This clockwise movement of the tripping bar structure 147 is limited by engagement of the arm 153 with one of the fuses 133.

With the fuse unit **7** in place and the contacts **22, 23** in the closed position, the circuit through each pole unit of the multi-pole circuit interrupter **3** extends from the line terminal **15** (FIG. 2) through a tulip-type connector **163** that is mounted on the base **11**, the plug-in type connector **139**, the conductor **135** (FIG. 3), the fuse **133**, the conductor **137**, the plug-in type connector **141**, a tulip-type connector **165** (FIG. 2) that is mounted on the base **11**, the conductor **125**, the flexible conductor **123**, the bimetal **105**, the conducting support **107**, a flexible conductor **167**, the switch arm **31**, the contact arm **25**, the contacts **23, 22**, to the load terminal conductor **17**.

When a fuse **133** in any of the poles blows in response to a severe overload current, biasing means (not shown) within the fuse operates to move the plunger **145** (FIG. 3) to the right against the associated arm **151** to rotate the tripping bar structure **147** counterclockwise against the bias of the spring **157**. During this movement, the arm **153** (FIGS. 1, 3, 6 and 7) on the tripping bar **149** engages the arm **155** (FIGS. 1, 8 and 9) on the common trip bar **99** (FIG. 1) rotating the trip bar **99** in a clockwise (FIG. 2) direction, whereupon the projection **97** on the trip bar **99** operates to move the arm **89** and the latch **83** clockwise to effect a tripping operation of the circuit breaker **5** in the same manner hereinbefore described. The plunger or actuator **145** of the blown fuse **133** will remain in the position holding the tripping bar **149** in the tripped position to thereby hold the trip bar **99** and, therefore, the latch **83** in the tripped position. The circuit breaker cannot be relatched, and, therefore, it cannot be operated while the fuse unit, with a blown fuse therein, is in the connected position.

Improved means are provided for tripping the circuit breaker **5** when the fuse unit **7** is removed, and also for maintaining the breaker **5** in the tripped position when the fuse unit **7** is removed if the breaker has been tripped prior to removal of the fuse unit **7**. Referring to FIGS. 1, 2, 4 and 5, an insulating barrier **171** which is provided to insulate part of the fuse unit **7** from the parts of the circuit breaker **5**, is supported in suitable slots molded in the housing base **11**. A metallic leaf spring **173** is mounted on the barrier **171** by means of rivets **175**. As can be seen in FIG. 2, a projection **177** having a cam surface **179** thereon is molded integral with the insulating housing **131** of the fuse unit **7**. When the fuse unit is moved down into the connected position seen in FIG. 2, the cam surface **179** on the projection **177** engages the leaf spring **173** to bias the leaf spring **173** to the inoperative position shown. When the fuse unit **7** is removed from the circuit breaker **5**, the leaf spring **173** is released whereupon it springs to the right (FIG. 2) to engage an arm **181** (FIGS. 1 and 8) that is attached to the trip bar **99**, rotating the trip bar **99** clockwise (FIG. 2) to effect tripping of the circuit breaker **5** in the same manner hereinbefore described if the circuit breaker **5** is in the closed position when the fuse unit **7** is removed. If the breaker **5** is in the open position when the fuse unit **7** is removed, the leaf spring **173** will move against the arm **181** to rotate the trip bar **99** clockwise to release the mechanism **19** to the tripped position to prevent closing of the breaker. As long as the fuse unit is removed, the spring **173** will maintain the trip bar **99** in the tripped position to prevent relatching of the breaker to thereby prevent a closing operation of the breaker. If the breaker **5** is in the tripped position when the fuse unit **7** is removed, the spring **173** biasing against the arm **181** will maintain the trip bar **99** in the tripped position to prevent relatching of the circuit breaker **5** to thereby prevent a closing operation of the circuit breaker.

