United States Patent

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[31] **23,158/68**

[54] **THERMALLY SENSITIVE ELECTRIC SWITCHES AND ACTUATING DEVICES THEREFOR**
15 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **337/89,** 337/113, 337/372
[51] **Int. Cl.** **H01h 37/04,** H01h 37/54
[50] **Field of Search** 337/85, 89, 92, 111, 112, 113, 362, 365, 369, 379, 380, 381, 372

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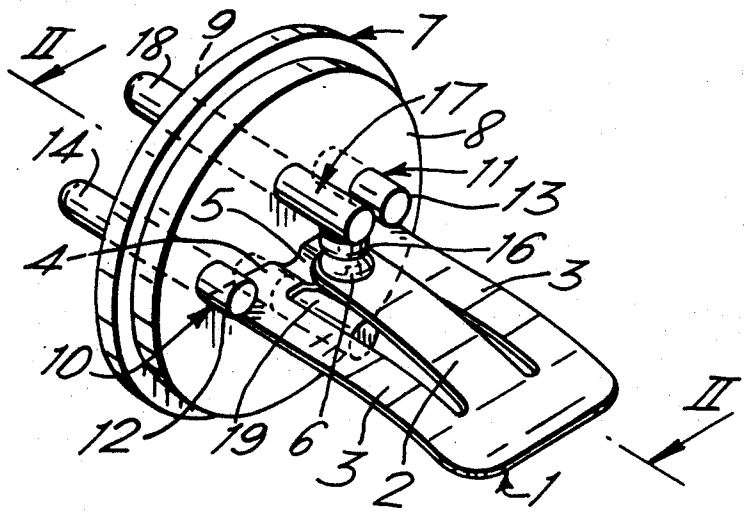
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ABSTRACT: Thermally sensitive switches, and thermally sensitive switch actuating devices, in which a bimetal sheet constituting the actuating member of the switch or switch actuating device is mounted in cantilever fashion from a face of a mounting block by means of one or more metal rods embedded in the mounting block and welded, brazed or soldered to the face of the bimetal sheet.



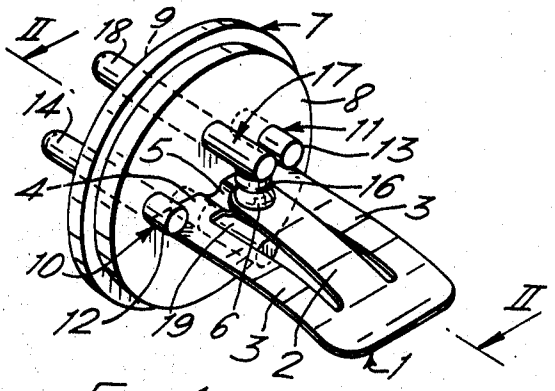


Fig. 1.

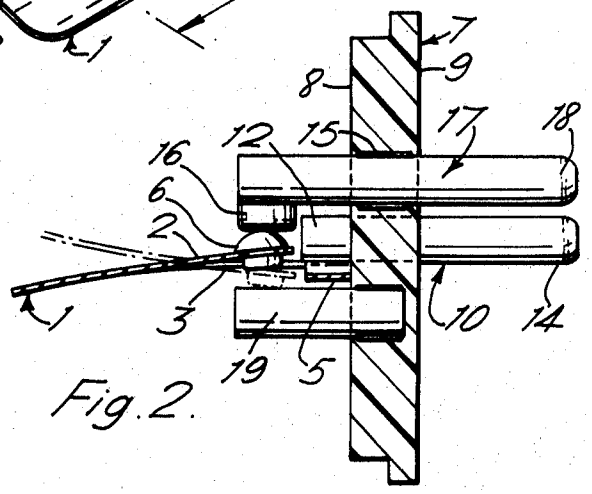


Fig. 2.

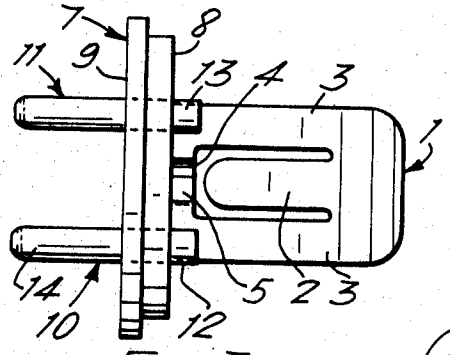


Fig. 3.

