Nov. 10, 1959 R. G. AREY 2,912,546

ELECTRICAL SWITCH STRUCTURES

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Fig. 1.

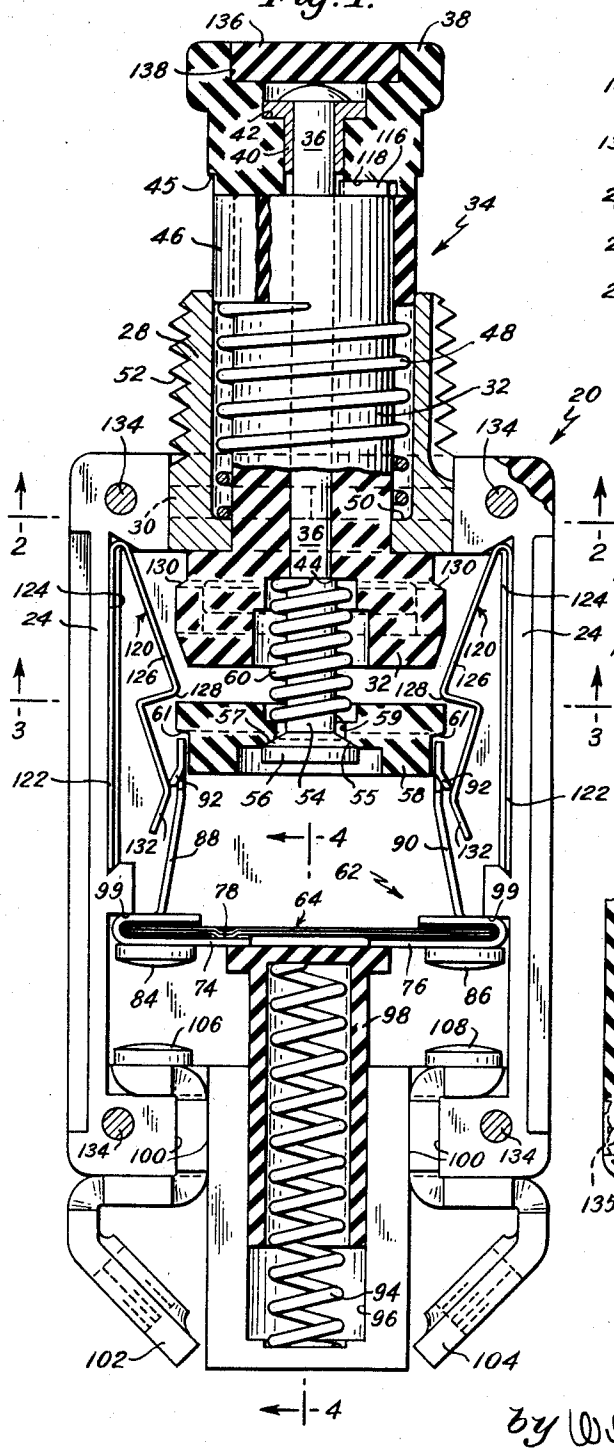


Fig. 2.

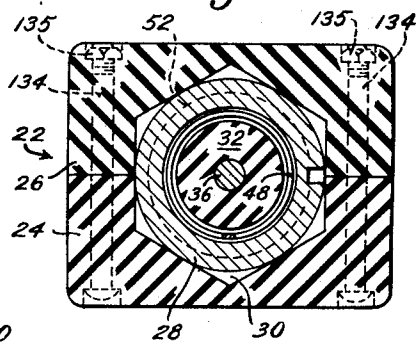


Fig. 3.

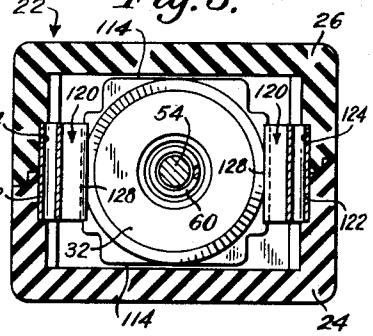
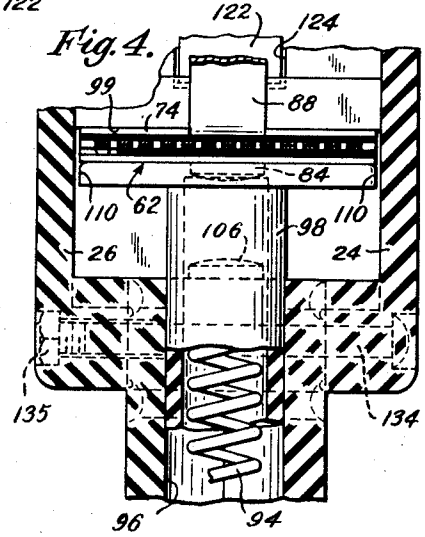


Fig. 4.



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ELECTRICAL SWITCH STRUCTURES

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Fig. 5.

