Nov. 14, 1961 C. L. JONES ET AL 3,009,037

CURRENT LIMITING CIRCUIT BREAKER

Filed Oct. 18, 1956 2 Sheets-Sheet 1

Fig. 1.

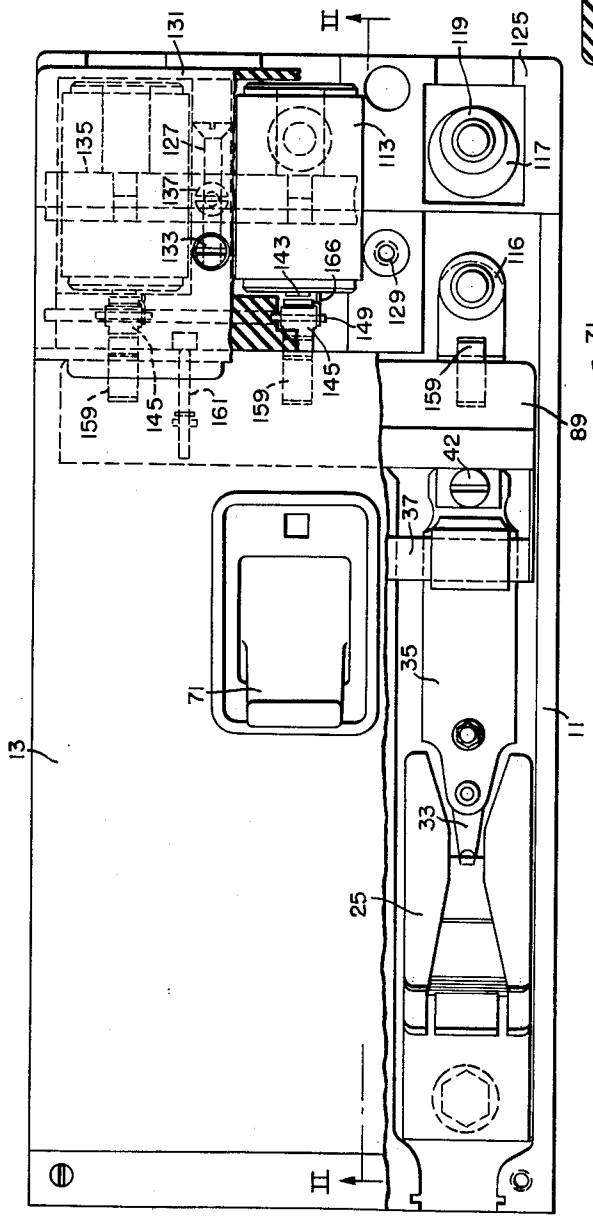
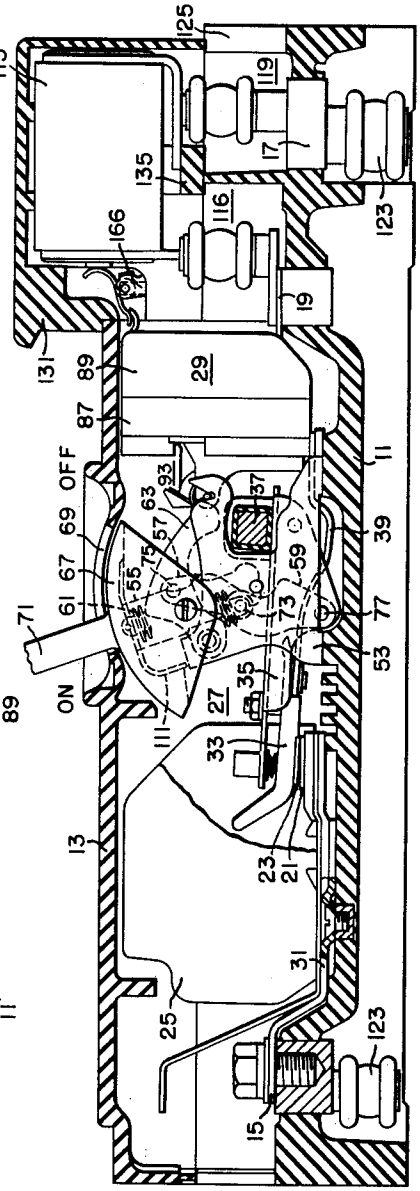


Fig. 2.



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Fig.3.

