

May 22, 1945.

L. W. DYER ET AL

2,376,759

CIRCUIT BREAKER

Filed Oct. 30, 1942

2 Sheets-Sheet 1

Fig. 1.

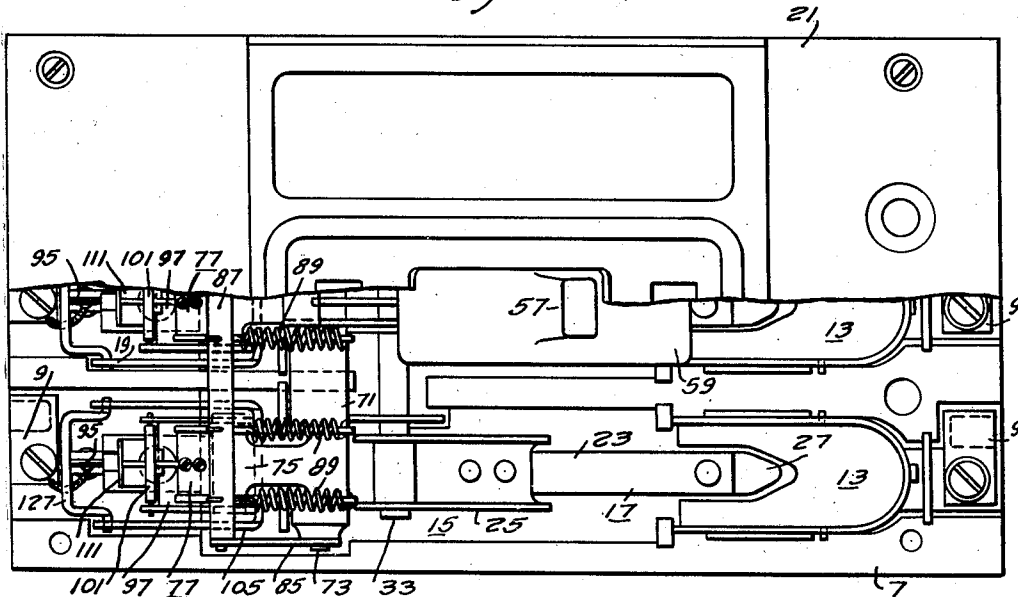
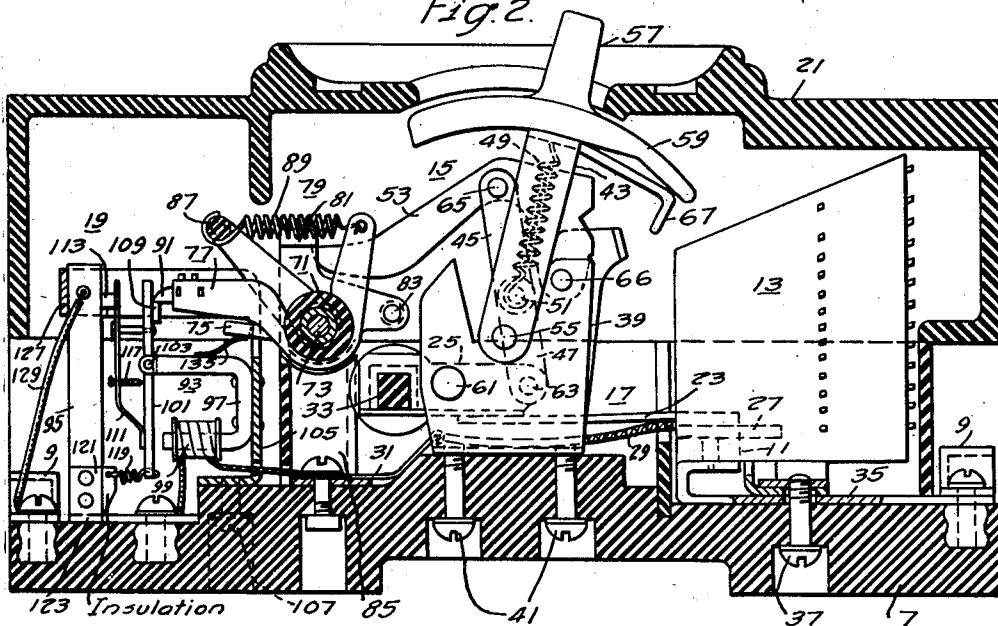


Fig. 2.



WITNESSES:

E. A. McLaughlin
G. S. Parker

INVENTORS

Lloyd W. Dyer and
Hiller D. Dorfman.

