

Thermally-Sensitive Controls

This invention relates to thermally-sensitive controls for electric heaters of containers such as electric kettles, jugs, urns, pans, coffee percolators, laboratory equipment and the like (hereinafter referred to as "containers of the kind described"). The electric heaters of such containers are typically either immersion heaters, or similarly constructed heaters mounted externally to the container in good thermal contact with a wall thereof, for example by being brazed to the underside of the container base. Traditionally 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 heaters of this type are well known which include electrical switch means operable to interrupt the power supply and thus deenergise the heater upon its element overheating, after for example having been switched on with insufficient liquid in the container to cover the element or having boiled dry. Such arrangements conventionally include a thermally responsive actuating means, 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 responsive actuating means 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 early morning tea maker.

In an attempt to overcome this problem it has been proposed to provide back-up protection including means operable to interrupt the power supply upon failure of the primary actuating means when the element overheats. One such arrangement is described in British patent specification No. 2,149,217, wherein back-up protection is provided by a further thermally responsive actuating means operable independently of the primary actuating means to open a set of switch contacts and thus deenergise the heater in the event of serious overheating consequent upon failure of the primary actuating means. In the arrangement described in British patent specification No. 2,149,217 the primary actuating means comprises a snap-acting bimetallic actuator whilst the back-up protection is provided by a slow acting creep bimetal, although it has also been proposed to include two snap-acting bimetallic actuators coupled to respective sets of switch contacts and calibrated to provide primary and back-up protection.

Whilst in many applications the use of a thermally responsive actuating means such as a bimetallic actuator coupled to a suitable switch



means provides adequate back-up protection, in certain circumstances, particularly in the case of high wattage density heaters, experience has shown that reliable operation may not be achieved. For example, problems can be caused by the effects of the "over-shoot" heating which results from the residual heat in the element after the heater is deenergised. Such heating can cause melting and deformation of plastic parts of the control and this in turn can render the known type of back-up protection means ineffective, and in certain circumstances a secondary bimetallic actuator may operate initially to open the switch contacts but shortly thereafter distortion of the control consequent upon the over-shoot heating is such that the contacts reclose. Under such circumstances current is thus allowed to flow once more to the element and this clearly represents a serious hazard.

An alternative approach to providing back-up protection is the provision of an electrical fuse wired in series with the element. Whilst a suitably calibrated fuse can provide adequate protection and avoid problems discussed above concerning possible re-closing of switch contacts, the provision of a fusible link can undesirably increase manufacturing costs.

Viewed from one aspect the invention provides a thermally-sensitive control for an electric heater of the kind described, said control including a thermally-sensitive actuating means arranged in use in good thermal contact with a part of the element and coupled to a set of switch contacts of electrical switch means of the control so that the actuating means is operable to open the contacts and deenergise the heater upon over heating of the element, wherein back-up protection for the control is provided by a pre-loaded spring mechanism



associated with the same or a further set of switch contacts of the control and comprising an actuating spring which in normal use of the control is held in a stressed condition by a retaining member and an operating member coupled to the spring, said retaining member being adapted and arranged to deform or melt so as to release the spring in the event of serious over-heating of the control consequent upon failure of said thermally-sensitive actuating means, whereupon the 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 the heater, the retaining member being arranged to co-operate with a part defining a mounting location for the control so as to be displaced in such a way as to pre-load the actuating spring when the control is mounted to the said part, such part being in thermal contact with respect to the heater.

The provision in accordance with the invention of a pre-loaded spring mechanism adapted and arranged to be released in the event of serious over-heating consequent upon failure of the actuating means providing primary protection is advantageous to the extent that reliable operation may be achieved despite deformation of plastic parts of the control due to over-shoot heating. Thus, a spring loaded mechanism can provide a stronger, more positive action for opening the contacts than is possible with bimetallic actuators used in the prior art proposals, and the possibility in extreme conditions of the contacts reclosing may be avoided.

In the design of thermally-sensitive controls of this type there are generally size constraints for the various components having regard to the desired overall compactness of the control, and a preloaded spring mechanism is also advantageous



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in this respect since such a mechanism can be designed relatively compactly. Moreover, such a spring mechanism can be incorporated in a control without substantially increasing the manufacturing costs.

5 The preloaded spring mechanism make take any convenient form, and it could for example comprise a tension spring normally held in an extended condition by the retaining member and adapted to be released in the event of serious over-heating so that the
10 switch contacts are opened. However, since it is desirable to provide a relatively strong biasing force generally within relatively narrow size constraints the preferred preloaded spring mechanism comprises a compression spring which in normal use is held
15 in a compressed state by the retaining member.

