

May 11, 1954

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2,678,359

TRIP MECHANISM OF CIRCUIT BREAKERS

Filed Jan. 15, 1952

5 Sheets-Sheet 1

FIG. 4

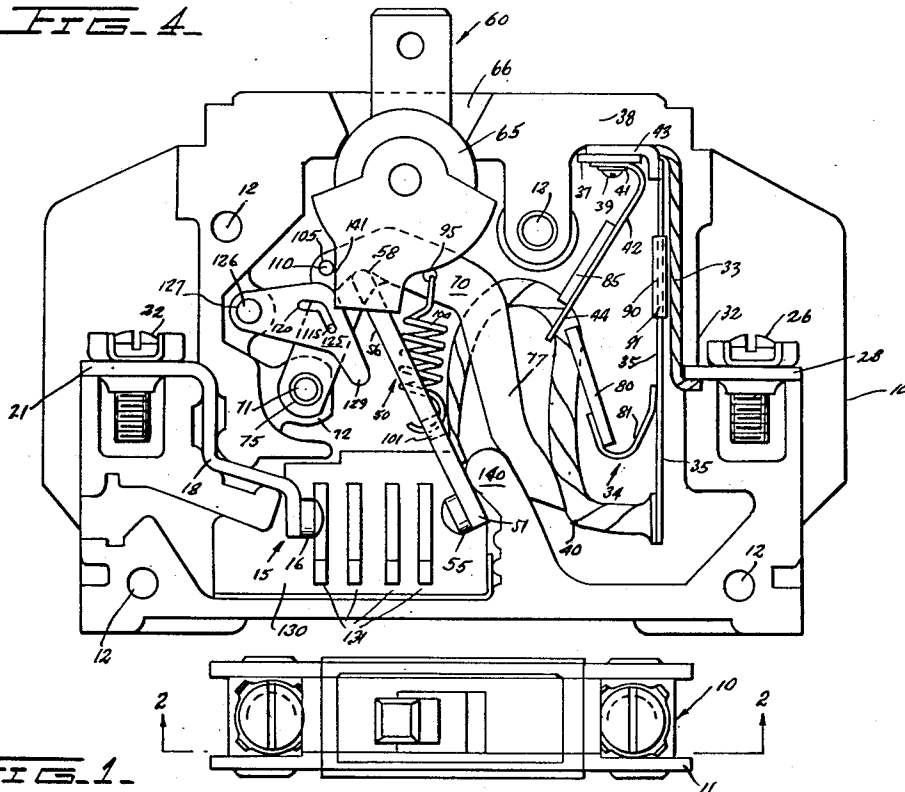
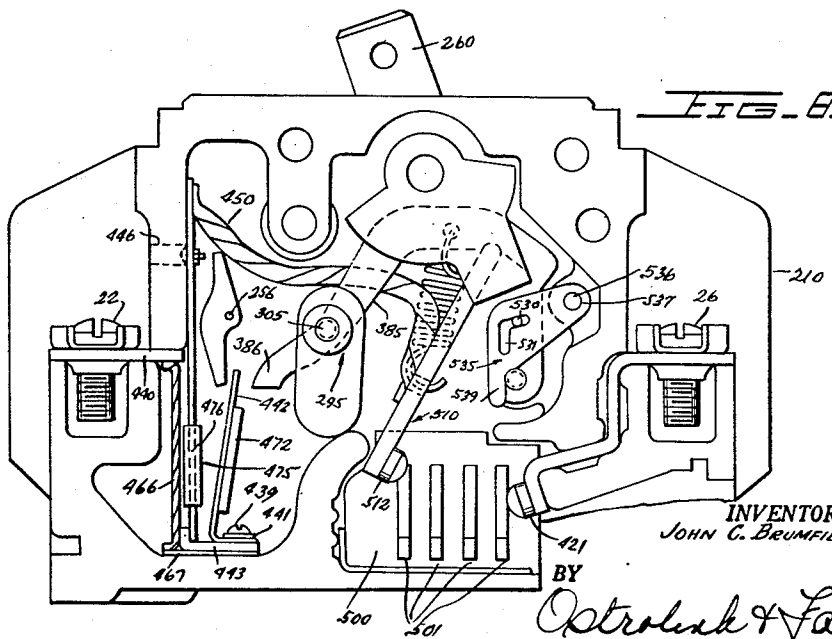


FIG. 1



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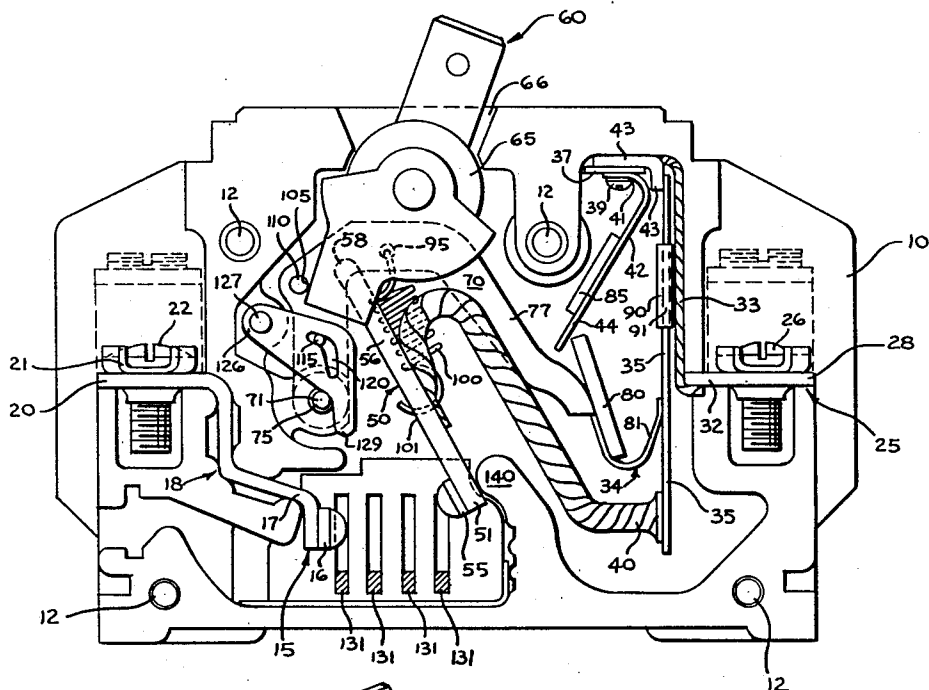


FIG. 2

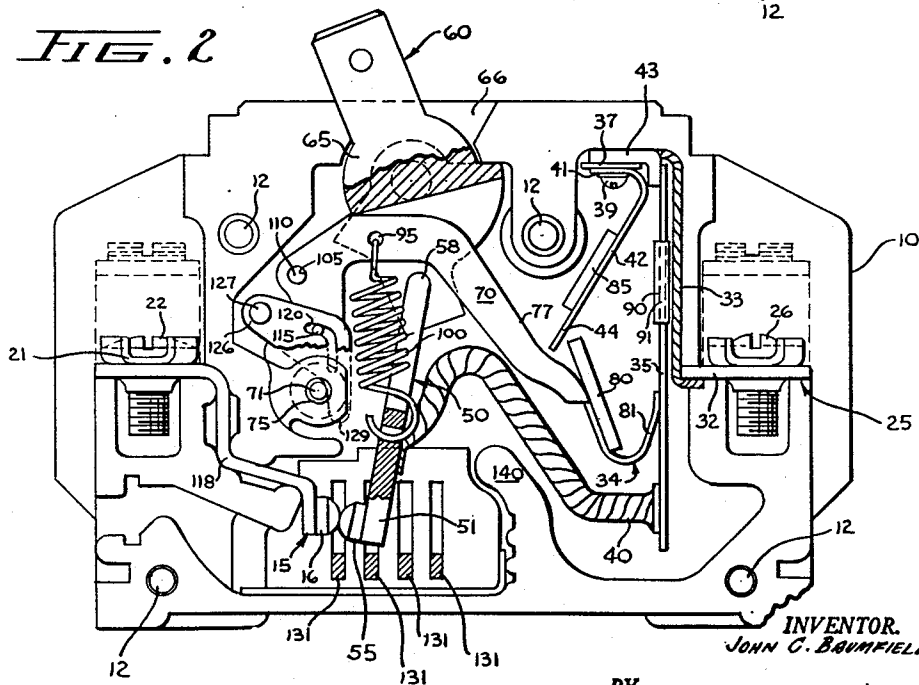


FIG. 3

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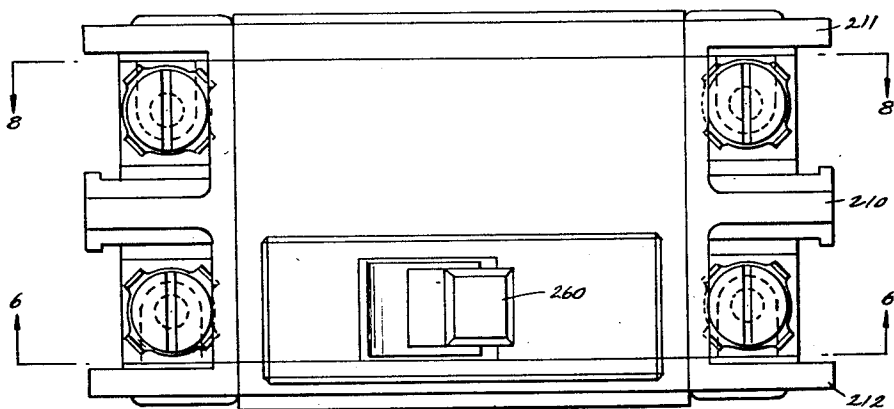


FIG. 5.

