

Thermally-sensitive controls for
electric immersion heaters

This invention relates to thermally-sensitive electrical controls for electric immersion heaters of containers such as electric kettles, jugs, urns, pans, coffee percolators, laboratory equipment
5 and the like. Such immersion heaters generally comprise a heating element carried by a head which is adapted to be secured in a watertight manner in or adjacent an opening in a wall of the container. Conventionally, the heating elements of such assemblies
10 terminate in so-called cold leads by means of which electrical connections are made to the heater. Such immersion heaters are referred to hereinafter as "immersion heaters of the kind described".

Thermally-sensitive electrical controls for
15 immersion heaters of the kind described are well known and generally comprise electrical switch means adapted and arranged to make electrical contact with the cold leads of the heater and effective in use to interrupt the power supply and thus disable
20 the heater when the liquid within the container boils or when the element overheats consequent upon, for example, having been switched on with insufficient liquid within the container to cover the element.

25 An example of an immersion heater provided with a thermally-sensitive control of this type is described in British Patent Specification No. 1470366 in which the control mounted externally on the container is clamped to the immersion heater head
30 after the head has been positioned adjacent the container opening. The control includes an electrical switch operable to disable the heater, there being first and second thermally-responsive actuating means coupled to the switch, the first being mounted

in good thermal contact with the heater head opposite a hot return of the element and the second being mounted adjacent a steam outlet aperture formed in the container wall above the level of the liquid therein. Thus, the first actuating means is operable to break the switch contacts upon the element overheating, and the second actuating means, which is coupled to the switch by means of an overcentre spring mechanism, is operable to open the switch contacts upon boiling.

Arrangements such as this have several drawbacks. Firstly, the container and control are specifically adapted for use one with the other, and therefore only a certain type of container may be accommodated by a particular combination of control and heater. Secondly, the requirement of a thermally responsive actuating means adjacent an opening in the upper part of the container wall and the associated overcentre spring mechanism is such that the control is not particularly compact in construction and is relatively bulky in appearance. Finally, the control must be secured to the element head from outside the container after the head has been appropriately positioned adjacent the opening in the container wall, and the control is therefore unsuitable for use in conjunction with a universal replacement heater adapted for user fitting to a wide range of containers.

A thermally sensitive control which may be used with a wider range of containers is described in British Patent Specification No. 2042269. This arrangement includes a switch-on-dry protection switch unit and a separate steam sensitive unit adapted to be mounted to the protector switch unit with a mechanical link therebetween. In this arrangement, the steam sensitive unit may be adapted for use with an immersion heater carrying a tube for the egress of steam from the interior of the kettle,

which tube passes through the immersion heater head, or alternatively with a container having a channel or passage formed at one side thereof for the transfer of steam to the control. However, 5 although this control is considerable compacter than the prior art control discussed above, it is still necessary to mount the steam sensitive unit after the element head has been secured in the container opening.

10 A further disadvantage with the above and other similar controls is that an external cover is required which is mounted after the heater and control have been secured to a container. Generally, such covers have to be especially adapted for use 15 with a particular container, and therefore even though a particular heater and associated control might be suitable for use with a number of containers, it is often necessary to design different covers depending on the size and shape of the container 20 concerned.

A thermally-sensitive control which goes some way to overcoming these drawbacks is described in British Patent Specification No. 1415843, and in this control all the parts of the control are 25 of less radial extent than a perimetric portion of the immersion heater head to which the control is mounted so as to be passable through the opening in the container wall from inside the container. Thus, the assembly of immersion heater and control 30 is mountable in the wall of the container without having to disconnect and reconnect any of its operative parts and this is convenient from the container manufacturers point of view and also renders the control inherently suitable for sale to the user 35 as a replacement element by means of which, for example, a non-automatic electric kettle may be converted to one which is automatically switched off when the water boils.

However, in the illustrated embodiment of the invention described in British Patent Specification No. 1415843 a power cable is permanently connected to the control, and moreover the arrangement of
5 the various components requires that the control is relatively elongate. Experience shows that the provision of a detachable socket connector is highly desirable, particularly in the case of relatively portable containers such as kettles
10 and in the prior art arrangement the provision of terminal pins would result in a longitudinal extension of the control since the radial extent could not be increased having regard to the need of the control to be inserted through the container
15 wall opening, and in practical terms such an increase in length would not be acceptable.

A thermally sensitive control intended to overcome the aforesaid disadvantages is described in British Patent Specification No. 2112209. This
20 control is likewise mountable on the head of an immersion heater and has an outer periphery of less radial extent than a peripheral portion of the head so as to be passable through the opening in the wall of an associated container whereby
25 the head may be positioned in or adjacent the opening with the control mounted thereon by insertion of the control through the opening from inside the container. The control comprises a body portion mounting thereon electrical switch means effective
30 to interrupt the power supply to the element and responsive to first and second thermally responsive actuating means respectively operable upon the element overheating and upon liquid in the container boiling, the second actuating means being coupled
35 to the switch means through an over-centre spring mechanism and being exposed to steam or vapour resulting from liquid within the container boiling. The control further comprises terminal pins adapted

to be engaged by a separate socket connector for connecting the element via the switch means to a source of electrical power. The various components are arranged such that the switch means and first
5 actuating means are disposed on the side of the body portion which in use faces the element head, whilst the over-centre spring mechanism and second actuating means are mounted to the other side of the body portion on one side of a generally axial
10 plane of the control, the free end portions of the terminal pins being disposed to the other side of the generally axial plane opposite the over-centre spring mechanism and the second actuating means.