BY

Ralph Z. Swingle
ATTORNEY

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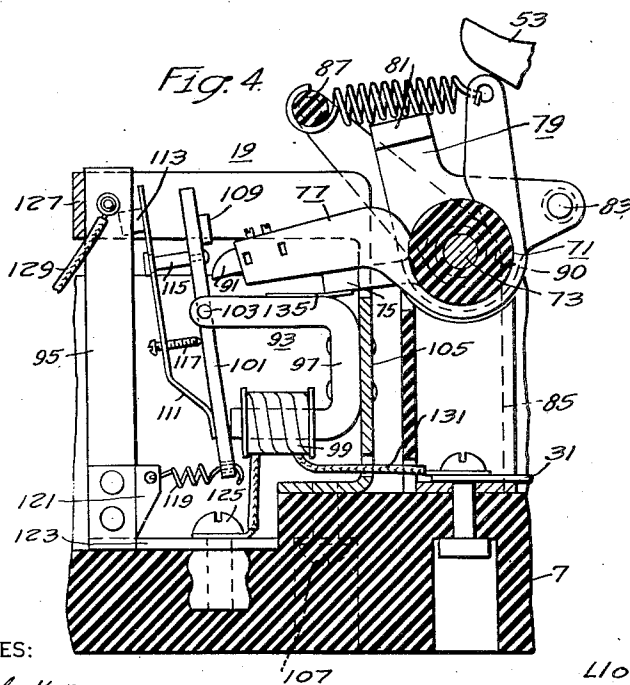
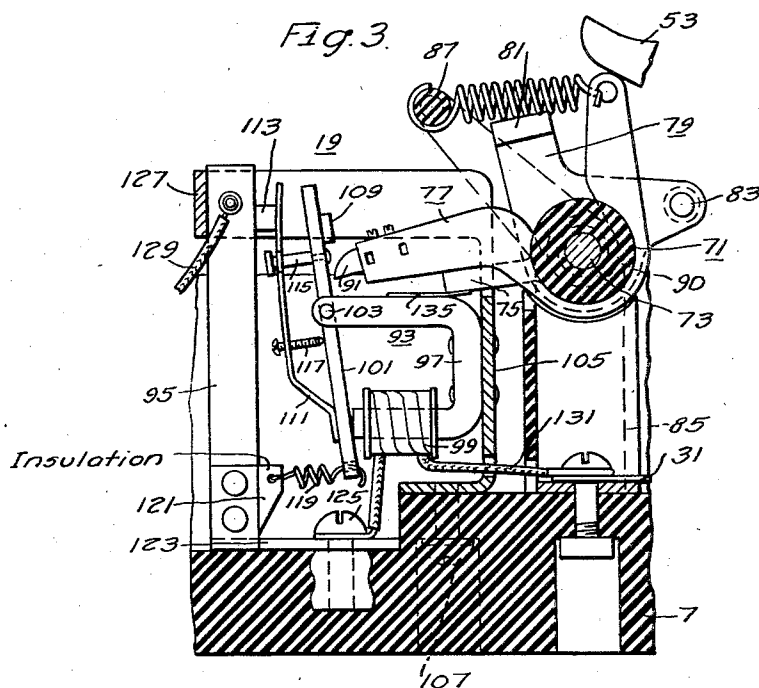
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WITNESSES:

E. A. McLaughlin
G. S. Parker

INVENTORS
Lloyd W. Dyer and
Hiller D. Dorfman.

BY

Ralph H. Swingle
ATTORNEY

UNITED STATES PATENT OFFICE

2,376,759

CIRCUIT BREAKER

Lloyd W. Dyer, Wilkinsburg, and Hiller D. Dorfman, Forest Hills, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application October 30, 1942, Serial No. 463,935

12 Claims. (Cl. 200—88)

The invention relates to circuit interrupters and, more particularly, to circuit breakers of the type that are automatically tripped open after a time delay in response to predetermined overload current conditions up to a certain magnitude and that are tripped open instantaneously upon the occurrence of heavy overloads or short circuits.

An object of the invention is the provision of an improved circuit breaker of the class described which is very simple and compact, accurate and reliable in operation, and economical to manufacture.

Another object of the invention is the provision of an improved circuit breaker of the class described which is substantially shock-proof, that is, it will not be falsely tripped by shocks or jars even though the breaker may be carrying the full rated current or even slight overload current.

Another object of the invention is the provision of a circuit breaker having an improved thermal-magnetic trip device wherein tripping of the breaker is controlled jointly by an electromagnetic tripping means and a current responsive bimetal element so arranged that the breaker will not be falsely tripped by shocks or jars.

Another object of the invention is the provision of a circuit breaker with an improved trip device comprising an electromagnetic tripping means operable to cause tripping of the breaker, and a current responsive bimetal element having an edge portion normally disposed in a blocking position directly in the path of movement of a part movable with the armature of the magnetic means to prevent tripping operation thereof except in response to predetermined overload conditions, the said bimetal element when heated a predetermined amount by overload current deflecting transversely of the plane of movement of the magnetic means to a non-blocking position to thereby permit tripping operation of the magnetic means.

Another object of the invention is the provision of a circuit breaker with a trip device as previously described, wherein the bimetal element is normally disposed in blocking position directly in the path of movement of a flat leaf spring carried by the armature of the electromagnetic tripping means, the spring being designed to permit instantaneous tripping operation of the armature upon heavy overloads and short circuits irrespective of the position of the bimetal element.