 The form of the retaining member may vary depending on the general configuration of the control and on the nature of the actuating spring provided. The member should be formed of an appropriate material
20 and be so arranged as to deform or melt so as to release the spring when heating of the control has reached a predetermined level consequent upon failure of the primary protector.

 The retaining member comprises a displaceable
25 member coupled to or carried by the spring and arranged to co-operate with a part defining the mounting location for the control so as to be displaced in such a way as to pre-load the actuating spring when the control is secured in place. Thus,
30 the retaining member is resiliently urged by the actuating spring against part of the mounting location for the control, and such part is arranged in suitable thermal contact with the element so that upon serious over-heating consequent upon failure of the primary
35 protector the end of the retaining member remote from the spring melts or deforms sufficiently to release the spring mechanism and open the contacts.



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In a particularly preferred such embodiment where the spring mechanism includes a compression spring, the retaining member may conveniently comprise a slidable push rod which at one end is coupled
5 to the spring and which at the other end projects externally of the control for engagement with part of the mounting location therefor.

The mounting location for the control will vary depending on the nature of the heater and
10 the type of container. For example, the control may be adapted for use with an immersion heater having a heating element carried by a head which is securable in a water tight manner in or adjacent an opening in the container wall. In such an
15 embodiment, the heater head may define the mounting location for the control, and in the arrangement discussed above wherein the retaining member comprises a slidable push rod, the push rod may conveniently be arranged for engagement with part of the head
20 when the control is mounted thereto. Thus, the push rod and spring mechanism are advantageously arranged so that upon mounting of the control to the heater head the push rod engages the head and is displaced axially so as to compress and pre-
25 load the spring. In the event of failure of the primary protector, when the head 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.

30 The operating member which is adapted to be moved under the force of the spring into engagement



with the contacts may take any convenient form, and in a preferred embodiment where the spring mechanism comprises a compression spring such member make conveniently comprise an arm which extends laterally from one end of the spring. In the case of a coil spring, such arm may conveniently be formed integrally therewith. The manner in which the operating member co-operates with the contacts of such a control may vary depending on the configuration of the switch means. Typically however, the switch contacts include interengaging contact members, at least one of which is carried by a resilient conducting strip or leaf spring so as to be displaceable away from the other contact member. In such an arrangement, the operating member may conveniently be arranged to engage the leaf spring carrying the movable contact member.

The general configuration of the switch means of the control may take any convenient form, and the pre-loaded spring mechanism may be associated either with the switch contacts which are adapted to be opened in response to operation of the thermally-responsive actuating means, or alternatively the control may comprise a further set of contacts arranged to be acted on by the spring mechanism. In one embodiment, the control additionally comprises means whereby the heater is disabled upon boiling of liquid within an associated container, such means including a further thermally-responsive actuating means exposed to steam or vapour emitting from the container and coupled to a set of switch contacts via an over centre spring mechanism. In such an embodiment, the pre-loaded spring mechanism can alternatively be associated with the contacts forming part of the steam sensitive switch mechanism.

The primary thermally-responsive actuating means and, if provided, the actuating means for



the steam sensitive switch mechanism, may both comprise snap acting bimetallic actuators of any convenient form, for example a stressed sheet of bimetal having a generally domed configuration and a central tounge such as that described in British patent 1,542,257. The control may be fabricated from the suitable thermoplastics material, and in a preferred embodiment wherein the retaining element comprises a push rod which is arranged to be engaged and axially displaced by the heater head, the body part of the control which confronts the head and mounts the push rod may if necessary be formed a material having a higher heat resistance than other plastic parts of the control and than the push rod itself. This avoids the possibility of this body portion being distorted in the event of serious overheating before release of the spring mechanism in such a way as to impair the movement of the push rod.

An embodiment 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 illustrating a thermally-sensitive control secured to the head of an immersion heater; and

Figures 2a and 2b are respectively diagrammatic cross-sectional elevational views illustrating in more detail a pre-loaded spring mechanism.

Referring firstly to Figure 1, a thermally-sensitive control 1 is mounted to the head 2 of an electric immersion heater, the control and heater 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 plate-like head 2 and having a so-called hot return part 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.

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 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. The live and neutral ones of the terminal pins 9 are connected via electrical switch means to the respective cold leads 4 of the element, the free end portions of which extend through apertures 10 formed in the first body portion 7 of the control.

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 improvement of the present invention is applicable to all of these and other known controls.

The control illustrated in Figure 1 further comprises a primary overheat protector including a snap-acting bimetallic actuator 11 mounted in good thermal contact with 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.1,542,257 and thus includes a central tongue 13 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 heater 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 in Figure 1 further comprises a second set of switch contacts 15 arranged in series between the other cold lead 4 of the element and a respective terminal pin 9. The contacts 15 include contact members 16 carried by conductive leaf spring elements 17, 18, one of which 17 is connected to the base portion of the respective terminal pin 9 and the other of which 18 is connected via a further conductive strip element to the respective cold lead 4. Such a contact arrangement is of the same general type as described in our co-pending



application no. 8502170, but many other similar configurations are possible.

