

IMPROVEMENTS RELATING TO THERMALLY RESPONSIVE
ACTUATORS

FIELD OF THE INVENTION:

5 This invention concerns improvements relating to
thermally responsive actuators, and has particular
though not exclusive application to the field of
thermally responsive electric switches for use in
electrically heated water boiling vessels such as
10 kettles, jugs, urns, pans, laboratory equipment and the
like for switching off or reducing the supply of power
to an electric heating element of the vessel when water
or another liquid boils in the vessel and the vapour
generated impinges upon a thermally-responsive switch-
15 actuating element.

BACKGROUND OF THE INVENTION:

Electrical switches for use with water boiling
vessels such as kettles, jugs, urns, pans and the like
and which are responsive to water boiling in the vessel
20 are disclosed in British Patent Specifications Nos.
1,470,365, 1,470,366 and 1,470,367, for example, and
additionally are disclosed for example in British Patent
Specifications Nos. 2,117,568 and 2,128,029. As may be
seen from a reading of these specifications, the
25 majority of which relate to commercially available and
relatively successful devices, the conventional _____

steam-sensing switches for water boiling vessels are of fairly complex construction and involve the assembly of a relatively large number of separate components. In one typical known device, for example, there are in total twelve components, namely a snap-acting bimetal blade, a blade retainer moulding, a push rod, an overcentre arrangement comprising a trip lever coupled to the bimetal via the push rod and a C-spring biasing the trip lever, lid, cover and chassis mouldings, and a pair of leaf springs with attached switch contacts. Such a high component count inevitably complicates the assembly of the respective switch and leads to increased manufacturing costs.

In addition to steam sensing electric switches for use in electrically heated water boiling vessels, element protector switches are also known which are adapted to switch off the supply of power to the heating element of the vessel in response to a sensed element overtemperature condition, caused for example by switching on the vessel with insufficient water in it or by allowing the vessel to boil dry. It has been known to provide element protectors and steam sensors as entirely separate units and it has also been known to provide combined element protector and steam sensing units. Furthermore, it has been known to provide element protector and steam sensing units such

that the element protector may be used alone or alternatively may be combined with a steam sensor in which case a mechanical interconnection between the element protector and the steam sensor has enabled the steam sensor to operate the switching contacts within the element protector.

Thus in one known arrangement, an element protector unit has comprised a bimetallic switch actuating element arranged to determine the condition of switch contacts within the unit through the intermediacy of a push-rod arrangement, and a steam sensor unit adapted for use with the element protector unit has comprised a further bimetallic switch actuating element arranged so as in use to be exposed to steam generated when water boils in an associated vessel and a lever arrangement for coupling the resulting movement of the steam sensor bimetal to the push-rod of the element protector unit for operating the switch contacts therein when the steam sensor unit is appropriately combined with the element protector unit. By manufacturing the element protector and the steam sensor as separate units but arranging that they can readily be combined together, a rationalisation of the need to manufacture a variety of different controls in order to accommodate the requirements of different manufacturers of water boiling vessels can

be obtained. However, such arrangements of this type that have previously been known have suffered from the limitation that the same element protector unit is not
5 capable of being operatively combined with a variety of different steam sensor unit designs and furthermore have placed limitations on vessel design.

OBJECTS AND SUMMARY OF THE INVENTION:

One object of the present invention is to enable
10 the provision of a new and improved thermally responsive switch actuator and thermally responsive switch which is of simplified construction as compared to the abovementioned prior art devices, is capable of automatic assembly and enables cost savings to be made.

15 Another object of the present invention is to enable the provision of a new and improved steam sensor for an electrically heated water boiling vessel, such steam sensor being flexibly utilizable with element protector switches in a variety of different ways
20 providing enhanced freedom for vessel design.

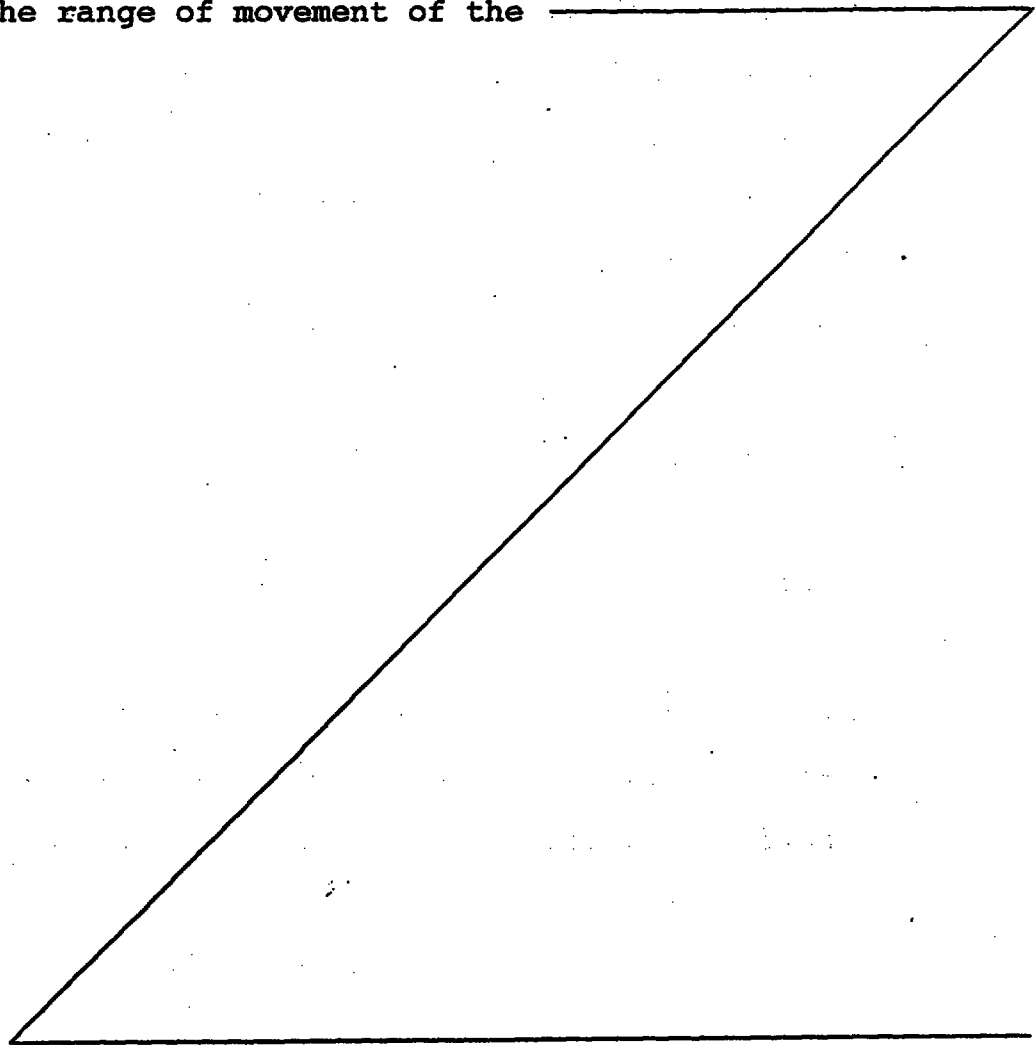
According to the present invention there is provided a thermally responsive snap-acting bimetallic actuator mechanism for developing an operational movement in response to a temperature change, said
25 actuator mechanism comprising a moulded plastics material chassis, a bimetal blade, and a moulded

