July 14, 1936. H. J. LINGAL 2,047,739

CIRCUIT INTERRUPTER

Filed March 23, 1932 4 Sheets-Sheet 1

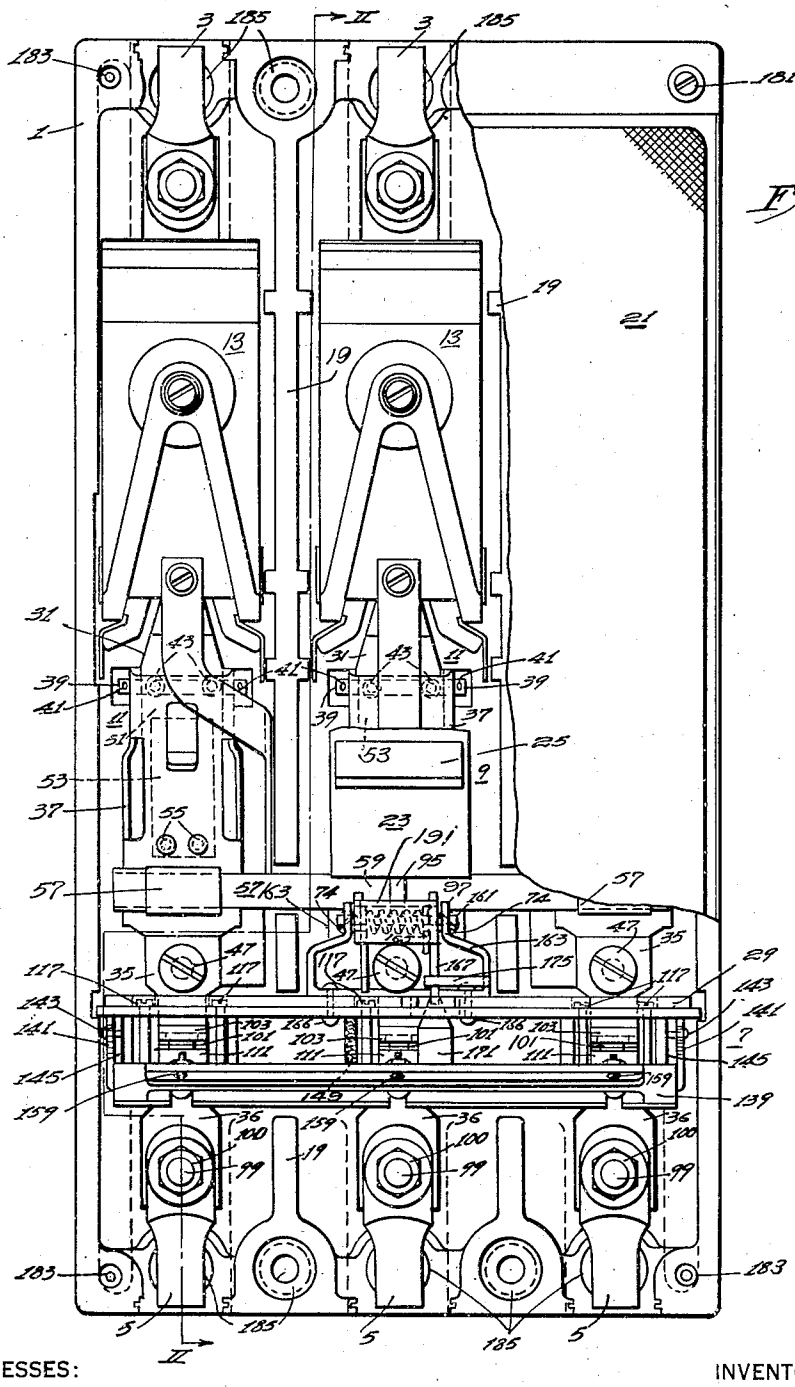


Fig. 1.

WITNESSES:

E. A. McCloskey.

Paul J. Glaister

INVENTOR

Harry J. Lingal.

BY F. W. Lyle.

ATTORNEY

July 14, 1936. H. J. LINGAL 2,047,739

CIRCUIT INTERRUPTER

Filed March 23, 1932 4 Sheets-Sheet 2

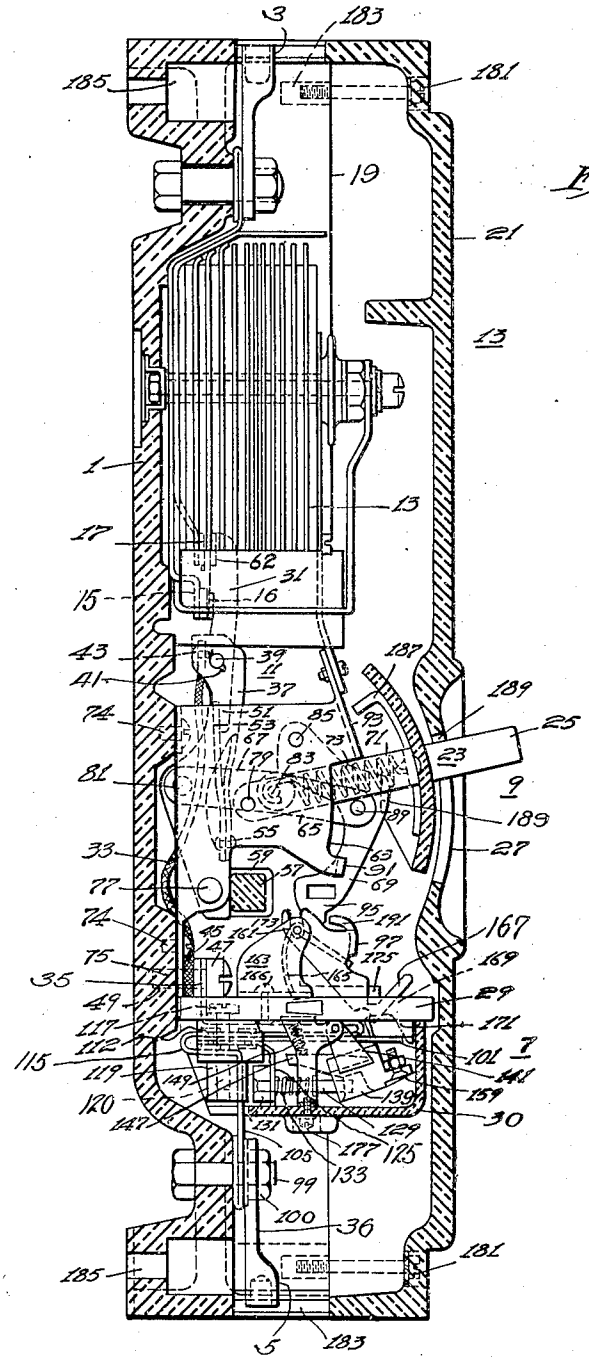


Fig. 2.

