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(54) IMPROVEMENTS RELATING TO ELECTRIC IMMERSION HEATER UNITS

(71) We, OTTER CONTROLS LIMITED, a British Company, and JOHN CRAWSHAW TAYLOR, a British subject, both 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:—

10 This invention relates to electric immersion heater units for water boiling containers such as electric kettles, jugs, coffee percolators, pans, urns, laboratory equipment and the like, of the kind comprising a heating element carried by a head which head is adapted to be secured in a water-tight manner in or adjacent an opening in the container wall, via which opening the heating element is connectible to the electric power supply. Such electric immersion heater units are those referred to hereinafter as being "of the kind described". It is a primary object of the present invention to provide improved means for enabling the electric power supply to the heating element of such a unit, when fitted to a container, to be cut off automatically when the water in the container boils.

30 It has already been proposed to make use of the steam produced when the water in an electric kettle fitted with such a unit boils, to operate a thermally sensitive switch to cut off the power supply to the heating element of the unit. In one known arrangement an opening is provided in the side wall of a kettle above the intended maximum water level therein, for the egress of steam to operate a thermally sensitive switch actuating member mounted on the outside of the kettle. In another known arrangement a thermally sensitive switch actuating member is mounted within a kettle from the roof thereof so as to be operated by the steam and is arranged to actuate switch contacts mounted on top of the kettle via a flexible diaphragm forming part of the kettle roof.

[Price 25p]

However, such known arrangements have the disadvantage that the kettle has to be specially adapted to the operation of the steam sensitive switch e.g. by the provision of a steam outlet opening in the kettle side wall, which is inconvenient from the kettle manufacturer's point of view.

According to the present invention there is provided an electric immersion heater unit of the kind described, which carries a tube for the egress of steam from the interior of an associated water boiling container in use of the unit, via the said head of the unit, which tube is arranged so as to extend above water level when the said head is mounted below water level, and steam-sensitive switch means connected or connectible to said head on the outside of the same and operable by steam passing through said tube to cut off or reduce the power supply to the heating element when the water in the container boils.

The said steam-sensitive switch means for cutting off or at least reducing the power supply to the heating element may be of any convenient kind. Thus such means could conceivably be an electronic switching circuit composed of miniature solid state components and including a temperature-sensitive element. Usually, however, the steam-sensitive switch means will comprise a thermally sensitive mechanical switch arranged to cut off the power supply to the heating element of the unit. The steam sensitive switch means may if desired be incorporated in the immersion heater unit as supplied for fitting into a container, e.g. by mounting it in or on said head, or it could be provided in a separate socket connector for receiving mains terminal pins of the heating element of such a unit to connect the element to the electrical power supply.

The combination of a tube for the egress of steam from a container with an immersion heater unit for the container results in the container itself not having to be adapted

in any way for the egress of steam therefrom to operate means for cutting off or reducing the power supply to its heating element. Immersion heater units according

5 to the invention can therefore be fitted to any container having a suitably dimensioned aperture in its wall for the reception of the head of the electric immersion heater unit; it will thus be appreciated that units
10 according to the invention can be fitted, for example, to all conventional electric kettles formed with a head-receiving aperture of standard size. Moreover, in addition to being applicable to new containers during
15 their final assembly, units according to the invention may be used to replace conventional units of the kind described in containers already in use, so permitting such
20 containers to be converted to steam-regulated operation with a minimum of inconvenience.

So as to facilitate its insertion into a container, and/or to facilitate packing of the unit, a unit according to the invention may be provided for use with its steam tube extending
25 in the same general plane as the heating element of the unit, the tube being bendable into a position in which its inlet is above the intended maximum water level in the container, either before the unit is mounted
30 therein or subsequent to such mounting if so necessitated by the shape of the container; the tube should be bendable into a position in which its steam inlet is protected from the entry of water when the
35 container is being filled, e.g. by having the inlet displaced out of alignment with the filling opening of the container. In a preferred embodiment the tube is made of copper, partly to facilitate bending thereof
40 and partly to provide for good heat conduction to the interior of the tube from the surrounding liquid in a container in use and so minimise condensation of the steam in the tube before it reaches the steam-sensitive means which it is to operate.

