April 29, 1941. R. R. PITTMAN ET AL 2,239,829

HIGH VOLTAGE CIRCUIT BREAKER

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Fig. 1

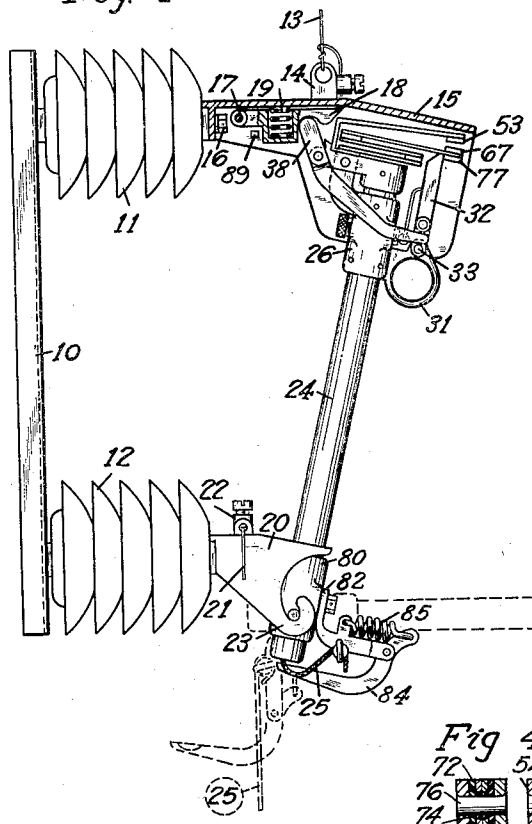


Fig. 3

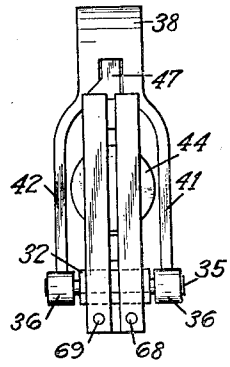


Fig 4

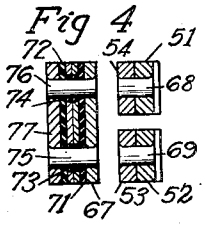


Fig. 2

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Fig. 5

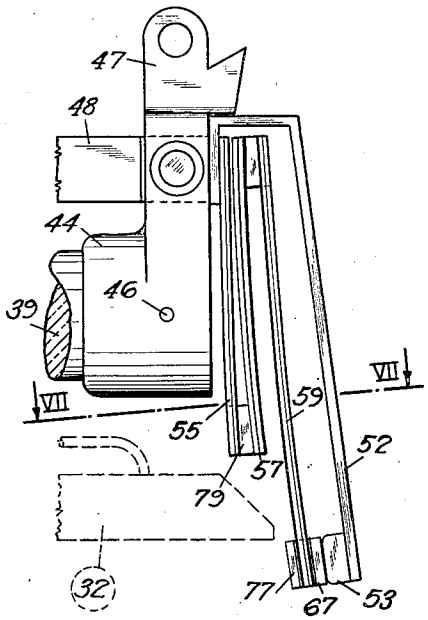


Fig. 6

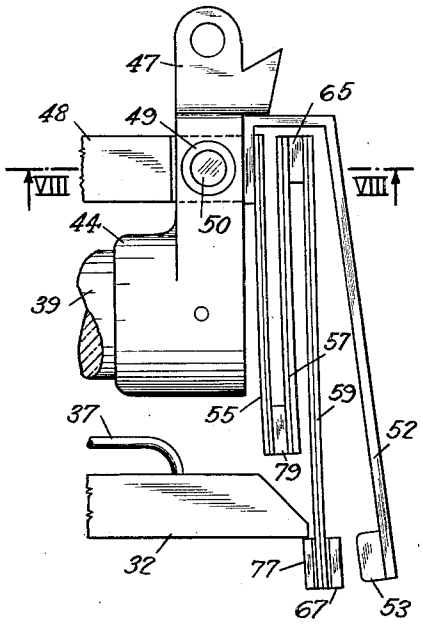


Fig. 7

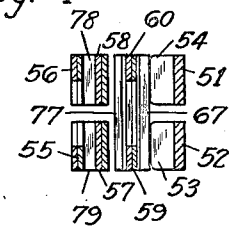
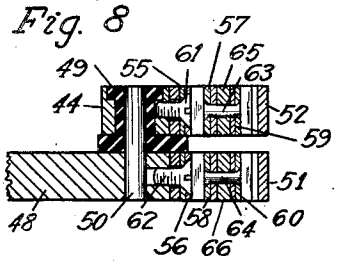


