(12) UK Patent Application (19) GB (11) 2 112 208 A

(21) Application No **8235781**
(22) Date of filing **16 Dec 1982**
(30) Priority data
(31) **8137995**
(32) **16 Dec 1981**
(33) **United Kingdom (GB)**
(43) Application published
**13 Jul 1983**
(51) **INT CL³**
**A47J 27/21**
(52) Domestic classification
**H1N** 263 276 543 54X
555 700 704 708 740 744
DP
**U1S** 1736 1976 H1N
(56) Documents cited
**GBA 2061013**
**GBA 2023818**
**GB 1579494**
**GBA 2102205**
(58) Field of search
**H1N**
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# (54) Thermally-sensitive electrical controls for electric heaters

(57) A thermally-sensitive electrical control for an electric heater of a kettle or the like includes a thermally-sensitive bimetallic actuator 56 exposed in use to steam or vapour resulting from liquid in an associated container boiling. Operation of the actuator 56 trips an overcentre lever 45 which is coupled to an electrical switch means of the control such that the heater is deenergised automatically upon boiling. The lever 45 is biased into one of two stable positions by an overcentre spring 48 acting between a body 10 and the lever 45. The spring 48 is a combined double spring and includes two U-shape portions 80, 81 disposed in back-to-back relation which interconnect a pair of generally parallel arms, 82, 83, one arm 83 being common to both U-shaped portions 80, 81.

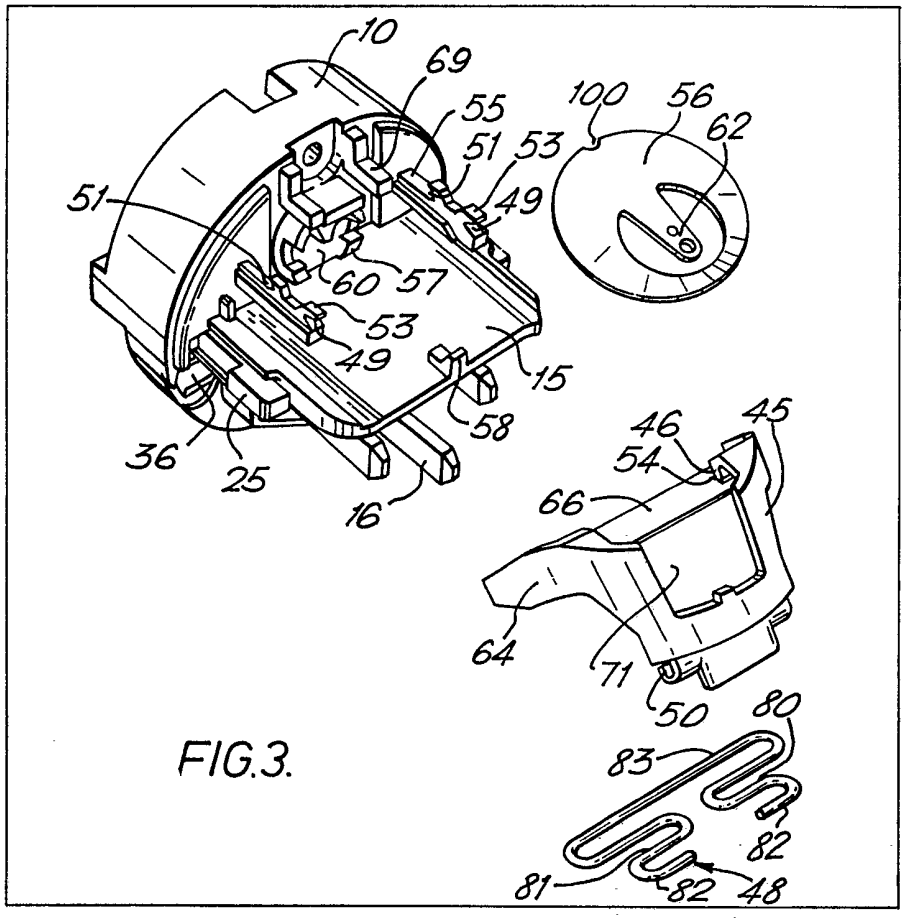


FIG.3.

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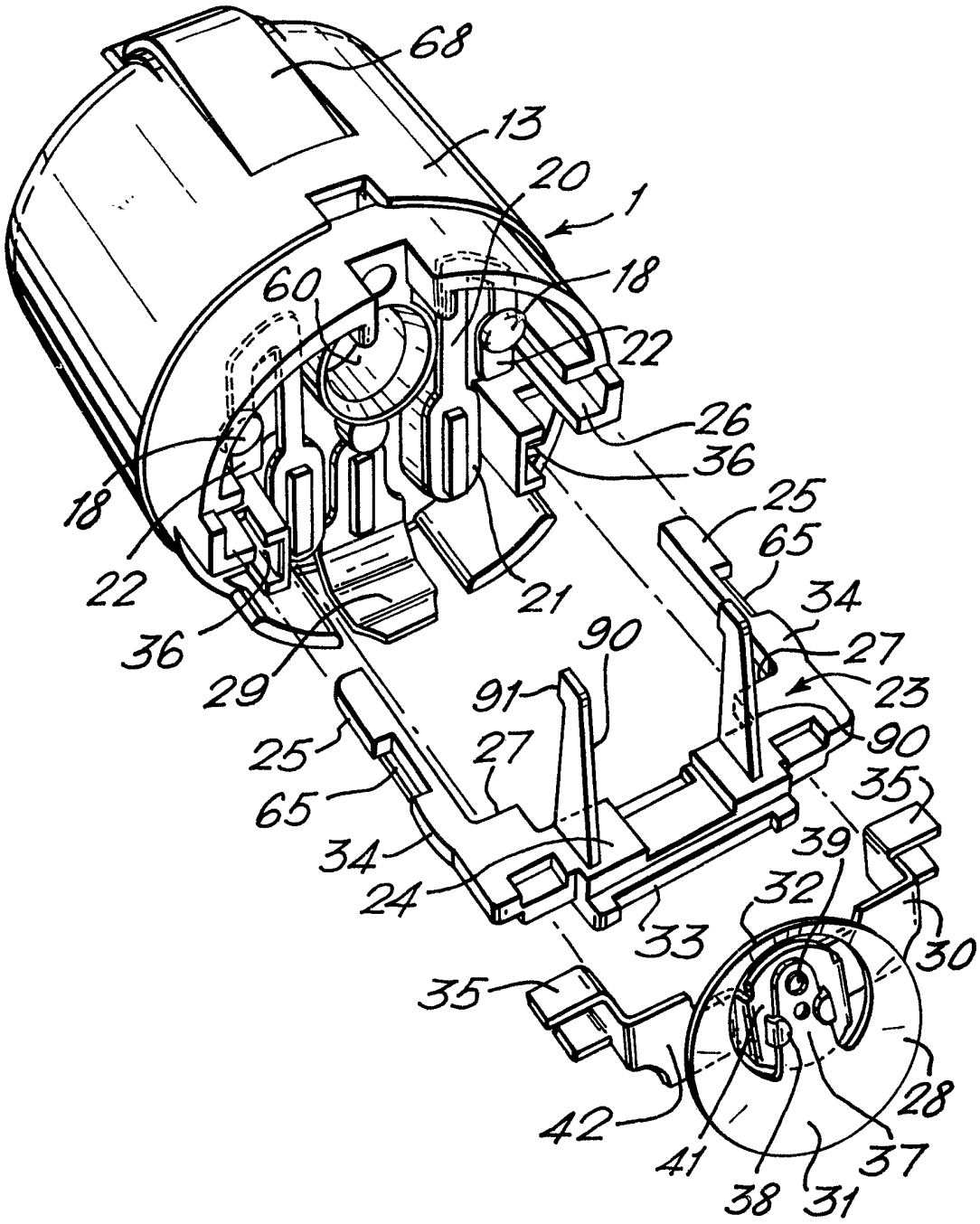
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FIG. 1.

