May 19, 1959 J. F. MARQUIS 2,887,547

CIRCUIT BREAKER

Filed May 28, 1957

Fig. 1.

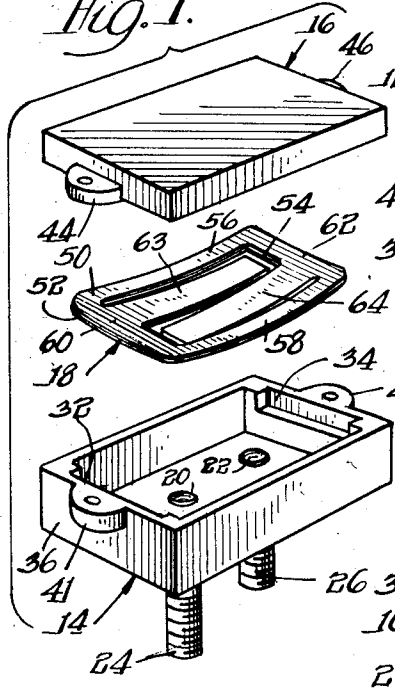


Fig. 2.

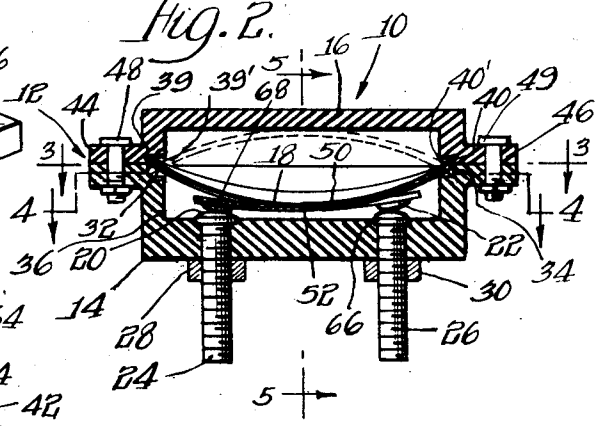


Fig. 3.

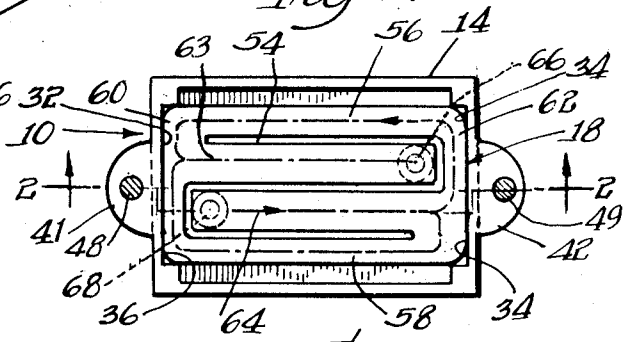


Fig. 5.

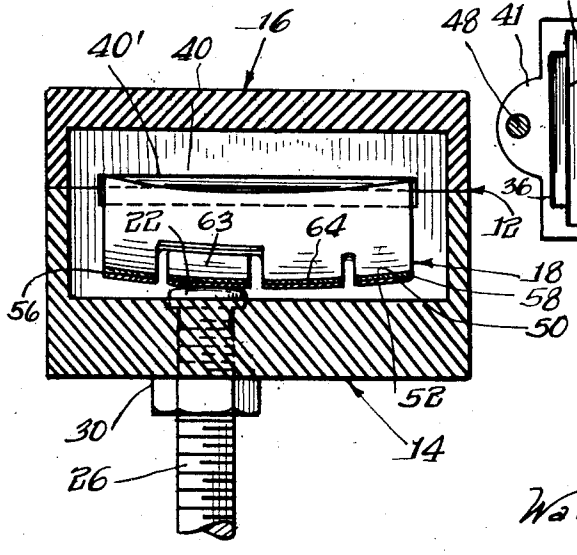
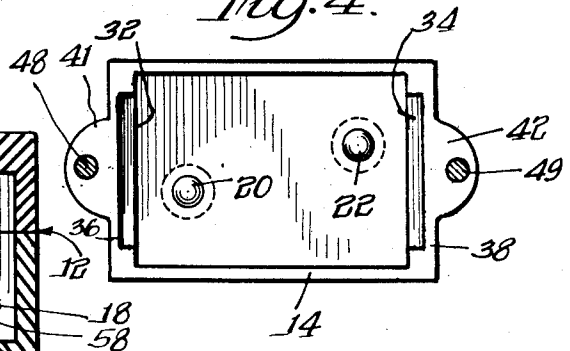


Fig. 4.