WITNESSES:

C. J. Weller.

Paul O. Glaister

INVENTOR

Harry J. Lingal.

BY F. W. Seyle.

ATTORNEY

July 14, 1936. H. J. LINGAL 2,047,739

CIRCUIT INTERRUPTER

Filed March 23, 1932 4 Sheets-Sheet 3

Fig. 3.

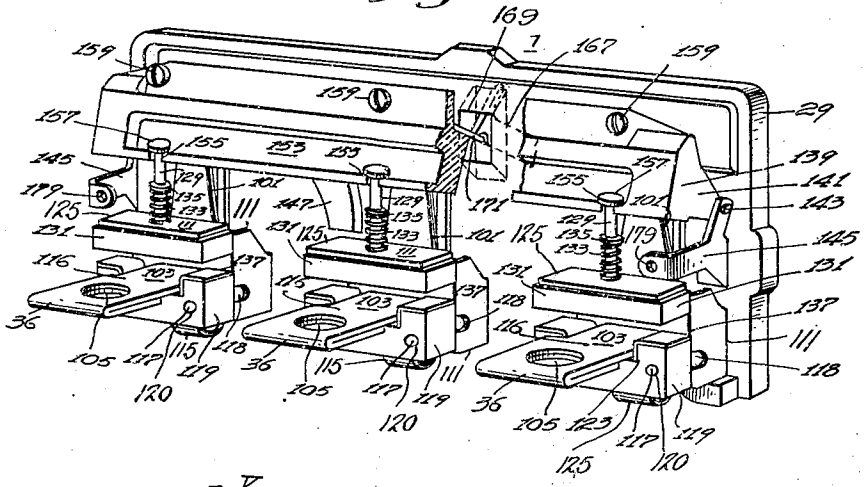


Fig. 4.

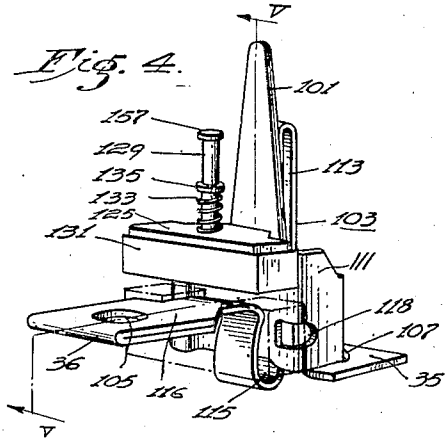


Fig. 5.

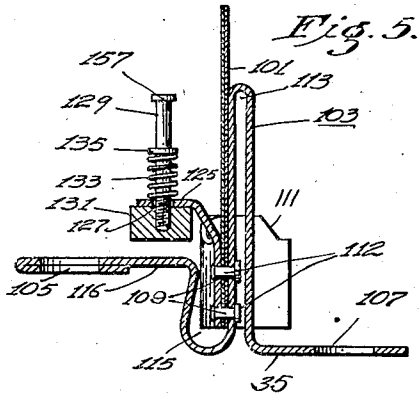


Fig. 6.

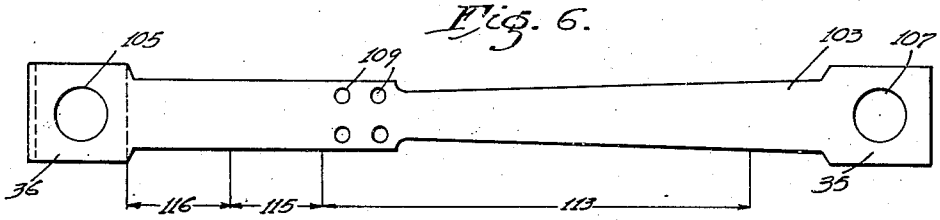
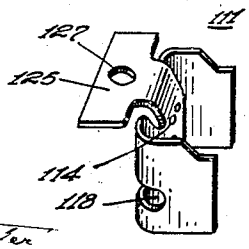


Fig. 7.



WITNESSES:

E. L. Liding,

Paul J. Gleister

INVENTOR

Harry J. Lingal.

BY F. W. Lysle

ATTORNEY

July 14, 1936. H. J. LINGAL 2,047,739

CIRCUIT INTERRUPTER

Filed March 23, 1932 4 Sheets-Sheet 4

Fig. 8.

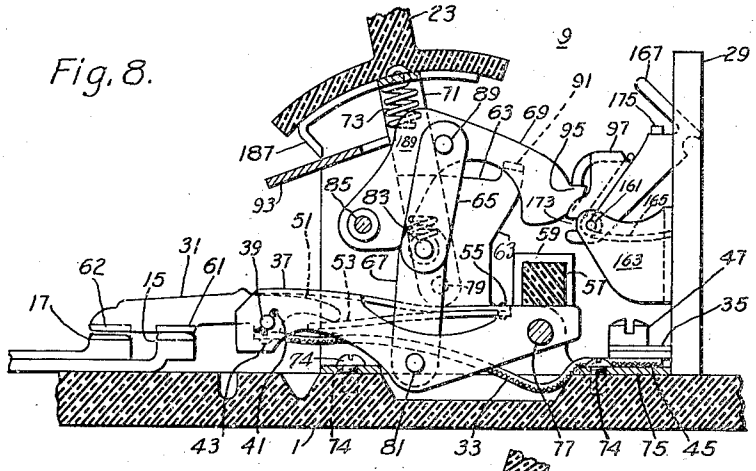


Fig. 9.