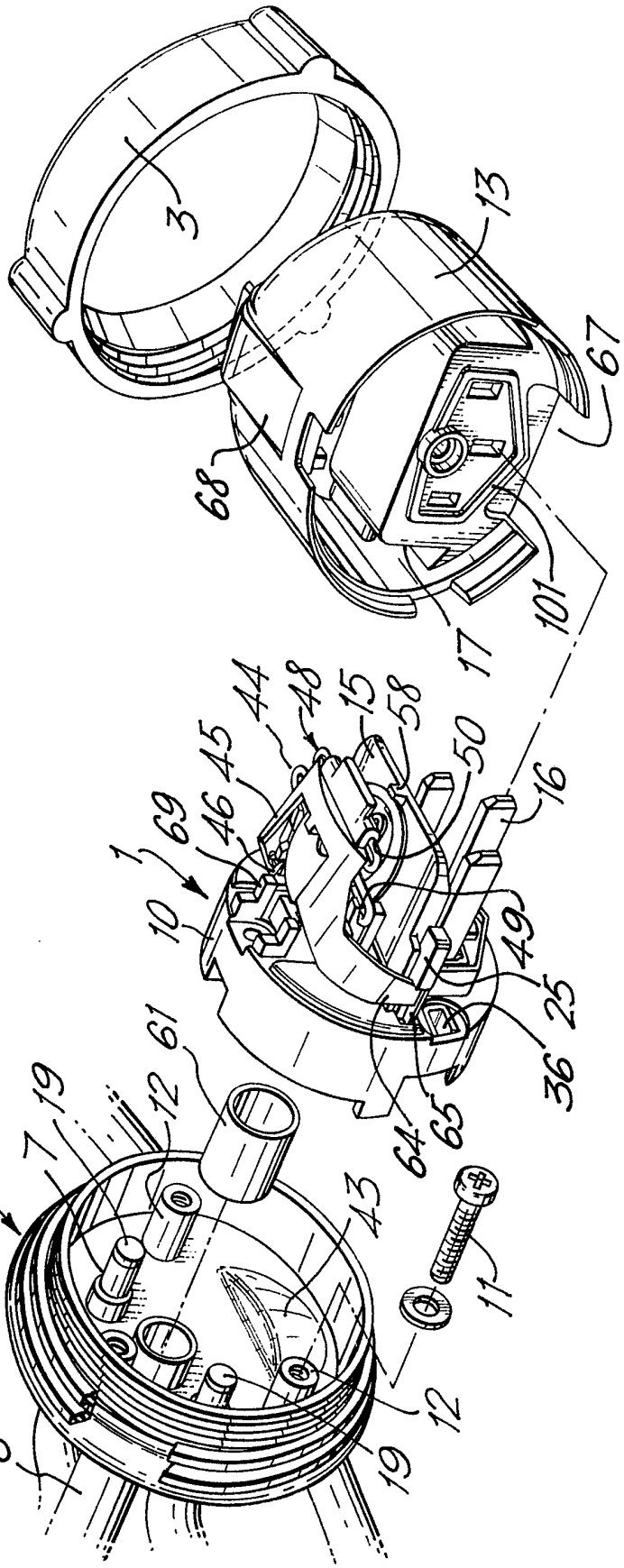
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FIG.2.