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CIRCUIT BREAKER

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8 Claims. (Cl. 200—113)

This invention relates to circuit breakers which utilize snap-acting bimetallic elements as the actuating means therefor.

In circuit breakers of this type, the current being controlled usually passes through a bimetallic element which has been initially formed into a dished shape. The bimetallic element includes superimposed strips of metal having substantially different thermal coefficients of expansion. Under normal temperature conditions, the metal having the higher thermal coefficient of expansion is on the concave side of the bimetallic element. Heat is generated in the bimetallic element by the current passing therethrough, and, as the temperature of the element progressively increases, the high expanding side thereof tends to flatten out and eventually reaches a snapping point when the temperature reaches a value indicating a current flow requiring a circuit interruption. The bimetallic element carries a movable contact which, in the normal dished condition of the bimetallic element, makes contact with a stationary contact. When the control temperature is reached, and the bimetallic element snaps into an oppositely dished condition, the movable contact is pulled away from the stationary contact to thereby break the circuit. Since current then ceases to flow in the bimetallic element, it cools down and will snap back into a circuit closing position, unless some means is provided to maintain the circuit breaker open until manually reset. Sometimes, the snap action characteristics of the bimetallic element are such that the element will hold itself in its initially snapped condition.

The lowest current to which these bimetallic elements will respond is a function of the watts it is possible to dissipate in the bimetallic element itself for a given limit of desired current flow in the circuit involved. There are numerous factors to be considered in the design of a bimetallic snap-acting circuit breaker once the current limit is specified. Uusually, the lower the current rating the more difficult it becomes to satisfy many of these requirements. In this connection, such characteristics as uniform heating of the portion of the bimetallic element controlling the snap action, precisely controllable snap action characteristics which are independent of the size or location of the contact or contacts carried by the bimetallic element, maintenance of a relatively high contact pressure up to the snapping point of the bimetallic element, compactness, ruggedness, and low cost are some of the desirable characteristics. Usually, a compromise must be made with the result that the most beneficial circuit breaker cannot be obtained.

It is, accordingly, the primary object of the present invention to provide a circuit breaker of the bimetallic snap-acting type which includes most, if not all, of these desirable characteristics above outlined, even when designed for low current interruption.

In accordance with the most preferred form of the invention, the bimetallic element has a continuous peripheral portion which controls the snap action of the bimetallic

element and a central contact-carrying portion which does not significantly affect the snap action characteristics of the bimetallic element. The central portion of the bimetallic element is perforated so as to form a continuous marginal portion comprising a first pair of opposed peripheral legs extending the length of the bimetallic element and a second pair of opposed peripheral legs bridging the ends of the first pair of legs. In the center portion of the element, the perforation or perforations form a pair of long slender fingers extending inwardly in opposite directions from one of the pairs of opposed peripheral legs. Each of the fingers carries at the distal end thereof, on the low expanding or convex side of the bimetallic element, a contact which normally makes engagement with a corresponding stationary contact carried by a mounting base. The projecting fingers and the continuous peripheral leg portion of the bimetallic element provide long, tortuous resistive paths of current flow, extending from one of the contacts at the distal end of one of the fingers to the contact at the distal end of the other finger and including parallel path portions formed by opposite peripheral leg portions of the bimetallic element.

Since the fingers are each connected to the periphery of the bimetallic element at only one end, they contribute little to the rigidity of the bimetallic element offered by the continuous peripheral portion of the bimetallic element, and thus have little effect on the snap action characteristics of the bimetallic element. This means that the operation of fastening the contacts to the fingers, and the size or location of such contacts do not appreciably affect the snap action control characteristics of the bimetallic element, which thus may be accurately controlled in the process of the fabrication of the bimetallic element before the contacts have been secured thereto. This construction also provides for uniform heating of the snap action control portion of the bimetallic element, namely the peripheral portion thereof. Such uniform heating is especially difficult to attain in bimetallic elements having a single movable contact thereon. Moreover, since the contacts are secured to the ends of the fingers on the sides thereof containing the low expanding metal, the contact pressure between the stationary and movable contacts actually increases as the snapping point of the bimetallic element is approached. This results in increased contact life and reliability, because it reduces arcing and chattering of the contacts and renders the circuit breakers substantially non-responsive to vibrations or shock forces found in vibrating machines, aircraft and other similar applications.

