

Electric immersion heaters

5           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 mounted  
on an element head, and in use are associated with a  
10 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. Such controls are termed  
herein controls of the kind referred to. This may occur  
15 either if, for example, a 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 hot return portion)  
20 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  
25 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, and keeps on  
30 rising after the control has terminated the power  
supply. This so-called overshoot temperature may raise  
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. Silicone  
35 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 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 diffusion from the hot return to the periphery of the head. However despite their intrinsic advantages stainless steel heads have not found acceptance with immersion heaters manufacturers largely on account of the greater cost of and the greater difficulty in working with such material as compared with brass.

Thermally-sensitive controls for heaters of the kind referred to conventionally include a thermally responsive actuator, typically a snap-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 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 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 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 used with an appliance which is likely to be unattended, for example an automatic electric kettle or an  
5 early morning tea maker.

In an attempt to overcome this problem it has been proposed to provide controls having thermally-sensitive back-up protection including means operable to interrupt the power supply upon failure of the  
10 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 has also been  
15 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 is provided  
20 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 under compression by a push-rod. In the event of serious over-heating of the control  
25 consequent upon failure of the primary protector the push-rod is adapted to soften and deform, whereupon the spring is released and the switch contacts open and deenergise the heater.

Thermally sensitive controls having a thermally  
30 sensitive back-up protector which sense the temperature of the element head in the section of the hot return to provide primary protection and at some other location of the head, removed from the location of the hot return, to provide back-up protection  
35 are hereinafter termed thermally sensitive controls of the kind referred to. 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  
5 is difficult.

According to the present invention the element head of an electric immersion heater of the kind referred to for use with a thermally sensitive control of the kind referred to, is thinned in  
10 an area partially or wholly surrounding or including the region of the hot return portion. In use under boil dry or switch on dry conditions this thinning will impede the radial diffusion of heat in the head and reduce the conduction of heat to the periphery  
15 of the head to give further protection to the peripheral seals. Impeding the radial diffusion of heat also has the effect of concentrating the heat near the hot return position and enhancing and directing heat conduction to the primary protector, thus  
20 reducing the response time of the primary protector and hence overshoot temperatures.

Also, if a sufficient area is thinned so as appreciably locally to reduce the thermal capacity of the head, this will also reduce the response  
25 time. The reduction of the response time is of particular advantage with element heads of a high thermal conductivity material such as brass.

By quickening the response of the primary protector, the temperature at which the back-up  
30 protector is set to operate may be reduced without unacceptable nuisance tripping, thus reducing the risk of damaging overheating should the primary protector fail. To reduce the response time of the back-up protector the thinning of the head  
35 in the region of the hot return may be extended to include the location of the head whose temperature is sensed by the back-up protector or an area of

the head may be thinned which surrounds or includes both the said location and the region of the hot return.

5 The thinned area of the head may also include or surround those parts of the element which extend through and are connected to the head. In this way heat fed into the head by conduction along the element sheath, as may be a problem when the element overheats particularly if the sheath is  
10 of a high thermal conductivity material e.g. brass, and the element has a high watts density, is also confined to limit overshoot temperatures.

The element head is preferably a metal plate e.g. of brass of between 0.5 and 1.5 mm thickness  
15 and the thinning is between 40% and 90% of its thickness. A thinning which surrounds the region of the hot return or that region and other parts of the head as previously envisaged may be constituted by a groove formed into the head e.g. by coining.

20 The back-up protector may take various forms as, for example, a slow-acting creep bimetal, or alternatively, a pre-loaded spring mechanism held in compression by a thermally-responsive retaining means, such as is described in UK Patent Application  
25 No. 2181598.

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  
30 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:

35 Figure 1 is a partly schematic vertical cross-section illustrating a thermally-sensitive control secured to the head of an immersion heater according

to the present invention; and

Figure 1a is an expanded cross-sectional view of a part of the control shown in Figure 1, showing the back-up protector; and

5        Figures 2a, 2b, 2c and 2d are elevational views illustrating schematically alternative patterns of thinning.

Referring firstly to Figure 1, a thermally-sensitive control 1 is mounted to a brass plate  
10 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  
15 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 head 2 and having a so-called hot return position  
20 5 which is brazed to the head in good thermal contact therewith. 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.

