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THERMO-SENSITIVE SWITCHES

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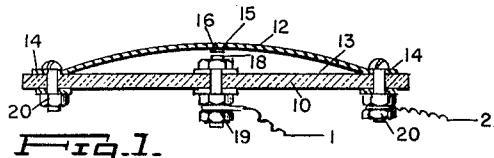


FIG. 1.

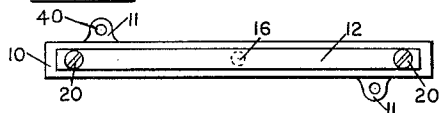


FIG. 2.

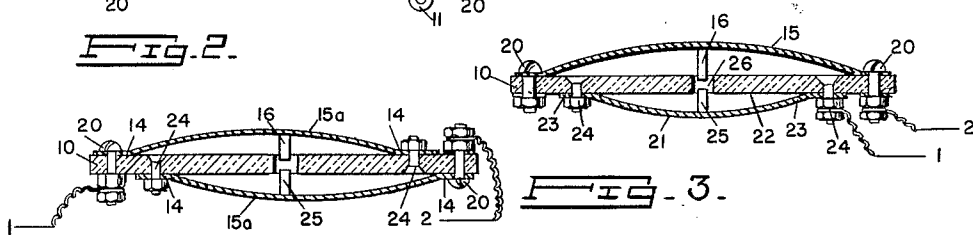


FIG. 3.

FIG. 4.

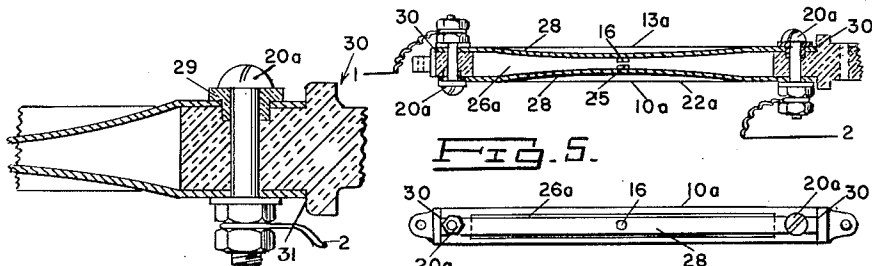


FIG. 5.

FIG. 6A.

FIG. 6.

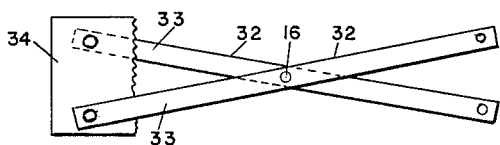


FIG. 7.

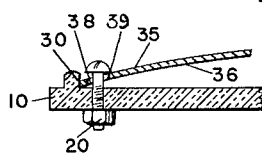


FIG. 8.

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THERMO-SENSITIVE SWITCHES

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19 Claims. (Cl. 200—137)

This invention relates to thermo-sensitive switches and this application is a continuation-in-part of my co-pending application Serial No. 343,731 filed March 30, 1953, now Patent No. 2,750,472.

In my co-pending application I have disclosed a bowed thermo expansion strip anchored, at each end, to a ceramic base so that the strip undergoes a buckling movement with changes of temperature, and the middle of the strip undergoes the maximum movement toward and from the base. This maximum movement is transmitted to a separate switch, mounted fast with respect to the base, the transmission of movement being accomplished by a rod between the strip and the switch. While my previously disclosed thermostatic switch assembly has functioned quite well for the purposes intended, I was able to discover that, with certain material changes, its field of use could be extended into areas where no thermostatic switch had hitherto been satisfactory for use, particularly where the space for the switch was quite limited and where the switch and its operating parts were subjected to forces due to their inertia such as acceleration, deceleration, and centrifugal action. For example, small motors regardless of location and use often overheat and burn out. Temporary loss of the motor is often far more preferable and safer than the burning out of the motor, for example in air-conditioning units. A thermostatic switch small enough to be built into the motor itself is of great advantage. Moreover armatures frequently burn out due to overheating because of their compact nature and temperatures of the motor as a whole are no indication of armature temperature. Even though not all armatures may lend themselves to the mounting of thermostatic switch thereon, motors having very little available space and used on moving vehicles may be improved by the incorporation of small thermostatic switches.

An object of the present invention is to provide a switch requiring a minimum of space, which is highly sensitive yet durable, and which is least affected by velocity changes, whether in direction or in linear speed. These objects are respectively attained in one or more forms of the invention which, briefly described, include a base, a bowed expansion ribbon having the end portions mounted in the base and having a light contact member fast on the ribbon for engagement with another contact member.

