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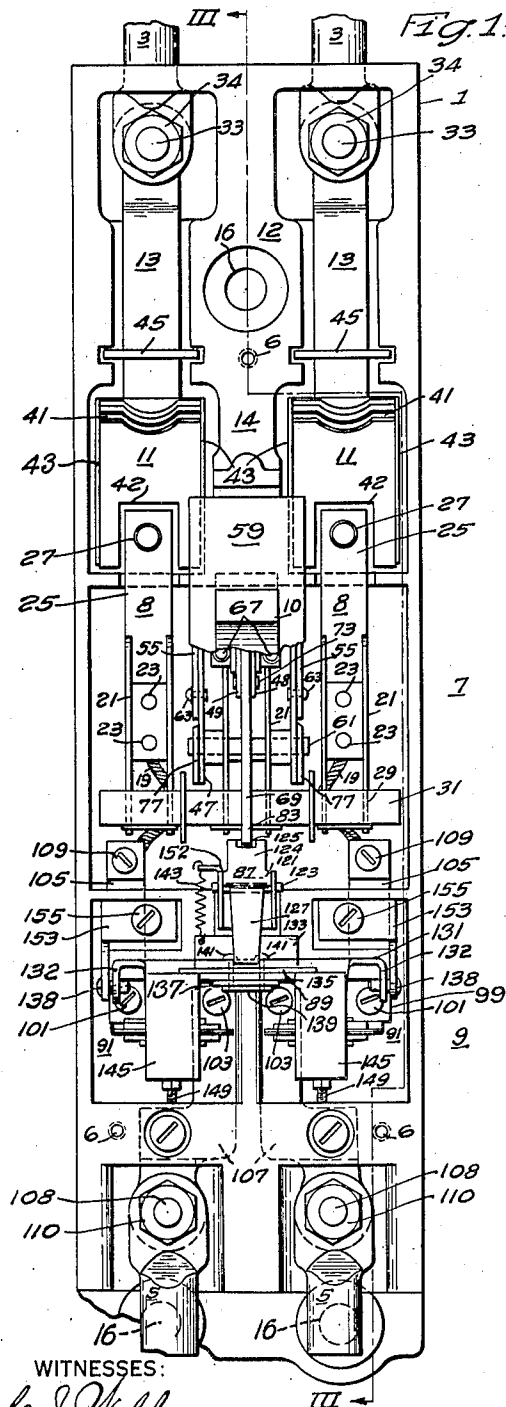
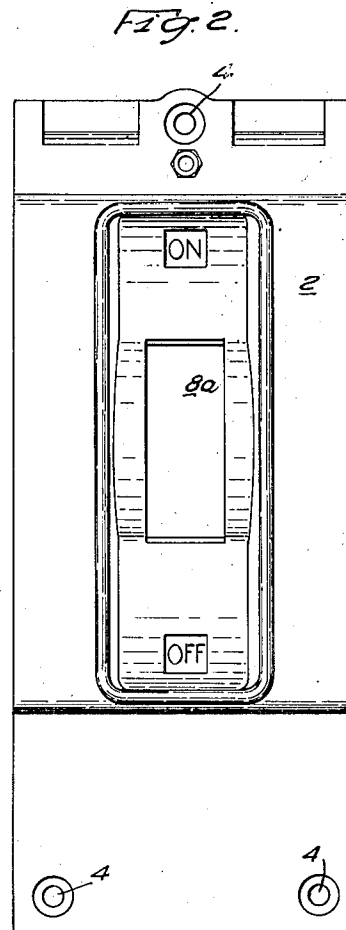
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2,050,284

CIRCUIT INTERRUPTER

Filed March 23, 1932

3 Sheets-Sheet 1



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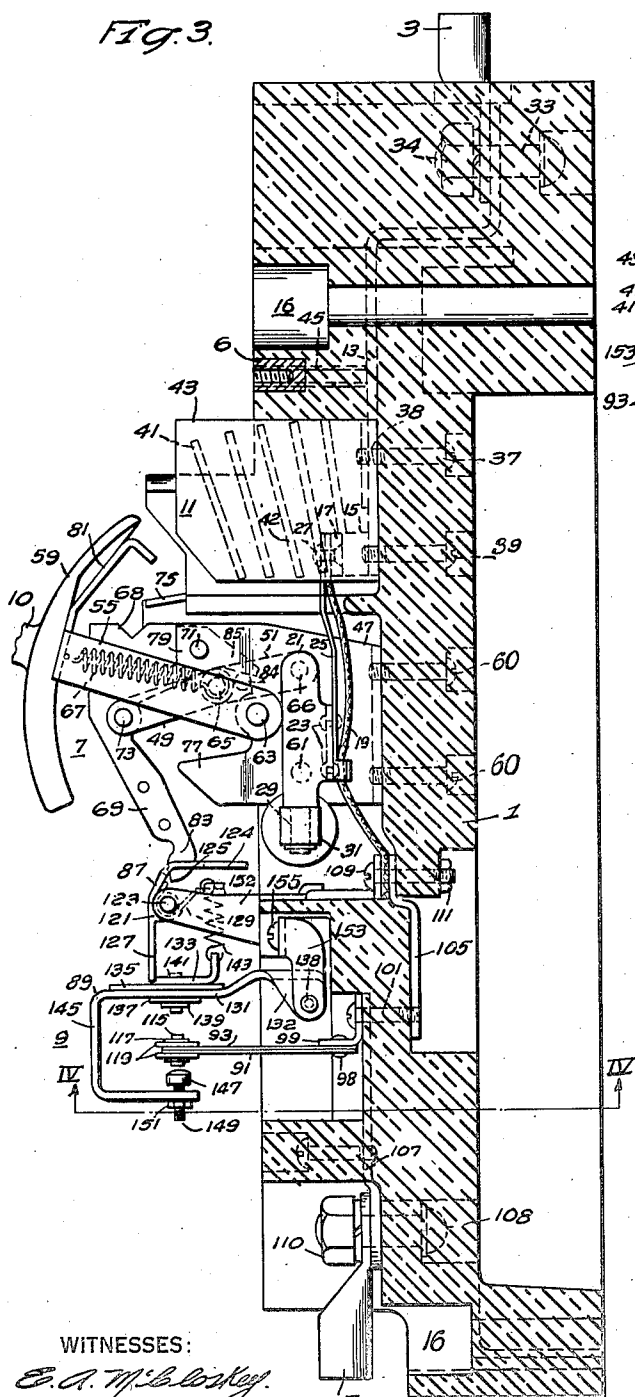
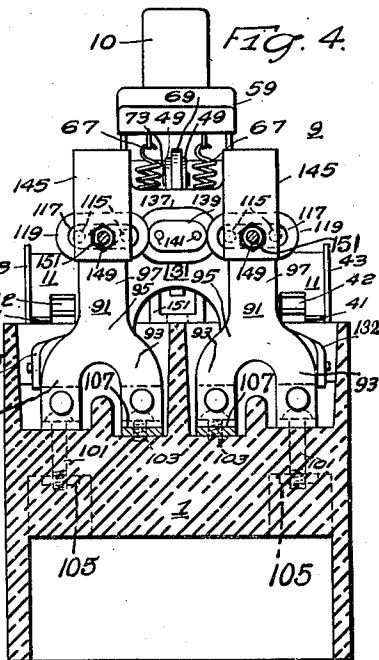
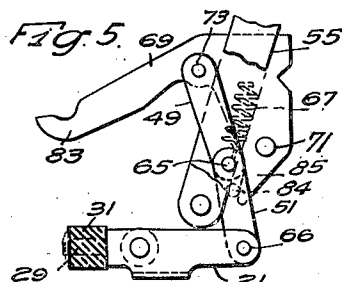
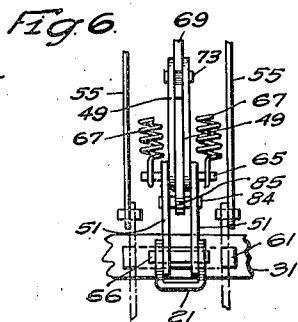
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CIRCUIT INTERRUPTER