The manner in which the steam tube is carried by the head of a unit according to the invention may vary depending mainly on
50 where the steam is to be applied relative to the head. When the head is of hollow construction, as is conventional in electric kettles for example, the steam tube itself need not pass through a wall of the head, but rather could terminate at an aperture in
55 the head wall through which the steam will pass; the steam would then be applied to steam-sensitive means mounted immediately inside the head wall, or alternatively could continue its flow via a further tube within
60 the head. In another alternative the steam tube could constitute part of a cylindrical wall of the head, extending parallel to the head axis. In presently preferred forms of
65 the invention, however, the steam tube is

sealed in and extends through the base, i.e. the inner wall, of the head.

Immersion heater units according to the invention will usually incorporate, or be adapted to incorporate, a protector device
70 in the form of a thermally sensitive switch for cutting off the power supply to the heating element, if a container fitted with the unit should boil dry or be switched on when dry. As is conventional, such a switch may
75 be mounted in the (hollow) head of the unit with its thermally sensitive actuating member immediately adjacent the base of the head so as to sense the temperature in a container by direction conduction of heat
80 through the said base. In a preferred form of the invention, therefore, the immersion heater unit has such a protector switch mounted or mountable in or on the head thereof and electrically connected or connectible in series with the heating element,
85 the outer end portion of the steam tube being arranged to extend past or through the protector switch for the passage of steam, in use, to the said steam-sensitive switch means for cutting off or reducing the power supply to the heating element when the water in the container boils. A suitable form of protector switch for use in units according to the invention is that described and claimed in Patent Specification No. 1,064,643, which comprises a one-piece plug mountable in the (hollow) head of a unit of the kind described; such plug is adapted directly to receive the heating element terminals within
100 the head, for the connection of such terminals (one of them via the protector switch) to mains terminal pins extending outwardly from the plug and of standard dimensions for insertion in a mains socket connector.

In one form of unit according to the invention incorporating a protector switch in the form of such a unitary plug, a steam-sensitive switch is mounted on the outer face of the plug, the steam tube being arranged
110 to extend through the plug and to terminate at such outer face for the impingement of the steam directly on a thermally sensitive actuating member of the steam-sensitive switch. In this embodiment one terminal of the plug constituting a mains terminal pin thereof (together with an earth terminal pin) is made longer than usual so as to extend outwardly beyond the steam-sensitive switch mechanism to a sufficient
115 extent for insertion in a mains socket connector; the other terminal of the plug is shorter and is connected via the steam-sensitive switch to a mains terminal pin extending outwardly of such switch for insertion in the mains socket connector. The latter terminal pin is preferably the one on the line side of the heating element. Such a protector switch (but without provision for the passage of a steam tube) is described
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and claimed in Patent Specification No. 1,264,464.

In another form of the invention, in which the steam-sensitive switch is not incorporated in the immersion heater unit but rather forms part of a main socket connector for use in conjunction therewith, the steam pipe extends through the said protector switch plug unit and beyond the outer face thereof in the same manner as the aforementioned mains terminal pin of the plug unit, so as to be receivable in the mains socket connector in a suitable fashion for the steam to actuate the steam-sensitive switch incorporated therein.

The steam pipe of units according to the invention may, in addition to its primary function, also provide an earth connection from the sheath of the heating element of the unit, via the connection between the head and the steam pipe.

The scope of the invention extends to a water boiling container incorporating an immersion heater unit as set forth above, whether or not such unit incorporates a protector switch; further, the scope of the invention extends to the combination comprising an immersion heater unit according to the invention but not incorporating a steam-sensitive switch, either alone or when fitted in a water boiling container, and a mains socket connector adapted for use therewith and incorporating a steam-sensitive switch means arranged, in use of the combination, to be operable by steam egressing from an associated container via the said steam tube to control operation of the heating element.

A steam-sensitive switch of a container incorporating an immersion heater unit according to the invention may be of a kind which will re-make automatically with falling temperature after having operated with rising temperature to cut off the power supply to the heating element, so as by cycling to maintain the water in the container near to boiling point. Alternatively the switch may be of a kind which requires manual re-setting once having operated with rising temperature; the latter kind of switch may incorporate manually releasable means, e.g. in the form of a mechanical latch, for holding its contacts open once they have broken, or its thermally sensitive actuating member may be such that it will not operate automatically with falling temperature at any temperature likely to be met in use. In either case, means may be incorporated for providing a visual signal to a user to the effect that the switch has operated with rising temperature and needs re-setting for power to be re-connected to the heating element; such means could, for example comprise a light source which is automatically energised when the switch contacts are broken.