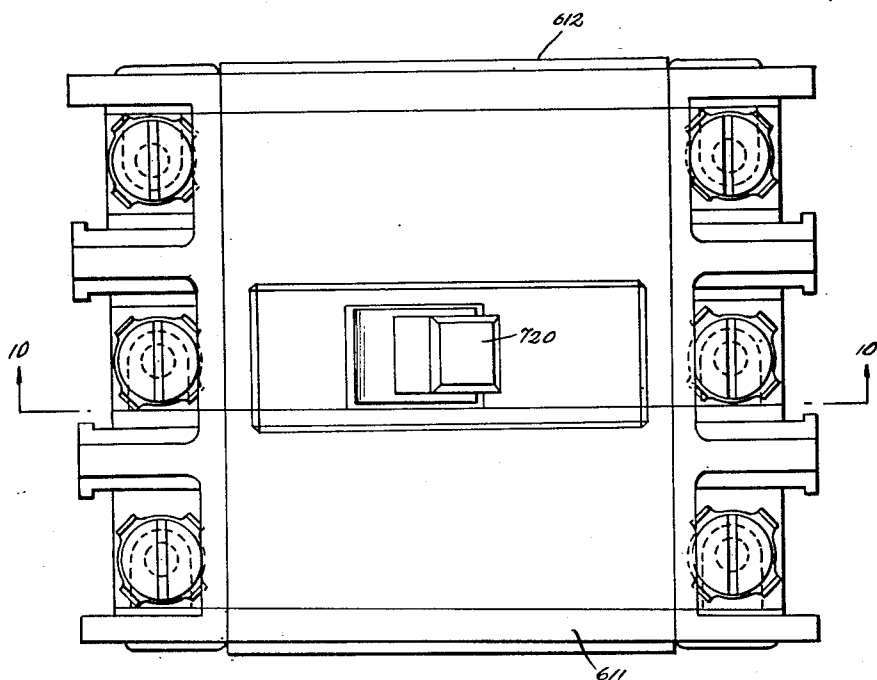


FIG. 9.

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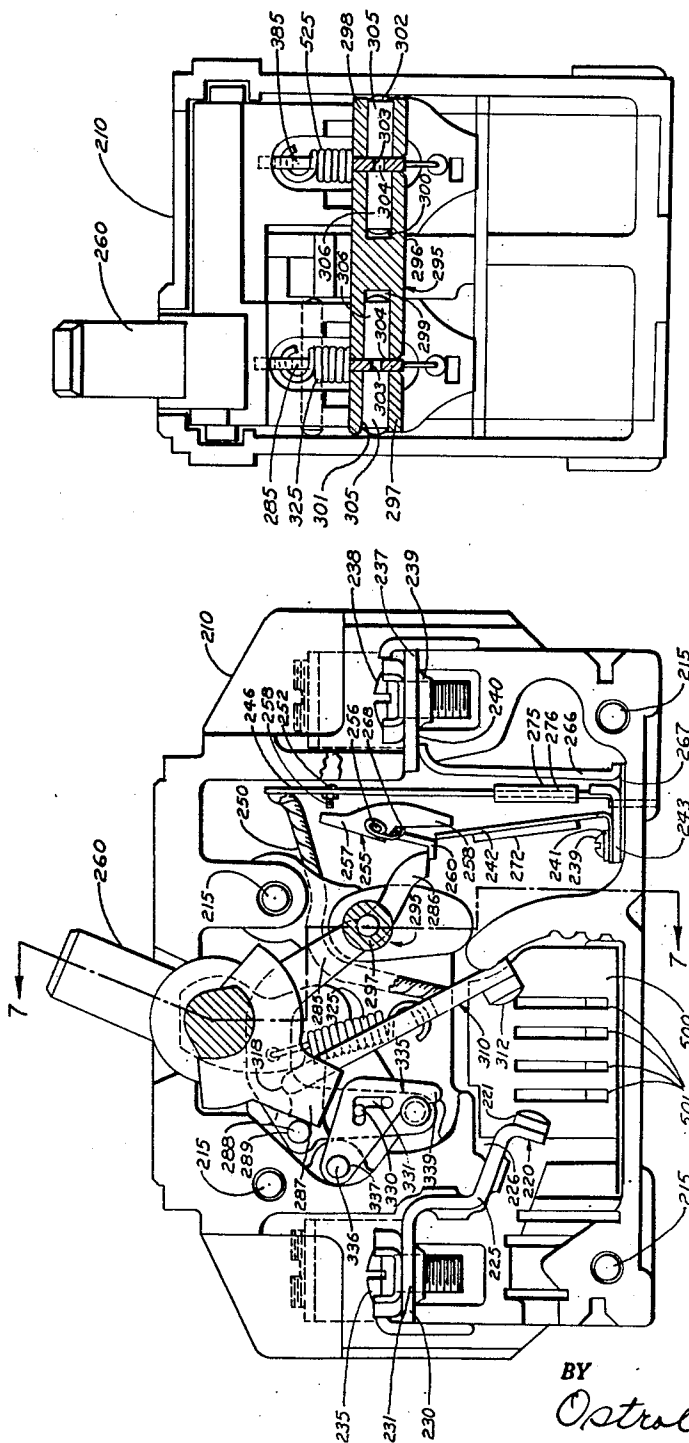


FIG. 7

FIG. 6

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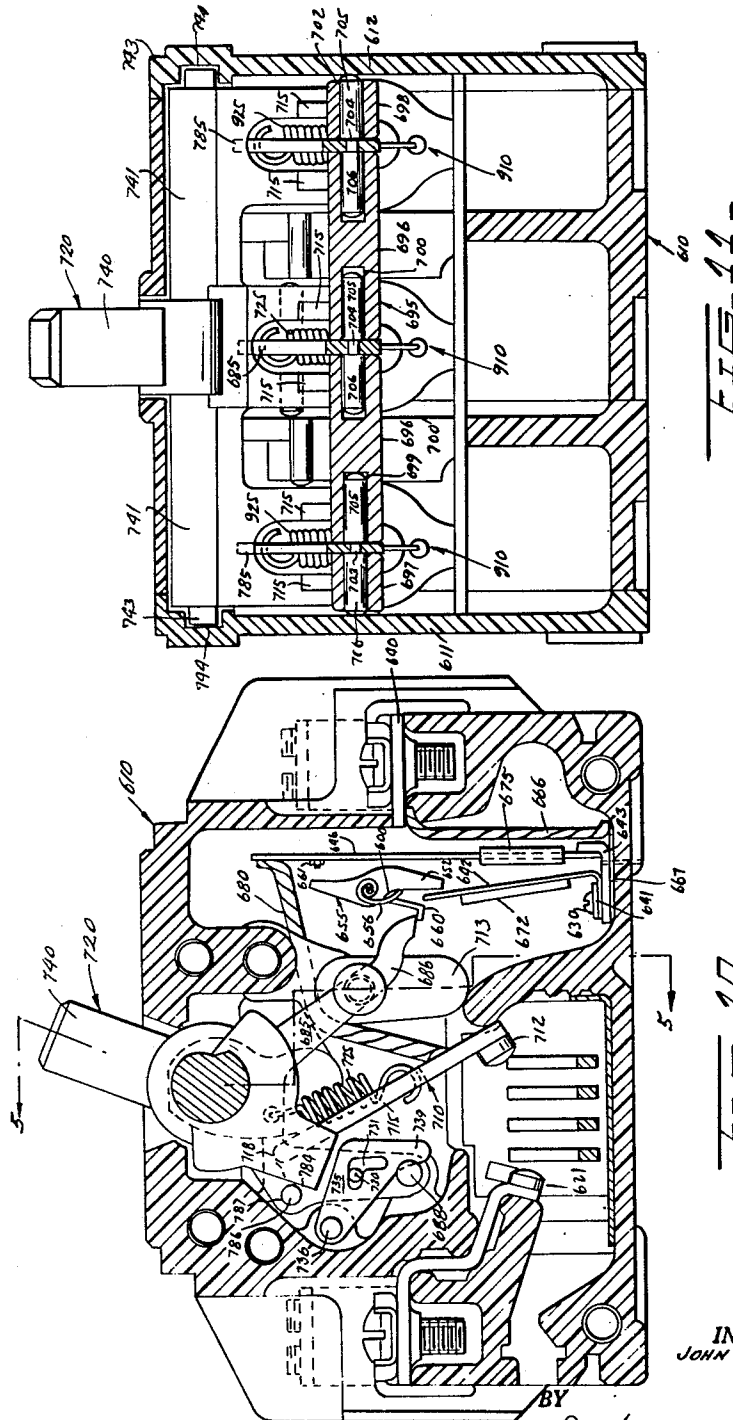
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TRIP MECHANISM OF CIRCUIT BREAKERS

