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THERMOSTAT CONTROL AND BIMETAL SNAP-ACTING ELEMENT THEREFOR

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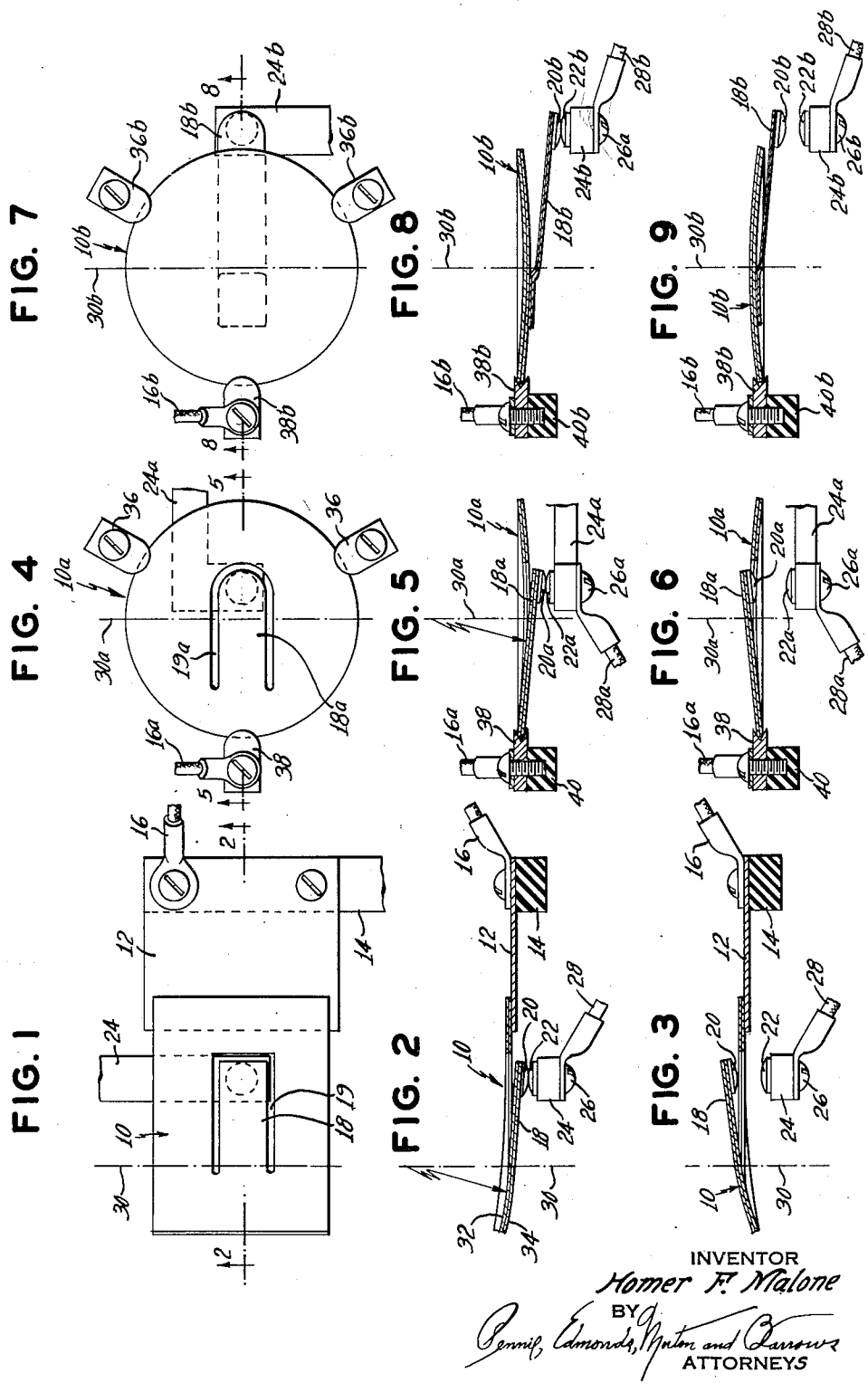

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THERMOSTAT CONTROL AND BIMETAL SNAP-ACTING ELEMENT THEREFOR

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My invention relates to improvements in thermostatic controls and to a novel bimetal snap-acting element therefor.

An object of my invention is to provide a control in which a bimetal blade or element will apply a pressure as great as possible, for example, on the contacts of an electric switch, and maintain such pressure or apply an increasing pressure up to the instant the blade snaps and breaks the circuit controlled by the switch, thereby avoiding flickering and erratic operation of the switch and resulting rapid deterioration of the switch contacts.