15 This general configuration provides an extremely compact control incorporating both switch-on dry protection and steam sensitive switching, together with terminal pins for a separate detachable socket connector. The arrangement is such that the control
20 may be mounted to the head of an immersion heater prior to securing the head, with the control mounted thereto, in or adjacent a container opening. Thus, this control is advantageous in that a reduction in the overall bulkiness of the control is achieved
25 together with ease of fitting.

 In the illustrated embodiment of the invention described in British Patent Specification No. 2112209, the switch means includes two sets of contacts which are independently breakable in response
30 to operation of the first or second thermally responsive actuating means, each contact set including a stationary contact mounted directly to a respective cold lead of the immersion heater. The contacts are coupled to the first actuating means and to the over-centre
35 spring mechanism by means of a push-pull link member slideably mounted to the body portion, the first actuating means being clamped between the body portion and the element head and acting directly

on the link member. A practical difficulty with this configuration is that very close tolerances have to be maintained for the link member to operate successfully to open the switch contacts, and since
5 the stationary switching contacts are mounted directly to the cold leads of the heater, close tolerances are not only involved in the manufacture of the control but are also required in the manufacture of the associated immersion heater. Whilst the
10 close tolerances involved may be acceptable to a manufacturer of thermally-sensitive controls, they may be difficult to achieve with traditional methods of manufacturing immersion heaters.

It follows with the preferred control illustrated
15 in British Patent Specification No. 2112209 that since the stationary switching contacts of the switch means are mounted directly to the cold leads of the element final testing of a control cannot be carried out until it is mounted to an immersion
20 heater and it is therefore not possible for a control manufacturer to supply fully precalibrated and tested controls separately from immersion heaters.

Furthermore, in the preferred control illustrated in Specification 2,112,209, having regard to the
25 direct mounting of the stationary contacts to the cold leads the movable contacts are mounted externally to the side of the body portion of the control which in use faces the heater head so as to be appropriately positioned for engagement with the
30 stationary contacts when the control is mounted to a heater head. Thus, the movable contacts and associated parts of the electrical switch means of the control are exposed and thus vulnerable to damaging when the control is not assembled to
35 a heater, and this further renders the control unsuitable for supply separately from immersion heaters.

Immersion heaters and their electrical controls require very different manufacturing techniques and skills. In practice it is unlikely that both products will be made by a single manufacturer.

5 Consequently a manufacturer of the preferred control described in Specification 2112209 will in general need to acquire immersion heaters from an independent source and will supply the assembled and tested heater and control to the customer for example
10 a kettle manufacturer or a retailer if the assembly is to be sold for replacement or conversion purposes. Aside from the possible difficulty for the control manufacturer in securing a supply of immersion heaters meeting the required manufacturing tolerances,
15 the bodily shipment of immersion heater firstly to the control manufacture and thereafter with control to the customer will in certain circumstances impose significant financial penalties. The electrical controls in question are as compared with immersion
20 heaters compact and light and can thus be economically transported over long distances; the same does not apply to immersion heaters either alone or assembled to electrical controls. Thus in certain commercial situations the preferred control described
25 in Specification No. 2112209 is not suitable.

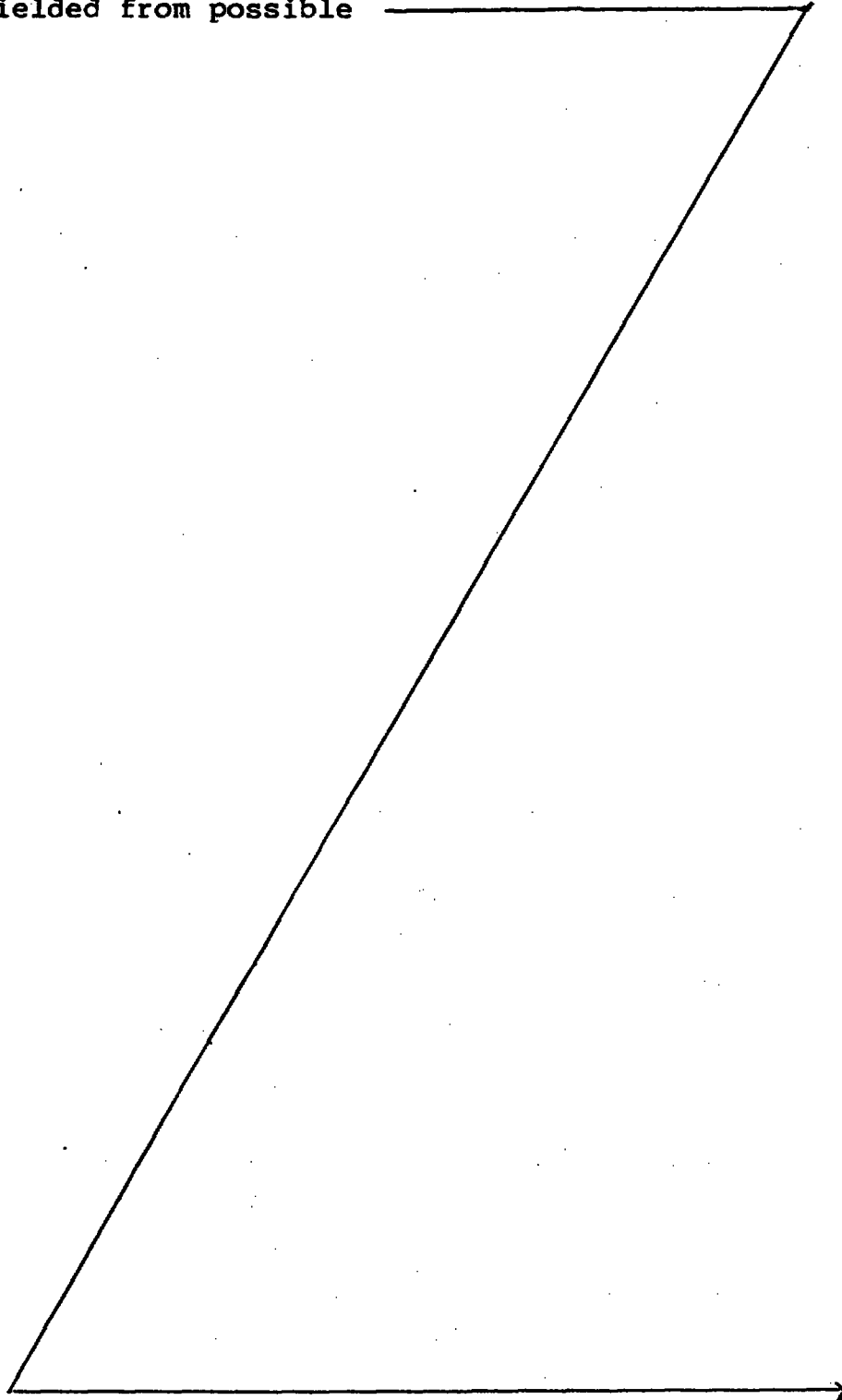
According to the invention there is provided a thermally-sensitive control for an electric immersion heater of the kind described, said control being in the form of a unit which is mountable on the
30 head of an immersion heater and having an outer periphery of less radial extent than a peripheral portion of the head so as to be passable through the opening in the wall of an associated container whereby said head may be positioned in or adjacent
35 the opening with the control mounted thereto by insertion of the control through the opening from inside the container, the control unit having a central axis which is aligned with the axis of

