

Electric immersion heaters and
thermally-sensitive controls therefor

This invention relates to electric immersion heaters of the kind which are used in liquid heating vessels such as jugs, urns and particularly electric kettles. Such heaters comprise a heater element
5 mounted on an element head, and in use are associated with a thermally-sensitive control including an electric switch and a thermally responsive actuator arranged to open the switch and cut off the supply of power to the element on overheating of the element. This
10 may occur either if the, for example, kettle is switched on dry or if it boils dry in use. The sensing by the actuator of the overheating of the element is conventionally achieved by welding or brazing a portion of the element which becomes hot in use (called the
15 hot return portion) to the element head and positioning the actuator opposite the hot return in good thermal contact with the head. Such heaters are termed herein heaters of the kind referred to.

The element heads of heaters of the kind referred
20 to are conventionally constructed of brass, because of its ease of forming, ready availability and high thermal conductivity. However, being such a good conductor of heat, in an overheating situation the temperature at the periphery of the head rises considerably
25 and keeps on rising after the control has terminated the power supply. This so-called overshoot temperature may rise to as much as 250°C and if the necessary peripheral seal is not to be damaged it must be made of a material which can withstand this order of temperature
30 Silicon rubber seals are suitable for this purpose, but they are expensive.

Such high temperatures could be avoided, and seals of less expensive material could therefore be used, if the element head were made of a material of relatively low thermal conductivity, such as
5 stainless steel, as described for example in British Patent Specification GB 2052227. In view of its strength a stainless steel head can be made much thinner than a brass head. This thinness, in combination with low thermal conductivity, reduces thermal
10 diffusion from the hot return to the periphery of the head.

Thermally-sensitive controls for heaters of the kind referred to conventionally include a thermally responsive actuator, typically a snap-
15 acting bimetallic actuator, coupled mechanically to a set of breakable switch contacts wired in series with the element and operable to open the contacts upon the element overheating. Examples of such controls are described in British patent
20 specifications Nos. 1,470,366 and 2,042,269.

In such arrangements failure of the thermally sensitive control can represent a serious problem since if, for example, the container boils dry and the element overheats, the power supply will
25 not be automatically interrupted, and in the absence of manual intervention the element will become hotter and hotter until it eventually burns out. This not only leads to the expense of a replacement element but may also constitute a serious
30 safety hazard in the case of plastic containers or containers having plastic parts, since the overheating can cause melting and in the extreme burning of all or part of the container. The problem is of particular significance where the control is
35 used with an appliance which is likely to be unattended, for example an automatic electric kettle or an early morning tea maker.

In an attempt to overcome this problem it has been proposed to provide control units having thermally-sensitive back-up protection including means operable to interrupt the power supply upon
5 failure of the primary protector when the element overheats. One such arrangement, the subject of British patent specification No. 2149217, includes a slow acting creep bimetal thermally connected to the element head for back-up protection. It
10 has also been proposed to use two snap-acting bimetallic actuators coupled to respective sets of contacts and calibrated to provide primary and back-up protection. Another arrangement is described in British patent specification No. 2181598, wherein back-up protection
15 is provided by a pre-loaded spring mechanism associated with a set of switch contacts of the control and comprising an actuating spring which in normal use of the control is held in a prestressed condition by a retaining means arranged to release the spring
20 in the event of serious over-heating of the control consequent upon failure of the primary protector whereupon an operating member is moved under the force of the spring and co-operates with the switch contacts so as to open the contacts and deenergise
25 the heater. By this arrangement reliable operation may be achieved despite deformation of plastic parts of the control due to overshoot heating. The spring loaded mechanism provides a stronger, more positive action for opening the contacts than
30 is possible with bimetallic actuators, for example, which can in extreme conditions reclose the contacts after operating once, if plastic parts are deformed by heat.