In a known form of thermostatic switch of this general type having certain of the desirable features mentioned above, a bimetal blade is provided with three generally parallel legs in a common plane, the free end of the center leg of which carries a contact for engaging a fixed switch contact. This device includes means for applying pressure on the outer legs opposite the contact to move them toward the center leg and thereby produce a compression stress in the blade which will cause a snap action when heated.

I have discovered that a much simpler and less expensive instrument can be produced, having the desirable features referred to above, by including a bimetal element having a spherical formation therein, and a leg, preferably of the same material as the bimetal element, and connected thereto in a predetermined relationship to the center or spherical radius of the spherical formation.

In a preferred construction the bimetal element comprises a body of bimetal sheet material having a spherically shaped formation as described, and a leg of the same material attached by one end to the bimetal body at a position located to one side of the center of the spherical formation, with the leg extending from its point of attachment toward or across the center of said formation. A thermostatic switch including such a bimetal element advantageously comprises a support on which the element is mounted, a contact on one side of the free end of the leg, and a fixed contact cooperating with the contact on the leg of the bimetal element.

In the operation of a switch constructed in this manner, in which the element is concave on its high-expanding side and the contact is on the low-expanding side of the leg, the application of heat to the bimetal element causes the leg to move in a direction such as to increase the contact pressure between the contacts of the

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switch. The pressure increases as the heating continues until the bimetal element snaps through from a condition of concavity on the high-expanding side of the spherical formation to a condition in which that side is convex. When this snap action occurs the leg moves so as to open the switch.

A thermostatic switch may also be advantageously produced in which the bimetallic element used therein has had a spherical deformation introduced which is concave on the low-expanding side and which has a contact attached to the high-expanding side of the described leg at its free end. A thermostatic switch constructed with a bimetallic element made in this fashion, when subjected to a decreasing temperature, as in a refrigerated chamber, will open its circuit at a specific lower temperature. In doing so the bimetallic element will snap from a condition in which it is concave on the low-expanding to one in which it is concave on the high-expanding side.

In a preferred form of construction a flat sheet of bimetal material is cut with a substantially U-shaped slot so as to form a leg in the sheet, the leg having one end attached to the body of material and the other end free. Thereafter the spherical formation is pressed into the sheet while leaving the leg flat, the center of such formation being located at a position along the leg adjacent to its point of attachment to the body of the sheet. A switch contact is then mounted on one side of the free end of the leg.

This form of element may be made in various shapes, and other forms of bimetal elements may be provided which will have the desirable features referred to above, as well as the general relationships described. It is furthermore to be understood that any of the bimetallic blade structures described hereafter may have the spherical deformation impressed so as to be concave on the low-expanding side and be operable upon a reduction in temperature.

Three different embodiments of the bimetal snap-acting elements made in accordance with the present invention are illustrated in the drawings which form a part of this application.

In the drawings:

Fig. 1 is a diagrammatic plan view of one form of thermostatic control including the features of the invention;

Fig. 2 is a sectional view of the control shown in Fig. 1, taken on the line 2—2, showing the formation and shape of the bimetal element in one position, and a switch controlled thereby;

Fig. 3 is a view similar to that of Fig. 2, showing the shape of the bimetal element in its other position;

Fig. 4 is a view similar to that of Fig. 1, showing a modified form of bimetal element;

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4 showing the shape and one position of the bimetal element, and a switch controlled by the element;

Fig. 6 is a view similar to that of Fig. 5 showing the bimetal element in its other position;

Fig. 7 is a view similar to those of Figs. 1 and 4 showing a further modified form of the bimetal element;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7, showing the shape of the bimetal element in one position, and a switch controlled by the element;

Fig. 9 is a view similar to that of Fig. 8 showing the bimetal element in its other position.

In the form of control shown in Figs. 1, 2 and 3, a rectangular-shaped bimetal element or blade 10 is carried by one end on a rigid metal supporting plate 12, which in turn is mounted on a support 14 of insulating material. The bimetal blade 10 is electrically connected through the support 12 to a conductor 16. The controls shown in all figures of the drawings are illustrated as electric switches.

The bimetal blade 10 includes an integral leg 18 cut from the body of the element by a U-shaped cut 19 leaving the leg 18 integrally connected to the body of the element opposite the end by which the element is attached to the support 12. The free end of the leg 18 carries a contact 20 engaging a fixed contact 22 mounted on a support 24 of insulating material, the contact 22 being electrically connected by a screw 26 to a conductor wire 28.