the heater head when the control unit is mounted thereto, said control unit comprising first and second insulating body portions which are interengaged in the axial direction and which define at least one enclosed or partly enclosed switch chamber therebetween, the arrangement being such that in use the second body portion faces the heater head whereby the cold leads of the heater extend through axially directed openings in such body portion into said chamber or chambers, electrical switch means including at least one set of breakable switching contacts being mounted within said chamber or chambers, the switch means further comprising connecting means arranged to make electrical contact between the switch means and the respective cold leads and being operable, in use of the control, to interrupt the power supply to the element, there being first and second thermally responsive actuating means for the switch means respectively operable upon the element overheating and upon liquid within the container boiling, said second actuating means being exposed in use to steam or vapour resulting from liquid in the container boiling and acting on said switch means through an over-centre spring mechanism, said control further comprising terminal pins adapted to be engaged by a separate socket connector for connecting the element via the switch means to a source of electrical power, the first actuating means being disposed on the side of the second body portion which in use faces the element head and being coupled to the switch means via a first push rod extending into the respective switch chamber and being slidably mounted in an axially directed opening formed in the second body portion, said overcentre spring mechanism and said second actuating means being mounted to the side of the first body portion which in use is remote from the head and being respectively disposed to

one side of a generally axial plane of the control,
the overcentre spring mechanism being coupled to
the switch means by means of a second push rod
extending into the respective switch chamber and
5 being slidably mounted in an axially directed opening
formed in the first body portion, and the free
end portions of the terminal pins of the control
being disposed to the other side of said generally
axial plane generally opposite said overcentre
10 spring mechanism and said second actuating means.

In accordance with the invention the general
layout of the parts is similar to that of the control
as broadly described in British Patent Specification
2112209 and the advantage that a heater with a control
15 mounted thereto may be secured to a container by inser-
tion of the control through the opening in a container
wall is retained. However, with a control in accordance
with the invention, the switch means including
at least one set of breakable contacts is mounted
20 within an enclosed or partly enclosed chamber or
chamber defined between two insulating body portions
thereof, the cold leads extending into such chamber
or chambers in use via openings in the second body
portion and making electrical contact with suitable
25 connecting means of the switch means. This arrangement
avoids the provision of stationary switching contacts
of the switch means mounted directly to the cold
leads and instead all the operative parts of the
switch means may form part of the control unit.
30 As such the drawbacks discussed above associated
with the preferred control described in Patent
Specification 2,112,209 in certain commercial situations
may be avoided since a control unit in accordance
with the invention may be manufactured, calibrated,
35 tested and despatched by a control manufacturer
independently of a heater, and controls can therefore
be supplied to a heater or container manufacturer
for attachment to immersion heaters without the

need for subsequent testing operations. Furthermore, the location of the switch means in an enclosed or partly enclosed chamber or chambers is such that the operative parts of the switch means are shielded from possible



damaging for example in transit when the control unit is not assembled to a heater. An additional operational advantage of an arrangement of this type is that since the electrical parts of the switch means are located in an insulating housing and are thus isolated from earthed conducting parts, the possibility of "tracking", i.e. current running from the live parts to earth consequent upon arcing across the contacts is avoided.