plastics trip lever, the bimetal blade and the trip lever being pivotally mounted in series with each other between two spaced-apart opposed mountings defined in said chassis so as to define a sprung overcentre bridge which is movable with a snap-action between two stable positions on opposite sides of an intermediate unstable position, the trip lever having one end portion which defines one end of the overcentre bridge and is pivotally mounted with respect to said chassis at one of said mountings, the bimetal blade having one end portion which defines the other end of the overcentre bridge and is pivotally mounted with respect to said chassis at the other of said mountings, the bimetal blade and the trip lever each having another end portion whereat the trip lever and the bimetal blade pivotally engage each other at an intermediate location in the overcentre bridge, and an abutment being provided in the chassis against which the bimetal blade acts in its development of the force necessary for causing the overcentre bridge to move between its two stable positions, the arrangement of said overcentre bridge thereby being such that in response to a predetermined temperature change the bimetal blade will itself develop the spring force necessary to cause the overcentre bridge to move

overcentre with a snap-action, and such overcentre movement of the bridge involving relative pivotal movement between the trip lever and the chassis which constitutes the operational movement of the actuator.

As will be appreciated from consideration of the following detailed description of exemplary embodiments of the present invention, the present invention, in one of its aspects resides in the realization that an effective steam sensing device can be obtained by combining the bimetal mounting and overcentre trip-lever arrangement, which in the conventional devices aforementioned has required as many as seven separate components, into a module which comprises only three functional parts and can be configured as only two structural components. As described in detail hereinafter, a thermally responsive switch actuator embodying the present invention comprises a bimetal blade, a trip lever, and a chassis which supports the bimetal and the trip lever, the chassis providing spaced-apart mountings which are bridged by the bimetal blade and the trip-lever mounted in series with each other and defining a snap-acting overcentre arrangement the range of movement whereof is limited by abutment with the chassis at least in the cold condition of the bimetal and preferably also in the hot condition of the

bimetal. The overcentre bridge extending between the spaced-apart mountings in the chassis is constituted by one end of the bimetal being pivotally received in one of the chassis mountings and defining one end of the bridge, one end of the trip-lever being received in the other of the chassis mountings and defining the other end of the bridge, and the other ends of the bimetal and the trip-lever abutting each other generally intermediate the ends of the bridge. The chassis further defines stops or abutments limiting the range of movement of the



overcentre bridge in both directions, that is to say both the cold condition position and the hot condition position of the overcentre bridge are defined by the chassis, and also provides an abutment against which the
5 bimetal may act to provide the actuating force for movement of the bridge between its two stable states, namely its cold state and its hot state. The chassis in this embodiment also provides compliance to accommodate the change in the dimensions of the overcentre bridge
10 between the spaced-apart bimetal and trip-lever mountings as the bridge moves between its two stable states, though this compliance could alternatively or additionally be provided by the trip-lever. The compliant abilities of the chassis can be augmented or
15 supplemented by use of a spring metal component supported in the chassis and in turn supporting one end of the bimetal.

The trip-lever could be formed integrally with the chassis moulding, with the result that a two-part switch
20 actuator is obtained. In such a construction, the trip lever might be pivotally mounted to the chassis moulding by means of an integral moulded hinge. Plastics materials are well known which are suitable for the formation of such integrally moulded _____

hinges, though it may be preferred, given that the moulding may be subjected to relatively high temperatures by virtue of the impingement of hot vapour thereon, to utilize a non-integral mounting arrangement which is not prejudiced by any reduction in the strength of the plastics material at elevated temperatures and enables stronger materials to be used which are not as well suited to the formation of integrally moulded hinges. Polypropylene, as is well known, is a material which can be formed into effective integral hinges but is weakened by exposure to high temperatures, and rather than using polypropylene it might accordingly be preferable instead to use a stronger material, such as glass filled nylon for example, and form the pivotal bimetal and trip-lever mountings as knife edge type mountings.

The switch actuator as above described thus has three functional parts, namely the bimetal, the trip-lever and the chassis, and can be formed in only two parts or as three. The bimetal serves two functions, firstly it acts as a thermally active component providing the force which generates the action of the device in response to a change in temperature, and secondly it provides the spring force which operates the overcentre bridge and provides a bistable latch mechanism which, for example, could open and hold open

switch contacts. The trip-lever is moved by the action of the bimetal and may be used to transmit this movement to switch contacts, for example. The chassis provides support for the bimetal and the trip-lever, 5 providing a pivotal mounting for both components and allowing them to rotate through an angle limited by stops or abutments on the chassis, and also providing the compliance necessary to accommodate the movement of the overcentre bridge. By manufacture of the 10 chassis of a suitable material, such as a flame retardant plastics material, it could also be used to support the electrical components of a switch.

The bimetal blade need not be of any special configuration and does not itself have to be snap 15 acting. Preferably and advantageously the bimetal is a flat rectangular blade of a grade suitable for the intended application of the actuator. For example, in the case of an actuator for use as a steam sensor, a corrosion (rust) resistant bimetal clearly would be 20 preferred, and generally a high-flexivity, high yield strength, spring-grade bimetal might be preferred. The bimetal requires no special forming or tooling and no subsequent stress relief or selection. The dimensions of the bimetal also are not critical, 25 enabling manufacturing tolerances to be readily accommodated without prejudicing the operational

characteristics of the actuator.

As will be described hereinafter, the switch actuator as generally described in the foregoing can be utilized with the chassis fixedly mounted as a switch component and switch-operating movement developed by the trip-lever, and can alternatively be utilized with the trip-lever fixedly mounted and the chassis moving to develop the requisite switch operation. The latter arrangement is particularly well suited to utilization in steam sensor switches for electric kettles and the like and where the chassis moulding or a part mounted thereon can conveniently be used as a reset knob.

The switch actuators hereinafter described and switches embodying such switch actuators have the advantage over conventional switch actuators as hereinbefore described that they require only a minimum number of components which furthermore are more simple than those previously utilized. The switches according to the invention are thus better suited to automatic assembly and can be cost advantageous. Furthermore, extended working life may be expected by utilization of appropriate materials and by virtue of the elimination of the high stress levels that are normally present in conventional bistable bimetal actuators and lead to fatigue

failures of such actuators. Additionally, the switch actuators hereinafter described have no push rod and no gap between the bimetal and the moving switch parts, as is present in conventional switches, and thus avoid the conventional difficulty that resetting cannot be accomplished until the bimetal cools; with the switches hereinafter described there can be no set/reset temperature differential and resetting can be achieved without the necessity of waiting until the bimetal cools.

