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(71) Applicant: **SHEATHED HEATING ELEMENTS
LIMITED**

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(54) **Electric heating device**

(57) A heating device, e.g. a heating element for a kettle, comprises a heating element (3) including a resistance heating wire (4) surrounded by and electrically insulated from a metal sheath (5), the heating element (3) being carried directly or indirectly on a metal base plate (1) for transferring heat from the heating element (3) to a medium to be heated by the device, wherein the heating element (3) is in thermally conductive commu-

nication with the base plate (1) via a heat diffusion layer (2), wherein the heat diffusion layer (2) is of a metal comprising copper. In preferred embodiments an underside of the heating element (3) contacts, or is directly attached to, the metal base plate (1) and the heat diffusion layer (2) wholly or partially overlies the heating element (3), or alternatively the heating element (3) is attached to the heat diffusion layer (2) which is in turn attached to the base plate (1).

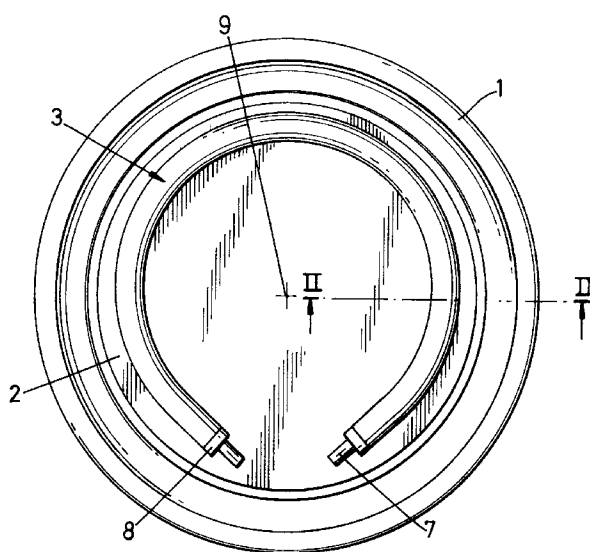


Fig. 1

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Description

The present invention relates to an electric heating device.

There are various known heating devices in which a metal plate is used to transfer heat from an electric heating element to the contents of a heating vessel in which the device is mounted.

One such device, which is mounted in the base of the water chamber in an electric kettle, includes a pair of aluminium plates with an electric heating element crimped between them, the electric heating element comprising a resistance heating wire surrounded by and electrically insulated from a stainless steel sheath. Such a device suffers from the perceived health hazard of aluminium leaching into the water, in addition to poor aesthetic characteristics of the aluminium plate visible within the kettle.

Another previously known kettle element assembly ameliorates these problems and comprises an aluminium plate, one side of which is brazed to an aluminium sheathed electric heating element. The opposite side of the plate is brazed to a second plate of stainless steel, which provides the surface that contacts the medium to be heated (normally water) within the kettle. The thermal conductivity of aluminium is, however, low compared with that of certain other metals, resulting in a relatively localised, inefficient heating of the water in the kettle and difficulties in efficiently controlling the kettle element assembly by way of a temperature sensitive electrical cut-out mounted on the aluminium plate. Furthermore, it is difficult to braze aluminium to other metals, thereby creating problems for efficiently assembling the device.

The present invention seeks to overcome these disadvantages by providing a more efficient pathway of thermal conduction between the heating element and the steel plate, and preferably also a better compatibility of the materials of the contact surfaces via which the heating element is mounted in the device.

Accordingly, in a first aspect the present invention provides a heating device comprising a heating element including a resistance heating wire surrounded by and electrically insulated from a metal sheath, the heating element being carried directly or indirectly on a metal base plate for transferring heat from the heating element to a medium to be heated by the device, wherein the heating element is in thermally conductive communication with the base plate via a heat diffusion layer, wherein the heat diffusion layer is of a metal comprising copper.

In preferred embodiments of the heating device of the invention the base plate is of ferrous metal, e.g. stainless steel.