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,678,359

TRIP MECHANISM OF CIRCUIT BREAKERS

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Application January 15, 1952, Serial No. 266,460

14 Claims. (Cl. 200—88)

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My present invention relates to a circuit breaker and more particularly relates to the instantaneous trip mechanism of a circuit breaker.

As is well-known in the art, circuit breakers used for protecting lighting circuits are usually provided with an automatic tripping device consisting of a thermally responsive member and a magnetic member where the thermally responsive member becomes operative to open the circuit breaker for values of fault currents below a certain maximum while the magnet becomes operative for any value of fault current above the previously mentioned maximum.

In other words, the magnetic member will protect the thermally responsive member from very large current that might permanently injure the thermally responsive metal.

Until now, however, the device used was rather clumsy and occupied a considerable portion of the circuit breaker housing.

My novel invention overcomes these difficulties and consists essentially of a latching device that becomes operable to open the circuit breaker when a fault current operates through the thermally responsive member or the magnetic member.

More specifically, my present invention consists of a thermally responsive metallic strip rigidly secured at one end of the housing of the circuit breaker and connected to the other end through a pigtail to the movable contact of the circuit breaker.

Secured on the thermally responsive member is a V-shaped spring carrying a latch surface. To the housing of the circuit breaker is also secured a leaf spring carrying the armature of a magnet, the magnet itself being also secured to the thermally responsive metallic member.

When a fault current flows in the circuit breaker circuit, and this current is below a certain maximum, the thermally responsive member will bend in one direction to unlatch a cradle which causes the contacts of the circuit breaker to open.

If the fault current passing through the circuit breaker circuit is greater than the above-mentioned maximum value, the magnet becomes operative and pulls toward itself the armature supported by the leaf spring. The tip of the leaf spring will then strike one end of the latching surface, thus releasing the cradle and opening the circuit breaker contacts.

For a value of fault current greater than a certain maximum value, the magnet will operate before the bimetal has had time to bend, thus

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protecting the thermally responsive member from dangerous fault currents.

In my invention as previously mentioned, the latch is directly carried by the bimetal while the armature of the magnet is mounted on a separate flat spring.

The main object of my present invention is the provision of means whereby a circuit breaker is automatically opened by a thermally responsive member or by a magnet depending on the magnitude of the fault current flowing through the circuit breaker.

Another object of my present invention is an instantaneous tripping device for circuit breakers that affords a considerable saving in space.

A further object of my present invention is an instantaneous tripping device that can be easily and inexpensively produced.

The foregoing and many other objects of my invention will become apparent from the following description and drawings in which:

Figure 1 is a top view of my novel circuit breaker.

Figure 2 is a sectional view of the circuit breaker of Figure 1 taken on line 2—2 looking in the direction of the arrows.

Figure 3 is another sectional view of the circuit breaker of Figure 1 showing the circuit breaker in its closed position.

Figure 4 is another sectional view of the circuit breaker of Figure 1 showing the circuit breaker in its tripped open position.

Figure 5 is a front view of the two-pole embodiment of my novel circuit breaker.

Figure 6 is a sectional view of the circuit breaker of Figure 5 taken on line 6—6 looking in the direction of the arrows.

Figure 7 is a sectional view of the circuit breaker of Figure 6 taken on line 7—7 looking in the direction of the arrows.

Figure 8 is another sectional view of the circuit breaker of Figure 5 taken on line 8—8 looking in the direction of the arrows.

Figure 9 is a front view of the three-pole embodiment of my novel circuit breaker.

Figure 10 is a sectional view of the circuit breaker of Figure 9 taken on line 10—10 looking in the direction of the arrows.

Figure 11 is a sectional view of the circuit breaker of Figure 10 taken on line 11—11 looking in the direction of the arrows.

Referring first to Figures 1 and 2 showing a single pole embodiment of my invention, the housing 10 is a shallow box, preferably a plastic insulating molding, having a cover plate 11 which

can be secured to housing 10 by any suitable means, for example, bolts and nuts placed in the appropriate aligned openings 12 of the housing 10 and cover plate 11.

The stationary contact assembly 15 consists of a contact button 16 welded to one bent end 17 of a conducting member 18. Member 18 is slidably mounted in housing 10; that is, it can be slid in and out of housing 10 when cover plate 11 is removed. The other end 20 of conducting member 18 has a center opening 21 threaded inside to be engaged by a terminal screw 22 which serves to secure the wire (not shown) to one terminal 20 of the circuit breaker. The other terminal 25 of the circuit breaker is similarly provided with a screw 26 engaging a contact member 28 and securing the other wire (not shown) to this second terminal 25.

Contact member 28 of rectangular cross-section is secured to housing 10 in any suitable manner. One end of terminal member 28 has the terminal screw 26 as previously described, while to the other end 32 is soldered a flexible conductor 33. Flexible conductor 33 serves to connect terminal member 28 to the fault current responsive member generally indicated by numeral 34. More specifically, flexible conductor or pigtail 33 is soldered to thermally responsive member 35. Support 37 is secured to housing 10 by means of a rivet 38 or by any other suitable means. To support 37 is also secured through screw 39 and washer 41 a flat leaf spring 42 and a metallic angle member 43. To one end of angle 43 is rigidly secured a thermally responsive member 35. To the farthest end of member 35 is soldered a flexible conductor or pigtail 40 which connects thermally responsive member 35 to movable contact member 50 to which it is soldered.

Contact member 50 has the shape of a U or that of a tuning fork and has an extension 51 at the bottom of the U which carries brazed to it a contact 55 engageable in the circuit breaker closed position with stationary contact 16.

Each extension 56 of U-shaped member 50 engages a groove or notch 58 of molded plastic handle 60. Handle 60 is provided with two co-axial laterally extending trunnions 65, one of which engages an appropriate opening (not shown) in housing 10 and the other engages another appropriate opening (not shown) in cover plate 11, thus rendering the handle 60 movable in opposite directions in opening 66 of housing 10.

An overload responsive member 70 approximately hook-shaped has an opening at one end 71. Opening 71 is aligned with an opening (not shown) in boss 72 which is part of molding 10. A pin 75 engages both openings 71 of overload responsive member 70 and the opening in boss 72 of housing 10.

The other end 77 of overload responsive member or cradle 70 engages normally a latch 80 rigidly secured through a V-shaped spring 81 to the thermally responsive member 35.

To the same thermally responsive member 35 is secured the overload responsive magnet 90 which consists of the rectangular piece of metal with a central recess 91 to receive thermally responsive member 35 to which it is secured by any suitable means.

Armature 85 of magnet 90 is secured on the flat leaf spring 42 so that when magnet 90 becomes sufficiently energized, it will pull to itself armature 85 and with it leaf spring 42 so that extension 44 of leaf spring 42 will at a certain time

bear against latch surface 80 freeing cradle 70 from latch 80.

It is quite evident that the action of the leaf spring 42 in freeing cradle 70 will be made against the biasing action of V-shaped spring 81 so that at the end of such fault current operation of the fault current responsive member, latch surface 80 will return to its original position.

Between opening 71 and end 77 of hook-shaped member 70 is another opening 95. An over center tension spring 100 placed between legs 56 of U-shaped member 50 engages on one side an opening 101 at the apex of U-shaped member 50 and on the other side opening 95 of overload responsive member 70.