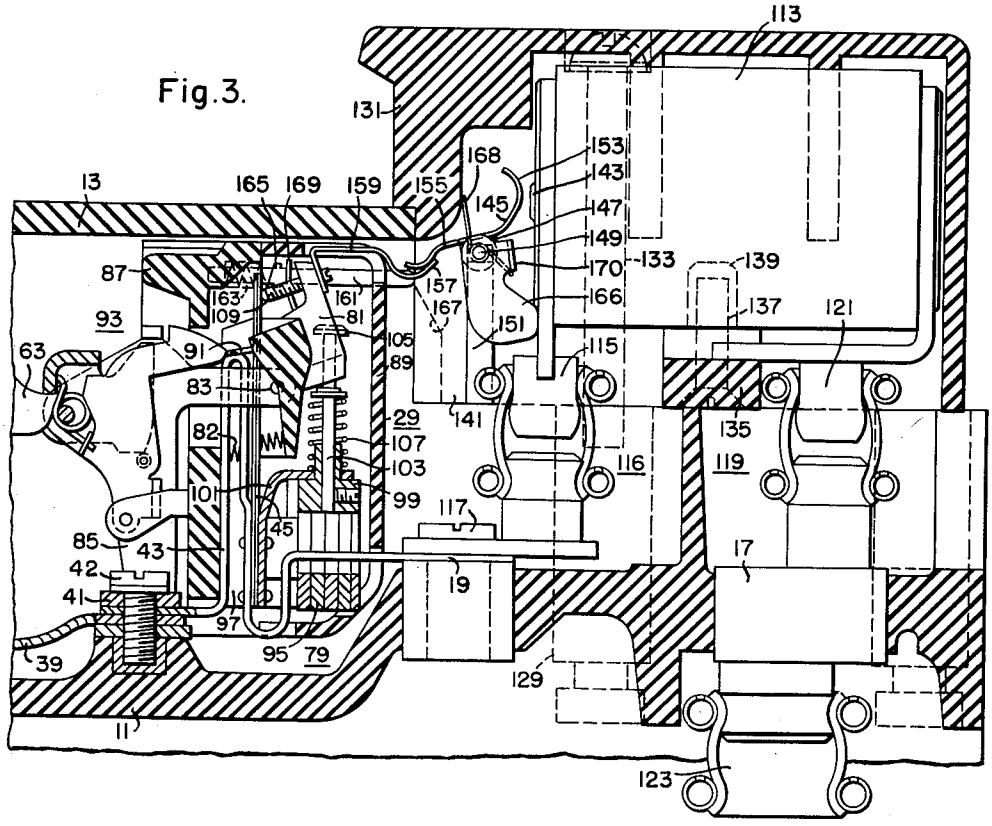
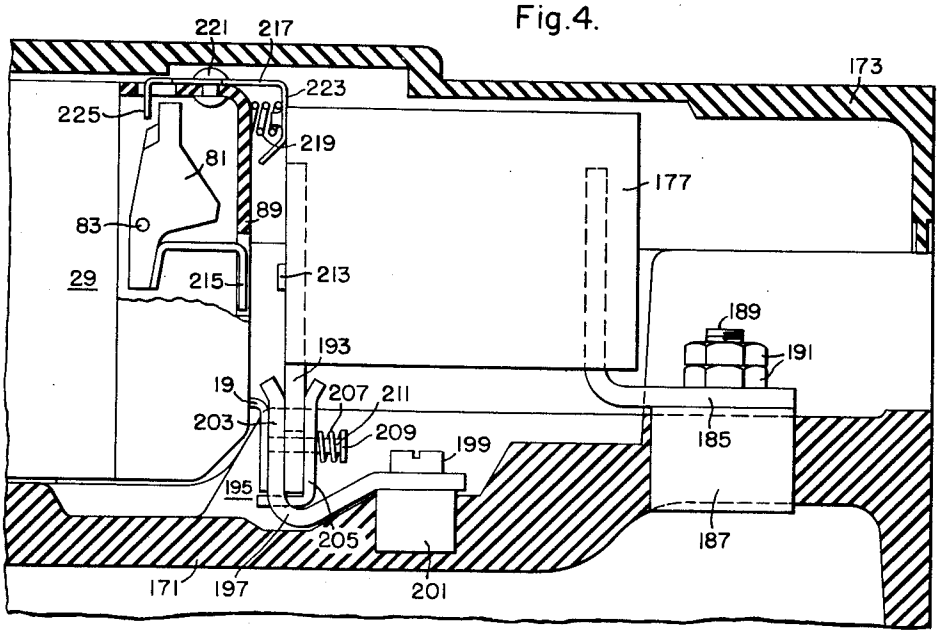


Fig.4.



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3,009,037

CURRENT LIMITING CIRCUIT BREAKER

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16 Claims. (Cl. 200—114)

This invention relates to circuit interrupters and, more particularly, to a circuit interrupter comprising a low-cost circuit breaker having a fusible member electrically connected in series relation therewith to interrupt fault currents far exceeding the interrupting capacity of the low-cost circuit breaker. This invention is a further development and improvement on that disclosed in the application of Hiller D. Dorfman and Howard E. Reichert, Serial No. 605,997, filed August 24, 1956.

There are available current-limiting fuses having a rated interrupting capacity of 100,000 amperes, meaning that they have the property of limiting the rise of current and of interrupting the current quickly before the instantaneous value of the current has risen to a peak value more than a small fraction of the available 100,000 amperes short-circuit current of the circuit. This current-limiting action is very desirable in that it protects the circuit, and the apparatus connected therein, from the destructive effects of the maximum available short-circuit current. On the other hand, the use of current-limiting fuses has a number of disadvantages as compared with the use of circuit breakers. For one thing, the current-limiting fuse is a relatively expensive type of fuse and if the circuit is one which is subject to frequent small overloads or to relatively high-resistance short circuits, the cost of repeatedly replacing the fuses becomes a large item. Another disadvantage in the use of fuses is that a fault on a single conductor of a three-phase circuit may blow only one fuse, or one of the fuses may be omitted, with the result that single-phase power is supplied over the other conductors. This can result in the burning out of motors or other equipment which may continue to operate on single-phase, though designed for three-phase operation.

It is an object of this invention to provide a 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.

An important object of the invention is to provide a unitary circuit interrupter comprising a circuit breaker having a trip device and current-limiting fuses connected in series in the circuit through the breaker embodying means actuated in the absence of any one of the fuses to operate the trip device to tripping position and hold the trip device in tripped position thus preventing closing the circuit breaker until all of the fuses are in place.

Another object of the invention is to provide a unitary circuit interrupter having an insulating housing comprising a base and a cover for housing a circuit breaker having current-limiting fuse means and a separate cover or holder for the fuse means, means being provided for tripping the circuit breaker open when the fuse cover or holder is removed.

Another object of the invention is to provide a unitary circuit interrupter having an insulating housing comprising a base and cover for housing a circuit breaker embodying current-limiting fuses with a separate cover or holder for the fuses and fuse sensing means mounted

on the cover or holder for tripping the circuit breaker open when the fuse cover or holder is put in position without all of the fuses in place.