If the fuse unit **7** should be placed in position on the interrupter with a blown fuse still in the holder, the plunger or actuator **145** (FIG. 3) would hold the tripping bar structure **147** in a tripping position, and the arm **153** on the tripping bar structure **147** would engage the arm **155** (FIG. 1) on the trip bar **99** to bias the trip bar **99** to the tripped position to prevent resetting of the circuit breaker **5**. Thus, when the spring **173** (FIG. 2) is biased to an inoperative position, the arm **153** on the tripping bar structure **147** will take over to maintain the trip bar **99** in the tripped position. Thus, the circuit interrupter cannot be operated when the fuse unit is replaced if the blown fuse is still in the fuse unit.

In order to facilitate removal of the fuse unit **7** from the circuit breaker **5**, the fuse unit housing **131** is molded with two projections **185** on one side thereof and a projection **187** on the opposite side. As can be seen in FIGS. 1 and 2, the projections **185** are disposed over openings **189** in the housing which openings are provided to accommodate two of the terminals **19**. The projection **187** is disposed over a depression or well-portion **191** in the housing. Thus, a worker can grasp the projections **185** and **187** with his fingers to lift the fuse unit **7** out of the circuit interrupter. The housing adjacent the depression or well-portion **191**, can also be used as a fulcrum for a screwdriver or similar lever to lift housing **131**. As can be seen in FIG. 2, when the fuse unit **7** is in the connected position, two plug-in type connectors **139, 141** engage in two tulip-connectors **163, 165** respectively, for each of the pole units. These connections are provided to have sufficient pressure to insure good electrical conductivity. Thus, it is often difficult for a worker to remove the fuse unit **7** from the circuit breaker **5** by grasping the projections **185** and **187**. Improved means, therefore, are provided to facilitate removal of the fuse unit **7** from the circuit interrupter when a worker has difficulty in removing the fuse unit by grasping and lifting on the projections **185, 187**.

Referring to FIGS. 1 and 2, two bolts **193** pass through suitable openings in the fuse unit **7** and are threaded into tapped metallic inserts **195** in the housing base **11** to secure the fuse unit **7** to the circuit breaker. When removal of the fuse unit **7** in the manner hereinbefore described is difficult, the bolts **193**, which are removed from their mounting positions, are threaded into tapped metallic inserts **197** in the fused unit housing **131**. As can be seen in FIG. 2, the inserts **195** are so positioned that the major portion of each of the bolts **193** extends outward from the fuse unit **7** to permit easy grasp thereof by a worker who can grasp one bolt with each hand to lift the fuse unit **7** out of place. The bolts **193** can also be grasped by means of a suitable tool to enable a worker to more easily remove the fuse unit **7** from the circuit breaker **5**.

Another embodiment of the invention is disclosed in FIGS. 10–17. There is disclosed in FIGS. 10 and 13 a circuit interrupter **3*a*** that is similar to the circuit interrupter **3** of FIGS. 1 and 2. The parts (FIGS. 10–17) of the circuit interrupter **3*a*** that are similar to the parts (FIGS. 1–9) of the circuit interrupter **3** are identified by reference characters each of which reference characters comprises a small "*a*" suffix after a numeral that is identical to the numeral of the similar part disclosed in the circuit interrupter **3**. Because of the similarity between the circuit interrupters **3** and **3*a***, only those parts that are substantially different will be specifically described, it being understood that unless otherwise set forth the parts of the circuit interrupter **3*a*** function in the same manner as those previously described with respect to the circuit interrupter **3**. The circuit breaker **5*a*** is a circuit breaker of the type that is described in more detail in the patent to Charles R. Paton et al., Patent No. 3,303,441, issued Feb. 7, 1967.