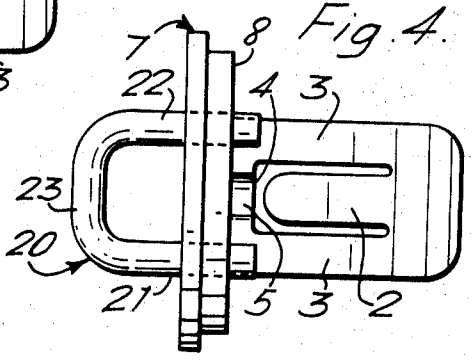


Fig. 4.

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THERMALLY SENSITIVE ELECTRIC SWITCHES AND ACTUATING DEVICES THEREFOR

This invention relates to snap-acting thermally sensitive electric switches and to actuating devices therefor, which incorporate a thermally sensitive actuating member comprising a sheet or strip of bimetal having a tongue released therefrom between two outer legs, said tongue being connected to the sheet or strip at one end and being free at its other end, and the said sheet or strip being stressed by drawing the said outer legs towards one another so that it is caused to buckle out of its original plane in two directions to form a stressed system which will move with changes in temperature between two positions on either side of an intermediate unstable position with a snap action. Such bimetal actuating members are those referred to hereinafter as being "of the kind described."

It is known to mount such a bimetal actuating member for use by permanently securing it face to face with a metal mounting plate, e.g. by welding, brazing or soldering; the metal mounting plate itself is then permanently embedded in a suitable mounting block, for example a block of moulded plastics insulating material. Although the use of such a mounting block is very convenient, it is a difficult operation to achieve the face-to-face interconnection of the bimetal actuating member and its metal mounting plate in a sufficiently secure manner to withstand prolonged use, particularly in comparatively rigorous circumstances involving, for example, more or less continuous vibration, as the movement of the bimetal member with changes of temperature tends to affect such connection.

Viewed from one aspect the present invention provides a snap-acting thermally sensitive switch-actuating device, comprising a bimetal actuating member of the kind described which member is secured to a mounting block therefor via at least one metal rod or rods being welded, brazed or soldered to the said outer legs of the bimetal member adjacent the free end of the said tongue thereof.

It is very much easier to make a secure connection between the face of the said bimetal sheet or strip and a portion of a metal rod than to connect such sheet or strip face to face to a metal mounting plate, and the present invention thus makes for easier (and therefore less expensive) manufacture and greater reliability in use.

It will be understood that such a switch-actuating device may be arranged, in use, for the movement of its bimetal member with changes in temperature to operate switch contacts remote therefrom in any convenient fashion, e.g. by means of a pushrod or pull rod for example.

Where a single metal rod is employed to mount the bimetal actuating member this may be of U-shape having its two arms embedded in the mounting block. In one embodiment the outer legs of the bimetal sheet or strip may then be secured to the respective ends of the rod where its arms protrude from the mounting block, the crosspiece of the U-shaped rod being on the opposite side of the mounting block from the bimetal sheet or strip. In an alternative arrangement in which the bimetal sheet or strip is on the same side of the mounting block as the crosspiece of the U-shaped rod the outer legs of the bimetal sheet or strip may be secured to the corners of such U-shaped rod, i.e. where the arms of the U join the crosspiece thereof; the central part of the crosspiece of the U may then be displaced, e.g. bowed or joggled, out of the plane of the arms thereof so as not to interfere with the movement of the bimetal member between its "hot" and "cold" positions with change of temperature.

Where two metal mounting rods are provided the outer legs of the bimetal sheet or strip will be secured respectively to end regions of the two rods protruding from the mounting block.

In a simple embodiment of this form of the invention, when the operation of the bimetal actuating member is to be dependent only on the temperature of its surroundings, the said metal rod or rods may be embedded in and extend from a single face of the mounting block without necessarily passing through the block. If, on the other hand, the switch actuating device of this form of the invention is to be current sensitive in use, it may be mounted on two metal rods as aforesaid which rods pass completely through the mounting block, the other ends of the rods constituting or being provided with terminals for the connection of the bimetal member in an electric circuit.

It is indeed a further and important advantage of the use of metal rods to mount the bimetal actuating member of switch actuating devices according to the invention, and to mount an actuating member (and if desired other elements) of switches to be referred to hereinafter, that such rods may also very easily be arranged to constitute or mount terminals of such actuating devices and switches.

Viewed from another aspect the invention provides a snap-acting thermally sensitive electric switch including a bimetal switch-actuating member of the kind described which member is secured to a mounting block therefor via at least one metal rod embedded in said mounting block, two portions of said rod or rods being welded, brazed or soldered to the said outer legs of the bimetal member adjacent the free end of the said tongue thereof, at least one fixed switch contact secured to said mounting block, and a movable switch contact arranged to be operated directly or indirectly by movement of said bimetal actuating member with changes in its temperature.

