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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, i.e. immersion heaters having electrical switch means and actuating means therefor sensitive to a condition in which overheating of the heater element may occur and/or sensitive to the boiling of the liquid contents of the vessel.

Such immersion heaters are well-known and it is an object of the invention to provide a simplified construction particularly as regards the fitting of the heater to a vessel with a view to reducing manufacturing costs.

In a first aspect, the invention provides a thermally-controlled electric immersion heater for mounting on the wall of a liquid heating vessel, the heater including a heater unit and clamping 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, an electrical switch for interrupting the electrical supply to the heater element, switch actuating means for actuating said switch, a plurality of connecting means for interconnecting the clamping unit and 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 said heater is to be fitted

and through which said connecting means will extend, the plurality of connecting means each being such as to draw the heater unit and clamping 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.

Since the units and connecting means constitute a sufficient means of mounting the heater according to the invention on the vessel wall, no other connecting or fastening means need necessarily be provided. Construction and fitting is thereby simplified. This combined with an element head in the form of a substantially flat or dished plate as opposed to the conventional hot-pressed housing enables substantial cost savings to be achieved.

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 clamping unit and clamped in that position when the heater is mounted. The sealing means are conveniently in the form of annular resilient seals.

Preferably a switch unit is provided, which may or may not be included in the clamping unit, carrying at least the movable contact of the electrical switch.

Where switch actuating means is provided responsive to a condition in which element overheating may occur such means may comprise a float arranged to actuate

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the electrical switch, disposed in the vessel and sensitive to a critically low level of liquid in the vessel in which the element is uncovered. Alternatively such means may

5 comprise a pressure sensitive means responsive to the weight of the vessel and its contents and arranged to actuate the electrical switch at a weight corresponding to a critically low level of liquid in the vessel.

10 Preferably however for simplicity, the switch actuating means is thermally responsive and is arranged to sense the temperature of the element to detect element overheating. Such thermally-responsive actuating means

15 may if desired be mounted on the heater head plate; for convenience however it is preferred to mount such means on the switch unit in a position for direct thermal contact with the head plate.

20 The thermally-responsive switch actuating means may be of any suitable type such as vapour capsules or Curie metal devices (see British Patent Specification 1,149,060), but are preferably bimetallic members. Because

25 of their large actuation movement and resistance to "creep", by which is meant resistance to permanent deformation through continued use, it is preferred to employ bimetallic snap-acting members comprising a

30 stressed sheet of bimetal of dished configuration which moves with changes in temperature between two opposite dished configurations.

35 Preferably in the present invention, the bimetallic member is mounted directly on a thermally insulating portion of the switch unit, so that there is no substantial heat loss from the heat conducted from the head plate to the bimetallic member whereby the bi-

40 metallic member reacts quickly to an element overheating condition. Such an arrangement is described and claimed in our copending Application 21101/74, 21102/74, 21103/74 (Serial No. 1,470,365).

45 The bimetallic member may be mounted on a pillar or boss integral with a thermally insulating body of the switch unit and preferably is mounted in such a way as to prevent any rotation of the member about its

50 mounting.

55 Where said liquid sealing means between the head plate and vessel wall comprises an annular resilient seal, and particularly where a similar seal is provided between the switch unit and the vessel wall, such seals tend to have wide manufacturing tolerances which may result in the bimetallic member responsive to element overheating being spaced a variable distance from the head

60 plate when the immersion heater is mounted on a vessel wall with consequent uncertain operation of the heater. In accordance with a preferred feature of the invention, the switch unit includes spacer means for abutting the heater head plate to space the switch

unit and hence the bimetallic member a predetermined distance from the heater head plate when the heater is mounted on a vessel wall.

The switch unit may incorporate only

70 thermally responsive switch-actuating means for protecting the element from overheating; it may additionally incorporate thermally responsive switch-actuating means sensitive to the boiling of the liquid contents of the vessel and positioned in use for exposure to vapour arising from such boiling; alternatively when the heater is to be fitted to a vessel as described and claimed in our co-

80 pending Application 7069/73 (Serial No. 1,470,364), from which this application is divided, the switch unit may incorporate switch actuating means sensitive to the boiling of liquid and fulfilling both a boiling control function and an element overheating function.