Another object of the invention is the provision of a circuit breaker with an improved trip device wherein the force for releasing the circuit

breaker latch to trip the breaker is produced by a spring actuated trip member which is normally latched in inoperative position by the armature member of the previously described electromagnetic tripping means.

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

Figure 1 is a front elevational view, partly in section, of a multi-pole circuit breaker embodying the features of the present invention;

Fig. 2 is a vertical sectional view of the circuit breaker taken substantially adjacent the center pole thereof, the parts being shown in the closed circuit position;

Fig. 3 is an enlarged fragmentary sectional view illustrating an instantaneous tripping operation of the trip device, such as is produced by a heavy overload or short-circuit condition in the circuit through one of the poles of the circuit breaker; and

Fig. 4 is a view similar to Fig. 3 but illustrating a time delay tripping operation of the trip device, such as is produced by an overload of lesser magnitude but which has persisted for a sufficient length of time to produce a deflection of the bimetal element.

The present invention in certain respects constitutes a further development of and improvement over the invention disclosed and claimed in our copending application for Shock-proof circuit breakers, Serial No. 463,934, filed October 30, 1942, and assigned to the assignee of the present invention.

Referring to Figs. 1 and 2 of the drawings, the base 7 of the circuit breaker is of molded insulating material and has mounted thereon six terminals 9, two for each of the three poles of the circuit breaker, three stationary contacts 11, and arc-extinguishing device 13 for each of the three poles, a circuit breaker operating mechanism 15 which has associated therewith the three movable switch members 17, and a trip device indicated generally at 19 for controlling automatic operation of the circuit breaker. A cover 21 is removably secured to the base 7 and cooperates therewith to form a casing for enclosing the circuit breaker mechanism. The base and cover are each provided with a plurality of barriers

which serve to divide the casing longitudinally into three compartments, one for each pole of the circuit breaker.

Each of the switch members 17 includes a resilient switch arm 23 preferably of spring steel which is riveted at one end to the associated switch member frame 25. The other end of the spring contact arm carries a movable contact 27 which is adapted to be moved into and out of engagement with the stationary contact 11. A flexible shunt conductor 29 is provided for connecting each of the movable contacts 27 with a corresponding one of the conducting straps 31 which serve to complete the electric circuit from the shunt conductor 29 to the corresponding pole of the trip device 19. The three switch member frames 25, which are substantially U-shaped, are rigidly mechanically connected together by means of an insulating tie bar 33 which extends through suitable openings in the sides of the switch member frames, the tie bar being rigidly fastened to each of the frame members 25 by means of a clamping strap. Each stationary contact 11 is mounted on the inner end of a corresponding conducting strip 35 which is secured to the base 7 by means of screw 37. The outer end of this conductor strip 35 is electrically connected to a corresponding one of the right-hand terminals 9. The electrical circuit for each of the poles is essentially the same. Beginning with the terminal 9 at the trip mechanism end of the breaker, the current flows successively through the corresponding pole of the trip device 19, conducting strip 31, flexible shunt conductor 29, movable contact 27, stationary contact 11 and conducting strip 35 to the right-hand end terminal 9.

The operating mechanism 15 which is of the quick-make and quick-break type is supported on a U-shaped main frame 39 mounted in the center pole compartment of the circuit breaker and secured to the base 7 by means of screws 41. The operating mechanism comprises a bifurcated operating lever 43, a toggle comprising toggle links 45 and 47 for engaging the interconnected switch members 17, a pair of overcenter springs 49 for operatively connecting the operating lever 43 with the knee pivot pin 51 of the toggle linkage, and a supporting lever or cradle 53 for supporting one end of the toggle linkage so as to provide a means whereby actuation of the trip device 19 can cause the operating mechanism to automatically move all of the switch members 17 to open circuit position irrespective of the position of the manual operating handle. The bifurcated operating lever 43 is pivotally supported on the sides of the U-shaped frame by means of two pivot pins 55 (only one being shown). An operating handle 57 is secured to the outer end of the operating lever 43 to provide for manual operation of the circuit breaker. This handle has a knob portion which projects through an elongated slot provided therefor in the cover 21, and is also provided with an arcuate shield portion 59 for closing the handle slot in all positions of the handle.

The mechanically interconnected switch members 17 are pivotally supported on the U-shaped main frame 39 by means of the pivot pin 61 which engages the frame 25 of the center pole switch member, the ends of the pin being supported by the sides of the main frame 39. The inner toggle link 47 is pivotally connected to the frame 25 of the center pole switch member by means of a pivot pin 63, this pin providing the only mechan-

ical connection between the operating mechanism and the assemblage of switch members. The other end of the inner toggle link 47 is pivotally connected to the inner end of the other toggle link 45 by means of the knee pivot pin 51. This knee pivot pin extends for some distance on either side of the pivotally connected toggle links and each of the projecting ends is adapted to be engaged by one end of the overcenter springs 49, the other end of the operating springs being fastened to the central portion of the bifurcated operating lever 43. The outer end of the toggle link 45 is pivotally connected by a pivot pin 65 to the carrier lever or cradle 53, which, in turn, is pivotally supported on the U-shaped main frame 39 by means of a pivot pin 66. The limits of motion of the operating lever 43 are defined by offset projections of the sides of the main frame 39.