Thermally sensitive control units having
35 a thermally sensitive back-up protector (hereinafter termed thermally sensitive controls of the kind referred to) thus sense the temperature of the

element head at the location of the hot return to provide primary protection and at some other location, e.g. of the head, removed from the location of the hot return. In the event that the primary protector fails it is imperative that the back- up protector operate before damaging overheating occurs. On the other hand the back-up protector unit must not operate unless the primary protector has failed. The balancing of these two requirements is difficult, particularly so if a stainless steel element head is contemplated and the control is such that the back-up protector operates by sensing the temperature of the head at a location spaced from the hot return, since it can take a considerable time for sufficient heat to diffuse from the location of the hot return to the back-up protector. In this time, so much heat may be conducted and radiated via the actuator of the failed primary protector to the control unit that plastic parts melt, leading to serious damage and a risk of fire. There is also a risk that overheating of the element, particularly a stainless steel element, may lead to the element rupturing and the resistive heating wire being exposed.

According to the invention there is provided an electric immersion heater of the kind referred to in combination with a thermally sensitive control of the kind referred to, the element head being formed of a material of lower conductivity than brass; and wherein a bridge member, formed of material of higher thermal conductivity than the element head, is positioned opposite said hot return in good thermal contact with said head for cooperation with a thermally responsive primary actuator of said control and extends to a location spaced from the location of the hot return for cooperation with a thermally sensitive back-up protector of

the control.

This invention thus enables the advantages of an element head of low thermal conductivity, made, for example, of stainless steel, to be realised in
5 conjunction with a thermally-sensitive control providing back-up protection.

The bridge member may be fixedly connected to said element head by, for example, brazing. Alternatively, the bridge member may be mounted on the control, and
10 arranged to be in good thermal contact with said head when said control is mounted to said head.

The invention also extends to an electric immersion heater provided with a bridge member as aforesaid for use with a thermally sensitive control of the kind
15 referred to, to such a thermally sensitive control provided with a bridge member for use with an electric immersion heater as aforesaid and to vessels fitted with such a combination of heater and control.

The back-up protector may take various forms as, for example, a slow-acting creep bimetal, or
20 alternatively, a pre-loaded spring mechanism held in compression by a retaining means, said retaining means being in thermal contact with said bridge member and arranged to release said spring mechanism and thereby
25 de-energize the heater on overheating. The element head may define the mounting location for the control, and the retaining means comprise a slidable push rod arranged to contact said bridge member when the control is mounted to the head. The push rod and spring
30 mechanism may be arranged so that upon mounting of the control to the heater head the push rod engages the head in contact with said bridge member and is displaced axially so as to compress and pre-load the spring. The push rod is formed of an appropriate material so that,

in the event of failure of the primary protector, when the bridge member reaches a certain temperature the end of the push rod softens sufficiently to be distorted under the force of the spring which is thus released to open the contacts.

The thermally-sensitive primary protector may comprise a snap acting bimetallic actuator of any convenient form, for example a stressed sheet of bimetal having a generally domed configuration and a central tongue such as that described in British patent 1,542,252.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 is a partly schematic vertical cross-sectional view illustrating a thermally-sensitive control secured to the head of an immersion heater according to the present invention; and

Figures 2a and 2b are elevational views illustrating alternative configurations of conductive bridge members.

Referring firstly to Figure 1, a thermally-sensitive control 1 is mounted to a stainless steel head 2 of an electric immersion heater, the control and head being interconnected by means of bolts (not shown) and thus being clamped within an aperture formed in the wall 3 of an associated container such as a kettle or hot water jug. The general configuration of the heater will be well known to those skilled in the art, and as is conventional the heater includes a heating element terminating in a pair of cold leads 4 which extend through the stainless steel plate-like head 2 and having a so-called hot return part 5 which is brazed to the head in good thermal contact therewith. The head 2 is typically between 0.3 and 1mm thick. A resilient annular sealing ring 6 is tightly engaged between the head and

the control so as to provide a water-tight seal with the container wall 3.