In the accompanying drawing showing, by way of example, several of many possible embodiments of the invention,

Figure 1 is a sectional view of one form of the invention;

Figure 2 is a plan of the form shown in Figure 1;

Figures 3 and 4 are sectional views, similar to Figure 1, showing two other forms of the invention;

Figure 5 is a sectional view of still another form of the invention;

Figure 6 is a plan of the invention as shown in Figure 5;

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Figure 6A is a fragmental sectional view showing an enlarged detail of an end of the invention as shown in Figure 5;

Figure 7 is a fragmental plan showing a modification of the form of the invention as shown in Figs. 2 and 6; and

Figure 8 shows details for adjustment of the invention.

The invention as shown in Figure 1 comprises a porcelain base, slab or strip 10 having suitable mounting means therefor such as lugs 11 and a bowed ribbon 12 having a relatively high coefficient of thermal expansion, such as brass or bronze secured over the top face 13 of and fast to the strip at the end portions 14 of the ribbon. The ribbon is bowed outwardly at the mid-portion 15 thereof from the strip, the mid-portion carrying a contact 16 in electrical contact with the ribbon so that changes in temperature cause movement of the contact toward and from the strip. A stationary contact 18 is mounted on an adjusting bolt 19 mounted on the strip opposite contact 16. The ribbon end portions 14 are secured to the strip as by fixing bolts 20. Circuit leads 1 and 2 may be connected to one of the fixing bolts and to the adjusting bolt. The set position of the contact 18 can be altered by the adjusting bolt 19 so that the contacts separate when the temperature reaches a predetermined value.

The invention of Figure 3 is similar to that of Figure 1 though more sensitive since an additional coating expansive ribbon 21 is mounted at its end portions 23 on the opposite or lower face 22 of the strip by another pair of fixing bolts 24 inner and insulated from the bolts 20. The coating ribbon 21 is provided with a contact 25 in the middle thereof. The two contacts 16 and 25 of Figure 3 are engageable with each other through a hole 26 in the base strip.

Not only is the switch of Figure 3 more sensitive, on account of nearly double the relative movement of the two contacts, but it is less affected by acceleration (linear or radial unless the switch is revolved about an axis lying close to the plane of the base and close to the contacts) since a change in velocity will affect the forces on both ribbons approximately alike. The ribbon 21 is shorter than ribbon 15 and preferably of the same material and bowed oppositely from ribbon 15.

If the switch is to be subjected to great rates of change in velocity it may be provided with two ribbons 15a of the same length and of the same size, shape and material, mounted on opposite faces of the base and bowed away from each other somewhat as in Figure 3. However the end portions 14 of each ribbon are mounted respectively on an inner bolt 24 and an outer bolt 20 so that the two ribbons are longitudinally offset as in Figure 4. The contacts 16 and 25 are about midway between the two inner bolts so that neither is in the middle of the ribbons. This construction equalizes most of the disturbing effects due to lack of symmetry in Figure 3.

The switches as shown in Figures 1 to 4 are of the "hot-off" type. The switch of Figures 5 and 6 is of the "hot-on" type wherein the base is in the form of a large frame 10a having two inwardly bowed ribbons 28 mounted on the upper and lower faces 13a and 22a thereof and across the opening or hole 26a of the frame, and insulated from each other. The ribbons may be mounted by bolts 20a passing through both ribbons and the frame suitable bushing 29, preferably of ceramic material is employed to insulate one ribbon from each bolt. I prefer ceramic or similar hard non-conducting material because of its rigidity at high temperature. Many other insulators creep or deform with age, and since any motion longitudinal of the ribbons will be reflected greatly magnified in the contact movement, it is essential that the ribbon be held against end movement

past a predetermined point. An abutment 30 for engaging against the end of the ribbon is desirable.

If the width of the switch need not be kept to a minimum, the ribbons shown as 32 in Figure 7 may be crossed, whether inwardly or outwardly bowed, so as to laterally space their end portion 33 and avoid many of the difficulties in insulating the ribbons. The ends may be mounted on a base generally designated 34 which may be a fragmental part of the strip 10 or frame 10a.

Adjustments for different temperature settings may be made, if necessary, by several means. For a two ribbon switch a preferred means is shown in Figure 8 wherein the ribbon 35 is not secured fast at one end portion 36 to the base (for example the base 10) but the ribbon end 38 normally remains against the abutment 30 which may be provided on the base 10. The end portion 36 is curved and provided with a longitudinal slot 39 through which one of the bolts such as 20 passes so that as the bolt is tightened the portion 36 is urged to approach a flattened position on the face of the base, and, shorten the bowable part carrying the contacts so that small total expansion gives increased bowing action. Depending on the direction of curvature of the end portion the tightening of the bolt may tend to urge the contacts together. As shown in Figure 8, the tightening urges them together. Provision for adjustment of the "hot-on" type may be had by employing crossed ribbons as in Figure 7 with the abutment 30 on the base 34.

