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(54) IMPROVEMENTS RELATING TO ELECTRIC IMMERSION HEATERS

(71) We, OTTER CONTROLS LIMITED, a British Company, of Otters 'Ole, Market Street, Buxton, Derbyshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to thermally-controlled electric immersion heaters for liquid heating vessels such as kettles, jugs, urns, pans and the like having associated therewith electrical switch means sensitive to overheating of the element.

Such heaters are well-known and it has for many years been a problem to ensure that the switch means whilst being of a simple and economic construction is sufficiently sensitive to detect element overheating, as a result of the vessel boiling dry or being switched-on dry, quickly enough to avoid damage to the element and neaby insulation and liquid-tight seals.

To overcome this problem, various proposals have been made but none has proved entirely satisfactory. The heater described in British Patent 1,064,643 has been extensively used and whilst a distinct improvement over earlier heaters has not proved entirely satisfactory. The heater includes a stressed sheet of bimetal movable with a snap-action between oppositely-dished configurations to actuate the electrical switch means. The bimetal sheet is secured to a brass mounting plate within a hollow mounting boss of the heater element so that heat is conducted from the element via the mounting boss and mounting plate to the bimetal sheet. The mounting boss is formed with an external shoulder and screw thread for mounting the heater and consequently is a massive structure, formed as a hot brass pressing, having a considerable thermal

capacity which results in a lengthy time interval before the bimetal sheet is heated sufficiently to actuate the switch means. Such a lengthy cut-off time results in overheating and further places an undesirable limitation on the power output/unit length ratio of the heating element since a high watts density would increase the temperature obtained resulting from the power supplied during the cut-off period.

In an effort to overcome these problems it is disclosed in our Patent Specification 1,430,229 to provide a thermal control unit, including a stressed sheet of bimetal mounted on a brass mounting plate, secured to an immersion heater head of substantially flat or dished configuration, with the bimetal sheet in contact therewith, the unit having a moulded plastics body formed with an external screw thread for the reception of a locking ring to secure the unit and the heater head to a vessel wall. By eliminating the massive mounting boss described above and substituting a heater head in the form of a plate, the cut-off time is substantially reduced, but not quite enough to provide the required safety margin to ensure little wastage when such units are mass-produced, as is nowadays usual.

We also disclose in our Patent Specification 1,401,954 as a means of shortening the cut-off time still further a thermal control unit having a stressed sheet of bimetal mounted on a brass mounting plate, which moves with changes in temperature between two oppositely dished configurations with a snap-action, the bimetal sheet being positioned adjacent a wall of the element head having a protrusion of a configuration complementary to the configuration of at least a substantial part of the concave side of the bimetal sheet (in its cold position) and which protrusion is situated in the concavity



of the bimetal sheet, close to or touching the latter.

In this way a good direct thermal contact can be established between the element head and the bimetal sheet which substantially reduces the cut-off time of the heater. However it has been found that the contact between the bimetal sheet and the protrusion and hence the cut-off time is critically dependent on an accurate mounting of the control unit to the heater head and this may produce a wide variation in the cut-off time of vessels assembled with heaters on a semi-automatic mass production line, as is nowadays employed.

Hence the need still exists for a heater of simple and economic construction which reacts quickly to an element overheating condition, which reaction is not closely dependent on an accurate assembly of the heater.

The present invention provides, a thermally-controlled electric immersion heater for mounting on the wall of a liquid heating vessel including a heater unit and a switch unit, the heater unit including a heater element carried by a heater head in the form of a plate of substantially flat or dished configuration, and the switch unit including at least the movable contact of an electrical switch for interrupting the electrical supply to the heater element and thermally responsive switch actuating means mounted to make direct thermal contact with said head plate and comprising a stressed sheet of bimetal, movable with changes in temperature between oppositely dished configurations with a snap-action, mounted on a thermally insulating portion of the switch unit so that there is in use no substantial conductive heat loss from the heat conducted to the bimetal sheet from the head plate.