Fig. 8



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HIGH VOLTAGE CIRCUIT BREAKER

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16 Claims. (Cl. 200—116)

This invention relates to high voltage circuit breakers for use in connecting and disconnecting electrical apparatus respectively to and from high voltage overhead circuits, and particularly to an automatic trip-free open type of breaker, embodying a thermally responsive element, which is suitable for use in connecting and protecting distribution transformers connected to these circuits.

Because of the fact that heretofore no suitable circuit breaker has been available for this purpose, the high tension windings of distribution transformers have been and are now generally connected to overhead high voltage circuits through expulsion fuses. Such fuses are unsatisfactory for the reason that a new fuse element is required after each operation of the fuse, and also because the current-time curve of the fuse does not follow that of the connected transformer. Low amperage fuse links are required for this service because of the high voltage, and such links are susceptible to blowing from harmless transient currents, and are generally mechanically weak.

Present available types of circuit breakers which are satisfactory for this purpose exceed the cost of the distribution transformers in many cases, and are therefore too expensive for general use, both as to price and as to cost of mounting.

To provide a suitably inexpensive breaker of desired effectiveness, the solution of several problems, representing the principal objects of the present invention, was necessary.

The first of these objects is the provision in a high voltage circuit breaker of a thermally responsive element capable of relatively large movement in response to moderate current, that is, an element which moves sufficiently to trip the breaker in response to small change in temperature.

Another object is the provision of means for preventing the tripping of the breaker due to changes in ambient temperature, since the thermally responsive element is actuated by a small change in temperature due to current therethrough.

Another object is the provision of means for shunt-circuiting the thermally responsive element when it has moved sufficiently to trip the breaker, since the element, being necessarily responsive to low currents, is liable to fusing at very high currents.

Another object is to provide means for interrupting the circuit within an expulsion chamber or tube in response to an over-current through the breaker.

Another object is the provision of means for removing from the circuit the expulsion tube in which the circuit is interrupted, to thereby prevent damage to the tube from creepage current, and to definitely visually indicate the open position of the breaker.

These and other objects will be apparent from the following description and claims taken in connection with the accompanying drawings forming a part of this application, in which:

Fig. 1 is a side elevational view of the invention.

Fig. 2 is a side elevational view of the device without the mounting, shown partly in section.

Fig. 3 is an upper end view of the device without the mounting.

Fig. 4 is an enlarged sectional view taken along the line IV—IV of Fig. 2.

Fig. 5 and Fig. 6 are fragmentary views of the upper end of the removable portion of the device.

Fig. 7 is a sectional view taken along the line VII—VII of Fig. 5.

Fig. 8 is a sectional view taken along the line VIII—VIII of Fig. 6.

Referring first to Fig. 1, the mounting of the device includes the base 10, having rigidly mounted thereon the spaced insulators 11 and 12. An outwardly extending weather hood 15 is secured to the outer end of the upper insulator 11 by means of the cap screw 16, and a connector 14 is suitably secured, as by welding, to the upper surface of the top of the weather hood 15, for the purpose of electrically connecting thereto a line wire 13. The upper conducting terminal 18 is pivotally mounted for rotation about the pivot 17 within the weather hood 15, and an upper terminal spring 19 is interposed between these members for urging the outer end of the terminal 18 in a downward direction, the extent of this downward movement being limited by the stop 89. The outer or forward end of the terminal 18 is provided with an enlarged downwardly extending portion for engaging and latching a cooperating contact, as will be explained later in more detail.