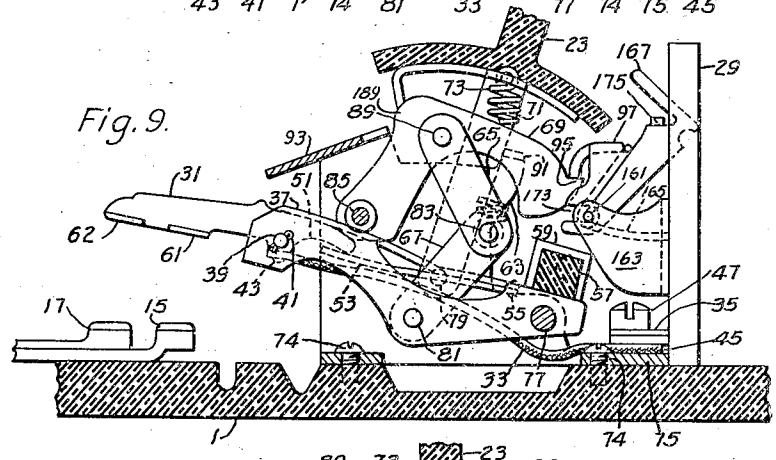
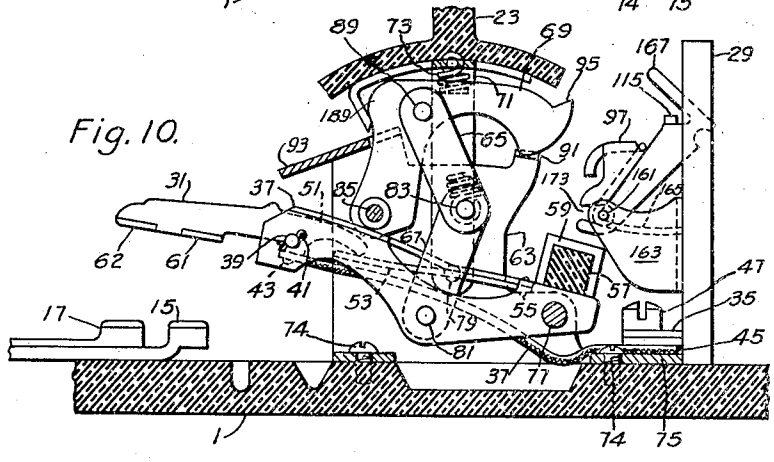


Fig. 10.



WITNESSES:

Fred. C. Williams

Carl J. Glaister

INVENTOR

Harry J. Lingal

BY F. W. Lyle.

ATTORNEY

Patented July 14, 1936

2,047,739

UNITED STATES PATENT OFFICE

2,047,739

CIRCUIT INTERRUPTER

Harry J. Lingal, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, a corporation of Pennsylvania

Application March 23, 1932, Serial No. 600,624

31 Claims. (Cl. 200—88)

My invention relates to circuit breakers and particularly to circuit breakers of the type in which the breaker-operating means is manually operable to open or to close the circuit, and is automatically operable to open the circuit and to prevent the closing of the circuit upon the occurrence of short-circuit or overload conditions.

One object of my invention is to provide a circuit breaker having an improved trip mechanism capable of opening the breaker after a predetermined time interval in response to an overload in the controlled circuit, and capable of opening the breaker immediately upon the occurrence of a short-circuit condition in the controlled circuit.

Another object of my invention is to provide an improved conducting means for a circuit-breaker trip device having a thermally responsive and a magnetically responsive element; the improved conducting means being capable of serving the double function of heating the thermally responsive element and magnetizing the magnetically responsive or instantaneous trip element.

A further object of my invention is to provide an improved supporting means for circuit breaker trip devices whereby the thermally responsive element and the magnetically responsive element are both supported by a single frame member.

A further object of my invention is to provide a simplified and improved means for slidably mounting the armature of a magnetically responsive trip element.

A further object of my invention is to provide an improved trip bar of insulating material engageable and operable by any one of a plurality of thermally responsive elements, each electrically connected in a different circuit.

A further object of my invention is to provide a trip bar for circuit breaker trip-devices which will be moved to open the breaker by forces acting in different directions.

A still further object of my invention is to provide an improved means for slidably and pivotally mounting the latch for circuit breaker trip devices which are resettable by means associated with the operating handle. The slidable mounting for the latch making it possible to bias the various elements of the trip device, including the latch itself, to the latched position, or, in other words, making possible a trip device which is entirely automatically resettable. And, what is equally important, the slidable mounting of the latch permits the resetting means to move to the latched position without in any way disturbing the automatic resetting feature of the trip device.

The principal field for immediate application of my invention is in connection with circuit breakers for controlling lighting and distribution feeder circuits, and I shall hereinafter describe an embodiment of my invention as applied to such circuit breakers, without, however, in any way intending to restrict the scope of my invention, except as indicated in the appended claims.

In this embodiment of my invention, I provide a plurality of switch members and a plurality of contact members for opening a plurality of poles. In addition, I provide a manually operable mechanism for opening and closing the breaker contacts with a snap action, an insulating base upon which the structure is assembled, an arc extinguishing device for each pole, a means for biasing each of the switch members to the open position, a releasable restraining means for holding all of the switch members closed, and a unitary, removable trip device for releasing the restraining means in response to a predetermined electrical condition in any one pole, thereby opening all of the poles of the breaker; the releasing means being operable to open the breaker regardless of the position of the operating handle.

The features of my invention which I believe to be new are particularly pointed out in the appended claims, and for a full understanding of the principles of the invention, reference may be had to the accompanying drawings, in which

Figure 1 is a plan view of a three-pole circuit breaker embodying the principal elements of my invention; the cover has been cut away to show part of the breaker mechanism and has been entirely removed from the trip structure.

Fig. 2 is a sectional view on the line II—II of Fig. 1; certain of the parts are shown in elevation to more clearly illustrate the structural features involved.

Fig. 3 is a perspective view of the unitary trip structure used in this embodiment of my invention.

Fig. 4 is a fragmentary perspective view showing a part of one of the individual trip mechanisms incorporated into the trip structure shown in Fig. 3.

Fig. 5 is a sectional view on the line V—V of Fig. 4.

Fig. 6 is an expanded detail view of one of the integral conducting strips used in the trip structure shown in Fig. 3.

Fig. 7 is a perspective view of the frame of one of the units shown in Fig. 4; and

Figs. 8, 9, and 10 are fragmentary views showing the moving parts of the circuit breaker operating mechanism in the closed, open, and tripped positions, respectively; one side of the frame has been cut away to more clearly illustrate the structural details involved.

Referring to the drawings, the base 1 is of molded insulating material and has mounted thereon the terminal contacts 3 and 5, the unitary trip structure 7, the circuit breaker operating mechanism 9 which has associated therewith the assembly of the switch members 11, and the arc extinguishers 13, which have integral therewith the main stationary contact 15 and the auxiliary stationary contact 17. The switch members 11 and the stationary contacts 15 and 17 combine to form a plurality of poles. Each of the poles is insulated from the adjacent pole by means of one of the insulating barriers 19 which are molded in the base 1. These insulating barriers 19 align with similar barriers (not shown) in the cover 21 which is likewise of molded insulating material. The operating handle 23 which is rigidly affixed to the switch operating mechanism 9 is also of molded insulating material, and it has a portion 25 which projects through a suitable opening 27 in the cover 21. The unitary trip structure 7 has a base 29 of insulating material and a cover 30 also of insulating material. The unitary trip structure 7 fits in a suitable recess in the insulating base 1 and is fastened therein, as will be described in some detail later, through the agency of suitable screw fastenings.