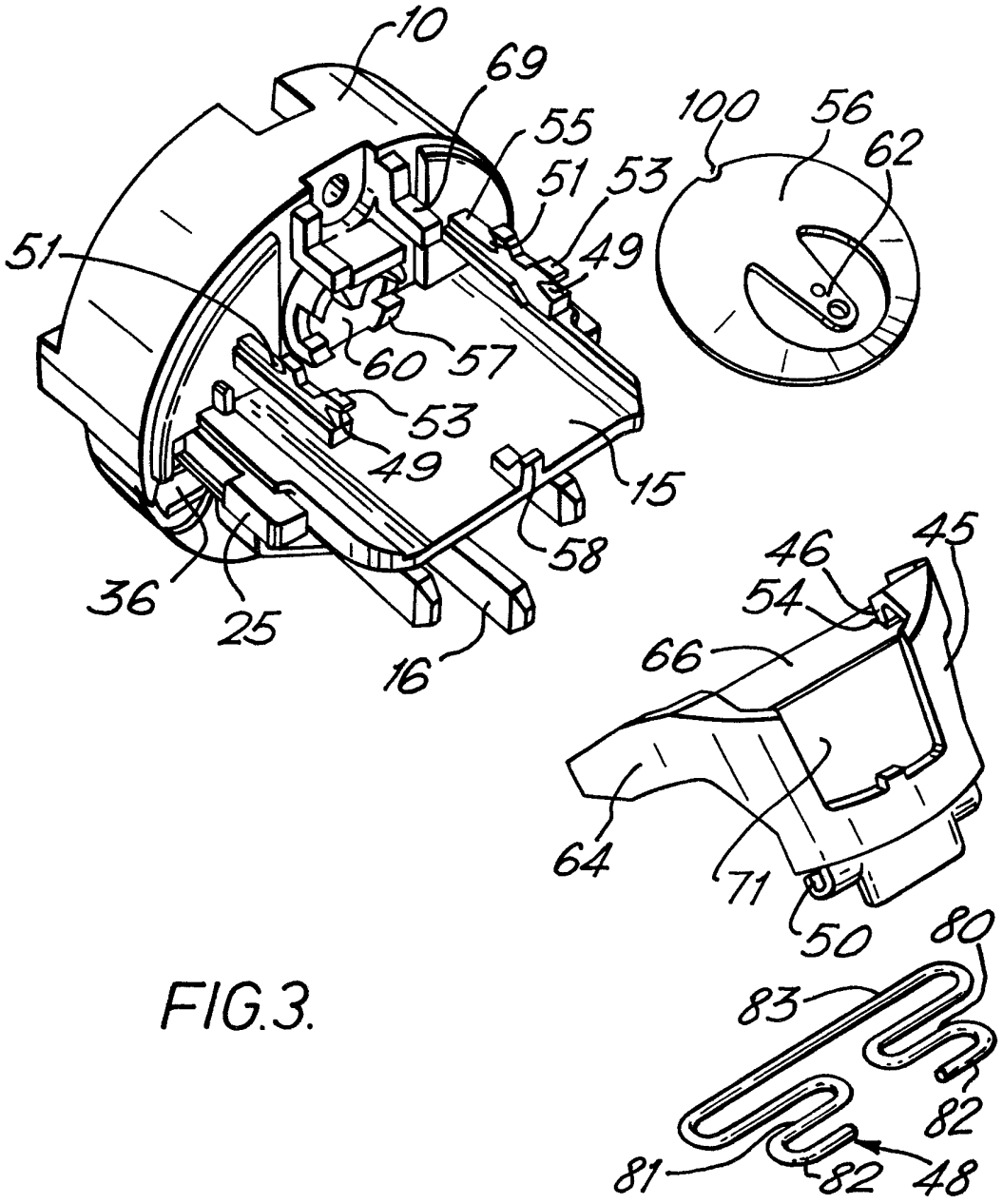
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FIG.3.

FIG.4.

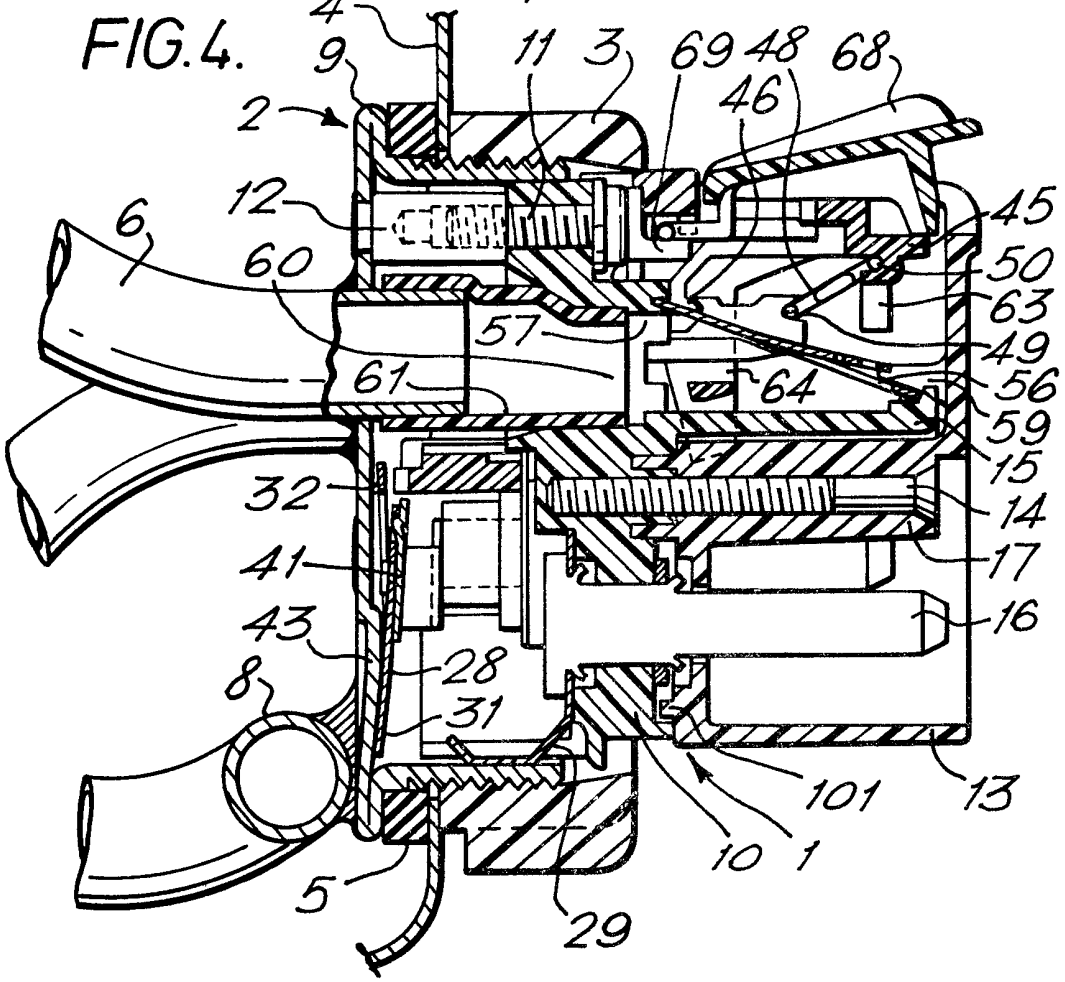
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FIG.5.