The bimetal actuating member of such a switch may be secured to the mounting block via either one or two metal rods as described above.

The or each fixed contact of the switch may be secured to the said mounting block in any of a number of ways. For example it could be mounted on a metal plate embedded in or otherwise fixed to the mounting block. Preferably, however, the or each such fixed contact is, like the bimetal actuating member, secured to a metal rod embedded in the block, which rod may extend through the block and have a portion thereof remote from the contact constituting or mounting a switch terminal associated with such fixed contact.

If the movable contact of the switch is to be operated indirectly by the bimetal actuating member such contact could also be mounted, e.g. by a spring strip, on a metal rod embedded in the said mounting block and extending therethrough to provide or mount a further terminal of the switch. Alternatively, the bimetal actuating member may itself carry the movable contact of the switch so as to operate such contact directly, e.g. by having the contact mounted on the free end of the tongue of the bimetal sheet or strip, in which case such actuating member will be arranged to be connected in the circuit to be controlled in use and the or one of the metal rods which mounts such bimetal member may be extended through the mounting block to constitute or mount a switch terminal associated with the said movable contact.

Thus in a preferred embodiment of a thermally sensitive switch according to the invention, the bimetal actuating member thereof is secured to the said mounting block by means of two metal rods permanently embedded in the block, one of which passes completely therethrough to provide one terminal of the switch at the end of the rod remote from the bimetal member. The movable contact is mounted on the tongue of the bimetal member whilst a fixed switch contact is provided on one end of a further metal rod embedded in said mounting block and extending therethrough to provide the other switch terminal, the fixed contact overlying the movable contact on the free end of the tongue of the bimetal sheet or strip. Preferably another metal rod is embedded in the mounting block on the other side of the bimetal member to provide a stop defining the position to which the said tongue moves when the contacts are broken. Alternatively, of course, if a changeover switch is to be provided, the last-mentioned rod could carry a second fixed contact and be extended through the mounting block to provide a terminal associated with the latter contact.

It would be possible to embed the said metal rods in the mounting block by mounting them in a suitable jig and then moulding the block about them. Such a procedure, however,

is rather complicated. In a preferred embodiment of the invention the mounting block is moulded with suitable holes for the reception of such rods and of such a diameter as to make the rods a tight interference fit therein; each rod is preferably slightly deformed at the appropriate part of its length to form splines thereon before being forced into its hole in the mounting block, so that the splines on the rod bite into the wall of the hole and hold the rod firmly in position.

The said rods may be of various cross-sectional shapes, but the operation of welding or otherwise securing the rod to the face of the bimetal sheet or strip is facilitated most of all if there is line contact between such parts. In a preferred form of the invention, therefore, the rods are of cylindrical form. They may be formed of any suitable metallic material; brass rods are very convenient to use but are comparatively expensive, and it is therefore preferred to use a less expensive material such as copper-coated steel.

It will be appreciated that many different kinds of switches may be embodying the broad principles of the present invention, in addition to the comparatively simple single-pole and changeover switches briefly mentioned above. Thus for example the invention is by no means limited to switches incorporating only a single bimetal actuating member of the kind described, as the convenience and reliability of the novel manner of mounting such members herein disclosed considerably facilitates the building up of complex assemblies of such members on a single mounting block, with both the actuating members and their various contacts interconnected in any desired way to achieve particular effects in operation. The use of metal rods embedded in the mounting block is not limited solely to providing the means for securing the bimetal actuating member(s) and contacts of a switch assembly to the block; such rods may also be employed with advantage to provide the desired electrical connections between the various elements of complex switch assemblies, or to carry heaters for controlling the operation of the bimetal members.

The mounting block itself may of course take various shapes; in a very simple form where it carries a single bimetal actuating member it may comprise a cylindrical block having two opposite flat faces from one of which said member extends, whilst in more complex applications the block may if desired be especially shaped to fit into a desired location in apparatus to be controlled. It will usually be formed of insulating material, e.g. a suitable plastic, but this is not essential in some cases as, for example, where a simple switch actuating device dependent for its operation on ambient temperature is provided.

In order that the invention may be more readily understood, certain embodiments thereof will now be described for example and with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a snap-acting thermally sensitive electric switch according to the invention;

FIG. 2 is medial cross-sectional view of the switch of FIG. 1, taken on the line II–II;

FIG. 3 is a plan view of a snap-acting thermally sensitive switch-actuating device according to the invention; and

FIG. 4 is plan view of a modified form of the device of FIG. 3.