Between openings 71 and 95 is a third opening 105 which receives a reset rod 110. Overload responsive member 70 has also rigidly secured to it rod 115 engageable with slot 120 of a contact kicker member 125. Contact kicker member 125 pivoted at one end by means of pin 126 engaging an appropriate recess 127 in molding 10 is provided in the center with the angularly shaped slot 120 and at the other end with an extension 129 whose function, as hereinafter described, is to assist the initial opening movement of the movable contact 50 during opening operation caused by a fault current.

In other words, the kicker 125 kicks the movable contact 55 away from stationary contact 16 after the over center spring 100 has been moved over center during automatic opening, thus preventing contacts 55 and 16 from sticking to each other.

An arc chute 130 consisting of conducting U-shaped plates 131 is placed in the path of operation of moveable contact 55 to extinguish the arc developed during the opening operation of the circuit breaker.

Referring now to Figure 3 showing the circuit breaker of my invention in the closed position, the over center spring 100 is on one side of contact member 50 and more precisely for this embodiment, the over center spring 100 is at the left of contact member 50, thus biasing contact 55 against stationary contact 16.

When a fault current flows in the circuit protected by the circuit breaker and its magnitude is below a certain predetermined maximum, the thermally responsive member 35 will become sufficiently heated and sufficiently bent in the direction away from cradle 70 to disengage end 77 of cradle 70 from latch 80 so that U-shaped cradle 70 will rotate around pivot pin 75.

Rotation of hook-shaped member 70 will bring the over center spring to the other side of contact member 50 passing through a position of unstable equilibrium on which the longitudinal axis of contact arm 50 and of spring 100 are substantially parallel and extend through the groove or notch 58, thus biasing contact member 50 away from stationary contact 16 and providing a snap opening of contacts 55 and 16. Rotation of hook-shaped member 70 during an opening caused by overload produces a movement of contact kicking member 125 around the pivot pin 126 through motion of rod 115 of member 70 in slot 120 of contact kicking member 125. This movement occurs just after spring 100 has been moved over center.

During its motion, contact kicking member 125 hits with its extension 129 one leg of U-shaped contact member 50, thus prying the contacts 55 and 16 open and providing an additional snap

action during the opening movement of contacts 16 and 55 produced by a fault current.

When the fault current is larger than a certain maximum, instead magnet 99 due to the current flowing through thermally responsive member 35 will become sufficiently magnetized to pull its armature 35 toward itself and, therefore, as previously explained freeing extension 77 of hook-shaped member 70 from latch 80. The movements following this disengagement are the same as those described above in connection with thermally responsive member 35.

When opened by fault current, the circuit breaker parts will be positioned as shown in Figure 4. Handle 60 will be positioned in the neutral position while spring 100 will bias contact member 56 toward hook-shaped member 70, but contact member 56 and extension 77 will remain separated by boss 140 of molding 10.

The closing operation consists of two steps from the position shown in Figure 4. Extensions 141 carrying grooves 58 engage reset rod 110 and move rod 110 and, therefore, also member 70 in the direction opposite to that followed by member 70 during the opening operation. When handle 60 is in the full open or "off" position, extension 77 of member 70 will have engaged latch 80 and the position of the various parts of the circuit breaker will be that shown in Figure 1.

To close the circuit breaker, it is now only necessary to move handle 60 to the closed or "on" position. During this motion of handle 60, extensions 56 of contact member 50 rotate in grooves 58 of plastic handle 60, thus moving contact member 50 first against the bias of over center spring 100 which is now on the right side of contact 50 (see Figure 2).

If this motion is continued, a position for contact member 50 will be reached in which contact member 50 will be slightly to the left of over center spring 100. At this time spring 100 will bias contact member 50 toward stationary contact 16, thus providing a "quick make" action during the closing of contacts 55 and 16.

If the fault still persists while the operator is closing the circuit breaker and has his hand on the operating handle 60, the automatic opening mechanism made operable again by the above-described movement of handle 60 in the full open position will operate and will allow U-shaped member 70 to rotate around its pivot 75, thus causing, as above-described, the separation of contact 55 from contact 16.

When, on the other hand, the circuit breaker is to be opened manually since member 70 does not move during manual opening of the circuit breaker, no contact kicking action is provided in addition to the snap action of spring 100.

More specifically, as the operator moves the handle 60 from full closed to full open position, in Figure 3 from left to right, extensions 56 of U-shaped contact member 50 rotate in grooves 58 of handle 60, thus moving the contact member extensions 56 toward the left in the embodiment shown with respect to spring 100. The opening of contacts 55 and 16 occurs only when extensions 56 are actually at the left of spring 100, that is, when spring 100 is over center to the right of extensions 56 and, therefore, capable of imparting a snap action to contact member 50.

Contrary to what happens in the older types of circuit breakers, when the circuit breaker mechanisms are in the position of Figure 4, contacts 55 and 16 are not pried apart because neither boss 72 nor section of member 70 around pin

75 acts now as a fulcrum during the initial leftward movement of both contact member extensions 56 and spring 100.

As above-mentioned, no initial opening of contacts 55 and 16 will occur when my invention is used with the result that contacts 55 and 16 will not be damaged by a prolonged arc.

As previously mentioned, in older types of circuit breakers, butt type contact engagements were obtained between movable and stationary contacts. This type of contact is undesirable in that no contact sliding can occur between the contact surfaces of contacts 55 and 16 with the result that these contact surfaces never wipe each other clean.

This shortcoming is overcome in my invention by placing contact 16 at end 17 of member 18 away from molding 10 as shown in Figure 4 so that when contacts 50 and 16 either come in contact or go out of contact, they always wipe their contact surfaces one against the other, producing the necessary cleaning of the two contact surfaces.

In fact, when handle 60 is moved from the full closed to the full open position, that is, from the position shown in Figure 2 to the position shown in Figure 1, contact arm 50 slides initially in the longitudinal direction with respect to its axis or radial with respect to the center of rotation of contact arm 50 if contact 16 makes a certain angle with surface 19 of molding 10.

This initial sliding movement of contact arm 50 permits wiping of moveable contact 55 and stationary contact 16.

To summarize the above, since circuit breakers for lighting circuits must be very small and inexpensive, their moveable contact arm 50 is pivoted to and moveable by handle 60. A hook-shaped cradle 70 in a toggle mounting is latched by latch 80 so that a spring 100 secured at one end of cradle opening 95 and on the other end to opening 101 of moveable contact arm 50 is on one side of the moveable contact arm 50 biasing it open when contacts 55 and 16 are not in contact and biasing the contact arm 50 closed when the contacts 55 and 16 are in contact, this being achieved as above-described by a toggle operation.

In order to move spring 100 over center by movement of cradle 70, cradle 70 had to be extended into the path of spring 100 and had to be pivoted around pin 75 engaging opening 71 in boss 72 of housing 10 away from handle 60 or better away from fulcrum 58 of handle 60 so that it acted in older embodiments as a fulcrum spring 100 and moveable contact arm 50 and tended to prevent quick break action during manual opening.

In the circuit breaker of my invention, as previously described, quick break action is present not only when the circuit breaker is automatically opened but also when the circuit breaker is manually opened. This improvement is obtained by so shaping cradle 70 and boss 72 of molding 10 that a clearance is always present between spring 100 on one side and cradle 70 and boss 72 on the other.

Referring now to Figures 5, 6 and 7 showing a two-pole circuit breaker in the open position, housing 210 is a shallow box, preferably a plastic insulating molding, having two cover plates 211 and 212, one on each side of housing 210. Cover plates 211 and 212 can be secured to housing 210 in any suitable way, for example, by means of bolts and nuts engaging openings 215 in housing

210 and cover plates 211 and 212, or rivets engaging the same opening 215.

Referring now to the phase of this circuit breaker having the manual operating means as shown in Figure 6, stationary contact assembly 220 consists of a contact button 221, welded or in any other appropriate way secured to the bent end of a conducting member 225. Member 225 with contact button 221 is slidably mounted in an appropriately shaped recess 226 of molding 210, that is, member 225 can be slid in place in housing 210 when cover plate 211 is removed. The other end 230 of conducting member 225 has a central opening 231 threaded inside and engageable by a screw 235. The line terminal of one phase (not shown) can be secured to the circuit breaker by means of screw 235 and extension 230 of contact member 225. The load terminal of the same phase is secured to the circuit breaker at terminal 237. Terminal 237 consists of a screw 238 engaging an opening 239 in conducting member 240. Conducting member 240 is soldered to a flexible conductor or shunt 266. The other end of pigtail 266 is soldered to metallic support 267. Metallic support 267 is secured by any appropriate means, for example, by a screw or a rivet, to housing 210.