10 The connecting means of the switch means arranged to make electrical contact with the cold leads may take any convenient form, although the arrangement should be such that the need for close tolerances in length of the cold leads is avoided
15 having regard to the inconvenience such may impose on a heater manufacturer. Thus, the connecting means may comprise leaf spring contacts mounted within the switch chamber or chambers and arranged to engage respective cold leads of the element when the control
20 unit is mounted to the heater head. Such leaf spring contacts are preferably resiliently supported e.g. by compression springs mounted behind the leaf springs since such an arrangement avoids the need for unusually close tolerances in the length
25 of the cold leads whilst enabling sufficiently high contact pressures to be achieved to ensure satisfactory electrical connection.

 In a preferred embodiment, the control unit is adapted to receive steam or vapour egressing
30 from the interior of a container via a tube carried by the element head and passing through the head, the second thermally actuating means being so located to be exposed to steam passing through the tube. It is also envisaged that the introduction of steam
35 or vapour to the second actuating means may be laterally from above, and the control unit may be adapted for use with, for example, a container having a tube or passage running down the outside

thereof and communicating with a steam or vapour aperture in the upper wall of the container.

In both cases, it will be appreciated that since the control unit is passable through the opening
5 in the container wall, the control unit can, if desired be mounted to an immersion heater before the head is secured in or adjacent the container opening.

In a preferred embodiment, the first and
10 second body portions of the control unit are fabricated separately from one another, the two body portions being interconnected by suitable means such as friction fit pins. Either or both of the mutually opposing sides of the first and second body portions
15 may be provided with recesses arranged to define the or each switch chamber when the body portions are interengaged. In a preferred embodiment both body portions are formed of a molded thermoplastics material.

The configuration of the switch means of
20 the control unit in accordance with the invention, may vary and it is envisaged that for example a single set of breakable switching contacts could be provided which are responsive to operation of either the first or the second thermally responsive
25 actuating means whereby to interrupt the power supply to the heater. In this case it will be appreciated that the contact set may include only a single movable contact which is arranged to be acted on by both said push rods so as to be displaced
30 away from an opposed stationary contact. Alternatively, both the contacts may be movable in opposite senses, in which case the push rods may likewise be arranged for displacement in opposite directions to act on the respective contact of the set.

35 In a preferred embodiment, however, two sets of contacts are provided which are acted on respectively by the first and second push rods so that the first set is breakable in response to operation of the

first thermally actuating means upon overheating of the element, and the second set is breakable in response to the operation of second thermally responsive actuating means upon liquid within the container
5 boiling.

Thus, in such an arrangement the first actuating means is coupled to the first set of breakable contacts by means of the first push rod extending through the second body portion into the switch
10 chamber and displaceable in response to operation of the first actuating means in a direction away from the heater head, whilst the over-centre spring mechanism associated with the second actuating means is coupled to the second set of breakable
15 contacts by means of the second push rod extending through the first body portion into the switch chamber and displaceable upon tripping of the over-centre mechanism in a direction towards the heater head. In this case the respective contact sets
20 may be located in separate chambers defined between the control body portions or alternatively a common switch chamber may be provided.

A control unit in accordance with the invention may additionally comprise a third thermally responsive
25 actuating means, for example in the form of a slow acting creep bimetal, which is operable to disable the heater only upon serious overheating of the element consequent upon failure of said first thermally responsive actuating means in an overheat condition.
30 Such an arrangement is important from a safety point of view, particularly when the control unit is used in conjunction with an immersion heater of a plastic hot water jug or a kettle with plastic parts. In a preferred such embodiment, a slow acting creep bimetal may
35 conveniently be coupled to either the first or the second set of contacts of the switch means

by means of a third push rod which extends through an opening in the second body portion into the switch chamber and is displaceable in a direction away from the head in response to operation of
5 the creep bimetal.

In such an arrangement the third push rod preferably acts on the other contact of the set coupled to the overcentre mechanism so that this set includes two movable contacts which are displaceable
10 in opposite senses in response to operation of the steam sensitive actuating means and of the back up bimetal respectively.

As discussed above, in a preferred embodiment the control unit comprises compression spring supported
15 leaf spring contacts located in the switch chamber or chambers and arranged for engagement with the respective cold leads of a heater in use when the control unit is secured to a heater head. The compression springs may take different forms, although
20 it will be appreciated that the springs should be of appropriate rate to provide a sufficient contact pressure over the required tolerance. In one preferred embodiment, the compression springs comprise coil springs which may conveniently be
25 seated in suitable recesses formed in the side of the first body portion which faces the head. Alternatively, the springs may comprise helically wound ribbon springs. A preferred such spring provides a minimum of 200 gms contact pressure
30 with a tolerance in the order of 1 mm to variations in cold lead length.

In a preferred embodiment, the first thermally responsive actuating means comprises a snap-acting bimetallic actuator in the form of a stressed sheet
35 of bimetal having a dished configuration which will snap between two oppositely dished configurations with changes in temperature. Examples of such actuators are described in British Patent Specifications

Nos. 657434 and 1542252. Such an actuator may conveniently be secured to the side of the second body portion of the control unit which in use faces the heater head by means of e.g. a friction fit stud or rivet in which case all of the operative parts of the control may form part of a self-contained unit. Alternatively, however, the actuator may be mounted by means of a bridge member of the sort illustrated in the aforesaid British Patent Specification No. 2112209 and forming the subject of British Patent Application No. 2097920. Such a bridge member may be clamped between the control unit and the heater head, in which case, where controls are supplied separately from heaters as discussed above, it may be necessary for the actuator and bridge member to be mounted to the control unit and heater by a heater manufacturer. However, this can be a straight forward operation, generally involving no close tolerances, and may therefore be acceptable from the point of view of a heater manufacturer. It is also envisaged that an alternative form of actuating means may be used, for example a memory metal device.