Filed March 23, 1932

3 Sheets-Sheet 2



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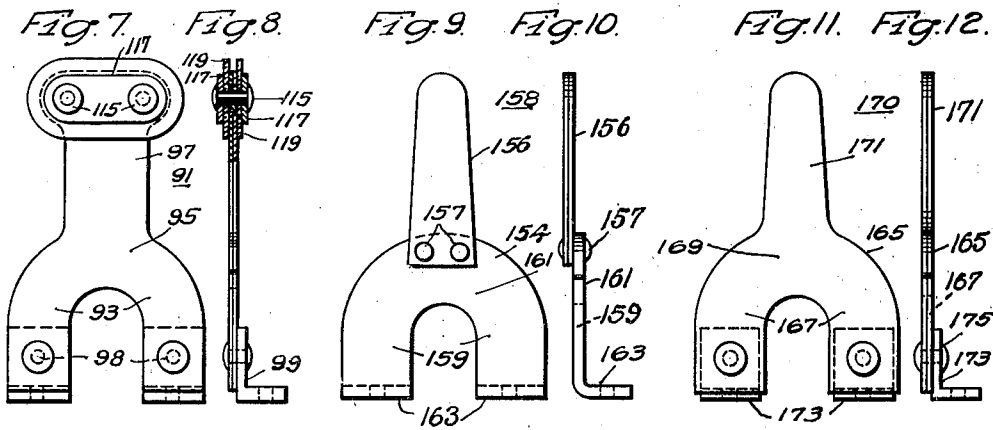
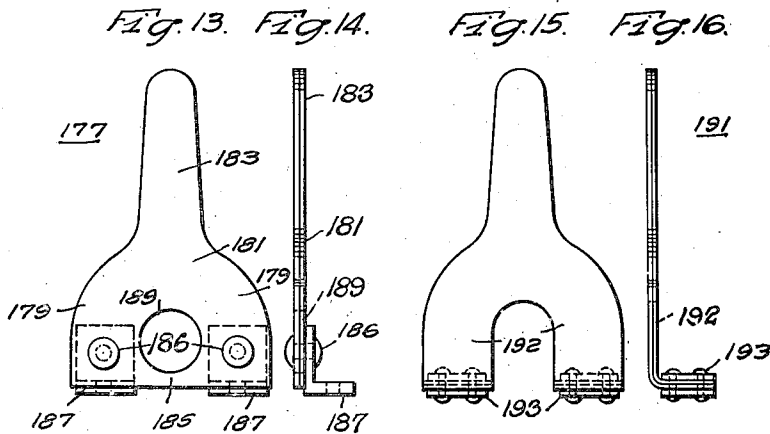
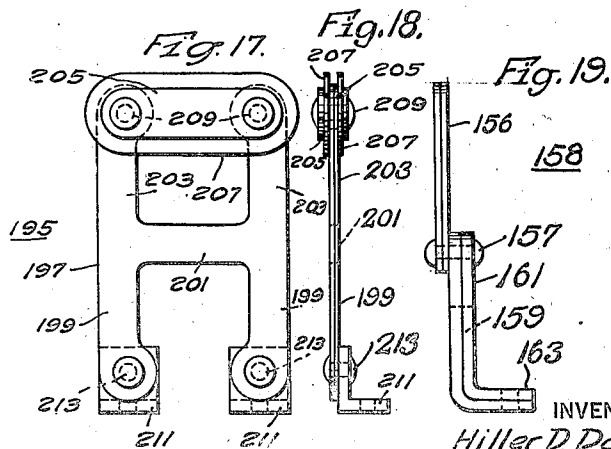
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2,050,284

CIRCUIT INTERRUPTER

Filed March 23, 1932

3 Sheets-Sheet 3



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2,050,284

CIRCUIT INTERRUPTER

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Application March 23, 1932, Serial No. 600,660

39 Claims. (Cl. 200—116)

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 in response to an overload condition in the controlled circuit, the trip mechanism being capable of distinguishing between overloads of differing magnitude and having means associated therewith for causing a time interval to elapse between the occurrence of an overload and the opening of the breaker, the time interval being inversely proportional to the magnitude of the overload current.

Another object of my invention is to simplify and improve the bimetallic thermally responsive elements used in circuit breaker trip mechanisms in order that those elements may be manufactured and operated more economically than has been heretofore possible. In carrying out this object, I provide bimetallic elements designed to give the maximum of deflections with a minimum of mass and a minimum of heating. I am, thereby, able to reduce the manufacturing costs of these elements both by reducing the amount of bimetal required and by simplifying the design. In addition, by reducing the amount of heating required, I am able to reduce the resistance of the element and thus reduce the normal operating losses of the breaker.

A further object of my invention is to provide a trip device for a circuit interrupter in which the thermally responsive elements shall be free from external stress.

A further object of my invention is to provide a trip mechanism for a multi-pole circuit breaker having a thermally responsive element associated with each pole thereof, and a means engageable and operable by any one of said thermally responsive elements to trip all of the poles of said breaker.

A still further object of my invention is to provide a trip mechanism for a circuit breaker which shall be capable of opening all of the poles of the breaker after a very short time delay upon the occurrence of a short circuit and after a predetermined longer time interval upon the occurrence of an overload condition, which shall be capable of tripping the breaker irrespective of the position of the operating handle, and which shall be re-

settable to the operating position by means associated with the operating handle.

The principal field for immediate application of my invention is in connection with multi-pole 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 in any way intending to restrict 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 moving the switch members to the open and closed positions 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 trip device for releasing the restraining means in response to a predetermined electrical condition in any one pole and 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. 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 two-pole circuit breaker embodying the principal elements of my invention; the cover has been removed and part of the operating handle has been cut away to more clearly show the various parts of the operating mechanism;

Fig. 2 is a plan view of the cover for the breaker shown in Fig. 1;

Fig. 3 is a sectional view on the line III—III of Fig. 1;

Fig. 4 is a sectional view on the line IV—IV of Fig. 3;

Figs. 5 and 6 are fragmentary views of the breaker operating mechanism; and

Figs. 7 to 19, inclusive, are enlarged detail views showing various modifications of the bimetallic thermally responsive elements used in this embodiment of my invention.