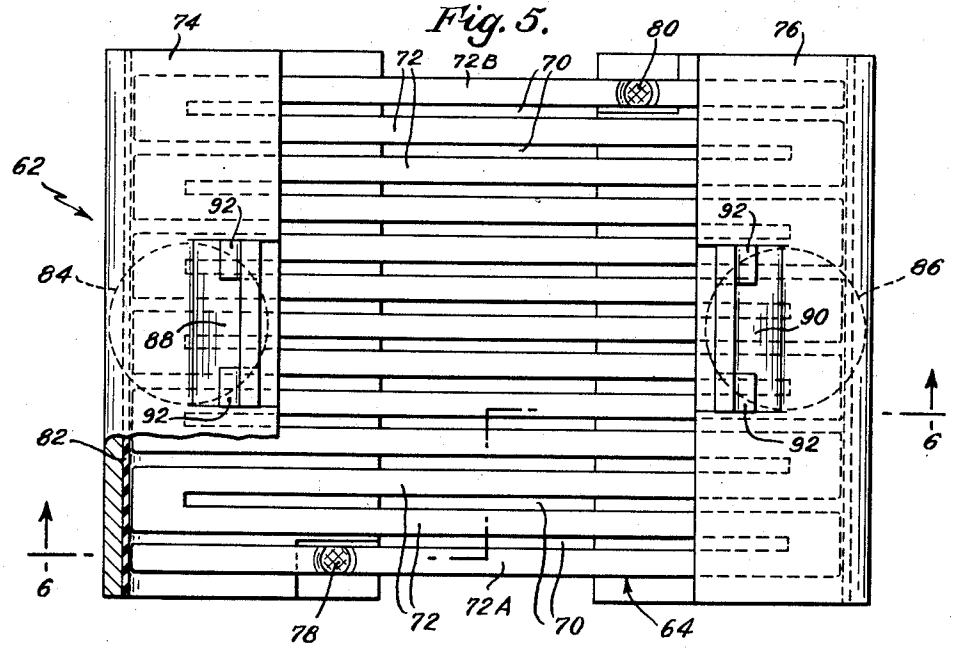
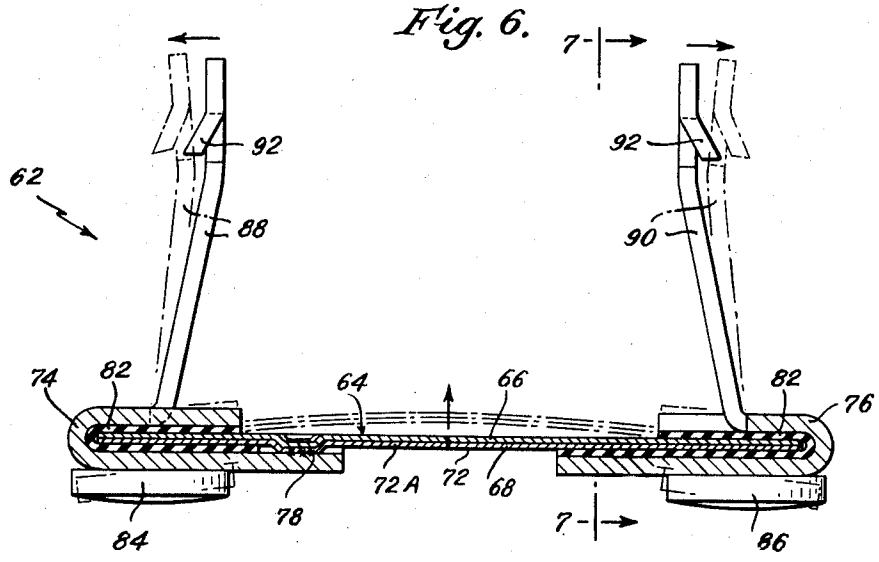


Fig. 6.



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ELECTRICAL SWITCH STRUCTURES

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Fig. 7.

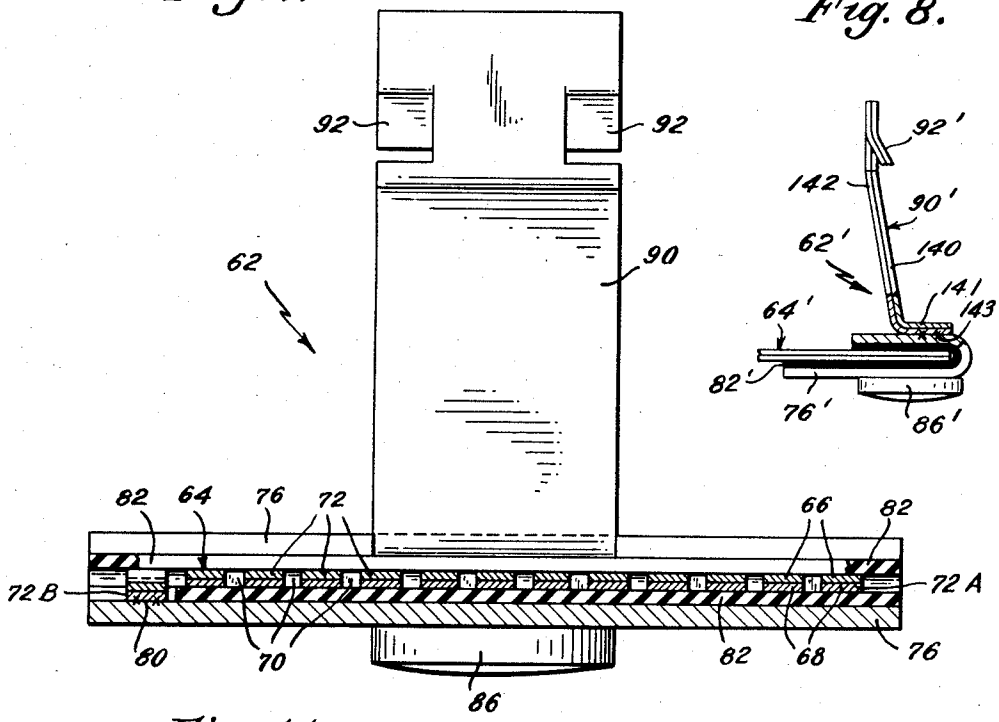


Fig. 8.

Fig. 11.

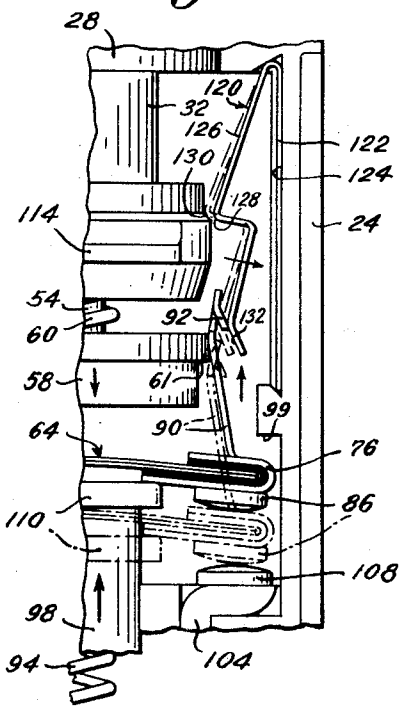
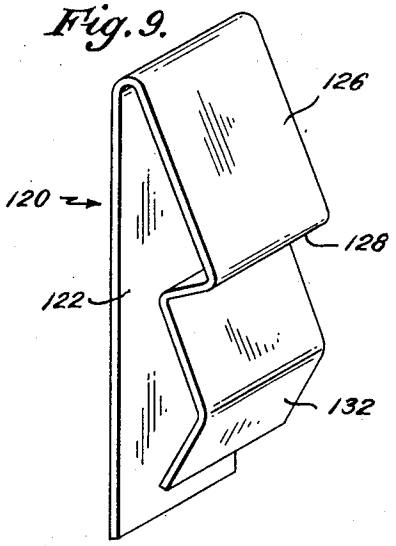


Fig. 9.



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ELECTRICAL SWITCH STRUCTURES

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Fig. 10.