The invention also extends to the switch unit of the aforesaid heater including at least the movable contact of an electrical switch for interrupting the electric supply to the heater element and thermally responsive switch actuating means mounted to make direct thermal contact with said head plate and comprising a stressed sheet of bimetal movable with changes in temperature between oppositely dished configurations with a snap action mounted on a thermally insulating portion of the switch unit so that there is in use no substantial conductive heat loss from the heat conducted to the bimetal sheet from the head plate.

Since the bimetal sheet is not mounted on a brass mounting plate having a substantial thermal capacity and since the head plate has a relatively low thermal capacity, and since it is unnecessary to align the bimetal sheet with a protrusion on the head

plate, the heater according to the invention has a low cut-off time which is not critically dependent on an accurate assembly of the heater.

The bimetal sheet may nevertheless if desired be positioned over a protrusion as described and claimed in our Patent Specification 1,401,954.

It is preferred to employ stressed sheets of bimetal as opposed to other switch-actuating means such as vapour capsules or Curie metal devices (see British Patent Specification 1,149,060) because of the large actuation movement of bimetal sheets and their resistance to "creep", by which is meant resistance to permanent deformation through continued use.

The bimetal sheet may be mounted on a pillar or boss integral with a thermally insulating body of the switch unit and is preferably mounted in such a way that it cannot rotate about its mounting to a position where it may not operate effectively. Where the bimetal sheet has a central tongue, for example where it is of the type described in British Patent Specification 657,434, it may be mounted by the central tongue.

The quick and reliable response to element overheating provided with the present invention lends itself to a simplified means of mounting the heater on a vessel wall wherein the bimetal may be positioned in contact with the head plate in the same operation as the mounting of the heater. Such means is described and claimed in our copending Application 21104/74, 21105/74, 30897/73, 31630/73, 49077/73 (Serial No. 1,470,366). The present invention accordingly provides a heater as aforesaid including a plurality of connecting means for interconnecting the switch unit and the heater unit when positioned with the clamping unit on the outside and the heater unit on the inside of an appropriate access aperture or apertures formed in the wall of a vessel to which the heater is to be fitted and through which the connecting means will extend, the plurality of connecting means each being such as to draw the heater unit and switch unit together whereby in use said units clamp the wall of the vessel therebetween, the combination of said units and said plurality of connecting means constituting a sufficient means of mounting the heater on the vessel wall and liquid sealing means for positioning between said head plate and the vessel wall to be compressed between said head plate and the vessel wall when the heater is mounted on the vessel wall.

Preferably said plurality of connecting means comprises studs mounted on said head plate, the switch unit being formed to receive the studs, and at least the ends of the studs being formed to receive fastenings

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forming part of the connecting means, to secure the switch unit to the studs.

Where there is a risk of vapour condensation on the exterior of the vessel, further sealing means may be provided between the vessel wall and the switch unit. Such sealing means may comprise annular resilient seals. Since it is not possible accurately to determine the degree to which the seals are compressed when the heater is fixed to a vessel wall, there is a risk of variation in the position of the bimetal sheet relative to the head plate with a corresponding variation in the cut off time. To overcome this problem, spacer means are provided for abutting the head plate to ensure that the head plate and the switch unit, and hence the bimetal sheet, are in a predetermined relative position when mounted on a vessel wall.

Where the heater is provided with mains terminal pins for engagement with a mains socket connector, one of said pins may be directly connected e.g. by welding to a cold lead of the heater element. An earth pin may also be directly mounted on the head plate. In such an arrangement the switch unit is provided with apertures through which these pins can pass.

It is however preferred to mount all the terminal pins on the switch unit and to provide suitable spring contacts for connecting the live and neutral pins to the element cold leads.

The switch unit may incorporate thermally responsive switch-actuating means sensitive to the boiling of the liquid contents of the vessel, and is preferably as described and claimed in our copending Application 29324/74, 29325/74 (Serial No. 1,470,367).