The invention encompasses devices in which the heat diffusion layer is preferably made of copper per se or alternatively may be made of an alloy or mixture of copper with one or more other suitable components. Such other suitable components may be selected for ex-

ample from zinc, phosphorus, nickel or chromium. An example of a copper alloy that may be used as the heat diffusion layer is brass. The invention further encompasses devices in which the heat diffusion layer is made of a laminate including at least one layer which is of copper or a copper alloy.

Copper, which is used according to the invention as or in the heating diffusing layer, has a significantly higher thermal conductivity than aluminium, resulting in several advantages over the previously known devices. Firstly, the transfer of thermal energy from the heating element to the base plate is faster and less localised, resulting in faster, more efficient energy transfer to the medium to be heated. Secondly, the better distribution of thermal energy away from the element extends the lifetime of the element, and means that it may be better protected from burn-out on occasions when the vessel in which the device is incorporated is empty. Protection against the latter is typically afforded by a temperature sensitive electrical cut-out, which may be mounted on the base plate, or on the heat diffusion layer or on the heating element itself. The degree of protection is enhanced due to the increased rate of heat transfer from the element to the electrical cut-out, which is a function of the relationship between thermal mass and thermal conductivity of the material of the heat diffusion layer. The optimum relationship is found with copper and its alloys.

Preferably the heat diffusion layer and the sheath of the heating element are of the same material or at least are of different metals having relative standard electrode potentials such that galvanic corrosion is eliminated or minimised, especially in heating devices in which the heat diffusion layer and the sheath of the element are in direct contact. This same relationship may also apply to the heat diffusion layer and the base plate, and/or also to the sheath of the heating element and the base plate, where those respective pairs of components are in contact. Such corrosion may be a problem when the device is located in a humid environment such as often occurs within the casing of an electric kettle.

It is also preferable that the metal or metals used in the heat diffusion layer have substantially the same or closely similar coefficient of expansion to the metal of the base plate, such that bending or other deformation of the device is prevented as its temperature changes.

In addition to copper, used according to the invention as or in the heat diffusion layer, having an advantageously high thermal conductivity, copper is also particularly advantageous over aluminium of the prior art in that it is a better material for attaching a heating element by brazing, since heating elements are commonly sheathed in copper. The attachment of such a heating element to the heat diffusion layer may thus be even further facilitated, and a simple solder connection may suffice instead of brazing or welding as in the prior art.

For ease of assembly of embodiments of the device in which the heat diffusion layer completely covers the metal base plate, it is preferable that the heat diffusion

layer and the base plate constitute the two layers of a bimetallic plate. The base plate of the device may have any suitable shape, depending for instance on the shape or configuration of the heating element itself and the practical application for which the device is intended for use, e.g. depending on the shape of the base of a heating appliance in which the device is to be mounted.

In practical preferred embodiments of the invention the heating element may be configured and arranged on the device so as to follow the line of an arc of a circle or so as to be coiled or otherwise of a convoluted shape. In particularly preferred embodiments the element is generally circular (i.e. toroidal), with the terminal portions of the element lying out of register with one another and overlapping one another by a short distance, e.g. by a few percent (e.g. 1 to 10 or 15%) of the total length of the element, such as by about 1 to 5 cm in a typical practical example. This particular arrangement of the element allows a greater length of element to be carried on a base plate of a given size and hence results in the element having a decreased watts density and a longer lifetime.

In preferred embodiments of the invention the means of attachment of any one of the heat diffusion layer, the heating element and the metal base plate to one or more other of those components may be selected from any suitable means of attachment known in the art, eg. brazing, welding, soldering, glueing, cementing, metal spraying, or even mechanical attachment by a simple pressure connection, eg. crimping. In certain instances a unitary connection between components may not be necessary and a simple surface to surface contact may suffice.

