Jan. 6, 1953 J. A. SPINA ET AL 2,624,819

SNAP ACTION SWITCH

Filed Jan. 10, 1951

Fig. 1.

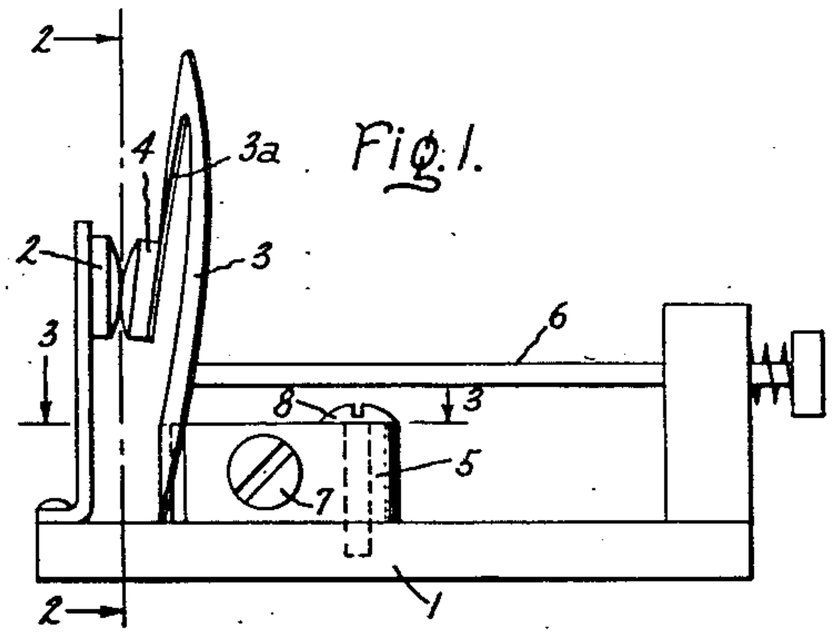


Fig. 2.

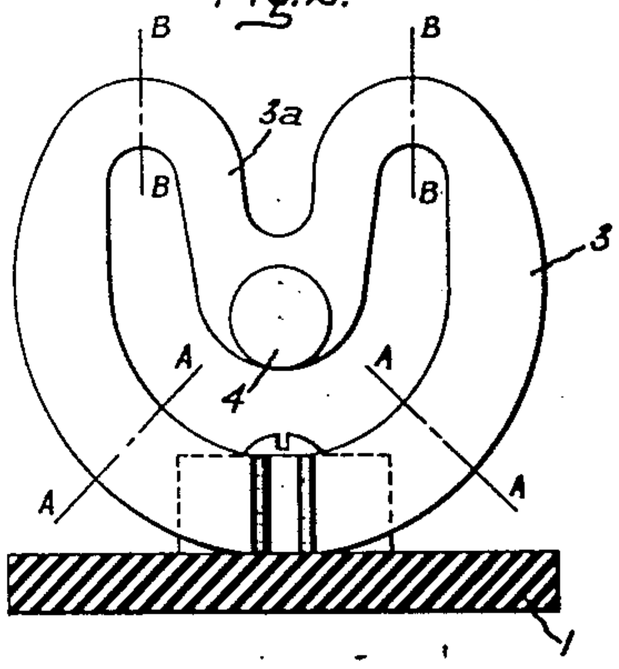


Fig. 3.

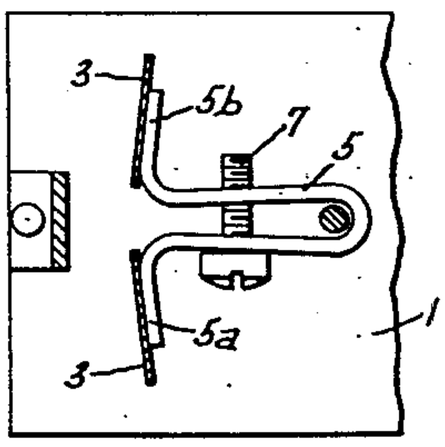


Fig. 4.

Fig. 5.

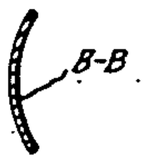


Fig. 7.