5 The control 1 includes first and second body portions 7,8 which interengage axially and are so shaped to define cavities therebetween within which electrical switch means of the control are mounted. The second body portion 8 includes three terminal pins (not shown) arranged in a triangular configuration and adapted to be engaged with a separate female socket connector for the supply of electrical power to the heater, as is conventional with this type of control.

10 Those skilled in this art will be familiar with the basic components of the illustrated control and will recognise that the general layout could be varied. Similar types of control are known, for example from British Patent Specifications Nos. 1470366, 2149217 and from our co-pending British Patent Application No. 8502170 (priority application for GB-A-2170956, now published).

20 The control illustrated in Figure 1 comprises a primary overheat protector including a snap-acting bimetallic actuator 11 mounted in good thermal contact with a conductive bridge member consisting of an apertured copper plate 20 brazed to a dimple 12 formed in the head adjacent the hot return 5 of the element. The actuator 11 is of the general type described in British Patent Specification No.1,542,252 and thus includes a central tongue which is secured to the first body portion 7 of the control by means such as a hammer drive screw 15, and an upper peripheral portion 14. The upper portion 14 is arranged for engagement with an axially slidable push rod 16 extending through an aperture in the first body portion 7 and co-operating with a set of switch contacts (not shown) wired in series between either the live or neutral terminal pin and a respective cold lead 4. The actuator 11

is calibrated with a nominal operating temperature of 130-140°C so as to undergo snap action when the element overheats, for example having been switched on with insufficient water in the container to cover the element or in the event that the container boils dry. Upon operation of the actuator 11 it reverses its curvature from the configuration shown in Figure 1 and the upper peripheral portion 14 thereof is moved rightwardly ie, away from the element head, so as to engage the push-rod which in turn opens the switch contacts so as to interrupt the power supply to the element. This general arrangement of primary protector is well known, and the particular configuration illustrated is similar to that described in more detail in our co-pending application no. 8502170.

In an alternative embodiment, the bridge member may consist of a copper plate secured directly to the control and held against the element head adjacent the hot return when assembled. This may be achieved, for example, by mounting the bridge member and actuator to the body of the control by means of a common rivet, drive screw or the like.

The illustrated control further comprises a pre-loaded spring mechanism associated with a second set of contacts which is arranged to provide back-up protection in the event that the primary protector should fail. The mechanism comprises a coil spring 25 which is mounted within a recess 26 formed in the second body portion 8 and which in normal use is held under compression by means of a retaining element in the form of a push-rod 27. Push-rod 27 is formed for example from nylon and extends through and is axially moveable within a bore 28 formed in the first body portion 7. Part 20a of the conductive bridge member 20 lies between

the control unit 1 and the element head 2 and extends from the dimple 12 to the end of the push-rod 27.

Thus, when the control is clamped to the heater head, the push-rod 27 urges the part 20b of the
5 bridge member into engagement with the head and is urged rightwardly relative to the control so that the spring 25 is placed under compression.

In the event of failure of the primary protector the arrangement is such that the consequent overheating
10 of the head, initially confined to the region of the dimple 12, causes the part 20a of the bridge member 20 to become hot. Heat is conducted swiftly through the copper plate of the member 20 to part 20b thereof, causing the end of the push-rod 27
15 which engages with part 20b the bridge member 20 to soften and deform under the force of the spring, while the region of the head 2 adjacent the push-rod 27 may still be relatively cool. The spring 25 is released sufficiently to enable an operating
20 arm (not shown) to open the associated set of contacts. The heater is thus disabled, and since the contacts are open under the positive action of the coil spring 25 the possibility of subsequent reclosing of the contacts as a result for example of distortion
25 of part of the control caused by overshoot heating is avoided.