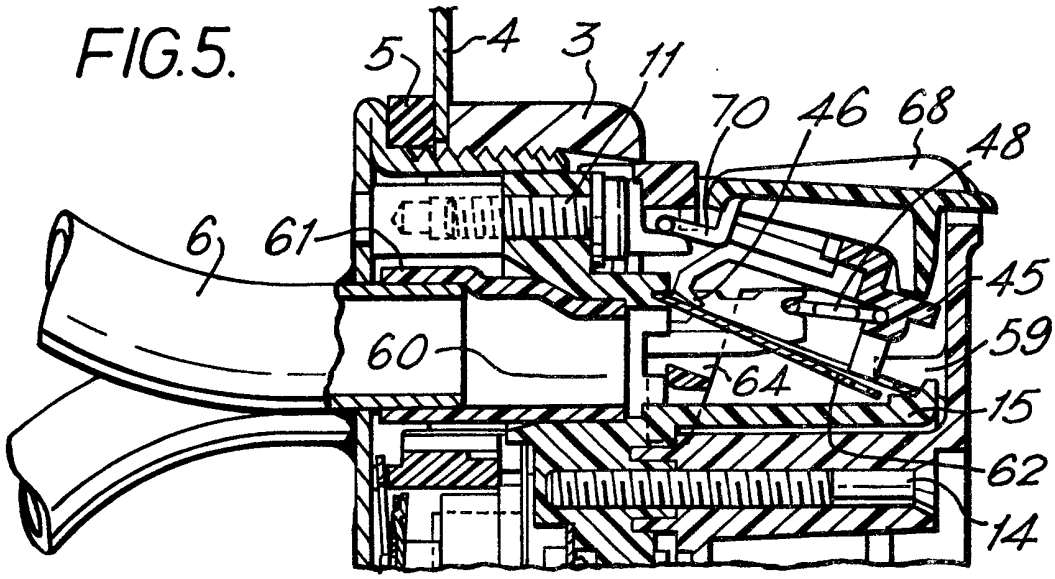
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FIG.6.

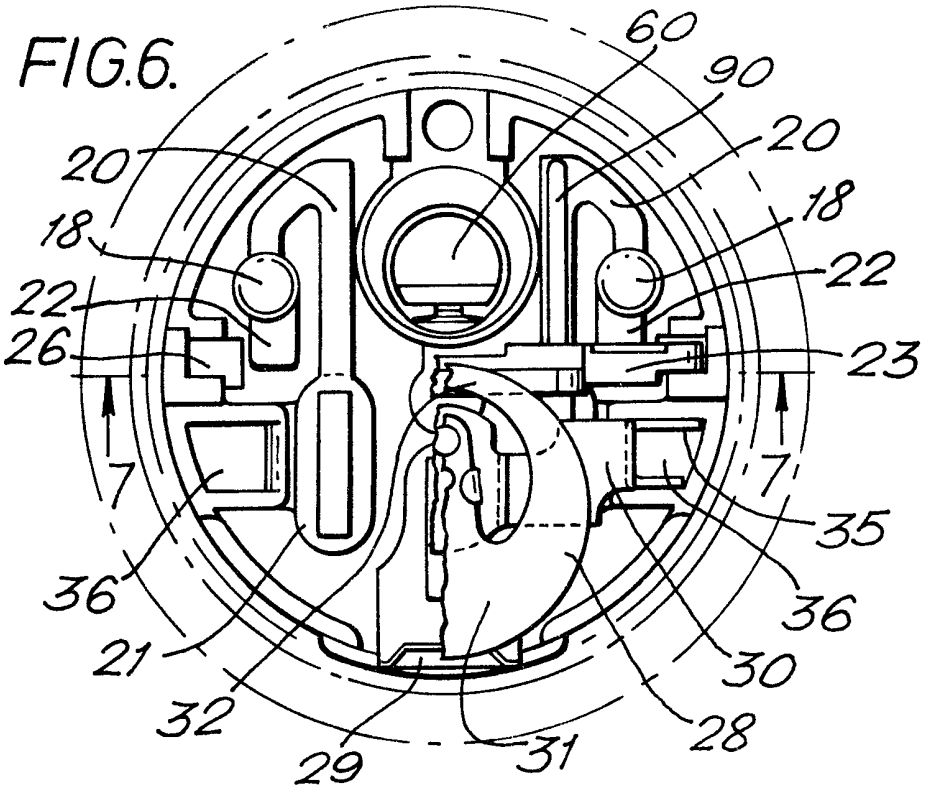
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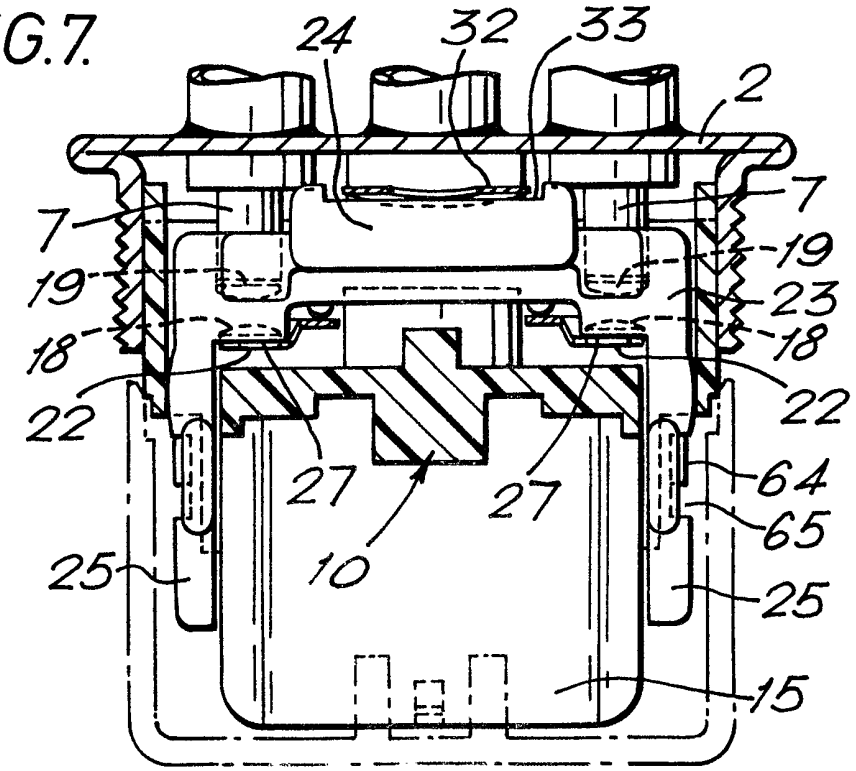
FIG.7.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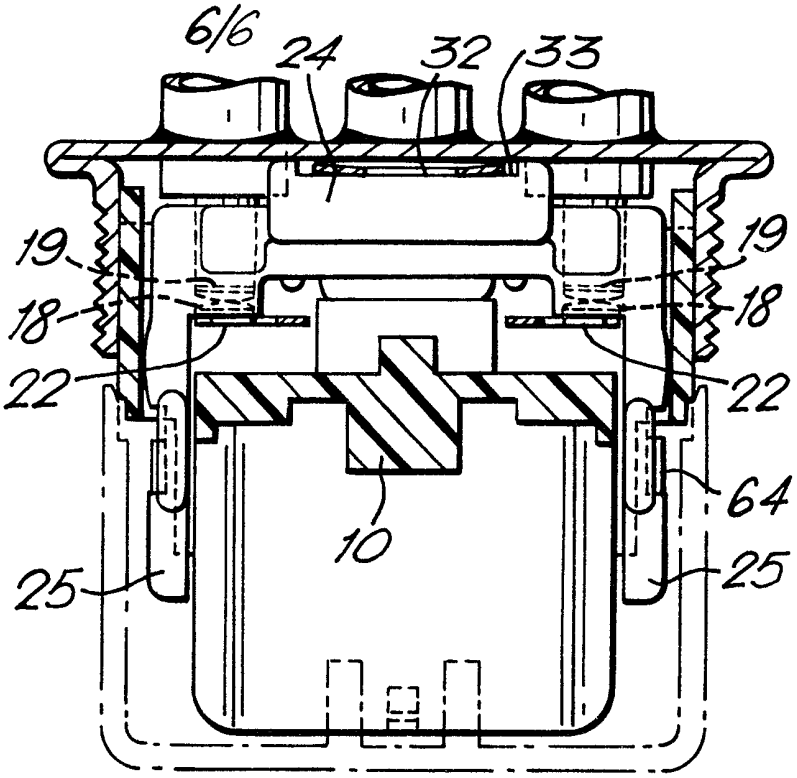


