This invention relates generally to bimetallic elements and more specifically to one piece snap-acting bimetallic thermostats.

As one of the more widely used elements of thermostatic controls, the bimetallic element has many and varied applications in the regulation and control of heating and cooling means. In such thermostatic application it is conventional to employ the bimetallic element to control a pair of electrical contacts. These contacts may be associated with a relay or contact circuit for operating any form of heating means or alternatively the contacts may be associated with a direct current heating circuit which is being controlled. In the last mentioned situation, the contacts are often required to carry total heating current of the device or appliance being controlled. In the case of many of the well known household appliances, such as; coffee makers, waffle bakers, toasters, egg cookers and the like, the power carried by the contacts is often in the order of 1,000 to 1,500 watts. Under such conditions of power it becomes desirable to decrease the make and break time for closing and opening the contacts in order that arcing and contact damage may be reduced.

To provide such quick make and break action in a bimetallic switch, the so-called snap-acting bimetallic switch was developed. The United States patent to Mottilau, No. 1,668,973, discloses one form of such a switch. This switch involves the use of a self-contained over center spring mechanism to create a snap-action as the bimetallic element is deformed upon heating. This over center spring action is obtained by applying axial forces to both ends of a bimetallic element such that the element is bowed in its rest position. With the element bowed so that it is convex on the low expansion side, the application of heat will cause the element to become bowed in the reverse direction. The intermediate shape between the two bowed conditions is unstable such that the element moves rapidly toward the other position after being moved past a neutral position.

In order that the compressive or bowing force on the bimetallic element might be easily applied, the one piece snap-acting bimetallic was developed. As can be seen in the above cited Mottilau patent, this construction involves the use of a single bimetallic element which has been formed with three transversely spaced longitudinally extending parallel strips. The strips are joined at their end portions so that a compressive force may be delivered to the center most strip by the outer strips to bow the center strip. This force is produced by shortening the outer strips so that they function much as a bow string in producing an arc in the center-most strip.

In the above described construction, which is old and well known in the art, there are several disadvantages which have seriously limited its commercial use for electrical appliances and the like.

In most control applications in the appliance field the bimetallic element is positioned to respond to the temperature of the surface or of a heat conducting lug upon which it is mounted. It is desirable, therefore, to have the bimetallic member be designed so that it is in good thermal conducting relation to the surface or heat lug so as to respond quickly and accurately. One of the disadvantages of the one piece snap-acting thermostat is that a considerable portion of the entire bimetallic structure cannot be in good thermal contact with the surface or heat lug. It would be desirable, therefore, if a snap-acting bimetallic element could be designed which would permit mounting in such a way that most of the bimetallic portion would respond quickly and accurately to the temperature of the mounting lug.

Another undesirable feature embodied in the prior art one piece snap-acting thermostats is the heat response exhibited by the outer strips of the bimetallic element. These strips, which are the shortened or tensioned strips described above, tend to deform as heat is applied to the bimetallic element as does the center portion. The deformation of the outer strips introduces another temperature response which may not be desirable. It should also be noted that the outer strips being in poor thermal conducting relation to the mounting lug will give a response which depends to a considerable extent on the ambient temperature to which they are subjected. It would be desirable, therefore, to eliminate or substantially reduce the response produced in the outer legs of the bimetallic thermostat.

It is, therefore, an object of this invention to provide a one piece snap-acting bimetallic thermostat which responds quickly and accurately to the temperature of the member upon which it is mounted.

It is a further object of this invention to provide an efficient snap-acting thermostat which is affected only to a negligible extent by variations in ambient temperature. It is an additional object of this invention to provide an inexpensive one piece snap-acting thermostat requiring a minimum amount of bimetallic material and having improved temperature control characteristics.

Further objects and advantages of the present invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claim annexed to and forming a part of this specification.

For a better understanding of the present invention reference may be had to the accompanying drawings in which:

FIG. 1 is a plan view of the bimetallic element embodying the present invention;
FIG. 2 is a side elevational view of FIG. 1 of the drawings with dotted lines used to indicate the alternative position of the bimetallic element; and
FIG. 3 is a sectional view taken along line 3-3 of FIG. 1.