The overcentre mechanism may include a lever member which is pivotably mounted to the second body portion and which is spring biased so as to be movable between first and second stable positions through an unstable dead centre position. With such an arrangement, it will be appreciated that the dead centre position occurs when the two ends of the biasing spring lie in a common plane with the fulcrum of the lever. In a preferred embodiment, the spring is a wire spring and is of the type described and claimed in British Patent Specification No. 2112208. Thus, the spring preferably includes two arms which with the spring mounted in the control unit are generally parallel and are interconnected by a generally "V" or "U" shaped portion lying

in the plane of and disposed between the parallel arms. Such a spring, while providing adequate biasing of the lever member into either of its stable positions, has a relatively low rate and thus can accommodate relatively large angular movement and compression as the lever is tripped. A preferred form of spring is a combined double spring, having two "U" or "V" shaped portions disposed in back-to-back relation.

- 10 The second thermally responsive actuating means which is operable to trip the overcentre spring mechanism in response to boiling of liquid within an associated container may take any convenient form, and in a preferred embodiment comprises a
- 15 snap-acting bimetallic actuator of the sort described above with regard to the first thermally responsive actuating means but set to operate at a lower nominal temperature of for example 80° (the first thermally responsive actuator will generally have a nominal
- 20 operating temperature in the order of 140°C, in order to minimise "nuisance" tripping of the actuator due to, for example, the heating element operating slightly above its normal temperature owing to scale being formed on the surface of the element).
- 25 The second bimetallic actuator may be mounted in a similar fashion to the actuator described in the aforesaid British Patent Specification No. 2112209 and thus preferably lies at an acute angle to the axial plane of the control. This configuration
- 30 is preferable in that the radial space taken up by the actuator is minimised. The overcentre lever member may conveniently comprise an upper heel portion which cooperates with the second push rod so that when the lever is tripped in response to
- 35 operation of the second actuator the heel portion thereof urges the push rod towards the heater head and thereby breaks a set of contacts of the switch means.

As discussed above the control unit may be adapted for impingement of steam or vapour on the second thermally responsive actuating means in various ways. Where the immersion heater carries
5 a tube for the egress of steam from inside the container via the head, there is preferably an axially directed bore or aperture which extends through the body portions of the control through which steam or vapour emitting from the tube outlet
10 may pass and which communicates with the second actuating means. The outlet of the steam tube may conveniently be sealed within or to the bore or aperture by means of a resilient sleeve as described and claimed in British Patent Specification No.
15 2113010.

As discussed above in a preferred form of the invention, two moulded plastics body portions are provided which are interference fitted together e.g. by means of friction fit pins. In a preferred
20 embodiment which is particularly convenient to manufacture, the terminal pins and switch means are loosely mounted to the first body portion before the second body portion is secured thereto, and when the second body portion is interference fitted
25 to the main body portion the arrangement is such that these electrical parts are securely engaged therebetween. The interference fit between the body portions need only be sufficient to hold the portions together before the unit is mounted to
30 a heater, since the unit will generally be secured to a heater head by means of axially directed screws or the like which pass through both body portions and engage in threaded studs brazed to the head thereby firmly clamping the body portions together.

35 In a preferred embodiment, the control is adapted for use with an immersion heater having an externally threaded cup-like head which in use is inserted through a container opening and is

retained therein by means of an externally mounted locking ring. In this embodiment, the control body portions are preferably generally cylindrical in cross-section.

5 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 elevation, partly broken away, taken from the end of a thermally sensitive control unit in accordance with the invention which in
10 use is remote from an associated heater head;

Figure 2 is a cross-sectional view of the control unit mounted to the head of an immersion heater taken along line II-II of Figure 1;

15 Figure 2a is a cross-sectional view of the overcentre spring mechanism shown in Figure 2 in its alternative position;

Figure 3 is a cross section taken along line III-III in Figure 2;

20 Figure 4 is a cross-section taken along line IV-IV in Figure 2;

Figure 5 is a cross-section taken along line V-V in Figure 3 illustrating the supported leaf spring contacts engaging the cold leads of the
25 element, with certain parts of the control unit omitted for clarity;

Figure 6 is a partial cross-section taken along line VI-VI in Figure 3; and

Figure 7 is a partially schematic cross section
30 of part of the control taken along line VII-VII in Figure IV.

Referring firstly to Figures 1 and 2, a thermally-sensitive control unit 1 is mounted on the head
2 of an electric immersion heater. The cup-like
35 head 2 in use may be retained in a water-tight

manner in an opening formed in the wall (not shown) of an associated container by means of an internally threaded retaining ring 3 (Figure 1) which engages the head and urges a peripheral flange 4 thereof into sealing engagement with a resilient o-ring seal (not shown), as is conventional. The immersion heater head 2 carries a tube 5 for the egress of steam from the interior of the container which tube is braised to the head and extends, in use, above water level within the container. The immersion heater also comprises two cold leads 6 and a hot return 7 which passes beneath the cold leads 6 and is braised to the head 2 so as to be in good thermal contact therewith.