FIG.8.

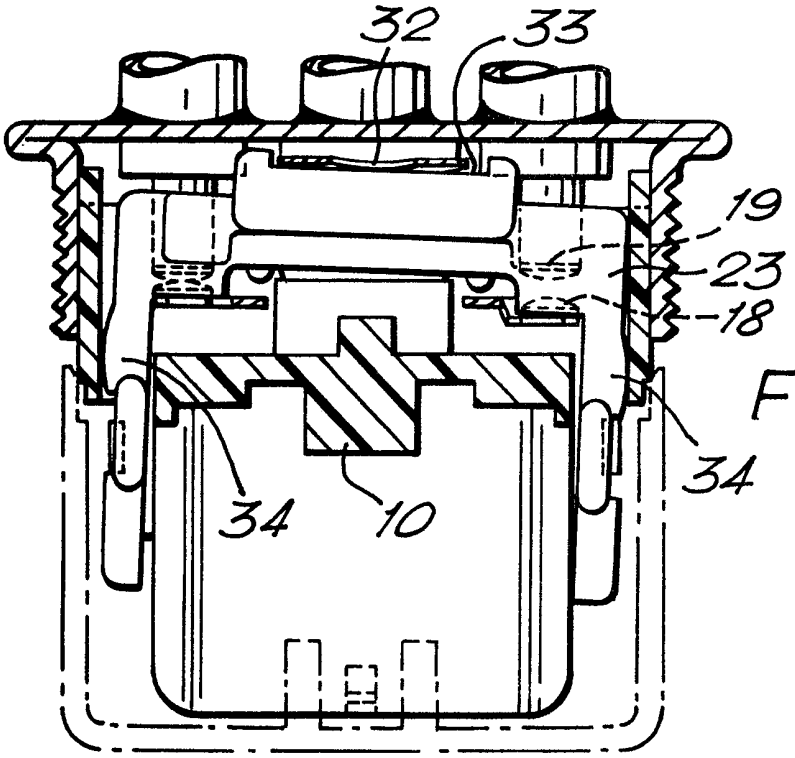


FIG.9.

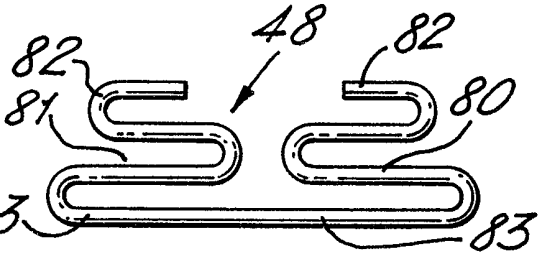


FIG.10.

SPECIFICATION

**Thermally-sensitive controls for electric heaters**

This invention relates to thermally-sensitive electrical controls for electric heaters of containers such as electric kettles, jugs, urns, pans, coffee percolators, laboratory equipment and the like (hereinafter called "containers of the kind referred to"). The electrical heaters of such containers may either be immersion heaters or similarly constructed heaters mounted externally of the container in good thermal contact with a wall thereof e.g. by being brazed to the underside of the container base. The heating elements of such heaters terminate in so-called cold leads by means of which electrical connections are made to the heater.