Also described hereinafter is an improved form of steam sensor embodying to the present invention which is designed to be capable of being plugged into an element protector as described in our British Patent Specification No. 2194099, the action of plugging the steam sensor into the element protector placing an electric switch within the steam sensor in series with an electrical switch in the element protector in the current supply path to the heating element. The arrangement of this particular steam sensor and element protector enables either device to be used alone and enables the two devices to be used together either with the steam sensor directly plugged into the element protector or with the two connected together by means of a connecting lead. In an alternative, but similar, arrangement which is also described

hereinafter, the steam sensor is configured as a switch actuator and does not itself have any switch contacts, and is arranged to be coupled by a Bowden cable or the like to the element protector device for operating a set of switch contacts provided therein.

Further features of the invention are set forth with particularity in the appended claims and they, together with other aspects features and advantages of the invention will become well understood by those possessed of the relevant skills from consideration of the following descriptions of exemplary embodiments which are illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

Figures 1A to 1H show perspective views of the component parts of a first embodiment of the present invention and views showing the stages of their assembly;

Figures 2A to 2G show similar views of the component parts and their assembly into a second embodiment of the present invention;

Figures 3A to 3M show various perspective, elevation and plan views of the component parts and their assembly into a third embodiment of the invention;

Figures 4A and 4B show exploded perspective views of an element protector generally as described in our British Patent Specification No. 2194099 with reference

to Figure 3A, 3B and 3C thereof, Figure 4A showing the element protector as viewed from the rear and Figure 4B showing it as viewed from the front;

5 Figures 5A to 5E are perspective views showing how a steam sensor similar to that shown in Figures 3A to 3M may be plugged into the element protector of Figures 4A and 4B hereof;

10 Figures 6A to 6C illustrate different ways in which an element protector in accordance with Figures 4A and 4B hereof may be utilized with a steam sensor similar to that shown in Figures 3A to 3M;

15 Figure 7 shows a more detailed showing of a modified form of the steam sensor of Figures 3A to 3M coupled to an element protector generally of the kind shown in Figures 4A and 4B;

Figure 8 is a schematic showing on an enlarged scale of a detail of Figure 7;

20 Figures 9A and 9B show exploded perspective views from different positions of yet another modified form of the steam sensor shown in Figures 3A to 3M; and

Figure 10 is a view, similar to Figure 3J, illustrating the operation of the steam sensor of Figures 9A and 9B.

DESCRIPTION OF THE EMBODIMENTS:

Referring first to Figures 1A to 1H, and initially to Figure 1A, there is shown a steam sensor module suitable for use with an electrically heated water boiling vessel for switching off the supply of electricity to the heating element of the vessel when water boils in the vessel and steam impinges upon a thermally sensitive element of the module. As shown in Figure 1A which is a perspective exploded view of the parts of the module, the module comprises a main moulding 1, a lower leaf spring 2, an insulator 3, a switch actuator sub-assembly 4, an upper leaf spring 5, and a closure moulding 6. The switch actuator sub-assembly 4 comprises a chassis moulding 7 having integrally formed therewith a trip-lever 8 which couples at one end to the chassis moulding via an integral hinge 9, and a rectangular bimetal blade 10. The chassis moulding 7 defines a V-notch pivotal mounting 11 for one end of the bimetal blade 10 and the other end of the bimetal blade 10 lodges in a V-notch formed in the end of the trip-lever 8 that is remote from the hinge 9, the bimetal blade 10 and the trip-lever 8 thereby defining an overcentre arrangement bridging the spaced-apart V-notch mounting 11 and hinge 9. The chassis moulding 7 is further formed with a member 12 defining a back stop for the trip-lever 8 in the cold condition of the bimetal, a

member 13 defining a front stop for the trip-lever in the hot condition of the bimetal (this being the condition shown in Figure 1A), and a member 14 defining an abutment against which the bimetal works when it flexes under temperature change to move the overcentre bridge from its cold to its hot condition with a snap-action.

The main moulding 1 is formed with upper and lower chambers 15 and 16 respectively, the upper chamber 15 serving to accommodate the switch actuator assembly 4 and the lower chamber serving to accommodate the lower leaf spring 2 which carries a first switch contact, the insulator 3, and the upper leaf spring 5 which carries a co-operating second switch contact. As shown in Figures 1B to 1G, the switch is assembled by first introducing the lower leaf spring 2 into the lower chamber 16 of the main moulding 1 as shown in Figure 1C, then introducing the insulator 3 as shown in Figure 1D, then inserting the switch actuator sub-assembly 4 into the upper chamber 15 as shown in Figure 1E, then introducing the upper leaf spring 5 into the lower chamber 16 as shown in Figure 1F, and finally snap-fitting the closure moulding 6 into the lower chamber 16. The main moulding 1 and the closure moulding 6 have formations which engage lugs 17 that are provided on opposite

sides of the trip-lever 8 (only one can be seen in Figure 1A) and trap the switch actuator sub-assembly 4 so that the trip-lever cannot move but the remainder of the chassis moulding 7 can pivot about the hinge 9, and a post 18 is provided on the chassis moulding 7 (as can be seen most clearly in Figure 1E) and extends in the assembled switch between the contact carrying parts of the leaf spring 2 and 5. When the bimetal 10 is subjected to heating and causes the over-centre arrangement to switch, the consequent relative movement between the trip-lever 8 and the remainder of the chassis moulding 7 causes the post 18 to open the normally (in the cold condition of the device) closed switching contacts carried by the leaf spring 2 and 5.

It will be seen from Figure 1A that in the hot condition of the switch actuator sub-assembly 4, the trip-lever 8 acts as a gate closing off access to the bimetal 10 of steam admitted into the main moulding 1 through access apertures formed therein. By virtue of this arrangement, the amount of steam admitted into the switch module to cause operation of the switch is restricted so that condensation of the steam within the switch does not constitute any significant problem.

Referring now to Figures 2A to 2G, and particularly to Figure 2A, a second embodiment of the

present invention is shown therein and comprises a main switch moulding 20, a switch sub-assembly comprising two identical contact-carrying leaf springs 21 and 22 staked to an insulator 23, a switch actuator assembly 24 comprising a moulded plastics chassis 25 formed with an integral trip-lever 26 hingedly coupled thereto and a bimetal (not shown) mounted in the chassis moulding and defining with the trip-lever 26 an overcentre bridge arrangement as in the first described embodiment, and a lid 27 for the main moulding 20. Though the shape of the chassis moulding 25 in the second embodiment is different to that of the first embodiment, it is nonetheless functionally identical in so far as the operation of the overcentre bridge arrangement is concerned, and the arrangement and operation of the bridge arrangement in the second embodiment will not be further described herein. It is however to be noted that the chassis moulding 25 is formed with a switch-operating projection 28 the function of which will be described hereinafter.

The main moulding 20 is formed with a mounting chamber 28 for the switch sub-assembly which fits into the chamber 28 in the manner shown in Figure 2C, the insulator 23 having grooved portions 29 which engage in a slot 30 formed in the wall portion 31 of the main moulding which defines the chamber 28, and there being

an upstand 32 formed on the main moulding 20 within the chamber 28 behind which lodges an ear portion 33 of the leaf spring 21. By virtue of this arrangement, the insertion of the switch sub-assembly into the chamber 28 of the main moulding 20 defines the contact carried by leaf spring 21 as the fixed switch contact of the switch and the contact carried by leaf spring 22 as the moving contact.