To support 267 are secured by means of screw 239 and washer 241 a flat leaf spring 242 and a metallic angle member 243. A thermally responsive member 246 is rigidly connected to one end of angle 243. At the farthest end of thermally responsive member 246 is soldered a pigtail 250. At the same end of thermally responsive member 246 is a regulating screw 252.

A tripper bar 255 is provided on each end with a trunnion 256 which are engaged by covers 211 and 212 of the circuit breaker. Tripper bar 255 is rotatable around trunnions 256 and is so shaped that its two extensions 257 and 258, of which extension 257 can be engaged by the end 258A of screw 252 while extension 258 can be engaged by leaf spring 242 to rotate tripper bar 255 in a counterclockwise direction as seen in Figure 6.

To tripper bar 255 is rigidly secured a latch member 260 which serves to latch end 286 of cradle 285. An armature 272 is secured in any suitable way to the flat leaf spring 242. Armature 272 is the moveable part of the fault current responsive magnet 275 which consists of the rectangular piece of metal with a central recess 276 to receive thermally responsive member 246 to which it is secured in any suitable way. Tripper bar 255 is also provided at one end with a coil spring 268 which bears on one side against extension 258 of tripper bar 255 and on the other side against an appropriate extension (not shown) of housing 210, coil spring 268 serves to return tripper bar 255 to its original position after it has been operated by either flat leaf spring 242 or thermally responsive member 246.

Thermally responsive member 246 and magnet 275 as is quite evident are designed to operate at different values of fault currents.

For example, when a fault current is relatively small, the thermally responsive member 246 will operate to open the circuit breaker as hereinafter described. If, on the other hand, the fault current is relatively high, magnet 275 will come into operation before thermally responsive member 246 and open the circuit breaker. This is important in that by this means thermally responsive member 246 is protected against very heavy

currents which could permanently distort and damage bimetallic member 246.

Latch member 260 carried by tripper bar 255 engages a hook-shaped cradle 285 and more precisely latch 260 engages one end 286 of cradle 285. Cradle 285 is pivoted on the other end 287 by means of a pin 288 engaging an opening 289 in cradle 285 in a lined opening 290 in a boss 291 of molding 210.

The tripper bar 255 is made of insulating material and is common to the two phases of the circuit breaker. In other words, tripper bar 255 extends from the phase of the circuit breaker now under consideration to the second phase of the same circuit breaker as hereinafter described.

It was previously mentioned that screw 252 is used to adjust the tripping time of each pole of the circuit breaker. In fact, the distance between the end 258A of screw 252 and extension 257 of tripper bar 255 terminates at what time, that is, at what value of fault current the tripper bar will be hit by end 258A of screw 252 to release cradle 285 from latch 260.

It is quite evident that by decreasing the distance between end 258A of screw 252 and extension 257 of tripper bar 255 the fault current opening of the circuit breaker will occur for relatively low values of fault current, while increasing the distance between end 258 of screw 252 and extension 257 of tripper bar 255, the fault current at which the circuit breaker will open will be considerably larger than in the previously mentioned case.

Screw 252 is adjusted by means of a screw driver inserted through a hole 293 in molding 210. After adjustment, hole 293 is sealed with porcelain or other insulating compound.

Referring now to Figures 6, 7, and 8, cradle 285 of the first phase moves together with cradle 385 of the second phase since the two cradles 285 and 385 are connected together by an insulating tie bar 295. Tie bar 295 actually consists of a center insulating sleeve 296 and two lateral insulating sleeves 297 and 298. Central sleeve 296, cylindrical in shape, has two recesses 299 and 300, one at each end of cylinder 296. Lateral sleeves 297 and 298 instead have an axial or longitudinal opening 301 and 302, respectively.

Cradles 285 and 385 both have an opening 303 near the ends 286 and 386, respectively. Each opening 303 is engaged by the cylindrical extension 304 of a cylindrical pin 305. A metallic hollow cylinder 306 is slid on the extension 304 and riveted there. Thus, cradles 285 and 385 are clamped to pins 305 and will move with pins 305. Sleeves 298 and 297 are placed around pins 305, while sleeve 296 is placed around the hollow cylinders 306, thus completely insulating one phase from the other and making at the same time a mechanism strong enough to resist damage produced by repeated opening or closing operations.

Pin 305 on cradle 285, in the case of the two-pole circuit breaker, has for its purpose in conjunction with resetting pin 356, the aligning of cradle 285. The cradle 285 is, therefore, positioned on one side by pin 305 bearing against cover 211 and on the other side by the shouldered resetting pin 356. This construction makes the cradle assembly between the poles more rigid and compensates for the unequal loading on the left cradle 285 by the load on the right cradle 385.

Pigtail 250 connected on one side to thermally responsive member 246 is connected on the other side to moveable contact arm 310. Moveable contact arm 310 is approximately U-shaped or is

shaped like a tuning fork, the lowest part 311 of moveable contact member 310 carrying an electrical contact 312. The two extensions 315 of contact arm 310 can rotate in groove 318 of handle molding 320. An over center tension spring 325 is connected on one side to moveable contact arm 310 through an opening 326 in contact arm 310 and on the other side to cradle 285 through an opening 327 in cradle 285. Cradle 285 is further provided with a pin 330 which engages a slot 331 of a contact kicking member 335. Contact kicking member 335 is pivoted around pin 336 which engages an opening 337 in contact kicking member 335 and an aligned opening, not shown, in molding 210. Contact kicking member 335 is provided with an extension 339 at the end of the contact kicking member 335 opposite that at which it is pivoted.

The function of the contact kicking member 335 is to assist the initial opening operation caused by a fault current; more specifically, it provides a means for kicking the moveable contact away from the complementary contact when the spring has been moved over center during automatic opening. In other words, kicker 335 prevents contact 312 from sticking to the stationary contact 221 at fault currents, thus preventing welding of the contacts.

Manual operating handle molding 320 operates simultaneously both contacts of the two phase circuit breaker under consideration. It has, therefore, a single handle 340 with an integral axially extending member 341. This axial member 341 has two pins 342 and 343, one on each side of axial member 341, both integral parts of molding 320. Axial member 341 has two pairs of fulcri 318 and 350 of which, as previously explained, fulcrum 318 is for moveable contact member 310, while a similar fulcrum (see Figure 8) is for moveable contact member 510 of the second phase of the two-phase circuit breaker under consideration. Molding 320 is also provided with two extensions 354, one on each side of fulcrum 318 operable to engage a reset pin 356 carried by cradle 285 in an appropriate opening 357 located between pin 330 and spring opening 327 in cradle 285.

Referring now more specifically to the second phase fault current responsive means (see Figure 8), it is there seen that it consists of a thermally responsive member 446 soldered to a metallic angle 443 which is secured together with the leaf spring 442 to support 467 by means of screw 439 and washer 441. Support 467 is secured to housing 210 in any suitable way. Thermally responsive member 446 is provided at the end farthest from support 467 with a regulating bolt 452 engaging a nut 265.

A pigtail 446 connects support 467 to terminal conducting member 440. A second pigtail 450 connects thermally responsive member 446 to moveable contact member 510.

As previously mentioned, tripper bar 255 extends into the second phase of the two-pole circuit breaker, but in this second phase which is shown in Figure 8, the tripper bar is not provided with a latch similar to latch 260 which was provided in the first phase. The second phase cradle 385, therefore, is not latched but will operate simultaneously with cradle 285 since the two cradles 285 and 385 are rigidly connected together by means of tie bar 295.

An armature 472 is secured to the flat leaf spring 242 and its magnet 475 is secured to the thermally responsive member 446. When a fault

occurs in the second phase, either thermally responsive member 446 or magnet 475 will operate, thus rotating tripper bar 255 around its trunnions 256 in such a direction as to unlatch cradle 285 from latch 284 of the first phase, but since cradle 385 of the second phase moves together with cradle 285 of the first phase as previously described, cradle 385 will rotate together with cradle 285 around its pivot pin 536.

This movement around the pivot point 536 will carry spring 525 of the second phase to the left as shown in Figure 8 of movable contact arm 510, thus opening the electrical contact between movable contact 512 and stationary contact 421.

The second phase is also provided with a contact kicking assembly 535 which operates in the same manner as the contact kicking assembly 335 of the first phase.