The cradle or carrier lever 53 is normally adapted to be held in the latched position shown in Fig. 2 by means of a latch of the trip device, and in this latched position the cradle forms a fixed support for the outer end of the toggle linkage so that the circuit breaker may be manually opened and closed by means of the operating handle 57. When the circuit breaker is in the closed position shown in Fig. 2, the three switch members are held locked in closed position by the overset relation of the operating toggle 45, 47 as long as the cradle 53 is held in latched position. In this position, the overcenter springs 49 act to maintain the operating handle in the "on" position and also bias the operating toggle to its overset locking position. The cradle 53 is always biased in a clockwise direction as viewed in Fig. 2, by a component of the force of the overcenter springs, and when this cradle is released by the operation of the trip device, the assemblage of the three movable switch members is quickly actuated to open position by means of the overcenter springs. Upon such release, the cradle 53 is rotated in a clockwise direction, as viewed in Fig. 2, and as soon as the axis of the pivot pin 65 is shifted to the right of the line of action of the overcenter springs 49, the operating toggle is caused to collapse, and the operating handle is moved to an intermediate indicating position. Before the breaker can be again closed, it is necessary to reset the cradle 53 to its latching position. For this purpose, the operating lever 43 is provided with a reset projection 67 which is adapted to engage and move the cradle 53 back to its latched position when the operating handle is moved to the "off" position to reset the mechanism.

The trip device 19 of the circuit breaker includes a rotatably supported trip bar 71 of molded insulating material which has a centrally disposed shaft 73 molded therein. The trip bar is provided with three T-shaped projecting members 75 formed integral therewith and six annular slots for supporting the three spring actuated trip members 77, there being one projection 75 and one trip member 77 for each of the three poles of the circuit breaker. The trip bar is also provided with a means for engaging and latching the cradle 53 of the circuit breaker operating mechanism. This engaging means comprises a latch 79 rigidly affixed to the trip bar and having spaced sides which are joined by a latch portion 81, which is adapted to engage and latch the free end of the cradle 53. The latch 79 also carries a cross-pin 83 between its sides, and this pin provides means whereby the trip device is reset by

the cradle 53 when the cradle 53 is manually reset to latching position by means of the operating handle 57. The trip bar 71 is rotatably supported on a pair of upstanding bracket members 85 secured to the base 7 adjacent the opposite side walls thereof. The outer ends of the bracket members 85 are connected by an insulating rod 87 which forms a support for one end of the tripping springs 89 which individually bias and actuate the trip members 77 to the tripped position. Each of the spring actuated trip members 77 is of bifurcated construction, the two side portions of each bifurcated trip member having aligned substantially semi-circular slots 99 (Fig. 3), and it is through the agency of these slots and the annular slots in the trip bar that the spring actuated trip members are supported on the trip bar so as to be individually movable thereon. The annular slots in the trip bar and the semi-circular bearing slots of the trip members are of substantially the same radius so that the movement of the spring actuated trip members is essentially one of rotation about the axis of the trip bar itself. Each of the trip members is biased in a counter-clockwise direction as viewed in Fig. 2, by two of the springs 89, so that when any one of the trip members is released, it will engage a corresponding one of the T-shaped projections 75 and actuate the trip bar 71 to tripped position to trip the circuit breaker. The spaced sides of each trip member 77 are disposed directly over the T-portion of a corresponding one of the projections 75 on the trip bar 71 so that the edges of these side portions will engage the projection and move the trip bar when the trip member is released. Each of the three trip members 77 carries an adjustable latch piece 91 adapted to be engaged by a latch to restrain the trip member in the latched position shown in Fig. 2.

The circuit breaker contacts, operating mechanism, and that portion of the trip device that has been described in the preceding paragraph are substantially similar to the corresponding parts of the circuit breaker disclosed in Patent No. 2,050,285, issued to H. D. Dorfman, August 11, 1936, and assigned to the assignee of the present invention. The remaining portions of the trip device, however, are of entirely different construction and have a different mode of operation from the trip structure shown in the aforementioned Patent No. 2,050,285.