The trip-lever 26 of the chassis moulding 25 is formed with a pair of lugs 34 one of which can be seen in Figure 2A and the other being on the opposite side of the trip-lever. The main moulding 20 has an aperture 35 on the rear wall thereof, and this aperture is designed to receive therein one of the lugs 34 of the trip-lever 26 when the chassis moulding 25 is fitted to the main moulding 20 in the manner shown in Figure 2D, the trip-lever 26 slotting into the slot 36 defined between the projecting portions 37 and 38 of the main moulding 20. When the chassis moulding 25 is thus fitted to the main moulding 20, the trip lever 26 becomes fixedly mounted with respect to the main moulding 20 whilst the remainder of the chassis moulding 25 is free to pivot about its hinged coupling with the trip-lever 26. With the chassis moulding 25 fixed to the main moulding 20 in this manner, the projection 28 on the

back of the chassis moulding 25 extends into an aperture 39 in the wall 31 of the enclosure 21 of the main moulding and, by-passing the leaf spring 21, extends into contact with the ear 40 of leaf spring 22. The cold condition position of the chassis moulding 25 is shown full line in Figure 2D and the position to which it moves in response to movement of the overcentre bridge into its hot condition is shown in phantom; it can be seen that in the hot position of the chassis moulding 25 the projection 28 pushes upon the leaf spring 22 and opens its carried contact from the contact on the leaf spring 21.

Figure 2E shows the lid 27 fitted onto the main moulding 20 and shows the position of the chassis moulding 25 in the contacts closed (cold) condition of the switch, and Figure 2F shows the device in its contacts open (hot) condition. Figure 2G is a side elevation view of the switch as shown in Figure 2F. A reset knob could, if desired, be affixed to the upper part of the chassis moulding 25 where it extends out of the main moulding 20 for enabling manual resetting of the switch.

In both of the above-described embodiments the trip-lever is integrally formed with the chassis moulding and coupled thereto by means of a plastics hinge portion. As previously mentioned, this

arrangement may not be preferred for certain applications and in the following an alternative embodiment will be described wherein the trip-lever is not integral with the chassis moulding.

5 Referring to Figures 3A to 3M, the device shown therein comprises a steam sensing module which is designed to be plugged into an element protector unit, that is to say a unit for protecting the electrically powered heating element of a water boiling vessel from
10 overheating, so as to convert the unit additionally into a steam sensing unit for automatically switching off the heating element when water boils within the vessel. The manner in which the steam sensing module attaches to the element protector unit will be
15 described hereinafter with reference to Figures 4A and 4B and Figures 5A to 5E.

 The steam sensing module of Figures 3A to 3M comprises a switch sub-assembly 40 shown in assembled condition in Figure 3B and consisting of two identical
20 contact-carrying leaf springs 41 and 42 staked to an insulator 43 shown in Figure 3A, a main moulding 44 shown in perspective in Figure 3C, a trip-lever 45 shown in various stages of assembly with the main moulding 44 in the perspective views of Figures 3F, 3G
25 and 3H, and a bimetal blade 46 shown in Figure 3H.

 The main moulding 44 is formed with a chamber 47

which accommodates the assembled switch sub-assembly 40, the grooved parts 48 of the insulator 43 engaging with a slot 49 formed in the wall of the chamber (see Figure 3H) and a catch portion 50 of the insulator
5 engaging with an aperture 51 formed in the main moulding 44 so as to lock the switch sub-assembly in position (see Figure 3E). When the switch sub-assembly 40 is fully engaged in the chamber 47, a wall portion 52 of the insulator 43 closes off the
10 entrance to the chamber 47 and access to the interior of the chamber 47 is then provided only via the opening 53 defined in the chamber wall (see Figures 3C, 3D and 3F). As will be explained more fully hereinafter, the opening 53 provides access to the
15 chamber 47 for a projection formed on the trip-lever 45, such projection serving for applying switch-actuating movement from the trip-lever 45 to the switch sub-assembly 40.

A limb 54 extends from the main moulding 44 as
20 shown in Figures 3C and 3D and is shaped to provide a knife edge pivotal mounting for the trip-lever 45 which, as can be seen in Figures 3F, 3G and 3H, has a part 55 adapted to be fitted over the limb 54 and to co-operate with the knife edge on the limb for
25 pivotally mounting the trip-lever 45. As can be seen from comparison of Figures 3F to 3G, the trip-lever is

adapted to be fitted onto the limb 54 of the main moulding 44 in the relative orientation of the two parts that is shown in Figure 3F and thereafter is rotating into the position shown in Figure 3G. This rotation of the trip-lever 45 brings a peg 56 on the main moulding 44 into engagement with a groove 57 formed in the trip-lever so as to prevent the trip-lever from sliding off of the limb 54, and also causes the end of a projection 58 formed on the trip-lever (see Figure 3F) to enter the opening 53 providing access to the switch sub-assembly 40 housed within chamber 47 of the main moulding 44.

The trip-lever 45 has a V-notch mounting 59 formed therein for receiving one end of the bimetal blade 46 and an opposed V-notch mounting 60 for the other end of the bimetal blade 46 is provided on a part of the main moulding 44 and, with the trip-lever 45 rotated into the orientation relative to the main moulding 44 that is shown in Figure 3G, the bimetal 46 can be inserted into the two opposed V-notch mountings 59 and 60 as shown in Figure 3H. The assembly of the steam sensing module is then complete.

The operation of the steam sensing module as thus described is substantially identical to that of the embodiment described hereinbefore with reference to Figures 2A to 2G irrespective of the fact that the

physical construction of the respective parts of the two embodiments is considerably different. In the cold condition of the bimetal 46, the contacts of the switch sub-assembly 40 are closed and the trip-lever 45 takes up a position such that the projection 58 does not interfere with the closed condition of the switch contacts (see the trip-lever position shown in phantom in Figure 3J). When the bimetal 46 is heated by the impingement of steam thereupon, the overcentre bridge defined by the trip lever 45 and the bimetal 46 snaps over and causes the trip-lever 45 to take up the position that is shown in full lines in Figure 3J and causes the projection 58 to enter into the chamber 47 housing the switch sub-assembly 40 and to move the leaf spring 41 in a direction such as to open the switch contacts.

An upstand 61 on the trip-lever 45 merely comprises an attachment for a reset knob and has no other operational significance. A post 62 (shown in Figure 3J) defines an abutment for the bimetal to work against when switching the overcentre bridge from its cold to its hot condition.

The steam sensing module as thus described with reference to Figures 3A to 3M is designed to be capable of being connected to an element protection unit either by being plugged directly into the element

protection unit, or by being remotely coupled therewith by means of a connecting lead provided with appropriate plug and socket connectors at its ends. As is well known, an element protection unit comprises

5 a thermally-responsive switch arrangement which is adapted to be connected in series with the power supply line of an electrically powered heating element and serves to disconnect the heating element from the power supply line in the event of an overtemperature

10 condition arising at the heating element, for example on account of the heating element being switched on when there is insufficient liquid in an associated vessel to absorb the heat output of the element or on account of the vessel being permitted to boil dry.