The control unit 1 is mounted snugly within the head 2 by means of bolts 8 (Figures 1 and 6) which engage in threaded female studs (8) brazed to the inside of the head. A cover member 9 of the control unit is engaged thereto by means of a single central fixing bolt 10.

The control 1 comprises a first body portion 11 interconnected axially with a second body portion 12, both such portions being moulded from a suitable thermo-plastic material. The mutually opposed faces of the body portions 11, 12 are recessed so that enclosed switch chambers C1 and C2 are defined therebetween which mount therewithin the electrical switch means of the control, as will be described in more detail below. During assembly of the control unit, the body portions 11, 12 are interference fitted together by means of pins 73 of the second portion 12 which are friction fitted into respective recesses 74 formed in the first body portion 11, as shown in Figure 5. The interference engagement between the two body portions of the control need only be sufficient to hold the portions together before the unit is mounted to the heater head, since once the unit is secured to the head

the bolts 8 extend through both body portions 11, 12 and thus firmly clamp the portions together.

The first body portion 11 includes a horizontal shelf member 13 which lies close to the central longitudinal axial plane of the control unit 1 and this defines at the side of the second body portion remote from the head upper and lower segmental volumes of the control unit lying respectively above and below the central horizontal axial plane of the unit. This configuration is similar to that of the control described in British Patent Specification No. 2112209 discussed above. Three terminal pins 14 extend through the first body portion 11 and include a live pin, a neutral pin and an earth pin arranged for connection to a separate female socket connector to supply mains electrical power to the heating element. The end portions of the pins 14, which extend parallel to and are located below the shelf member 13, are arranged in a triangular configuration with the central or earth pin lying below the live and neutral pins as shown in Figure 1. The cover member 9 of the control unit defines a shroud 15 which surrounds the pins 14 and is shaped so as snugly to receive a standard socket connector. As shown in Figure 2, the terminal pins 14 include enlarged base portions 16, and during assembly of the control unit the terminal pins 14 are simply loosely mounted to the first body portion 11, and when the second body portion 12 is secured thereto the pins are firmly clamped in place by means of projections 17 of the second body portion 12 which abut and tightly engage the base portions 16 of the pins.

As shown in Figure 4, leaf spring connectors 18, 19, 20 formed of a resilient metallic strip material are engaged with the base portions 16 of the earth, neutral and live terminal pins respectively. The leaf spring connector 18 engaged with the earth

pin is engaged at the end thereof remote from the pin with one of the bolts 8 which clamp the control unit to the head so that the metallic head is earthed. The leaf spring connectors 19 and 20
5 located respectively in chambers C2 and C1 are connected via respective sets 21, 22 of breakable contacts to second leaf spring connectors 23, 24 which are in turn electrically connected to respective cold leads 6 of the element, as will be described
10 in more detail below. As shown in Figure 5 the leaf spring contacts are located by means of the respective matingly engaging parts 73, 74 which hold the body portions 11, 12 together.

The second body portion 12 is formed with
15 apertures 25 arranged to receive the respective cold leads 6 of the heater, as shown in Figure 5 so that the ends of the cold leads extend into the respective chambers C1 and C2. Thus, when the control unit is mounted to the heater head,
20 the ends of the cold leads engage the respective free ends of the connectors 23, 24 remote from the breakable contact sets 21, 22. The free ends of the leaf spring connectors 23, 24 and of the cold leads 6 are preferably provided with a silver
25 coating, silver having the advantage that silver oxide produced by any arcing occurring between the cold leads and the contacts is electrically conductive.

As also shown in Figure 5, mounted behind
30 the free ends of the leaf springs 23, 24 are compression springs 28 which support the leaf springs and ensure that a sufficient contact pressure is maintained. In the illustrated embodiment, the compression springs 28 comprise coil springs located in suitable
35 recesses provided in the first body portion 11, although it is envisaged that helically wound ribbon springs may also be used. A preferred contact arrangement provides a minimum of 200 gms contact

pressure up to a nominal pressure of 500 gms over a tolerance to variations in the length of the cold leads of approximately 1 mm. A connection 29 may conveniently be provided behind one of the compression springs 28 for a neon indicator light (not shown) arranged to provide an indication as to whether or not the heater is operative.

Thus, during normal operation of the heater, the respective pairs of leaf spring connectors 19, 23 and 20, 24 urge the contact sets 21, 22 together such that electrical power may be supplied from the live and neutral terminal pins to the element.

The control unit further comprises a first thermally responsive actuating means in the form of a bimetallic actuator 30 of the sort described in British Patent Specification No. 1542252. As shown in Figures 2 and 3, the actuator 30 is secured to the side of the second body portion 12 which in use faces the head by means of a hammer drive screw 31 passing through an aperture in the tongue 32 of the actuator 30. A lower peripheral portion of the actuator 30 is held in good thermal contact with a wedge-shaped protrusion 33 formed on the inside of the heater head 2 adjacent the point where the hot return 7 of the element is welded thereto. An upper bridge portion 34 is arranged for engagement with the front end of a first push rod 35 which is slidably mounted in and extends through an axially directed aperture formed in the second body portion 12 of the unit into the switch chamber C2 (Figure 2). The other end of the push rod is arranged for engagement with the leaf spring connector 19 in the region thereof closely adjacent the first contact set 21, as shown in broken lines in Figure 4. The actuator 30 is calibrated with a nominal operating temperature of 140°C so as to undergo snap action when the

element overheats. Thus, in the event that the element overheats after for example having been switched on dry, the actuator 30 reverses its curvature from the configuration shown in Figure 1 whereupon
5 the bridge portion 34 engages and moves rightwardly, i.e. away from the head, the push rod 35 which in turn pushes the free end of the leaf spring connector 19 away from the connector 23 and thus opens the first set of contacts 21 whereby to cut
10 off the power supply and disable the heating element.