Other features of the invention will become apparent upon making reference to the specification to follow, the the claims and the drawings wherein:

Fig. 1 is an exploded view of the parts making up a circuit breaker constructed in accordance with a preferred form of the invention;

Fig. 2 is a longitudinal, vertical sectional view through the circuit breaker of the invention, taken along section line 2—2 of Fig. 3;

Fig. 3 is a horizontal sectional view of the circuit breaker, taken along line 3—3 of Fig. 2;

Fig. 4 is a horizontal sectional view of the circuit breaker taken along section line 4—4 of Fig. 2 with the bimetallic element removed; and

Fig. 5 is an enlarged transverse vertical sectional view through the circuit breaker taken along section line 5—5 in Fig. 2.

One form of circuit breaker constructed in accordance with the present invention is generally designated at 10, and it includes a housing 12 having a base portion 14 and a cover 16, and a bimetallic snap-acting element 18

carried within the housing 12. Stationary contacts 20 and 22 are secured in spaced apart relation within the base portion 14 of the housing by terminal studs 24 and 26 and nuts 28 and 30. The base portion 14 has rectangular recesses 32—34 formed in the top of the end walls 36—38, respectively, thereof, which recesses receive the similarly sized and shaped ends of the bimetallic element 18. The cover 16 has similar rectangular recesses 39 and 40 in the end walls thereof. The recesses 32—34 and 39—40 confine the bimetallic element 18 against lateral movement in the housing. The cover recesses 39 and 40 also form stop shoulders 39' and 40' against which the normally upturned ends of the bimetallic element bear, to force the central contact-carrying portion of the element into firm electrical contact with the stationary contacts 20 and 22. The base portion 14 of the housing additionally has laterally extending ears 41 and 42 extending from the opposite end walls 36 and 38 thereof, the ears being formed at the upper extremities of these end walls so as to receive in face-to-face relationship corresponding ears 44 and 46 of the cover portion 16 of the housing. The base and cover portions of the housing may be secured together by bolts or screws 48 and 49, respectively, passing through holes in the cover ears 44 and 46 and base ears 41 and 42.

The bimetallic element 18 is formed of two generally elongated rectangular superimposed metal strips 50 and 52 which are secured together as by welding and then deformed into a segmental spherical shape by any suitable metal shaping method. The bimetallic element under normal temperature conditions preferably has the generally segmental spherical dished shape shown, although the exact shape may take a wide variety of forms. The dished shape and the bimetallic construction thereof give it a snap acting characteristic. The metal strip 52 on the normally convex side of the bimetallic strip has a relatively low thermal coefficient of expansion, and the other metal strip 50 on the concave side thereof has a relatively high thermal coefficient of expansion. For example, the metal strip 52 may be formed of Invar or the like and the other metal strip 50 may be formed of brass, copper, nickel, chromium or iron alloys or the like.

In accordance with the most preferred form of the invention, the bimetallic element 18 is provided with a generally wide, square, S-shaped through-slot 54 centered therein, to form a continuous, relatively narrow marginal portion, including a pair of opposed long and narrow peripheral legs 56 and 58 and a pair of short and narrow peripheral legs 60 and 62 along the short sides of the bimetallic element, and a central portion including a pair of long, slender juxtaposed fingers 63 and 64 extending inwardly in opposite direction from offset points on the short peripheral legs 60 and 62. The fingers 63 and 64 extend generally parallel to one another and to the longitudinal peripheral legs 56 and 58 and terminate contiguous to but spaced from the short legs from which they do not extend.

A pair of movable contacts 66 and 68, made of a suitable contact material such as platinum alloy, palladium alloy or the like, are riveted or otherwise suitably secured to the ends of the fingers 63 and 64 on the low expanding or normally convex side of the bimetallic element. The stationary contacts 20 and 22, which may also be made of a platinum or palladium alloy or other suitable contact material, are longitudinally and laterally spaced like the movable contacts 66 and 68 so that the contact pairs 20—68 and 22—66 are in engagement during normal temperature conditions.