Referring particularly to Figs. 1, 3, and 4 of the drawings, the insulating base 1 is of molded insulating material and has mounted thereon the contact terminals 3 and 5, the circuit breaker operating mechanism 7 which has associated therewith the

assemblage of the two switch members 8, the trip mechanism 9, the arc extinguishing structures 11, and the stationary contact assemblages. As will be more fully pointed out later, these various parts 5 are all attached to the insulating base 1 by means of suitable screws. The switch members 8 and the stationary contact assemblages combine to form the two poles of the breaker. An insulating barrier 14 which is molded in the base, serves to separate the two poles. An insulating cover 2 (Fig. 2) 10 is provided which completely encloses the breaker operating mechanism and the tripping mechanism.

The electrical circuit for each pole of the 15 breaker is substantially the same. Beginning with the terminal contact 3, the current next flows through the stationary contact assemblage comprising the conducting strip 13 and the stationary contact 15, the moving contact 17 and the conducting shunt 19 of the switch member 8, the trip device 9, and the terminal contact 5.

Each of the switch members 8 has an iron frame 21 upon which the remainder of the structure is assembled. Fastened to the part of the 25 frame 21 adjacent the base 1, by means of the rivets 23, is a flat spring 25; the moving contact 17 and one end of the shunt 19 are fastened to the free end of the flat spring 25, by means of the rivet 27, which extends through suitable openings in the conducting shunt 19 and the spring 25. The spring 25 provides a means for securing contact pressure between the contacts 15 and 17, and, in addition, serves to bias the switch member 8 to the open position. Each of the switch member 35 frames 21 has two projections 29 of reduced width which extend downwardly (Figs. 1 and 3) from the frame proper. These projections are provided to engage an insulating bar 31 which extends across both of the poles. Suitable openings are provided in the insulating bar 31 for the reception of these projections 29; the projections being of sufficient length that they may be bent over and clinched after passing through the openings in the insulating bar 31, and thus serve to securely 45 fasten each of the frames 21 to the bar 31. It will be noted that three switch member frames 21 are provided, although there are only two switch members; the centrally disposed frame being utilized for engaging the circuit breaker operating mechanism. The insulating bar 31 provides a convenient means for operating both of the switch members 8 from the single operating mechanism 7, and, in addition, it provides a means for interconnecting the switch members 8 55 so that both open and close together.

One end of each of the conducting strips 13 is fastened to a terminal contact 3 by means of a bolt 33 and its associated nut 34. The conducting strip itself is fastened to the insulating base 1 by means of a screw 37 which engages a suitable threaded opening 38 therein. Each of the stationary contacts 15 is fastened to its associated conducting strip 13 by means of a screw 39. I prefer to use arc resisting materials for the stationary contacts 15 and the moving contacts 17, a mixture of silver and graphite being utilized for the former, and an alloy of silver and molybdenum for the latter.

The arc extinguishers 11 are of the spaced-plate type in which a plurality of plates of magnetic material, each insulated from the other and having slots therein, are provided. These extinguishers are disposed adjacent to the arc path—the slots being of substantially the 75 same outline as the moving contacts—and upon

the establishment of the arc, the magnetic field around the arc is altered by the plates so as to force the arc to move into the spaces between the plates where it is quickly cooled and extinguished.

In the structure which I prefer to use, the magnetic plates 41, having slots 42 therein, are assembled between two end plates 43 of insulating material, projecting lugs (not shown) being provided in the magnetic plates 41 for engaging the end plates 43. In the assembled breaker structure, two insulating members 45 are provided. These insulating members 45 extend across the upper part (Fig. 1) of the open end of the arc extinguishing structures 11 and engage the central insulating barrier 12 which separates the two 15 poles of the breaker. They serve to more completely separate the arc chambers from the remainder of the structure, and give an increased margin of safety when interrupting heavy arc currents by assisting in preventing flashovers between the adjacent poles.

The operating mechanism 7 comprises, in general, a U-shaped frame 47, a pair of toggle links 49 and 51, a trigger 69 for releasably restraining the toggle links 49 and 51 in the operative position, a bifurcated operating lever 55, springs 67 for connecting the operating lever 55 to the knee of the toggle links, and the operating handle 59. The U-shaped frame 47 is fastened to the insulating base 1 of the circuit breaker proper by means of two screws 60. A pin 61 extends through aligned openings in the U-shaped base and engages the central frame member 21 of the moving contact assembly. This pin 61 provides a pivot point for both of the switch members 8 which are 35 mechanically tied together by the insulating bar 31.

Other holes are provided in the frame 47 for the reception of the pivot pins 63—one on either side of the U—which provide pivot points for the bifurcated operating lever 55. The lower end of the toggle link 51 is pivoted to the end of the central frame 21 by the pin 66. The upper end of the link 51 is pivoted to the lower end of the toggle link 49 by means of the knee pin 65; and the upper end of the link 49 is pivoted to the trigger 69 by the pin 73. The pin 65 extends for some distance on either side of the links 51 and 49, and has means associated therewith for engaging the operating springs 67, one on either side (Fig. 6). The trigger 69, which is pivoted about the pin 71, provides a releasably restraining means for holding the toggle links 49 and 51 in the operative positions.

The movement of the trigger 69 in a clockwise direction is limited by the projection 75, which extends inwardly from one side of the U-shaped base 47. The movement of the bifurcated operating member 55 is limited by the projections 77 and 79 which extend outwardly from the sides of 60 the U-shaped base. A projecting member 81 is fastened to the operating handle 59 and provides a means for resetting the trigger 69. The projecting end 83 of the trigger 69 is releasably restrained by the latch means associated with the trip device 9.

Referring particularly to Figs. 5 and 6, it will be noted that the toggle links 49 and 51 are of parallel construction. This results in a more rigid structure and contributes to the ease of assembly. The parallel links 51 are fastened together by a pin 84. This pin 84 engages a projection 85 on the trigger 69, and acts as a stop for limiting the movement of the knee of the toggle during the closing operation.

As previously pointed out, the trip device 9 is entirely assembled upon the insulating base 1. It comprises a latch 87, a latch retaining means 89, and two thermally responsive elements 91 for engaging and releasing the latch retaining means 89. Each of the thermally responsive elements 91, as shown in this particular modification (Figs. 4, 7, and 8) is composed of bimetallic material. Each comprises a pair of leg portions 93 joined to each other by a connecting portion 95 so as to form a substantially U-shaped conducting loop, and a portion 97 which extends outwardly from the loop. Substantially L-shaped terminals 99 are fastened to the opposite ends of the U by means of the rivets 98 and connect, by means of the screws 101 and 103, to the conducting strips 105 and 107. Each of the conducting strips 105 is connected by the screw 109 and the nut 111 with the conducting shunts 19 associated with each of the switch members 8. The conducting strips 107 are each connected to one of the contact terminals 5, by a bolt 108 and a nut 110 and serve to complete the electric circuit through the interrupter. The bimetallic element 91 is shown in detail in Figs. 7 and 8, and is more completely described in a subsequent paragraph.