Water heating containers incorporating an immersion heater unit according to the invention may be provided with a secondary low wattage heating element to maintain the water in the container in a simmering condition once the power supply to the main heating element has been cut off. Such a secondary element may be arranged to operate continuously, or it could be controlled by the operation of the steam-sensitive means so as only to be energised when the main element is de-energised.

The thermally sensitive actuating member of a steam-sensitive switch to be associated with an immersion heater unit according to the invention may be of any convenient kind suitable for operation by the impingement of steam thereon. Preferably such member is of bimetal and comprises a sheet, strip or disc of the snap-acting variety. A preferred form of snap-acting bimetal actuating member is that described in Patent Specification No. 657,434, comprising a sheet or strip of bimetal from which a U-shaped portion has been removed to define a central tongue flanked by two outer legs, the legs being joined by a bridge portion opposite the free end of the tongue and the two outer legs being drawn towards one another, e.g. by crimping the said bridge portion, so as to impart a dished configuration to the sheet or strip, which will snap between two oppositely dished configurations with changes in temperature. The movable switch contact may then be mounted on the tongue of the bimetal sheet, or be movable by a push-rod extending between it and the tongue.

In order that the invention may be more readily understood, one embodiment of an electric immersion heater unit according to the invention, together with a protector switch unit and a steam-sensitive switch unit for use in combination therewith, will now be described by way of example and with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of an electric immersion heater unit according to the invention, the head of the unit being shown in ghost lines for the sake of clarity;

Figure 2 is a vertical medial cross-sectional view of the unit of Fig. 1 mounted in the wall of an electric kettle;

Figure 3 is a perspective view of a protector switch plug unit for mounting in the hollow head of the unit of Figs. 1 and 2;

Figures 4 and 5 are front and rear elevations respectively of the plug unit of Fig. 3;

Figure 6 is a view in rear elevation of a steam-sensitive switch unit for mounting on the front (outer) face of the plug unit of Figs. 3 to 5;

Figure 7 is a view similar to Fig. 6 but

with the rear cover plate of the switch unit removed to show the interior; and

Figure 8 is a vertical medial cross-sectional view (partly in side elevation) of the assembly of all of the three units mentioned above, mounted in the wall of an electric kettle.

Referring first to Figs. 1 and 2, this embodiment of the invention comprises an electric immersion heater unit particularly adapted for fitting in an electric kettle.

The unit includes a hollow metal head 1 of standard shape and dimensions for fitting in an aperture in the side wall 2 (Fig. 2) of an electric kettle, the head having a flat circular base 3 and a cylindrical side wall 4 formed with an outwardly extending annular shoulder 5 between its ends for engagement with the inside wall surface of the kettle, the part of the cylindrical wall outwardly of such shoulder being externally screw-threaded at 6 for the reception of a locking ring 7 to secure the head in position in the aperture in the kettle wall. The heating element 8 of the unit is also of conventional form, being mounted from the base 3 of the hollow head and having cold leads 9 extending through such base to the interior of the head for connection to the electric power supply.

A tube 10 for the passage of steam out of the kettle when the water boils is carried by the hollow head 1 of the unit. The tube 10 is of copper and is watertightly secured adjacent one end thereof (its outer end in use) by brazing in an aperture in the base 3 of the hollow head, such end of the tube then extending outwardly through the hollow head, parallel to the axis of the latter, and terminating with its steam outlet end 11 slightly proud of the plane of the open end of the head. The part 12 of the tube 10 which will be within the kettle in use extends upwardly, substantially parallel with the plane of the base 3 of the head, so that its steam inlet end 13 is above the intended maximum water level 14 in the kettle and is displaced from the filling opening thereof so as to prevent water entering the tube 10 when the kettle is being filled. Thus, in a typical kettle having a circular filling opening closed by a lid, the tube will be arranged so that its steam inlet end 13 is adjacent the rear wall 2 of the kettle and under the rim of the filling opening. The tube 10 is brazed at 16 to the heating element sheath 17.

Referring now to Figs. 3 to 5, a plug unit 18 is provided incorporating a thermally sensitive protector switch for cutting off the power supply to the heating element if the kettle boils dry or is switched on when dry, such plug unit being a modified form of the unit described and claimed in Patent Specification No. 1,264,464, to which reference may be made for further details and illus-

trations of the internal structure of the unit.