Another object of the invention is to provide a circuit interrupter comprising a circuit breaker and removable plug-in type fuse means according to the preceding paragraphs wherein cover means is provided which may be sealed to protect at least the trip unit of the circuit breaker from being tampered with, but which sealed cover need not be removed to replace the fuses, and having a separate enclosing cover member removable with the fuse means and interlocking means for actuating the trip unit to trip the circuit breaker open upon removal of said fuse means.

A further object of the invention is to provide a unitary circuit interrupter comprising a circuit breaker and current-limiting fuse means having one insulating enclosing housing for housing the circuit breaker and a housing for the current-limiting fuse means removably secured to the circuit breaker housing, in which interlocking means is provided for effecting opening of the circuit breaker when the fuse housing and the fuse means are removed.

Another object of the invention is to provide a unitary circuit interrupter comprising a circuit breaker and plug-in current-limiting fuses having an insulating enclosing housing for the circuit breaker and a fuse holder for the current-limiting fuses removably secured to the circuit breaker housing, and embodying sensing means independent of the plug-in contacts for effecting opening of the circuit breaker when any fuse is missing from the holder, together with means for preventing closing the circuit breaker until the fuse holder is replaced with all of the fuses in position.

Another object of the invention is to provide a multipole circuit interrupter comprising a circuit breaker and a plug-in type current-limiting fuse electrically connected in series relation with each pole of the circuit breaker having an enclosing housing for the circuit breaker and a separate housing for all of said current limiting fuses removable to replace said fuses, each of said fuses having means operable when the fuse blows to actuate the trip means of the circuit breaker to tripping position and hold said tripping means in tripping position until the blown fuse is removed, said circuit interrupter also having means for tripping said circuit breaker open when said fuse housing is removed, and means independent of the plug-in contacts for preventing closing said circuit breaker until said fuse housing and all of said fuses are replaced.

The invention, 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 drawings.

In said drawings:

FIGURE 1 is a top plan view, with the cover partly broken away, of a circuit interrupter embodying the principles of the invention.

FIG. 2 is a vertical sectional view taken substantially on line II—II of FIG. 1 and looking in the direction indicated by the arrows.

FIG. 3 is an enlarged vertical sectional view of a portion of the circuit interrupter showing the trip device of the circuit breaker and the fuse interlock.

FIG. 4 is a vertical sectional view of a portion of a circuit breaker showing a modification of the invention and embodying means for tripping the circuit breaker when a fuse blows and for tripping the circuit breaker when the fuse is removed.

Referring to FIGS. 1 and 2 of the drawings, the circuit interrupter comprises a base 11 of molded insulating material on which the several elements of the circuit breaker mechanism and the current-limiting fuses are mounted.

A cover 13 of molded insulating material, which may be fastened or sealed to the base 11, cooperates with the base 11 to form an enclosing housing for the circuit breaker.

The circuit interrupter is of the multipole type, each pole having line terminals 15 and load terminals 17, disposed at opposite ends of the base 11 and a terminal 19 (FIGS. 2 and 3) disposed intermediate the ends of the base. The circuit breaker mechanism may be of the general type disclosed in Patent No. 2,508,178, issued May 16, 1950, to T. Lindstrom et al., the mechanism being shown and briefly described herein for purposes of illustration. The circuit breaker includes a stationary contact 21, a movable contact 23 and an arc extinguisher 25 for each pole of the breaker. A common operating mechanism indicated generally at 27 is provided for simultaneously actuating the three movable contacts to open and closed positions, and a sealed removable trip device indicated generally at 29 serves to effect automatic opening of the breaker contacts in response to predetermined overload conditions in the circuit through any pole of the breaker.

The line terminal 15 forms the outer end of a conducting strip 31 which extends into the housing and rigidly supports the stationary contact 21. The movable contact 23 for each pole is rigidly mounted on a contact arm 33 supported on a switch arm 35 secured on a tie bar 37 which extends across all of the poles of the breaker and supports the switch arms for the several poles of the breaker for movement together to open and closed positions. The contact arm 33 is connected by a flexible conductor 39 to a terminal 41 (FIG. 3) secured to the base 11 by a screw 42 (FIG. 3) which also serves to secure one end or leg of a heater element 43 to the base. A bimetal element 45 forming a part of the trip device 29 is mounted on the other leg of the heater element 43 which is electrically integral with the intermediate terminal 19.

The operating mechanism 27 (FIG. 1) for the breaker is disposed in the center compartment of the housing and is supported by a pair of frame members 53 (only one being shown) secured to the base 11. The operating mechanism comprises a pivoted forked operating lever 55, a toggle comprising links 57—59, overcenter springs 61 and a pivoted releasable cradle 63 controlled by the trip device 29. An arcuate insulating shield 67 for substantially closing an opening 69 in the cover 13 is mounted on the end of the operating lever 55 and has an integral handle 71 extending out through the opening 69 to permit manual operation of the breaker mechanism.

The toggle links are pivotally connected together by a pivot pin 73. The toggle link 57 is pivotally connected by a pivot pin 75 to the cradle 63 and the toggle link 59 is pivotally connected to the switch arm 35 for the center pole by a pivot pin 77. The overcenter springs 61 are connected under tension between the knee pivot pin of the toggle 57—59 and the outer end of the operating lever 55.

The circuit breaker is operated to open position by manipulation of the handle 71 (FIG. 1) in a clockwise direction to the "off" position actuating the overcenter springs 61 to cause collapse of the toggle 57—59 and opening movement of the switch arms 35 for all of the poles of the breaker in a well-known manner.

The breaker is manually closed by reverse movement of the handle 71 from the "off" to the "on" position which causes the springs 61 to move overcenter and straighten the toggle thereby moving the switch arms 35 for all of the poles to the closed position.