The latch 87 is essentially a centrally pivoted bell-crank lever. The projections 121 which extend downwardly toward the base 1 engage the pivot pin 123, and provide the pivot point. An opening 125 is provided in the end 124 of the lever for engaging the end 83 of trigger 69. The other end 127 of the latch 87 is engaged by the latch retaining means 89. A spring 129 biases the latch in a counter-clockwise direction (Fig. 3) to the unlatched position.

The latch retaining means 89 includes a body member 131, which extends across both poles and has two projections 132 for engaging pivot pins 138. An L-shaped iron member 133, two mica plates 135 and 137, and a flat iron member 139 are riveted to the body portion 131 by means of the rivets 141; these provide a means insulated from the body member 131 for releasably engaging the projection 127 on the latch 87. In addition, they provide a means for engaging a spring 143 which biases the latch retaining means to the retained position. Two overhanging projections 145 extend outwardly from the body portion 131. Each of these projections 145 has a threaded opening for engaging the stud 149 of an insulating knob 147. A nut 151 is provided for locking the stud 149 in position. The insulating knob 147 and the overhanging projection 145, together, provide means whereby a movement of the thermally responsive element 91 may be transmitted to the latch retaining means 89, to open the breaker. It should be noticed that since the projection 127 forms a stop limiting the clockwise rotation of the latch retaining member 89 under the influence of its biasing spring 143, the thermally responsive element 91 is under no external stress of any sort when in its normal position so that there is no tendency for it to take a permanent set in a distorted position.

The latch 87 is supported in a U-shaped iron cradle 152 which is fastened to the insulating base 1 by means of a screw (not shown). In like manner, the pivot pins 138 for the latch retaining means 89 are supported by two base members 153 fastened to the insulating base 1 by screws 155.

The insulating cover 2 has openings 4 therein which align with the threaded openings 6 in the insulating base 1, and provide means for the re-

ception of screws to hold the cover in position. An opening 8a is provided for the projection 10 on the operating handle 59. The holes 16 in the insulating base 1 provide a convenient means for mounting the breaker.

Figs. 9 to 18, inclusive, illustrate various designs and modifications of the thermally responsive elements used in carrying out my invention. The reason for the various shapes employed and the advantages resulting from the use of each design will be more apparent after an examination of the general characteristics of bimetallic thermally responsive elements. It is well known in the art that the deflection of a bimetallic member, due to heating, is proportional to the square of the free length of that member. Thus, in the design of bimetallic thermally responsive elements, it is desirable to secure the maximum possible effective length, the minimum electrical resistance—if the element is directly heated by current flow therethrough—and the most efficient distribution of the surface and mass—to reduce the quantity of bimetal required. The various designs, and the modifications thereof, which I disclose in the application all fulfill as many of the above requirements as is possible for the particular current condition and the particular time delay characteristic involved.

All of the thermally responsive elements herein disclosed are primarily intended to be directly heated—that is, terminals are provided, and it is intended that the current in the controlled circuit should flow through a portion of the element, which portion serves as a heater. It is quite possible, however, to utilize any or all of these designs with indirect or auxiliary heaters, and it is my wish and intention that the appended claims should cover structures of that type.

Figs. 7 and 8, are enlarged views of the bimetallic thermally responsive element 91 used in the complete embodiment of my invention. This bimetal design is particularly adapted for moderate values of current. The current conducting loop or heater portion, formed by the two leg portions 93 and the conducting portion 95, is of appreciable area and permits the passage of considerable current without undue heating. Furthermore it is not readily burned out by heavy short circuit currents. The projecting portion 97 is likewise of considerable thermal capacity. Thus, the element 91 is capable of carrying moderate currents continually without undue heating and with a low I²R loss, and the mass distribution of the element is such as to introduce an appreciable time lag between the beginning of an overload condition and the deflection of the projecting portion 97 to a position where it opens the breaker. By making the conducting heater loop form only a part of the element proper, I am able to reduce the amount of bimetallic material required while retaining the desired time interval, and in addition I am able to reduce the resistance of the heater. It is especially desirable to reduce the mass of the bimetal to a minimum because of the high cost of bimetallic thermally responsive material. The iron members 117, which are insulated from the end 97 of the bimetallic element 91 by the mica plates 119 and are fastened together by the rivets 115 serve to stiffen the free end of the element and make for more reliable operation.

The design 158 shown in Figs. 9 and 10 comprises a heater portion 154 and a projecting portion 156, the projecting portion being riveted to the heater portion by means of two rivets 157. Essentially, the heater portion is of substantially

the same outline as the corresponding heater portion in the element 91. It has two leg portions 159 and a portion 161 connecting the leg portions. The terminals 163, however, are formed integral with the heater portion. This design has several advantages for certain applications. It is particularly satisfactory for use in trip devices where large currents are to be carried with a minimum of deflection. Also it has considerable merit for applications where a considerable time delay is desired. The projecting portion 156 is of bimetallic material, and the heater portion 154 may or may not be of bimetallic material as is pointed out in some detail in the following paragraph.

If it is desirable to carry heavy currents, and if the trip device controlled by the thermally responsive element is actuatable by a moderate deflection thereof, I prefer to use a material such as stainless steel for the heater portion 154. This material is considerably cheaper than bimetal, and, despite the cost of the riveting process, results in a cheaper thermally responsive element for higher currents. If, however, the currents to be carried are of comparatively small magnitude, and if it is desired to secure a maximum deflection, the heater portion 154 and the projecting portion 156 may both be formed of bimetallic material (Fig. 19). In this case, I prefer to use materials of different thicknesses for the two portions. That is, the heater portion is usually of heavier gauge plate than the projecting portion. This type of construction gives a somewhat greater deflection for the same heating effect than does the element in which the heater and projecting portions are of different materials.

The design 170 shown in Figs. 11 and 12 is similar to the design shown in Figs. 7 and 8, except that the end portion has been simplified. It comprises a heater portion 165 having two leg portions 167, a connecting portion 169, and a projecting portion 171, all formed integral with each other. The terminals 173 are riveted to the leg portions 167 by the rivets 175. The same advantages which are claimed for the bimetallic element 91 may be claimed for this element—the conducting loop comprises only a part of the total length of the element, thus large deflection is secured with a small expenditure of energy, and a minimum mass of bimetal, consistent with the currents to be carried, is made possible. In addition, the design 170 has a simplified projecting portion 171, which aids considerably in reducing the cost of manufacture, the projecting portion 171 not being subject to buckling.