The present invention involves an improvement of the well known one piece snap-acting bimetallic element. By changing the outline of the well known three legs of such a thermostat, it has been made possible to reduce the amount of bimetallic material required and improve the response of the thermostat. Recognizing the function of the outer legs of the bimetal as merely tension members they have been reduced in section so that they are merely thin strips of bimetallic material which can transmit the necessary tensile forces, but which will have a negligible effect from a heat response standpoint. With the section of the outer legs so reduced, it is necessary to
position the crimp or shortening bends for the outer legs in a portion of increased sectional area. In the drawings, there is illustrated a one piece bimetallic element designated by the reference numeral 11. The element 11 is formed in any well known manner of uniting by brazing or the like two sheets of metal having different coefficients of thermal expansion. The sheet of bimetallic material has been shaped to form the substantially rectangular element 11 having a pair of longitudinally extending slots 11a and 11b formed therein. The slots 11a and 11b serve to divide the element into three transversely spaced leg portions 12, 13 and 14. The outer leg portions 12 and 14 are of relatively small cross-sectional area as compared to the leg portion 13. The center leg portion 13 provides the primary temperature response of the bimetallic element 11 due to its substantially greater surface area than the outer legs 12 and 14. For the purpose of mounting the bimetallic element 11 on a suitable surface or heat conducting lug a number of holes 13a, 13b and 13c have been blanked in the leg portion 13. The hole 13a is adapted to receive an assembly screw or bolt, while the holes 13b and 13c are intended to be engaged by orienting protruberances which serve to locate the bimetallic member relative to the appliance or component with which it is mounted. The slots 11a and 11b in the bimetallic member 11 terminate in a pair of transversely extending connecting portions 15 and 16. The connecting portions 15 and 16 merely relate the three longitudinally extending strips 12, 13 and 14 to form the one piece bimetallic element 11. In order that the outer leg portions 12 and 14 may be formed to cause the center portion 13 to become bowed in the manner described in the Mottina patent, it is necessary to crimp or sharply bend these legs so that they are effectively shorter than the leg 13, although in fact they remain the same length. Because of the amount of shortening desired and because of the small sectional area of the legs 12 and 14, it is not desirable to place the crimps or bends in the narrow leg portions. If the desired amount of shortening were to be effected by placing crimps in the portions of legs 12 and 14 having small cross-sectional areas, the tensioning force produced by the bowing of the center leg 13 would tend to straighten the legs 12 and 13 and remove the crimps which were placed therein. To provide suitable portions in which the shortening crimps or bends may be placed, there are enlargements 12a and 14a at adjacent ends of the respective legs 12 and 14. The enlargements 12a and 14a serve to connect the connecting portion 15 with the reduced sectional portions of the legs 12 and 14. Immediately adjacent the portion 15, the enlargements 12a and 14a are formed with V-shaped bends 17 and 18 which extend below the plane of the bimetallic member 11. The bends 17 and 18 are accurately stamped in the respective enlargements 12a and 14a to provide the effective shortening of the legs 12 and 14 to produce the bowed form of the center leg 13. As was explained above, the tensioning which results from this shortening of the legs 12 and 14 would have been such that the crimps could not have been maintained in the legs 12 and 14. For this reason, the crimps 17 and 18 were placed in the enlargements 12a and 14a where the increased cross-sectional area would be sufficient to maintain the crimps therein in spite of the tension exerted by the bowed center leg 13 on the outer legs 12, 14 and their respective enlargements 12a, 14a.