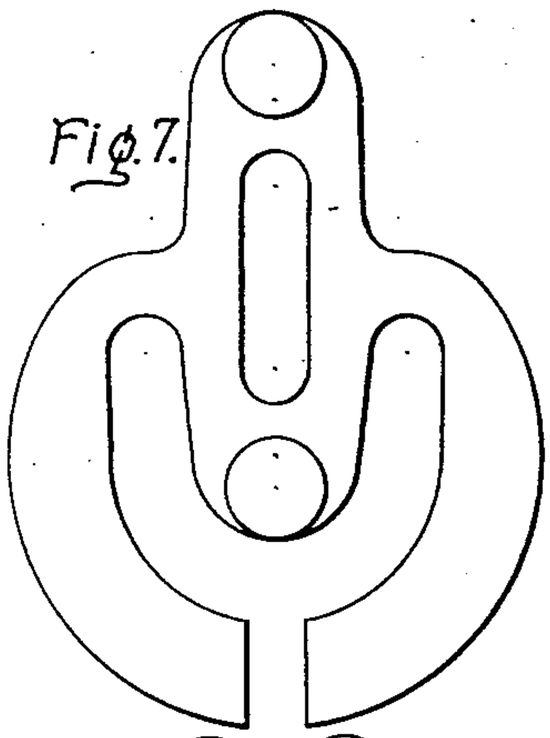


Fig. 6.

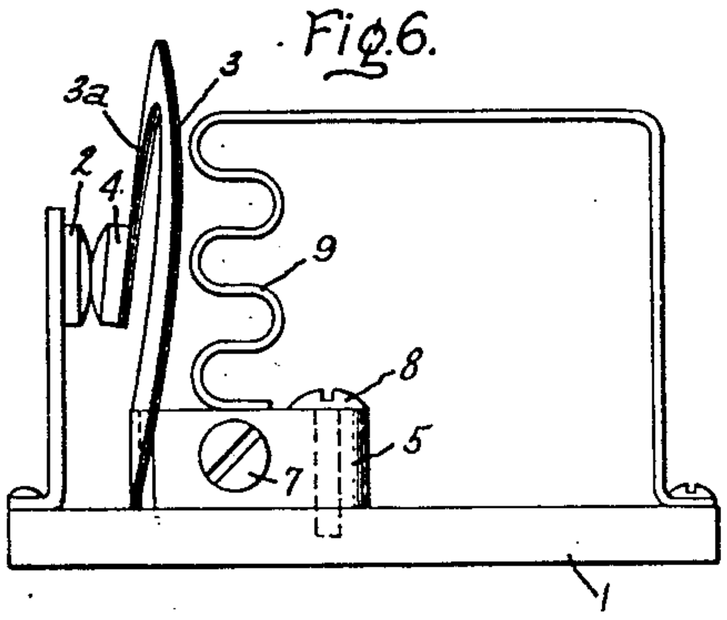


Fig. 8.

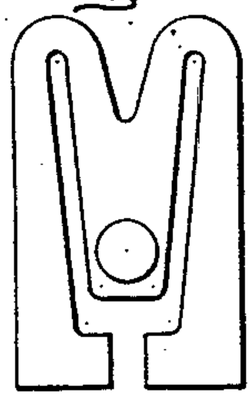
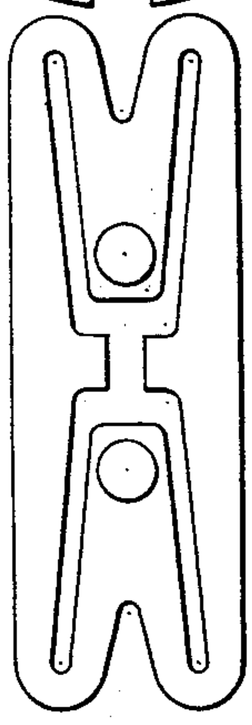


Fig. 9.



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UNITED STATES PATENT OFFICE

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SNAP ACTION SWITCH

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Application January 10, 1951, Serial No. 205,282

13 Claims. (Cl. 200—138)

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Our invention relates to snap action devices, and more particularly to snap action devices of the reversible dished type and especially suitable for use in thermostatically operated switches.

Internally stressed snap-acting devices of the dished type may be made of homogeneous spring metal and actuated by external force, or may be formed of bimetal and actuated by thermal self-deformation. Heretofore snap acting thermostatic devices of the dished composite metal over-center acting type have been particularly difficult to manufacture, and those types which most readily adapt themselves to the manufacturing process have not been of a form which facilitates the inclusion of adjustable means for controlling the critical temperature.