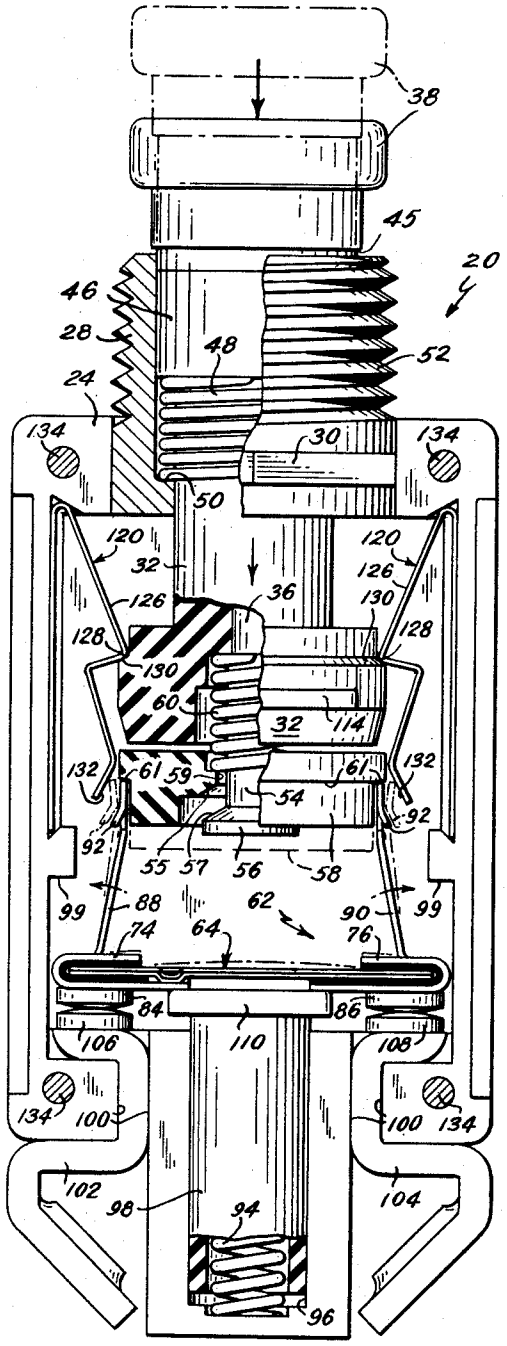
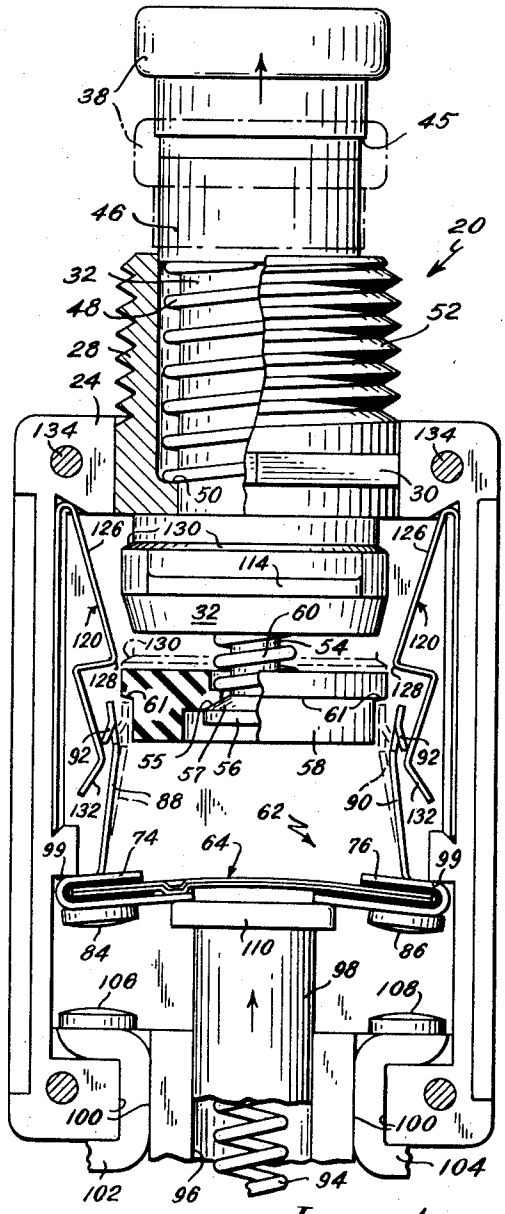


Fig. 12.



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2,912,546

ELECTRICAL SWITCH STRUCTURES

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Application May 2, 1958, Serial No. 732,550

19 Claims. (Cl. 200—116)

This invention relates to electrical switch structures, and more particularly, to thermally responsive switch structures.

An object of this invention is to provide an improved switch structure incorporating a new and improved combination of interrelated parts.

A further object is to provide such a switch structure which accommodates the use of compressive resilient biasing means for biasing operating parts thereof.

Another object is to provide such a switch structure utilizing new and improved thermally responsive means.

A further object is to provide such a switch utilizing such thermally responsive means which reliably effects a comparatively low electrical current rating.

A further object is to provide a thermally responsive switch which is also mechanically actuable repeatedly as an on-off switch without upsetting the calibration of the thermally responsive means thereof.

Another object of the invention is to provide such a switch structure which exhibits improved electrical contact pressure characteristics.

Still further objects of the invention are to provide such a switch structure which is simple in construction, economical to manufacture and dependable in use.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated:

Fig. 1 is a view of a thermally responsive electrical switch embodying the instant invention and showing the parts thereof in retracted, contacts-open position, one part of the two-part casing being removed and certain of the parts being shown in section;

Figs. 2, 3 and 4 are sectional views of the switch on a slightly reduced scale and taken along lines 2—2, 3—3 and 4—4, respectively, of Fig. 1;

Fig. 5 is a plan view on an enlarged scale of the thermally responsive member of the switch;

Fig. 6 is a sectional view taken along line 6—6 in Fig. 5;

Fig. 7 is a sectional view taken along line 7—7 in Fig. 6;

Fig. 8 is a fragmentary view of a portion of the thermally responsive means according to a second embodiment;

Fig. 9 is a perspetcive view of one of the latch springs as shown in Fig. 1;

Fig. 10 is a view similar to Fig. 1 but showing the parts, in full lines, in reset, contacts-closed position;

Fig. 11 is a fragmentary view of a portion of the switch

as shown in Figs. 1 and 10, certain of the parts being shown in full lines and in broken lines at intermediate positions during operation thereof; and

Fig. 12 is a view similar to Figs. 1 and 10, and showing the parts, in full lines, in retracted, contacts-open position before cooling of the thermally responsive member.