The electrical circuit for each of the poles is substantially the same. Beginning with the terminal contact 3, the current passes successively through the arc extinguishing structure 13, the stationary contact 15, the moving contact 31 and the conducting shunt 33 associated with the switch member 11, the unitary trip structure 7—the shunt 33 connecting with the terminal 35 of the trip device—and thence through the trip structure to the other terminal contact 5.

Each of the switch members 11 has a channel shaped frame 37 of iron upon which the remainder of the structure is assembled. The moving contact 31 is pivotally fastened to the iron frame 37 by a pivot pin 39 extending through two holes placed in opposite sides of the frame 37. Two cotter pins 41 prevent the pivot pin 39 from moving out of position. The flexible shunt 33 is riveted to the moving contact 31 by the rivets 43, and it is provided with a terminal portion 45 on the free end for engaging the corresponding terminal 35 of the trip structure 7; the screws 47 which engage suitable threaded recesses 49 in the base 1 being provided to releasably connect those terminals.

Each of the moving contacts 31 has a portion 51 extending downward into the frame (Fig. 2). This portion 51 is engaged by the free end of a flat spring 53; the other end of the spring 53 is rigidly fastened to the frame 37 by rivets 55. A square insulating bar 57 extends across all three poles of the breaker. This bar is rigidly affixed to the lower part of each of the switch members 11 by means of an iron strap 59 which loops about the bar 57 and has projections (not shown) which extend through suitable openings in the frame 37 and are therein clinched. This bar 57 serves to rigidly connect all of the switch members 11, and thereby makes it possible to operate all three of the switch members from a single operating mechanism. Also, this bar provides a means whereby all of the poles of the breaker are opened and closed simultaneously; thus an overload or a short circuit condition in the circuit controlled by any one of the poles will, through the trip mechanism 7, cause all of the poles of the breaker to open.

The main stationary contact 15 and the engaging portion 61 of the moving contact 31 are composed of silver in order to improve the current-carrying qualities. The auxiliarly stationary contact 17 and its engaging portion 62 are composed of an arc resisting alloy of tungsten and silver; the proportions being 60% of the former and 40% of the latter. I prefer to use arc resisting material for these contact surfaces in order to reduce to a minimum the injurious effects of the arc which is established therebetween during the operation of the breaker.

The arc extinguishers 13 which I prefer to use with my invention are of the spaced-plate type which comprises a stack of composite plates, each having an edge portion of magnetic material and a central portion of non-magnetic material. Each composite plate is insulated from the adjacent plate and has a slot therein. The extinguishers are disposed adjacent to the arc path, the slots being of substantially the same outline as the moving contacts, and upon the establishment of the arc, due to the altering of the magnetic field adjacent to the arc path, force the arc to move into the spaces between the plates where it is rotated by suitable means associated with the extinguisher until it is cooled and extinguished.

The details of construction and the principles of operation of this preferred type of arc extinguisher are completely described in the application of M. W. Brainard, Serial No. 593,236, which was filed February 16, 1932, and which is also assigned to the assignee of this invention.

As previously pointed out, each of the arc extinguishers 13 is separated from the adjacent arc extinguisher by the insulating barriers 19, this construction gives an increased margin of safety while interrupting heavy arc currents by reducing the possibility of flash-over between adjacent poles.

The operating mechanism 9 comprises, in general, a U-shaped base 63, a pair of toggle links 65 and 67 for engaging the assembly of the switch members 11, a trigger 69 for releasably restraining the toggle links 65 and 67 in an operative position, a bifurcated operating lever 71, springs 73 for connecting the operating lever 71 to the knee of toggle links, and the operating handle 23. The U-shaped base 63 is fastened to the insulating base 1 of the circuit breaker proper by means of four screws 74, two at either end, and, in addition, it has a downwardly projecting portion 75 (Fig. 2) which is engaged by the central screw 47; the mechanism 9 is thus electrically connected to the circuit of the central pole of the breaker, the reason for this will be brought out in a subsequent paragraph.

A pivot pin 77 extends through suitable aligned openings in the U-shaped base 63 and engages the frame 37 of the central switch member 11. This pin 77 provides a pivot point for the assembly of switch members 11, all of which are mechanically tied together by the insulating bar 57.

Other holes are provided in the base 63 for the reception of the pivot pins 79—one on either side of the U—which provide pivot points for the bi-

furcated operating lever 71. The lower end (with respect to the base 1) of the toggle link 67 is pivotally connected to the frame 37 of the central switch member 11 by the pin 81, the pin 81 serving to connect the operating mechanism 9 and the assembly of switch members 11. The other end of the toggle link 67 is pivoted to one end of the second toggle link 65 by means of the knee pivot pin 83. The knee pivot pin 83 has means associated therewith for engaging one end of each of the operating springs 73, one on either end, the other end of the operating springs being connected to the operating handle 23. The trigger 69 which is pivoted about pin 85 provides a releasably restraining means for holding the toggle links 65 and 67 in the operable position; the movement of the trigger 69 in a counterclockwise direction (Fig. 2) about the pin 85 is limited by the projection 87 which extends inwardly from one side of the U-shaped base 63. The other end of the toggle link 65 is pivotally fastened to the trigger 69 by the pin 89.

The movement of the bifurcated operating member 71 is limited by the inwardly extending projections 91 and 93 of the U-shaped base. The projecting end 95 of trigger 69 is releasably engaged by the latch 97 associated with the trip structure 7.

As previously pointed out, the trip structure 7 is a unitary device entirely assembled upon its own insulating base 29 and completely removable from the breaker; the screws 47 and the bolts 99 with their associated nut 100 being utilized to mount the trip structure on the base 1 and to make the necessary electrical connections. The trip structure 7 includes a thermally responsive element 101 and a magnetically responsive element for each of the three poles. The three conducting bars or strips 103—one of which is associated with each of the poles of the breakers—have the quadruple function of providing terminals for the trip structure 7, of providing energizing means for each of the magnetically responsive elements, of providing heater means for the thermally responsive elements 101, and for providing a supporting means for the entire trip structure.