15 Exemplary element protection units are described in British Patent Specifications Nos. 1,264,464, 1,316,436, 1,439,229, 2,045,588 and others, to which reference may be made for a fuller understanding, but for the purposes of the present specification it is

20 sufficient only that it be appreciated that an element protection unit commonly comprises live and neutral conductor leaf springs which contact the cold tails of a heating element when the protector unit is fitted to the head of the heating element and serve for

25 conveying electrical power from power supply terminal pins of the element protection unit to the heating

element, a switch arrangement in the neutral side at least of the power supply line to the heating element and comprising a leaf spring carrying a contact normally biased into electrical engagement with a
5 contact provided on a portion of the neutral conductor leaf spring and movable out of contact therewith for opening the switch, a push rod for applying switch-operating movement to such movable contact, and a bimetallic switch-actuating element which is arranged
10 to be in close thermal contact with the heating element head plate when the element protection unit is coupled thereto and which, in response to the heating element temperature increasing above a predetermined normal level, develops a movement which is transferred
15 by way of the push rod to the movable contact of the switch so as to open the switch. Element protection units are known which provide only a single level of protection, and other element protection units are known which provide a primary protection and an
20 additional back-up or secondary protection operative in the event of failure of the primary protection. The steam sensing device of the present invention can in principle be used with any kind of element protection unit, and the embodiment hereinafter
25 described is particularly (though not exclusively) adapted for use with an element protection unit as

described in our British Patent Specification No. 2194099 with reference to Figures 3A, 3B and 3C thereof so as to extend the element overtemperature sensing facility of the element protection unit to the provision also of steam sensing facilities. The same element protection unit can therefore be associated with the heating elements of simple electric kettles, for example, and can also be used with fully automatic kettles which switch off when they boil.

Referring to Figures 4A and 4B, the construction and operation of the element protector will now be briefly described, it being appreciated that reference may be made to our British Patent Specification No. 2194099 for a more complete description. The element protector as shown comprises a sub-assembly 20 (the same reference numerals will be used herein as are used in our British Patent Specification No. 2194099 to denote like parts) comprising a collapsible carrier 21, a bimetal blade 22 and a push rod 23, the sub-assembly 20 being adapted to locate in use of the element protector between the rear face of the heating element head 24 and the outer side of an inner moulding 25 of the element protector. The inner moulding 25 is adapted to co-operate with a main moulding 26 defining a socket inlet 27 for a kettle connector plug so as to define within the assembled

control a chamber for accommodating the L,N and E terminal pins 28, 29 and 30 of the control and for accommodating a contact carrying live (L) connecting spring 31, a contact carrying live leaf spring 32, a
5 neutral (N) connecting spring 33 and an earth (E) connecting spring 34.

The inner moulding 25 is adapted to be clipped to the main moulding 26 and has a pair of integrally-formed moulded spring clips 36 which co-operate with a
10 pair of apertures 37 in the main moulding so that the inner moulding 25 makes a positive fit into the mouth of the main moulding 26 and is positively retained therein by the clips 36. Upstands are formed on the inner face of inner moulding 25 (that is the face that
15 can be seen in Figure 4A) and co-operate with formations provided on the opposed face of the main moulding 26 (that is the face that can be seen in Figure 4B) for retaining the L,N and E terminal pins 28, 29 and 30 securely in the assembled control, the
20 terminal pins extending through respective apertures provided within the socket inlet part 27 of the main moulding 26, and in similar fashion the live connecting spring 31, the live leaf spring 32 and the neutral connecting spring 33 are trapped between the
25 inner moulding 25 and the main moulding 26 when the two are assembled together. The earth connecting

spring 34 is adapted to affix to the upstand 41 provided on the element head 24 when the element protector is fully assembled and is attached to the element head and, within the element protector, makes
5 contact with the earth terminal pin 30.

Referring now more particularly to the sub-assembly 20, the bimetallic blade 22 is generally rectangular with a central cut-out 42 of generally X-shaped configuration and is dished so as to be capable
10 of moving with a snap action between two oppositely dished configurations, the X-shaped cut-out 42 ensuring a substantially greater operating movement at the centre of the bimetal than would be provided by a plain dished blade. The bimetallic blade 22 is
15 retained in the sub-assembly 20 by means of the engagement of the push rod 23 both with the central cut-out 42 of the blade 22 and with the collapsible carrier 21, the push rod 23 being adapted to be inserted into a guide passage 45 formed in the carrier
20 21 from the side thereof which can be seen in Figure 1A, but being incapable of passing completely through the guide passage 45, and having a nose portion adapted to be engaged in the centre of the cut-out 42 in the bimetal blade 22. As will be appreciated, the
25 position of the opposite, pusher end of the push rod 23 relative to the carrier 21 will be dependent upon

whether the bimetal 22 is in its hot or its cold state.

The carrier 21 is generally in the form of a four-legged table and has relatively large feet 46 for ensuring good thermal contact with the rear face of the heating element head 24 when the assembled element protector is affixed to the element head. The bimetallic blade 22 seats at its corners on the ends of the four legs 47 of the carrier, flush with the soles of the feet 46. A pair of locating grooves 48 are provided in the carrier 21 and the inner moulding 25 is provided on its outer face with a pair of upstanding rails 49 adapted to slidably engage in the grooves 48. On its upper surface, as shown in Figure 1A, the carrier 21 has four upstanding posts designed to project through an aperture 50 provided in the inner moulding 25, there being two small posts 51 and two larger posts 52 and 53.

When the element protector as thus described is assembled together and to the element head 24 of an electrically heated water boiling vessel for example, the heating element cold tails 54 and 55 (that is the terminal ends of the heating element proper) extend through apertures 56 and 57 provided in the inner moulding and contact the upper ends of the live connecting spring 31 and the neutral connecting spring 33 respectively, the upper end portions of the springs

31 and 33 being curved as shown for accommodating such contacts. The heating element cold tails may be tipped with silver solder or may be provided with crimped ferrule terminations to enhance their connections with the leaf springs. The lower end of the live connecting spring 31 extends across the aperture 50 of the inner moulding 25 and carries a contact which constitutes the "moving" contact of the switching contacts set of the element protector. This lower limb of the live connecting spring 31 is arranged to be abutted by the pusher end of the push rod 23 for moving the moving contact in response to switching of the bimetallic blade 22 into its "hot" condition from its normal "cold" condition.

The live leaf spring 32 is trapped between the inner and main mouldings 25 and 26 when the two are assembled together, and has a first, relatively-substantial limb 58 which extends across the aperture 50 formed in the inner moulding 25 and is contacted and urged away from the inner moulding 25 and towards the main moulding 26 by the large post 52 upstanding from the carrier 21, which causes the limb 58 of the live leaf spring 32 to be biased into contact with the live terminal pin 28. The live leaf spring 32 also has a second, less-substantial limb 59 which extends across the aperture 50 in the inner moulding

25 and carries at its free end a contact which co-operates with the "moving" contact provided on the live connecting spring 31 and constitutes the "fixed" contact of the switching contacts set. The second
5 limb 59 of the live leaf spring 32 is arranged to be contacted by the lowermost of the two small posts 51 provided on the carrier 21, such posts projecting through the aperture 50. This contact between the lower post 51 and the limb 59 of the live leaf spring
10 32 establishes the position of the contact carried by the live leaf spring 31 (the "fixed" contact of the switching contacts set) relative to the carrier and thus relative to the push-rod, the bimetallic blade and the element head and establishes the position of
15 the "fixed" contact relative to the element head irrespective of variations in the dimensions of the element head.