Referring to Fig. 1, an electrical switch embodying the instant invention is shown taking the form of a circuit breaker generally indicated by the reference numeral 20. This switch includes a base or casing 22 formed of a pair of interfitting casing members 24 and 26. Carried by casing 22 is a bushing 28 having a hexagonal flange 30 mating with a correspondingly shaped recess provided by each of the casing members. Mounted for slidable movement within and along bushing 28 is a member 32 forming part of the resetting means 34 of the switch. Resetting means 34 further includes a stem 36 extending through apertures provided by member 32, a push button member 38 and a flanged collar 40. The flange carried by collar 40 seats against a shoulder 42 provided by push button member 38, stem 36 is headed over against the adjacent end of collar 40, and stem 36 provides a shoulder 44 bearing against the adjacent portion of member 32 whereby the stem and members 32, 38 and 40 are fixed with respect to each other. Push button member 38 provides an annular abutment 45 engageable with the adjacent end of bushing 28 to limit downward movement of the push button as viewed in Fig. 1. An annulus or band 46 of a color contrasting with that of push button member 38 and bushing 28 is biased against the adjacent portion of push button member 38 by a compression spring 48 having one end abutting band 46 and the other end abutting an internal shoulder 50 provided by bushing 28. Bushing 28 is externally threaded at 52 for the reception of a nut or nuts (not shown) for mounting the switch on a support.

Stem 36 carried by member 32 includes an extension 54 having a flange or stop 56. Resetting means 34 further includes a member 58 having an aperture 59 through which extension 54 extends whereby member 58 is slidably mounted on the extension. Compressive resilient biasing means in the form of a compression spring 60 is disposed about the stem extension 54 and resiliently biases member 58 against stop 56 and away from member 32. Aperture 59 provided by member 58 has a substantially larger diameter than the outside diameter of stem extension 54 whereby member 58 has a loose, unconfined fit with this extension while the resetting means is in reset position as shown in Fig. 10. Aperture 59 includes a countersink 55 engaged, under the bias of spring 60, with an interfitting beveled portion 57 provided by stop 56 when the resetting means is in the retracted position shown in Fig. 1. Resetting means 34 provides an annular abutment 61 and is movable from the position shown in Fig. 1 to the position shown in full lines in Fig. 10 to move a thermally responsive member 62 from contacts-open to contacts-closed position as will be more fully described.

Referring particularly to Figs. 5–7, thermally responsive means 62 includes a thermally responsive element 64 formed of a section of composite material. The high expansion component of the composite material as shown in the embodiment of the drawing is indicated at 66 and the low expansion component is indicated at 68. Thermally responsive element 64 is slotted alternately from opposite sides at 70 to provide a plurality of transverse lengths 72 electrically connected in series circuit relation. Thermally responsive member 62 further includes a pair of U-shaped strips 74, 76 respectively, each of which is formed of electrically conductive material and

encloses one end of each of lengths 72 of the thermally responsive element. Lowermost strip 72A as viewed in Fig. 5 is electrically connected to U-shaped strip 74 as by means of a weld 78. In a similar manner, the uppermost length 72B of the thermally responsive element is electrically connected to U-shaped strip 76 as by a weld 80. The remaining ends of all of lengths 72, 72A and 72B are electrically insulated from the adjacent U-shaped strip by means of a layer of electrical insulating material 82 as best shown in Figs. 5–7. Insulating material 82 may be any one of a number of well known kinds. In any case, insulating material 82 is bonded to and between each of the U-shaped strips and the remaining ends of lengths 72, 72A and 72B enclosed thereby. According to one particular example, flat strips of insulating material in the form of glass fiber impregnated with a thermosetting heat-curable resin are cut to the desired size and shape, folded about the respective sides of the thermally responsive element to leave the end of lengths 72A and 72B exposed, after which U-shaped strips 74 and 76 are juxtaposed with the thermally responsive element, the end of each of lengths 72A and 72B is welded to its respective U-shaped strip, the U-shaped strips are flattened to compress the insulating material between and about the ends of said remaining lengths of the thermally responsive element, and the assembly is then heat-cured to effect the bond of the insulating material to and between each of the U-shaped strips and said remaining lengths enclosed thereby.

Electrically connected to each of U-shaped strips 74 and 76 and carried thereby are a pair of contacts 84 and 86, respectively. Accordingly, thermally responsive member 62 provides an electrically conductive path leading from contact 84, through U-shaped strip 74, through length 72A of the thermally responsive element, and then serially through successive lengths 72, through length 72B and through U-shaped strip 76 to electrical contact 86.

By virtue of the slotted construction of the thermally responsive element 64 the latter has a total or effective electrical resistance substantially equal to the sum of the resistances of each of the lengths thereof along with the thermally responsive action or force equal to the combined action or force of all of the individual lengths thereof. It will be apparent that an advantage of the slotted construction of the thermally responsive element is that a thermally responsive element is provided having a much higher resistance than a similar but unslotted thermally responsive element while at the same time the thermostatic action or force exhibited by the slotted element is substantially or nearly that of the similar but unslotted element. It follows that thermally responsive member 62 and a switch incorporating the same is capable of a very low current rating. An advantage of the construction whereby insulating means 82 is bonded to each of the U-shaped strips 74 and 76 and the ends of the lengths of the thermally responsive element is that the overall structure is greatly rigidified at the sides of the element about which the U-shaped strips are disposed, and the width of the successive slots 70 and thickness of the lengths 72, 72A and 72B can be successfully kept to a minimum. According to one specific example, the thermally responsive element as described above has slots 0.010 of and inch in width and each of the successively interconnected lengths is 0.007 of an inch thick; the thermally responsive member having a rating of one-half an ampere. It will be apparent that thermally responsive elements of different ratings can be provided by varying the number and width of lengths 72 as well as the composite material of which the latter are formed.

Each of U-shaped strips 74 and 76 carries an arm 88 and 90, respectively, which may be integral with the respective U-shaped strip as shown. Each of arms 88 and 90 is provided with a pair of angularly disposed tabs 92 for a purpose later to become apparent. Due to heating of the thermally responsive element 64 upon the flow of electrical current therethrough, the thermally responsive element flexes or warps to the dotted line condition shown in Fig. 6 whereby arms 88 and 90 are deflected away from each other. The distal ends of arms 88, 90 are engageable with abutment 61 provided by member 58, and the surface presented by this abutment is tangential to the arc traced by said distal ends as the latter move away from each other under said warping of the thermally responsive element.