Referring to FIG. 2, a side elevational view of the bimetallic element 11 is shown which discloses the downward bowing of the leg portion 13 which has resulted from the shortening of the legs 12 and 14. Prior to the crimping of the enlargements 12a and 14a, the bimetallic element 11 was substantially flat. After such crimping, the center leg portion 13 is bowed while the outer legs 12 and 14, which may again be likened to bow strings, are substantially straight with the exception of the crimps in the enlarged end portions. In that the low expansion side of the bimetallic member 11 is uppermost in FIG. 2, the center leg portion 13 will tend to deform to a concave upward position from the concave downward position upon the application of heat. This deflection will be fairly gradual until such time as the neutral position is reached. At that time, upon application of additional heat, the element 11 will snap across to the position shown by the dotted lines in FIG. 2. This snap action may be used to open or close a set of electrical contacts rapidly so that no arcing will result between the contacts. In addition, such snap movement is often desirable when a switch is designed so that it will shut off at one predetermined high temperature and cycle within some lower range of temperatures, as will be explained below. The dotted line position of the outer leg 14 demonstrates that it is substantially straight in either of the bowed positions which may be assumed by the center leg 13.

It should also be understood that a snap-acting thermostat of this type may control not only by virtue of its critical snapping temperature at which the center element bows in the reverse direction, but it may also function as a conventional bimetallic blade to control a desired temperature at which it has snapped. Thus, the thermostat in FIG. 2 may deflect gradually up and down from the dashed line position indicated in that figure. This type of high temperature snap followed by lower temperature cycling finds frequent application in the coffee makers of the type described in my issued U.S. Pat. No. 2,687,469 granted August 24, 1954.

As was explained above, the bimetallic element 11 is mounted on a suitable lug or surface which engages the portion of the center leg 13 adjacent the holes 13a, 13b and 13c. When so mounted, the end portion 16 may serve as an actuating member to engage a contact opening device. With the heat being transmitted to the thermostat at a point near the middle of the leg 13, it is obvious that there will be a considerable amount of lag in transmitting the heat to the outer legs 12 and 14 of the bimetallic element 11. Because of this lag in heat transfer to the outer legs it would be desirable to minimize the effect produced by these legs on the over all response of the thermostatic element. By reducing the cross-sectional area of the legs 12 and 14 the temperature response of these legs is held at a minimum. By utilizing the enlarged portions 12a and 14a to contain the crimps 17 and 18 the outer legs 12 and 14 may be made extremely thin since they need only transmit a tensile force between the end portions 15 and 16. While only a single embodiment of the present invention has been described and illustrated it should be understood that the present invention is capable of various changes and modifications. It is intended in the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is desired to be secured by Letters Patent of the United States is:

A snap-acting bimetallic member comprising a substantially rectangular piece of bimetallic material of the type formed by two layers of material with different coefficients of thermal expansion united together in a laminated sheet, a pair of longitudinally extending slots being formed in said bimetallic member adjacent the edges thereof, adjacent ends of said slots being inwardly directed at an angle to the longitudinal axes of said member, said slots including said inwardly directed portions forming thin strips of bimetallic material on the enlarged end portions, the combined widths of said thin strips being less than the width of the adjacent portion of said bimetallic material lying between said slots and said en-
larged portions being deformed to shorten said thin strips and produce a bow in the center portion of said bimetallic member between said slots.

References Cited in the file of this patent

<table>
<thead>
<tr>
<th>UNITED STATES PATENTS</th>
<th>FOREIGN PATENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,668,974 Mottlau May 8, 1928</td>
<td>Clark et al. Dec. 2, 1941</td>
</tr>
<tr>
<td>2,249,837 Lee July 22, 1941</td>
<td>Woodman Nov. 21, 1944</td>
</tr>
<tr>
<td>2,264,276</td>
<td>Dougherty Feb. 11, 1947</td>
</tr>
<tr>
<td>2,363,376</td>
<td>Matulaitis et al. Dec. 12, 1950</td>
</tr>
<tr>
<td>2,415,473</td>
<td>Bean Sept. 11, 1951</td>
</tr>
<tr>
<td>2,533,274</td>
<td>Protz Mar. 11, 1958</td>
</tr>
<tr>
<td>2,567,361</td>
<td>Great Britain May 13, 1931</td>
</tr>
<tr>
<td>2,825,960</td>
<td></td>
</tr>
</tbody>
</table>