A preferred embodiment of the invention will now be described with reference to the accompanying drawings, wherein:—

Figure 1 is an exploded perspective view of a first, preferred, embodiment of an immersion heater according to the invention for a kettle, including a combined switch and clamping unit sensitive both to element overheating and to water boiling in the kettle, a cover of the unit being removed for clarity;

Figure 2 is a side sectional view of the first embodiment mounted on a kettle wall, with a switch-open position indicated in dotted lines;

Figure 3 is a part sectional exploded view of a bell crank lever for actuating the electric switch of the first embodiment; and

Figure 4 is a view of the face of the switch unit of the first embodiment adjacent the kettle wall when mounted on a kettle.

Referring to Figures 1 to 4, there is shown a preferred embodiment of a thermally controlled electric immersion heater for a kettle comprising a combined clamping and switch unit C and a heater unit H for

mounting on the kettle wall K on either side of an access aperture A in the wall.

Heater unit H comprises an element 1 carried by a substantially flat head plate 2, formed as a cold pressing of brass. The ends 3 of the element are brazed in apertures in the head plate 2 and extend therefrom into the kettle. The ends are bent downwardly a short distance from the head plate 2 so that the major part of the element is disposed adjacent the base of the kettle. The element is shaped as two parallel lengths 4 diverging from each other into curved portions 5. The element extends back to the plate 2 in two straight portions 6. The hot return 7 of the element completes a loop of the element and is brazed to the head plate 2 above the ends 3.

The head plate 2 has a raised dimple portion 8 which cooperates in a way to be described with a thermally sensitive means of the clamping and switch unit to make good and direct thermal contact with such means.

The head plate 2 has a flat raised rim 9 which abuts the kettle wall when mounted and serves to compress liquid sealing means comprising a resilient sealing ring 10 therebetween. Three screw studs 11 regularly spaced about the periphery of plate 2 are spot welded to the head plate to extend, in use, through access aperture A.

Clamping and switch unit C includes an electrically insulating glass fibre reinforced plastics chassis plate 12 whose top side has a series of ribs 13 defining an inner space in which the electrical components of the combined clamping and switch unit are mounted. A cover 14, defining with chassis plate 12 a housing, encloses plate 12 and the inner edge of the cover abuts the kettle wall. The cover 14 is secured to chassis plate 12 by screws inserted in apertures 15. The cover defines a recess 16 for receiving a mating mains socket connector (not shown) for connecting with terminal pins of the clamping and switch unit projecting into the recess.

The clamping and switch unit has apertures 17 registering with screw studs 11 so that when the combined clamping and switch unit and the heater unit are positioned on opposite sides of access aperture A, the screw studs 11 can be inserted through apertures 17 and nuts 18 can be threaded onto the studs to mount the combined clamping and switch unit and heater unit on the kettle wall. Each stud and nut thus comprises a connecting means and is such as to draw the units together. The chassis plate 12 has on its underside a projecting annular rim 19 which serves to clamp and compress a resilient sealing ring 20 between the rim and the kettle wall. Chassis plate 12 also has on its underside three spacer studs 21 which serve to space the plate a predetermined dis-

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tance from the kettle wall. Such spacers are necessary by reason of the relatively wide manufacturing tolerances on the width of commercially available sealing rings and because it is not possible accurately to determine the degree to which the rings are compressed.

The underside of chassis plate 12 has an integral projecting pillar 22 on which is mounted thermally responsive switch actuating means comprising a bimetallic snap-acting actuator member 23 of the type described in British Patent Specification No. 657,434. Actuator 23 comprises a substantially rectangular sheet of bimetal having a central tongue 24 released from between two outer legs 25 whose ends adjacent the free end of the tongue 24 are joined by a crimped bridge portion 26. Bridge portion 26 draws legs 25 together to impart a dished configuration to the bimetal sheet and sets up a stressed system which moves with changes in temperature with a snap-action between two oppositely dished configurations via an intermediate unstable position. The free end of tongue 24 is riveted at 27 to the end of pillar 22 and a small aperture adjacent the rivet engages a pin 28 projecting from the end of the pillar to prevent rotation of actuator 23. In the assembled condition, actuator 23 is positioned with its concave face in the cold position extending over and contacting over at least part of its area raised dimple portion 8 to ensure good and direct thermal contact between actuator 23 and the element head plate 2. Such an arrangement is described and claimed in our Patent Specification 1,401,954. If desired, thermal contact may be ensured by smearing silicon paste heat sink compound between the actuator 23 and head plate 2. Actuator 23 is calibrated (and by virtue of its simple mounting, can be calibrated prior to mounting) so that at say 120°C at which temperature the element is overheating as a result of a boil dry or dry switch on condition, the actuator moves with a snap action to its oppositely dished configuration. Since actuator 23 is mounted on thermally insulating material, there is no substantial conductive heat loss from the heat conducted from the element to the actuator and therefore the actuator reacts quickly, in about 15-20 seconds, to element overheating. In this configuration it engages a push rod 29 extending through an aperture in chassis plate 12 to move push rod 29 to flex a resilient conductive spring strip 30.