The design of bimetal 177, shown in Figs. 13 and 14, is a modification of the design 170, and is particularly adapted for handling very heavy currents. The usual terminals 187 fastened by the rivets 186, a conducting portion 181, and a projecting portion 183 are provided. A portion 189 has been cut out between the terminals 187; this cut out portion defines two leg portions 179 and a second conducting portion 185 which is shunted across the terminals 187. The size of the opening 189 depends upon the specific rating of the element under consideration, and its function is to alter the electrical circuit between the terminals and to divide the current path into two parts. The bimetal design 177 has low resistance between the terminals 187, and is of a design particularly adapted for stock purposes. That is, blank forms having the general outline of the element 177 and having the terminals 187 may be placed in stock. Then, when it is necessary to construct a trip unit for a particular rat-

ing, the opening 189 may be punched out to suit that particular requirement. This design thereby cuts down in the number of stock forms which it is necessary to keep on hand, and provides a very satisfactory and a very economical method for securing thermally responsive devices of different current ratings.

The design 191, which is shown in Figs. 15 and 16, is very similar to the design 170 with one exception—the two terminals 193 are formed by bending over the ends of the leg portions 192. This design reduces the points where the electrical circuit is maintained by pressure contact, and is effective in cutting down the heat losses.

The design 195, which is shown in Figs. 17 and 18, is of somewhat different form than the previously described designs, it being substantially H-shaped. The heater portion 197 comprises two leg portions 199 and a conducting portion 201 extending therebetween. In addition, two projecting members 203 extend outwardly from the heater portion. These members 203 are fastened to each other by means of two iron members 205, each insulated from the thermal element 195 by a mica strip 207, and rigidly fastened together by the rivets 209 which extend through suitable openings in the projections 203 and from which openings the rivets are insulated. The terminals 211 are fastened to the leg portions 199 by means of rivets 213. This design is of particular value when a considerable mass of bimetal is desired for securing a considerable time delay in the operation of the device, and when it is desirable, at the same time, to reduce the resistance of heater portion to minimum. The two projecting portions 203 provide the additional mass required, and the connection portion 201 reduces the resistance of the heater. The deflection of an H-shaped bimetal is substantially equal to the deflection secured by a U-shaped bimetal having the same overall dimensions, and a considerable operating saving is effected by the reduction of heat losses made possible with the H-shape. The amount of bimetal used is about the same for the H or the U shape.

The terminals on all of the bimetal elements shown in Figs. 7 to 18, inclusive, are positioned similarly, and any of the elements shown in Figs. 9 to 18 may be substituted for the element 91 illustrated in the other figures of the drawings, the screws 101 and 103 serving as fastening means.

In Figs. 1 to 6, the circuit breaker used in illustrating this embodiment of my invention is shown in the closed position. It will be noted that the knee pivot pin 65 of the toggle links 49 and 51 has moved to a point above (Fig. 3) the center line of the toggle. Thus the switch members 8 are locked in the closed position and maintain, through the agency of the flat springs 25, a substantially constant contact pressure. To open the breaker manually, the operating handle 59 is pushed in a counter-clockwise direction (Fig. 3) about its pivot point 63. This moves the springs 67 in a similar direction about the knee pivot 65, and at some point, before the limit of motion of the operating handle 59 has been reached, a component of force will be exerted by the springs 67, tending to move the knee pivot 65 to break the toggle downwardly toward the trip device 9.

A continued movement of the operating handle 59 will then cause the collapse of the toggle and the movement of the switch members 8 to

the open position, the switch members 8 being mechanically tied together by the insulating bar 31. The closing operation, when effected by the operating handle, is substantially the reverse of the opening operation. The operating handle is now moved in a clockwise direction about the pin 63, and as the movement progresses the spring 67 exerts a force tending to move the knee pivot 65 of the toggle upward, this movement being completely effected when the handle has nearly reached the closed position. The movement of the toggle links 49 and 51 during the closing process is restricted by the engagement of the pin 84 and the projecting portion 85 on the trigger 69.

In the event of an overload or a short circuit in either one of the circuits controlled by the switch members 8, the bimetallic thermally responsive element 91 in that particular pole will begin to deflect downwardly (Fig. 3). If the overload continues for a predetermined time interval, the free end 97 of the bimetal element 91 will eventually engage the insulating knob 147, and will move the latch retaining means 89 against its biasing spring 143 to the unlatched position. The projection 127 on the latch 87 will then disengage the latch retaining means 89, and the latch 87 will rotate in a counter-clockwise direction under the influence of its biasing spring 129 and the bias of the spring 67 transmitted through the projection 83 of the trigger 69. This movement of the latch 87 will release the trigger 69 and permit it to rotate about its pivot 71 until it engages the projection 75. This rotation of the trigger 69 moves the pivot point 73 of the upper link 49 of the toggle mechanism to a point above the center line of the toggle (Fig. 3), and at the same time the projection 85 presses against the pin 84 thereby setting the knee of the toggle in motion. The toggle then breaks to the left (Fig. 5) under the influence of the springs 67, and in so doing opens the circuit controlled by both the switch members. The time interval elapsing between the occurrence of an overload condition and the opening of the breaker is dependent upon the magnitude of the overload, the interval being substantially inversely proportional to the magnitude of the overload.

After the breaker has been opened by the trip device, it is necessary to restore the mechanism to an operative condition. In order to do this, the operating handle 59 is moved counter-clockwise about its pivot 63, (Fig. 3). The projection 81 of the operating handle 59 engages the end 68 of the trigger 69, and upon continued movement the operating handle 59 forces the trigger 69 to rotate in a counter-clockwise direction against the bias of the springs 67. As this movement continues, the end 83 of the trigger 69 engages the opening 125 in the latch 87 and rotates the latch against the effect of its bias until the projection 127 has moved above the latch retaining member 133 of the latch retaining means 89—this last-mentioned member being biased to the latched position. The breaker is now in the open position, the mechanism has been restored to an operative condition, and the breaker may be closed by a movement of the operating handle 59, as previously described.

Should an attempt be made to close the breaker against a short circuit condition and hold it closed manually, the thermally responsive element 91 will be heated immediately and will release the latch retaining means in exactly the same manner as before. The trigger 69 will thus be re-

leased, and the breaker will open regardless of the position in which the operating handle may be held.

It will thus be seen that I have provided an improved trip mechanism for multi-pole circuit breakers which is capable of opening all of the poles of the breaker after a very short time delay upon the occurrence of a short circuit, and after a predetermined longer time interval upon the occurrence of an overload condition, which is capable of tripping a breaker irrespective of the position of the operating handle, and which is resettable to the operative position by means associated with the operating handle. In addition, I have disclosed designs for bimetallic thermally responsive elements which are simpler and more efficient than previous designs of this type, and which may be manufactured at a lower cost.

Moreover, I have disclosed a trip device having a thermally responsive element which is completely free from external stress. This last is of particular value in securing reliable and accurate trip operation, because in practically all cases wherein the bimetal is subjected to the force of the breaker operating means considerable permanent distortion of the bimetal will develop thus changing the amount of movement necessary to trip the breaker. This disturbs the operation of the thermally responsive devices and alters the calibration of the thermal element—both of which are very undesirable results.