The lower or load terminal 20 is rigidly secured to the outer end of the lower insulator 12, and has suitably secured thereto the connector 22, for electrically connecting the load conductor 21 to the terminal 20. The terminal 20 is substantially U-shaped, extending outwardly from the insulator 12, and at its lower outer end is provided with an integral pair of hooks, 23, 23.

The tubular insulating member, or expulsion

tube of insulating material 24 is arranged to span the terminals 18 and 20. A metal sleeve 80 is tightly pressed over the tube 24 at its lower end, and a pair of pins 81, 81 extend outwardly from the sleeve along a diameter, the pins 81 fitting into and being arranged for rotation in the hooks 23, 23; the metal sleeve 80 thus providing a lower removable contact for the tube 24. An outwardly extending metal bracket 82, secured to the sleeve 80 by means of the cap screw 83, has pivotally mounted at its outer end for rotation about the pivot 86, the metal lever 84. A portion of the lever 84 extends upwardly above the pivot 86, and a tension spring 85, having one end secured to the upwardly extending portion and the other to the bracket 82, constantly urges the lever 84 is a counter-clockwise direction about the pivot 86. The lever 84 extends to a point near the bottom of the tube 24, and is there provided with a laterally extending grooved portion 87 for engaging a flexible conductor 25 which extends from the tube 24, and the thumb screw connector 88 provides means for securing the end of the conductor 25 to the bracket 82, the arrangement being such that the spring 85 is constantly biasing the conductor 25 in a direction to extract it from the tube.

A hollow metal sleeve 26, having a portion thereof fitted over the upper end of the tube 24, is rigidly attached to the tube 24 by means of the pins 27 and 28, and is provided with an integral eye 31 for convenience in manipulating the device. A removable metal plug 29 is screwed through a threaded opening between the ends of the sleeve 26, and so positioned as to compress the upper end of the conductor 25 between the threaded plug 29 and the metal plug 30, the latter being slidably fitted into an opening opposite the threaded plug.

At the upper end of the sleeve 26 is mounted the insulating member 39, the lower end thereof extending downwardly into the sleeve and being rigidly secured thereto by the pin 45 to tightly close the upper end of the tube 24. A metal cap 44 is fitted over the upper end of the insulating member 39 in insulated spaced relation with the sleeve 26, being secured thereto by the pin 46, and provided with the outwardly extending portion 47. At the outer end of the outwardly extending portion 47 of the cap 44 is pivotally mounted the yoke shaped upper contact 38, shown in Fig. 3. The two arms of the yoke, 41, 42, extend laterally downward across the sleeve 26 and in spaced insulated relation thereto, and the stem of the yoke extends upwardly and outwardly from the pivot 43. A metal latch member 32, pivotally mounted on the sleeve 26 by means of the pivot 33, carries a pair of insulating rollers 36, 36, mounted on the pins 35, 35, and are so positioned as to engage the upper surface of the ends of the arms of the yoke 38 when the latch member is in a vertical position. Under this condition, the tube 24 is latched in the closed position shown in Fig. 1 by the engagement of the downwardly depressed terminal 18 with the contact 38.

Near the upper end of the latch member 32 is secured one end of the latch spring 37, the latter extending downwardly along the latch member to a point at the outer end of the slidable member 30, and a roller 34 is fitted over the lower end of the latch member spring 37, the arrangement being such that the latch member spring concurrently urges the slidable member 30 against the conductor 25 and the upper end of the latch member 32 in a clockwise direction.

It will be apparent from the above description that a clockwise movement of the latch member 32 about the pivot 33 will release the upper end of the conductor 25 and allow the contact 38 to move downwardly and out of engagement with the upper terminal 18.

It will also be apparent, in the arrangement described, that the upper terminal spring 19 may apply a very large downward pressure against the contact 38 to assure high conductivity without increasing the pressure of the upper end of the latch member 32 against the latch detent 77, since the downward pressure on the member 38 is transmitted about the pivot 43 through the yoke arms 41 and 42 so that the resultant force applied to the latch member 32 is in a vertical direction, and not laterally against the detent 77.