The plug 18 is dimensioned to fit in the hollow head 1 (as shown in Fig. 8), through the base 3 of which head the cold leads 9 of the heating element extend outwardly as previously mentioned. The plug is adapted to fit on and be soldered to the cold leads 9 of the heating element within the head 1 and is provided with its own two mains terminals 19 and 20, plus an earth terminal 21, for connection to the power supply. The mains terminal 19 in fact comprises an electrical contact mounted only a short distance outwardly of the front face of the plug. The terminals 20 and 21 are of more conventional form but are made substantially longer than usual for a purpose to be explained below.

Referring now in more detail to the construction of the plug 18, this comprises a substantially cup-shaped moulding of insulating plastics material having a cylindrical wall 22 and a base 23 and moulded with various internal block portions to support the parts of the plug now to be described. A pair of brass sleeves 24 and 25 are moulded in two such block portions to receive the respective cold leads 9 of the heating element. The sleeve 25 is electrically connected to the neutral mains terminal 20 by connecting means 26 moulded in the body of the plug, whilst the end of the sleeve 24 within the plug mounts a spring strip 27 carrying a movable contact (not visible in the drawings) of the thermally sensitive protector switch. The live mains terminal 19 is mounted on an arm 28 of a brass plate 29 carrying a fixed contact 30 of the switch. The switch contacts are normally closed but the movable contact is movable out of engagement with the fixed contact 30 by flexing its mounting strip 27 towards the floor 23 of the plug. Thus, in operation, the current flow from live mains terminal 19 is via plate 29, fixed switch contact 30, the movable switch contact, spring strip 27, sleeve 24, the heating element 8, sleeve 25 and neutral mains terminal 20.

An earthing sleeve 31 is provided in the plug to receive an earth lead from the metal sheath of the heating element, and is electrically connected to the earth terminal 21 by a connector 32 moulded in the body of the plug.

The thermally sensitive means for actuating the switch contacts comprises a bimetal plate 33 (shown in ghost lines in Fig. 5) of the general kind disclosed in Patent Specification No. 657,434. The plate, which is substantially rectangular, is formed with a U-shaped cut-out to release a central tongue flanked by two outer legs, the portion of the plate which bridges the legs adjacent the free end of the tongue being crimped so as to draw the outer legs together and thus

impart a dished configuration to the plate so that it forms a differentially stressed system which will move between two stable positions on either side of an intermediate unstable position with a snap action. The bimetal plate 33 is spot welded at the ends of its said bridge portion to a brass mounting plate 34 which is riveted at 35 to respective block portions of the plug moulding.

A push-rod 36 extends between the spring strip 27 and the free end of the tongue of the bimetal switch actuating plate 33, so that when the bimetal plate operates with rising temperature and the free end of its tongue moves inwardly of the plug body the movement of the tongue is transmitted to the spring strip 27 by the push-rod 36 so as to separate the switch contacts and thus interrupt the electrical power supply to the heating element.

The plug moulding is formed with a passage 37 through its floor 23 for the steam tube 10 to extend therethrough.

It will be noted that, when the plug unit 18 is fitted in the head 1, the bimetal plate 33 (although mounted on the inside face of the plate 34) is in good thermal contact with the base 3 of the head so as to be highly sensitive to temperature within the kettle. The bimetal plate 33 is arranged to reset automatically when its temperature has fallen sufficiently after operation thereof to break the heating element circuit, so as to re-connect the power supply.

The floor 23 of the plug 18 has a central boss 38 formed with an internally threaded blind bore 39 for a purpose to be explained later. Furthermore the brass plate 29 is formed with a tag 40 extending through an aperture in the floor 23 and bent through a right angle at its outer end, again for a purpose to be explained below.

A steam-sensitive switch unit 41 for use in conjunction with the apparatus of Figs. 1 to 5 will now be described with reference to Figs. 6 to 8.

This unit comprises a somewhat barrel-shaped moulded plastics housing 42 which is divided into two parts by a transverse internal wall 43. The space 44 on one side (the inside) of the wall 43 houses the steam-sensitive switch of the unit, whilst the space 45 on the other side (the outside) of the wall is for the reception of a mains socket connector. The switch elements within the space 44 are not shown in Fig. 8 for the sake of clarity. The space 44 is closed by a cover plate 46 referred to in more detail below.

Referring particularly to Fig. 7, the steam-sensitive switch has a movable switch contact 47 (shown in its break position) mounted on a spring strip 48 secured to a brass plate 49 which in turn is secured to the inside face of the wall 43; the free end

of the spring strip 48 is connected to a right-angled arm 50 of the brass plate 49 via an over-dead-centre leaf spring device 51 operative to cause the movable contact 47 to move with a snap action between its make and break positions.