Strip 30 forms part of the switch means of the clamping and switch unit C through which current is conducted to the element. One end of the strip 30 is soldered to an end of a line terminal pin 31 and is secured to a pillar 32 of chassis plate 12. Pin 31 has an extension projecting through a central aper-

ture in pillar 32 and is secured in an apertured brass plate 33 on the other side of pillar 32 by deforming the end of the extension. Spring strip 30 mounts a movable switch contact 34 which engages in the closed position of the switch a fixed switch contact 35 mounted on a spring strip 36 secured on a boss 37. Spring strip 36 is riveted to boss 37 as at 38. The free end of strip 36 is silver slashed and extends over an aperture 39 in plate 12 which receives an element cold lead 40. In the assembled condition the cold lead 40, which is smoothed for contact, contacts the free end of strip 36 so that current can flow from line pin 31 to the element 1.

A neutral terminal pin 41 is secured on a boss upstanding from chassis plate 12 in a manner similar to line pin 31 and is there soldered to a spring strip 42 whose free end is silver slashed and curved over to be position adjacent an aperture 39 in the chassis plate receiving the other element cold lead 43 so that contact is made between the cold lead 43 (the end of the cold lead being smoothed for contact) and the free end of strip 42. A current path is thereby established between the element and neutral pin 41.

An earth pin 44 is mounted on chassis plate 12 and secured in a way similar to that of pin 31 and is soldered to a brass strip 45, whose free end is enlarged and has an aperture registering with an aperture 17 in chassis plate 12 receiving a screw stud 11. When a securing nut 18 is threaded onto the stud, an earth connection is established between the element and the earth pin.

As mentioned above when actuator 23 moves to its oppositely dished configuration as a result of element overheating, push rod 29 flexes spring strip 30, and electrical contact is broken between switch contacts 34, 35. Power to the element is cut off and the element cools down. When the element cools down sufficiently, which may take about 20 minutes, the actuator 23 moves to its original dished configuration, and the resilience of strip 30 slides push rod 29 back to its original position, and automatically remakes contact between switch contacts 34, 35 so that power is again supplied to the element.

The switch can also be actuated to cut off power to the element by thermally sensitive means sensitive to water boiling in the kettle. Such means is described and claimed in our copending Application 29324/74, 29325/74 (Serial No. 1,470,367) and comprises a bimetallic actuator member 46 similar to member 23 but positioned at the top of plate 12 adjacent a steam venting aperture V in the kettle wall. The crimped bridge portion of actuator 46 is spot welded

to a brass support plate 47 mounted on locating studs 48 and riveted by rivets 49 in a hood portion 50 of the chassis plate. This hood portion provides in transit protection for this part of the clamping unit. The free end of the central tongue 24 of actuator 46 is free to move with a snap action as a result of steam impinging on the member and raising its temperature. Actuator 46 will normally be calibrated, before mounting, so that tongue moves at about 90°C. The free end of the tongue 24 is arranged to engage the end of a bell crank lever 51. This bell crank lever forms part of an overcentre switch actuator which is completed by a U-spring 52 coupled between the lever 51 and chassis plate 12.