In addition to the bimetal element 45 for each of the poles, the trip device also includes a series overload tripping magnet 79 (FIG. 3) for each pole and a trip bar 81 common to all of the poles and biased to latching position by a spring 82 (FIG. 3). The trip bar 81 is made of insulating material and is pivotally supported by means of pins 83 (only one being shown) supported in a bracket 85 secured to the base 11 by the screws 42. The

bracket 85 also supports an insulating base 87 for the trip device. A sealed cover 89 of insulating material is provided to enclose the trip device. A latch 91 (FIG. 3) on the trip bar 81 normally engages a latch mechanism 93 which, in turn, engages the cradle 63 to releasably restrain the operating mechanism in closed position.

The tripping magnet 79 comprises a U-shaped magnet yoke 95 (FIG. 3) supported on a bracket 97 which is rigidly supported on the base 87 for the trip device. A movable armature 99 is slidably supported in an extension 101 of the bracket 97 and has secured thereto a rod 103 which, at its outer end, has a head 105 for engaging and operating the trip bar 81 upon energization of the magnet. A spring 107 coiled about the rod 103 biases the rod and the armature 99 to the unattracted position. The tripping magnet 79 is energized by the terminal conductor 19 which extends between the legs of the U-shaped magnet yoke.

When a low overload current occurs the bimetal element 45 is heated by the heater element 43 and when heated a predetermined amount bends toward the right (FIG. 3) to engage an adjustable calibrating screw 109 on the trip bar 81 and actuate the latter to effect release of the cradle 63 and opening of all of the breaker contacts after the time delay afforded by the time required to heat the bimetal.

The circuit breaker is tripped open instantaneously by operation of the tripping magnet 79. When the magnet is energized by overload currents of, for instance, 1000% or more of normal rated current, or by a short-circuit current, the armature 99 is attracted causing the head 105 to engage and actuate the trip bar 81 thereby effecting instantaneous release of the cradle 63. This effects automatic opening of the contacts of all three poles of the breaker.

It is necessary to reset and relatch the mechanism before the breaker contacts can be closed following an automatic opening operation. Resetting and relatching is effected by moving the handle clockwise as far as it will go. During this movement a projection 111 on the operating lever 55 engages a shoulder on the cradle 63 and moves the latter in a clockwise direction. Near the end of the clockwise movement of the cradle 63 the latching end thereof is reengaged with the latch mechanism 93 in a well-known manner. The breaker contacts are then closed in the previously described manner by movement of the handle to the "on" position.

The arc extinguisher 25 may be of any suitable type, the one shown consisting of a plurality of slotted plates of magnetic material, into which the arc is drawn and quickly extinguished.

The circuit breaker illustrated, by way of example, may have a continuous current-carrying capacity of 225 amperes and an interrupting capacity of 25,000 amperes at 600 volts alternating current, and will safely interrupt fault currents up to its interrupting capacity. Buildings, such as factories, hospitals, apartment buildings, etc., have branch and feeder circuits for lighting and power circuits. Such circuits are, at times, connected to power sources that are capable of full amplitude instantaneous fault currents in the neighborhood of 100,000 or more amperes which far exceeds the interrupting capacity of the circuit breakers. Inserting current-limiting fuses having a higher interrupting capacity than that of the circuit breaker in series with the circuits through the several poles of the breaker permits the circuit breaker to function normally to interrupt fault currents up to values less than its interrupting capacity, but, should a fault current of greater magnitude than the interrupting capacity of the circuit breaker occur, the current-limiting fuses become effective to limit and interrupt the current.

Such a circuit interrupter structure, of which the instant application is an improvement, is disclosed in application Serial No. 457,135, filed September 20, 1954, by Lloyd W. Dyer, and assigned to the assignee of this

application. In the application just referred to, the current-limiting fuses are disposed in open compartments outside the breaker cover and at the line end of the breaker. It is possible to close the circuit breaker before a blown fuse is replaced. This fact, together with the easy accessibility of the fuses may present a hazard to a person attempting to replace one or more of the fuses.

According to the present invention there is a current-limiting fuse **113** for each of the three poles of the interrupter and all of the fuses are mounted in or on a separate fuse housing or fuse holder which is attached to the load end of the circuit breaker housing so that, together with the fuses, it can be removed without removing the circuit breaker cover.

One terminal **115** of the fuse **113** is connected to the intermediate terminal **19** of the breaker by means of a plug-in type connector **116** secured by a screw **117** to the trip unit terminal **19**. The other terminal **121** of the fuse **113** is similarly connected to the load terminal **17** by a plug-in type connector **119**. The line terminals **15** and the load terminals **17** at opposite ends of the base are provided with suitable connectors **123** for connecting the circuit interrupter in an electrical circuit. Such connections are not provided for the intermediate terminals **19** since all of the current flows through both the circuit breaker and the fuses.

The fuses **113** for all of the poles are mounted in a separate housing including a cover member or holder **131** of insulating material removably secured to the base **11** by means of screws **133** which threadedly engage the upper ends of plugs **129** in the base **11** so that it, together with the fuses, can be removed without removing the circuit breaker cover **13**. The fuses **113** are rigidly held in the cover member **131** by a second housing member in the form of a cross bar **135** of insulating material secured to the bottom of the cover member by screws **137** which are threaded into metal inserts **139** molded in barriers **141** in the cover member and extending between the fuses **113**.

When an overload current close to or above the interrupting capacity of the circuit breaker occurs one or more of the fuses **113** will blow and interrupt the current. The tripping electromagnet **79** will also function in most cases to actuate the trip bar **81** and trip the breaker open even though the fuse will interrupt the current before the breaker contacts open.