The back-up protector is designed to be actuated at a temperature of 225-260°C. In the absence of the conductive bridge member 20, an appreciable
30 time would be taken for sufficient heat to dissipate through the relatively poorly conductive head 2 to the region of the push-rod 27. Thus, when the primary protector failed, the dimple 12 and adjacent regions of the element head would become extremely
35 hot while the upper region of the head remained relatively cool, and even after the back-up protector had operated, heat would continue to build up in

an overshoot heating effect. As a result of the high temperature in the dimple region of the head, plastic parts within the control unit 1 might melt, with a possible risk of fire. Reducing the actuating
5 temperature of the back-up protector is undesirable because it would lead to a greater likelihood of nuisance actuation as a result of overshoot heating after normal operation of the primary actuator.

In an alternative embodiment the back-up
10 protector may comprise a creep bimetal coupled at one end to a leaf spring connector and in thermal contact at the other end with the bridge member 20. Other arrangements of back-up protectors are also possible with which the present invention
15 is suitable for use.

Figures 2a and 2b show alternative shapes of the conductive bridge member 20 suited to different configurations of control 1. The member, typically about 1mm thick, is preferably formed of copper
20 but other materials exhibiting good thermal conductivity, such as brass or aluminium, are also suitable.

It will be understood that the bridge member of the invention could be formed in a variety of other shapes.

Claims:

1. An electric immersion heater of the kind referred to in combination with a thermally sensitive control of the kind referred to, the element head being formed of a material of lower conductivity than brass; and wherein a bridge member, formed of material of higher thermal conductivity than the element head, is positioned opposite said hot return in good thermal contact with said head for cooperation with a thermally responsive primary actuator of said control and extends to a location spaced from the location of the hot return for cooperation with a thermally sensitive back-up protector of the control.
2. An electric immersion heater of the kind referred to for use with a thermally-sensitive control of the kind referred to, the element head being formed of a material of lower conductivity than brass; and wherein a bridge member, formed of a material of higher thermal conductivity than the element head is connected to said head opposite said hot return in good thermal contact with said head for cooperation with a thermally responsive primary actuator of said control and extends to a location spaced from the location of the hot return for cooperation with a thermally sensitive back-up protector of the control.
3. A thermally-sensitive control of the kind referred to for use with an electric immersion heater of the kind referred to, the element head being formed of a material of lower conductivity than brass, said control including a bridge member which is formed of a material of higher conductivity than the element head and which



- is mounted on said control in such a position that when said control is mounted to said head in use, said bridge member is positioned opposite said hot return in good thermal contact with said head for cooperation with a thermally responsive primary actuator of the control, said bridge member then extending to a location spaced from the location of the hot return for cooperation with a thermally sensitive back-up protector of the control.
4. An electric immersion heater in combination with a thermally sensitive control as claimed in claim 1 or a thermally sensitive control as claimed in claim 3 wherein said back-up protector comprises a pre-loaded spring mechanism held in compression by a retaining means, said retaining means being in thermal contact with said bridge member and arranged to release said spring mechanism and thereby de-energize the heater on overheating.
5. An electric immersion heater in combination with a thermally sensitive control or a thermally sensitive control as claimed in claim 4 wherein said retaining means comprises a slidable push rod arranged to contact said bridge member when the control is mounted to the head.
6. An electric immersion heater in combination with a thermally sensitive control or a thermally sensitive control as claimed in claim 5 wherein said push rod and spring mechanism are arranged so that upon mounting of the control to the heater head the push rod engages the head in contact with said bridge member and is displaced axially so as to compress and pre-load the spring.
7. An electric immersion heater in combination with a



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thermally sensitive control or a thermally sensitive control as claimed in any of claims 1, 3, 4, 5 or 6 wherein said thermally-sensitive primary protector comprises a snap acting bimetallic actuator.

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8. A vessel including an electric immersion heater in combination with a thermally sensitive control as claimed in claim 1 or any of claims 4 to 7.

10 9. An electric immersion heater, thermally-sensitive control or heater and control in combination as hereinbefore described with reference to Fig. 1.



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