Bell crank lever 51 shown in part-sectional view in Figure 3 comprises an electrically insulating plastics moulding 53 moulded around a strengthening brass insert 54. Insert 54 has a bifurcated end 55 extending through registering slots 56 in chassis plate 12 and support plate 47 for engagement with actuator 46; it has been found such an arrangement provides a sufficient vapour seal to prevent any substantial amount of steam penetrating to the switch components of the clamping and switch unit and is in contrast to prior constructions having an actuator responsive to the boiling of water mounted in a separate sealed compartment. The prongs of the bifurcation 55 may be moved further apart or closer together so that a final adjustment can be made of the relative position of the tongue 24 of actuator 46 and the upper prong of bifurcation 55.

Insert 54 has a generally triangular central part and an inner part 57, at right angles to the central part, supporting a hammer portion 58 of the moulding 53. Hammer portion 58 engages the free end of spring strip 30.

An end portion 59 of moulding 53 adjacent an opening 60 in cover 14 is reduced in thickness and formed as a hook portion for receiving a plastics clip-on manual push button 61. Button 61 is slotted at 62 so that it can be pushed over hook portion 59 and has a resilient retaining bar 63 for locking button 61 in position on hook portion 59.

A pivot hole 64 in lever 51 receives a steel pivot bar 65 fixedly mounted in moulded bosses 66. Insert 54 has a recess 67 receiving one end of U spring 52. The other end of spring 52 is received in a groove in a brass bar 68 fixedly mounted in moulded bosses 69. Spring 52 permanently biases lever 51 against bar 68. An advantage of this manner of mounting lever 51 and spring 52 is that the action of the overcentre spring mechanism, determined by the relative positions of pivot 65 and the mounting points of the spring, is not affected by creep in the

chassis plate 12. This is because the rigidity of brass insert 54 maintains a constant spacing between pivot 65 and mounting recess 67 whereas any movement of mounting bar 68 relative to pivot 65 is taken up by a following movement of mounting recess 67 arising from spring 52 constantly biasing lever 51 into engagement with bar 68.

The limits of movement of the lever 51 are determined by the engagement of bar 68 with the side edges of the aperture of the triangular central part of lever 51.

In operation water boiling in the kettle causes steam to emerge from aperture V. Such steam actuates bimetallic member 46 to cause the bell crank lever 51 to move through its top dead centre position whereupon spring 52 forces the bell crank lever 51 to a position in which hammer portion 58 flexes the free end of spring strip 30. Contact between switch contacts 34, 35 is broken and power to the element is cut off. This condition is shown in solid lines in Figure 2. To reset the switch, it is necessary manually to depress push button 61 extending through aperture 60 in cover 14 to return the bell crank to the position shown in dotted lines in Figure 2.

There is thus provided at least in this embodiment, an electric immersion heater comprising a heater unit and a combined clamping and switch unit, the combined clamping and switch unit in particular being of simplified construction but without in any important way sacrificing accuracy of construction. The bimetallic members can be calibrated before being mounted on the clamping and switching unit. The action of the overcentre spring mechanism is not affected by creep in the chassis plate. Final adjustment of the overcentre mechanism can be made by the forked end of the bell crank lever. No screws are provided in the construction of the clamping and switch unit, all securing being made by friction force fits to the chassis plate; long term stability is thereby provided.

Modifications of the above described embodiment may be envisaged. For example, the embodiment may be modified so as to provide only element overheating control merely by removing that part of the chassis plate of the clamping and switch unit, and the parts mounted thereon, which is above the circular rim on the underside of the chassis plate, indicated by the line X—X. A suitable cylindrical cover would then be provided to cover the switch of the clamping and switch unit and to surround the remaining part of the chassis plate.

WHAT WE CLAIM IS:—

1. A thermally-controlled electric immersion heater for mounting on the wall of a liquid heating vessel including a heater unit



to a brass support plate 47 mounted on locating studs 48 and riveted by rivets 49 in a hood portion 50 of the chassis plate. This hood portion provides in transit protection for this part of the clamping unit. The free end of the central tongue 24 of actuator 46 is free to move with a snap action as a result of steam impinging on the member and raising its temperature. Actuator 46 will normally be calibrated, before mounting, so that tongue moves at about 90°C. The free end of the tongue 24 is arranged to engage the end of a bell crank lever 51. This bell crank lever forms part of an overcentre switch actuator which is completed by a U-spring 52 coupled between the lever 51 and chassis plate 12.