It is very important, especially in applications of circuit breakers where vibrations and severe jars or shocks are encountered, that the circuit breaker should not falsely trip open in response to such vibrations, jars, or shocks. The main source of trouble which causes the circuit breaker to be falsely tripped by vibrations, jars, or shocks usually resides in the electro-responsive trip elements, such as the electro-magnetic tripping means and the thermally responsive trip elements, since these elements are usually very sensitive to shocks. The main circuit breaker latch and the trip bar can very easily be made substantially shock-proof by various known methods. In accordance with the present invention, each pole of the circuit breaker is provided with an improved electro-responsive tripping means of very simple and reliable construction, in which the parts thereof are so arranged as to make the circuit breaker substantially shock-proof. The construction of each electro-responsive tripping means is such that it affords a time delay action before tripping the breaker in response to over-

loads up to a predetermined magnitude, and also effects instantaneous tripping of the circuit breaker upon the occurrence of heavy overloads or short circuits in the circuit of any pole of the breaker. Each electro-responsive tripping means comprises an electro-magnet indicated generally at 93 and a current responsive bimetal element 95 each energized in response to the current of the circuit of its corresponding pole. The electro-magnet 93 comprises a U-shaped stationary core 97 of magnetic material, an energizing winding 98 wound upon the shorter leg of the stationary core, and an armature member 101 which is pivoted intermediate its ends by a pivot 103 on the longer leg of the stationary core. The stationary core 97 is secured by rivets to a U-shaped supporting frame 105, which is, in turn, secured to the base 7 of the circuit breaker by a screw 107. A hardened latch element 109 is secured to the extension of the armature member 101 adjacent the outer end thereof, and this latch element is adapted to engage the latch piece 91 of a corresponding one of the spring actuated trip members 77 to hold the trip member in the latched position shown when the armature member 101 is in its unattracted position. A relatively strong flat leaf spring 111 is rigidly secured at its inner end to the armature member 101 adjacent the inner end of the armature member. The leaf spring 111 is slightly offset and a major portion thereof extends in spaced relation substantially parallel to the armature member, and a cylindrical latch piece 113 is secured to the outer free end of the leaf spring. A guide pin 115 secured to the armature member 101 extends loosely through an opening provided therefor in the leaf spring 111 to prevent any substantial lateral displacement of the leaf spring 111 relative to the armature member. An adjusting screw 117 is threaded through an intermediate portion of the leaf spring 111 and engages the armature member 101. The purpose of this adjusting screw is to provide a means for adjusting the strength or force of the leaf spring 111 to thereby adjust the instantaneous tripping point of the electromagnetic trip means. A relatively light biasing spring 119 is connected at one end to the lower end of the armature member 101 and the other end of this biasing spring is anchored to a fixed insulating plate 121 secured to the bracket which supports the bimetal element 95.

The current responsive bimetal element 95 comprises a flat strip of bimetallic material which is rigidly secured and electrically connected at its lower end to a supporting terminal bracket 123, which is, in turn, secured to the base by means of a screw 125 threadedly engaged in an insert molded in the base of the breaker. The bimetal strip 95 is mounted with its flat side substantially in the plane of movement of the armature member 101 so that one of the edges of the outer end of the bimetal strip is normally disposed in blocking relation directly in the path of movement of the latch piece 113 carried by the free end of the leaf spring 111 on the armature member 101. The edge portion of the bimetal strip opposite the edge which engages the latch piece 113 rests against and barely touches a cross-portion 127 of the U-shaped frame 105. The free end of the bimetal strip 95 is electrically connected by a flexible shunt conductor 129 to one of the end terminals 9 of the corresponding pole of the circuit breaker, and the inner or base end of the bimetal strip is electrically connected to one end of the winding 98 of the electro-magnet by the

terminal bracket 123. The other end of the energizing winding is electrically connected by a conductor 131 to the terminal strip 31 which is connected to the movable contact 27. It will thus be seen that the bimetal strip 95 and the energizing winding 99 of the electro-magnet are connected in series with the contacts of the corresponding pole of the circuit breaker so as to be responsive to the current of the circuit of the corresponding pole.

The current responsive bimetal element 95 normally, that is, during normal current conditions, acts through the relatively strong leaf spring 111 to maintain the armature member 101 in the unattracted latching position, in which it holds the spring actuated trip member 77 in latched position. The bimetal element 95 is designed so that it will bend or deflect when heated a predetermined amount by overload currents in excess of the predetermined value, for example, in excess of 125% of the normal rated current of the breaker. When heated a predetermined amount by such overload current, the bimetal strip deflects in a direction 90° transverse to the plane of movement of the armature member 101 to a non-blocking position in which the outer end of the bimetal disengages the latch piece 113 carried by the leaf spring 111, so that it thereby permits the electro-magnet to operate the armature member 101 to attracted position, as shown in Fig. 4, to release the spring actuated trip member 77 and effect tripping of the circuit breaker. In this instance, the electro-magnet does not have to overcome the opposing force of the relatively strong leaf spring 111 in moving the armature to attracted position. The electro-magnet is so designed that it will develop sufficient tractive force to operate the armature to attracted position and release the trip member 77 when overload current through its corresponding pole exceeds a predetermined magnitude, preferably the same minimum magnitude that will ultimately produce sufficient heat to deflect the bimetal element 95, that is to say, for example, 125% or more of the normal rated current of the breaker. Currents below the predetermined magnitude will not produce sufficient force to actuate the armature to attracted position even though the bimetal element has disengaged the latch piece of the leaf spring. The time required to heat the bimetal strip 95 a predetermined amount sufficient to cause it to unlatch the armature member provides a time delay in the tripping operation of the breaker which varies inversely as the current of the circuit, that is to say, the higher the overload current the shorter the time delay before tripping of the breaker will occur.