In similar manner, the neutral connecting spring 33 is trapped between the assembled mouldings 25 and
20 26 and has a relatively substantial limb 60 which extends across the aperture 50 and is butted by the post 53 on the carrier 21 into contact with the neutral terminal pin 29.

In operation of the element protector as thus
25 described, an element head overtemperature condition will normally cause bimetal 22 to snap to its hot

configuration thereby causing the moving contact carried by live connecting spring 31 to be pushed away from the fixed contact carried by live leaf spring 32 by the push rod 23. In the event of an abnormal over-
5 temperature condition, such as might arise if the switching contacts were to weld themselves together for example, then a secondary protection mode comes into operation when the temperature of the element head reaches such a high level as to cause the carrier
10 21 to collapse towards the element head by virtue of heat distortion of its legs under pressure from the spring parts 58 and 60 of the live and neutral leaf springs 32 and 33 respectively. As is more completely explained in British Patent Specification No. 2194099,
15 the collapse of the carrier 21 towards the element head 24 causes the leaf spring parts 58 and 60 to move out of contact with the live and neutral terminal pins 28 and 29 thereby disconnecting the heating element from its power supply.

20 Referring now to Figures 5A to 5E of the accompanying drawings, Figure 5A shows a perspective view of a slightly modified form of the steam sensor main moulding 44 described hereinbefore with reference particularly to Figure 3C of the accompanying
25 drawings, the principal modifications being the provision of a portion 100 for shielding the chamber

47 of the main moulding against the entry therein of steam condensate and the provision of an engaging portion 200 for positive engagement with an element protector. As shown in Figure 5B hereof the chamber 47 of the main moulding 44 is adapted to accommodate a switch sub-assembly 40 comprising contact-carrying leaf springs staked to an insulating body having a side wall portion 52 shaped to close off the entrance to the chamber 47 when the switch sub-assembly is fully engaged therein. The same reference numerals are employed in Figures 5A to 5E hereof as are used to designate like parts in Figures 3A to 3M. When the switch sub-assembly 40 is fitted into the chamber 47 of the steam sensor main moulding 44, a lower part of the switch sub-assembly 40 projects outwardly from the chamber 47, such lower part comprising a flat portion of the insulating body of the switch sub-assembly flanked on either side by parts of the contact-carrying leaf springs thereof. As shown in Figures 5C, 5D and 5E of the accompanying drawings, this lower part of the switch sub-assembly of the steam sensor is adapted to be plugged into a socket portion defined in an element protector as described with reference to Figures 4A and 4B hereof.

To enable the steam sensor to be plugged into the

element protector, the main moulding 26 of the element protector is provided with an aperture 125 in its upper surface (see Figure 4A hereof) which provides access to the location within the element protector whereat, in use of the element protector on its own, that is to say without a steam sensor, the cold tail 55 of the heating element would contact the upper part of the neutral connecting spring 33. As shown in Figure 5C hereof which shows a modified form of the main moulding of the element protector, there is provided externally of the aperture 125 a structure 250 which is complementary to the engaging portion 200 of the steam sensor as shown in Figure 5B so that when the depending lower part of the switch sub-assembly 40 of the steam sensor is plugged into the aperture 125 in the top of the element protector the steam sensor will engage positively with the element protector as is shown in Figures 5D and 5E hereof. With the steam sensor thus assembled with the element protector and the element protector assembled to a heating element, the switch sub-assembly of the steam sensor is introduced between the cold tail 55 of the element head and the upper end of the neutral connecting spring 33 of the element protector whereby the steam sensor is placed electrically in series with the switching contacts set of the element protector.

Referring now to Figures 6A, 6B and 6C of the accompanying drawings, these illustrate a variety of applications options for the element protector and steam sensor as hereinbefore described. As shown

5 schematically in Figure 6A, the element protector may be used on its own in a variety of water boiling vessels exemplified in the drawing as a conventional kettle 301 and a jug type of vessel 302. In Figure

6B, a steam sensor is shown plugged into the top of an

10 element protector and the drawing schematically shows the combination assembled with the heating element of a conventional kettle 301 provided with an aperture for venting steam onto the steam sensor bimetal and alternatively assembled with the heating element of a

15 jug type vessel 302 incorporating a steam duct for directing steam from the interior of the vessel to the location of the steam sensor where it is plugged into the element protector. Figure 6C shows an alternative option whereby the steam sensor can be located spaced

20 apart from the element protector and coupled thereto by means of an appropriate connecting lead having at one end thereof a plug type connector adapted to be plugged into the top of the element protector and at the other end thereof a socket type connector adapted

25 to receive the plug type end portion of the steam sensor switch sub-assembly.

Yet another way in which a steam sensor embodying the present invention can be utilized with the element protector is described with reference to Figures 7 and 8 of the accompanying drawings. The element protector shown is a modification of the element protector illustrated in Figures 5A and 5B of the accompanying drawings and similar or common parts bear the same reference numerals as are used in Figures 5A and 5B. The view of the element protector shown in Figure 7 is a view into the open face of the main moulding 26 with the contact carrying live connecting spring 31, the contact carrying line leaf spring 32, and the neutral connecting spring 33 assembled with the main moulding. As will be recalled from the description given hereinbefore, in use of the element protector the heating element cold tails butt against the upper parts of the leaf springs 31 and 33, that is to say the parts which are shown uppermost in Figure 7 of the accompanying drawings, and the parts 58 and 60 of the leaf springs 32 and 33 respectively are urged into contact with the live and neutral terminal pins by the action of the posts 52 and 53 provided on the rear of the collapsible carrier. In normal operation of the element protector the contacts provided on the leaf springs 31 and 32 are closed so as to permit current flow through the heating element,

but in an element overtemperature condition, caused for example by the vessel being switched on empty, the lower part of leaf spring 31 is pushed by the push rod mounted in the collapsible carrier, pursuant to
5 operation of the bimetal, so as to open the normally closed contacts. If the element overtemperature condition persists, for example on account of the contacts welding together, then a secondary protection will come into play when the collapsible carrier
10 begins to melt thereby releasing the connections made between the leaf springs 32 and 33 and the power supply terminal pins.

In the modified form of the element protector that is shown in Figure 7, the leaf spring 31 has a
15 portion 311 which acts as a torsion arm enabling rotation of the portion 312 which carries the contact, and an abutment portion 313 is provided which co-operates with a movable slider 314 to determine the position in the element protector of the contact
20 carried by the leaf spring 31. This arrangement is schematically illustrated in Figure 8 and it will be appreciated from Figure 8 that when slider 314 is in its forward position, it abuts portion 313 of leaf spring 31 and causes a rotation of the portion 312
25 about torsion arm portion 311 thereby bringing the contact carried at the lowermost end of leaf spring 31

into a position for contacting the contact carried by leaf spring 32. When slider 314 is in its rearward position (as shown in Figure 8) however, the contact carried by leaf spring 31 does not make contact with the contact carried by leaf spring 32.