Each phase is further provided with an arc extinguishing chamber 500 having a plurality of conducting arc extinguishing plates 501. One of the two chambers 500 is located between the stationary contact 221 and movable contact 312, while the other chamber 500 of the second phase is located between the corresponding contacts 421 and 512 of the second phase. As above mentioned, all the other parts of this second phase are the same as those used in the first phase.

When the two circuits protected by this two-phase circuit breaker are to be closed, handle 340 is rotated from right to left of Figure 1. When handle 340 is rotated in this direction, the two contact arms 310 and 510 rotate around fulcri 318 and 350, respectively, to engage their stationary contacts 221 for the first phase and 421 for the second phase. The closing movement is actually a snap action movement in that the two contact arms 310 and 510 will move to close the two phases only after springs 325 and 525, respectively, have gone over center with respect to contact arms 310 and 510, thus biasing the two contact arms 310 and 510 against their respective stationary contacts 221 for the first phase and 421 for the second phase. Since the two contact arms 310 and 510 are biased toward the stationary contacts 221 in one phase and 421 in the other phase, the two contacts 310 and 510 will snap closed at a relatively high speed, thus preventing an arc from being formed or better from being prolonged between movable contacts 312 and 512 on one side and stationary contacts 221 and 421. When a fault current of a certain magnitude develops in one of the circuits, protected by this two phase circuit breaker, and for example, when a fault current develops in the first phase of a circuit breaker, depending on the magnitude of this fault current, either the thermally responsive member 246 or the magnet 275 will operate and will move with leaf spring 242 against extension 258 of tripper bar 255 to release latch 260 from engagement with extension 286 of cradle 285.

Cradle 285 is now free to rotate around its pivot pin 336 bringing with it during its rotation spring 325 until spring 325 is at the right of contact member 310. When spring 325 is at the right of contact member 310, contact member 310 is biased away from stationary contact 221 and will, therefore, break the electrical contact between movable contact 312 and stationary contact 221. At the same time that spring 325 moved by cradle 285 goes over center, pin 330 also moved by cradle 285 slides from one dimension in slot 331 to the other dimension

of slot 331 of contact kicking member 335, thus rotating contact kicking member 335 around its pivot 336 to kick the contact arm 310 and prevent the sticking of contact 312 to 221.

The action of spring 325 provides an excellent quick-break action and, therefore, the arc between contacts 312 and 221 will last for a very small interval of time. Since the second phase cradle 385 is connected by means of tie bar 295 to the first phase, the movement of cradle 285 to open contacts 312 and 221 is accompanied by a similar movement of cradle 385 of the second phase to open the corresponding second phase contacts 512 and 421, and the opening operation of the second phase contacts 512 and 421 and the opening operation of the second phase will be exactly the same as the one described above in connection with the first phase.

If, on the other hand, a fault current is developed in the second phase of the circuits protected by this circuit breaker, the second phase thermally responsive member 446 or the second phase magnet 475 will move tripper bar 255 in such a direction as to produce unlatching between latch 260 and extension 286 of cradle 285, that is, a fault current in the second circuit will operate a fault current responsive device in the second phase which by means of common tripper bar 255 will free cradle 285 of the first phase from engagement with latch 260.

As above described, when cradle 285 moves to open contacts 312 and 221, a similar action is produced for the second phase since the two cradles 285 and 385 of the first and second phase, respectively, are tied together by the tie bar 295. By this means dangerous single phasing is avoided, that is, at no time when a fault occurs will only one of the two circuits remain closed. A fault in any of these two circuits will produce immediate opening of both circuits. As for its manual opening operation, a movement of handle 340 from the left to the right, Figure 6, will produce movements of spring 325, spring 525, contact arm 310 and contact arm 510 similar but in opposite directions to those described in connection with the closing procedure of this circuit breaker.

It must be underlined that when the circuit breaker is manually opened, a quick-break action is also obtained in that at no time will spring 325 rotate around a fulcrum produced by cradle 285 and boss 295 of housing 210, but a clearance will always be present between spring 325 on one side and cradle 285 and boss 291 on the other. A similar situation exists for the respective elements of the second phase of the circuit breaker.

Referring finally to Figures 9, 10 and 11 showing the three-pole embodiment of my present invention, all parts for each of the three phases are the same as those described for the two-pole circuit breaker except for the elements common to all three poles.

In fact, handle molding 720 consists of a handle 740 and in a direction perpendicular to said handle 740 two extensions 741 similarly shaped, one on each side of handle 740. At the ends of these extensions 741 are two cylindrical extensions 743 which by engaging appropriate openings 744 of cover plates 611 and 612 makes possible the rotational movement of molding 720 around cylindrical extensions 743. Members 741 actually constitute a single piece having three pairs of grooves 718 in which arms 715 of movable contact arms 710 can rotate.

The central phase in the three-pole circuit breaker corresponds to the first phase of the two-pole circuit breaker above described in that it is the only phase provided with a latch 660 for its cradle 685.

The center phase as also described in connection with the first phase of the two-pole circuit breaker is the only phase that has a latch 680, the other phases being provided with thermally responsive members but not with latches for their cradles.

More specifically, the center phase of the three-pole circuit breaker is provided with a thermally responsive member 646 rigidly supported by a metallic angle 643 which is secured together with a flat leaf spring 642 to a metallic support 667 by means of a screw 639 and a washer 641.

At the end of the thermally responsive member that is farthest from support 667 is a regulating bolt 652 which engages a nut 661. A pigtail 666 connects support 667 to terminal contact member 640. A second pigtail 650 connects the thermally responsive member 646 to the moveable contact arm 710. An armature 672 is secured to flat leaf spring 642 and is located opposite to a magnet 675 rigidly secured to thermally responsive member 646.

An insulating tripper bar 655 which extends through all phases of the three-pole circuit breaker is provided at the center phase with a latch 660 for latching the center phase cradle 685.

In other words, the other two phases of the three-pole circuit breaker do not have a latch similar to latch 660.

Tripper bar 655 can rotate around its trunnions 656. Trunnions (not shown) similar to 656, located at the end of the tripper bar 655, engage appropriate openings in the cover plates 611 and 612 of the three-pole circuit breaker. Tripper bar 655 is also provided at one end with a coil spring 668 which bears on one side against extension 658 of tripper bar 655 and on the other side against an appropriate indentation of housing 610.

Coil spring 668 serves to return tripper bar 655 to its original position after it has been operated either by flat leaf spring 642 or by thermally responsive member 646.

As previously mentioned, tripper bar 655 extends through opening in phase separating walls (not shown) of molding 610 into the two lateral phases.

Tripper bar 655 extends sufficiently so that any one of the two flat leaf springs 642 or any other screw 652 can engage tripper bar 655 to unlatch the central phase latch 660 from engagement with the center cradle 685.

Central cradle 685 now free from engagement with latch 680 will rotate around its pivot 688. Rotation of central cradle 685 around pivot 688 will produce similar rotations in the other two cradles 785 since all cradles are connected for simultaneous movement by tie bar 695.

Tie bar 695 extending through openings 713 of phase separating walls 660 into the two other phases actually consists of two center insulating sleeves 696 and two lateral insulating sleeves 697 and 698. Central sleeves 696, cylindrical in shape, have two recesses 699 and 700 one on each end of insulating cylinders 696. Lateral sleeves 697 and 698 instead have axial or longitudinal openings 701 and 702, respectively.

Cradles 685 and 785 all have an opening 703 near the ends 686 and 786, respectively. Each

opening 703 is engaged by a reduced diameter portion 704 of a cylindrical pin 705. A metallic hollow cylinder 706 is slid on the extension 704 and riveted there. Thus, cradles 685 and 785 are clamped to pins 705 and will move with pins 705.

Sleeves 697 and 698 are placed around hollow cylinders 709 of the first phase (left phase in Figure 11), and pin 705 of the third phase (right phase in Figure 11). Each sleeve 696, on the other hand, is placed on the hollow cylinder 706 of one cradle, as for example, cradle 685 and on the pin 705 of the adjoining cradle, as for example, cradle 785 of the right phase. It may also be said that pin 705 and hollow cylinder 706 are one riveted assembly which provides projection for mounting sleeves 696, 697 and 698.

Sleeves 697 and 698 serve also to position and retain the current carrying braid 650.

The use of sleeves 696, 697 and 698 completely insulates one phase from the others and makes the mechanism strong enough to resist damage produced by repeated opening or closing operations. Sleeves 697 and 698 and pins 705 are kept in place by the two cover plates 611 and 612, one on each side of the three-pole circuit breaker.