As shown in Figure 2, the control unit further comprises an overcentre spring mechanism 40, which is disposed above the shelf member 13 on the side of the first body portion remote from the element
15 head i.e. above the axial horizontal plane of the control. The mechanism 40 includes a lever member 41 having a generally semi-cylindrical profile (Figure 1) so as to fit snugly within the upper segmental space of the control. The lever member
20 41 is pivotably mounted by suitable means to the first body portion 11, and a biasing spring 42 is provided so that the lever member 41 is pivotable between a first stable position (shown in Figure 2) and a second stable position (shown in Figure
25 2a). In moving from the first stable position to the second, the lever member 41 passes through an unstable dead centre position. The biasing spring 42 is not shown in detail, but is of the sort described and claimed in British Patent Specification
30 No. 2112208, and thus comprises a combined double spring including two U-shaped portions disposed in back to back relation. The spring 42 is seated in notches 43 formed on the free ends of a pair of arms 44 extending downwardly from the first
35 body portion 11 in a direction parallel to the shelf member 13, and thus acts between the arms 44 and the underside of the lever member 41.

A bimetallic actuator 45 similar to the actuator 30 but having a nominal operating temperature of 80°C is located below the lever member 41 and lies at an acute angle to the shelf member 13 between the arms 44 (only one of which is shown in Figure 2) which serve to locate the actuator laterally. The front part of the actuator 45 rests on a support member 46 of the first body portion, and the rear portion of the actuator 45 is engaged between one or more projections 47 of the cover member 9 and the shelf member 13.

The steam or vapour resulting from liquid within the container boiling is transmitted to the actuator 45 via an aperture 50 extending through the first and second body portions 11, 12 of the control unit. The steam tube 5 is sealed to the aperture 50 by means of a silicone rubber sleeve 51 one end of which is stretched over the end of the tube 5 and the other end of which is pushed into the aperture 50, which it will be seen is outwardly tapered towards the front of the control unit. This arrangement is described and claimed in British Patent Specification No. 2113010 and is advantageous in that precise positioning of the steam tube relative to the head in order to align with the aperture in the control unit is not required, and this again is advantageous to the heater manufacturer.

Upon liquid within the container boiling, steam or vapour impinges on the steam sensitive bi-metallic actuator 45 which then reverses its curvature by snap action so that the tongue 52 thereof engages and bears upwardly against a post 53 provided on the underside of the lever member 41 thus tripping the lever member in a generally anti-clockwise direction as viewed in Fig. 2 from its first stable position illustrated in Fig. 2 to its second stable position illustrated in Figure 2a.

The over-centre lever mechanism is coupled to the second breakable set of switch contacts 22 by means of a second push rod 55 which extends through and is slideable in an axially directed aperture formed in the first body portion 11 and thus extends into the switch chamber C1 as shown in Figure 7. Thus, as shown in Fig. 7, the push rod 55 is arranged for engagement with the leaf spring connector 24 adjacent the free end thereof.

10 A heel 56 provided on the upper part of the lever member is arranged to co-operate with the other end of the push rod 55 such that when the lever member is tripped to its second stable position (Figure 2b) consequent upon boiling of liquid within

15 the container, the push rod 55 is urged towards the heater head, whereby to open the set of contacts 22 and disable the heater as shown schematically in Figure 7. A knob 57 is mounted above the lever member and extends through an aperture 58 in the

20 upper part of the cover member 9, the knob enabling manual resetting of the control after the over-centre mechanism has been tripped.

It will be seen that the electrical parts of the control located in the chambers C1 and C2

25 on the side of the first body portion 11 which faces the head are shielded from the steam or vapour by means of the resilient sleeve 51. On the other side of the body portion 11, the terminal pins 14 are shielded from the steam and from condensed

30 liquid by the shelf member 13 and by the cover member shroud 15. Thus, liquid condensing on the shelf member 13, under the actuator 45, runs off the shelf member at each side into a peripheral passage defined between the shroud 15 and the outer

35 wall of the cover member 9, a suitable drainage aperture being provided at the base of the cover member to allow condensed liquid to drain out of the control.

As shown in Figures 3 and 6, a control unit in accordance with the invention may additionally comprise a so-called creep bi-metal 60 as a back up for the overheat protector bi-metal 30. The creep bimetal 60 is secured to the side of the second body portion 12 which faces the heater head by means of a hammer drive screw 80, apertures being provided in the bimetal 60 through which the respective cold lead 6 and fixing bolt 8 pass. The bimetal 60 is thus arranged in thermal contact with the head so as to be operable in the event of serious overheating consequent upon failure of the main protecting mechanism. In the illustrated embodiment such bimetal is coupled to a free end portion 61 of the leaf spring connector 20 by means of a third push rod 62 extending through an aperture in the second body portion 12 into the chamber C2. The creep bi-metal 60 is set to operate in the event of serious overheating of the element consequent upon failure of the bi-metal 30, and is effective to urge the push rod 62 and thus the end 61 of the leaf spring connector 20 rightwardly as shown in Fig. 6 and thereby open the contact set 22. The provision of a creep bi-metal is important from the safety point of view when the control unit is used in conjunction with for example a plastic hot water jug or a kettle having plastic parts, and preferably it is a one shot device in that the subsequent overshoot heating of the control is effective to render the control inoperable. As shown in Figs. 6 and 7, the body portions, 11, 12 define in the regions of the push rods 55, 62 opposed stops 63, 64 for the free end portions of the leaf spring connectors 20, 24. These stops ensure that the contacts 22 are always broken in response to actuating movement of either the push rod 55 or the push rod 62 and do not become welded together.