Bell crank lever 51 shown in part-sectional view in Figure 3 comprises an electrically insulating plastics moulding 53 moulded around a strengthening brass insert 54. Insert 54 has a bifurcated end 55 extending through registering slots 56 in chassis plate 12 and support plate 47 for engagement with actuator 46; it has been found such an arrangement provides a sufficient vapour seal to prevent any substantial amount of steam penetrating to the switch components of the clamping and switch unit and is in contrast to prior constructions having an actuator responsive to the boiling of water mounted in a separate sealed compartment. The prongs of the bifurcation 55 may be moved further apart or closer together so that a final adjustment can be made of the relative position of the tongue 24 of actuator 46 and the upper prong of bifurcation 55.

Insert 54 has a generally triangular central part and an inner part 57, at right angles to the central part, supporting a hammer portion 58 of the moulding 53. Hammer portion 58 engages the free end of spring strip 30.

An end portion 59 of moulding 53 adjacent an opening 60 in cover 14 is reduced in thickness and formed as a hook portion for receiving a plastics clip-on manual push button 61. Button 61 is slotted at 62 so that it can be pushed over hook portion 59 and has a resilient retaining bar 63 for locking button 61 in position on hook portion 59.

A pivot hole 64 in lever 51 receives a steel pivot bar 65 fixedly mounted in moulded bosses 66. Insert 54 has a recess 67 receiving one end of U spring 52. The other end of spring 52 is received in a groove in a brass bar 68 fixedly mounted in moulded bosses 69. Spring 52 permanently biases lever 51 against bar 68. An advantage of this manner of mounting lever 51 and spring 52 is that the action of the overcentre spring mechanism, determined by the relative positions of pivot 65 and the mounting points of the spring, is not affected by creep in the

chassis plate 12. This is because the rigidity of brass insert 54 maintains a constant spacing between pivot 65 and mounting recess 67 whereas any movement of mounting bar 68 relative to pivot 65 is taken up by a following movement of mounting recess 67 arising from spring 52 constantly biasing lever 51 into engagement with bar 68.

The limits of movement of the lever 51 are determined by the engagement of bar 68 with the side edges of the aperture of the triangular central part of lever 51.

In operation water boiling in the kettle causes steam to emerge from aperture V. Such steam actuates bimetallic member 46 to cause the bell crank lever 51 to move through its top dead centre position whereupon spring 52 forces the bell crank lever 51 to a position in which hammer portion 58 flexes the free end of spring strip 30. Contact between switch contacts 34, 35 is broken and power to the element is cut off. This condition is shown in solid lines in Figure 2. To reset the switch, it is necessary manually to depress push button 61 extending through aperture 60 in cover 14 to return the bell crank to the position shown in dotted lines in Figure 2.

There is thus provided at least in this embodiment, an electric immersion heater comprising a heater unit and a combined clamping and switch unit, the combined clamping and switch unit in particular being of simplified construction but without in any important way sacrificing accuracy of construction. The bimetallic members can be calibrated before being mounted on the clamping and switching unit. The action of the overcentre spring mechanism is not affected by creep in the chassis plate. Final adjustment of the overcentre mechanism can be made by the forked end of the bell crank lever. No screws are provided in the construction of the clamping and switch unit, all securing being made by friction force fits to the chassis plate; long term stability is thereby provided.

Modifications of the above described embodiment may be envisaged. For example, the embodiment may be modified so as to provide only element overheating control merely by removing that part of the chassis plate of the clamping and switch unit, and the parts mounted thereon, which is above the circular rim on the underside of the chassis plate, indicated by the line X—X. A suitable cylindrical cover would then be provided to cover the switch of the clamping and switch unit and to surround the remaining part of the chassis plate.

WHAT WE CLAIM IS:—

1. A thermally-controlled electric immersion heater for mounting on the wall of a liquid heating vessel including a heater unit



and a switch unit, the heater unit including a heater element carried by a heater head in the form of a plate of substantially flat or dished configuration, and the switch unit including at least the movable contact of an electrical switch for interrupting the electrical supply to the heater element and thermally responsive switch actuating means mounted to make direct thermal contact with said head plate and comprising a stressed sheet of bimetal movable with changes in temperature between oppositely dished configurations with a snap-action, mounted on a thermally insulating portion of the switch unit so that there is in use no substantial conductive heat loss from the heat conducted to the bimetal sheet from the head plate.