As above mentioned, rotation of central cradle 685 produces, through the bar 695, similar rotations in the other two cradles 785.

Rotation of cradles 685 and 785 brings the springs 725 and 925 of the center and lateral phases, respectively, over center with respect to the moveable contact arms 710 and 910, respectively, thus opening contacts 621 and 712 of the center phase, and also the contacts (not shown) of the other two phases.

At the same time, the three contact kicking member 735 pivoted around pin 736 and provided with an extension 739 are moved by cradles 685 and 785 through a pin 730 carried by cradles 685 and 785 and slots 731 in contact kicking member 735 to kick contact arms 710 and 910 after springs 725 and 925 have gone over center, thus prying the contacts open should they stick to each other.

For reclosing after an automatic opening, the center phase cradle 685 is provided with an opening 787 having a reset pin 786 so that extensions 784 of molding 720 can engage this reset pin 786 and move the cradle 685 back to the original position by rotation of the handle 740 to the full open position (shown in Figure 10). Since the cradles 685 and 785 are tied together through tie bar 695 also, the other two cradles 785 will return to their original position. If now the circuit breaker is manually closed by rotation of handle 740 from right to left (Figure 1), the circuit breaker is again ready to automatically open at fault currents.

When the circuit breaker is to be manually opened, handle 740 is moved from left to right (Figure 10). Movement of handle 740 produces rotation in cylindrical member 741 around its axis, with the consequent displacement of contact arms 710 and 910 with respect to springs 725 and 925, respectively, until springs 725 and 925 are over center. When springs 725 and 925 are over center, a force directed to the contact open position is produced on the contact arms 710 and 910, thus snapping the contacts 710 and 910 to the open position.

Here the cradles 685 and 785 are so shaped in the region directly facing springs 725 and 925, respectively, that a clearance exists at all times between springs 725 and 925 and that portion of

cradles 685 and 785 that faces springs 725 and 925, respectively. It is clear that at no time during the initial manual opening operation will springs 725 and 925 hit the portion of cradles 685 and 785 directly facing springs 725 and 925 to produce harmful prying of contacts before springs 725 and 925 become operative to move the movable contact arms 710 and 910 to the open position.

The closing operation is similar to the above described manual opening operation with all movements occurring in the opposite direction.

In the foregoing I have described my invention solely in connection with specific illustrative embodiments thereof. Since many variations and modifications of my invention will now be obvious to those skilled in the art, I prefer to be bound not by the specific disclosures herein contained but only by the appended claims.

I claim:

1. In a circuit breaker for opening with a trip action, a movable contact, a complementary contact, said movable contact having a circuit closed position in which it engages said fixed contact and a circuit open position in which said contacts are disengaged; a toggle comprising a pivotally mounted handle and said movable contact, a spring for biasing said toggle toward the collapsed positions, one of said collapsed positions corresponding to said closed circuit position of the circuit breaker, the other of said collapsed positions corresponding to said open circuit position of the circuit breaker, a U-shaped cradle mounted for rotation around the end of one of its legs, said spring engaging at one end the apex of said U-shaped cradle and at the other end said movable contact, a latch engaging the other leg of said U-shaped member under normal operating conditions, said latch disengaging said U-shaped member on fault currents, collapsing said toggle to open said contacts, thermal means and magnetic means responsive to fault currents, said latch being secured to said thermal means at relatively low values of fault currents, said latch being moved by said magnetic means at relatively high values of fault currents.

2. In a multi-pole circuit breaker for opening with a trip action, a plurality of movable contacts, a plurality of complementary contacts, said movable contacts having a circuit closed position in which they engage said fixed contacts and a circuit open position in which said contacts are disengaged; a plurality of toggles comprising a pivotally mounted handle and said movable contacts, a plurality of springs for biasing said toggles toward their collapsed positions, one of said collapsed positions corresponding to said closed circuit position, the other of said collapsed positions corresponding to said open circuit position, a plurality of U-shaped cradles mounted for rotation around the end of one of their legs, a tie bar, said tie bar securing the other legs of said U-shaped cradles together for simultaneous movement of said cradles, said springs engaging at one end said movable contacts and at the other end the apexes of said U-shaped cradles, a latch engaging one of said other legs of said U-shaped member in normal operating conditions, said latch disengaging said one other leg of said U-shaped members at fault currents, collapsing said toggles and therefore opening said contacts, a plurality of thermal means and magnetic means responsive to fault currents, a tripper bar common to all phases of said multi-pole

circuit breaker, said latch mounted on said tripper bar, said tripper bar being movable by said thermally responsive means and said magnetic means for rotation around its axis to disengage said latch from said U-shaped member to open said circuit breaker contacts, said magnetic means acting directly on said tripper bar.

3. Tripping mechanism for a single pole circuit breaker comprising a spring latch, said latch having an extending member, a thermally responsive means, said latch being mounted on said thermally responsive means and moveable with said thermally responsive means, a magnet and an armature, said magnet being mounted on said thermally responsive means, a spring member, said spring member being secured to said thermally responsive member and carrying said armature, said magnet attracting said armature, causing said spring member to engage said extending member and move simultaneously said latch at values of fault currents different from those at which the thermally responsive means operate to move said latch.

4. A tripping mechanism for multi-pole circuit breakers comprising a tripper bar having a latch and a plurality of radially extending members, a plurality of thermally responsive means extending each in front of one of said radial members and having at that extension a screw, said screw being moveable together with said thermally responsive means to engage said trip bar at fault currents, a plurality of magnets and an equal plurality of armatures, said magnets being mounted on said thermally responsive means, a plurality of spring members secured to said thermally responsive members and carrying each one of said armatures, one of said magnets attracting one of said armatures and causing the corresponding spring member to engage one of said radial extensions of said trip bar and to move therefore said latch in one direction at values of fault currents different from those at which the thermally responsive means operate to move said latch.

5. In a circuit breaker for opening with a trip action, a moveable contact, a complementary contact, said moveable contact having a circuit closed position in which it engages said fixed contact and a circuit open position in which said contacts are disengaged; a toggle comprising a pivotally mounted handle and said moveable contact, a spring for biasing said toggle toward the collapsed positions, one of said collapsed positions corresponding to said closed circuit position of the circuit breaker, the other of said collapsed positions corresponding to said open circuit position of the circuit breaker, a U-shaped cradle mounted for rotation around the end of one of its legs, said spring engaging at one end the apex of said U-shaped cradle and at the other end said moveable contact, a latch engaging the other leg of said U-shaped member under normal operating conditions, said latch disengaging said U-shaped member on fault currents, collapsing said toggle to open said contacts, said latch having an extending member, a thermally responsive means, said latch being mounted on said thermally responsive means and moveable with said thermally responsive means, a magnet and an armature, said magnet being mounted on said thermally responsive means, a spring member, said spring member being secured to said thermally responsive member and carrying said armature, said magnet attracting said armature, causing said spring member to engage said extending

member and move simultaneously said latch at values of fault currents different from those at which the thermally responsive means operate to move said latch.

6. In a multi-pole circuit breaker for opening with a trip action, a plurality of moveable contacts, a plurality of complementary contacts, said moveable contacts having a circuit closed position in which they engage said fixed contacts and a circuit open position in which said contacts are disengaged; a plurality of toggles comprising a pivotally mounted handle and said moveable contacts, a plurality of springs for biasing said toggles toward their collapsed positions, one of said collapsed positions corresponding to said closed circuit position, the other of said collapsed positions corresponding to said open circuit position, a plurality of U-shaped cradles mounted for rotation around the end of one of their legs, a tie bar, said tie bar securing the other legs of said U-shaped cradles together for simultaneous movement of said cradles, said springs engaging at one end said moveable contacts and at the other end the apexes of said U-shaped cradles, a latch engaging one of said other legs of said U-shaped member in normal operating conditions, said latch disengaging said one other leg of said U-shaped members at fault currents, collapsing said toggles and therefore opening said contacts, a tripper bar, said latch being mounted on said tripper bar, said tripper bar being a plurality of radially extending members, a plurality of thermally responsive means extending each in front of one of said radial member and having at that extension a screw, said screw being moveable together with said thermally responsive means to engage said trip bar at fault currents, a plurality of magnets and an equal plurality of armatures, said magnets being mounted on said thermally responsive means, a plurality of spring members secured to said thermally responsive members and carrying each one of said armatures, one of said magnets attracting one of said armatures and causing the corresponding spring member to engage one of said radial extensions of said trip bar and to move therefore said latch in one direction at values of fault currents different from those at which the thermally responsive means operate to move said latch.