The bimetal element 10 is provided with a permanent spherical formation, the spherical radius or center of which is preferably located approximately at the intersection of the line 2—2 in Fig. 1 with the dot-and-dash line 30. The spherical formation includes only the area around the attachment end of the leg 18 and to the left of the dot-and-dash line 30. The remainder of the element 10, particularly the attachment end portion including most of the body of the element is left flat. For purposes of illustration, the spherical set in the element 10 is formed so that the spherical formation is concave on the high-expanding side of the element. For example, in Fig. 2 the high-expanding metal is indicated at 32 and the low-expanding metal at 34. In this structure, as shown in Figs. 2 and 3, the leg 18 extends substantially at a tangent to the spherical surface at its point of attachment, but beyond this point the leg may be bent up or down to suit a particular switch structure.

In the operation of the control shown in Figs. 1 to 3, the application of heat to the cold bimetal element 10, including the leg 18, causes the contact end of the leg 18 to tend to move down or to apply an increasing pressure against the contact 22. This pressure increases as the temperature increases until the element 10 snaps through from a condition in which the spherical formation is concave, as shown in Fig. 2, to a condition in which the spherical formation is reversed or convex on the high-expanding side of the element, as shown in Fig. 3. At the instant this snap action occurs, the contact 20 is snapped away from the contact 22 and breaks the circuit between the current leads 16 and 28.

When the bimetal element 10 is cooled while in the position shown in Fig. 3, the operations and functions described above are reversed.

If, in the instrument shown in Figs. 1 to 3, the metal sheets 32 and 34 are regarded as, or are the low-and-high-expanding metals, respectively, the instrument then will be responsive to a decreasing temperature to open the switch with a snap action at a specific lower temperature.

In the modified form of construction shown in Figs. 4, 5 and 6 the bimetal element 10*a* is in the form of a disc of bimetal material having a symmetrical spherical formation covering its whole area, so that the high-expanding side of the element is concave. This element 10*a* is mounted in a supporting means at its periphery including two supports 36 of insulating material and a third support 38 of metal engaging or integral with element 10*a* and carried on an insulating support 40. A current conductor 16*a* is connected to the member 38. The conductor connection 38 may be on the opposite side of the disc adjacent the free end of the leg so that current flows through the whole disc.

The bimental element 10*a* includes an integral leg 18*a* corresponding substantially to the corresponding leg in Fig. 1 and formed in the same way by cutting out a U-shaped slot in the body of the bimental element, which leg is left flat while the remainder of the structure is having a spherical deformation impressed in it. The free end of the leg 18*a* carries a contact 20*a* which cooperates with a contact 22*a* mounted on a support 24*a* of insulating material. A conductor screw 26*a* electrically connects the contact 22*a* with a conductor 28*a*.

The function and operation of the control shown in Figs. 4, 5 and 6, is essentially the same as that of the bimetal element 10. In this case the leg 18*a* is attached to the body of the element 18*a* substantially to one side of the center axis or spherical radius 30*a*. When the element 10*a* is heated the high-expanding side of the leg 18*a* increases the pressure between the contacts 20*a* and 22*a* until the instant of snap action. At that instant the disc-like element 10*a* snaps from the concave form shown in Fig. 5 to the convex form shown in Fig. 6.

Thereafter, when the element is at the point of snapping to switch-closing position, the contact on the leg 18*a* is substantially spaced from the fixed contact, and, at the instant of snap action, the circuit is closed instantly and maintained closed by the pressure applied.

Figs. 7, 8 and 9 show a form of device very similar to that shown in Figs. 4 to 6, except that a solid spherically shaped or dished disc 10*b* is employed. In Figs. 7, 8 and 9, the parts of the device which are the same as in Figs. 4, 5 and 6 are given the same reference characters followed by the letter *b*. The bimetal element 10*b*, as seen in Figs. 8 and 9, includes a bimetal leg 18*b* with its high-expanding side secured to the low-expanding convex surface of the disc 10*b*, to one side of the radius 30*b*, and in a position so that the leg extends toward and across the center of the disc, generally tangent to the spherical formation in the disc at its point of attachment.