2. A heater as claimed in claim 1 including a plurality of connecting means for interconnecting the switch unit and the heater unit when positioned with the clamping unit on the outside and the heater unit on the inside of an appropriate access aperture of apertures formed in the wall of a vessel to which the heater is to be fitted and through which the connecting means will extend, the plurality of connecting means each being such as to draw the heater unit and switch unit together whereby in use said units clamp the wall of the vessel therebetween, the combination of said units and said plurality of connecting means constituting a sufficient means of mounting the heater on the vessel wall, and liquid sealing means for positioning between said head plate and the vessel wall to be compressed between said head plate and the vessel wall when the heater is mounted on the vessel wall.

3. A heater as claimed in claim 2 wherein said plurality of connecting means comprises studs mounted on said head plate, the switch unit being formed to receive the studs, and at least the ends of the studs being formed to receive fastenings forming part of said connecting means to secure the switch unit to the studs.

4. The switch unit of a thermally controlled electric immersion heater for mounting on the wall of a liquid heating vessel as claimed in claim 1, the switch unit including at least the movable contact of an electrical switch for interrupting the electrical supply to the heater element and thermally responsive switch actuating means mounted to make direct thermal contact with said head plate and comprising a stressed sheet of bimetal movable with changes in temperature between oppositely dished configurations with a snap action mounted on a thermally insulating portion of the switch unit so that there is in use no substantial conductive heat loss from the heat conducted to the bimetal sheet from the head plate.

5. The switch unit of a thermally controlled electric immersion heater for mounting on the wall of a liquid heating vessel as claimed in claim 3, the switch unit including at least the movable contact of an electrical switch for interrupting the electrical supply to the heater element and thermally responsive switch actuating means mounted to make direct thermal contact with said head plate and comprising a stressed sheet of bimetal movable with changes in temperature between oppositely dished configurations with a snap-action mounted on a thermally insulating portion of the switch unit so that there is in use no substantial conductive heat loss from the heat conducted to the bimetal sheet from the head plate, said switch unit being formed to receive said studs of said heater unit and having an annular portion for positioning around said access aperture or apertures to engage the wall of the vessel when the heater is mounted on the vessel.

6. A heater or switch unit as claimed in any preceding claim wherein the bimetal sheet has a central tongue and is mounted at the free end thereof.

7. A heater or switch unit as claimed in claim 6 wherein the bimetal sheet is mounted in such a way that it cannot rotate.

8. A heater or switch unit as claimed in any preceding claim including spacing means for abutting said head plate when the heater is mounted on the vessel wall so that the bimetal sheet is in a predetermined position relative to said head plate.

9. A heater or switch unit as claimed in claim 8 wherein said spacing means comprise a plurality of studs extending from said switch unit to abut said head plate when the heater is mounted on the vessel wall.

10. A heater or switch unit as claimed in any preceding claims wherein the switch unit mounts the terminals for connection to a mains connector and the switch unit mounts spring contacts for connecting the live and neutral terminals to the cold leads of the heater element.

11. A heater or switch unit as claimed in any preceding claim wherein the switch unit mounts the terminals for connection to a mains connector, an earth terminal being arranged for electrical connection with an electrically conductive one of a plurality of connecting means for interconnecting the switch unit and heater unit.

12. A heater as claimed in claim 1 wherein the bimetal sheet is arranged for direct thermal contact with said head plate on its concave side in the position to which it moves with falling temperature.

13. A heater as claimed in claim 12 wherein the bimetal sheet is arranged so that when the heater is mounted on a vessel wall, the sheet is positioned over a protrusion



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sion of the head plate and contacts the protrusion over at least a substantial area of the bimetal sheet.

- 5 14. A switch unit of a thermally controlled electric immersion heater as claimed in claim 4 substantially as described with reference to the accompanying drawings.

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