Referring again to Figs. 1–4, thermally responsive member 62 is resiliently biased from the contacts-closed position (shown in full lines in Fig. 10) to the contacts-open position as shown in Fig. 1 by means of a compression spring 94. One end of spring 94 abuts the closed end of a socket 96 provided by casing members 24 and 26 and the other end of this spring abuts the closed end of a socket-providing member 98 which interfits with and is telescopically slidable along socket 96 whereby member 98 is biased against the adjacent portions of U-shaped members 74 and 76 of the thermally responsive member 62. Casing members 24 and 26 provide a pair of abutments 99, 99 for limiting the extent of movement of thermally responsive member 62 from contacts-closed to contacts-open position by the engagement thereof with U-shaped members 74 and 76 carried by the thermally responsive element.

Each of casing members 24 and 26 provides a recess 100 for the reception of a terminal 102 and 104, respectively. As will be apparent from the drawing, the mutually engaging surfaces of casing members 24 and 26 and terminals 102 and 104 are configured and interfitted for rigid mounting of the terminals on the casing. Terminal 102 carries a fixed contact 106 for cooperation with movable contact 84 and terminal 104 carries a fixed contact 108 for cooperation with movable contact 86. As is apparent from the drawing, thermally responsive member 62 provides a bridging member electrically connecting contacts 106 and 108 when the thermally responsive member is in the contacts-closed position as shown in Fig. 10.

It will be noted that member 98, thermally responsive member 62, and members 58 and 32 are prevented from rotation about their respective axes and with respect to the casing by the engagement of respective surfaces thereof with the adjacent portions of the casing. In this regard, side surfaces 110, 110 of member 98 (see Fig. 4) engage the adjacent surfaces of casing members 24 and 26 to prevent rotation of member 98. Referring to Figs. 1 and 4, it will be apparent that the marginal edges presented by thermally responsive member 62 engage the adjacent surfaces of the casing to prevent undue lateral shifting thereof as well as to prevent rotation thereof. Member 32 provides surfaces 114, 114 engageable with the adjacent internal surfaces of the casing. In addition, push button member 38 is prevented from rotating relative to member 32 by means of a rib 116 integral with and projecting from member 32 into an interfitting recess 118 provided by member 38.

Switch 20 further includes a pair of latch spring members 120, 120 for retaining member 32 and the parts fixed with respect thereto in reset position until released as will be more particularly described. Each of latch members 120 includes a leg 122 disposed in a recess 124 provided by casing members 24 and 26 whereby the latter are mounted on the casing. Each of latch members 120 further includes a second leg 126 having a return bent portion or corner 128 engageable with an angularly disposed abutment 130 provided by member 32. In addition, each of legs 126 of the latch members 122 provides a cam surface 132 for cooperation with angularly disposed tabs 92 of the arms 88, 90 provided by the thermally responsive member 62.

Casing members 24 and 26 may be retained in assembled relationship by means, for example, such as screws

134 threaded into nuts 135 as shown in the drawing. A plug 136 may be marked with the rating of the electrical switch and force fitted in a recess 138 provided by push button member 38 as best shown in Fig. 1.

Illustrated in Fig. 8 is a modification which can be incorporated into the embodiment of the thermally responsive member 62 as described heretofore. The parts of the modified thermally responsive member are or may be substantially identical with those of the embodiment as shown in Figs. 1–7 and 9–12 except as pointed out hereinafter. In this regard, those parts of the modified thermally responsive member as shown in Fig. 8 which have primed reference numerals are or may be identical with their respective counterparts in Figs. 1–7 and 9–12 except as pointed out hereinafter, these respective counterparts having the same but unprimed reference numerals. It will be understood that the broken away portion of the thermally responsive member as shown in Fig. 8 is or may be of the same form as that of the portion included in this figure. This modification is different from that of the remaining figures of the drawing in that arm 90' is formed of composite, thermally responsive material, the high expansion component 140 and low expansion component 142 of which are disposed in the relation opposite to that of the thermally responsive element 64'. In this regard, the arms provided by the thermally responsive member of both of the disclosed embodiments move away from each other upon heating of the thermally responsive element 64 or 64' whereas upon heating of the arm 90' and another mounted opposite it, the latter arms warp or flex in a direction toward each other. Arm 92' is mounted on U-shaped strip 76' by means of an angularly disposed leg 141 welded to strip 76' at 143. Both of the arms provided by the thermally responsive element 62' of the embodiment shown in Fig. 8 are so calibrated that changes in the ambient temperature to which the thermally responsive member is subjected are compensated for by the action of the thermally responsive arms; the result being that these arms move out of engagement with the abutment 61 provided by member 58 at the same value of current flow regardless of changes in the ambient temperature.

The operation of circuit breaker 20 will now be described. With the parts in the respective positions shown in Fig. 1, thermally responsive member 62 is in the retracted, contacts-open position, member 58 is in the retracted position and biased by spring 60 against the stop 56 provided by the extension 54 of stem 36, and member 32, along with the parts fixed with respect thereto, is biased to the retracted position under the bias of compression spring 48 whereby band 46 which is formed of a color contrasting with that of push button member 38 is visible from outside the casing. Push button 38 is depressed to the advanced or reset position whereby the parts take the respective positions shown in full lines in Fig. 10. As movement of push button member 38 from the position shown in Fig. 1 to that shown in Fig. 10 ensues, the abutment 61 provided by member 58 moves into engagement with the distal end of each of arms 88 and 90 provided by the thermally responsive member 62. Continued movement of push button 38 results in continued compression of spring 48, outward deflection of latch spring arms 126, 126 due to movement of member 32 against and slidably along these arms, and movement of the thermally responsive member to the contacts-closed position shown in full lines in Fig. 10. It will be noted that movement of thermally responsive member 62 to the contacts-closed position shown in Fig. 10 occurs against the resilient bias exerted by compression spring 94. With further movement of push button 38 to the reset position shown in Fig. 10 after engagement of movable contacts 84 and 86 with fixed contacts 106 and 108, member 58 is prevented from further downward movement and compression spring 60 is compressed as member 32 continues movement with the push button. Just before the shoulder 45 provided by push button 38 comes into engagement with the adjacent portion of bushing 52 to limit downward movement of the push button and the parts fixed with respect thereto, legs 126, 126 of latch spring members 120, 120 move under their inherent resilient bias into engagement with angularly disposed abutment 130 provided by member 32. When push button 38 is released, latch members 120, 120 retain member 32 and the parts fixed with respect thereto against the bias of springs 60 and 48 tending to move the member 32, push button 38, etc. from the reset position to the retracted position. With the parts in the reset, contacts-closed position shown in Fig. 10, member 58 retains thermally responsive member 62 in the contacts-closed, advanced position under the bias exerted by compression spring 60. It may be noted at this point that none of the force exerted by compression spring 48 is transmitted to or directly affects the forces on or action of the thermally responsive member 62.