85 Preferably the connecting means comprises a plurality of screw studs mounted on said head plate and preferably spaced around the perimeter thereof and said

90 clamping unit is constructed to receive the studs as they extend through the wall of the vessel, so that when nuts, spring clip fastenings or other suitable fastenings are secured to the studs, the heater is mounted on the

95 wall of the vessel. In an alternative construction said connecting means comprise a plurality of internally screw threaded bosses mounted on said head plate for receiving bolts inserted from the outside of the vessel

100 and extending through said clamping unit. Preferably in either of the above constructions, the clamping unit has a body provided with apertures for registering with the bolts or screw studs, so that they can be

105 inserted through the apertures, and an annular portion for positioning around said access aperture or apertures to clamp the wall of the vessel.

110 There is accordingly provided in a further aspect of the invention the combination of a clamping unit and a switch unit for a heater as aforesaid including thermally-

115 responsive switch actuating means sensitive to element over-heating comprising a stressed sheet of bimetal movable with changes in temperature between oppositely dished configurations with a snap-action mounted for direct thermal contact with said head plate,

120 and at least the movable contact of said electrical switch, the clamping unit being formed to receive studs comprising said plurality of connecting means, and having an annular portion for positioning around

125 said access aperture or apertures to clamp the wall of said vessel when the heater is mounted on said vessel.

Where the clamping unit is separated from the switch unit, means may be provided for securing the switch unit to said head plate so

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that the switch unit and heater unit together can form a compound unit, said plurality of connecting means each being such as to draw together said compound unit and clamping unit whereby in use the said compound unit and clamping unit clamp the wall of said vessel therebetween to mount the heater on the vessel wall, the switch unit and head plate being adapted to cooperate when secured together to form a liquid-tight seal therebetween such that, in use, any liquid which might penetrate between the wall of the vessel and the compound unit is prevented from contacting the electrical components of said switch unit.

This form of the invention is particularly intended for use where only a thermally-responsive means sensitive to element overheating is provided.

Where this form of the heater according to the invention is to be marketed as a replacement heater to be fitted to existing vessels it may be supplied with the switch unit secured to the head plate and forming said compound unit so that it is not necessary to rely on a member of the public buying the heater correctly connecting the switch unit and head plate to form the said seal therebetween.

Said switch unit securing means may be of any suitable kind for example bolts extending through the switch unit into internally threaded bosses mounted on the head plate or, as preferred, studs mounted on the head plate for extending through the switch unit, the end portions of the studs being formed to receive securing nuts or spring clip fastenings.

Said plurality of connecting means may if desired be arranged to connect said clamping unit directly to said head plate or to said switch unit. In a preferred arrangement from the point of view of cost and the economical use of space, said securing means may form part of said connecting means. For example said studs of the securing means may be sufficiently long to extend through the clamping unit and further securing nuts or spring clip fastenings may be provided to fasten the locking member on the studs. As preferred, intermediate connecting means such as internally threaded sleeves are provided for receiving at one end the screw studs to secure the switch unit to the head plate and for receiving at the other end connecting members such as bolts inserted through the locking member, thereby to form connecting means to connect the clamping unit and compound unit.

Where said connecting and securing means are combined, an electrically insulating body of the switch unit preferably has apertures registering with the securing means so that the securing means can extend therethrough.

The clamping unit is preferably arranged to

receive the compound unit as a snug fit and to form a protective cowl to cover exposed terminals of the compound unit. The clamping unit preferably has apertures registering with the apertures of the compound unit so that the connecting means can extend therethrough.

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 one 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 preferred however 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 earth pin may conveniently be connected with the heater element by connecting it to an electrically conductive one of said plurality of connecting means.

The heater head plate may be a cold pressing of for example brass plate and may be brazed or welded to the heater element. Alternatively the head plate may be of relatively thin deformable material crimped onto the element.

Some embodiments 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-closed 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;

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;

Figure 5 is an exploded perspective view of a second embodiment including a switch unit sensitive to element overheating only, and a clamping unit separate from the switch unit;

Figure 6 is a side sectional view of the second embodiment mounted on a vessel wall; and

Figure 7 is an exploded perspective view of a third embodiment including a combined switch and clamping unit and thermally-responsive actuating means mounted on the heater unit.

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 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 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 clamping 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 unit projecting into the recess.