The combined action of the disc 10*b* and the leg 18*b* when heated increases the pressure between the contacts controlled thereby until the snap action occurs, when the disc and the leg assume the respective positions shown in Fig. 9 of the drawings. Since the leg 18*b* is attached

to the convex side of the disc and to one side of the spherical radius, opposite that of the switch, the change in the angle or curvature of the part of the disc to which the leg is attached together with pressure applied by the leg produces the desirable results described above.

The leg 18 of the element 10 in Figs. 1 to 3 may be attached to the sheet in the manner shown in Figs. 7 to 9. While the legs 18, 18*a* and 18*b* are illustrated in Figs. 2, 5 and 8, as extending generally straight at a tangent to the dished formations of the respective elements to which they are attached, these legs may be formed or shaped to present their contacts at any desired or necessary angle to the general plane of the body of the element, according to the particular thermostat design being used. For example, the legs 18 and 18*a* may extend from their respective points of attachment in any direction on either the convex or the concave side of their respective elements, regardless of which side is low-or-high-expanding, and the leg 18*b* may extend in any direction from its point of attachment on the convex side of the element 10*b*, to which it is attached, whether said side is low-or-high-expanding. In a particular instrument it may be advantageous to have the fixed contact face to the right at 90° to that illustrated. A set bend could therefore be put in the leg so that the leg extends downwardly from the point of the bend with its contact facing and engaging the fixed contact. This bend in the leg may be adjacent its point of attachment or at some point therealong preferably some distance away from the leg contact.

The characteristics of the bimetal elements described may be precisely controlled for any use because of the permanent character of the spherical formation or shape given to the elements. The radius of the spherical formation may be selected to give a particular rating to the element and a particular temperature differential between the points of shape-reversal or snap.

It is to be understood that the present invention may be applied to other forms of bimetal elements and that the bimetal element may be employed for actuating other forms of controls such as valves and leverage mechanisms. However, the bimetal element is preferably employed in connection with electric switches because of the advantageous results obtained by the application of increased pressure on the switch contacts as the bimetal element is heated or cooled.

In the illustrative embodiments the switches are arranged so that electric current is passed through the leg and body of the bimetal element so that it is heated by the current. The device therefore alternately makes and breaks the circuit controlled by the switch. While this is an advantageous application of the features of the invention, it is to be understood that the bimetal element may be employed under conditions in which it is either heated or cooled externally and used for other purposes.

I claim:

1. A thermostatic switch comprising a support, a snap-acting bimetal element mounted on said support, said element being comprised of a sheet of bimetallic material having therein a spherically shaped formation and a leg of bimetal sheet material one end of which is attached to said sheet at one side of the center of said spherical formation, said sheet being mounted on said support only by a portion of the bimetal sheet on the side of the center of said spherical formation opposite the point of attachment of the leg, the high-and-low-expanding sides of the leg being oriented the same as those of the sheet, said leg extending from its point of attachment toward the center of the spherical formation and at a tangent to the surface thereof, an electrical contact on one side of the free end of the leg, and a fixed contact engaged by said contact on the leg, the leg of said snap-acting bimetal element when subjected to a change in temperature being adapted to apply increasing pressure to said contacts up to the instant when the leg contact is snapped away from the fixed contact.

2. A thermostatic control comprising a support, a snap-acting bimetal element mounted on said support, said element being comprised of a sheet of bimetallic material having therein at one end a spherically-shaped formation concave on the high-expanding side of the sheet, and a leg of bimetallic sheet material one end of which is attached to said sheet at the side of the spherical radius at the center of said spherical formation toward said one end, the high-and-low-expanding sides of the leg being oriented the same as those of said sheet, the other end of said sheet being flat and attached to said support, an electrical contact on the low-expanding side of the free end of the leg, and a fixed contact engaged by said contact on the leg, said snap-acting bimetal element when heated and because of said orientation being adapted to apply increasing pressure to said contacts up to the instant when the leg contact is snapped away from the fixed contact.

3. An article of manufacture, comprising a snap-acting element of bi-metallic sheet material comprising an oblong-shaped body portion and a bi-metallic leg attached thereto, said body portion having a dished spherically-shaped formation therein located at one end portion of the oblong body, the other end portion of the oblong body being flat, one end of said leg being attached to said body adjacent to the end provided with said spherical formation and to one side of the center of said formation with its high-expanding side oriented the same as that of the body, the leg extending from its point of attachment generally toward the center of said formation and normally at a tangent to the convex surface of said formation, the other end of the leg being free for movement relative to the body of the element in response to changes in the temperature of the element.

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