With the parts in the contacts-closed, reset positions shown in Fig. 10, an electrically conductive path is established leading from terminal 102 through, in succession, contact 106, contact 84, the thermally responsive element 64, contact 86, contact 108 and terminal 104. Upon the flow of current of sufficiently high values along the electrically conductive path just described, thermally responsive element 64 is heated whereupon it warps or flexes toward the dotted-line position shown in Fig. 10 thereby moving arms 88 and 90 outwardly and away from each other toward the broken-line positions shown in Fig. 10. When thermally responsive element 64 warps or flexes sufficiently to move the distal ends of arms 88 and 90 out of engagement with abutment 61 provided by member 58 to the broken-line position shown in Fig. 10; member 58 moves to the broken-line position shown in this figure under the bias of spring 60, and thermally responsive member 62 is no longer restrained in the contacts-closed position and immediately begins movement to the contacts-open, retracted position shown in Fig. 12 under the resilient bias exerted by compression spring 94. Referring to Fig. 11, as thermally responsive member 62 moves toward the contacts-open position from the contacts-closed position, angularly disposed tabs 92 provided by each of arms 88 and 90 move into camming engagement with cam surfaces 132, 132 provided by legs 126, 126 of latch spring member 120, 120. Under the kinetic energy of spring 94 and the thermally responsive element 62, tabs 92 strike and cam arms 126, 126 away from each other releasing portions 128, 128 of arms 126, 126 from angular abutment 130 of member 32 whereby member 32 and the parts fixed with respect thereto quickly move to the retracted position shown in Fig. 12.

Immediately after tripping of circuit breaker 20 from the condition shown in Fig. 10 to the condition shown in Fig. 12, thermally responsive member 62 as shown in Fig. 12 will still be heated and, due to the warping of the thermally responsive element 64, arms 88 and 90 will be disposed in the outwardly displaced positions shown in Fig. 12. Accordingly, upon depression of push button 38 from the retracted position shown in Fig. 12 while the thermally responsive element 64 is still in the heated condition and therefore warped as shown in this figure, downward movement of member 58 fails to bring abutment 61 into engagement with the distal ends of arms 88 and 90 whereby the thermally responsive member remains in its retracted, contacts-open position. This feature is advantageous in that movable contacts 84 and 86 cannot be closed against fixed contacts 106 and 108, respectively, on the fault which caused tripping of the circuit breaker until the thermally responsive element 64 has cooled for a significant time interval. Also, upon depression of the push button from retracted to advanced position while the thermally responsive element is in the warped condition as shown in Fig. 12, arms 88 and 90 retain latch spring members 120, 120 out of latching en-

gagement with abutment 130 of member 32 whereby the latter member and the parts carried thereby are free to move from advanced to retracted position under the bias of spring 48 upon release of the push button.

Upon cooling of the thermally responsive element 64 from the warped condition shown in full lines in Fig. 12 back to the broken-line position shown in this figure, the parts are again in the conditions and positions shown in Fig. 1 ready for resetting of the circuit breaker as just described.

Circuit breaker 20 is further capable of being manually actuated for use as an on-off electrical switch. In this regard, with the parts in the reset, contacts-closed positions as shown in Fig. 10, push button member 38 may be grasped and forcibly pulled outwardly toward retracted position whereby the reaction of angularly disposed ledge 130 of member 32 against portions 128, 128 of latch members 120, 120 forces legs 126, 126 outwardly and away from each other whereby member 32, the parts fixed with respect thereto and member 58 move to their retracted positions, and the contacts 84 and 86 carried by thermally responsive member 62 are separated from their mating contacts 106 and 108 under the resilient bias exerted by compression spring 94 against the thermally responsive member.

As noted above, the latching forces exerted to retain member 32 and the parts fixed with respect thereto in the reset position are independent of the forces on thermally responsive member 62. This is advantageous in that repeated latching and unlatching due to manual on-off switching of the circuit breaker does not upset calibration of the thermally responsive member.

Circuit breaker 20 is "trip-free" in that thermally responsive member 62 cannot be retained in contacts-closed position by forcibly retaining push button 38 in the advanced position upon the occurrence of a current overload through thermally responsive element 64. If member 32 is restrained in the advanced position by forcibly holding push button 38 in the depressed, advanced position when the thermally responsive element warps sufficiently to disengage the distal ends of arms 88 and 90 from abutment 61, the thermally responsive member will move to contacts-open position under the bias of spring 94 (member 32 will, of course, remain in the advanced position) and member 58 will move away from member 32 and against stop 56 of stem extension 54 (from the full-line position shown in Fig. 10 to the broken-line position of Fig. 10 and full-line position of Fig. 11) under the bias of spring 60. Fig. 11 shows the respective positions of the parts after tripping of thermally responsive member 62 from contacts-closed to contacts-open position while member 32 and the push button are forcibly retained in the advanced, contacts-closable position. It will be noted from Fig. 11 that members 32 and 58 will then move to retracted position under the bias of spring 48 upon release of the push-button, this because the tabs 92 carried by arms 88 and 90 retain latch spring member 120, 120 in unlatched position with respect to member 32 until thermally responsive element 62 cools to the contacts-closable condition as shown in broken lines in Fig. 12.

Unless push button 38 is forcibly held in the reset position when thermally responsive member 62 is in the contacts-open position and heated condition as shown in full lines in Fig. 12, band 46 will be within bushing 28 (and therefore hidden from view) when the thermally responsive member is in contacts-closed position. Since band 46 is of a color contrasting with that of push button 38 and bushing 28, the respective position of the thermally responsive member is readily discernible to an observer even though the latter be hidden within casing 22.