Each of the thermally responsive elements 101 is composed of bimetallic material. Four holes are provided therein for engaging the rivets 112 which fasten each of the bimetallic elements 101 to one of the conducting members 103. The sides of the thermally responsive element 101 taper toward each other in order to reduce the amount of bimetallic material required, and in order to secure a more uniform distribution of the bending stresses—the maximum mass being positioned nearest the hottest portion of the heater.

Fig. 6 shows a detailed view of one of the conducting strips 103 before being bent to its reflexed shape. It will be noted that openings 105 and 107 are provided in the terminals 36 and 35 for engaging the bolts 99 and the screws 47, respectively. Also, there are four holes 109 for engaging the rivets 112 which provide means for fastening the conducting strip 103 to the thermally responsive element 101 and to the frame 111 of each of the individual trip devices.

As shown, particularly in Figs. 2, 4, and 5, the conducting strips 103 in the assembled structure are bent so as to form two reflexed bends on loops 113 and 115. The straight part 116 of the conducting strip 103 which connects the terminal 36 and the loop 115 is utilized for energizing the magnetically responsive device while the loop 113 is utilized as a heater for the thermally responsive element 101. The portion of the conducting strip 103 which is used in forming the loop 113 is tapered so as to give a conducting section of gradually increasing electrical resistance; the point of the maximum resistance and the point of the maximum heating are located adjacent to the base of the thermally responsive element 101 (Fig. 5). The heating is thus concentrated at the point of maximum effectiveness. The portion 116 of the conducting strip 103 which is utilized as an energizing means for the magnetically responsive element is not of reduced section and does not heat appreciably while carrying the rated current of the breaker. The terminal 36 of the conducting strip 103 which engages the bolt 99 has been bent back upon itself to provide a better contact.

Each of the individual trip devices are built up around the conducting strip 103 and the frame 111. Each of the frames 111 which are of non-magnetic material is substantially U-shaped and has suitable openings 114 through which the rivets 112 pass. In addition to the openings 114, two other openings 118 are provided in the body of the U. The openings 118 provide means whereby the mounting screws 117 which extend through the base 29 may engage and position the iron core member 119, a suitable threaded opening 120 being provided therein. Each of the individual trip devices is thus rigidly fastened to the base 29, the conducting strip 103 providing terminals and supporting means for the entire structure. A cut portion 123 is provided in the core member 119 to permit the passage of the portion 116 of the conducting strip 103. A portion 125 extends outwardly from the top of the frame 111 and has a hole 127 therein. This hole 127 permits the passage of a pin 129 which is fastened to the moving armature 131. The moving armature 131 is of a magnetic material such as iron and has substantially the same overall dimensions as the core member 119.

A spring 133 which engages a suitable enlargement 135 of the pin 129 provides a biasing means for releasably holding the armature 131 against the lower side of the projecting portion 125 of the frame 111, the core member 119 being sufficiently energized upon the occurrence of a short circuit or heavy overload condition to attract the armature 131 against the bias of the spring 133. A thin strip of non-magnetic material 137 is interposed between the pole piece 111 and the armature 131 to prevent any sticking of the armature which might result from the residual magnetism in the two members.

A common trip bar 139 of molded insulating material which is actuable by all of the individual trip devices is provided. This bar 139 has two rearwardly extending arms 141 for engaging the pivot pins 143 which project through suitable openings in the supporting members 145. The supporting members 145 are fastened to the base 29 by suitable means (not shown). A second projecting portion 147 of insulating material (Figs. 2 and 3) extends downwardly from the trip bar 139 and through the agency of a suitable recess, engages a compression spring 149 which biases the trip bar inwardly toward the base 29 of the trip structure.

A depression 153 having three cut out portions 155 is molded into the trip bar 139. Each of these cut out portions 155 is engaged by one of the pins 129 associated with each of the individual moving armatures 131. An enlargement 157 on

the head of each of the pins 129 prevents the disengagement of the trip bar therefrom. Three screws 159 extend through suitable openings in the upper portion of the trip bar and provide adjustable means engageable by each of the thermally responsive elements 101.

It will be noted that the tripping forces supplied by the magnetically responsive elements and the tripping forces supplied by the thermally responsive elements have different lines of action. In fact the lines of action are 90 degrees apart—the armature 131 pulling downwardly (Fig. 3) and the bimetal 101 pushing outwardly—and the design of the trip bar 139 is such that these two sets of forces are caused to move the bar in the same direction. This arrangement is most effective for securing a trip device of small dimensions—it being possible to position the various trip elements so as to most effectively utilize the available space without regard to the line of action of the tripping forces supplied by those elements.

The trip latch 97 which engages the end of the trigger 69 is slidably pivoted about a pin 161 which extends through suitable openings in two brackets 163 which are affixed to the trip base 29 by rivets 166. The free end 167 of the latch 97 projects through a suitable opening 169 in the trip base 29 and engages the trip bar through the agency of a projecting metallic member 171 which is embedded in the trip bar proper. The latch 97 has two slots 173 for slidably engaging the pivot pin 161. A spring 165 exerts a force which prevents the slots 173 from disengaging the pivot pin 161, and, in addition, the spring 165 biases the latch 97 in a counter-clockwise direction (Fig. 2). The movement of the latch 97 in a counter-clockwise direction is limited by the projection 175 which extends inwardly from one of the bracket arms 163. When the trigger 69 is in the operative position, that is, when the end 95 is restrained by the latch 97, the latch is biased in a clockwise direction due to the relatively large force transmitted by the trigger. This force is balanced by the trip bar 139 which, through its projecting member 171, releasably engages the free end 167 of the latch 97 and prevents it from turning under the biasing action of the trigger 69.

The insulating cover 30 of the trip structure 7 is held in position by two screws 177 which extend through suitable openings therein and engage two threaded holes 179 on the bracket member 145. The insulating cover 21 for the breaker proper is retained in position by four screws 181 which engage threaded openings 183 in the insulating base 1. Openings 185 are provided in the insulating base 1 for the reception of mounting screws (not shown).

Referring particularly to Figs. 2 and 8, wherein the circuit breaker of my invention is shown in the closed position, it will be noted that the knee of the toggle links 65 and 67 is in the over-center locked position. Thus, the contacts 15 and 61 are held against each other with a substantially uniform contact pressure maintained by the springs 53.

To open the contacts manually, the operating handle 23 is moved clockwise about its pivot 75 (Fig. 8) whereupon the springs 73 exert a force having a component tending to move the knee pivot pin 83 of the toggle mechanism toward the base 29 of the trip device, or out of toggle. At a certain point, this component of force exerted by the springs 73 is sufficient to cause the toggle to break and move the switch members 11 clockwise about the pin 77, thus separating the contacts. The various parts of the mechanism are then disposed as shown in Fig. 9. The motion of the central switch member 11 is transmitted to the switch members for the outer poles by the insulating bar 57, as has been previously pointed out. The closing process is substantially the reverse of the opening process, the knee of the toggle links being moved, in this case, away from the base 29 of the trip device.