Movement of the latch member 32 is normally prevented by the engagement of its upper end with the latch detent 77, the latter being rigidly secured, by means of the rivets 75 and 76, Fig. 4, to the closed end of a thermally responsive element mounted at the upper end of the tube, the detent 77 being insulated from the element by means of the insulating member 72, and the insulating tubes 73 and 74. It will now be apparent that an upward movement of the latch detent 77 due to movement of the thermally responsive element will permit a clockwise movement of the latch member 32, and result in the extraction of the conductor 25 from the tube 24, the tube and the members attached thereto taking the open position indicated by the broken lines of Fig. 1.

The breaker being in the open position, the latch member 32, following the cooling of the bimetallic element, may again be latched against the latch detent 77, and the conductor 25 reinserted and clamped in its original position by manipulation of the threaded plug 29. By means of an insulated switch stick cooperating with the eye 31, the tube 24 may be rotated back to the closed position. In the event a fault exists in the connected circuit, the latch member 32 is immediately unlatched, and the conductor 25 released at its upper end and extracted from the tube 24, thus interrupting the faulty circuit. Since the eye 31 is formed as a part of the sleeve 26, the circuit interruption cannot be prevented by manipulation of the device as described; in other words, the device is of that type commonly known as "trip-free."

The thermally responsive element embodies several novel features, and its mounting and relation to the circuit are shown in Figs. 3, 4, 5, 6, 7, and 8. The element itself includes three pairs of bimetallic strips which bend in response to temperature change; an upper pair, 59 and 60, joined at their outer adjacent ends by the member 67, Fig. 4; an intermediate pair 57 and 58, positioned below and parallel to the upper pair and having adjacent ends thereof electrically connected and mechanically joined to the open ends of the strips 59 and 60 through the spacers 65 and 66 by the rivets 63 and 64, respectively; and a lower pair 55 and 56, extending along and spaced from the intermediate pair, and having their outer adjacent ends electrically connected and mechanically joined to the remaining ends of the intermediate pair through the spacers 78 and 79; the remaining adjacent ends of the lower strips being mechanically secured to the out-

wardly extending portion of the cap **44** by means of the screws **61** and **62**, Fig. 8.

This figure also illustrates the manner in which the strips **55** and **56** are insulated to provide an electrical circuit through the element. The upwardly extending portion **48** of the sleeve **26** supports the strip **56**, and is electrically connected therewith, while the strip **55** is insulated from the portion **48** by means of the spool-shaped insulator **49**, but electrically connected to the upper contact **38** through a portion of the cap **44**. The rivet **50** maintains the insulation in rigid assembled relation with the portion **48** to provide mechanical stability.

The electrical circuit through the breaker in the normal closed position, from the terminal **18**, includes serially the contact **38**, the outwardly extending portion of the cap **44**, the lower strip **55**, the intermediate strip **57**, the upper strip **59**, thence across the end portion to the upper strip **60**, the intermediate strip **58**, the lower strip **56**, the portion **48** of the sleeve **26**, the flexible conductor **25**, and the lower contact **80**.

We have found that the zigzag arrangement of strips herein described, when mounted as disclosed herein, provides a relatively large movement at the detent **77** in response to relatively small currents, which is desirable for successful operation of the device under small currents at high voltages. We have also found that such an arrangement is very susceptible to ambient temperature change, and for this reason the incorporation in the element of some means for ambient temperature compensation is desirable. This we have accomplished by making the intermediate strips **57** and **58** of larger section and lower resistance than the upper and lower pairs, as shown in Fig. 7, and arranging the strips, so that, when bent due to change in temperature, the concave sides of all the strips face in the same direction.

Fig. 6 illustrates a position of the members of the thermally responsive element when carrying normal current, and Fig. 5 the position when carrying an over-load current. It may be noted that the intermediate strip **57**, because of its comparatively low resistance, is substantially undeflected, while the deflection due to the upper and lower higher resistance strips is very apparent. It may also be observed that deflection of the intermediate strips due to rise in ambient temperature will necessitate greater deflection of the upper and lower strips to unlatch the device, thus compensating for ambient temperature.