With the construction of the bimetallic element 18 just described, the snap action characteristics thereof are controlled by the relatively continuous peripheral leg portions thereof, since the central portion of the bimetallic element comprised of the fingers 63 and 64 are unconnected at their ends and therefore free to flex independently of the peripheral leg portions of the bimetallic element. Thus,

the size, weight and position of the movable contacts 66 and 68 and the operations performed in securing them to the ends of the fingers will not significantly affect the snap action characteristics of the bimetallic element, and the ultimate snap-acting characteristics of the bimetallic element can be closely controlled during the deformation of the welded strips 50 and 52. Other advantages of the bimetallic element construction will be explained in connection with the description of the operation of the circuit breaker to follow.

The circuit breaker just described is designed particularly as a low ampere circuit interrupter. At any given instant, current flows from one of the contacts 20 or 22 to the base of the associated finger and then along parallel paths including the long peripheral legs 56 and 58, which parallel paths meet near the base of the other finger where the current flows to the movable contact at the end thereof. As the current flows through the relatively long paths offered by the legs and fingers of the bimetallic element, heat is generated therein which, due to the substantially different thermal coefficients of expansion of the metal strips 50 and 52 making up the bimetallic element, causes flexing of the peripheral leg and finger portions of the bimetallic strip to take place. The flexing of the ends of the fingers is in a direction which increases contact pressure between the stationary and movable contacts, and the flexing of the peripheral portion of the bimetallic element is in a direction to snap the element into an oppositely dished shape. Until the snapping temperature of the bimetallic element is reached, the upper ends of the bimetallic element bear against the stop shoulders 39' and 40' formed by the cover recesses 39 and 40 to provide, in conjunction with the downward flexing of the fingers 63 and 64, firm contact between the contact pairs 20—68 and 22—66.

When current flowing through the peripheral leg portions of the bimetallic element reaches the limit for which the circuit breaker is designed, then the heat developed in this portion of the bimetallic element is sufficient to cause the bimetallic element to snap into the oppositely dished condition, as shown in dotted lines in Fig. 2, where the movable contacts are spaced from the stationary contacts. Because of the above-mentioned direction of flexing of the contact carrying fingers 63 and 64, the contact pressure between the stationary and movable contacts is at a maximum at the snapping point. This avoids the undesired arcing, chattering and vibration instability inherent in many forms of snap-acting bimetallic circuit breakers heretofore constructed, wherein the contact pressure decreases as the snapping point of the bimetallic element involved is reached. When the bimetallic element is actuated into the oppositely dished condition shown in dotted lines in Fig. 2, then the upper position of the bimetallic element fits loosely within the cover 16, with the side defining walls of the housing base recesses 32 and 34 laterally confining the bimetallic element, as they do at all times, so that the element assumes definite consistent positions in its oppositely dished states.

When the movable contacts are spaced from the stationary contacts, obviously current ceases to flow in the bimetallic element and the latter cools down. The circuit breaker shown is constructed so as to automatically re-close the movable and stationary contacts by a reverse snapping action. It may be so designed, however, to maintain the contacts separated until such time as they are manually set to their closed positions.

Besides the advantages already mentioned above, the circuit breaker of this invention is very compact, considering the lengths of the current paths involved. Also, the heating of the peripheral leg portions of the bimetallic element, which controls the snap action characteristics thereof, is uniform, since no contact, mounting posts or other good heat conducting elements are attached directly to it. Such uniform heating is difficult to obtain with bimetallic elements having only a single movable con-

tact thereon and wherein the bimetallic element is secured at one end to a mounting post. Additional advantages of the circuit breaker of this invention are in the simplicity, ruggedness and low cost thereof.

It should be understood that numerous modifications may be made of the most preferred form of the invention above described without deviating from the broader aspects of the invention.

I claim as my invention:

1. A circuit breaker comprising a thin, flexible, snap-acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substantially different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature, with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished form above said temperature, said bimetallic element having a bimetallic snap-action control portion which controls the snap action characteristics of the bimetallic element, and a pair of long slender bimetallic fingers connected at their bases to said snap-acting control portion and being free to flex substantially independently thereof, a contact secured near the end of each of said fingers on the side of the bimetallic element which fingers, under the heat generated by current flow therethrough, flex to force the contacts outward as the bimetallic element deforms from said first normal dished form toward the snapping position thereof, said bimetallic element having relatively long and irregular resistive paths including said snap-action control portion and said fingers extending between said contacts, which paths heat up to cause said snap action control portion and said fingers to deform, and a pair of stationary contacts which are positioned to make firm contact with said movable contacts when said bimetallic element is in said first dished form and which are separated from said movable contacts when said bimetallic element is in said oppositely dished form.