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 desirable in many applications. I desire, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction, and that my invention be limited only by what is explicitly stated in the claims and by the prior art.

I claim as my invention:

1. In electrical apparatus, a thermally responsive device including a substantially U-shaped heater of conducting material, and a separate member of bimetallic material thermally conductively joined to said heater and extending outwardly therefrom.

2. In electrical apparatus, a member of bimetallic material having a pair of electrical terminals, and a current carrying heater portion between said terminals, said current carrying portion having a hole therein for defining two parallel current carrying paths, one on either side of said hole, said hole being spaced from the edges of said current-carrying member.

3. In electrical apparatus, a thermally responsive device including a substantially U-shaped heater of conducting material, and a tapered member of bimetallic thermally responsive material, one end of which is thermally conductively joined to said heater adjacent the closed end of said U and which extends outwardly therefrom.

4. In electrical apparatus, a thermally responsive device comprising a substantially H shaped member entirely of bimetallic material and means of insulating material extending across the side portions of the H at at least one end thereof.

5. In electrical apparatus, a thermally responsive device having a pair of electrical terminals, a looped current carrying heater of non-bimetallic material extending between said termi-

nals, and a separate member of bimetallic material projecting outwardly from the closed end of said looped heater, said projecting portion being thermally conductively joined to said heater portion.

6. In a circuit interrupter, a switch member for opening the circuit, means for biasing said switch member to the open position, releasable means for holding said switch member in the closed position against said biasing means, and a releasable retaining means operable by a thermally responsive element, said retaining means and said thermally responsive element moving substantially in the same direction to trip said interrupter, said retaining means having an overhanging projection thereon for engaging said thermally responsive element, said thermally responsive element being normally out of contact with said retaining means.

7. In a circuit interrupter, a switch member for opening the circuit, means for biasing said switch member to the open position, a releasable latching means for holding said switch member in the closed position against said biasing means, a thermally responsive element, and a pivoted releasable latch retaining means operable by said thermally responsive element, said thermally responsive element being fixed at one end and having a portion extending along said latch retaining means, said latch retaining means being pivoted at a point adjacent to said fixed end of said thermally responsive element, and having means associated therewith for engaging said thermally responsive element, said thermally responsive element and said latch retaining means moving in substantially the same direction when releasing said latch.

8. In a circuit interrupter, a switch member for opening the circuit, spring means for biasing said switch member to the open position, a releasable latch and a contact restraining member for releasably restraining said switch member in the closed position against the bias of said spring means, a latch retaining means for engaging and operating said releasable latch, and a member of bimetallic material for engaging and releasing said latch retaining means, said releasable latch comprising a centrally pivoted member engaged at one end by said contact restraining member and prevented from turning under the transmitted force of said spring means by said latch retaining means, said latch retaining means being pivoted at one end and having a portion for engaging said bimetallic member which is fastened at one end adjacent to the pivot point of said latch retaining means and is free to move at the other end.

9. In electrical apparatus a thermally responsive device comprising a substantially H-shaped member of bimetallic material having terminals at one end thereof, and having means for joining the side portions at the other end thereof in order to prevent buckling of said device during its operation.

10. In electrical apparatus, a thermally responsive device including a looped heater of bimetallic material, and a member of bimetallic material extending outwardly from said looped heater, said heater and said outwardly extending member being formed from sheet material of differing thicknesses.

11. In electrical apparatus, a thermally responsive device including a substantially U-shaped heater of bimetallic material, and a member of bimetallic material thermally conduc-

tively joined to said heater adjacent the closed end of said U and extending outwardly therefrom, said heater and said outwardly extending member being formed from sheet material of differing thicknesses.

12. In electrical apparatus, a thermally responsive device comprising a current-carrying heater which includes means for defining a pair of leg portions and means for electrically connecting said leg portions, and a separate member of bimetallic material thermally conductively joined to said heater and extending outwardly therefrom.

13. In electrical apparatus, a thermally responsive device comprising a substantially U-shaped, current-carrying means of bimetallic material, and a separate means mechanically joined to said current-carrying means and extending outwardly therefrom for a considerable distance along the plane of the means of bimetallic material, said separate means being adapted to engage and actuate said apparatus.

14. In a circuit interrupter, a switch member for opening the circuit, means movable to cause said switch member to move to the open position, means for biasing said movable means to cause said switch member to move to the open circuit position, releasable latching means for restraining said biasing means from moving said movable means to cause the opening of the circuit through said interrupter, and a thermally responsive element for causing said latch means to release said biasing means upon the occurrence of predetermined conditions, said thermally responsive element being fixed at one end and having a movable portion, said latching means including a member that is pivotally supported adjacent the fixed end of said thermally responsive element and that has a portion extending along said movable portion of said thermally responsive element, the movable portion of said thermally responsive element and said latch member moving in substantially the same direction to release said biasing means.

15. In a multi-pole circuit interrupter, contact means including movable switch members for each of a plurality of poles, means movable to cause at least one of said switch members to move to the open circuit position, means for biasing said movable means to a position where at least one of said switch members is caused to move to the open circuit position, releasable latching means for restraining said biasing means from causing the opening of said circuit interrupter, and a plurality of thermally responsive elements, each heated in response to the current flowing through one of the poles of said interrupter, for causing said latch means to release said biasing means upon the occurrence of predetermined conditions in any one of the poles of said interrupter, each of said thermally responsive elements comprising a member fixed at one end and having a movable portion, said latching means including a single latch member that is supported through the agency of pivot means whose axis extends adjacent the fixed end of each of said thermally responsive elements, said latch member having a portion extending along the movable portion of each of said thermally responsive elements and being actuable to release said biasing means by movement of any one of said thermally responsive elements, the movable portion of each of said thermally responsive elements and of said latch member moving in substantially the

same direction when effecting the release of said biasing means.

16. In a circuit interrupter, separable contact means, actuating means for causing said contact means to be moved to the open and to the closed circuit position with a snap action, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position likewise with a snap action, said trip means including a latch, a bimetallic, thermally responsive element, and a member intermediate said latch and said bimetallic element, which member is movable independently of said latch in response to movement of said bimetallic element to effect the release of said latch, said bimetallic element having a fixed end and a movable end normally free from external stress.

17. In a circuit interrupter, separable contact means, actuating means for causing said contact means to be moved to the open and to the closed circuit position with a snap action, means associated with said actuating means for biasing said contact means to the open circuit position when said interrupter is in the closed circuit position, and a trip means which normally prevents said biasing means from causing said contact means to move to the open circuit position, but which is operable upon the occurrence of predetermined conditions to cause said biasing means to separate said contact means at high speed, said trip means including a latch, biased to the unlatched position, for engaging said biased actuating means, a latch retaining member biased to the retained position, and a current carrying, thermally responsive member normally out of contact with said latch retaining means, said thermally responsive element moving to engage and operate said latch retaining member upon the occurrence of predetermined conditions.