In addition to facility of manufacture and ease of adjustment, it is highly desirable that such switches, particularly those of the thermostatic type, demonstrate a "no zero" action in operation. By "no zero" it is meant that a positive contact pressure is maintained until such time as there has been initiated an over-center action which is irreversible even though further application of the actuating influence is withheld. Thus at the time that the contact pressure becomes zero the device is in a transient and self-completing condition of operation, so that the contacts cannot be stopped in a dead center position of zero pressure.

Accordingly, therefore, it is a general object of our invention to provide a new and improved snap acting device of the internally stressed spring plate form which permits ready inclusion of adjusting means.

It is a further object of our invention to provide a new and improved snap acting thermostat of the dished internally stressed over-center acting type which is simple to manufacture and is readily provided with accurate and dependable temperature adjusting means.

It is another object of our invention to provide a new and improved snap acting switch of the internally stressed spring plate type which demonstrates a "no zero" action.

It is still another object of our invention to provide a new and improved snap acting thermostatic switch of the "no zero" type.

A still further object of our invention is the provision of a new and improved snap acting thermostatic switch of the dished over-center acting bimetallic type which is readily adjustable and demonstrates a "no zero" action in operation.

In carrying out our invention in a preferred

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form we provide a substantially U-shaped split ring, or blade, of spring material curved flatwise and having opposite its juxtaposed ends a substantially U-shaped re-entrant arm which carries at its inner end a movable contact. The blade is mounted at its juxtaposed ends in a mounting bracket which holds the juxtaposed ends in cambered relation and deforms the blade into a dished formation, so that the central arm is angularly displaced outwardly on the convex side of the blade. When the blade is formed of bimetal it is so deformed that the high expansion metal is on the normally concave side of the dish. In order to provide adjustment of the critical point at which such a blade, or plate, reverses its concavity when actuated means are provided for holding the juxtaposed ends of the U-shaped blade in abnormal spaced apart relation, and this later holding means is adjustable.

In order to ensure a "no zero" snapping action the blade is formed with weakened portions of reduced transverse cross section at the points of connection between the side arms and the re-entrant central arm. The internal stress in the plate resulting from both the camber and the abnormal spacing of its juxtaposed ends is concentrated in these relatively weak sections, so that the ring has a greater transverse curvature at these points than at any other point. Thus when actuated over center, by external pressure or by heating, the side arms of the ring, having a relatively slight transverse curvature, first reverse their curvature, and this over-center snapping action irreversibly induces a similar over-center snapping action at the weakened sections. Thus the blade maintains a positive pressure until a part of the blade has snapped over-center and irreversibly initiated a complete operation.

Our invention itself will be more fully understood and its various objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the drawing, in which Fig. 1 is a side elevational view of a snap acting electric switch embodying my invention; Fig. 2 is a transverse cross-sectional view of the same switch taken along the line 2—2 of Fig. 1; Fig. 3 is a fragmentary cross-sectional view taken along the line 3—3 of Fig. 1; Figs. 4 and 5 are cross-sectional views of the switch blade taken along the lines AA and BB respectively of Fig. 2; Fig. 6 is a side elevational view of a snap action thermostatic switch embodying our in-

vention; and Figs. 7, 8 and 9 are plan views of various modified forms of snapper blades which may be utilized in carrying out our invention in other forms.

Referring now to the drawing, and more particularly to Figs. 1 to 5 inclusive, we have shown a manually operable snap acting electric switch comprising a base 1 having mounted thereon a stationary contact 2 and a snap acting switch blade 3 carrying a movable contact 4. The switch blade 3, as more clearly shown at Fig. 2, is formed from a normally flat sheet of resilient metal and shaped as a split ring having a substantially U-shaped re-entrant contact carrying arm 3*a* disposed opposite the juxtaposed ends of the ring and between the side arms thereof. The blade 3 has weakened portions of reduced transverse section at each side of the central arm 3*a* where this arm joins the side arms of the blade, as at the sections B—B, Fig. 2. The blade, or plate, 3 is mounted upon the base 1 in cantilever fashion by a bracket 5 which engages the juxtaposed ends of the side arms. A manually operable push rod 6 is mounted upon the base 1 and arranged to engage the side arms of the blade 3 to actuate the switch. It will be understood that this push rod may be operated by any suitable slow acting temperature responsive device.