Thermally sensitive controls for such heaters are known which include electrical switch means actuable upon liquid within the container boiling to interrupt the power supply to the heater element. Such a control generally includes thermally responsive actuating means positioned for exposure in use to steam or vapour resulting from liquid within the container boiling and coupled to the breakable contacts of an electrical switch means by way of an overcentre spring mechanism. The overcentre mechanism generally includes a lever member which is spring biased so as to be movable between first and second stable positions, wherein the switch contacts are respectively open and closed, via an unstable dead-centre position.

Examples of controls incorporating such steam sensitive switching are described in British Patent Specification Nos. 1316436, 1470366 and 2042269. In these arrangements one or more generally 'C' or 'U' shaped springs are used to bias the overcentre lever member, the springs being formed from a spring strip material. Such springs are relatively high rate and therefore only suitable for use with overcentre mechanisms in which a relatively small angular movement and compression of the spring is involved as the lever member moves between its first and second stable positions. A further example is described in British Patent Specification No. 2061013 in which a generally 'Z' shaped wire spring is used; this spring is of lower rate than the C-springs described above and can therefore adequately accommodate a larger angular movement and compression. However, the geometry of the spring is such that during compression thereof the horizontal arms of the Z are displaced laterally relative to one another. This can lead to unwanted lateral forces being induced within the over-centre mechanism which in turn can lead to unreliable operation of the steam sensitive control and could be particularly troublesome if as is known the spring force is also used to maintain the pivotal mounting of the lever member.

According to the invention there is provided a thermally-sensitive electrical control for an electric heater of a container of the kind referred to, said control including thermally responsive actuating means exposed in use of the control to steam or vapour resulting from liquid within the container boiling and an overcentre spring mechanism coupling the actuating means to an electrical switch means, the overcentre mechanism being movable upon operation of the actuating means from a first stable position wherein the switch means is closed and power can be supplied to the heater and a second stable position wherein the switch means is open and the power supply to the heater is interrupted, the overcentre mechanism comprising a pivotally mounted lever member and at least one spring acting on the lever member, wherein the or each spring is a wire spring and includes two arms which with the spring mounted in the control are generally parallel and are interconnected by a generally 'V' or 'U' shaped portion in the plane of and disposed between the parallel arms.

The wire spring provided in a control according to the invention can be of lower rate than the 'U' or 'C' shaped springs of spring strip material used heretofore and as such can accommodate larger angular movement and compression as the lever member moves between its stable positions. Furthermore, the geometry of the spring is such that there is no substantial lateral displacement between the arms during compression and therefore no substantial lateral forces are induced. Thus, the general restraints previously imposed on the design of the overcentre mechanism concerning the mounting and movement of the lever member are relaxed.

The lever member may be conveniently pivotally mounted by means of a pair of spaced knife edges thereof which rest in a pair of notches formed in part of the control, the knife edges being retained within the notches by the action of the spring. In this arrangement, a combined double spring is advantageously provided one arm being common to both springs so that the two substantially 'V' or 'U' shaped portions at either end thereof are disposed in back-to-back relation. The symmetrical configuration of such a double spring results in increased stability of the lever member and ensures that the knife edges thereof are correctly retained in position within the respective notches.

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is an exploded perspective view of a control in accordance with the invention taken from the side of the control which is adapted to be secured to an immersion heater head.

Figure 2 is an exploded perspective view of the control illustrated in Figure 1 taken from the opposite side of the control and showing an immersion heater head.

Figure 3 is a perspective view similar to Figure 2 with certain parts of the control removed.

Figure 4 is a cross-sectional view taken from one side of the control of Figures 1 to 3 mounted to the head of an immersion heater showing the overcentre spring mechanism in the deactivated

position.

Figure 5 is a view similar to Figure 4 but showing the overcentre mechanism in the operational position.

Figure 6 is an elevational view, partly broken away, of the end of the control adapted to be secured to the immersion heater head.

Figure 7 is a cross-sectional view taken along line 7—7 in Figure 6 showing the switch contacts open.

Figure 8 is a view similar to Figure 7 but showing the switch contacts closed.

Figure 9 is a view similar to Figures 7 and 8 but showing one contact open and one closed.

Figure 10 is a plan view of the over centre spring for the control illustrated in Figures 1 to 9.

Referring firstly to Figures 1 to 5, a thermally-sensitive control 1 is mounted on the head 2 of an electric immersion heater. The cup-like head 2 is retained in a water-tight manner in an opening formed in the wall 4 of an associated container by means of an externally threaded retaining ring 3 which urges a peripheral flange 9 of the head 2 against the inside of the wall 4 compressing a resilient O-ring seal 5 therebetween as shown in Figure 4. The immersion heater head 2 carries a tube 6 for the egress of steam from the interior of the container which tube is brazed to the head and extends, in use, above water level within the container. The immersion heater comprises two cold leads 7 and a hot return 8 which passes underneath the cold leads 7 and is brazed to the head 2 so as to be in good thermal contact therewith. The low position of the hot return 8 enables the container to boil small quantities of liquid if desired.

The control 1 comprises a body portion 10 of thermo-plastic material, mounted snugly within the head 2 by means of three bolts 11 which engage threaded female studs 12 brazed to the inside of the head, and a cover member 13 which is secured to the body portion 10 by means of a single central fixing bolt 14. The body portion 10 includes a horizontal shelf member 15 which lies close to the central longitudinal axial plane of the control 1 and defines at the side of the body portion remote from the head, upper and lower segmental volumes of the control lying respectively above and below the central horizontal axial plane of the control. Three terminal pins 16 are secured to and extend through the body portion 10 and include a live pin, a neutral pin and an earth pin for connection to a female socket connector to supply mains electrical power to the heating element. The end portions of the pins 16, which extend parallel to and are disposed below the shelf member 15, are arranged in a triangular relationship with the central or earth pin lying below the live and neutral pins. The cover member 15 defines a shroud 17 which surrounds the pins 16 and is shaped so as to snugly receive a standard socket connector.