In one preferred heating device according to the invention an underside of the heating element contacts, or is directly attached to, eg. by brazing, the metal base plate. The heat diffusion layer which is preferably brazed to the base plate is shaped so as to wholly or partially overlie the element, with the contacting surfaces optionally being bonded such as by brazing.

In a second preferred heating device according to the invention the heating element is attached, e.g. by brazing or soldering, to the heat diffusion layer which is in turn attached, eg. by brazing, to the base plate.

In a further aspect the present invention provides a heating vessel or appliance including a heating device according to the first aspect of the invention.

Preferred exemplary embodiments of the heating device of the invention will now be described in detail with reference to the accompanying drawings, in which:

- Figure 1 is a plan view of a first embodiment of a heating device of the present invention;
 Figure 2 is a sectional view along line II-II of Figure 1, showing the spatial arrangement of the heating element, the base plate and the heat diffusion layer;
 Figure 3 is a view similar to that shown in Figure 2

but showing a second embodiment of the heating device of the invention, with a different arrangement of the heating element, base plate and heat diffusion layer;

- 5 Figure 4 is a view similar to that shown in Figure 2 but showing a third embodiment of the heating device of the invention, with a further different arrangement of the heating element, base plate and heat diffusion layer;
 10 Figure 5 is a plan view of a preferred configuration of the heating element of use in various embodiments of the heating device of the invention.

15 Referring firstly to Figures 1 and 2, one exemplary heating device of the invention, which in practice is mounted in the base of the water chamber of an electric kettle, includes a stainless steel base plate (1), substantially covered by and brazed to a copper heat diffusion layer (2), onto which a copper sheathed electric heating element (3) is soldered. The stainless steel base plate (1) is shaped so as to be cooperative with the shape of the casing of the kettle in the region in which the device is mounted. The heating element (3) comprises a coiled resistance heating wire (4) surrounded by a copper sheath (5). The ends of the resistance heating wire (4) are connected to metal pins (7) which project from the end of the sheath and serve to make the electrical connections to the resistance wire (4). Both the wire (4) and the pins (7) are electrically insulated from the surrounding sheath (5) by a layer of magnesium oxide (6). A plug (8) located at each end of the element (3) holds the pins (7) in position and seals the magnesium oxide (6) inside the sheath (8).

35 The heat diffusion layer of copper (2) provides for a faster, and less localised transfer of thermal energy from the element (3) to the water in the kettle when compared to a heating device in which the heat diffusion layer is absent and the only thermally conductive pathway between the element and the water in the kettle is via a base plate made entirely of stainless steel, or is a stainless steel plate brazed to an aluminium plate: stainless steel and aluminium both have lower thermal conductivities than copper. The enhanced transfer of thermal energy from the element (3) via the copper heat diffusion layer (2) also extends the lifetime of the element (3). A temperature sensitive electrical cut-out may be mounted on the copper heat diffusion layer (3), for example at position (9) in Figure 1. The means for mounting the electrical cut-out on the heat diffusion layer may for example comprise a U-shaped slot cut into the heat diffusion layer, the portion of the heat diffusion layer surrounded by the slot being folded along a line between the ends of the slot so as to project away from the base plate. The electrical cut-out may then be mounted on this upstanding projection of the heat diffusion layer. Alternatively, the means for mounting the electrical cut-out on the heating device may comprise a rivet. The head

of the rivet is mounted on the metal base plate and the rivet projects through a circular aperture in the heat diffusion layer. The electrical cut-out may then be mounted on the rivet.

The rapid heat transfer from the element (3) to the cut-out via the copper heat diffusion layer (2) ensures that the element (3) is better protected from burn-out on the occasions when the kettle is operated empty, than if the heat diffusion layer (2) were absent.

Referring to Figure 3, in a second embodiment of the heating device of the invention, a heating element (3) of similar construction to that in the first embodiment of Figure 1 is brazed directly to a stainless steel base plate (1). A copper heat diffusion layer (2), a portion of which is brazed to the base plate (1), is shaped so as to lose contact with the base plate (1) in the vicinity of the heating element (3) and to make contact with the sheath (5) of the element (3), thereby establishing a thermally conductive pathway from the heating element (3) to remote parts of the steel base plate (1).