The electrical connection between the steam-sensitive switch unit 41 and the protector switch plug unit 18 is via the terminal 19 of the latter unit which, when the two units are interconnected, extends through an aperture 52 in the cover plate 46 of the steam-sensitive switch unit and thus into alignment with (beneath) the movable contact 47 of the latter.

One of a pair of inwardly projecting flanges 53 of the side wall of the housing 42, at the bottom of the space 44, carries via an insulating mounting block 54 a bimetallic switch actuating member 55, which is of the same kind as the bimetal plate 33 in the protector switch unit 18. The bimetal plate 55 is connected to its mounting block 54 by screws 56 passing through a brass mounting plate 57 formed with an integral extension 58 with which the tongue 59 of the bimetal plate engages to define the "cold" condition of the bimetal.

An insulating push-rod 60 extends between the tongue 59 of the bimetal plate 55 and the spring strip 48 carrying the movable contact 47, being supported for axial movement in a passage formed in the cover plate 46 of the unit, so that upward movement of tongue 59 from its illustrated position, upon operation of the bimetal with rising temperature, is transmitted via the push-rod 60 to the spring strip 48 to snap the movable contact 47 out of engagement with the fixed contact 19 and thus break the circuit. Return movement of the movable switch contact 47 is effected manually by means of a push button 61 having two legs 62 mounted for up and down sliding movement between lugs 63 integral with the wall 43 and spring-biased upwardly, one of the legs 62 being engageable with the spring strip 48 to displace it downwardly when the circuit is to be re-made.

Referring particularly to Fig. 6, the cover plate 46 mentioned above is screwed to the wall 43 by means of six screws 64 so as to enclose the space containing the movable contact 47 and its push-button return device. Both the cover plate 46 and the wall 43 are formed with apertures 65 and 66 for the passage of the neutral terminal pin 20 and the earth terminal pin 21 of the protector switch unit 18 therethrough into the space 45 on the front side of the wall 43. The live mains terminal pin of the unit 41 is mounted in the wall 43 and riveted to the brass plate 49 at 67. Further apertures 68 in the wall 43 and 69 in the cover plate 46 are for the passage of a fixing screw 70 into the boss

38 of the unit 18 to secure the steam-sensitive switch unit 41 to the outside face of the unit 18, as seen in Fig. 8, the cover plate being formed with a boss 71 defining the aperture 69.

The cover plate 46 is further provided with a passage 72 for the outer end of the steam tube to extend therethrough and is formed with a channel 73, communicating with the passage 72, for the passage of steam downwardly to impinge on the bimetal plate 55. A rubber O-ring 74 is fitted in the inner end of the passage 72 through the cover plate, to prevent leakage of steam to the current-carrying components. It will of course be understood that the bimetal plate 55 does not form part of any electrical circuit; a sheet of expanded metal 75 is mounted beneath the bimetal plate to permit the egress of steam and condensate and to protect the bimetal against interference which could disturb its setting.

The steam-sensitive switch unit incorporates means for providing a visual signal as an indication to a user that the steam-sensitive switch has operated with rising temperature to cut off the power supply to heating element 8, and must therefore be reset to enable the water in the kettle to boil again. Such means comprises a light source in the form of a neon tube (not visible) mounted in a translucent housing 76 and connected via a resistor 77 to the brass plate 49, a conducting wire 78 from the other side of the neon tube passing through a small hole in the cover plate 46 (adjacent the aperture 52) for current-transmitting engagement with the tag 40 of the protector switch plug unit 18 when the two units are interconnected.

Fig. 8 shows the whole apparatus in its assembled condition, with the protector switch plug unit 18 mounted in the head 1 (to which it is secured via the cold leads 9 of the heating element 8) and the steam-sensitive switch unit 41 secured to the outer face of the plug unit 18 by means of the screw 70. A rubber sealing ring 79 is inserted between the inside face of the cover plate 46 and the head/plug combination to prevent access of steam to the inner face of the cover plate and thence through the latter to the current-carrying components.

With the parts so assembled, the path of electric current from the live mains terminal pin of the steam-sensitive switch unit 41 to the heating element 8 is via the brass plate 49, the spring strip 48, the movable contact 47, the terminal contact 19 of the protector switch unit 18, and thence through the heating element 8 in the manner previously described, to the neutral mains terminal pin 20 of the unit 18 which pin, as already described, passes through the steam-sensitive

switch unit 41 for connection with a mains socket connector.