Means is provided to hold the trip bar **81** in the tripped position following the blowing of a fuse to prevent relatching of the breaker mechanism and closing of the breaker contacts until the blown fuse is removed. This means comprises a spring-loaded plunger or actuator **143** (FIG. 3) on each of the fuses which is biased to move toward the left when the fuse blows. This plunger and the spring or other means for operating it may be in one of the forms disclosed in Rawlins et al. Patent No. 2,435,844, issued February 10, 1948. The plunger of each fuse actuates one of the three pivoted trip levers **145**. Each lever or member **145** responsive to the blowing of a fuse is provided with spaced ears **147** which pivotally support the member on a pin **149** mounted in slots in the barriers **141** on the fuse cover or holder and held in place by insulating inserts **151**. One end of each lever or trip element **145** is curved upwardly as at **153** and the other end **155** of the trip element **145** is disposed adjacent the free end **157** of one of the three brackets **159** each of which extends through an opening in the trip device cover **89** and is secured to the trip bar **81**.

When the fuse **113** for any one of the poles of the interrupter blows, the plunger **143** of the affected fuse is released and driven toward the left. The plunger **143** engages the end **153** of one trip element **145** and moves the latter counterclockwise causing the end **155** of the lever to engage the free end **157** of the bracket **159** and move the trip bar **81** to the tripping position. The trip bar **81** will be thus held in the tripped position until the blown fuse is removed. With the trip bar **81** held in the tripped position, the breaker mechanism cannot be reset and the breaker cannot be closed.

The fuse housing or cover **131** together with the fuses **113** are removed from the interrupter by first removing the screws **133** and then lifting the fuse cover **131** upwardly to disengage the fuse terminals **115** and **121** from their respective plug-in connections **116** and **119**. As the fuses and the fuse housing are removed, the three trip levers **145**, which are mounted in the fuse housing, are removed therewith. This releases the bracket **159** and permits the spring **82** to restore the trip bar **81** to the latching position. With the trip bar **81** in its normal latching position, the breaker mechanism could be relatched and the breaker contacts closed. While, in this situation, the circuit would be open between the plug-in connectors **116** and **119**, a dangerous situation would obtain if an effort were made to reinsert the fuses with an excessive fault current on the line. Means is provided to prevent return of the trip bar to the latching position when the fuse housing is removed and to hold the trip bar in the unlatching position until the fuse housing is returned to its position on the interrupter and the fuses are re-engaged with their plug-in connectors.

This means comprises a spring-biased plunger **161** slidably supported in an opening in the trip device cover **89** and an opening in the base **87** of the trip device. The plunger **161** is biased toward the right against the fuse housing by a spring **163** compressed between the base **87** of the trip device and shoulders **165** on the plunger **161**. When the fuse housing **131** is moved upwardly to disengage the fuses, a cam surface **167** on the fuse housing permits the spring **163** to move the plunger **161** toward the right, causing the shoulders **165** to engage a projection **169** on the trip bar and move the trip bar to tripping position. The spring **163** will hold the trip bar in the tripped position until the fuse housing is replaced on the interrupter, at which time the cam surface **167** engages the plunger **161** and moves it to the left to the position shown in FIG. 3. This permits the spring **82** to return the trip bar to the latching position so that the breaker can be reset and closed.

The plunger **161** also makes it impossible to draw an arc between the fuse terminals **115, 121** and the connectors **116, 119** as could be done if the fuses were pulled out while the circuit breaker contacts are closed and current is flowing. The position and slope of the cam surface **167** is such that the plunger **161** is actuated upon outward movement of the fuse cover or holder **131** before the fuse terminals disengage the connectors, with the result that breaker contacts are opened first and the arc is extinguished in the arc chutes **25** without any arc being drawn between the fuse terminals and connectors. The plunger **161** also prevents the circuit from being closed if the three fuses should be plugged in separately without first being mounted on the holder which acts as a housing or cover to prevent the live parts from being touched when they are energized.

If the fuse holder shoulder be placed in position on the interrupter with a blown fuse still in the holder, the plunger **143** of the blown fuse will hold its trip lever **145** in its operated position and, as the holder is replaced, the end **155** of the lever **145** will engage the end **157** of the bracket **159** and hold the trip bar **81** in tripped position. This insures that all of the blown fuses are replaced before the fuses and the holder are replaced on the interrupter.

Sensing means is also provided for sensing the presence or absence of each of the fuses and to hold the trip bar in the tripped position if one of the fuses is omitted when the fuse holder or housing is placed in position on the interrupter. This sensing means comprises a sensing finger **166** for each of the fuses **113** pivoted on the pin

149 and biased in a counterclockwise direction against the fuse by a spring 168. After the fuse housing 131 and the fuses 113 are removed from the interrupter, the fuse or fuses are removed from the fuse housing by removing the screws 137 and the retainer bar 135. The fuses may then be removed by sliding them toward the bottom of the housing as viewed in FIG. 3. Removal of any one of the fuses from the housing frees the sensing finger 166 and the spring 168 immediately rotates the finger counterclockwise. During this motion, a yoke portion 170 of the sensing finger engages the lever 145 and rotates the latter also counterclockwise. The fuse is inserted in the fuse housing by first manually moving the finger 166 clockwise far enough to allow the fuse to be placed in position in the housing. The fuse is then inserted and the retainer bar 135 replaced and secured in position by the screws 137. With all of the fuses in the position shown, the fingers 166 are held in their retracted positions. However, if the fuse for one of the poles is omitted from the housing when it is placed in position on the interrupter, the sensing finger 166 for that pole or fuse will be moved by the spring 168 to its extreme counterclockwise position and move its trip lever 145 to its counterclockwise position. If the fuse housing is placed in position on the interrupter with one or more of the fuses omitted from this housing, the end 155 of the trip lever 145 for the fuse omitted will engage the end 157 of the bracket 159 and hold the trip bar 81 in the tripping position even though the cam surface 167 moves the plunger 161 to release the trip bar.