It will be noted (see Figs. 6 and 10) that thermally responsive element 64 warps upon heating thereof in the direction urging contacts 84 and 86 against contacts 106 and 108, respectively. Also, compression spring 94 acts against a portion of thermally responsive member 62 between contacts 84 and 86 on a line perpendicular to a line connecting these latter contacts, and the thermally responsive element 64 warps upon heating thereof in the direction to urge said portion upwardly (as viewed in Fig. 6) to decrease the deflection of spring 94. Spring 94 is of conventional form which follows Hooke's law in that the force exerted thereby is directly proportional to the deflection thereof. It will be clear that spring 94 need not follow Hooke's law for the beneficial result to be pointed out following, but only that the force exerted thereby decrease with decrease in deflection thereof (and vice versa). Furthermore, it will be clear that the force exerted by member 58 of resetting means 34 under the bias of compression spring 60 acts against the thermally responsive element. Since abutment 61 presents a surface tangential to the arc traced by the distal ends of arms 88, 90 upon heating of the thermally responsive element, the force exerted against thermally responsive member 62 by member 58 under the bias of spring 60 remains constant, and any decrease in the force exerted by spring 94 is reflected by an increase in the pressure between contacts 84, 86 and 106, 108, respectively. It will be apparent, therefore, that so long as the force exerted by member 58 against thermally responsive member 62 under the bias of compression spring 60 does not decrease as thermally responsive element 64 warps from the full-line to the broken-line positions as shown in Fig. 10 and since any expansion of spring 94 to accommodate such warping of the thermally responsive element can result only in a decrease in the force exerted by the latter spring with a concomitant increase in the pressure exerted by contacts 84 and 86 against contacts 106 and 108, no decrease in the pressure between the latter respective contacts will occur during this warping of the thermally responsive element until the distal ends of arms 88 and 90 move out of engagement with abutment 61 for release of the thermally responsive member to contacts-open position.

As arms 88 and 90 move away from each other upon warping of thermally responsive element 64 due to heating of the latter when the parts are in the full-line, contacts-closed position shown in Fig. 10, it is likely, or possible at least, that one of these arms will move out from engagement with abutment 61 slightly before the other. The result will be that member 58 will tilt about the point of engagement of said other arm and abutment 61 and move laterally relative to extension 54 under the force couple effected by the bias of springs 60 and 94. This tilting and lateral movement of member 58 is permitted by virtue of the clearance as described above between the surface of member 58 defining aperture 59 and the outer surface of stem extension 54. This tilting and lateral movement of member 58 permits disengagement of said other arm from abutment 61 and movement of thermally responsive member 62 to the retracted contacts-open position shown in full lines in Fig. 12 promptly upon disengagement of said one arm from abutment 61. Lateral and pivotal realignment of member 58 immediately after release of thermally responsive member to the retracted, contacts-open position is effected when countersunk portion 55 moves into engagement with beveled surface 57 of stop 56 under the bias of spring 60 thus forcing member 58 back to laterally and pivotally aligned relation with the remaining parts of the switch. Accordingly, abutment 61 provided by member 58 will be realigned with the distal ends of arms 88 and 90 upon cooling and return warping of thermally responsive member 62 from the full-line position of Fig. 12 to the broken-line and full-line positions of Figs. 12 and 1, respectively.

Due to the structural arrangement of the embodiments of the invention as shown in the drawing, it is a simple matter to substitute one thermally responsive member 62 for another to obtain a different current rating for the switch or for any other reason. This would entail merely separating one of the casing members 24, 26 from the

rest of the assembly, slipping the thermally responsive member out and inserting another, and then reassembling the removed casing member.

Another feature of the structural arrangement of the operating parts of the instant invention is that it lends itself to the use of compressive resilient biasing means which provide substantial advantages over tension springs and the like.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

The dimensions of certain of the parts as shown in the drawing have been modified for the purposes of clarity of illustration.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In combination: a base; a pair of electrical contacts mounted on said base; a bridging member carrying an electrical contact engageable and disengageable with each contact of said pair; a pair of arms supported by said bridging member; means biasing said member toward contacts-open position; resetting means movable from retracted to reset position and against the distal end of said arms to move said bridging member to contacts-closed position; and said bridging member including a composite thermally responsive element warpable upon change in temperature thereof in a direction to move the distal ends of said arms out of engagement with said resetting means whereby said bridging member moves to contacts-open position under the bias of said biasing means.

2. The combination as set forth in claim 1 wherein each of said arms is formed of composite thermally responsive material warpable in the direction opposite to its direction of movement under warping of said thermally responsive element thereby to compensate for changes in ambient temperature.

3. The combination as set forth in claim 1 wherein said thermally responsive element comprises a section of electrically conductive, composite material slotted alternately from opposite sides thereof to provide a plurality of transverse lengths electrically connected in series circuit relation; a U-shaped strip formed of electrically conductive material enclosing each of said sides and mounting one of the contacts carried by the bridging member; each of said U-shaped strips being electrically connected to the end of one of said lengths to establish an electrically conductive path from one of said last-mentioned contacts, through the U-shaped strip mounting the latter contact, serially through the successive lengths of said composite strip, through the other of said U-shaped strips, to the contact mounted on the latter U-shaped strip; and electrical insulating material bonded to and between the ends of the remaining lengths of said section and the respective U-shaped strip.

4. In combination: a pair of electrical contacts, resetting means comprising two members, resilient means compressively biasing said two members apart; a thermally responsive member operatively connected for movement to open and close said contacts; resilient means compressively biasing said thermally responsive member from contacts-closed to contacts-open position; one of said two members being movable from retracted position to reset position for moving the other of said two members against a portion of the thermally responsive member thereby moving the latter to contacts-closed position and compressing said first-named resilient biasing means; and latch means for retaining said one member in reset position against the bias of both of said biasing means, said thermally responsive member being responsive to temperature change for moving said portion thereof out of engagement with said other of said two members thereby permitting movement of the thermally responsive member to contacts-open position under the bias of said second-named biasing means.

5. The combination as set forth in claim 4 wherein said thermally responsive member comprises a section of electrically conductive, composite material slotted alternately from opposite sides thereof to provide a plurality of transverse lengths electrically connected in series circuit relation; a U-shaped strip formed of electrically conductive material enclosing each of said sides; each of said U-shaped strips being electrically connected to the end of one of said lengths to establish an electrically conductive path from one of said U-shaped strips, serially through the successive lengths of said composite strip, to the other of said U-shaped strips; and electrical insulating material bonded to and between the ends of the remaining lengths of said section and the respective U-shaped strip.

6. The combination as set forth in claim 4 including means resiliently biasing said one of said two members toward retracted position and against said latch, and said thermally responsive member including a portion movable against a portion of said latch during movement of the former from contacts-closed to contacts-open position thereby to release said latch from said one of said two members and to permit movement of the latter from reset to retracted position under the bias of said last-named biasing means.

7. Electrical switch structure comprising a pair of electrical contacts; a thermally responsive member operatively connected for opening and closing said contacts; said member including a thermally responsive element formed of a section of composite material having a high expansion component and a low expansion component; said section being slotted alternately from opposite sides to provide a plurality of transverse lengths interconnected in series circuit relation; a U-shaped strip of electrically conductive material at opposite sides of said section; each of said U-shaped strips enclosing one of the ends of each of said lengths; the end of one of said lengths being electrically connected to one of said U-shaped strips the end of another of said lengths being electrically connected to the other of said U-shaped strips and a layer of electrical insulating material bonded to and between each of the U-shaped strips and the remaining ends of the lengths of the respective side of said section; whereby an electrically conductive path is established leading from one of said U-shaped strips, serially through said transverse lengths, to the other of said U-shaped strips.