As illustrated at Fig. 3, the mounting bracket 5 is formed as a U-shaped clamp having oppositely outwardly turned ears 5*a* and 5*b* extending from the ends of its side arms, and having its side arms tied together by means of an adjusting bolt 7. The outwardly extending ears 5*a* and 5*b* are slightly cambered with respect to each other and about the axis of symmetry of the blade 3 (i. e. the longitudinal axis of the inwardly extending arm 3*a*). The juxtaposed ends of the side arms of the blade 3 are fastened to the oppositely outwardly extending ears 5*a* and 5*b* of the mounting bracket 5, as by welding, and are thus held in cambered relation. This is clearly illustrated at Figs. 1 and 3. The mounting bracket 5 is shown fixed to the plate 1 by means of a bolt 8 through the bight portion of the bracket.

With the side arms of the blade 3 held in cambered relation at their juxtaposed ends as shown at Figs. 1 and 3, the blade itself is internally stressed and deformed into a dished formation, so that the inwardly extending central arm 3*a* is angularly displaced outwardly from the normal plane of the blade and towards the convex side of the blade in its dished form. In this position the contact 4 is in engagement with the fixed contact 2.

In order to strengthen the over-center snapping action of the switch blade 3, the bolt 7 is either drawn up or backed off, thereby to hold the juxtaposed ends of the switch plate in an abnormal spaced apart relation and further to internally stress the blade. Such additional internal stress is concentrated primarily in the weak portions of reduced cross section at the top of the plate. Moreover the snapping action of the plate is rendered adjustable by adjustment of the bolt 7.

With the spring blade 3 mounted and stressed in the manner heretofore described, not only is the blade as a whole deformed into a dished formation, but the side arms of the blade are also curved transversely by reason of the internal stress, and have a somewhat channel-shaped cross section. This transverse curvature

of the side arms is only slight for the greater part of the length of each arm, but is much more marked (i. e. the radius of transverse curvature is smaller) at the weakened upper sections of the blade. This is illustrated at Figs. 4 and 5, where transverse sections of the blade in the regions AA and BB respectively, are shown, the plate being in its stressed condition.

With the spring blade 3 mounted and deformed in the manner described above, the mode of operation of the switch will be evident from the following brief description.

When the push rod 6 is forced against the blade 3 it first deflects the entire plate in the manner of a cantilever spring and increases the pressure between the contacts 3 and 4. As the contact pressure increases sufficiently to overcome the internal stress in the blade 3, the external forces exerted upon the blade by the operating rod 6 and the stationary contact 2 force the side arms of the blade to reverse their transverse curvature. This reversal of transverse curvature takes place first at the lower ends of the side arms of the blade 3, because the transverse curvature in this region is only slight. As these portions of the side arms pass over-center and reverse their transverse curvature with a snap action, this internal over-center action travels upward along the side arms and forces a like over-center snapping action and reversal of transverse curvature at the weakened sections BB at the top of the blade. This traveling snap action, once it is started at the lower part of the side arms, is self completing without further application of the operating force. Thus, as soon as an over-center snapping action is initiated at the lower parts of the side arms, a complete reversing of the dished formation of the blade 3 will take place, even though no additional operating force is applied. By this action it is assured that the blade is already in motion before the contact pressure arrives at zero, since the initial over-center snapping action at the lower parts of the side arms occurs before the contact pressure falls to zero. This self-completing snap action precludes stoppage of the movable contact in a dead center position of zero pressure.

At Fig. 6 we have shown a thermostatic snap acting electric switch embodying our invention wherein the snap acting switch blade 3 is similar to that shown at Figs. 1 to 5 inclusive except that it is bimetallic. The switch blade 3 of Fig. 6 is formed of two metallic sheets or laminations secured together in fixed relation, as by welding or the like, with that lamination on the side remote from the movable contact 4 having a greater coefficient of expansion than the other lamination. The switch shown at Fig. 6 is provided with a heating resistor 9 in place of the manually operable push rod of Fig. 1, but in all other respects is similar to the switch of Figs. 1–5, and like parts have been assigned the same reference numerals.

It will now be understood that, in the operation of the device shown at Fig. 6, the bimetallic blade 3, when first heated, deflects in cantilever fashion toward the fixed contact 2. At the same time the re-entrant central arm 3*a*, by reason of its own similar distortion, further tends to increase the pressure between the contacts 2 and 4. When the blade reaches a predetermined temperature, the side arms of the blade, having a relatively slight transverse curvature, suddenly reverse their curvature due to the high expansion of the metal on the normally concave side of the dished blade.