The clamping unit has apertures 17 registering with screw studs 11 so that when the clamping 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 clamping and heater units 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 distance 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 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 dish 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 head plate. 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 the 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 aperture 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 positioned 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 re-makes 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 bi-metallic 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 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 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 be-

cause 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 with switch contacts 34, 35 closed 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 from a first through its top dead centre position to a second 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 clamping unit, the clamping 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 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 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 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 unit and to surround the remaining part of the chassis plate.

Referring now to the second embodiment shown in Figures 5 and 6, it comprises generally a heater unit H, a switch unit S securable to the heater unit, and a clamping unit C which cooperates with connecting means to mount the entire heater on a vessel

wall. Switch unit S is responsive only to element overheating and does not incorporate a liquid boiling control.

Many of the components of this second embodiment are similar to components of the first embodiment and for convenience similar components are referred to by the same reference numerals.

Heater unit H is generally similar to that shown in Figure 1. Aliquid sealing means comprising a resilient sealing ring 10 is disposed against a flat rim of head plate 2. A hollow cylindrical neutral mains pin 70 is crimped to element cold lead 43. Element cold lead 40 carries a circular end stud 71. A rectangular earth pin 72 is brazed directly to plate 2.

Switch unit S has a hollow generally cylindrical electrically insulating body 73. One end on the body is closed by a web 74 which serves to mount the various electrical components of the switch unit. Three internal bosses 75 disposed around the perimeter of body 73 have axially extending apertures 76 registering with screw studs 11 so that the studs can be inserted through the apertures.

Bimetallic snap acting switch actuator member 23 is mounted by a screw 23¹ on a thermally insulating rectangular mounting block 77 integral with web 74 and is positioned at the open end of body 73 so as to make direct thermal contact with head plate 2, thereby to respond to element overheating.

Actuator 23 serves to control an electrical switch of the switch unit, and movement of member 23 is transmitted by a push rod 78 contacting the end of a leg 25 of actuator 23. Push rod 78 is in the form of a rectangular frame slidably mounted in opposing channel members 79 upstanding from web 74 and web 74 is slotted at the base of channel members 79 to allow the push rod 78 to move therethrough.

An inner edge of the push rod contacts a free end of a resilient conductive inverted U-shape spring strip 80, the free end bearing movable switch contact 34. The other end of spring 80 is secured by a screw 81 to the inner face of web 74. Screw 81 also serves to secure a cylindrical line pin 82 by being screwed into an internally threaded shank portion 83 extending through web 74.

Movable switch contact 34 normally engages fixed switch contact 35 mounted on a conductive strip portion 84 secured to a mounting block 85 by a screw 84¹. An end portion 86 of strip 83 is tinned so that the end portion can make good electrical connection with the stud 71 of cold lead 40.

Web 74 has apertures 87, so that earth and neutral pins 70 and 72 can be inserted therethrough.

A clamping unit C is provided in the form of an electrically insulating cowl of

frusto-conical shape. A central web 89 extends across the unit C so as to define on one side a recess for receiving switch unit S as a snug fit. Web 89 has apertures 90 to allow terminal pins 70, 72 and 82 to pass through to its other side where there is defined a recess R for receiving a socket connector (not shown).

Unit C has apertures 91 registering with apertures 76 of body 73, and bolts 92 and internally screw threaded sleeves 93 are provided for assembling the heater H, switch unit S and clamping unit C.

In the assembly of the immersion heater, switch unit S is first mounted on plate 2 by locating screw studs 11 in apertures 76. Screw sleeves 93 are screwed onto the ends of studs 11 to secure the unit S to plate 2 to form a compound unit. The edge of the open end of body 73 cooperates with the flat surface of head plate 2 to form a liquid tight seal. If desired, an annular seal member may be located between plate 2 and the edge of body 73. The tinned end portion 86 contacts cold lead 40 so that fixed switch contact 35 is in electrical connection with the heater element. In the compound unit, actuator 23 is in good thermal contact with head plate 2.

To mount the immersion heater on the wall of a liquid heating vessel, the compound unit is inserted in a vessel K and the switch unit S is positioned to extend through an appropriate access aperture in the wall of the vessel. Clamping unit C is then positioned outside the vessel wall to receive switch unit S and bolts 92 are inserted through apertures 91 and are screwed into the open ends of sleeves 93, thereby to connect clamping unit C to the compound unit, and to draw together the compound unit and the clamping unit to clamp the wall of the vessel therebetween to mount the heater on the vessel wall. It can thus be seen that three connecting means are provided for interconnecting the clamping unit and the compound unit, each means being constituted by a screw stud 11, a sleeve 93 and a bolt 92. Annular seal 10 is disposed between the outer perimeter of plate 2 and the vessel wall; if desired, an annular seal may be disposed between the inner edge of clamping unit C and the vessel wall.