25        The control 1 includes first and second body portions 7,8 which interengage axially and are so shaped as to define cavities therebetween within which electrical switch means of the control are mounted. The second body portion 8 includes three  
30 terminal pins 9 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.

35        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.

The head 2 consists of a 1 mm thick brass plate having a 2 mm wide groove 12 formed around the location of the hot return portion of the element. The groove is coined to a depth of 0.75 mm. Figure 2a shows diagrammatically the element head in elevation to illustrate the shape of the area enclosed by the groove. As an alternative to the groove alone, the whole area of metal within the line of the groove may be thinned.

The control comprises a primary overheat protector including a snap-acting bimetallic actuator 11 mounted in good thermal contact with a dimple 15 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 20 which is secured to the first body portion 7 of the control by means such as a hammer drive screw and an upper peripheral portion 14. The upper portion 14 is arranged for engagement with an axially slidable push rod (not shown) 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 9 and a respective cold lead 4. The actuator 11 is calibrated with a nominal operating temperature of 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.

The control illustrated further comprises a second set of contacts 16 carried by conductive leaf spring elements 17, 18 connected respectively to a terminal pin 9 and the cold lead 4. This second set of contacts forms part of a steam-sensitive control to de-energise the heater on boiling, and is shown in Figure 1a. Upon boiling a lever member 21 is tripped to a second position by means, for example, of a snap-acting bimetallic actuator. A push-rod 20 is thereby urged towards the head and engages the free end 22 of the leaf spring 18 whereby the contacts 16, shown closed in Figure 1a, are broken as in Figure 1.

The illustrated control further comprises a pre-loaded spring mechanism associated with the second set of contacts 16 which is arranged to provide back-up protection in the event that the primary protector should fail. Referring to Figure 1a, 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 formed in the first body portion 7. Thus, when the control is clamped to the heater head, the push-rod 27 engages with the head and is urged rightwardly relative to the control so that the spring 25 is placed under compression. The push-rod 27 is adapted

to soften and deform in the even of serious overheating of the heater consequent upon failure of the primary protector, whereby the spring 25 is released and moves an operating member 30 into engagement with set switch contacts 28 to open the contacts and disable the heater.

In an alternative embodiment the back-up 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 element head 2. Other arrangements of back-up protectors are also possible.

Figure 2b shows an alternative pattern of thinning of the head 2 whereby a groove 12' extends partly around the location of the hot return and also encompasses the region of the head opposite the back-up protector actuator. Figure 2c shows another possible pattern of thinning in which a groove 12" encircles the cold leads 4 as well as the hot return region and the area opposite the back-up protector actuator. Figure 2d shows substantially the same pattern but having the location of the hot return portion fully encircled. The invention covers these and other similar patterns of thinning. The choice of pattern will be governed by various factors including the relative operating temperatures and response times desired for the two protectors.

CLAIMS:

1. An immersion heater of the kind referred to including an element head for use with a thermally sensitive control of the kind referred to, the element head being thinned over an area partially  
5 or wholly surrounding, or : including the region of the hot return portion.
- 2, An immersion heater as claimed in claim 1 wherein said thinned area includes or surrounds the location of the element head whose temperature  
10 is sensed by a primary protector of a thermally sensitive control of the kind referred to.
3. An immersion heater as claimed in claim 1 or 2 wherein said thinned area includes or surrounds the location of the element head whose temperature  
15 is sensed by a back-up protector of a thermally sensitive control of the kind referred to.
4. An immersion heater as claimed in any preceding claim wherein said thinned area includes or surrounds those parts of the element which extend through  
20 and are connected to the head.
5. An immersion heater as claimed in any preceding claim, said element head comprising a metal e.g. brass plate of between 0.5 and 1.5mm thickness.
6. An immersion heater as claimed in any preceding  
25 claim, wherein said thinning is of 40% to 90% of the thickness of the head.
7. An immersion heater as claimed in any preceding claim wherein said thinning comprises a groove



formed in the head.

8. An immersion heater as claimed in any of claims 1 to 6, said element head being thinned over a sufficient area so as appreciably locally  
5 to reduce the thermal capacity of the head.
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