The combination of the toggle mechanism and the operating springs connected at their knee makes it possible to open and close the breaker contacts with a snap action. The proportions of the moving contact 31 are such that the circuit is first made and finally interrupted through the auxiliary stationary contact 17 and the tip 62 of the moving contact 31. When the breaker is in the fully closed position, the auxiliary stationary contact 17 does not engage the moving contact 31.

When the breaker is in the closed position and an overload comes on the circuit controlled by any one of the poles, the heater portion 113 of the conducting strip 103 is heated. The bimetal element 101 is in intimate contact with this heater portion 113 and immediately begins to deflect away from the base 29 of the trip structure. If the overload continues for a sufficient length of time, the bimetal element 101 engages the screw 159 and begins to move the trip bar 139 against its biasing spring 149. After a predetermined time delay, the trip bar 139 has been moved a sufficient distance to disengage the projection 171 from the free end 167 of the latch 97. The latch 97 is then free to rotate clockwise (Fig. 10) about the pin 161 under the biasing influence of the trigger 69. This rotation disengages the end 95 of the trigger 69 from the overhanging portion 191 of the latch 97 and permits the trigger to rotate counter-clockwise about the pivot pin 85. One end of the toggle link 65 is carried above the center line of the toggle, and the toggle then collapses toward the base 29 of the trip device thereby opening the breaker, the various parts of the mechanism moving to the positions shown in Fig. 10.

Similarly, in the event of a short circuit or a very heavy overload in the circuit controlled by any one of the poles, sufficient magnetomotive force is supplied by the conducting strip 103 to cause the armature 131 to be attracted to the pole piece 119. By altering the size of the spring 133, it is possible to calibrate the unit to operate to any reasonable degree of overload approaching the short circuit condition. The downward movement of the armature 131 toward the base 1 is transmitted to the trip bar through the projecting stud 129, the latch being released in substantially the same manner as before.

It is desirable to have a trip structure for a circuit breaker that is capable of opening the breaker after a predetermined time interval upon the occurrence of an overload in the controlled circuit, because in the normal operation of industrial feeder circuits, momentary moderate overloads are of frequent occurrence, and it is essential that the breaker does not open immediately in response to one of these moderate overloads. It is, however, equally important that the breaker open immediately upon the occurrence of a short circuit or a very heavy overload in order to protect the circuit equipment,

and it was with these requirements in view that the trip structure of my invention has been evolved. By proper adjustment of the springs 133 it is possible to secure instantaneous operation upon the occurrence of heavy overload within reasonable limits, and it is always possible to secure instantaneous operation of the breaker upon the occurrence of an overload approximating a short circuit condition. The thermally responsive elements introduce a time delay in the operation of the trip devices and are capable of carrying moderate overloads for short periods of time without opening the interrupter.

Should an attempt be made to close the breaker against an overload or against a short circuit condition, the latch 97 will be released after a predetermined time delay or instantaneously, depending upon the magnitude of overload exactly as described before. The trigger will likewise be released and will cause the toggle mechanism to break so as to open the breaker independently of the position of the operating handle. Thus, it is not possible to hold the breaker closed against a short circuit or against a continued overload condition.

After the breaker has been opened by the trip device, it is necessary to restore the mechanism from the tripped position (Fig. 10) to the operative position (Fig. 8). The projection 187 on the operating handle 23 is provided for this purpose. Following the tripping of the breaker, the handle 25 may be moved clockwise (Fig. 10) whereupon the projection 187 which engages the end 189 of the trigger 69 will cause the trigger to rotate clockwise about its pivot 85. As the operating handle 23 nears the limit of travel in a clockwise direction, the end 95 of trigger 69 abuts against the overhanging portion 191 of the latch 97—trigger 97 having been returned by its biasing spring 165 to its normal position where it is held by the projection 171 on the trip bar—and moves the entire latch 97 (Fig. 10) toward the base 29, the latch sliding in the slots 173. Finally, the projecting end 95 passes beneath the overhanging portion 191 and the latch snaps back to the normal position under the influence of its biasing spring 165. The entire breaker mechanism is now in the open operative position (Fig. 8) and may be closed by a movement of the operating handle 23 exactly as described above.

While in accordance with the patent statutes, I have given the foregoing details of a practical embodiment of my invention, it is to be understood that many of these are merely illustrative and that variations of their precise form will be desired in some applications. I desire, therefore, that the language of the accompanying claims be accorded the broadest reasonable construction and that my invention be limited only by that which is explicitly stated in the claims and by the prior art.

I claim as my invention:

1. In a trip device for a circuit interrupter, a conducting member, and a thermally responsive member, said conducting member having a portion of reduced section, a part of which portion extends along a part of said thermally responsive member, a portion of said thermally responsive element being thermally conductively joined to said conducting member adjacent said reduced portion.

2. In a trip device for a circuit interrupter, a bar of conducting material, and a member of bimetallic thermally responsive material, said conducting bar having a portion of reduced section, a part of which portion is disposed closely adjacent to a part of said bimetallic member, said bimetallic member having a portion which is thermally conductively joined to said conducting bar.

3. In a trip device for a circuit interrupter, a bar of conducting material having a portion of reduced section, and a member of bimetallic thermally responsive material having tapering sides, one end of said bimetallic member being thermally conductively joined to said conducting bar adjacent said reduced portion, a part of said reduced portion being disposed substantially parallel to a part of said bimetallic member.

4. In a trip device for a circuit interrupter, a strip of conducting material having a portion of reduced section, and a thermally responsive member of bimetallic material having tapering sides, the end of the thermally responsive member having the greatest width being thermally conductively joined to said strip of conducting material, a part of said portion of reduced section extending along a part of said thermally responsive element.

5. In a trip device for a circuit interrupter, a conducting member having a single reflexed bend therein, and a thermally responsive member of bimetallic material supported on said conducting member and having a portion thermally conductively joined to a portion of said conducting member and a portion extending along a considerable portion of one side of said reflexed bend.

6. In a trip device for a circuit interrupter, a conducting bar having a portion of reduced section and a reflexed bend therein, and a thermally responsive member of bimetallic material having tapering sides, the end of the thermally responsive member having the greatest width being supported on, and thermally conductively joined to, said bar of conducting material, adjacent said portion of reduced section, a part of said thermally responsive member extending along and closely adjacent to a considerable portion of one side of said reflexed bend.