The live and neutral pins are each connected to a respective cold lead 7 via a pair of breakable contacts, each pair including a movable contact 18 and a stationary contact 19 mounted directly to a respective cold lead 7. The stationary contacts 19 may be mounted to the cold leads 7 by means of cylindrical spring clips to which the contacts 19 are secured and which are simply pushed over the ends of the cold leads. The movable contacts 18 are mounted towards the free ends 22 of respective generally 'U'-shaped leaf springs 20 formed form resilient metallic strip material. The leaf springs 20 extend upwardly adjacent the side of the body portion 10 facing the head from the bases of the respective live and neutral terminal pins and are secured thereto by means of apertured base portions 21 of the leaf springs 20 which surround the base portions of the pins. During normal operation of the heater, the leaf springs 20 urge the movable contacts 18 against the respective stationary contacts 19 and electrical power may be supplied from the live and neutral terminal pins to the element. The earth pin, by virtue of its disposition towards the outer periphery of the control, is conveniently electrically connected with the head 2 by means of a metallic spring clip 29 which is secured to the base of the pin and directly engages the inside of the head 2.

A generally 'U' shaped link member 23 of moulded plastics material lies in a horizontal plane of the control slightly below the switch contacts 18, 19 and includes a transverse arm 24 disposed between the body portion 10 and the head 2, beneath the contacts, and to spaced longitudinal arms 25. The longitudinal arms 25 extend through the body portion 10 and are slidably mounted in axially directed channels 26 formed on either side of the body portion 10 close to the outer periphery thereof. The transverse arm 24 of the link member 23 includes two stepped abutments 27 at either end thereof adjacent the longitudinal arms 25 which abutments 27 are adapted to engage respective free ends 22 of the leaf springs 20 whereby movement of the link member 23 in a direction away from the head 2 causes the free ends 22 of the springs 20 and the respective movable contacts 18 to be displaced in a direction away from the head 2 thereby opening the contacts and interrupting the power supply to the heater.

In addition, two vertical abutment arms 90 extend upwardly from the link member transverse arm 24 which are provided with abutment surfaces 91 adapted for engagement with the uppermost portions of the respective leaf springs 20. Upon displacement of the link member 24 away from the head, the abutment surfaces 91 engage the leaf springs slightly after engagement thereof by the abutments 27 and urge the contacts further apart.

A first thermally responsive actuating means comprises a snap-action bimetallic actuator 28 of the sort described in British Patent Specification No. 1,542,252. The bimetallic actuator 28 is mounted on a stainless steel bridge member 30 as described in more detail below and overlies the bases of the terminal pins 16. A lower peripheral

portion 31 of the actuator 28 is held in good thermal contact with wedge-shaped protrusion 43 formed on the inside of the head 2 towards the bottom thereof adjacent to the point where the hot return 8 of the element is welded thereto, and an upper bridge portion 32 of the actuator 28 is adapted for engagement with a central abutment surface 33 formed on the 'U'-shaped link member 23. The actuator 28 is calibrated with a nominal operating temperature of 140°C so as to undergo snap action when the element overheats. Thus, when the element overheats after for example having been switched on dry, the actuator 28 reverses its curvature by snap-action whereupon the bridge portion 32 engages and moves rightwardly, i.e. away from the head, the link member 23 which in turn pushes the movable contacts 18 away from the stationary contacts 19 as shown in Figure7 so as to cut off the power supply to the heating element.

A safety feature of the preferred control arises from the fact that the 'U'-shaped link member 23 in addition to being slidable in a substantially axial direction is pivotable to a limited extend in its horizontal plane about a vertical axis. Such pivotal movement is accommodated by the outer edges of the longitudinal arms 25 of the link member 23 being contoured within the channels 26 so as to define curved surfaces 34 which abut the outer wall of respective channels 26 therebeing a lateral clearance between the major part of the edges of the arms 25 and the channels 26. Thus, in the event of either pair of contacts 18, 19 becoming welded together after an extended period of use, upon operation of the actuator 28 engagement of the bridge portion 32 thereof with the abutment surface 33 of the link member 23 will cause the link member 23 to pivot about the welded-together pair of contacts and open the remaining pair as shown in Figure 9 thereby de-energising the heater.

The stainless steel resilient bridge member 30, includes a pair of spaced lateral flanges 35 projecting from each side thereof which fit snugly within respective generally rectangular apertures 36 formed at either side of the body portion 10 and through which the lowermost two of the body portion mounting bolts 11 extend. As the bolts 11 are tightened, the flanges 36 bear directly against the respective female studs 12 of the head and are firmly clamped between the heads of the respective bolts 11 and the studs 12 within the apertures 36.

The bimetallic actuator 28 is mounted to the bridge member 30 by means of its tongue 37 which passes between two folded-over ears 38 of the bridge member 30 and over a folded-up ramp 39 thereof which enters an aperture in the tongue 37. The portion 41 of the bridge member 30 which carries the bimetallic actuator 28 is longitudinally offset from the side arms 42 of the bridge member so as to provide necessary clearance between the periphery of the actuator and the bridge member for the actuator to reverse its curvature by snap-action and to permit the necessary movement of the bridge portion 32 of the actuator. In addition, as seen most clearly in Figure 4, the portion 41 which carries the ears 38 and the ramp 39 is at an acute angle to the vertical wall of the head 2 so as to ensure that lower peripheral portion 31 of the actuator 28 is in intimate contact with the protrusion 43.

The overcentre spring mechanism 44 is disposed above the shelf member 15 on the side of the body portion remote from the element head i.e. above the axial horizontal plane of the control. The mechanism 44 includes a lever member 45 having a generally semi-cylindrical profile so as to fit snugly within the upper segmental space of the control. The lever member 45 is pivotably mounted to the body portion by means of two knife edges 46 formed integrally with the member 45 which engage in respective pivot notches 51 formed respectively in spaced arms 47 extending from the body portion 10 in a direction parallel to the shelf member 15. An overcentre spring 48 extends between notches 49 formed at the free ends of the arms 47 and notches 50 formed in the lever member 45 in the end thereof remote from the knife edges 46 and biases the knife edges 46 into engagement with the pivot notches 51. As illustrated in Figure 10, the wire spring 48 is a combined double spring and includes two U-shaped portions 80, 81 disposed in back-to-back relation. Each U-shaped portion interconnects a pair of generally parallel arms 82, 83 one of which arm 83 is common to both U-shaped portions. The spring imparts a symmetrical biasing force on the lever member 45 and is sufficiently low rate to adequately accommodate the pivotal movement of the member 45. The lever member 45 is pivotable between a first stable position as shown in Figure 5 wherein a lower surface of the lever member 45 engages stops 53 formed on the free ends of the arms 53 and a second stable position shown in Figure 4. In moving from the first stable position to the second, the lever member 45 passes through an unstable dead centre position in which the spring notches 49, 50 and the knife edges 46 all lie in a common horizontal plane.

