

Electrical Control

This invention relates to electrical controls for electric immersion heaters of containers such as electric kettles, jugs, urns, pans, coffee percolators, laboratory equipment 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 immersion heaters 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".

Electrical controls for immersion heaters of the kind described are known which comprise electrical switch means including connecting means in the form of leaf spring connectors arranged to engage respective cold leads of the heater elements to make electrical contact therewith when the control is mounted to the heater head, such controls being effective in use to interrupt the power supply and thus disable the heater. For example, controls may be provided which operate automatically 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.

Certain designs of containers impose great demands on the cold leads in terms of their ability to establish an adequate temperature gradient between the resistive heating member of the element to which they are connected and the extremities thereof with which electrical connections are made. The length available for a cold lead may be restricted by design

considerations. Furthermore, in adapting immersion heaters for use in very compact containers, the portions of the heating element into which the cold leads extend may be located above a plane in which the main extent of the heating element lies, so that if the water level is very low, those portions of the element into which cold leads extend may not be immersed. Reliance is then placed on the copper sheath which encases the heating element to conduct sufficient heat back into the water to prevent the cold leads overheating.

In certain applications, however, it has been found that a small percentage of controls may fail in that the heat shielding provided by the cold leads proves inadequate with the result that the contacts between the cold leads and the spring connectors overheat leading either to oxidation of the contacts and loss of electrical continuity or to such heating of the connector as to result in melting of the control fixings and control failure. In some cases the control will fail to safety, with the power being permanently disconnected. In other cases the failure will establish a fixed connection between the power supply and the cold lead. The heating element will then overheat, with the consequent risk of serious damage to the appliance and fire. It is particularly important to prevent overheating where the heater is used in an appliance containing plastic parts, for example in a plastic jug kettle.

The spring connector is typically a sheet of beryllium copper alloy, a fraction of a millimetre thick and the problem of heat dissipation is exacerbated by the build-up of a surface oxide layer. At high temperatures, oxidation of the alloy occurs and, while copper oxide is a fair electrical conductor, beryllium oxide conducts poorly. A runaway effect is thus established, as the quantity of beryllium oxide builds up, the electrical conduction becoming poorer and poorer and the connector becoming hotter

and hotter until eventually either electrical continuity is lost or such heat is generated as to cause the plastic mountings of the connector to melt.

Another contributory cause of overheating may
5 be the presence of residual plating salts left after the heating element is coated with nickel by a wet plating process. In the presence of moisture, these salts can recrystallise, forming an insulating layer on the cold lead. The temperature of the cold lead
10 will therefore increase and the contact between cold lead and connectors will start to oxidise and overheat.

The leaf spring connectors are preferably resiliently supported e.g. by compression springs mounted behind the leaf springs since such an arrangement avoids
15 the need for unusually close tolerances in the length of the cold leads whilst enabling sufficiently high contact pressures to be achieved to ensure satisfactory electrical connection.

The leaf spring connector presents a continuous
20 flat plate to the cold lead which is usually terminated by a nickel-plated brass ferrule which is pushed or crimped onto the end of the cold tail. The end of the ferrule is generally rounded. A disc-shaped contact area between ferrule and spring connector
25 is thus provided. Heat is also transferred by radiation onto the spring connector. Should the cold leads become hot, therefore, heat will be fairly readily transferred to the spring connector causing oxidation. The deterioration of the electrical contact caused
30 by the oxide layer can be allayed to some extent by increasing contact pressure e.g. by using stiffer compression springs. However this has the unwelcome effect of improving thermal contact.

It is an object of this invention to provide
35 a contact between cold tails and spring contacts which restricts heat transfer therebetween whilst also providing good electrical contact.

According to the invention there is provided

an electrical control for an electric immersion heater of the kind described, said control comprising electrical switch means including connecting means arranged to engage respective cold leads of the heater element
5 to make electrical contact therewith when the control is mounted to the heater head, said control being operable, in use, to interrupt the power supply to the element, said connecting means comprising leaf spring connectors formed to define one or more sharp
10 edge or pointed contact areas which in use engage and thus establish electrical contact with the ends of the cold leads.

By confining contact between connector and cold lead to pointed or sharp areas, heat transfer
15 by conduction can be reduced whilst adequate electrical connection is maintained if not improved in that, particularly with a pointed or sharp edge contact, a wiping action between connector and cold lead brought about by small relative movements caused by thermal
20 expansion and contraction serves to keep the contact area(s) clean.

To provide the sharp edge or pointed contact areas the connectors can be provided with one or more lateral tabs which are down turned to face the ends of
25 the cold leads. Alternatively the connectors may be pierced to release such tabs to be turned down to face, in use, the ends of the cold leads. Yet again the connector may be deformed to provide pips or ridges therein to create said contact areas.

30 To reduce the transfer of heat from the cold leads to the connectors, apertures may be formed in areas of the connectors which in use lie opposite the cold leads. Such apertures may be created by the formation of said contact areas or may be formed
35 independently thereof. Apertures formed in the connectors at or adjacent the contact areas may also serve to restrict the conduction of heat along the connectors

towards their mountings in the control.

In a preferred construction a hole is formed in the connector to lie opposite the end of a cold lead and the edge of the hole is deformed toward
5 the cold lead to define an annular edge facing the end of the cold lead. Thus not only is an annular sharp contact area provided but the hole in the connector facing the end of the cold lead reduces transfer of heat by radiation from the cold lead
10 to the connector.