7. In a circuit breaker for opening with a trip action, a moveable contact, a complementary contact, said moveable contact having a circuit closed position in which it engages said fixed contact and a circuit open position in which said contacts are disengaged; a toggle comprising a pivotally mounted handle and said moveable contact, a spring for biasing said toggle toward the collapsed positions, one of said collapsed positions corresponding to said closed circuit position of the circuit breaker, the other of said collapsed positions corresponding to said open circuit position of the circuit breaker, a U-shaped cradle mounted for rotation around the end of one of its legs, said spring engaging at one end the apex of said U-shaped cradle and at the other end said moveable contact, a latch engaging the other leg of said U-shaped member under normal operating conditions, said latch disengaging said U-shaped member on fault currents, collapsing said toggle to open said contacts, said latch having an extending member, a thermally responsive means, said latch being mounted on said thermally responsive means and moveable with said

thermally responsive means, a magnet and an armature, said magnet being mounted on said thermally responsive means, a spring member, said spring member being secured to said thermally responsive member and carrying said armature, said magnet attracting said armature, causing said spring member to engage said extending member and move simultaneously said latch at values of fault currents different from those at which the thermally responsive means operate to move said latch, a housing for enclosing said single-pole circuit breaker.

8. In a multi-pole circuit breaker for opening with a trip action, a plurality of moveable contacts, a plurality of complementary contacts, said moveable contacts having a circuit closed position in which they engage said fixed contacts and a circuit open position in which said contacts are disengaged; a plurality of toggles comprising a pivotally mounted handle and said moveable contacts, a plurality of springs for biasing said toggles toward their collapsed positions, corresponding to said closed circuit position, the other of said collapsed positions corresponding to said open circuit position, a plurality of U-shaped cradles mounted for rotation around the end of one of their legs, a tie bar, said tie bar securing the other legs of said U-shaped cradles together for simultaneous movement of said cradles, said springs engaging at one end said moveable contacts and at the other end the apexes of said U-shaped cradles, a latch engaging one of said other legs of said U-shaped member in normal operating conditions, said latch disengaging said one other leg of said U-shaped members at fault currents, collapsing said toggles and therefore opening said contacts, a tripper bar, said latch being mounted on said tripper bar, said tripper bar being a plurality of radially extending members, a plurality of thermally responsive means extending each in front of one of said radial member and having at that extension a screw, said screw being moveable together with said thermally responsive means to engage said trip bar at fault currents, a plurality of magnets and an equal plurality of armatures, said magnets being mounted on said thermally responsive means, a plurality of spring members secured to said thermally responsive members and carrying each one of said armatures, one of said magnets attracting one of said armatures and causing the corresponding spring member to engage one of said radial extensions of said trip bar and to move therefore said latch in one direction at values of fault currents different from those at which the thermally responsive means operate to move said latch, a housing for enclosing said multi-pole circuit breaker.

9. In a circuit breaker for opening with a trip action, a movable contact, a complementary contact, said movable contact having a circuit closed position in which it engages said fixed contact and a circuit open position in which said contacts are disengaged; a toggle comprising a pivotally mounted handle and said movable contact, a spring for biasing said toggle toward the collapsed positions, one of said collapsed positions corresponding to said closed circuit position of the circuit breaker, the other of said collapsed positions corresponding to said open circuit position of the circuit breaker, a U-shaped cradle mounted for rotation around the end of one of its legs, said spring engaging at one end the apex of said U-shaped cradle and at the other end said movable contact, a latch en-

gaging the other leg of said U-shaped member under normal operating conditions, said latch disengaging said U-shaped member on fault currents, collapsing said toggle to open said contacts, time delay means and instantaneous means responsive to fault current to effect disengagement of said latch; said latch resiliently secured to said time delay means and movable therewith; said time delay means having one end rigidly secured to said circuit breaker; said instantaneous time delay means effective to disengage said latch on the occurrence of relatively high values of fault current.

10. A tripping mechanism for a circuit breaker comprising a time delay and instantaneous means; a latch mounted on and secured to said time delay means and movable therewith; said instantaneous time delay means comprising a magnet and an armature; said magnet being mounted on said time delay means; said time delay means effective to move said latch at first predetermined values of current; said magnet attracting said armature; said armature effective to disengage said latch when attracted by said magnet due to the occurrence of a second predetermined magnitude of over current.

11. In a circuit breaker for opening with a trip action; a movable contact; a complementary contact; said movable contact having a circuit closed position in which it engages said fixed contact and a circuit open position in which said contacts are disengaged; a toggle comprising a pivotally mounted handle and said movable contact; a spring for biasing said toggle toward the collapsed positions, one of said collapsed positions corresponding to said closed circuit position of the circuit breaker, the other of said collapsed positions corresponding to said open circuit position of the circuit breaker; a U-shaped cradle mounted for rotation around the end of one of its legs; said spring engaging at one end the apex of said U-shaped cradle and at the other end said movable contact; a latch engaging the other leg of said U-shaped member under normal operating conditions; said latch disengaging said U-shaped member on fault currents collapsing said toggle to open said contacts; said latch having an extending member; a thermally responsive means; said thermally responsive means being rigidly secured at one end of said circuit breaker; said latch being mounted on said thermally responsive means and movable with said thermally responsive means; a magnet and an armature, said magnet being mounted on said thermally responsive means; a spring member, said spring member being secured to said thermally responsive member and carrying said armature; said magnet attracting said armature causing said spring member to engage said extending member and move simultaneously said latch at values of fault currents different from those at which the thermally responsive means operate to move said latch.

12. In a circuit breaker for opening with a trip action; a movable contact; a complementary contact; said movable contact having a circuit closed position in which it engages said fixed contact and a circuit open position in which said contacts are disengaged; a toggle comprising a pivotally mounted handle and said movable contact; a spring for biasing said toggle toward the collapsed positions; one of said collapsed positions corresponding to said closed circuit position of the circuit breaker, the other of said collapsed positions corresponding to said open circuit position of the circuit breaker, a U-shaped cradle mounted for rotation around the end of one of its legs, said spring engaging at one end the apex of said U-shaped cradle and at the other end said movable contact, a latch en-

cuit position of the circuit breaker; a U-shaped cradle mounted for rotation around the end of one of its legs; said spring engaging at one end the apex of said U-shaped cradle and at the other end said movable contact; a latch engaging the other leg of said U-shaped member under normal operating conditions; said latch disengaging said U-shaped member on fault currents collapsing said toggle to open said contacts; said latch having an extending member; a thermally responsive means; said thermally responsive means being rigidly secured to said circuit breaker; said latch being mounted on said thermally responsive means and movable with said thermally responsive means; a magnet and an armature; said magnet being mounted on said thermally responsive means; a spring member; said spring member being secured to said thermally responsive member and carrying said armature; said magnet attracting said armature causing said spring member to engage said extending member and move simultaneously said latch at values of fault currents different from those at which the thermally responsive means operate to move said latch; a housing for enclosing said single-pole circuit breaker.

13. In a trip mechanism for a circuit breaker comprising a bimetallic member and a magnet; one end of said bimetallic member secured to said circuit breaker, a spring mounted latch secured near the other end of said bimetallic; said magnet mounted on said bimetallic member intermediate said one end and said mounting of said latch; said magnet attracting said armature to effect operation of said latch on the occurrence of predetermined fault currents; said bimetallic member effective to cause operation of said latch on the occurrence of predetermined over currents; said armature effecting operation of said latch independent of the movement of said bi-

metallic member; said bimetallic member effective to cause movement of said latch independent of the movement of said armature.

14. In a circuit breaker for opening with trip action; a pair of cooperating contacts comprising a movable and a stationary contact; said movable contact having a circuit closed position in which it engages said fixed contact and a circuit open position in which said fixed contact and said movable contact are disengaged; a toggle comprising a pivotally mounted handle and said movable contact; a spring for biasing said toggle toward collapsed position; said collapsed position corresponding to said contact engaged position; the other of said collapsed positions corresponding to said contact disengaged positions; a U-shaped cradle mounted for rotation around the end of one of said legs; said spring engaged at one end of said movable contact and at the other end to the apex of said U-shaped cradle; a latch engaging one leg of said U-shaped member under normal operating conditions; said latch disengaging said U-shaped member at fault current conditions collapsing said toggle and thereby disengaging said cooperating contacts; a thermal means and a magnetic means responsive to fault current; said thermal means effective to cause disengagement of said latch on the occurrence of predetermined over currents; said magnetic means effective to cause disengagement of said latch on the occurrence of predetermined fault currents; said magnetic means and said thermal means operating independently to effect operation of said latch.

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