The slider 314 is mounted within a coupling member 315 for reciprocatory movement therein, and the coupling member is adapted to be plugged into an opening provided for the purpose in the top of the element protector and to make a snap fit therein. The movement of the slider 314 within the coupling member 315 is determined by the steam sensor as described hereinafter such that when the steam sensor operates in response to the generation of steam when water boils within the vessel the slider is withdrawn to its rearward position thereby permitting the contacts to break and switching off the heating element.

Referring to the upper part of Figure 7, there is shown a perspective view of a steam sensor which is a modification of the steam sensors described hereinbefore. As shown, and wherever practical using the same reference numbers for like or similar parts as are used hereinbefore, the steam sensor comprises a moulding 44 formed with a limb 54 which provides a knife edge pivotal mounting for one end of a trip lever 45, and the other end of the trip lever 45 has a

V-notch mounting for receiving one end of a bimetal blade 46, the other end of the bimetal blade 46 being received in an opposed V-notch formed in a spring metal reinforcing part 320 captured in the moulding 44
5 behind the post 321. As has been fully explained hereinbefore, the bimetal 46 and trip lever 45 together constitute an articulated member which is movable with a snap action between two stable conditions upon exposure of the bimetal to an
10 appropriate high temperature, namely the temperature of steam generated when water boils in an associated vessel.

As is schematically shown in Figure 7, the trip lever 45 is secured to one end of the core wire of a
15 Bowden cable 325 and the corresponding end of the outer sheath of the cable is secured to the moulding 44. At the other end of the cable, the core wire is connected to the slider 314 and the outer sheath is connected to the coupling member 315. By virtue of
20 this arrangement, the movements of the bimetal 46 and trip lever 45 of the steam sensor are coupled to the element protector so that in the cold condition of the steam sensor the slider 314 biases the contacts in the element protector into their closed condition, and
25 when the steam sensor responds to water boiling in the associated vessel the slider 314 is withdrawn.

whereupon the switch contacts in the element protector open.

In the arrangement of Figures 7 and 8 as thus described, the contact carried by the lower end of leaf spring 32 is thus a "fixed" contact and the
5 leaf spring 32 is thus a "fixed" contact and the contact carried by the lower end of leaf spring 31 is a "movable" contact the position of which is dependent upon both the condition of the steam sensor and the condition of the element protector. This
10 arrangement is exemplary only and it could alternatively be arranged, for example that both contacts were "movable" with the position of one contact determined by the steam sensor and the position of the other contact determined by the
15 element protector. It could furthermore be arranged that separate sets of switching contacts were provided in the element protector, one to be controlled by the element protector per se and the other to be controlled by the steam sensor per se.

20 The described arrangement of Figures 7 and 8 has advantageous simplicity and avoids tolerancing problems which have hitherto been encountered in seeking to couple a steam sensor mechanically with an element protector. By virtue of the use of a Bowden
25 cable, electrical isolation of the steam sensor from the components of the element protector can be assured

at low cost and furthermore minimum constraints are imposed upon the aesthetic vessel design. Advantages also arise in the use of common parts with the steam sensors and element protectors described hereinbefore, and in this regard it is to be noted that the same basic steam sensor could be designed to deliver, optionally, either an electrical or a mechanical signal to the element protector, and likewise the same basic element protector could be designed to accept, optionally, either an electrical or a mechanical input from the steam sensor. The element protector could, for example, be designed such that when used with an electrical input from the steam sensor (in the manner described herein with reference to Figures 5A to 5E for example) a dummy coupling member 315 is plugged into the element protector to bias the contact spring 31 into an appropriate position.

As shown in Figure 7, one end of the bimetal blade 46 is received in a V-notch formed in a spring metal reinforcing part 320 captured in the moulding 44 behind the post 321. It would be preferable to avoid use of the spring metal reinforcing part 320 but, on account of difficulties that we have encountered in finding a plastics material for the moulding 44 which will provide a compliance mounting for the bimetal

without also being subject to mechanical creepage as it ages, the provision of the spring metal part 320 has provided an elegant solution to the problem of providing a compliant mounting for the bimetal. The arrangement of the spring metal part 320 can be seen more clearly in Figures 9A and 9B and Figure 10 of the accompanying drawings wherein the same reference numerals are used for the same or similar parts as have been used in the descriptions of preceding embodiments. Many other variations will be seen in Figures 9A, 9B and 10 as regards the detailed form of the various component parts of the illustrated embodiment, but the overall function and operation of the embodiment remains as described hereinbefore and accordingly no further discussion of Figures 9A, 9B and 10 is considered to be necessary.

There have thus been described several embodiments of a steam sensing switch, or a device suitable for use in or as a steam sensing switch, which has various advantages. When the device is used as part of a steam sensitive switch, for example in an electric automatic kettle or hot water jug, the form of the device allows for free access of steam to the bimetal before operation which permits rapid response of the device, and, in some of the described embodiments, will allow obstruction to the passage of

steam after operation which permits the device to be reset more readily than with existing devices. The fact that only a plain bimetal need be used and that the bimetal does not need to change the sense of its curvature in moving from a cold to a hot condition is further advantageous in this respect in that whereas a conventional Otter type of snap-acting bimetal displays a temperature differential between its set and reset conditions and therefore cannot be reset until it has cooled, no such differential exists with a plain bimetal. The described embodiments utilize a low number of component parts, as compared to conventional devices, and, even in those embodiments such as that of Figures 3A to 3M for example which employ relatively complex mouldings, are of simple construction leading to the promise of more readily achieved automatic assembly, and furthermore promise to be effective and efficient in long term operation by virtue inter alia of the elimination of the high stress levels that are normally present in conventional bistable bimetallic actuators and can lead to fatigue failure.

The embodiments and arrangements hereinbefore described are in all respects exemplary only and many modifications and variations will occur to those possessed of relevant skills without departure from

the scope of the invention.

It is considered that calibration of the arrangements hereinbefore described to suit specific applications might readily be achieved by corresponding selection and/or adjustment of the bimetal characteristics, but it would be possible, additionally or alternatively, to achieve calibration by provision of adjustable abutments defining the working conditions of the bimetal. Thus in the embodiment of Figures 1A to 1H for example, the abutment 14 and/or the members 12,13 defining back and front stops for the trip lever could be adjustable, for example by use of set screws in appropriate positions or by use of separately moulded and adjustably positionable click-fit moulding parts. A one piece moulding is advantageous from the viewpoint of simplicity and calibration by bimetal characteristics selection is perfectly feasible, but it is to be well understood that the invention extends to alternative means of achieving calibration.