It should be noted that the sensing fingers 166 are mounted on the removable fuse cover or holder 131 so as to be removable therewith. This has the advantage that the movement of the fingers against their springs 168 takes place when the individual fuses are put in position and when the fuse holder is separated from the breaker. This means that the proper positioning of the fuses relative to the fingers can be visually checked before the holder is put in place. Also, the plug-in action does not have to move the sensing fingers as the holder is being plugged in. Another advantage of this invention is that the sensing fingers are independent of the plug-in connectors 116 and 119 and cannot affect the making of proper electrical contact.

FIG. 4 illustrates a modification of the breaker or fuse housing and of the means for tripping the breaker when a fuse is removed or is omitted. In the FIG. 4 modification, the circuit breaker housing is extended at the load end thereof and the fuses are mounted in separate compartments formed in the extension without a separate fuse housing.

Referring to FIG. 4 of the drawings, the circuit breaker housing comprises an integral base 171 and an integral cover 173 of molded insulating material which together enclose both the breaker mechanism and the fuses. Since the trip device of FIG. 4 is the same as that shown in FIG. 3, only the trip bar 81 and the trip device cover er shown in FIG. 4. A current-limiting fuse 177 is provided for each pole of the breaker and each fuse has at its outer end a blade 185 which is rigidly but removably mounted on a metal insert 187 molded in the base 171 adjacent the end thereof. The fuse blade 185 is secured to the insert 187 by a bolt 189 and nuts 191 which also serve as a load terminal to connect the interrupter in an electrical circuit.

The inner end of the current-limiting fuse 177 has a downwardly extending blade 193 that is slotted at its lower end so that it can be plugged into a plug-in type connector indicated generally at 195. The plug-in connector 195 comprises an angular conducting member 197 having one end rigidly secured by means of a screw 199 to a metal insert 201 molded in the base 171. The conducting member has finger 203 extending upwardly in close contact with the blade 193 to which finger the intermediate terminal 19 is is rigidly mechanically secured to form a good electrical connection. A contact plate 205 is disposed on the other side of the blade 193 from the finger 203 and is biased against the blade 193 by a spring 207 compressed between the contact plate 205 and the head 209 of a screw 211 which is threaded into the finger 203.

Means is provided to mechanically trip the breaker open when a fuse blows and to hold the circuit breaker in tripped condition to prevent closing the breaker until the blown fuse is removed from the interrupter. This means comprises a spring loaded plunger 213 (FIG. 4) for each of the fuses, the plunger 213 being actuated outwardly from the end of the fuse when the fuse blows. The plunger and the spring means for operating it when the fuse blows can be of the type illustrated in Rawlins et al. Patent No. 2,435,844, issued February 10, 1948, or other means can be used.

When the fuse for any pole of the interrupter blows, the plunger 213 associated therewith is actuated toward the left and engages a bracket 215 secured to the trip bar 81, there being a bracket 215 or a portion on the trip bar for each pole of the breaker to be engaged by the plunger of each fuse to actuate the trip bar and effect tripping of the breaker. The plunger 213 of any one fuse then holds the trip bar 81 in tripping position until the blown fuse is removed thus preventing relatching of the breaker mechanism and closing of the breaker contacts, and also preventing a single-phase condition.

The blown fuse is removed by first removing the cover 173. The blown fuse is then removed by removing the nuts 191 and then lifting the fuse upwardly to disengage the fuse blade 193 from the plug-in device 195. When the fuse is removed, the plunger 213 is no longer effective to hold the trip bar 81 in the tripped position. However, means is provided to move the trip bar to the tripped position when a fuse is removed and to hold it in the tripped position until the fuse is replaced in the interrupter. This means comprises a slide 217 (FIG. 4) for each of the fuses 177 slidably mounted on the cover 89 of the trip device and biased by a spring 219 against the fuse. The slide 217 is held in place by a rivet 221 which passes through an elongated slot (not shown) and an opening in the cover 89 of the trip device. The spring 219 is compressed between a downwardly extending portion 223 of the slide and the trip device cover 89. An ear 225 on the other end of the slide 217 extends downwardly through a slot in the trip device cover 89 and is adapted to engage the upper end of the trip bar 81.

When any one of the fuses 177 is removed from the interrupter, the spring 219 forces the corresponding slide 217 toward the right causing its ear 225 to engage and move the trip bar 81 to the tripping position. The trip bar will be held in the tripping position until the fuse is replaced in the interrupter. When the fuse is replaced, the end thereof engages the portion 223 of the slide 217 and moves the slide toward the left which releases the trip bar and permits the trip bar to resume its normal position after which the breaker mechanism may be relatched and the breaker closed.

The invention provides a circuit interrupter device comprising a manually and automatically operable circuit breaker having current-limiting fuses of high interrupting capacity in series therewith. The operating characteristics of the two devices are so related that the circuit breaker functions in a conventional manner in response to fault currents within its interrupting capacity and the fuses become effective to interrupt fault currents greater than those which the circuit breaker can safely interrupt. The circuit breaker is mounted on its own insulating housing and the fuses in one form of the invention are mounted in a separate housing which is removably mounted on the circuit breaker housing. Or the circuit breaker housing may be extended as shown in FIG. 4 and the fuses mounted in the circuit breaker housing. Means is provided to prevent resetting the breaker mechanism and

closing the breaker contacts following the blowing of a fuse until the blown fuse is removed. Means is also provided to prevent resetting the breaker mechanism when the fuse housing or any one of the fuses is removed and until the fuse housing is replaced or all of the fuses are replaced in position in the interrupter.