7. In a trip device for a circuit interrupter, a substantially U shaped frame, a thermally responsive member extending through said frame, an armature slidably supported by said frame, a core member positioned adjacent said armature, and a trip bar disposed adjacent said frame, said bar being operable by either said thermally responsive member or by said armature.

8. In a trip device for a circuit interrupter, a frame member, a thermally responsive member of bimetallic material mounted thereon, an armature slidably supported thereby, a core member positioned adjacent said armature, and a trip bar disposed adjacent said frame, said bar being operable by either said thermally responsive member or by said armature.

9. In a trip device for a circuit interrupter, a frame member, a thermally responsive member of bimetallic material mounted thereon, an armature slidably supported thereby, a core member likewise mounted on said frame and positioned adjacent said armature, and a single conducting means for heating said thermally responsive member and for energizing said core member.

10. In a trip device for a circuit interrupter, a substantially U shaped frame, a thermally responsive member of bitmetallic material mounted thereon and extending through said U, an armature slidably supported thereby, a core member positioned adjacent said armature, and a pivotally

mounted trip bar disposed adjacent said frame, said bar being operable by either said thermally responsive member or by said armature.

11. In a trip device for a circuit interrupter, a substantially U shaped frame, a thermally responsive member of bimetallic material mounted thereon and extending through said U, an armature slidably supported thereby, a core member mounted upon said frame adjacent said armature, and a single conducting means having a portion looped into said U for heating said thermally responsive member, and a portion for energizing said core member.

12. In a removable trip device for circuit interrupters, a base, electro-responsive means mounted on said base, and an integral conducting strip, releasably connectible at each end, for supporting said base and for providing terminals for said trip device, said conducting strip acting as an energizing means for said electro-responsive means during the operation of said device.

13. In a circuit interrupter, a switch member, means for biasing said switch member to one position, means including a trigger member for releasably restraining said switch member in one position, and a trip device including a latch engaging one end of said trigger and thereby releasably restraining said switch member in one position, said latch being slidably and pivotally mounted.

14. In a circuit interrupter, a switch member, means for biasing said switch member to the open position, means including a pivoted trigger member for releasably restraining said switch member in the closed position, and a trip device including a releasable latch for engaging one end of said trigger and thereby releasably restraining said switch member in the closed position, said latch being slidably and pivotally mounted, and rotating about its pivot point to release said trigger.

15. In a circuit interrupter, a switch member, means for biasing said switch member to the open position, means including a pivoted resettable trigger for releasably restraining said switch member in the closed position, said trigger rotating in one direction when releasing said switch member and rotating in the opposite direction when moving to the reset position, and a trip device including a releasable latch for engaging one end of said trigger and thereby releasably restraining said switch member in the closed position, said latch being slidably and pivotally mounted, said latch rotating about its pivot point to release said trigger and sliding along its mounting to reengage said trigger when said trigger moves to the reset position.

16. In a circuit interrupter, a base, an operating mechanism mounted on said base, and a removable trip device which is disposed within a suitable recess in said base, said trip device comprising a base member, at least one electro-responsive trip element mounted thereon, a means for operatively engaging said operating mechanism, and supporting means which includes the terminals of said trip device for supporting and positioning said device within said recess in said base member.

17. In a trip device for a circuit interrupter having a plurality of poles, a base member, a plurality of current carrying, bimetallic, thermally responsive elements, each electrically connected in the circuit controlled by one of said poles and each supported at one end thereof on said base member, a movable trip bar of insulating material pivotally supported on said base member and extending across two or more poles of said circuit interrupter, said trip bar being moved from a normal inoperative position to a tripped position during each tripping operation through the engagement therewith of one or more of said thermally responsive elements, means biasing said trip bar to said inoperative position, and individually adjustable engaging means intermediate each of said thermally responsive elements and said trip bar.

18. In a trip device for a circuit interrupter having a plurality of poles, a plurality of bimetallic thermally responsive elements, each electrically connected in the circuit controlled by one of said poles, a plurality of magnetically responsive elements, each energized in response to the current flowing in the circuit controlled by one of said poles, and a movable trip bar extending across two or more poles of said interrupter, each of said thermally responsive elements and each of said magnetically responsive elements including individual means for directly engaging said trip bar to cause said trip bar to move to the tripped position upon the occurrence of predetermined conditions, said trip bar including means for insulating the points on said bar which are engaged by said thermally responsive elements and by said magnetically responsive elements from each other.

19. In a trip device for a circuit interrupter having a plurality of poles, a plurality of bimetallic thermally responsive elements, each electrically connected in the circuit controlled by one of said poles, a plurality of magnetically responsive elements, each energized in response to the current flowing in the circuit controlled by one of said poles, and a movable trip bar extending across two or more poles of said circuit interrupter for engagement by any one of said plurality of thermally responsive elements, said plurality of magnetically responsive elements each including a movable armature mechanically connected to said trip bar at all times, said trip bar including means of insulating material positioned between the points on said trip bar engaged by said thermally responsive elements and the armature of said magnetically responsive elements, any one of said plurality of thermally responsive and said magnetically responsive elements being capable of causing said trip bar to move to the tripped position upon the occurrence of predetermined conditions.

20. In a circuit interrupter; a base; contact means and actuating means for moving said contact means to open and to close the electrical circuit through said interrupter mounted on said base; and a removable trip device for cooperating with said actuating means; said trip device including a separate base, at least one electro-responsive trip element mounted thereon, means for operatively engaging said actuating mechanism, and supporting means for rigidly supporting the base of said trip device upon said main base and for accurately positioning said trip base with respect to said main base; said supporting means including an integral conducting strip releasably connectible at each end into the electrical circuit through said interrupter; said conducting strip acting as an energizing means for said electro-responsive means during the operation of said trip device and in addition providing terminals for said trip device.

21. In a circuit interrupter; a base; separable contact means and actuating means for moving

said contacts to open and to close the electrical circuit through said interrupter supported on said base; and a removable trip device which is normally disposed within a suitable recess formed within said base; said trip device including a secondary base member, at least one electro-responsive trip element mounted on said secondary base member, means for operatively engaging said operating mechanism, and an integral, conducting strip, releasably connectible at each end, for supporting said secondary base and for providing terminals for said trip device; said conducting strip acting as an energizing means for said electro-responsive means during the operation of said device, and being adapted to accurately position said device within said recess in said base member.