The rate of movement of the bimetallic element, or the time required for sufficient movement to trip the breaker, is preferably slightly shorter than the time required for an overload on a connected transformer to cause thermal damage. Fuse elements now employed to connect distribution transformers must carry such overloads for a short time as do not damage the transformer, in order to prevent fusing due to short time over-loads, such as may be due to motor starting currents. Under this condition, the transformer may be seriously damaged on small continuous over-loads which do not cause fuse blowing. Our bimetallic element, however, may be made to follow the transformer heating curve for all conditions of loading and ambient temperatures, and thus provide a much higher degree of both protection and utilization of the transformers connected through our circuit breaker.

Due to the fact that high values of current are available from high voltage circuits, together with the fact that high resistance strips are embodied in the thermally responsive element, some means for preventing thermal damage from overheating by high currents is desirable in our breaker. This is accomplished by means of a pair of low resistance metal members **51** and **52**, having one pair of adjacent ends electrically connected and mechanically secured respectively to the members **48** and **44**, and having mounted hereon, by means of the rivets **68** and **69**, the contacts **53** and **54** at the other pair of ends, as shown in Figs. 4 and 7. The contacts **53** and **54** are positioned in the path of movement of the conducting bar **67**, which is rigidly secured to the outer closed end of the bimetallic element by the rivets **75** and **76**, Fig. 4, the bar being insulated from the bimetallic strips by the insulating spacer **71**, and the insulating tubes **73** and **74**. The relation of these elements is such that the contact bar **67** engages the contacts **53** and **54** whenever the thermally responsive element has moved sufficiently to disengage the latch member **32** from the latch detent **77**, as shown in Fig. 5. The thermally responsive element is thus shunt-circuited, and undamaged by current which may pass through the breaker for the time necessary to elongate and extinguish the circuit-interrupting arc within the expulsion tube **24**.

It will be apparent from the above description that in response to a predetermined current through the thermally responsive element under given ambient temperatures, the element will move to disengage the latch member, and be shunt-circuited by this movement, that the conductor **25** will be extracted from the tube **24**, the contact **38** will be disengaged from the terminal **18**, and the circuit breaker actuated from the closed position to the open position.

Although this invention has been shown in only one form it will be evident to those skilled in the art that many other forms and modifications may be employed without departing from the spirit of this invention as described above or as set forth in the following claims.

We claim as our invention:

1. A high voltage circuit breaker comprising spaced terminals, a hollow tube of insulating material spanning said terminals and movable between closed and open positions, means including a conductor within said tube and a bimetallic element externally mounted on said tube for electrically connecting the terminals, latch means cooperating with said bimetallic element for maintaining said tube in the closed position, means biasing said tube to the open position, and means responsive to a movement of said bimetallic element for unlatching said tube, said bimetallic element embodying ambient temperature compensating means whereby said movement is substantially dependent only upon the magnitude of current therethrough.

2. A high voltage circuit breaker comprising spaced terminals, a hollow tube of insulating material spanning said terminals and movable between closed and open positions, means including a conductor within said tube and a bimetallic element externally mounted on said tube for electrically connecting the terminals, latch means cooperating with said bimetallic element for maintaining said tube in the closed position, means biasing said tube to the open position, means releasably holding said conductor and resilient means urging the retraction of said con-

ductor from said tube, and means responsive to a movement of said bimetallic element for contemporaneously unlatching said tube and releasing said conductor, said bimetallic element embodying a compensating member substantially unaffected by current and relatively greatly affected by ambient temperature.

3. A high voltage circuit breaker comprising spaced terminals, a hollow tube of insulating material spanning said terminals and movable between closed and open positions, means including a conductor within said tube and a bimetallic element externally mounted on said tube for electrically connecting the terminals, latch means cooperating with said bimetallic element for maintaining said tube in the closed position, means biasing said tube to the open position, and means responsive to a movement of said bimetallic element for unlatching said tube, said bimetallic element embodying ambient temperature compensating means whereby said movement is substantially dependent only upon the magnitude of current therethrough, and means for shunt-circuiting said element in response to continued movement thereof in the direction to unlatch said tube.