The electromagnet 93 is also operable to cause instantaneous tripping of the breaker upon the occurrence of heavy overloads above a predetermined magnitude or on short circuits. For this purpose, the leaf spring is designed, or its strength is adjusted by means of the screw 117, so that the pull of the electromagnet will be sufficient to overcome the strength of the spring 111 and actuate the armature 101 to attracted position upon the occurrence of overloads in excess of predetermined desired value, for example, in excess of 10 to 12 times the normal rated current of the circuit breaker. Instantaneous tripping will occur under such conditions even though the bimetal element 95 has not had sufficient time to heat up and deflect to non-blocking position, because the pull of the magnet will be sufficient under such conditions to move the armature 101

to attracted position against the force of the leaf spring 111, even though the free end of the leaf spring is held in latched position by the bimetal element.

The electro-responsive tripping means of the other poles of the breaker are identical to the one that has just been described.

A plurality of springs 135 engage the underside of the trip bar projections 75 and act to bias the trip bar to its latching position. The trip bar is preferably constructed so that it is balanced with respect to its center of rotation, and hence will not be moved by vibrations, jars or shocks. Moreover, the line of action of the force exerted by the spring biased cradle 53 on the trip bar passes through the axis of rotation of the trip bar, so that this force does not tend to rotate the trip bar in either direction. The main breaker latch 79 is strongly held in latching position not only by the latch load produced by the overcenter operating springs 49 acting through the cradle 53, but also by the relatively strong frictional forces of the three trip members 77 which are pressed rather strongly against the trip bar when the three trip members are held in latched position by the armature members 101. The construction of the electro-responsive tripping means is such that it is made substantially shock-proof so that it will not be falsely operated by vibrations, jars or shocks. This is due to the fact that the armature members 101 are strongly held in latching position by the relatively strong leaf springs 111 which are, in turn, held against movement by the blocking effect of the current responsive bimetal elements 95. The armature members 101 are preferably pivoted as near their center of gravity as possible so as to minimize the possibility of these members being moved by shock. Any vibration, jar or shock in a direction which might tend to move the armature members 101 to attracted position is resisted and prevented by the relatively strong leaf springs 111 and by the blocking effect of the bimetal elements 95 which are immovable in the tripping direction of the armatures 101. Lateral shocks which might move the bimetal elements 95 to non-blocking position, will not cause tripping of the breaker since such forces are not in such a direction as to produce movement of the armature members 101.

The operation of the circuit breaker is briefly as follows: The circuit breaker is shown in Fig. 2 in the closed circuit position, the trip device being in the untripped position. To open the contacts manually, the operating handle 57 is moved in a counter-clockwise direction to the "off" position. This movement brings the line of action of the springs 49 to the left of the pivot axis 65, thereby causing the operating toggle to be moved to a collapsed position and effect movement of the three movable switch members 17 to open position. To close the contacts, the operating handle is moved from the "off" position in a clockwise direction back to the "on" position shown in Fig. 2. This movement of the handle shifts the line of action of the springs to the right of the axis of the pivot pin 65 and thereby causes the springs to actuate the operating toggle to its overset position to effect movement of the three movable switch members 17 to closed position.

Upon the occurrence of an overload above the minimum trip setting of the device in the circuit controlled by any of the poles of the breaker, the corresponding current responsive bimetal element 95 is heated by such overload current and when heated a predetermined amount deflects to a non-

blocking position, in which it is disengaged from and disposed out of the path of movement of the latch piece 113 carried by the leaf spring 111. This releases the electro-magnet for operation, whereupon the electro-magnet moves the armature member 101 to attracted position to thereby effect release of the corresponding spring actuated trip member 77. Upon release, the spring actuated trip member engages the corresponding T-shaped projection 75 on the trip bar and rotates the trip bar to tripping position to disengage the main circuit breaker latch 79 from the cradle 53. The operating springs 49 thereupon actuate the three movable switch members to open position and cause collapse of the operating toggle irrespective of the position of the operating handle 57. This time delay tripping operation of the trip device is illustrated in Fig. 4.

Upon the occurrence of a large overload or short circuit condition in the circuit controlled by any one of the poles of the breaker, the corresponding electro-magnet 93 will be energized a sufficient amount thereby to operate the armature member 101 to attracted position against the force of the leaf spring 111, even though the bimetal element has not had time to move to non-blocking position. The operation of the armature 101 to attracted position effects tripping of the breaker in the same manner as described above. Tripping of the breaker on such heavy overloads or short circuit conditions occurs instantaneously, that is, without any time delay action such as would occur on lower overloads up to the predetermined instantaneous tripping point. Tripping operation of the trip device on heavy overloads or short circuit conditions is illustrated in Fig. 3.