The bimetal actuating member 55 of the steam-sensitive switch unit 41 may be set to operate with rising temperature at about 90°C., but this setting need not be especially accurate. In tests on one unit constructed as described above, with the bimetal actuating member so set, it was found that the steam-sensitive switch operated within about 8 to 15 seconds of the water in the kettle boiling.

It will thus be seen that in this embodiment the invention provides an electric immersion heater unit adapted for mounting in an aperture of standard dimensions in the wall of a water heating container (such as an electric kettle), without any modification of the container being necessary, which unit is adapted to mount firstly a protector switch for cutting off the power supply to the heating element of the unit if the container boils dry or is switched on when dry, and secondly a steam-sensitive switch for cutting off such power supply when the water in the container boils, whilst the unit itself provides means for the passage of steam from the interior of the container to such steam-sensitive switch to operate the same.

As previously mentioned, such a unit may be incorporated in a water boiling container during the initial assembly thereof, or it can just as easily be used to replace a conventional immersion heater unit so as readily to convert a water boiling container to automatic operation.

WHAT WE CLAIM IS:—

1. An electric immersion heater unit of the kind described, which carries a tube for the egress of steam from the interior of an associated water boiling container in use of the unit, via the said head of the unit, which tube is arranged so as to extend above water level when the said head is mounted below water level, and steam-sensitive switch means connected or connectible to said head on the outside of the same and operable by steam passing through said tube to cut off or reduce the power supply to the heating element when the water in the container boils.
2. An electric immersion heater unit according to claim 1, wherein the said head of the unit is of hollow substantially cylindrical form closed by a base wall at the end thereof which faces inwardly of a container in use, such base wall being formed with an aperture for the said egress of steam.
3. An electric immersion heater unit according to claim 2, wherein the said steam tube extends in watertight fashion through the said aperture in the base wall of the head.
4. An electric immersion heater unit according to claim 3, wherein the outer end



38 of the unit 18 to secure the steam-sensitive switch unit 41 to the outside face of the unit 18, as seen in Fig. 8, the cover plate being formed with a boss 71 defining the aperture 69.

The cover plate 46 is further provided with a passage 72 for the outer end of the steam tube to extend therethrough and is formed with a channel 73, communicating with the passage 72, for the passage of steam downwardly to impinge on the bimetal plate 55. A rubber O-ring 74 is fitted in the inner end of the passage 72 through the cover plate, to prevent leakage of steam to the current-carrying components. It will of course be understood that the bimetal plate 55 does not form part of any electrical circuit; a sheet of expanded metal 75 is mounted beneath the bimetal plate to permit the egress of steam and condensate and to protect the bimetal against interference which could disturb its setting.

The steam-sensitive switch unit incorporates means for providing a visual signal as an indication to a user that the steam-sensitive switch has operated with rising temperature to cut off the power supply to heating element 8, and must therefore be reset to enable the water in the kettle to boil again. Such means comprises a light source in the form of a neon tube (not visible) mounted in a translucent housing 76 and connected via a resistor 77 to the brass plate 49, a conducting wire 78 from the other side of the neon tube passing through a small hole in the cover plate 46 (adjacent the aperture 52) for current-transmitting engagement with the tag 40 of the protector switch plug unit 18 when the two units are interconnected.

Fig. 8 shows the whole apparatus in its assembled condition, with the protector switch plug unit 18 mounted in the head 1 (to which it is secured via the cold leads 9 of the heating element 8) and the steam-sensitive switch unit 41 secured to the outer face of the plug unit 18 by means of the screw 70. A rubber sealing ring 79 is inserted between the inside face of the cover plate 46 and the head/plug combination to prevent access of steam to the inner face of the cover plate and thence through the latter to the current-carrying components.

With the parts so assembled, the path of electric current from the live mains terminal pin of the steam-sensitive switch unit 41 to the heating element 8 is via the brass plate 49, the spring strip 48, the movable contact 47, the terminal contact 19 of the protector switch unit 18, and thence through the heating element 8 in the manner previously described, to the neutral mains terminal pin 20 of the unit 18 which pin, as already described, passes through the steam-sensitive

switch unit 41 for connection with a mains socket connector.