2. A circuit breaker comprising a thin, flexible, snap-acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substantially different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature, with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished form above said temperature, said bimetallic element having a bimetallic snap-action control portion which controls the snap action characteristics of the bimetallic element, and a pair of long slender bimetallic fingers connected at their bases to said snap-acting control portion and being free to flex substantially independently thereof, a contact secured near the end of each of said fingers on the low expanding normally convex side of the bimetallic element, which fingers, under the heat generated by current flow therethrough, flex to force the contacts outward as the bimetallic element deforms from said first normal dished form toward the snapping position thereof, said bimetallic element having relatively long and irregular resistive paths including said snap-action control portion and said fingers extending between said contacts, which paths heat up to cause said snap-action control portion and said fingers to deform, and a pair of stationary contacts which are positioned to make firm contact with said movable contacts when said bimetallic element is in said first dished form and which are separated from said movable contacts when said bimetallic element is in said oppositely dished form, said snap-action control portion being free of any external connections.

3. A circuit breaker comprising a thin, flexible, elongated snap-acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substantially different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature, with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished form above said temperature, said bimetallic element having a continuous bimetallic, peripheral, snap-action control portion which controls the snap action characteristics of the bimetallic element, and a pair of long slender bimetallic fingers formed integrally with said peripheral snap-action control portion and extending longitudinally of the elongated bimetallic element within said peripheral snap-action portion, said fingers being connected at their bases to said peripheral snap-action control portion and being free to flex substantially independently thereof, a contact secured near the end of each of said fingers on the low expanding normally convex side of the bimetallic element, which fingers, under the heat generated by current flow therethrough, flex to force the contacts outward as the bimetallic element deforms from said first normal dished form toward the snapping position thereof, said bimetallic element having relatively long and irregular resistive paths including said peripheral snap-action control portion and said fingers extending between said contacts, which paths heat up to cause said peripheral snap-action control portion and said fingers to deform, and a pair of stationary contacts thereon which are positioned to make firm contact with said movable contacts when said bimetallic element is in said first dished form and which are separated from said movable contacts when said bimetallic element is in said oppositely dished form.

4. A circuit breaker comprising a thin, flexible, elongated, rectangular snap-acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substantially different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature, with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished form above said temperature, said bimetallic element having a continuous bimetallic, peripheral, snap-action control portion which controls the snap action characteristics of the bimetallic element, and a pair of long slender bimetallic fingers formed integrally with said peripheral snap-action control portion and extending longitudinally of the elongated bimetallic element within said peripheral snap-action portion, said fingers being connected at their bases to said peripheral snap-acting control portion and being free to flex substantially independently thereof, a contact secured near the end of each of said fingers on the low expanding normally convex side of the bimetallic element, which fingers, under the heat generated by current flow therethrough, flex to force the contacts outward as the bimetallic element deforms from said first normal dished form toward the snapping position thereof, said bimetallic element having relatively long and irregular resistive paths including said peripheral snap-action control portion and said fingers extending between said contacts, which paths heat up to cause said peripheral snap-action control portion and said fingers to deform, and a housing made of insulating material having end recesses forming side walls for laterally confining said bimetallic element and stop shoulders for providing bearing surfaces for the ends of the bimetallic element when in a circuit-closing position, said bimetallic element being in said housing where it is mounted for free bodily movement, limited only by said side walls and stop shoulders, and a pair of stationary contacts in said housing which are positioned to make firm contact with said movable contacts when said bimetallic element is in said first dished form, the ends thereof then bearing against said stop shoulders, said contacts of said bimetallic element being separated from said movable contacts when said bimetallic element is in said oppositely dished form.