Having described the invention 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 disclosed and in the arrangement of parts without departing from the spirit of the invention.

We claim as our invention:

1. A multipole circuit interrupting device comprising a plurality of sets of separable contact means and means releasable to effect separation of all of said contact means, a trip bar movable to a tripping position to effect release of said releasable means, a plurality of fuse means each removably connected in series relation with one set of said separable contact means, a trip element for each pole movable relative to said trip bar and operable to mechanically cause movement of said trip bar to tripping position, means actuated when each said fuse means blows to cause said trip element for its pole to move and cause movement of said trip bar to tripping position, and sensing means responsive to the absence of any one of said fuse means from its pole to cause the same said trip element for the respective pole to move and cause movement of said trip bar to tripping position and separation of all of said sets of contact means.

2. A circuit interrupting device comprising a base having thereon separable contact means and means releasable to effect separation of said contact means, a trip member movable to a tripping position to effect release of said releasable means, a fuse housing removably mounted on the base and having a fuse connected in series relation with said separable contact means, a pivoted lever having one end disposed to effect movement of said trip member, means actuated when said fuse blows to operate said lever and cause said lever to effect movement of said trip member to tripping position, and biased sensing means mounted on the fuse housing and actuated when said fuse is absent and the fuse housing is in place on the base to operate said lever and cause said lever to effect movement of said trip member to tripping position.

3. A circuit interrupting device comprising separable contact means and means releasable to effect separation of said contact means, a trip bar movable to a tripping position to effect release of said releasable means, fuse means removably connected in series relation with said separable contact means, a lever having one end disposed to cause actuation of said trip bar, pivot means pivotally supporting said lever, means comprising a member actuated when said fuse blows to engage the other end of said lever and operate said lever to cause movement of said trip bar to tripping position, an actuating member pivoted on said pivot means and biased against said fuse means, and said actuating member being actuated when said fuse means is removed to engage and operate said lever to cause movement of said trip bar to tripping position and to cause said trip bar to remain in tripping position until said fuse means is replaced.

4. A circuit interrupting device comprising separable contact means and means releasable to effect separation of said contact means, a trip bar movable to a tripping position to effect release of said releasable means, a fuse removably connected in series relation with said separable contact means, an actuating member biased against said fuse, a lever having one end disposed to engage a portion on said trip bar, pivot means supporting said actuating member and said lever, said actuating member when said fuse is absent being actuated to engage and operate said lever to cause said lever to move said trip bar to tripping position, and means actuated when said fuse means blows to engage the said lever and operate said lever independently of said actuating member and cause said lever to move said trip bar to tripping position.

5. A multipole circuit interrupting device comprising a plurality of separable contact means and means releasable to effect separation of all of said contact means, a trip bar common to all of the poles of the interrupter movable to effect release of said releasable means, a plurality of pairs of connectors each electrically in series with one of said contact means, a plurality of fuses each having a pair of terminals removably engageable with one pair of said connectors, a plurality of sensing members independent of said connectors, and each of said sensing members being individually responsive to the absence of one of said fuses to mechanically move and cause operation of said trip bar and release of said releasable means and separation of all of said contact means if any one of said fuses is absent.

6. A multipole circuit interrupting device comprising a plurality of separable contact means and means releasable to effect separation of said contact means, a plurality of pairs of connectors each electrically in series with one of said contact means, a plurality of fuses each having a pair of terminals removably engageable with one pair of said connectors, a fuse holder on which said plurality of fuses are mounted together as a unit, a plurality of sensing members each mounted on said fuse holder for movement independently of the other sensing members, and each of said sensing members being responsive to the absence of one of said fuses when the fuse holder is in place on the circuit interrupting device to cause said releasable means to effect separation of the contact means.

7. A multipole circuit interrupting device comprising separable contact means for each pole of the interrupter and means releasable to effect separation of the contact means for all of the poles, a trip device including a trip bar common to all of the poles movable to a tripping position to effect release of said releasable means, means operable in response to overload currents to move said trip bar to tripping position, a fuse in each of said poles and means removably connecting each of the fuses in series relation with said separable contact means for one pole, means operable when any one of said fuses blows to move said trip bar to tripping position, and a separate slidable member in each pole mounted on said trip device independently of said connecting means and each biased against one of the fuses, said slidable member for any one pole being actuated when the fuse for said pole is removed to move said trip bar to tripping position and said slidable members holding said trip bar in tripping position until all of said fuses are replaced.

8. A multipole circuit interrupting device comprising separable contact means for each pole of the interrupter and means releasable to effect separation of the contact means for all of the poles, a trip device including a trip bar common to all of the poles movable to a tripping position to effect release of said releasable means, means operable in response to overload currents to move said trip bar to tripping position, a fuse in each of said poles and means removably connecting each of the fuses in series relation with said separable contact means for one pole, a separate slidable member in each pole independent of said means removably connecting the fuses, and each slidable member being biased against one of the fuses, said slidable member for any one pole being actuated when the fuse for said pole is removed to effect movement of said trip bar to tripping position and said slidable members effecting holding of said trip bar in tripping position until all of said fuses are replaced.

9. A circuit interrupting device comprising separable contact means and means releasable to effect separation of said contact means, a trip bar movable to a tripping position to effect release of said releasable means, fuse means removably connected in series relation with said separable contact means, an insulating housing member

covering said fuse means and removable with said fuse means, a trip lever mounted on and removable with said fuse housing member, said trip lever being movable to an operated position in which it effects movement of said trip bar to tripping position, means comprising a spring-biased plunger on said fuse means actuated when said fuse means blows to move said trip lever to said operated position, biased fuse sensing means mounted on and removable with said fuse housing member, said fuse sensing means being actuated when said fuse means is removed from said fuse housing member to move said trip lever to said operated position, stored energy means operable when said fuse housing member is removed to move said trip bar to tripping position and to hold said trip bar in tripping position until said fuse housing member is replaced, and said trip lever when said fuse housing member is replaced with said fuse means omitted from said housing member effecting movement of said trip bar to said tripping position.