Referring to FIGS. 10–13, there is shown therein two side plates **201** and **203** that support certain parts of the circuit breaker mechanism. The side plates **201** and **203** are provided with lower leg portions **205** (FIG. 12) that are passed through openings in the insulating base **11*a*** and riveted over at **206** (FIG. 13), which operation fixedly mounts the side plates in the center pole unit of the multi-pole circuit interrupter **3*a***. The shaft **83*a*** extends through openings in the side plates **201** and **203**, and insulating

members 207 and 209 are fixedly secured to opposite ends of the shaft 83*a* in the two outer pole units. The notch 211 which receives part of a main latch 73*a* during a tripping operation, is visible in FIG. 13. During thermal tripping operations, the bimetal 105*a* which is heated by the current flowing therethrough, deflects to the right to engage the member 89*a* (or one of the members 207 or 209 if the overload is one of the two outer pole units) to rotate the shaft 83 in a clockwise (FIG. 13) direction to move the notch 211 adjacent a part 212 of the latch 73 whereupon the latch part 212 snaps into the notch 207 to release the trip member 57 to effect a tripping operation in the same general manner hereinbefore described. A generally V-shaped magnet yoke 215 is supported on a rigid conductor 217 and the two legs of the yoke extend on opposite sides of the bimetal 105*a*. An armature structure 219, which is pivotally supported at 221 on a supporting plate 223, comprises a magnetic armature 225 that is attracted to the yoke 217 upon the occurrence of short circuits or severe overloads to effect a magnetic tripping operation. Upon the occurrence of an excessive overload or short circuit the electromagnet 217, 225 is energized sufficiently to attract the armature 225 to the yoke 217 pivoting the armature structure 219 in a clockwise (FIG. 13) direction. During this movement, an upper part 229 of the armature structure 219 engages the lever 89 (or one of the members 207, 209 if the overload is in one of the two outer pole units) to rotate the shaft 83 in a clockwise (FIG. 13) direction to effect tripping operation in the same manner as was hereinbefore described.

As can be seen in FIGS. 10–12, a trip arm 233 is fixedly mounted on the member 207 in one of the outer pole units. The members 83, 89, 207, 209 and 233 (FIG. 11) cooperate to form a unitary trip bar structure 234. When the parts of the circuit interrupter 3*a* are mounted in position, the trip arm 233 is disposed adjacent an actuating arm 237 (FIG. 13) that is fixedly secured to the tripping bar 149*a* of the tripping bar structure 147*a*. The actuating arm 237 of the tripping bar structure 147*a* is disposed in the outer pole unit of the tripping bar structure 147*a* and adjacent the plunger 145*a* of the fuse 133*a* in the outer pole unit. In each of the two other pole units, an arm 241 is mounted on the tripping bar 149 and disposed adjacent the associated plunger 145*a* of the associated fuse 133*a*.

When a fuse 133*a* in any of the three pole units is actuated in response to a severe overload current, biasing means (not shown) within the fuse operates to move the associated plunger 145*a* against the associated actuating arm 237 or 241 to rotate the tripping bar structure 147*a* in a counterclockwise (FIG. 13) direction against the bias of the spring 157*a*. During this movement, the actuating arm 237 of the tripping bar structure 147*a* engages the arm 233 to rotate the trip bar structure 234 to a tripped position moving the shaft 83 in a clockwise (FIG. 13) direction to effect a tripping operation of the circuit breaker 5*a* in the same manner hereinbefore described.

If the fuse unit 7*a* should be placed in position with an actuated fuse still in the holder, the plunger 145*a* of the actuated fuse would still engage the associated actuating arm 237 or 241 to maintain the tripping bar structure 147 in the actuated tripping position thereby providing that the member 237 would engage the arm 233 to hold the trip bar structure 234 in the tripped position.

In each pole unit of the fuse unit 7*a*, a leaf spring 245 is secured to the housing 131*a* by means of a screw 247. In each pole unit, an actuating member 249, which is fixedly secured to the outer end of the associated leaf spring 245, engages the associated fuse 133*a* to maintain the resilient leaf spring 245 in a fixed charged condition. When the associated fuse 133*a* is removed from the housing 131*a* the fuse 133*a* moves away from the associated member 249 releasing the spring 245. The released spring defects toward a straightened position during which movement the outer end of the spring 245 engages a tail portion 253 (FIG. 13) on the associated actuating arm 237 or 241 to rotate the tripping bar structure 147 in a counterclockwise (FIG. 13) direction to provide an engagement between the member 237 and the arm 233 that will maintain the trip bar structure 234 in the tripped position with the shaft 83 in the unlatching position. With the shaft 83*a* in the unlatching position the circuit breaker 5*a* cannot be reset into the operating position. Thus, the missing fuse interlock 245, 249, 253 provides that the circuit interrupter 3 cannot be operated when a fuse is missing from the removable fuse unit 7*a*.