18. In a circuit interrupter, separable contact means, actuating means, including an operating member, for causing said contact means to be moved to the open and to the closed circuit position with a snap action, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position with a snap action, regardless of the position of said operating member, said trip means including a latch, a bimetallic, thermally responsive element, and a member intermediate said latch and said bimetallic element, which member is movable independently of said latch in response to movement of said bimetallic element to effect the release of said latch, said bimetallic element having a fixed end and a movable end normally free from external stress.

19. In a circuit interrupter, separable contact means, actuating means, including an operating member, for causing said contact means to be moved to the open and to the closed circuit position with a snap action, means associated with said actuating means for biasing said contact means to the open circuit position when said interrupter is in the closed circuit position, and a trip means which normally prevents said biasing means from causing said contact means to move to the open circuit position, but which is operable upon the occurrence of predetermined conditions to cause said biasing means to separate said contact means at high speed, regardless of the position of said operating member, said

trip means including a latch for normally restraining said biasing means, a bimetallic, thermally responsive element, and a member intermediate said latch and said bimetallic element, which member is movable independently of said latch in response to movement of said element to effect the actuation of said latch, thereby allowing said biasing means to move said contact means to the open circuit position, said bimetallic element having a fixed end and a movable end normally free from external stress.

20. In a circuit interrupter, a switch member for opening the circuit, means movable to cause said switch member to move to the open position, means for biasing said movable means to cause said switch member to move to the open circuit position, releasable latching means for restraining said biasing means from moving said movable means to cause the opening of the circuit through said interrupter, and a thermally responsive element for causing said latch means to release said biasing means upon the occurrence of predetermined conditions, said thermally responsive element having a fixed end and a movable end normally free from external stress, said latching means including a member that is pivotally supported adjacent the fixed end of said thermally responsive element and that has a portion extending along said movable portion of said thermally responsive element, the movable portion of said thermally responsive element and said latch member moving in substantially the same direction to release said biasing means.

21. In a circuit interrupter, a switch member for opening the circuit, means movable to cause said switch member to move to the open position, means for biasing said movable means to cause said switch member to move to the open circuit position, releasable latching means for restraining said biasing means from moving said movable means to cause the opening of the circuit through said interrupter, and a thermally responsive element for causing said latch means to release said biasing means upon the occurrence of predetermined conditions, said thermally responsive element having a fixed end and a movable end normally free from external stress, said latching means including a member that is pivotally supported at the end thereof which is nearest said fixed end of said thermally responsive element and that has a portion extending along said movable portion of said thermally responsive element, the movable portion of said thermally responsive element and said latch member moving in substantially the same direction to release said biasing means.

22. In a multi-pole circuit interrupter; contact means for opening and for closing a plurality of poles; actuating means for said contact means, including means movable to cause said contact means to move to the open circuit position and means for biasing said movable means to cause said contact means to move to the open circuit position; a releasable latching means for restraining said biasing means from moving said movable means to cause the opening of the circuit through said interrupter; and a plurality of thermally responsive elements for causing said latch means to release said biasing means upon the occurrence of predetermined conditions, each of said thermally responsive elements being fixed at one end and having a movable portion; said latching means including a single latch member and a latch retaining member which has a portion extending across two or more poles of said

interrupter; said latch retaining member being pivotally supported at its end nearest the fixed ends of said plurality of thermally responsive elements, having a portion extending along the movable portion of two or more of said thermally responsive elements, and being movable to cause the release of said latch member by any one of two or more of said thermally responsive elements; the movable portion of each of said thermally responsive elements and said latch retaining member moving in substantially the same direction to release said biasing means.

23. In a circuit interrupter, separable contact means, actuating means for moving said contact means to the open and to the closed circuit position with a snap action, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, likewise with a snap action, said trip means including a latch, a bimetallic thermally responsive element, at least one member intermediate said latch and said bimetallic element, which member is movable independently of said latch in response to movement of said bimetallic element to effect the release of said latch, means biasing said movable member against movement to effect the release of said latch, and a stop means for preventing said biasing means from moving said intermediate member beyond a predetermined point.

24. In a circuit interrupter, separable contact means, actuating means for moving said contact means to the open and to the closed circuit position with a snap action, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, likewise with a snap action, said trip means including a latch, a bimetallic, thermally responsive element, at least one pivotally supported member intermediate said latch and said bimetallic element, which member is movable about its pivot point in response to movement of said bimetallic element to effect the release of said latch, spring means biasing said movable member against movement to effect the release of said latch, and a stop means for preventing said spring biasing means from moving said intermediate member beyond a predetermined point.

25. In a circuit interrupter, a base member, separable contact means and actuating means for moving said contact means to the open and to the closed circuit position, supported on said base, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, said trip means being supported on said base and including a latch, a bimetallic, thermally responsive element, one end of which is fixedly supported adjacent said base and the other end of which is freely movable, at least one member intermediate said latch and said bimetallic element, which intermediate member is movable independently of said latch in response to movement of said movable end of said bimetallic element to effect the release of said latch, said intermediate member having at least a portion thereof which extends along said bimetallic element and being adapted to move in the same direction as said movable end of said bimetallic element when effecting the release of said latch, means biasing said intermediate member against movement to

effect the release of said latch, and a stop means for preventing said biasing means from moving said intermediate member beyond a predetermined point.

26. In a circuit interrupter, a base member, separable contact means and actuating means for moving said contact means to the open and to the closed circuit position, supported on said base, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, said trip means being supported on said base and including a latch, a bimetallic, thermally responsive element, one end of which is fixedly supported adjacent said base and the other end of which is freely movable, at least one member intermediate said latch and said bimetallic element, which intermediate member is pivotally supported at the end thereof which is nearest said base and is movable in response to movement of said bimetallic element to effect the release of said latch, said freely movable end of said bimetallic element and said intermediate member moving in the same direction when effecting the release of said latch, spring means biasing said intermediate member against movement to effect the release of said latch, and a stop means for preventing said spring biasing means from moving said intermediate member beyond a predetermined point.

27. In a circuit interrupter, separable contact means, actuating means, including an operating member, for moving said contact means to the open and to the closed circuit position with a snap action, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position regardless of the position of said operating member, said trip means including a latch, a bimetallic, thermally responsive element, at least one member intermediate said latch and said bimetallic element, which member is movable independently of said latch in response to movement of said bimetallic element to effect the release of said latch, said bimetallic element having a fixed end and a movable end which is normally substantially free from external stress, means biasing said intermediate member against movement to effect the release of said latch, and a stop means for preventing said biasing means from moving said intermediate member beyond a predetermined point.