When this action occurs, the over-center reversing action is self-propelled along the length of the side arms and forces a reversal of the transverse curvature at the weakened sections BB at the top of the blade. The entire blade then reverses its dished formation, so that the high expansion lamination is on the convex side of the blade. This action causes a reversal of the angular displacement of the central arm 3*a* to the other side of the normal plane of the blade 3, thereby separating the contacts 2 and 4. Thus it will be evident that when the blade 3 is heated, the contact pressure is first increased, and a self-completing over-center snapping action is then begun at the lower part of the side arms of the blade before the contact pressure has decreased to zero. This self-completing over-center snap action ensures that the movable contact cannot be stopped in the position of zero pressure.

At Figs. 7, 8 and 9 we have shown various modified forms of over-center snap acting blades which may be utilized in snap acting devices embodying my invention. Fig. 7 shows a blade which is generally similar to that shown at Figs. 1, 2 and 6, except that the central switch arm is extended to the outer as well as the inner side of the ring and provided with a contact at each end. Fig. 8 shows another blade of generally U-shaped configuration, but in which the side arms are straight and substantially parallel rather than ring shaped as heretofore described. Fig. 9 shows a double ended form of the blade shown at Fig. 8. It will be understood that the blade shown at Fig. 9 is mounted at its center, as by a cambered mounting bracket disposed centrally between the two side arms. It will further be understood, of course, that any of the snap acting blades shown at Figs. 7, 8 and 9 may be formed either of a homogeneous spring material such as a resilient copper alloy, or may be formed of composite metal such as the bimetallic blade heretofore described in connection with Fig. 6.

While we have described only certain preferred embodiments of our invention by way of illustration, many modifications will occur to those skilled in the art, and we, therefore, wish to have it understood that we intend in the appended claims to cover all such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A snap action device comprising a normally flat resilient blade formed to provide a pair of side arms and a reentrant central arm disposed in edgewise side-by-side relation and connected together at one end of said central arm, said blade having a reduced transverse section at the points of connection of said side and central arms and when unstressed lying in a normal plane with said side arms juxtaposed in a region adjacent the other end of said central arm, means for holding said side arms in cambered relation at said region and about the axis of said central arm thereby to stress and deform said blade into a dished formation and angularly displace said central arm from said normal plane, means for holding said side arms in abnormal spaced relation at said region thereby further to stress said blade, and means for inverting the dished formation of said blade thereby to reverse the angular displacement of said central arm with a snap action.

2. A snap action device comprising a normally flat resilient blade formed to provide a pair of side arms and a reentrant central arm disposed in edgewise side-by-side relation and connected together at one end of said central arm, said blade having a reduced transverse section at the points of connection of said side and central arms and when unstressed lying in a normal plane with said side arms spaced apart a predetermined normal distance in a region adjacent the other end of said central arm, means for holding said side arms in cambered relation at said region and about the axis of said central arm thereby to stress and deform said blade into a dished formation and angularly displace said central arm from said normal plane, adjustable means for holding said side arms in abnormal spaced apart relation at said region thereby adjustably to further stress said blade, the internal stress in said blade being concentrated at said reduced sections, and means for inverting the dished formation of said blade thereby to reverse the angular displacement of said central arm with a snap action.

3. A snap action device comprising a normally flat resilient metal blade slotted to form a flat split ring and having a U-shaped re-entrant portion opposite the juxtaposed ends of said ring forming an inwardly extending arm, said ring having a reduced transverse section at each point of connection of said arm and ring and when unstressed lying in a normal plane, with said juxtaposed ends in a predetermined normal spaced relation, means for holding said juxtaposed ends in cambered relation thereby to deform said ring to a dished formation and bias said arm to a position of angular displacement to one side of said normal plane, clamping means for holding said juxtaposed ends in abnormal spaced relation thereby to concentrate internal stress in said ring at said reduced sections, and means for inverting the dished formation of said ring thereby to snap said arm to a reversed position of equilibrium oppositely angularly displaced from said normal plane.

4. A snap action electric switch comprising a base, a stationary contact mounted upon said base, a normally flat resilient switch blade formed to provide a pair of side arms and a re-entrant central arm disposed in edgewise side-by-side relation and connected together at one end of said central arm, said blade when unstressed lying in a normal plane with said side arms juxtaposed in a region adjacent the other end of said central arm, a movable contact mounted upon said other end of said central arm, means for holding said side arms in cambered relation at said region, said holding means deforming said blade into a dished formation and angularly displacing said central arm from said normal plane with said movable contact on the convex side of said blade, and means for pressing said blade toward said stationary contact thereby to invert the dished formation of said blade and reverse the angular displacement of said central arm with a snap action.