The operation of this second embodiment is similar to that of the element overheating control of the first embodiment.

If desired, the switch of the switch unit of this second embodiment could be modified for example by replacing spring strip 80 with an overcentre spring mechanism, so that upon actuation of the switch, the switch does not automatically regain its original state when the element cools down, but has to be reset manually.

A third embodiment responsive only to

element overheating is shown in Figure 7. This embodiment comprises a combined clamping and switch unit C and a heater unit H. Components similar to those of the first and second embodiments are denoted by similar reference numerals.

Heater unit H has a hot return 7 brazed to the head plate 2 below the cold leads. Head plate 2 mounts actuator 23 on heat transferring dimple 8 by means of a nut 100 screwed on a bolt 101 brazed on dimple 8. As an alternative means of mounting actuator 23, the free end of tongue 24 may have a square aperture and may be riveted to dimple 8 by a square sectioned rivet to prevent rotation of the actuator.

Clamping and switch unit C comprises a generally cylindrical plastics body 102 having a diametrically extending web mounting the electrical components of the switch unit.

Bridge portion 26 of actuator 23 is arranged to engage a push rod 103 slidably mounted in an aperture 104 of the body 102 of the switch unit. The other end of the push rod 103 contacts the free end of a resilient leaf spring 105 carrying movable switch contact 34. The movable contact 34 engages in use cold lead 40 extending through an aperture 106 in body 102. End 35 of cold lead 40 is formed as a circular stud to ensure good electrical contact with movable contact 34 and serves as a fixed contact of the electrical switch.

The fixed end of leaf spring 105 is apertured to receive line terminal 31 of steel which is brazed to the leaf spring. It can thus be seen that the electrical switch of switch unit C couples the line terminal 31 to cold lead 40. Line terminal 31 extends through the apertured leaf spring and is located in a rectangular recess 107 in body 102 to mount terminal 35 and leaf spring 105.

A neutral terminal 108 formed as an L-shaped steel piece is brazed directly to the end of cold lead 43 and extends through a locating slot 109 in body 102. A recessed cover portion 110 of body 102 covers the leg of terminal 108 connected to cold lead 43. A steel earth terminal 111 is capacitor discharge welded directly to head plate 2 and extends through a locating slot 112 in body 102.

A plurality of connecting means comprising three screw studs 11 are capacitor discharge welded around the perimeter of plate 2 and extend through registering apertures 113 in body 102. Fixing nuts 114, 115 are provided for securing studs 11. Thus with head plate 2 disposed on the inside of a vessel wall K and studs 11 extending through an access aperture A in the vessel wall the securing of each stud in a respective aperture 113 of body 102 disposed on the outside of the vessel wall serves to draw the

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heater and clamping units together to clamp the kettle wall K between plate 2 and the edge of body 102 and thus secure both the heater unit H and the switch units to the vessel wall. It may thus be seen that body 102, having an inner edge or rim for engaging a vessel wall and apertures 113, serves as a clamping unit cooperating with the screw studs 3 to mount the heater to the vessel wall.

Fixing nut 115 is formed as a relatively long internally screw threaded sleeve so that while one end receives a screw stud 11, the other end receives a bolt 116 serving to secure an electrically insulating shroud 117 to body 102. Shroud 117, of hollow and generally frusto conical shape, surrounds body 102 and terminals 31, 108, 111 in the assembled condition.

At the same time as the heater unit and the switch unit are secured to the vessel wall, liquid sealing means comprising a ring seal 20 is compressed between the body 102 and the outer surface of the vessel wall. A further ring seal 10, received in an annular recess 118 around the perimeter of plate 2 is compressed between plate 2 and the inner surface of vessel wall.

The operation of this embodiment is similar to the element overheating control of the first embodiment as described above.

WHAT WE CLAIM IS:—

1. A thermally-controlled electric immersion heater for mounting on the wall of a liquid heating vessel, the heater including a heater unit and clamping 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, an electrical switch for interrupting the electrical supply to the heater element, switch actuating means for actuating said switch, a plurality of connecting means for interconnecting the clamping unit and 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 said heater is to be fitted and through which said connecting means will extend, the plurality of connecting means each being such as to draw the heater unit and clamping 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.