The embodiment of the invention illustrated in FIGS. 1 and 2 comprises a snap-acting thermally sensitive electric switch in the form of a simple circuit breaker, including a bimetal actuating member of the kind described which is to be connected in an electric circuit to be controlled by the switch.

The bimetal actuating member comprises a rectangular sheet of bimetal 1 from which a U-shaped portion has been removed to define a central tongue 2 flanked by two outer legs 3, such legs being joined by a bridge portion 4 adjacent the free end of the tongue 2. Such bridge portion is deformed at 5 by a crimping operation so as to draw the two outer legs 3 towards one another and thus to buckle the sheet 1 out of its original plane whereby it will snap between two positions on either side of an intermediate unstable position with changes in temperature. In FIG. 2 the position of the tongue 2 in the "cold" condition of the bimetal sheet is shown in full lines whilst its position in the "hot" condition of the sheet is shown in ghost lines. A movable contact 6 of the switch is mounted on the free end of the tongue 2.

The bimetal sheet 1 is secured to a mounting block 7 in the form of a thick disc of moulded plastics insulating material having two opposite parallel faces 8 and 9. Two copper-coated steel rods 10 and 11 are embedded in the mounting block 7 at right angles to the said opposite faces thereof, the rod 10 extending completely through the block and having its ends protruding on both sides thereof, whilst the other rod 11 had only one end protruding. Thus two respective ends 12 and 13 of the rods 10 and 11 protrude from the front face 8 of the mounting block 7 at right angles thereto and substantially on a common diameter of such face, whilst the other end 14 of the rod 10 protrudes from the rear 9 of the block to provide one terminal of the switch.

The rods 10 and 11 are embedded in the mounting block 7 by moulding two holes in the block of such a diameter that the rods are a tight interference fit in the holes, and slightly deforming the rods at appropriate positions in their lengths so as to form splines 15 thereon (see FIG. 2). The rods are then forced into the holes so that the splines bite into the walls thereof to hold the rods in position.

The bimetal sheet 1 is welded to the two ends 12 and 13 of the rods 10 and 11 via one face of the sheet, at the respective end regions of its outer legs 3 adjacent the free end of the tongue 2, so that such member extends from the front face 8 of the mounting block in cantilever fashion, the said ends of the rods lying adjacent and parallel with the side edges of the plate.

A fixed contact 16 of the switch is mounted on the end of a third copper-coated steel rod 17 similarly embedded in the mounting block 7, which rod passes completely through the block and extends from the front face 8 thereof to a greater extent than the two rods 10 and 11 so as to overlie the movable contact 6 on the free end of the tongue 2 of the bimetal sheet. The other end 18 of the rod 17 extends from the rear face 9 of the mounting block as to provide the second terminal of the switch.

A fourth copper-coated steel rod 19 is embedded in the mounting block on the opposite side of the bimetal sheet 1 from the rod 17 and extends only from the front face 8 of the block so as to underlie the tongue 2 of the bimetal sheet to provide a stop defining the position to which such tongue moves when the bimetal actuating member 1 operates to break the switch contacts.

Thus in this very simple embodiment the invention provides a circuit breaker switch connectable in a circuit via the terminals provided by those rods 10 and 17 which extend from the rear face 9 of the mounting block 7, and which will be operative to break such circuit when the bimetal actuating member operates with rising temperature.

Referring now to FIG. 3, this shows a snap-acting thermally sensitive switch actuating device according to the invention, which simply comprises the switch of FIGS. 1 and 2 with the rods 17 and 19 and the switch contacts 6 and 16 omitted, and the rod 11 lengthened to protrude from the rear face 9 of the block 7. All of the other parts, being the same as in FIGS. 1 and 2, are given the same reference numerals as in those Figures and will not be described again. The device of FIG. 3 may be used to actuate switch contacts in any desired manner upon operation of the bimetal actuating member 1 with changes in temperature, for example by connecting the tongue 2 of the device to the movable contact of an associated switch by means of a simple push and/or pull rod. The device may operate in response to ambient temperature or may be connected in an electric circuit by way of the free ends of the rods 10 and 11 so as to be current sensitive.

FIG. 4 shows a modification of the device of FIG. 3 in which the two rods 10 and 11 are replaced by a single substantially U-shaped rod 20 whose respective arms 21 and 22 are em-

bedded in the block 7 and serve the same functions as the rods 10 and 11 of FIG. 3. The device may if desired be mounted via the crosspiece 23 of the U-shaped rod 20.