4. A high voltage circuit breaker comprising spaced terminals, a hollow tube of insulating material spanning said terminals and movable between closed and open positions, means including a conductor within said tube and a bimetallic element externally mounted on said tube for electrically connecting the terminals, latch means cooperating with said bimetallic element for maintaining said tube in the closed position, means biasing said tube to the open position, means releasably holding said conductor and resilient means urging the retraction of said conductor from said tube, means responsive to a movement of said bimetallic element for contemporaneously unlatching said tube and releasing said conductor, said bimetallic element embodying a compensating member substantially unaffected by current and relatively greatly affected by ambient temperature, and means for shunt-circuiting said element in response to continued movement thereof in the direction to unlatch said tube.

5. A circuit breaker comprising spaced upper and lower terminals, a tube of insulating material having upper and lower contacts adjacent its respective ends arranged to engage and disengage said terminals, a current responsive element associated with said tube, resilient means biasing said tube to the disengaged position, a conductor extending upwardly through said tube from the lower contact, resilient means urging the withdrawal of said conductor from said tube, a slidable member arranged to engage said conductor at its upper end, a detent carried by said current responsive element, a swingably movable latch member carried by said tube and engaging said detent, and common resilient means for biasing said latch member against said detent and said slidable member against said conductor.

6. A circuit breaker comprising spaced upper and lower terminals, a tube of insulating material having upper and lower contacts adjacent its respective ends arranged to engage and disengage said terminals, a current responsive element associated with said tube, resilient means biasing said tube to the disengaged position, a conductor extending upwardly through said tube from the lower contact, resilient means urging the withdrawal of said conductor from said tube, a slidable member arranged to engage said conductor at its upper end, a detent carried by said current responsive element, a latch member swingably mounted on said tube and engaged with said detent, and a spring carried by said latch member for urging said slidable member against said conductor and said latch member against said detent.

7. A circuit breaker comprising spaced upper and lower terminals, a tube of insulating material having upper and lower contacts adjacent its respective ends arranged to engage and disengage said terminals, a current responsive element associated with said tube, resilient means biasing said tube to the disengaged position, a conductor extending upwardly through said tube from the lower contact, resilient means urging the withdrawal of said conductor from said tube, a slidable member arranged to engage said conductor at its upper end, a detent carried by said current responsive element, a latch member swingably mounted on said tube and engaged with said detent, and a spring interposed between said latch member and said plug for concurrently urging said latch member against said detent and said slidable member against said conductor.

8. A circuit breaker comprising spaced upper and lower terminals, a tube of insulating material having upper and lower contacts adjacent its respective ends arranged to engage and disengage said terminals, said upper contact being pivotally movable into and out of engagement with said upper terminal independent of movement of said tube, a current responsive element associated with said tube, a detent carried by said current responsive element, a swingably mounted latch member engaged with said detent, a conductor extending upwardly through said tube from the lower contact, a slidable member arranged to engage said conductor at its upper end, a common spring urging said slidable member against said conductor and said latch member against said detent, means responsive to a movement of said detent away from said latch member for relaxing said spring, and means dependent upon said movement for concurrently withdrawing said conductor from said tube and actuating said upper contact to the disengaged position.

9. In a circuit breaker having an open and a closed position, a thermally responsive element comprising a group of at least three bimetallic strips assembled in substantially parallel relationship and arranged in series circuit relation, said three strips consisting of two outside strips and one intermediate strip, said intermediate strip having a resistance substantially less than that of said outside strips, said strips bending in response to the passage of current therethrough and being arranged so that the concave sides of said outside strips face respectively toward and away from said intermediate strip, means for electrically connecting said element in the circuit, means operable in response to a movement of said element for actuating said breaker from the closed to the open position, and means responsive to said movement for shunt-circuiting said element.