5. A snap action electric switch comprising a base, a stationary contact mounted upon said base, a normally flat resilient switch blade including a pair of side arms and a re-entrant central arm disposed in edgewise side-by-side relation and connected together at one end of said central arm, said blade when unstressed lying in a normal plane with said side arms in a predetermined normal spaced relation in a region adjacent the other end of said central arm, a movable contact mounted upon said other end of said central arm, means for mounting said blade upon said base and holding said side arms in cambered relation at said region and about the

axis of said central arm, said mounting means deforming said blade into a dished formation concave on the side remote from said movable contact and angularly displacing said central arm from said normal plane, means for holding said side arms in abnormal spaced relation at said region, and means for pressing said blade toward said stationary contact thereby to invert the dished formation of said blade and reverse the angular displacement of said central arm with a snap action.

6. A snap action thermostat comprising a normally flat substantially U-shaped bimetallic blade having at its bight portion a re-entrant central arm, said blade having a reduced transverse section at the point of connection of each side arm thereof with said central arm and when unstressed lying in a normal plane with the juxtaposed ends of said side arms in predetermined normal spaced relation, means for holding said juxtaposed ends in cambered relation about the axis of said central arm thereby to stress and deform said blade into a dished formation, said blade when so dished having the high expansion metal on the concave side thereof and said central arm being angularly displaced from said normal plane toward the convex side of said blade, and means for holding said juxtaposed ends of said side arms in abnormal spaced relation thereby further to stress said blade, the stress in said blade being concentrated at said reduced sections and said blade when heated reversing its dished formation thereby to snap said central arm to a reverse position of angular displacement with respect to said normal plane.

7. A snap action thermostatic switch comprising a base, a fixed contact mounted upon said base, a normally flat bimetallic switch blade formed to provide a pair of side arms and a re-entrant central arm disposed in edgewise side-by-side relation and connected together at one end of said central arm, said blade having a reduced transverse section at the point of connection of each side arm thereof with the said central arm and when unstressed lying in a normal plane with said side arms spaced apart in a region adjacent the other end of said central arm, a movable contact mounted upon said other end of said central arm and on the low expansion side of said blade, and means for mounting said blade upon said base, said mounting means holding said side arms in cambered relation at said region and about the axis of said central arm with the high expansion metal of said blade on the concave side thereof thereby to deform said blade into a dished formation and angularly displace said central arm from said normal plane and toward the convex side of said blade, said blade when heated reversing its dish formation thereby to snap said central arm to a reverse position of angular displacement with respect to said normal plane.

8. A snap action thermostatic switch comprising a base, a fixed contact mounted upon said base, a normally flat bimetallic switch blade including a pair of substantially parallel side arms and a re-entrant central arm disposed in edgewise side-by-side relation and connected togethr at one end of said central arm, said blade having a reduced transverse section at the point of connection of each side arm thereof with the said central arm and when unstressed lying in a normal plane with said side arms spaced apart a predetermined normal distance in a region adjacent the other end of said central arm, a movable contact mounted at said other end of said central arm on the low expansion side of said blade for cooperation with said fixed contact, means for mounting said blade upon said base and holding said side arms in cambered relation at said region and about the axis of said central arm, said mounting means deforming said blade into a dished formation with the high expansion metal on the concave side thereof and angularly displacing said central arm toward the convex side thereof to bring said contact into engagement, and means for holding said side arms in abnormal spaced apart relation at said region, said blade when heated first increasing the pressure between said contacts and then reversing its dished formation thereby to snap said central arm to a reverse position of angular displacement and separate said contacts.

9. A snap action thermostatic switch comprising a base, a fixed contact mounted upon said base, a normally flat bimetallic switch blade formed to provide a pair of side arms and a substantially U-shaped re-entrant central arm dispised in edgewise side-by-side relation and connected together at the open end of said central arm, said blade having reduced transverse sections at the open ends of said central arm and when unstressed lying in a normal plane with said side arms in predetermined normal spaced relation adjacent the other end of said central arm, a movable contact mounted upon said other end of said central arm at the low expansion side of said blade for cooperation with said fixed contact, means for mounting said blade upon said base and holding said side arms in cambered relation at said region and about the axis of said central arm, said mounting means deforming said blade into a dished formation with the high expansion metal of said blade on the concave side thereof and angularly displacing said central arm toward the convex side thereof to bring said contacts into engagement, and means for holding said side arms in abnormal spaced relation at said region thereby further to stress said blade, said blade when heated first increasing the pressure between said contacts and then reversing its dished formation to snap said central arm to a reverse position of angular displacement thereby to separate said contacts.