A bimetallic actuator 56 similar to the actuator 28, but having a nominal operating temperature of 80°C is located below the lever member 45 and lies at an acute angle to the shelf member 15 between the arms 47 which engage the outer periphery of the actuator 56 and serve to locate the actuator laterally. The base of the actuator 56 rests on support members 56 of the body portion and is retained longitudinally by a projection 58 at the end of the shelf member which abuts the bridge portion of the actuator 56. A small cut-out 100 is provided on the actuator which is engaged by a small projection on the control to prevail rotation of the actuator. During assembly, the actuator is simply dropped into position and is later secured in place when the cover member 13 is mounted by means of flanges 59 thereof which extend over the bridge portion of the actuator 56 thereby clamping it to the shelf member 15. Thus the actuator 56 may conveniently be replaced

during testing if it malfunctions in some way.

Steam or vapour resulting from liquid within the container boiling is transmitted to the actuator 56 via an aperture 60 formed in the body portion 10. The steam tube 6 is sealed to the aperture 60 by means of a silicone rubber sleve 61 one end of which is stretched over the end of the tube 6 and the other end of which is pushed into the aperture 60. The upper wall of the aperture 60 is upwardly tapered at the side adjacent the head. The lower wall however has no such taper as it has been found that this can result in condensed liquid collecting at adjacent the tube outlet which in turn can lead to blocking of the tube.

Upon liquid within the container boiling, steam or vapour impinges on the steam sensitive bimetallic actuator 56 which then reverses its curvature by snap-action so that its tongue 62 engages and bears upwardly against a post 63 extending downwardly from the lever member 45 thus tripping the lever member 45 from its first stable position to its second stable position. The lever member 45 includes two downwardly projecting legs 64 which extend either side of the shelf member 15 and terminate within notches 65 formed in the longitudinal arms 25 of the 'U'-shaped link member 23. A strengthening bridge 66 extends between the legs 64 and passes between the body portion arms 47 and shelf member 15. Thus, upon the lever member 45 being tripped form its first stable position to its second stable position the legs 64 thereof engage the ends of the notches 65 and pull the link member 23 rightwardly away from the element head and open the switch contacts as described above. The effect is that when the liquid within the container boils the actuator 56 trips the lever member 45 from its first to its second position thereby opening the switch contacts and de-energising the heating element.

As described above, the steam or vapour is shielded from the electrical components on the side of the body portion facing the head by means, of the resilient sleeve 61. On the lower side of the body portion, the terminal pins 16 are shielded from steam and from condensed liquid by the shelf member 15 and by the cover member shroud 17. Liquid condensing on the shelf member 15 runs off the member at each side into a peripheral passage defined between the shroud 17 and the outer wall of the cover member 13. An aperture 67 is provided at the base of the cover member to allow condensed liquid within the peripheral passage to drain out of the control. The shroud forming portion of the cover member cooperates with the body portion to form a capillary seal 101 therebetween to prevent liquid seeping into contact with the terminal pins.

A knob 68 is pivotably mounted above the lever member 45 for manually resetting the control after the overcentre mechanism has been tripped as a result of liquid within the container boiling. The knob 68 is mounted by means of a flange 70 thereof which is held between a shoulder 69 projecting from the body portion and part of the cover member. When the knob 68 is pressed downwardly, the lever member 45 is returned to its first position thus allowing the movable contacts 18 to move into contact with the respective stationary contacts 19 and the electrical power suply to the element can be resumed.

Upon movement of the link member due to operation of the switch-on-dry sensitive actuator 28, the lever member is tripped slightly after the contacts are opened. Thus, if an attempt is made to energise the heater with no liquid in the container by manually holding the knob in the closed position, the actuator 28 will cycle causing the contacts to open and close thus preventing serious overheating of the element.

The embodiment of the control illustrated herein is particularly suitable for sale ready-mounted to an immersion heater carrying a steam tube as a replacement element for home-fitting. However, the control may be readily adapted for use with different containers and immersion heaters. For example, the steam tube might be emitted and the control adapted to receive steam from above. In this case, the steam aperture 60 of the body portion 10 would simply be blocked and the steam would be introduced to the actuator 56 from above via a cut-away portion 70 at the top of the lever member 45.

CLAIMS

1. A thermally-sensitive electrical control for an electric heater of a container of the kind referred to, said control including thermally responsive actuating means exposed in use of the control to steam or vapour resulting from liquid within the container boiling and an overcentre spring mechanism coupling the actuating means to an electrical switch means, the overcentre mechanism being movable upon operation of the actuating means from a first stable position wherein the switch means is closed and power can be supplied to the heater and a second stable position wherein the switch means is open and the power supply to the heater is interrupted, the overcentre mechanism comprising a pivotally mounted lever member and at least one spring acting on the lever member, wherein the or each spring is a wire spring and includes two arms which with the spring mounted in the control are generally parallel and are interconnected by a generally 'V' or 'U' shaped portion in the plane of and disposed between the parallel arms.

2. A thermally-sensitive electrical control as claimed in claim 1 wherein said lever member is mounted by means of a pair of spaced knife edges thereof which rest in respective notches formed in part of the control, the knife edges being retained within the notches by the action of the spring.

3. A thermally-sensitive electrical control as claimed in claim 1 or 2 including a combined double spring, one arm being common to both

springs such that two substantially 'V' or 'U' shaped portions at either end thereof are disposed in back-to-back relation.

4. A thermally-sensitive electrical control substantially as herein described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.