8. In combination: a casing; a pair of electrical contacts mounted within said casing; thermally responsive means operatively connected for movement to open and close said contacts; means compressively biasing said thermally responsive means in a first direction with respect to said casing from contacts-closed to contacts-open position; resetting means for moving said thermally responsive means to contacts-closed position; said resetting means including a first member and a second member; means biasing said first member in the opposite direction with respect to said casing and from retracted to reset position; an extension carried by said first member; said second member being mounted for movement along said extension; means compressively biasing said second member in said first direction relative to said first member; said first member being movable relative to said casing in said first direction to move said second member against a portion of the thermally responsive means to move the latter to contacts-closed position against the bias of said first-named biasing means; and latch means for retaining said one member in reset position against the bias of both of said biasing means; said thermally responsive member being responsive to temperature change for moving a portion thereof out of engagement with said other

of said two members thereby permitting movement of the thermally responsive member to contacts-open position under the bias of said second-named biasing means.

9. In combination: a pair of electrical contacts; thermally responsive means movable for opening and closing said contacts; means for resiliently biasing said thermally responsive means from contacts-closed to contacts-open position; resetting means for moving said thermally responsive means to contacts-closed position against the bias of said biasing means; said resetting means including a first member having a stem extending therefrom; a second member mounted for slidable movement along said stem; stop means carried by said stem; resiliently compressive biasing means mounted on said stem for biasing said second member against said stop means; said first member being movable in a first direction first to move said second member against said thermally responsive means for moving the latter to contacts-closed position and then further to move said first member to reset position to compress said last-named biasing means; and latch means for retaining said resetting means in said reset position until released.

10. The combination as set forth in claim 9 wherein thermally responsive means comprises an element formed of composite, thermally responsive material supporting a pair of arms against the distal ends of which said second member is movable; said element being warpable upon change in temperature thereof for moving the distal ends of said arms out of engagement with said second member thereby permitting movement of the thermally responsive means to contacts-open position under the bias of said first-named biasing means.

11. The combination as set forth in claim 10 including means resiliently biasing said first member from reset to retracted position; said latch means comprising a pair of members resiliently biased toward latching position with respect to said first member; and wherein each of said latch members provides a cam surface lying in the path of movement of one of the arms supported by said element during movement of the latter to contacts-open position thereby to permit camming of said latch members out of latching engagement with said first member.

12. The combination as set forth in claim 10 wherein each of said arms is formed of composite thermally responsive material warpable in the direction opposite to its direction of movement under warping of said thermally responsive element thereby to compensate for change in ambient temperature.

13. In combination: a casing; a pair of electrical contacts; a thermally responsive member operatively connected for movement to open and close said contacts; resilient biasing means acting against a portion of said thermally responsive member for biasing the latter from contacts-closed to contacts-open position with a force which decreases with decrease in deflection of the biasing means; resetting means for retaining said thermally responsive member in said contacts-closed position against the bias of said biasing means; said thermally responsive member including a thermally responsive element warpable upon change in temperature thereof in a direction to decrease the deflection of said biasing means; and said thermally responsive member being operatively connected for release from retention in said contacts-closed position by said resetting means upon sufficient warping of said thermally responsive element.

14. In combination: a casing; a pair of electrical contacts carried by said casing; a bridging member carrying a pair of spaced electrical contacts; said bridging member being movable between a first position and a second position; each of said first-named pair of contacts being engaged with one of the contacts carried by said bridging member when the latter is in said first position; means acting against a portion of said bridging member between the contacts carried thereby and along a line substantially perpendicular to a line connecting the contacts carried thereby resiliently biasing said bridging member from said first position to said second position with a force which decreases with decrease in deflection of the biasing means; resetting means movable to reset position for retaining said bridging member in said first position against the bias of said biasing means; said bridging member including a thermally responsive element warpable upon change in temperature thereof and in the direction to urge each of the contacts carried by the bridging member against the contact engaged therewith and to urge said portion of the bridging member for decreasing the deflection of said biasing means; said bridging member being operatively connected for release from retention in said first position upon sufficient warping of said thermally responsive element.

15. An electrical switch structure comprising at least a pair of electrical contacts, thermally responsive means for opening and closing said contracts, said means including a thermally responsive element formed of a section of thermostat material, said section being slotted alternately from opposite sides thereof to provide a plurality of transverse lengths interconnected in series circuit relation, electrically conductive means at opposite sides of said section, each of said electrically conductive means at its respective side of said section overlapping the ends of said lengths, a portion of one of said lengths being electrically connected to one of said electrically conductive means and a portion of another of said plurality of lengths electrically connected to the other of said electrically conductive means and a layer of electrical insulating material interposed between each of said electrically conductive means and the remaining ends of the lengths of the respective side of said section; whereby an electrically conductive path is established leading from one of said electrically conductive means, serially through said transverse lengths, to the other of said electrically conductive means.

16. The electrical switch structure as recited in claim 15 and wherein each of said electrically conductive means comprises a U-shaped strip overlapping opposite surfaces of the ends of said lengths and wherein said layer of electrical insulating material interposed between each of the U-shaped strips and the remaining ends of the lengths of the respective sides of said section is bonded to said lengths and U-shaped strips and one surface of said U-shaped strips is provided with at least one electrical contact of said pair of electrical contacts for engagement with the other of said pair of electrical contacts.

17. In a switch structure, a base having an electrical contact means mounted therein, a movable bridging member with a part thereof carrying electrical contact means adapted for engagement with said first-named contact means, means compressively biasing said member toward a contacts-open position, resetting means movable from a first position to a second position, said resetting means including means thereon engageable with spaced portions of said bridging member to move the latter to, and releasably maintain the same in, the contacts-closed position when said resetting means is in its second position, said part of said bridging member comprising thermally responsive means warpable at predetermined temperature conditions in a direction to move said portions of said bridging member out of engagement with said resetting means to permit said bridging member to move to a contacts-open position under the bias of said biasing means.

18. The structure of claim 17 and wherein said spaced portions of said bridging member engageable with the setting means comprises arms secured to and angularly disposed to said bridging member, the distal ends of said arms being engageable by said resetting means.

19. The structure as recited in claim 18 wherein said arms are formed of a composite thermally responsive material warpable in a direction opposite to its direction of movement under warping of said thermally responsive

means on said bridging member thereby to compensate for changes in ambient temperature.

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