In a further modification of the switch of FIGS. 1 and 2 or of the devices of FIGS. 3 and 4 the crimped bridge portion 4 of the bimetal sheet 1 may be omitted and the sheet stressed simply by means of its connection with its mounting rod. Thus if the rods are embedded in the mounting block before the bimetal sheet is welded to them, the sheet may be held in a suitable jig with the free ends of its outer legs 3 drawn towards one another to the desired extent whilst the welds are being effected; alternatively the legs could be welded to the rods before the latter are embedded in the mounting block and the legs then drawn towards one another by suitable positioning of the rods in the block.

It will thus be seen that the invention provides switch-actuating devices (and switches) whose bimetal actuating member is mounted in a very simple, robust and convenient manner which facilitates manufacture and provides great reliability in operation.

I claim:

1. A snap-acting thermally sensitive switch-actuating device, comprising: a thermally sensitive actuating member in the form of a sheet of bimetal having a tongue released therefrom between two outer legs, said tongue being connected to the sheet at one end and being free at its other end, the said sheet being stressed so that it is buckled out of its original plane in two directions to form a stressed system which moves with changes in temperature between two oppositely buckled conditions with a snap action; a mounting block for said bimetal actuating member; and metal rod means embedded in and projecting from a face of said mounting block, two spaced side surface portions of said rod means being fixedly secured to said outer legs of said bimetal actuating member, by welding or the like, adjacent the free end of said tongue, to secure the bimetal actuating member to said mounting block.

2. A device as claimed in claim 1, wherein the said portions of the metal rod means which are secured to the outer legs of the bimetal member are end portions thereof.

3. A device as claimed in claim 1, wherein the bimetal member is secured to the mounting block by two metal rods.

4. A device as claimed in claim 3, wherein at least one of the said rods extends through the mounting block, the end of such rod remote from the bimetal member constituting a terminal for the connection of the bimetal member in an electric circuit.

5. A device as claimed in claim 1, wherein the bimetal member is secured to the mounting block via only one such metal rod, such rod being substantially of U-shape and having its two arms embedded in the mounting block.

6. A snap-acting thermally sensitive electric switch, comprising: a thermally sensitive actuating member in the form of a sheet of bimetal having a tongue released therefrom between two outer legs, said tongue being connected to the sheet at one end and being free at its other end, the said sheet being stressed so that it is buckled out of its original plane in two directions to form a stressed system which moves with changes in temperature between two oppositely buckled conditions with a snap action; a mounting block for said bimetal actuating member; metal rod means embedded in and projecting from a face of said mounting block, two spaced side surface portions of said rod means being fixedly secured to said outer legs of said bimetal actuating member, by welding or the like, adjacent the free end of said tongue, to secure the bimetal actuating member to said mounting block; a fixed switch contact secured to said mounting block; and a movable switch contact arranged to be operated by movement of said bimetal actuating member with changes in temperature.

7. A switch as claimed in claim 6, wherein the said portions of the metal rod means which are secured to the outer legs of the bimetal member are end portions thereof.

8. A switch as claimed in claim 6, wherein the bimetal member is secured to the mounting block by two of said metal rods.

9. A switch as claimed in claim 8, wherein at least one of the said rods extends through the mounting block, the end of such rod remote from the bimetal member constituting a terminal for the connection of the bimetal member in an electric circuit.

10. A switch as claimed in claim 6, wherein the said movable switch contact is mounted on the free end of the tongue of the said bimetal member and the said bimetal member is arranged to be connected in an electric circuit in use of the switch.

11. A switch as claimed in claim 6, wherein said fixed switch contact is secured to a further metal rod embedded in the said mounting block which rod extends through the said mounting block and has a portion thereof remote from the said fixed switch contact which constitutes a terminal for connection of said fixed switch contact in an electric circuit.

12. A switch as claimed in claim 11, which has only one fixed switch contact and wherein another metal rod is embedded in the mounting block and extends on the side of the bimetal opposite from said fixed switch contact to provide a stop defining the position to which the said tongue moves when the switch contacts are broken.

13. A switch as claimed in claim 6, wherein said metal rod means has splines or similar protrusions thereon over the part of its length where it is embedded in the mounting block, such protrusions biting into the wall of the hole in the mounting block to hold the rod means firmly in position.

14. A switch as claimed in claim 6, wherein said metal rod means is cylindrical.

15. A switch as claimed in claim 6, wherein said metal rod means is made of copper-coated steel.