The same actuating arm 237 on the tripping bar structure 147*a* cooperates with the same member 233 on the trip bar structure 234 when any of the fuses is actuated or when any of the fuses is missing from the fuse unit 7.

Referring to FIGS. 10, 13, 16 and 17, the fuse unit 7*a* comprises the housing 131*a* of molded insulating material which housing comprises three compartments separated by means of insulating barriers 257 (FIGS. 16 and 17) that are molded integral with the housing part 131. Each of the barriers 257 is provided with an opening 259 (FIG. 17) therein to permit mounting of the common tripping bar structure 147*a* in the fuse unit 7*a*. After the tripping bar structure 147*a* is moved into the mounted position, two insulating barriers 261 are moved into the mounted position seen in FIGS. 16 and 17 to substantially close the openings 259 in the barriers 257 and to rotatably support the tripping bar structure 147*a* in position in the fuse unit 7*a*. As is illustrated in FIG. 17, each of the barriers 261 is provided with an arcuate notch portion 265 that receives the tripping bar 149*a* to rotatably support the tripping bar structure 147*a* in position. With the tripping bar structure 147*a* and the three fuses 133*a* positioned in the three compartments of the insulating housing 131*a*, all of which members are moved into position from the open bottom of the housing 131*a*, an insulating support 267 that extends across the bottom of all three pole units of the fuse unit 7*a*, is moved into position engaging the two barriers 257 and two screws 269 are passed through openings in the support 267 and threaded into tapped openings in the two insulating barriers 257 to capture the three fuses 133*a* in position in the insulating housing 131*a*. Each of the barriers 261 (FIG. 17) is provided with a ledge portion 271 that is engaged by the member 267 to support the barrier 261 and therefore the tripping bar 149 in position.

Referring to FIGS. 13 and 16, it will be noted that there is a generally L-shaped rigid metallic member 273 fixedly secured to the associated conductor 135. A lower leg 275 of the member 273 is disposed in a notch 277 in the insulating housing 131 to prevent rotation (about an axis extending generally between the conductors 135*a*, 137*a*) of the associated fuse 133*a* in the housing 131*a*. The member 275 also engages the end wall of the housing 131*a* to prevent generally rectilinear axial movement of the associated fuse 133*a* in a direction to the left as seen in FIG. 13. The member 267 engages the members 139 to limit movement to the right (FIG. 13) of the fuses 133. There are two arcuate barriers 279 and 281 (FIG. 13) in each of the three compartments of the housing 131 which barriers are molded integral with the housing 131 to limit upward (FIG. 13) movement of the fuses 133*a*.

Referring to FIGS. 13–15, a metallic leaf spring member 285 is fixedly secured to a ledge part 286 of the base 11 by means of a screw 287 that passes through a suitable opening in a generally flat low part 291 of the member 285 and is threaded into a tapped opening in the ledge part 286. The ledge part 286 of the base 11 is part of one of the barriers that is molded integral with insulating housing base 11 to separate two adjacent pole units of the housing. The leaf spring 285 comprises the generally horizontal base part 291 that receives the screw 287 and a vertical part 293 (FIG. 14) that extends upward from the base part 291. The part 293 is bent over to provide another horizontal part 295 that is generally