According to another aspect of the invention, a method of forming a leaf spring connector suitable for providing electrical connection to a cold lead of a heating element comprises the step of forming
15 one or more sharp edge or pointed contact areas from a conductive plate, so that said contact area or areas are displaced out of the plane of said plate. The method preferably also includes blanking out a hole in said plate in the region of said contact area or areas and thereafter
20 deforming the connector around said hole to provide an annular contact edge for engaging the end of a cold lead.

One embodiment of the invention in the form of a modification of the control described in published
25 U.K. Patent Application No. 2170956A will now be described, by way of example only, with reference to the accompanying drawings, of which:-

Fig. 1 is a cross sectional view of the aforesaid control illustrating the engagement of the leaf spring
30 connectors with cold leads of the immersion heater;

Fig. 2 is a scrap sectional view showing in plan one leaf spring connector; and

Fig. 3 is a scrap longitudinal section of one cold lead and the associated leaf spring connector.

35 For full details of this control unit reference is made to our co-pending application No. 2170956A More particularly and referring firstly to Fig. 1,

the control 1 is mounted on the head 2 of an electric immersion heater. The control 1 comprises two portions 11, 12 moulded from thermo-plastic material. The two portions 11, 12 are so shaped that enclosed chambers 13, 14 are formed where the two portions are brought together, and within these chambers are mounted the leaf spring connectors 5, 7 and respective coil springs 15, 17. The heating element terminates in two cold leads 6, 6' the ends of which protrude into respective chambers 13, 14.

The two portions 11, 12 of the control 1 are initially held together by a friction fit of pins 8 in recesses 9 and thereafter the control is bolted to the head of the immersion heater and all the parts are thus firmly held together. When thus assembled the leaf spring connectors 5, 7 engage with nickel plated ferrules 26, 26' respectively on the ends of the cold leads 6, 6'. The coil springs 15, 17 ensure that sufficient contact pressure is maintained, and their provision allows cold leads to be made to less strict tolerances than would otherwise be necessary.

As illustrated in Fig. 2 ferrule 26 mounted on cold lead 6 is connected to a pin terminal 16 via a pair of leaf spring connectors 5, 25 which meet at a set of breakable contacts 21. One leaf spring connector 5, is in permanent engagement with the ferrule 26 of cold lead 6, as shown in Fig. 1, and indicated on Fig. 2, while the other 25 is permanently engaged with the pin terminal 16. When one of the conditions of boiling or overheating obtains, an actuating device (indicated at 35) pushes that other leaf spring connector 25, thereby breaking the connection with the first leaf spring connector 5. A similar arrangement is provided in association with the other cold lead 6'.

It is possible in a faulty appliance for the

cold leads to become too hot during normal use and, as already described, this can lead to oxidation of the Be-Cu contacts and runaway overheating. To reduce the risk of damage, therefore, each leaf spring connector is formed with a small annular edge or ridge 3 on its surface and only this edge contacts the cold lead. To form this edge 3 a circular hole is blanked in the leaf spring connector and a forming punch is driven through the hole to raise a small ridge of metal around the circumference. Fig. 3 shows the shaped contact in cross-section in the region of the blanked hole. The edge 3 is sharp as a result of being formed in the blanking step and it has been found that this sharp edge makes a good electrical contact and also has the effect of cleaning the contact area as small movements occur during thermal expansion and contraction. Consequently, electrical conduction is improved because any oxide layer or other deposit is removed. At the same time, heat transfer from the cold leads is significantly reduced, firstly because of the small line contact area, and secondly because the hole in the contact plate directly above the cold lead reduces heat transfer by radiation.

25 Although the invention has been illustrated with reference to the control described in U.K. Patent Specification No. 2170956A it will be understood that it is applicable to other forms of control.

Claims:

1. An electrical control for an electric immersion heater of the kind described, said control comprising electrical switch means including connecting means arranged to engage respective cold leads of the heater element to make electrical contact therewith when the control is mounted to the heater head, said control being operable, in use, to interrupt the power supply to the element, said connecting means comprising leaf spring connectors formed to define one or more sharp edge or pointed contact areas which in use engage and thus establish electrical contact with the ends of the cold leads.
2. An electrical control as claimed in claim 1, comprising connectors provided with one or more tabs which are down turned to face the ends of the cold leads.
3. An electrical control as claimed in claim 1, comprising connectors deformed to provide pips or ridges therein to create said contact areas.
4. An electrical control as claimed in any one of the preceding claims comprising connectors having apertures formed in areas of the connectors which in use lie opposite the cold leads.



5. An electrical control as claimed in claim 1,
30 having a hole formed in each connector to lie
opposite the end of a cold lead, the edge of the
hole being deformed toward the cold lead to define
an annular edge facing the end of the cold lead.

6. An electrical control for an electric immersion
35 heater of the kind described substantially as herein
described with reference to the accompanying drawings.

7. A method of forming a leaf spring connector
suitable for providing electrical connection to a
cold lead of a heating element comprising the step
40 of forming one or more sharp edge or pointed contact
areas from a conductive plate, so that said contact
area or areas are displaced out of the plane of said
plate.

8. A method as claimed in claim 7, which includes
45 blanking out a hole in said plate in the region of
said contact area or areas and thereafter deforming the connector
around said hole to provide an annular contact edge
for engaging the end of a cold lead.

9. An electrical control for an electric immersion
50 heater of the kind described as claimed in any one
of claims 1 to 6 when produced by the method as claimed
in claim 7 or claim 8.