The specific form of the invention to be employed will, of course, vary with the use to which it must be put. The species of Figure 5 is least susceptible to inertia effects since the contacts can be small and light. If the ribbons are crossed as in Figure 7 they are better exposed to the surrounding atmosphere but if there is much windage against the planes of the ribbons, unless they are very narrow and cross at right angles, the wind will bear more against one than the other. A similar effect is also present if the switch is immersed in a liquid moving relative thereto. If a "hot-off" switch is required with maximum sensitivity and minimum disturbance by inertia I would prefer the form as shown in Figure 4, where smallness of size is of utmost importance. I contemplate the form shown in Figure 1 as being my best form of the invention. I have contemplated many other forms of the invention but I limit the description to what I contemplate the best embodiments for use under a few of the various different conditions of use. The extent of my contemplations is indicated by the scope of the appended claims after the remainder of the description.

The same forms of the invention may be used with a change of materials wherein the insulating porcelain base having a coefficient of expansion of from about 1, and less, to about 4×10^{-6} is replaced by highly expansive material insulated therefrom such as thermosetting resins or plastics having coefficients of about a hundred to a thousand times greater such as unfilled phenolformaldehyde and so the base becomes the expansive element rather than the ribbons, the resin mentioned having a coefficient of $4-15 \times 10^{-5}$, and metals having a coefficient in the range of about 10 to 30×10^{-6} . Of course most such plastics are subject to heat distortion above about 125° C. and so the operating temperatures and materials must be considered. By substitution of the plastic for the porcelain, a "hot-off" switch is converted to one of the "cold-off" type, and a "hot-on" to a "cold-on." Stability of the base against deformation is improved by employing two ribbons such as in Figures 3, 4, 5 and 7 to reduce tendency of the base to bend.

Of course a switch having a plastic expansion element is not as quick acting as one having a highly heat conductive metal one. However, there are many instances where momentary over-heating is not dangerous and quick acting controls interfere unnecessarily with normal operations. Where the switch is to protect against a gradual build up of excessive temperature as in the pro-

longed use of a motor, when intermittent use was contemplated, a slow acting switch is desirable. In such an instance a manual reset control should sometimes be provided, or some other protective device, lest the quick responsive metal ribbon tend, by quick contraction, to overcome the effect of the expanded base which contracts only slowly. A switch of the construction shown in Figure 5 may remain open for a long time after automatically opening.

By having the element with the higher coefficient of expansion also with a lower coefficient of heat transfer, as is here the case, the switch is in fact a control for rate of heating. For example, if base 10 of Figure 1 be of plastic the switch may be used to control the rate of heating contents of a drying oven, starting at a slow rate and gradually increasing the rate as the base warms up throughout. A similar switch with a porcelain base and in series might be used to limit maximum oven temperature.

Of course when highly expansive bases are used provision must be made in mount such as a slot 40 (Figure 2) for allowing the base to expand.

The invention claimed is:

1. A temperature responsive switch comprising a base of insulating material having upper and lower faces and a hole through the base and faces; a bowed ribbon of metal having the ends thereof secured on the upper face and limited against motion therealong; an electrical contact fast on the mid portion of the ribbon and projecting toward the interior of the hole; an electrical conductor in the hole and presenting a contact face toward the contact on the ribbon and normally insulated from the ribbon, said face and contact being mutually engageable; a member on the conductor and projecting laterally therefrom and against the lower face of the base for holding the conductor away from the contact when the latter is in a predetermined position, said ribbon and base having substantially different coefficients of thermal expansion.

2. A temperature responsive switch comprising a base having exposed upper and lower faces; a bowed ribbon of metal having the end portions thereof mounted on the upper face; an electrical contact piece fast on the mid portion of the ribbon and projecting along a line substantially normal to one of the faces but short of at least one of the faces; a contact point; and means for carrying the contact point mounted on the base, said piece and contact point being engageable with each other, the ribbon and base having substantially different coefficients of thermal expansion, and the contact piece and point normally being insulated from each other.

3. A thermostatic switch comprising a base of insulating material; a ribbon having a bend therein and of thermo-expansive electrically conductive material and having both ends thereof disposed on the base; means on the base for limiting expansion of the ribbon in the direction of the chord of the bend and adjacent the ends of the bend for causing displacement of the ribbon as the ribbon expands; an electrically conductive contact member fast on the ribbon at the mid portion of the bend, a cooperating contact member normally insulated from the ribbon, and means on the base for mounting the cooperating contact member adjacent the first mentioned contact member for electrical engagement therewith.