The invention as described provides steam sensor and element protection units which can be used individually if required, and also can be combined together with the steam sensor plugging into the element protector or with an electrical lead or a mechanical movement transmitting device such as a Bowden cable operatively interconnecting the two. Whereas in the

embodiments described herein the steam sensor and the element protector each takes a specific form, the invention is capable of wider application and not only could various modifications be made to the embodiments described without departing from the scope of the invention, but also different forms of steam sensor and element protector units could be adapted to couple together in accordance with the teachings hereof. It is particularly to be noted that whilst it is convenient in the embodiments described herein that the steam sensor should connect into the element protector between an element cold tail and a leaf spring of the element protector, various alternative arrangements could be adopted for connecting the switch in the steam sensor in series with the switch in the element protector.

Reference may be made to our British Patent Application Nos. 9123639.8 (GB 2248519) and 9123640.6 (GB 2248520) which were divided out of the present application and which relate, respectively, to an arrangement, exemplified by Figures 5A to 5E hereof, wherein a steam sensor can be plugged into an element protector and an arrangement, exemplified by Figures 7 and 8 hereof, wherein a steam sensor located remotely from an element protector can operate an electrical switch within the element protector via a Bowden cable or other mechanical movement transmitting means.



CLAIMS:

1. A thermally responsive snap-acting bimetallic actuator mechanism for developing an operational movement in response to a temperature change, said
5 actuator mechanism comprising a moulded plastics material chassis, a bimetal blade, and a moulded plastics trip lever, the bimetal blade and the trip lever being pivotally mounted in series with each other between two spaced-apart opposed mountings
10 defined in said chassis so as to define a sprung overcentre bridge which is movable with a snap-action between two stable positions on opposite sides of an intermediate unstable position, the trip lever having one end portion which defines one end of the
15 overcentre bridge and is pivotally mounted with respect to said chassis at one of said mountings, the bimetal blade having one end portion which defines the other end of the overcentre bridge and is pivotally mounted with respect to said chassis at the other of
20 said mountings, the bimetal blade and the trip lever each having another end portion whereat the trip lever and the bimetal blade pivotally engage each other at an intermediate location in the overcentre bridge, and an abutment being provided in the chassis against



which the bimetal blade acts in its development of the force necessary for causing the overcentre bridge to move between its two stable positions, the arrangement of said overcentre bridge thereby being such that in
5 response to a predetermined temperature change the bimetal blade will itself develop the spring force necessary to cause the overcentre bridge to move overcentre with a snap-action, and such overcentre movement of the bridge involving relative pivotal
10 movement between the trip lever and the chassis which constitutes the operational movement of the actuator.

2. A thermally-responsive snap-acting bimetallic actuator as claimed in claim 1 wherein said abutment is adjustable.

15 3. A thermally-responsive snap-acting bimetallic actuator as claimed in claim 1 or 2 wherein the moulded plastics material chassis has abutment portions which define respective predetermined, stable, cold-condition and hot-condition positions of
20 said trip lever relative to said chassis, the actuator thereby being predeterminedly bistable.

4. A thermally-responsive snap-acting bimetallic actuator as claimed in claim 1 or 2 or 3 wherein that



end portion of the bimetal blade which pivotally engages the trip lever is pivotally received in a V-notch formed in the end of the trip-lever at said intermediate location in the overcentre bridge.

5 5. A thermally-responsive snap-acting bimetallic actuator as claimed in any one of the preceding claims wherein said one end portion of the bimetal blade is received in a V-notch pivotal mounting in the chassis.

10 6. A thermally-responsive snap-acting bimetallic actuator as claimed in any one of the preceding claims wherein the moulded plastics material trip lever is formed integrally with said moulded plastics material chassis and is pivotally mounted thereto by means of an integrally formed, flexible, plastics material
15 hinge portion.

20 7. A thermally-responsive snap-acting bimetallic actuator as claimed in any one of claims 1 to 5 wherein the moulded plastics material trip lever and the moulded plastics material chassis are pivotally mounted together by means of a knife-edge coupling.



8. A thermally-responsive snap-acting bimetallic actuator as claimed in any one of the preceding claims wherein the arrangement of the overcentre bridge in said two spaced-apart opposed mountings is compliant
5 for accommodating the overcentre movement of the overcentre bridge.

9. A thermally-responsive snap-acting bimetallic actuator as claimed in claim 8 wherein the required compliance is provided, at least in part, by virtue of
10 the plastics material of said chassis having an appropriate inherent flexibility.

10. A thermally-responsive snap-acting bimetallic actuator as claimed in claim 8 wherein the required compliance is provided by virtue of one of said
15 mountings being defined by a compliant spring metal element in said chassis.

11. A thermally-responsive snap-acting bimetallic actuator as claimed in any one of the preceding claims wherein the bimetal blade of the overcentre bridge is
20 not in itself snap-acting and comprises a plain rectangular bimetal blade.

12. An electrical switch comprising, in combination,



a thermally-responsive snap-acting bimetallic actuator as claimed in any one of the preceding claims and electrical switch components, the combination being such that the position of the overcentre bridge of the actuator determines the status of the electrical switch components.

13. An electrical switch as claimed in claim 12 wherein said moulded plastics material chassis defines a first compartment for accommodating said overcentre bridge and a second compartment for accommodating a switch sub-assembly including said switch components, the arrangement being such that when said overcentre bridge and said switch sub-assembly are installed in said compartments the trip lever of the bridge co-operates with said switch sub-assembly for switch operation.

14. An electrical switch as claimed in claim 13 wherein the trip-lever is formed with a switch-operating portion which extends into said second compartment and is arranged to co-operate with the switch sub-assembly for operating the switch.

15. An electrical switch as claimed in claim 13 or 14 and which includes an electrical terminal portion



adapted to co-operate with a complementary terminal in plug-and-socket fashion, switch terminals adapted to make electrical connections with said complementary terminal being provided in said terminal portion.

5 16. An electrical switch as claimed in claim 15 wherein the electrical terminal portion of the switch is formed as a plug-in portion adapted to be received in a complementary socket.

10 17. An electrical switch as claimed in claim 15 or 16 which is adapted for use as a steam-sensor with an electrically heated water boiling vessel and wherein said electrical terminal portion is adapted for co-operation with a complementary terminal of an element protector of the vessel which is provided for
15 switching off the supply of electricity to the vessel heating element in the event of a sensed element overtemperature condition, the action of connecting the electrical terminal portion of the steam-sensor to the complementary terminal of the element protector
20 being arranged to introduce the electrical switch circuitry of the steam sensor into a power supply line extending through the element protector.

18. A thermally-responsive bimetallic actuator, or an



electrical switch including such an actuator, substantially as herein described with reference to any of Figs. 1A to 1H, Figs. 2A to 2G, Figs 3A to 3M, Figs. 5A and 5B, Figs 7 and 8, and Figs. 9A and 9B of the accompanying drawings.

19. An electrically-heated water boiling vessel having an electrical switch as claimed in any one of claims 12 to 16 operatively associated with the electrically-powered heating element thereof.
- 10 20. An electrically-heated water boiling vessel as claimed in claim 19 wherein the said electrical switch is arranged to operate as a steam-sensor for determining the supply of electrical power to the heating element of the vessel when water boils in the vessel.
- 15
21. An electrically-heated water boiling vessel as claimed in claim 20 wherein an element protector is associated with the heating element of the vessel for switching off the supply of electrical power thereto in the event of the heating element overheating.
- 20
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