Following each tripping operation of the breaker, it is necessary to restore the operating mechanism to an operative condition. This is done by moving the operating handle 57 in a counter-clockwise direction as far as it will go in the "off" direction. This movement of the operating handle is transmitted to the cradle 53 through the projection 57. As the cradle is rotated in the resetting direction, the free end thereof engages the cross-pin 93 on the circuit breaker latch 79 and moves the trip bar and latch in a clockwise direction a sufficient distance to permit the latch portion 81 to reengage the free end of the cradle 53. This reengagement occurs somewhat before the operating handle reaches the limit of its motion. The rotation of the trip bar back to its reset latching position not only effects reengaging of the cradle 53, but in addition, it acts through the T-shaped projections 75 to reset any of the spring actuated trip members 77 that have been released, thereby restoring the spring actuated trip members to their latched position, in which they are engaged by the latches of the armature members 101. The bimetal elements 95 when cooled, return to their normal blocking position. The circuit breaker mechanism is thus reset and the circuit breaker may be again closed by moving the operating handle to the "on" position.

Although the invention has been illustrated as applied to a circuit breaker mechanism of a particular construction, it will be understood by those skilled in the art that the invention is also applicable to other types of circuit breakers.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details, arrangement of parts

and combinations of elements may be made without departing from some of the essential features of the invention. It is desired, therefore, that the language of the appended claims should be given as reasonably broad an interpretation as the prior art permits.

We claim as our invention:

1. A circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a trip device comprising an electromagnet having an armature movable to an attracted position to cause said operating mechanism to open said contacts, a spring biased member extending generally parallel to said armature and movable therewith and also relative thereto, and a current responsive bimetal element extending generally parallel to said spring biased member and having a deflectable portion normally disposed in blocking relation directly in the path of movement of said spring biased member to normally prevent movement of said armature to attracted position, said bimetal element when heated a predetermined amount deflecting to a non-blocking position out of the path of movement of said part to thereby permit operation of said armature, and said bimetal element being disposed so that it is deflectable only in a direction transverse to the plane of movement of said armature.

2. In a circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a trip device comprising a trip element operable to cause a tripping operation of said mechanism, an electromagnet energized by the current of the circuit for operating said trip element in response to predetermined overload conditions, and a generally flat current responsive bimetal element mounted with its flat side substantially in the plane of movement of said trip element and having a longitudinal edge portion normally disposed in blocking relation directly in the path of movement of a part movable with said trip element to thereby normally prevent operation of said trip element, a fixed member barely touching the opposite longitudinal edge portion of the bimetal element, and said bimetal element when heated a predetermined amount deflecting in a direction transverse to the plane of movement of said trip element to a non-blocking position to thereby permit operation of said trip element.

3. In a circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor including a spring actuated member releasable to cause opening of said contacts, a trip device comprising an electromagnet having an armature operable to an attracted position in response to predetermined overload conditions to cause release of said spring actuated member, a spring biased member extending generally parallel to said armature and movable therewith and also relative thereto, and a current responsive bimetal element having a longitudinal edge portion normally disposed in blocking relation directly in the path of movement of said spring biased member to normally prevent operation of said armature, said bimetal element when heated a predetermined amount deflecting in a direction transverse to the plane of movement of said armature to a non-blocking position to thereby permit operation of said armature.

4. In a circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor including a spring actuated member releasable to cause open-

ing of said contacts, an electromagnet energized by the current of the circuit having an armature biased to a normal position in which it latches said spring actuated member and operable by the electromagnet to an attracted position in response to predetermined overload conditions to release said member, and a current responsive bimetal element having a longitudinal edge portion normally disposed in blocking relation directly in the path of movement of a part carried by said armature to thereby normally prevent movement of said armature to attracted position, a fixed member barely touching the opposite longitudinal edge portion of the bimetal element, and said bimetal element being heated in response to the current of the circuit and when heated a predetermined amount by overload current deflecting in a direction transverse to the plane of movement of said armature to a non-blocking position to thereby permit operation of said armature.

5. A circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a trip device comprising an armature element operable to cause said mechanism to automatically open said contacts, resilient means including a member carried by said element generally parallel thereto, an electromagnet energized by the current of the circuit and operable in response to predetermined overload conditions to operate said armature element, and a current responsive bimetal element extending generally parallel to said member of the resilient means and normally disposed in blocking relation directly in the path of movement of said resilient means so as to normally prevent operation of said magnetically actuated element except when said electromagnet is energized sufficiently to overcome the tension of said resilient means, said bimetal element being disposed to deflect only in a direction transverse to the plane of movement of said magnetically actuated element, and said bimetal element when heated a predetermined amount deflecting to a non-blocking position out of the path of movement of said resilient means to thereby permit said electromagnet to operate said magnetically actuated element without overcoming the tension of said resilient means.