The bimetal actuating member 55 of the steam-sensitive switch unit 41 may be set to operate with rising temperature at about 90°C., but this setting need not be especially accurate. In tests on one unit constructed as described above, with the bimetal actuating member so set, it was found that the steam-sensitive switch operated within about 8 to 15 seconds of the water in the kettle boiling.

It will thus be seen that in this embodiment the invention provides an electric immersion heater unit adapted for mounting in an aperture of standard dimensions in the wall of a water heating container (such as an electric kettle), without any modification of the container being necessary, which unit is adapted to mount firstly a protector switch for cutting off the power supply to the heating element of the unit if the container boils dry or is switched on when dry, and secondly a steam-sensitive switch for cutting off such power supply when the water in the container boils, whilst the unit itself provides means for the passage of steam from the interior of the container to such steam-sensitive switch to operate the same.

As previously mentioned, such a unit may be incorporated in a water boiling container during the initial assembly thereof, or it can just as easily be used to replace a conventional immersion heater unit so as readily to convert a water boiling container to automatic operation.

WHAT WE CLAIM IS:—

1. An electric immersion heater unit of the kind described, which carries a tube for the egress of steam from the interior of an associated water boiling container in use of the unit, via the said head of the unit, which tube is arranged so as to extend above water level when the said head is mounted below water level, and steam-sensitive switch means connected or connectible to said head on the outside of the same and operable by steam passing through said tube to cut off or reduce the power supply to the heating element when the water in the container boils.

2. An electric immersion heater unit according to claim 1, wherein the said head of the unit is of hollow substantially cylindrical form closed by a base wall at the end thereof which faces inwardly of a container in use, such base wall being formed with an aperture for the said egress of steam.

3. An electric immersion heater unit according to claim 2, wherein the said steam tube extends in watertight fashion through the said aperture in the base wall of the head.

4. An electric immersion heater unit according to claim 3, wherein the outer end

portion of the steam tube extends through the interior of the said head parallel to the head axis and the steam egress end of the tube is situated in the region of the plane of the open end of the head.

5 5. An electric immersion heater unit according to claim 4, wherein the said steam egress opening is situated outwardly of the plane of the open end of the head.

10 6. An electric immersion heater unit according to any of the preceding claims, which is so arranged that, when the said head is secured in a substantially vertical wall of a container in use, the steam inlet end of the steam tube is located adjacent said wall, above the head.

15 7. An electric immersion heater unit according to any of the preceding claims, wherein the steam tube is manually bendable.

20 8. An electric immersion heater unit according to any of the preceding claims, wherein the steam tube is made of copper.

25 9. An electric immersion heater unit according to any of the preceding claims, in combination with a thermally sensitive protector switch mounted or mountable in or on the said head of the unit and electrically connected or connectable in series with the heating element, the outer end portion of the steam tube being arranged to extend past or through the protector switch for the passage of steam, in use, to the said steam sensitive switch means for cutting off or reducing the power supply to the heating element when the water in the container boils.

30 10. A combination according to claim 9, when dependent directly or indirectly on claim 2, wherein the said protector switch is incorporated in a substantially cylindrical plug unit arranged to fit into the said head, the plug unit being formed with a passage parallel to its axis through which the outer end portion of the steam tube is arranged to extend.

11. A combination according to claim 10, wherein the said steam-sensitive switch means comprises a switch unit mounted or mountable on the outer face of the said plug unit, the steam tube being arranged to extend through the plug unit and to terminate adjacent such outer face for the impingement of the steam directly on a thermally sensitive actuating member of the steam-sensitive switch unit.

12. A combination according to claim 11, wherein one terminal of the said plug unit, constituting a main terminal pin thereof, together with an earth terminal pin thereof, are arranged to extend through the said steam-sensitive switch unit for insertion in a mains socket connector, whilst the other terminal of the plug unit is connected or connectable via the steam-sensitive switch unit to a mains terminal pin forming part of the steam-sensitive switch unit, for insertion in a mains socket connector.

13. A combination according to claim 11 or 12, wherein the said steam-sensitive switch unit incorporates manually operable means for re-closing its switch contacts once they have broken.

14. A combination according to any of claims 11 to 13, wherein the said steam-sensitive switch unit incorporates a light source visible to a user which is automatically energised when the switch contacts are broken.

15. An electric immersion heater unit as claimed in claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

16. A water boiling container incorporating an electric immersion heater unit as claimed in any of claims 1 to 15.

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