4. A switch as claimed in claim 1 the last mentioned member being fast with respect to the base.

5. A switch as claimed in claim 1, the last mentioned means being a ribbon mounted as the first mentioned ribbon and having a bend in the opposite direction from that of the first.

6. A thermostatic switch comprising a base of ceramic material; a bowed ribbon of thermo-expansive electrically conductive material on the base; an electrically conductive contact member fast on the mid portion of the ribbon; means on the base for engaging against at least

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one end of the ribbon, the end portion of the ribbon thereat being provided with a longitudinal slot; a bolt passing through the slot and engaged on the base, and means holding the other end portion of the ribbon in a substantially fixed position on the base.

7. A thermostatic switch comprising a ceramic base having opposed faces and having a hole therethrough; a pair of bowed ribbons of thermo-expansive electrically conductive material mounted on opposite faces of the base and bowed in opposite directions; means on the base for limiting movement of the end portions of the ribbons in the direction of the chords of the bow of the ribbon; electrical contact members fast on the mid portions of the ribbons and adjacent each other for mutual contact and within the hole.

8. A thermostatic switch comprising a ceramic base having a hole therethrough and a top face; a bowed ribbon of thermo-expansive electrically conductive material on the face and having the mid portion bowed from the plane thereof and having the end portions thereof limited against substantial movement along the plane; an electrical contact member fast on the mid portion of the ribbon and projecting toward the interior of the hole; an electrical conductor in the hole in the base and having a contact face for engagement with the contact member.

9. A switch as claimed in claim 8, the conductor being substantially fast on the base.

10. A switch as claimed in claim 8, said conductor and face being movable with respect to the contact member and to the base.

11. A thermostatic switch comprising a ceramic base having a hole therethrough and opposite substantially parallel faces; a bowed ribbon of thermo-expansive electrically conductive material on one face and bowed out of the plane thereof, the end portions of the ribbon being substantially in the plane and limited against movement therealong; an electrically conductive contact member fast on the mid portion of the ribbon; an electrically conducting member having a face bare toward the contact member, and means against the opposite base face for holding the second mentioned out of contact with the first mentioned member when the first mentioned member is in a predetermined position.

12. A switch as claimed in claim 11 the second mentioned member being a bolt and the means being a nut thereon.

13. A switch as claimed in claim 11 said means being a second ribbon and the second mentioned member being fast thereon.

14. A switch as claimed in claim 1, the base having a higher coefficient of thermal expansion than that of the ribbon.

15. A thermostatic switch comprising a base having opposed faces and having a hole therethrough; a pair of bowed ribbons of thermo-expansive electrically conductive material mounted on opposite faces of the base and bowed in opposite directions and substantially insulated from each other; means on the base for limiting move-

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ment of the end portions of the ribbons in the direction of the chords of the bow of the ribbon; and electrical contact members fast on the mid portions of the ribbons and adjacent each other for mutual contact and at least partially within the hole, said ribbons extending in substantially the same direction, the end portions of the two ribbons being mutually offset in said direction.

16. A thermostatic switch comprising a base having opposed faces and having a hole therethrough; a pair of bowed ribbons of thermo-expansive electrically conductive material mounted on opposite faces of the base and bowed in opposite directions and substantially insulated from each other; means on the base for limiting movement of the end portions of the ribbons in the direction of the chords of the bow of the ribbon; electrical contact members fast on the mid portions of the ribbons and adjacent each other for mutual contact and within the hole, said ribbons extending in substantially the same direction, the end portions of the two ribbons being mutually offset in said direction and having their bowed portions of the same length.

17. A thermostatic switch comprising a base having opposed faces and having a hole therethrough; a pair of bowed ribbons of thermo-expansive electrically conductive material mounted on opposite faces of the base and bowed in opposite directions and substantially insulated from each other; means on the base for limiting movement of the end portions of the ribbons in the direction of the chords of the bow of the ribbon; electrical contact members fast on the mid portions of the ribbons and adjacent each other for mutual contact and within the hole, said ribbons being of substantially the same length and extending in the same direction and having the end portions of the ribbons mutually offset.

18. A thermostatic switch comprising a base having opposed faces and having a hole therethrough; a pair of bowed ribbons of thermo-expansive electrically conductive material mounted on opposite faces of the base and bowed in opposite directions and substantially insulated from each other; means on the base for limiting movement of the end portions of the ribbons in the direction of the chords of the bow of the ribbon; electrical contact members fast on the mid portions of the ribbons and adjacent each other for mutual contact and within the hole, the ribbons being crossed at the zone of the contact members.

19. A thermally actuated control switch comprising two elongated expansion elements, one being a base and the other being bowed and having the two end portions thereof secured to the base, one element having the higher coefficient of heat expansion and the lower coefficient of heat conduction than those of the other.

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