10. In a circuit breaker having an open and a closed position, a thermally responsive element comprising a series circuit arrangement of at least three bimetallic strips mechanically joined in zigzag relation to one another, there being two outer strips and one strip interposed therebetween, said strips bending in response to passage

of current therethrough and being so arranged that the concave sides of said outer strips face respectively toward and away from said intermediate strip, means electrically connecting said element in the circuit, means operable in response to a movement of said element for actuating said breaker from the closed to the open position, and means responsive to said movement for shunt-circuiting said element.

11. In a circuit breaker, a thermally responsive element comprising a group of at least three bimetallic strips assembled in substantially parallel relationship and in series circuit arrangement, there being two outside strips and one intermediate strip, said intermediate strip having an electrical resistance substantially less than that of each of said outside strips, said bimetallic strips bending in response to passage of current therethrough and being arranged so that the concave sides of said outside strips face respectively toward and away from said intermediate strip.

12. In a circuit breaker, a thermally responsive element comprising a group of at least three bimetallic strips assembled in substantially parallel relationship and in series circuit arrangement, there being two outside strips and one intermediate strip, said intermediate strip having an electrical resistance substantially less than that of each of said outside strips whereby the rate of bending of said outside strips due to passage of current through said element is greater than that of said intermediate, said strips being so related to one another that the concave sides of said outside strips face respectively toward and away from said intermediate strip.

13. In a circuit breaker, a thermally responsive element comprising three pairs of bimetallic strips assembled in substantially parallel relationship, means for electrically connecting and mechanically joining adjacent ends of the first pair of strips, means electrically connecting and mechanically joining adjacent ends of the second pair of strips to the other adjacent ends of said first pair of strips, means for electrically connecting and mechanically joining adjacent ends of the third pair of strips to the other adjacent ends of said second pair of strips, means for connecting the remaining adjacent ends of said third pair of strips in series with the circuit, and means for securing said remaining ends to a support, said bimetallic strips bending in response to passage of current therethrough and being arranged so that the concave sides of all of said strips face in the same direction.

14. In a circuit breaker, a thermally responsive element comprising three pairs of bimetallic strips assembled in substantially parallel relationship, means for electrically connecting and mechanically joining adjacent ends of the first pair of strips, means electrically connecting and mechanically joining adjacent ends of the second pair of strips to the other adjacent ends of said first pair of strips, means for electrically connecting and mechanically joining adjacent ends of the third pair of strips to the other adjacent ends of said second pair of strips, means for connecting the remaining adjacent ends of said third pair of strips in series with the circuit, and means for securing said remaining ends to a support, said bimetallic strips bending in response to current therethrough and being arranged so that the concave sides of said second pair of strips faces the convex sides of said first pair of strips and the convex sides of said second pair of strips faces the concave sides of said third pair of strips.

15. In a circuit breaker, a thermally responsive element comprising three pairs of bimetallic strips assembled in substantially parallel relationship, means for electrically connecting and mechanically joining adjacent ends of the first pair of strips, means electrically connecting and mechanically joining adjacent ends of the second pair of strips to the other adjacent ends of said first pair of strips, means for electrically connecting and mechanically joining adjacent ends of the third pair of strips to the other adjacent ends of said second pair of strips, means for connecting the remaining adjacent ends of said third pair of strips in series with the circuit, and means for securing said remaining ends to a support, said bimetallic strips bending in response to current therethrough and being arranged so that the concave sides of said second pair of strips faces the convex sides of said first pair of strips and the convex sides of said second pair of strips faces the concave sides of said third pair of strips, and means responsive to said bending for shunt-circuiting said element.

16. A high voltage circuit breaker comprising spaced upper and lower terminals, an upwardly extending hollow tube of insulating material spanning said terminals and movable between closed and open positions, a conductor within said tube, a current responsive element mounted externally of said tube at the upper end thereof, means including the serial arrangement of said conductor and said current responsive element for electrically connecting said terminals when said breaker is in the closed position, and means responsive to passage of a predetermined current through said current responsive element for contemporaneously withdrawing said conductor from said tube at the lower end thereof and moving the upper end of said tube away from the upper terminal to the open position whereby said current responsive element is electrically isolated with respect to each of said terminals when said breaker is in the open position.

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