The second set of contacts 15 is arranged to engaged by a slidable push-rod 20 which in turn co-operates with a lever member 21 forming part of a steam-sensitive over-centre spring mechanism (not shown). The over-centre spring mechanism may take any convenient form, and conventionally comprises a second thermally-responsive actuating means, for example a further snap-acting bimetallic actuator, which is exposed to steam or vapour emitting from the container during boiling and which is adapted to trip the over-centre spring mechanism so as to de-energise the heater. Thus, in the arrangement illustrated in Figure 1, upon boiling the lever 21 is tripped to a second position (not shown) wherein the push-rod 20 is urged leftwardly, i.e. towards the head, and engages a free-end part 22 of the leaf spring 18 whereby the contacts 15 are broken. As is conventional means (not shown) are provided whereby the over centre mechanism may readily be manually reset.

The illustrated control further comprises a pre-loaded spring mechanism associated with the second set of contacts 15 which is arranged to provide back-up protection in the event that the bimetallic actuator 11 should fail. One form of spring mechanism is shown in more detail in Figures 2a and 2b, from which it will be seen that 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 in a compressed state by means of a retaining member 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. Thus, when the control is clamped to the heater



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head, the push-rod 27 engages the head and is urged rightwardly relative to the control so that the spring 25 is compressed.

As shown in Figure 2b the spring 25 includes an operating member in the form of an arm 30 formed integrally therewith which extends laterally and which is arranged for engagement with the leaf spring 18 adjacent the free end portion 22 thereof. However, as shown in Figure 1 in normal use when the spring is pre-loaded by means of the push-rod 27, the operating member 30 of the spring is spaced axially from the leaf spring 18 so that normally the contacts 15 are free to open and close in response to operation of the lever member 21 forming part of the steam-sensitive over-centre spring mechanism.

However, in event of failure of the actuator 11, the arrangement is such that the consequent overheating of the head causes the end of the push-rod 27 which engages the head to soften and deform under the force of the spring whereby the spring is released sufficiently to enable the operating arm 30 to engage the leaf spring 18 and open the contacts. The heater is thus disabled, and since the contacts 15 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 of part of the control caused by over-shoot heating is avoided.

Modifications of the control described and illustrated herein will be apparent to persons skilled in this art and the disclosure hereof is intended to encompass all such modifications.

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Claims:

1. A thermally-sensitive control for an electric heater of the kind described, said control including a thermally-sensitive actuating means arranged in use in good thermal contact with a part of the element and coupled to a set of switch contacts
5 of electrical switch means of the control so that the actuating means is operable to open the contacts and deenergise the heater upon over heating of the element, wherein back-up protection for the control is provided by a pre-loaded spring mechanism
10 associated with the same or a further set of switch contacts of the control and comprising an actuating spring which in normal use of the control is held in a stressed condition by a retaining member and an operating member coupled to the spring, said
15 retaining member being adapted and arranged to deform or melt so as to release the spring in the event of serious over-heating of the control consequent upon failure of said thermally-sensitive actuating means, whereupon the operating member is moved
20 under the force of the spring and co-operates with the switch contacts so as to open the contacts and deenergise the heater, the retaining member being arranged to co-operate with a part defining a mounting location for the control so
25 as to be displaced in such a way as to pre-load the actuating spring when the control is mounted to the said part, such part being in thermal contact with respect to the heater.
2. A thermally-sensitive control as claimed
30 in claim 1 wherein said preloaded spring mechanism comprises a compression spring.

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3. A thermally-sensitive control as claimed in claims 1 and 2 wherein the retaining member comprises a slidable push rod which at one end is coupled to the spring and which at the other end projects externally of the control for engagement with part defining the control mounting location.
4. A thermally-sensitive control as claimed in claim 3 wherein the part defining a mounting location for the control comprises the head of an associated electric heater, the push rod and spring mechanism being arranged so that upon mounting of the control to the heater head the push rod engages the head and is displaced axially so as to compress and pre-load the spring.
5. A thermally-sensitive control as claimed in claim 4 wherein a plastics body part of the control which confronts the heater head and mounts the push rod is formed of a material having a higher heat resistance than other plastic parts of the control and than the push rod itself.
6. A thermally-sensitive control as claimed in any preceding claim wherein the operating member comprises an arm which extends laterally from one end of the spring.
7. A thermally-sensitive control as claimed in claim 6 wherein said arm is arranged for engagement with a leaf spring carrying a movable contact of switch means of the control.
8. A thermally-sensitive control substantially as herein described with reference to the accompanying drawings.