22. In a circuit interrupter; separable contact means; actuating means for moving said contact means to open and to close the electrical circuit through said interrupter; and a trip device for cooperating with said actuating means; said trip device being operable upon the occurrence of predetermined conditions to cause said actuating means to move said contact means to the open circuit position, and including a latch member which normally engages and holds said actuating means, said latch member being rotatable about a pivot point which is fixed during its releasing movement, electro-responsive means for effecting the release of said latch member, and biasing means normally biasing said latch member to the latched position; said electro-responsive means being operable upon the occurrence of predetermined conditions to effect the release of said latch member, and said actuating means, upon the release of said latch member, automatically moving said contact means to the open circuit position; said trip device being automatically resettable following each operation thereof, and said latch member which normally engages and holds said actuating means being movable independently of the other elements of said trip device in order to permit the reengaging of said actuating means following each automatic resetting operation.

23. In a circuit interrupter; separable contact means movable to an open circuit and to a closed circuit position; actuating means for said contact means including a member movable from a normal inoperative position to an operative position to cause said contact means to be moved from the closed circuit to the open circuit position, and means biasing said member to said operative position; and a trip device for cooperating with said actuating means; said trip device including a latch which normally restrains said member from moving to said operative position, means biasing said latch to the latched position, and electro-responsive means for effecting the release of said latch upon the occurrence of predetermined conditions; said trip device being resettable following each operation thereof to the extent that said latch is automatically restored to the normal latched position immediately following the release of said movable member; said actuating mechanism including means for causing said movable member to reengage said latch means following each circuit opening operation produced by the operation of said trip device, and said latch being movable independently of the other elements of said trip device in order to permit the relatching of said movable member without disturbing the normal reset position of the other elements of said trip device.

24. In a circuit interrupter; separable contact means movable to an open circuit and to a closed circuit position; actuating means for said contact means including a pivotally supported member movable from a normal inoperative position to an operative position to cause said actuating means to move said contact means from the closed circuit to the open circuit position, and means biasing said movable member to said operative position; and a trip device for cooperating with said actuating means; said trip device including a pivotally supported latch which normally restrains said member from moving to said operative position, means biasing said latch to the latched position, a plurality of electro-responsive elements each operable upon the occurrence of differing predetermined conditions to effect the release of said latch, a member intermediate said latch and said electro-responsive elements which is movable in response to the operation of any one of those elements to effect the release of said latch, and means biasing said intermediate member against movement to effect the release of said latch; said trip device being automatically resettable following each operation thereof; said actuating means including means for causing said movable member to reengage said latch following each circuit opening operation produced by the operation of said trip device, and said latch being movable independently of said intermediate member and said electro-responsive elements to permit the reengagement of said latch and said pivotally supported member movable to cause said actuating means to move said contact means to the open circuit position without moving said intermediate member or said electro-responsive elements from their normal reset position.

25. In a trip device for a circuit interrupter, a conducting member, and a thermally responsive member, said conducting member having a portion of increased resistance, at least a part of which portion extends along a part of said thermally responsive element, and a portion of said thermally responsive element being thermally conductively joined to said conducting member adjacent said portion of increased resistance.

26. In a trip device for a circuit interrupter, a strip of conducting material having a portion of increased resistance, and a thermally responsive member of bimetallic material having tapering sides, the end of the thermally responsive member having the greatest width being thermally conductively joined to said strip of conducting material, and at least a part of said portion of increased resistance extending along a part of said thermally responsive element.

27. In a trip device for a circuit interrupter, a relatively rigid member of conducting material having a single reflexed bend therein, a thermally responsive member of bimetallic material supported on said conducting member and having a portion thermally conductively joined to said conducting member adjacent said portion of increased resistance and a portion extending along a considerable portion of one side of said reflexed bend.

28. In a trip device for a circuit interrupter, a frame member, a thermally responsive element supported on said frame, a core member also supported on said frame, an armature for cooperating with said core member, and a single conducting member for heating said thermally responsive member and energizing said core member, said conducting member having a por-

tion of increased resistance normally disposed adjacent said thermally responsive element.

29. In a trip device for a circuit interrupter, a frame member, a thermally responsive element, comprising a flat strip of bimetallic material having a length at least several times its width, supported at one of its ends on said frame, a core member also supported on said frame, and a single conducting member for heating said bimetallic thermally responsive element and for energizing said core, said conducting member including a portion of increased resistance normally disposed adjacent said thermally responsive element and a single reflexed bend normally looped about said core.

30. In a multi-pole circuit interrupter, a base, separable contact means for opening and for closing a plurality of poles mounted on said base, actuating means for said contact means, and a removable trip device operable upon the occurrence of predetermined conditions to cause said actuating means to move said contact means automatically from the closed circuit to the open circuit position thereof, said trip device including a separate base, a plurality of thermally responsive tripping elements mounted thereon, a single trip bar mounted on said base so as to extend across a plurality of the poles of said interrupter, said trip bar being movable by any one of said thermally responsive elements from a normal inoperative to an operative position to effect the operation of said trip device, and means for rigidly supporting the base of said trip device upon said main base and for accurately positioning said trip base with respect to said main base, said supporting means including a plurality of integral conducting strips each of which is releasably connectible at each end thereof into the electrical circuit through one of the poles of said interrupter, each of said conducting strips being provided with a portion of increased resistance, in order that it shall serve as an energizing means for one of said thermally responsive elements during the operation of said trip device, and with portions which serve as terminals for said trip device.

31. In a multi-pole circuit interrupter, a main base, separable contact means for opening and for closing a plurality of poles mounted on said base, actuating means for said contact means, and a removable trip device operable upon the occurrence of predetermined conditions to cause said actuating means to move said contact means from the closed circuit position to the open circuit position, said trip device including a separate base, a plurality of thermally responsive tripping elements mounted thereon, a plurality of magnetically responsive tripping elements, each of which includes a core member and movable armature, likewise mounted on said separate base, a single trip bar supported on said separate base so as to extend across a plurality of the poles of said interrupter, said trip bar being movable from a normal inoperative to an operative position to effect the operation of said trip device in response to the actuation of any one of said thermally responsive or said magnetically responsive tripping elements, and supporting means for rigidly supporting the base of said trip device upon said main base and for accurately positioning the said trip base with respect to said main base, said supporting means including a plurality of integral conducting strips releasably connectible at each end thereof into the electrical circuit through one of the poles of said interrupter, each of said conducting strips having a portion of increased resistance for energizing one of said thermally responsive elements and a portion adapted to inductively link with one of said core members for energizing one of said magnetically responsive elements, said conducting strips being also provided with portions which serve as terminals for said trip device.

HARRY J. LINGAL.