2. A heater as claimed in claim 1

wherein said plurality of connecting means comprise studs mounted on said head plate, the clamping 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 clamping unit to the studs.

3. A heater as claimed in claim 1 or 2 wherein the clamping unit includes an annular portion for positioning around said access aperture or apertures to clamp the wall of said vessel when the heater is mounted on said vessel.

4. A heater as claimed in any preceding claim including a switch unit carrying at least the movable contact of said electrical switch.

5. A heater as claimed in claim 4 wherein the switch unit includes thermally responsive switch actuating means responsive to element overheating mounted to be in direct thermal contact with said head plate.

6. A heater as claimed in claim 5 wherein the thermally responsive actuating means comprises a stressed sheet of bimetal of dished configuration which moves with changes in temperature between two oppositely dished configurations with a snap-action.

7. A heater as claimed in any of claims 4 to 6 wherein the switch unit is separate from the clamping unit and including means for securing the switch unit to the plate to form a compound unit of said switch and heater units, the switch unit and head plate cooperating when secured together to form a liquid-tight seal therebetween such that, in use, any liquid which might penetrate between the wall of the vessel and the compound unit is prevented from contacting the electrical components of the switch unit.

8. A heater as claimed in claim 7 wherein said securing means comprises studs mounted on said head plate for extending through said switch unit, said studs serving as part of said plurality of connecting means, fastenings being provided to secure the switch unit and clamping unit to said studs.

9. A heater as claimed in claim 4 wherein said clamping unit includes said switch unit.

10. A heater as claimed in claim 5 or 6 wherein said clamping unit includes said switch unit.

11. A heater as claimed in any of claims 1 to 6, 9 or 10 including further compressible liquid sealing means for positioning between the clamping unit and the vessel wall.

12. A heater as claimed in either of claims 7 or 8 including further compressible liquid sealing means for positioning between the clamping unit and the vessel wall.

13. A heater as claimed in claim 6 wherein the switch unit includes spacer means for abutting the head plate to posi-



heater and clamping units together to clamp the kettle wall K between plate 2 and the edge of body 102 and thus secure both the heater unit H and the switch units to the vessel wall. It may thus be seen that body 102, having an inner edge or rim for engaging a vessel wall and apertures 113, serves as a clamping unit cooperating with the screw studs 3 to mount the heater to the vessel wall.

Fixing nut 115 is formed as a relatively long internally screw threaded sleeve so that while one end receives a screw stud 11, the other end receives a bolt 116 serving to secure an electrically insulating shroud 117 to body 102. Shroud 117, of hollow and generally frusto conical shape, surrounds body 102 and terminals 31, 108, 111 in the assembled condition.

At the same time as the heater unit and the switch unit are secured to the vessel wall, liquid sealing means comprising a ring seal 20 is compressed between the body 102 and the outer surface of the vessel wall. A further ring seal 10, received in an annular recess 118 around the perimeter of plate 2 is compressed between plate 2 and the inner surface of vessel wall.

The operation of this embodiment is similar to the element overheating control of the first embodiment as described above.

WHAT WE CLAIM IS:—

1. A thermally-controlled electric immersion heater for mounting on the wall of a liquid heating vessel, the heater including a heater unit and clamping 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, an electrical switch for interrupting the electrical supply to the heater element, switch actuating means for actuating said switch, a plurality of connecting means for interconnecting the clamping unit and 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 said heater is to be fitted and through which said connecting means will extend, the plurality of connecting means each being such as to draw the heater unit and clamping 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.

2. A heater as claimed in claim 1

wherein said plurality of connecting means comprise studs mounted on said head plate, the clamping 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 clamping unit to the studs.

3. A heater as claimed in claim 1 or 2 wherein the clamping unit includes an annular portion for positioning around said access aperture or apertures to clamp the wall of said vessel when the heater is mounted on said vessel.

4. A heater as claimed in any preceding claim including a switch unit carrying at least the movable contact of said electrical switch.

5. A heater as claimed in claim 4 wherein the switch unit includes thermally responsive switch actuating means responsive to element overheating mounted to be in direct thermal contact with said head plate.

6. A heater as claimed in claim 5 wherein the thermally responsive actuating means comprises a stressed sheet of bimetal of dished configuration which moves with changes in temperature between two oppositely dished configurations with a snap-action.