Claims

1. A thermally-sensitive control for an electric immersion heater of the kind described, said control being in the form of a unit which is mountable on the head of an immersion heater and having an
5 outer periphery of less radial extent than a peripheral portion of the head so as to be passable through the opening in the wall of an associated container whereby said head may be positioned in or adjacent the opening with the control mounted thereto by
10 insertion of the control through the opening from inside the container, the control unit having a central axis which is aligned with the axis of the heater head when the control unit is mounted thereto, said control unit comprising first and
15 second insulating body portions which are interengaged in the axial direction and which define at least one enclosed or partly enclosed switch chamber therebetween, the arrangement being such that in use the second body portion faces the heater head
20 whereby the cold leads of the heater extend through axially directed openings in such body portion into said chamber or chambers, electrical switch means including at least one set of breakable switching contacts being mounted within said chamber or chambers,
25 the switch means further comprising connecting means arranged to make electrical contact between the switch means and the respective cold leads and being operable, in use of the control, to interrupt the power supply to the element, there being first
30 and second thermally responsive actuating means for the switch means respectively operable upon the element overheating and upon liquid within the container boiling, said second actuating means being exposed in use to steam or vapour resulting
35 from liquid in the container boiling and acting on said switch means through an over-centre spring



mechanism, said control further comprising terminal pins adapted to be engaged by a separate socket connector for connecting the element via the switch means to a source of electrical power, the first
5 actuating means being disposed on the side of the second body portion which in use faces the element head and being coupled to the switch means via a first push rod extending into the respective switch chamber and being slidably mounted in an
10 axially directed opening formed in the second body portion, said overcentre spring mechanism and said second actuating means being mounted to the side of the first body portion which in use is remote from the head and being respectively disposed to
15 one side of a generally axial plane of the control, the overcentre spring mechanism being coupled to the switch means by means of a second push rod extending into the respective switch chamber and being slidably mounted in an axially directed opening
20 formed in the first body portion, and the free end portions of the terminal pins of the control being disposed to the other side of said generally axial plane generally opposite said overcentre spring mechanism and said second actuating means.

25

2. A control as claimed in claim 1 wherein the connecting means comprise leaf spring contacts mounted within the switch chamber or chambers and arranged to engage respective cold leads of the
30 element when the control unit is mounted to the heater head.

3. A control as claimed in claim 2 wherein the leaf spring contacts are resiliently supported
35 by means of compression springs mounted behind the leaf springs.

4. A control as claimed in claim 3 wherein the compression springs comprise coil springs.

40



5. A control as claimed in claim 3 wherein the compression springs comprise helically wound ribbon springs.

5 6. A control as claimed in any preceding claim wherein the control unit is adapted to receive steam or vapour egressing from the interior of a container via a tube carried by the element head and passing through the head, the second thermally actuating
10 means being so located to be exposed to steam passing through the tube.

7. A control as claimed in any preceding claim wherein the first and second body portions are
15 fabricated separately from one another.

8. A control as claimed in claim 7 wherein the body portions are interconnected by means of friction fit pins.
20

9. A control as claimed in claim 8 wherein, during assembly of the unit, the terminal pins and switch means are loosely mounted to the first body portion before the second body portion is secured
25 thereto, and when the second body portion is interference fitted to the main body portion the arrangement is such that these electrical parts are securely engaged therebetween.

30 10. A control as claimed in any preceding claim wherein both the body portions are formed of thermoplastics.

11. A control as claimed in any preceding claim
35 wherein the switch means comprises two sets of switch contacts which are acted on respectively by the first and second push rods so that the first set



is breakable in response to operation of the first thermally-responsive actuating means upon overheating of the element, and the second set is breakable in response to the operation of second thermally responsive actuating means upon liquid within the container boiling.

12. A control as claimed in claim 11 wherein the respective contact sets are located in separate chambers defined between the body portions.

13. A control as claimed in any preceding claim additionally comprising a third thermally responsive actuating means which is operable to disable the heater upon serious overheating of the element consequent upon failure of said first thermally responsive actuating means in an overheat condition.

14. A control as claimed in claim 13 wherein the third thermally responsive actuating means is coupled to either the first or the second set of contacts of the switch means by means of a third push rod which extends through an opening in the second body portion into the switch chamber and is displaceable in a direction away from the head in response to operation of the third actuating means.

15. A control as claimed in claim 14 wherein the third push rod acts on one contact of the set coupled to the overcentre mechanism so that this set includes two movable contacts which are displaceable in opposite senses in response to operation of the steam sensitive actuating means and of the third actuating means respectively.

16. A control as claimed in any of claims 13 to 15 wherein the third thermally-responsive actuating means comprises a slow acting creep bimetal.



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

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The following corrections were allowed under Section 117 on 3 August 1990

Front page Heading (73) Proprietor delete (Incorporated in United Kingdom)
insert (Incorporated in the Isle of Man)

THE PATENT OFFICE
20 August 1990