5. A circuit breaker comprising a thin, flexible snap-

acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substantially different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished condition above said temperature, said bimetallic element having a generally wide S-shaped through-slot in the central portion of the bimetallic element forming a peripheral snap-action control portion, comprising two pairs of opposed bimetallic legs extending along the perimeter of the element, and a contact-carrying central portion, comprising a pair of long slender fingers extending transversely inwardly in opposite directions from an opposite pair of said legs, the end portion of said fingers being free to flex independently of the snap-action control portion of the bimetallic element, a contact secured near the end of each of said fingers on the normally convex side of the bimetallic element, said legs and fingers providing resistive paths of current flow extending from the contact at the end of one of said fingers to the base thereof and then along parallel paths including the other of said legs, which parallel paths meet at the base of the other finger, where the current flows to the contact at the end of the latter finger, said paths heating up under said current flow, to cause said fingers to deform in a direction which forces the contacts carried thereby outwardly and to raise the temperature of said legs to the snapping temperature, in response to current flow above a given magnitude.

6. A circuit breaker comprising a thin, flexible, snap-acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substatinally different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature, with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished condition above said temperature, said bimetallic element having a generally wide S-shaped through-slot in the central portion of the bimetallic element forming a peripheral snap-action control portion, comprising two pairs of opposed bimetallic legs extending along the perimeter of the bimetallic element, and a contact-carrying central portion comprising a pair of long slender fingers formed integrally with said snap-action control portion and extending transversely inwardly in opposite directions from an opposite pair of said legs, the end portions of said fingers being free to flex indedependently of the snap-action control portion of the bimetallic element, a contact secured near the end of each of said fingers on the low expanding or convex side of the bimetallic element, said legs and fingers providing resistive paths of current flow extending from the contact at the end of one of said fingers to the base thereof and then along parallel paths including the other of said legs, which parallel paths meet at the base of the other finger where the current flows to the contact at the end of the latter finger, said paths heating up under said current flow, to cause said fingers to deform in a direction which forces the contacts carried thereby outwardly and to raise the temperature of said legs to the snapping temperature in response to current flow above a given magnitude.

7. A circuit breaker comprising a thin, flexible snap-acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substantially different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature, with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished condition above said temperature, said bimetallic element having a generally wide S-shaped through-slot in the central portion of the bimetallic element forming a peripheral snap-action control portion, comprising two pairs of opposed bimetallic legs extending respectively along the perimeter of the bimetallic element, and a contact-carrying central portion comprising a pair of long slender fingers extending transversely inwardly in opposite directions from offset points on an opposite pair of said legs to points respectively adjacent the legs which are opposite the legs from which they extend, the end portions of said fingers being free to flex independently of the snap-action control portion of the bimetallic element, a contact secured near the end of each of said fingers on the normally convex side of the bimetallic element, said legs and fingers providing resistive paths of current flow extending from the contact at the end of one of said fingers to the base thereof and then along parallel paths including the other of said legs, which parallel paths meet at the base of the other finger where the current flows to the contact at the end of the latter finger, said paths heating up under said current flow to cause said fingers to deform in a direction which forces the contacts carried thereby outwardly and to raise the temperature of said legs to the snapping temperature in response to current flow above a given magnitude.

8. A circuit breaker comprising a thin, flexible, elongated, rectangular snap-acting bimetallic switch blade element formed by two superimposed and secured together metal parts having substantially different thermal coefficients of expansion, said bimetallic element having a first dished form below a given control temperature, with the higher expanding metal on the concave side thereof, and being adapted to snap into an oppositely dished condition above said temperature, said bimetallic element having a generally wide S-shaped through-slot in the central portion of the bimetallic element forming a peripheral snap-action control portion, comprising two pairs of opposed bimetallic legs extending respectively along the long and short sides of the bimetallic element, and a contact-carrying central portion comprising a pair of long slender fingers formed integrally with said snap-action control portion and extending transversely inwardly in opposite directions from offset points on the short pair of said legs to points respectively adjacent the legs which are opposite the legs from which they extend, the end portions of said fingers being free to flex independently of the snap-action control portion of the bimetallic element, a contact secured near the end of each of said fingers on the low expanding or convex side of the bimetallic element, said legs and fingers providing resistive paths of current flow extending from the contact at the end of one of said fingers to the base thereof and then along parallel paths including the other of said legs, which parallel paths meet at the base of the other finger where the current flows to the contact at the end of the latter finger, said paths heating up under said current flow to cause said fingers to deform in a direction which forces the contacts carried thereby outwardly and to raise the temperature of said legs to the snapping temperature in response to current flow above a given magnitude.

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