7. A heater as claimed in any of claims 4 to 6 wherein the switch unit is separate from the clamping unit and including means for securing the switch unit to the plate to form a compound unit of said switch and heater units, the switch unit and head plate cooperating when secured together to form a liquid-tight seal therebetween such that, in use, any liquid which might penetrate between the wall of the vessel and the compound unit is prevented from contacting the electrical components of the switch unit.

8. A heater as claimed in claim 7 wherein said securing means comprises studs mounted on said head plate for extending through said switch unit, said studs serving as part of said plurality of connecting means, fastenings being provided to secure the switch unit and clamping unit to said studs.

9. A heater as claimed in claim 4 wherein said clamping unit includes said switch unit.

10. A heater as claimed in claim 5 or 6 wherein said clamping unit includes said switch unit.

11. A heater as claimed in any of claims 1 to 6, 9 or 10 including further compressible liquid sealing means for positioning between the clamping unit and the vessel wall.

12. A heater as claimed in either of claims 7 or 8 including further compressible liquid sealing means for positioning between the clamping unit and the vessel wall.

13. A heater as claimed in claim 6 wherein the switch unit includes spacer means for abutting the head plate to posi-



tion the bimetal sheet in a predetermined position relative to the head plate.

14. A heater as claimed in any preceding claim including thermally responsive means sensitive to boiling liquid mounted on a body of the switch unit in a position for exposure, in use, to vapour emerging from the vessel, an overcentre spring mechanism coupling said thermally responsive means to a movable contact of an electrical switch for opening and closing said switch, said overcentre spring mechanism being movable between a first position in which said switch is closed and power can be supplied to the immersion heater, and a second position in which said switch is open for interrupting the supply of power to the immersion heater, a lever of the overcentre mechanism being pivotally mounted on said body and a spring of the overcentre mechanism being mounted between said lever and an abutment on said body so that the spring biases said lever into engagement with the abutment in the inoperative position of the overcentre mechanism wherein power can be supplied to the immersion heater.

15. A heater as claimed in claim 14 wherein said body provides a barrier for vapour between said thermally responsive means and said electrical switch, and the lever has a metal strip insert having an end portion extending through a slot in the barrier, said insert end portion and slot being so relatively dimensioned that a sufficient vapour seal is formed throughout the range of movement of said end portion to prevent harmful penetration of vapour through the slot.

16. A heater as claimed in claim 14 or 15 wherein the insert end is deformable for adjusting the spacing between it and said thermally responsive means.

17. A heater as claimed in claim 15 or 16 wherein the insert end is bifurcated and the legs of the bifurcation are deformable towards and away from each other.

18. A heater as claimed in any preceding claim wherein terminals for connection to a mains connector are mounted on a switch unit which includes at least the movable contact of said electrical switch, spring contacts being mounted on the switch unit for connecting live and neutral terminals to the cold leads of the heater element.

19. A heater as claimed in any preced-

ing claim wherein terminal for connection to a mains connector are mounted on a switch unit which includes at least the movable contact of said electrical switch, an earth terminal being arranged for connection with an electrically conductive one of said plurality of connecting means.

20. A thermally controlled electric immersion heater as claimed in claim 1 substantially as hereinbefore described with reference to Figures 1 to 4 of the accompanying drawings.

21. A thermally controlled electric immersion heater as claimed in claim 1 substantially as hereinbefore described with reference to Figures 5 and 6 of the accompanying drawings.

22. A thermally controlled electric immersion heater as claimed in claim 1 substantially as hereinbefore described with reference to Figure 7 of the accompanying drawings.

23. The combination of a switch unit and a clamping unit for a heater as claimed in claim 4, including thermally responsive switch actuating means sensitive to element overheating comprising a stressed sheet of bimetal movable with changes in temperature between oppositely dished configurations with a snap-action mounted for direct thermal contact with said head plate, and at least the movable contact of said electrical switch, the clamping unit being formed to receive studs comprising said plurality of connecting means, and having an annular portion for positioning around said access aperture or apertures to clamp the wall of said vessel when the heater is mounted on said vessel.

24. The combination as claimed in claim 23 including spacer means for abutting said head plate to space the clamping unit a predetermined distance from said head plate when the heater is mounted.

25. A heater as claimed in any of claims 1 to 22 mounted on the wall of a liquid heating vessel.

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