parallel to the base part **291**. The horizontal part **295** is disposed under the arm **233**. The end part of the spring structure **285** extends upward at **297** to provide an upper end that is engaged by the fuse unit housing structure **131***a* (FIG. 13) to flex the spring structure **285** to a charged lower inoperative position (shown in full lines in FIGS. 13 and 14) when the fuse unit **7***a* is moved into the connected position seen in FIG. 13. When the fuse unit **7***a* is removed from the circuit breaker **5***a*, the charged resilient leaf spring structure **285** is released whereupon it springs upward from the position in which it is seen in full lines in FIGS. 13 and 14 to the position in which it is seen in broken lines during which movement the horizontal part **295** thereof engages the member **233** to rotate the shaft **83***a* in a clockwise (FIG. 13) direction moving the trip bar structure **234** to the tripped position to trip the circuit breaker in the same manner hereinbefore described. While the fuse unit **7***a* is removed the spring structure **285** will maintain the trip bar structure **234** in the tripped position to prevent operation of the circuit breaker **5***a*. When the fuse unit **7***a* is moved into the connected position seen in FIG. 13, a ledge portion **299** on the insulating housing **131***a* engages the upper part **297** of the leaf spring structure **285** flexing the structure **285** to the full line position seen in FIGS. 13 and 14 to release the arm member **233** to thereby permit a relatching operation of the circuit breaker in the same manner as was hereinbefore described.

From the foregoing, it will be understood that there is provided by this invention an improved compactly constructed circuit interrupter comprising a fuse unit having a common tripping bar structure therein and a circuit breaker having a trip bar structure therein. The fuse unit comprises an insulating housing having a plurality of compartments therein and means fixedly retaining a separate fuse in each of the compartments. When any one of the fuses of the multi-pole fuse unit is actuated, the actuated fuse operates to rotate the common tripping bar structure whereupon the tripping bar structure engages an actuating arm of the breaker trip bar structure to rotate the trip bar structure to a position to effect tripping of the multi-pole circuit breaker. A leaf spring or safety trip member is provided to effect tripping of the circuit breaker when the fuse unit is removed and to maintain the circuit breaker in a tripped position as long as the fuse unit is removed. The leaf spring or safety trip member, which is biased to an inner unactuated position when the fuse unit is in place, operates automatically when the fuse unit is removed, to directly engage part of the tripping bar structure to rotate the tripping bar structure to trip the circuit breaker.

In one embodiment of the invention the same actuating arm of the trip bar structure is operated to trip the breaker or to maintain the breaker in the tripped position when any of the fuses is actuated; when the fuse unit is removed from the circuit breaker; when the fuse unit is mounted on the circuit breaker with an actuated fuse in the unit; and when the fuse unit is mounted on the breaker with one or more of the fuses missing from the unit.

The circuit interrupter is constructed so that the fuse unit does not extend substantially higher than the highest part of the front surface of the circuit breaker housing. Thus, a flat panel plate can be placed over the compact circuit interrupter with the handle of the circuit interrupter extending through an opening in the panel plate to enable manual operation of the circuit interrupter.

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

We claim as our invention:

1. A multi-pole circuit interrupting device comprising, in combination, a circuit breaker comprising a first housing, a multi-pole circuit breaker mechanism disposed generally within said first housing and comprising separable contact means for each pole, a common unitary trip bar structure comprising a rotatable member and two arm members extending from said rotatable member, means operable upon the occurrence of certain current conditions in any of said poles to rotate said common unitary trip bar structure to effect opening of the contact means in all of said poles, a multi-pole fuse unit comprising a second housing and fuse unit means supported on said second housing, said fuse unit means comprising a fuse for each pole of said circuit breaker and a common unitary tripping bar structure, each of said fuses comprising means operable upon the occurrence of certain current conditions to operatively move said common unitary tripping bar structure, said common unitary tripping bar structure when operatively moved engaging one of said arms and rotating said common unitary trip bar structure to effect opening of the contact means in all of said poles, means removably connecting said fuse unit to said circuit breaker, said circuit breaker comprising a leaf spring, a portion molded integral with said second housing engaging said leaf spring to bias said leaf spring to an inoperative position when said fuse unit is mounted on said circuit breaker, and upon removal of said fuse unit from said circuit breaker said leaf spring automatically moving to directly engage said other arm to rotate said common unitary trip bar structure to effect opening of the contact means in all of said poles.