6. A circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a trip device comprising an electromagnet energized by the current of the circuit and having an armature movable to an attracted position in response to predetermined overload conditions to cause tripping of said operating mechanism, a spring carried by said armature, a current responsive bimetal element having an edge portion normally disposed in blocking relation directly in the path of movement of said spring to normally prevent operation of said armature except when said electromagnet is energized sufficiently to overcome the tension of said spring, said bimetal element being heated in response to overload current and when heated a predetermined amount deflecting in a direction transverse to the plane of movement of said armature to a non-blocking position to thereby permit said electromagnet to operate said armature without compressing said spring.

7. A circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a trip device comprising an electromagnet energized by the current of the circuit and having an armature member operable to an attracted position in response to

predetermined overload conditions to cause said mechanism to automatically open said contacts, a leaf spring carried by said armature member, and a current responsive bimetal element having an edge portion normally disposed in blocking relation directly in the path of movement of said leaf spring to normally prevent operation of said armature member except when said electromagnet is energized sufficiently to overcome the tension of said leaf spring, said bimetal element being heated in response to overload currents and when heated a predetermined amount deflecting to a non-blocking position out of the path of movement of said armature member to thereby permit said electromagnet to operate said armature member without overcoming the tension of said spring.

8. A circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a trip device comprising an electromagnet energized by the current of the circuit and having an armature member pivoted intermediate its ends and operable to an attracted position to cause said mechanism to automatically open said contacts, a leaf spring carried by said armature member, a second spring engaging said armature member for biasing said member to unattracted position, and a current responsive bimetal strip mounted with its flat side substantially in the plane of movement of said armature and having an edge portion normally disposed in blocking relation directly in the path of movement of said leaf spring to normally prevent operation of said armature member except when said electromagnet is energized a sufficient amount to overcome the tension of both springs, said bimetal element being heated in response to overload currents and when heated a predetermined amount deflecting transversely of the plane of movement of said armature member to a non-blocking position to thereby permit said electromagnet to operate said armature without overcoming the tension of said leaf spring.

9. A circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a trip device comprising an electromagnet having a pivoted armature member movable to an attracted position to cause said mechanism to automatically open said contacts, a leaf spring secured at one end to said armature, a current responsive bimetal element having an edge portion normally disposed in blocking relation directly in the path of movement of said leaf spring to normally prevent operation of said armature except when said electromagnet is energized a sufficient amount to overcome the force of said spring, said bimetal element being heated in response to overload current and when heated a predetermined amount deflecting to a non-blocking position out of the path of movement of said spring to thereby permit operation of said armature without overcoming the force of said spring, and means for adjusting the force of said spring.

10. A circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a normally restrained spring actuated member operable when released to cause automatic opening operation of said contacts, an electromagnet having an armature member operable to an attracted position in response to predetermined overload conditions to cause release of said spring actuated member, a leaf spring carried by said armature member, and a bimetal element having an edge portion nor-

mally disposed in blocking relation directly in the path of movement of said leaf spring to normally prevent operation of said armature except when said electromagnet is energized sufficiently to overcome the force of said spring, said bimetal element when heated a predetermined amount deflecting in a direction transverse to the plane of movement of said armature member to a non-blocking position to thereby permit operation of said armature by said electromagnet without overcoming the force of said leaf spring.

11. In a multi-pole circuit breaker of the class described having, in combination, a plurality of sets of separable contacts, an operating mechanism therefor including a single normally restrained spring actuated member operable when released to cause automatic opening of said plurality of sets of contacts, a trip bar operable to effect release of said spring actuated member, a plurality of electromagnets each having an armature operable to an attracted position in response to predetermined overload conditions and said armatures comprising the only means acting directly to actuate said trip bar, a leaf spring carried by each armature, and a separate current responsive bimetal element for each of said armatures having an edge portion normally disposed in blocking relation directly in the path of movement of the leaf spring of the corresponding armature to normally prevent operation of said armature except when the corresponding electromagnet is energized sufficiently to overcome the tension of said spring, each bimetal element when

heated a predetermined amount deflecting in a direction transverse to the plane of movement of its corresponding armature to non-blocking position to thereby permit operation of said armature by said electromagnet without overcoming the force of said leaf spring.

12. In a circuit breaker of the class described having, in combination, relatively movable contacts, operating mechanism therefor, a normally restrained spring actuated member operable when released to cause said mechanism to open said contacts, an electromagnet having a pivoted armature member biased to a normal position in latching engagement with said spring actuated member to restrain the same and operable to an attracted position in response to predetermined overload conditions to release said member, a leaf spring carried by said armature member, and a current responsive bimetal element having an edge portion normally disposed in blocking relation directly in the path of movement of said spring to normally prevent operation of said armature except when said electromagnet is energized sufficiently to overcome the force of said leaf spring, said bimetal element when heated a predetermined amount deflecting in a direction transverse to the plane of movement of said armature member to a non-blocking position to thereby permit said electromagnet to operate said armature member without overcoming the force of said leaf spring.

LLOYD W. DYER.
HILLER D. DORFMAN.