10. A snap action thermostatic switch comprising a base, a fixed contact mounted upon said base, a normally flat bimetallic switch blade formed to provide a pair of side arms and a substantially U-shaped re-entrant central arm disposed in edgewise side-by-side relation and connected together at the open end of said central arm, said blade having reduced transverse sections at the points of connection of said central arm with said side arms and when unstressed lying in a normal plane with said side arms spaced apart a predetermined normal distance in a region adjacent the other end of said central arm, a movable contact mounted upon said other end of said central arm at the low expansion side of said bimetallic blade, means for mounting said blade upon said base and holding said side arms in cambered relation at said region and about the axis of said central arm, said mounting means deforming said blade into a dished formation with the high expansion metal on the concave side thereof and angularly displacing said central arm from said normal plane toward the convex side of said blade to hold said contacts in engagement, and adjustable means holding said side arms in abnormal

spaced apart relation at said region thereby adjustably to further stress said blade and concentrate deformation of said blade at said reduced sections, said blade when heated first deflecting to increase the pressure between said contacts and then reversing its dished formation to snap said central arm to a reversed position of angular displacement and separate said contacts.

11. A snap action thermostatic switch comprising a base, a fixed contact mounted upon said base, a normally flat substantially U-shaped bimetallic switch blade having at its bight portion a substantially U-shaped re-entrant central arm, said blade having reduced transverse sections at the points of connection of said central arm with the side arms of said blade and when unstressed lying in a normal plane with the juxtaposed ends of said side arms spaced apart a predetermined normal distance, a movable contact mounted upon the inner end of said central arm at the low expansion side of said blade, means for mounting said blade upon said base and holding said juxtaposed ends of said side arms in cambered relation thereby to deform said blade into a dished formation, said blade when so dished having the high expansion metal thereof on the concave side with said central arm angularly displaced from said normal plane toward the convex side to bring said contacts into engagement, and adjustable means for holding the juxtaposed ends of said side arms in abnormal spaced apart relation thereby to concentrate deformation of said blade at said reduced sections, said blade when heated first deflecting to increase the pressure between said contacts and then reversing its dished formation to snap said central arm to a reverse position of angular displacement and separate said contacts.

12. A snap action thermostatic switch comprising a base, a fixed contact mounted upon said base, a normally flat bimetallic switch blade formed as a split flat ring having a substantially U-shaped re-entrant arm opposite the juxtaposed ends of said ring, said ring having weakened sections at its points of connection to said re-entrant arm and when unstressed lying in a normal plane with said juxtaposed ends in predetermined normal spaced relation, a movable contact mounted upon the inner end of said arm on the low expansion side of said blade, means

mounting said blade upon said base and holding said juxtaposed ends in cambered relation, said mounting means deforming said ring to a dished formation with the high expansion metal on the concave side thereof and biasing said arm to a position of angular displacement toward the convex side of said deformed ring, and adjustable means for holding said juxtaposed ends of said ring in abnormal spaced relation thereby to concentrate internal stress in said ring at said reduced sections, said blade when heated first deflecting to increase the pressure between said contacts and then reversing its dished formation to snap said arm to a reverse position of angular displacement and separate said contacts.

13. A snap action thermostat comprising a normally flat bimetallic blade formed to provide a pair of side arms and a re-entrant central arm disposed in side-by-side relation and connected together at one end of said central arm, said blade having a reduced transverse section at the point of connection of each of the said side arms with the central arm and when unstressed lying in a normal plane with said side arms spaced apart a predetermined normal distance in a region adjacent the other end of said central arm, means for holding said side arms in cambered relation at said region and about the axis of said central arm thereby to stress and deform said blade into a dished formation and angularly displace said central arm from said normal plane, and adjustable means for holding said side arms in abnormal spaced apart relation at said region thereby adjustably to further stress said blade, said blade when changed in temperature a predetermined amount inverting its dished formation thereby to reverse the angular displacement of said central arm with a snap action.

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