10. A multipole circuit interrupting device comprising separable contact means for each pole of the interrupter and means releasable to effect separation of the contact means for all of the poles, a trip bar common to all of the poles of the interrupter, electro-responsive means for moving said trip bar to a tripping position to effect release of said releasable means, a fuse in each of said poles removably connected in series relation with said separable contact means for its respective pole, a fuse holder connecting said fuses together for removal as a unit, and a plurality of sensing members each movably mounted on the fuse holder and responsive to the absence of the fuse for one pole from the holder to effect operation of the trip bar when the fuse holder is in place.

11. A multipole circuit interrupting device comprising separable contact means for each pole of said interrupter and means releasable to effect separation of the contact means for all of the poles, a trip bar common to all of the poles of the interrupter movable to a tripping position to effect release of said releasable means, fuse means in each of the poles removably connected in series relation with said separable contact means for the respective poles, an enclosing cover member for said fuse means removable with said fuse means, a separate trip member in each pole operable to effect movement of said common trip bar to tripping position, means on each of said fuse means comprising a spring-biased plunger actuated when fuse blows to move the associated trip member, sensing means in each pole mounted on said cover member and responsive to the absence of the fuse means for any of the poles to operate the associated trip member, and a sensing device operable when said cover member is removed to effect movement of said common trip bar to tripping position.

12. A multipole circuit interrupting device comprising separable contact means for each pole of the interrupter and means releasable to effect separation of the contact means for all of the poles, a trip bar common to all of the poles of the interrupter movable to a tripping position to effect release of said releasable means, a trip device operable in response to overload currents to move said common trip bar to tripping position, fuse means in each of the poles removably connected in series relation with said separable contact means for one of the poles, an enclosing cover member for said fuse means removable with said fuse means, a separate trip member for each of said fuse means mounted in said cover member and operable to move said common trip bar to tripping position, means on each of said fuse means comprising a spring-biased plunger actuated when any one of said fuses blows to operate the associated one of the trip members, a sensing device operable in response to removal of said fuse cover member to move said trip bar to tripping position, and separate sensing means in each pole operable when the associated fuse is removed from said cover member to operate the trip member so that when the fuse cover member is replaced with a fuse missing from one of said poles, the trip member for that pole will engage and move the common trip bar to tripping position.

13. A multipole circuit interrupting device comprising separable contact means for each pole of the interrupter and means releasable to effect separation of the contact means for all of the poles, a trip bar common to all of the poles of the interrupter, an electro-responsive means in series with each of said separable contact means for moving said trip bar to a tripping position to effect release of said releasable means, a plurality of fuses each removably connected electrically in series relation with said electro-responsive means and said separable contact means for one pole, each of said fuses being mounted in the circuit interrupter independently of the mounting of the other fuses so that each fuse can be removed from the circuit interrupter while the other fuses remain in place in the circuit interrupter, a plurality of sensing members each responsive to the removal of one fuse to mechanically move and effect operation of the trip bar to tripping position and separation of the contact means for all of the poles.

14. A multipole circuit interrupting device comprising separable contact means for each pole of the interrupter and means releasable to effect separation of the contact means for all of the poles, a trip device including a trip bar common to all of the poles movable to a tripping position to effect release of said releasable means, means operable in response to overload currents to move said trip bar to tripping position, a plurality of fuses and means removably connecting each of the fuses electrically in series relation with the separable contact means for one pole, a plurality of sensing members movable independently of each other and mounted on said trip device separate from said connecting means, means biasing each of said sensing members to engage one of the fuses and to move to mechanically effect operation of the trip bar to tripping position if its corresponding fuse is removed.

15. A multipole circuit interrupter comprising a base having thereon separable contacts for each pole and means releasable to effect separation of the contact means for all of the poles, a trip unit removably mounted on the base and including a trip bar common to all of the poles movable to a tripping position to effect release of said releasable means, means responsive to overload currents in each of a plurality of poles to move said trip bar to tripping position, an enclosure for said removable trip unit having a plurality of openings therein, a plurality of extensions on the trip bar each projecting through one of the openings in the trip unit enclosure, a housing removably mounted on the base, a plurality of fuses mounted on said housing and each fuse having a member actuated when the fuse blows, a plurality of independently movable trip elements each mounted on the fuse housing, each of said trip elements on the fuse housing being movable when the member on its respective fuse is actuated independently of any movement of the other trip elements and engaging one of the extensions projecting through the trip unit enclosure to move the trip bar and effect movement of all of the contacts to open position.

16. A multipole circuit interrupter comprising a base having thereon separable contacts for each pole and means releasable to effect separation of the contact means for all of the poles, a trip unit removably mounted on the base and including a trip bar common to all of the poles movable to a tripping position to effect release of said releasable means, means responsive to overload currents in each of a plurality of poles to move said trip bar to tripping position, an enclosure for said removable trip unit, a plurality of extensions on the trip bar, a housing removably mounted on the base, a plurality of fuses mounted on said housing and each fuse having a member actuated when the fuse blows, a plurality of inde-

pendently movable trip elements each mounted on the fuse housing, each of said trip elements on the fuse housing being movable when the member on its respective fuse is actuated independently of any movement of the other trip elements and engaging one of the extensions to move the trip bar and effect movement of all of the contacts to open position, a biased member mounted on the removable trip unit and engageable with said fuse housing and movable under its bias to move the trip bar on the removable trip unit to tripping position when said fuse housing is removed from the base.

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