2. A multi-pole interrupting device comprising, in comprising, in combination, a circuit breaker comprising a first housing, a multi-pole circuit breaker mechanism disposed generally within said first housing and comprising separable contact means for each pole, a common trip bar structure common to all of said poles and operatively movable to a tripped position to effect opening of all of said contact means, a multi-pole fuse unit comprising a second housing, fuse unit means supported on said second housing and comprising a removable fuse for each pole of said circuit breaker and a common tripping bar structure, each of said fuses comprising means operable upon the occurrence of certain current conditions to operatively move said common tripping bar structure to a tripping position, said common trip bar structure comprising a trip arm, said common tripping bar structure when operatively moved to the tripping position engaging said trip arm to operatively move said common trip bar structure to a tripped position to effect opening of all of said contact means, said fuse unit being movably mounted on said circuit breaker, said fuse unit comprising safety trip means at each pole unit thereof mounted on said second housing each of which safety trip means moves automatically to move said common tripping bar structure to the tripping position when the associated fuse is removed from said fuse unit.

3. A multi-pole circuit interrupting device comprising, in combination, a circuit breaker comprising a first housing, a multi-pole circuit breaker mechanism disposed generally within said first housing and comprising separable contact means for each pole, said circuit breaker comprising a common trip bar structure common to all of said poles and operatively movable to a tripped position to effect opening of all of said contact means, a multi-pole fuse unit comprising a second housing, fuse unit means supported on said second housing and comprising a separate removable fuse for each pole of said circuit breaker, said fuse-unit means comprising a common tripping bar structure, each of said fuses comprising means operable upon the occurrence of certain current conditions to operatively move said common tripping bar structure to a tripping position, said common

tripping bar structure when operatively moved to said tripping position engaging and operatively moving said common trip bar structure to said tripped position, means removably connecting said fuse-unit to said circuit breaker, said circuit breaker comprising a resilient safety trip member, said fuse-unit comprising means holding said safety trip member in an inoperative position when said fuse-unit is mounted on said circuit breaker, upon removal of said fuse unit said resilient safety trip member engaging said trip arm to operatively move said common trip bar structure to said tripped position, said fuse unit comprising safety trip means at each pole unit mounted on said second housing each of which safety trip means is operable to maintain said common tripping bar structure in said tripping position when any of the fuses in said fuse unit is removed.

4. A multi-pole circuit interrupter device comprising, in combination, a circuit breaker comprising a first housing, a multi-pole circuit breaker mechanism disposed generally within said first housing and comprising separable contact means for each pole, a common trip bar structure movable to a tripped position to effect opening of all of said contact means, means operable upon the occurrence of certain current conditions in any of said poles to operate said common trip bar structure to the tripped position, said common trip bar structure comprising, a trip arm, a multi-pole fuse unit comprising a second housing and fuse unit means supported on said second housing, said fuse unit means comprising a removable fuse for each pole of said circuit breaker and a common tripping bar structure, upon rotation of said common tripping bar structure to a tripping position means on said common tripping bar structure engaging said trip arm to

move said common trip bar structure to the tripped position, each of said fuses comprising means operable upon the occurrence of certain overload current conditions to operatively move said common tripping bar structure to said tripping position, means removably connecting said fuse unit to said circuit breaker, said circuit breaker comprising resilient means engageable by said fuse unit and held in an inoperative position when said fuse unit is mounted on said circuit breaker, upon removal of said fuse unit from said circuit breaker said resilient means operating automatically to engage said trip arm to move said common trip bar structure to the tripped position, said fuse unit comprising resilient safety trip means in each pole unit mounted on said second housing each of which safety trip means is maintained in a charged inoperative position by the associated fuse, and upon the removal of any of said fuses associated resilient safety trip means being automatically released to engage the said common tripping bar structure to move said common tripping bar structure to the tripping position.

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