28. In a circuit interrupter, separable contact means, actuating means for moving said contacts to the open and to the closed circuit position with a snap action, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, likewise with a snap action, said trip means including a member movable to effect the operation thereof, a bimetallic, thermally responsive element, at least one member intermediate said movable member and said bimetallic element, said member which is movable to effect the operation of said device engaging said intermediate member with a latching engagement, said intermediate member being movable in response to movement of said bimetallic element to disengage said movable member, means biasing said intermediate member against movement to disengage said movable member, and a

stop means for preventing said biasing means from moving said intermediate member beyond a predetermined point.

29. In a circuit interrupter, separable contact means, actuating means for causing said contacts to be moved to the open and to the closed circuit position with a snap action, and a trip device operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, likewise with a snap action, said trip device including a member movable to effect the operation thereof, means biasing said member to effect the operation of said trip device, a bimetallic, thermally responsive element, at least one member intermediate said movable member and said bimetallic element, said member which is movable to effect the actuation of said trip device engaging said intermediate member with a latching engagement, said intermediate member being movable in response to movement of said bimetallic element to disengage said movable member and thereby effect the operation of said trip device, and stop means for preventing said intermediate member from being moved beyond a predetermined point by the reaction forces of said biasing means for said member which is movable to actuate said device when that member and said intermediate member are in latching engagement with each other.

30. In a circuit interrupter, separable contact means, actuating means for moving said contact means to the open and to the closed circuit position and a trip device operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, said trip device including a pivotally supported member movable to effect the operation of said trip device, means biasing said member to effect the operation of said trip device, a bimetallic, thermally responsive element fixedly supported at one of its ends, the other end of said element being movable, at least one member intermediate said member movable to actuate said trip device and said bimetallic element, said member movable to effect the actuation of said trip device having a latching portion for engaging cooperating latching means forming a part of said intermediate member, said intermediate member being pivotally supported adjacent the fixed end of said bimetallic element and having a portion extending along the movable portion of that element, and said intermediate member being movable by said bimetallic element to effect the release of said latching portion in order to allow said movable member to move so as to effect the actuation of said trip device, and stop means for preventing the reaction forces of said biasing means which are transmitted from said member movable to actuate said trip device to said intermediate member when those members are in latching engagement with each other from moving said intermediate member beyond a predetermined point.

31. In a circuit interrupter, separable contact means, actuating means for causing said contact means to be moved to the open and to the closed circuit position, and a trip device operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, said trip device including a member movable to effect the operation thereof,

means biasing said member to effect the operation of said trip device, a bimetallic, thermally responsive element, at least one member intermediate said movable member and said bimetallic element, said member which is movable to effect the actuation of said trip device engaging said intermediate member with a latching engagement, said intermediate member being movable in response to movement of said bimetallic element to disengage said movable member and thereby effect the operation of said trip device, means biasing said intermediate member against movement to disengage said member which is movable to effect the operation of said trip device, and stop means for preventing said intermediate member from being moved beyond a predetermined point by the force of the biasing means for said intermediate member, or by the reaction forces of said biasing means for said member which is movable to actuate said trip device, these reaction forces being transmitted to said intermediate member through said latching engagement.

32. In a circuit interrupter, separable contact means, actuating means for moving said contact means to the open and to the closed circuit position, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, said trip means including a latch, a bimetallic thermally responsive element, a pivoted member intermediate said latch and said bimetallic element which member is movable independently of said latch in response to movement of said bimetallic element to effect the release of said latch, said bimetallic element having a fixed end and a movable end normally free from external stress.

33. In a circuit interrupter, separable contact means, actuating means for moving said contact means to the open and to the closed circuit position, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, said trip means including a pivotally supported latch, a bimetallic thermally responsive element, a pivotally supported latch retaining member biased to the retained position and movable, independently of said latch, in response to movement of said bimetallic element to release said latch, said bimetallic element having a fixed end and a movable end normally free from external stress.

34. In a circuit interrupter, separable contact means, actuating means for moving said contact means to the open and to the closed circuit position, and a trip means operable upon the occurrence of predetermined conditions to cause said actuating means to automatically move said contact means to the open circuit position, said trip means including a latch, a bimetallic thermally responsive element, at least one pivotally supported member intermediate said latch and said bimetallic element, which member is movable about its pivot point in response to movement of said bimetallic element to effect the release of said latch, means biasing said movable member against movement to effect the release of said latch, and a stop means for preventing said biasing means from moving said intermediate member beyond a predetermined point.

35. For use as the current-responsive element of an automatic circuit breaker, a U-shaped bimetallic current-carrying strip slotted adjacent its inner or supporting end to provide two paral-

10 1el short legs of uniform narrow section and relatively high resistance and quickly deflectible as the result of excess current therethrough and comprising adjacent its outer end a long unslotted
5 body portion deflectible only to a negligible extent as the result of the said current but nevertheless subject to delayed deflecting by reason of heat transmitted from the current heated legs, the said long body portion of the strip having
10 therein between the ends thereof a portion sharply reduced in area to restrict the heating of the said body portion.

36. In a current responsive device, a strip of bimetallic material, a slot in one end of said strip,
15 means for making a pair of current connections to said strip, one of said connections being at each side of said slot whereby the current flows in a looped path about said slot and causes said end of the strip to be quickly heated and deflected upon
20 the flow of excess current, the other end of said strip extending a distance beyond the end of said slot at least as great as the length of said slot, and said strip having a portion sharply reduced in width between the end of said slot and the other
25 end of the strip for restricting the flow of heat from said looped path to the other end of the strip.

37. In a current responsive device, a strip of bimetallic material having a cut out portion at
30 one end thereof, means for making a current connection to said strip of bimetallic material at the end thereof on each side of said cut out portion, a long portion extending beyond the inner end
35 of said cut out portion a distance at least as great as the length of said cut out portion and the end of said long portion when moved causing actuation of the device, and said long portion being greatly reduced in width a short distance beyond the inner end of said cut out portion.

38. For use as the current-responsive element of an automatic circuit breaker, a U-shaped bimetallic current-carrying strip slotted adjacent its inner or supporting end to provide two legs of relatively high resistance and quickly de-
5 flectible as the result of excess current therethrough and comprising adjacent its outer end a long unslotted body portion deflectible only to a negligible extent as the result of the said current but nevertheless subject to delayed deflecting by
10 reason of heat transmitted from the current heated legs, the said long body portion of the strip extending beyond the end of the slot a distance at least as great as the length of the slot and said long body portion having therein be-
15 tween the ends thereof a portion sharply reduced in area to restrict the heating of the said body portion.

39. In a circuit interrupter, a switch member for opening the circuit, means for biasing said
20 switch member to the open position, a releasable latching means for holding said switch member in the closed position against said biasing means, a thermally responsive element, and a pivoted
25 latch controlling member operable by said thermally responsive element, said thermally responsive element being fixed at one end and having a portion extending along and generally parallel to said latch controlling member, said latch controlling member being pivoted at its end nearest
30 to said fixed end of said thermally responsive element, and having means associated therewith to be engaged by said thermally responsive element, said thermally responsive element and said
35 latch controlling member moving in substantially the same direction when releasing said latching means.

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