According to Figure 4, in a third related embodiment of the heating device of the invention, a heating element (3) again of similar construction to that in the first embodiment of Figure 1 is brazed directly to a stainless steel base plate (1). Here, however, a copper heat diffusion layer (2) brazed to the base plate (1) is shaped so as to lose contact with the base plate (1) in the vicinity of the heating element (3), to make contact with the sheath (5) of the heating element (3), and to maintain this contact as it bends over the element (3). The contact between the element (3) and the copper heat diffusion layer (2) is lost on the other side of the element (3) where the copper heat diffusion layer (2) again lies against and is brazed to the stainless steel base plate (1). The heating element (3) thus becomes encased in the copper heat diffusion layer (2), and an efficient indirect thermal conductive pathway from the element (3) to the base plate (1) is once again established.

Figure 5 shows a preferred conformation for the heating element (3) in which the element is generally circular (i.e. toroidal) with the thermal portions of the element overlapping. This configuration allows a greater length of element to be accommodated on a base plate of a given size and hence results in the element having a decreased watts density and an increased lifetime. This preferred conformation of the element may be used in any of the embodiments of the invention previously described and shown in Figures 1 to 4.

The exemplary heating devices as described above with reference to the accompanying drawings are suitable for mounting in a kettle or other heating device in accordance with well known techniques, as will be readily apparent to a man skilled in the art.

It is to be understood that the present invention has been described above by way of example only with reference to specific exemplary preferred embodiments. Many variations and modifications from those which have been specifically described and illustrated are pos-

sible within the scope of the invention, as will be readily apparent to persons skilled in the art.

5 Claims

1. A heating device comprising a heating element including a resistance heating wire surrounded by and electrically insulated from a metal sheath, the heating element being carried directly or indirectly on a metal base plate for transferring heat from the heating element to a medium to be heated by the device, wherein the heating element is in thermally conductive communication with the base plate via a heat diffusion layer, wherein the heat diffusion layer is of a metal comprising copper.
2. The heating device of claim 1, wherein an underside of the heating element contacts, or is directly attached to, the metal base plate and the heat diffusion layer wholly or partially overlies the heating element.
3. The heating device of claim 1, wherein the heat diffusion layer and the base plate constitute two layers of a bimetallic plate.
4. The heating device of claim 1 or 2, wherein the heat diffusion layer is a laminate including at least one layer which is of copper or a copper alloy.
5. The heating device of any one of claims 1, 2 or 3, wherein the metal of the heat diffusion layer consists of copper.
6. The heating device of any preceding claim, wherein any one component of the heating device, which component is selected from the heat diffusion layer, the heating element and the metal base plate, is attached to one or more other of those components by brazing, welding, or soldering.
7. The heating device of claim 1, wherein the heating element is attached to the heat diffusion layer which is in turn attached to the base plate.
8. The heating device of any preceding claim, wherein the heat diffusion layer and the sheath of the heating element are of the same material or are of different metals having relative standard electrode potentials such that galvanic corrosion between the heat diffusion layer and the sheath of the heating element is minimised.
9. The heating device of claim 8, wherein the sheath of the heating element is of copper.
10. The heating device of any preceding claim, wherein

the heat diffusion layer and the metal base plate have a similar coefficient of expansion, such that bending or other deformation of the device is prevented as its temperature changes.

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11. The heating device of any preceding claim, wherein the metal base plate is of ferrous metal.

12. The heating device of any preceding claim, wherein the heating element includes a first terminal portion at one end and a second terminal portion at an opposite end, the heating element being generally toroidal and the first and second terminal portions lying out of register with one another and overlapping one another by a short distance.

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13. A heating vessel or heating appliance including a heating device of any preceding claim.

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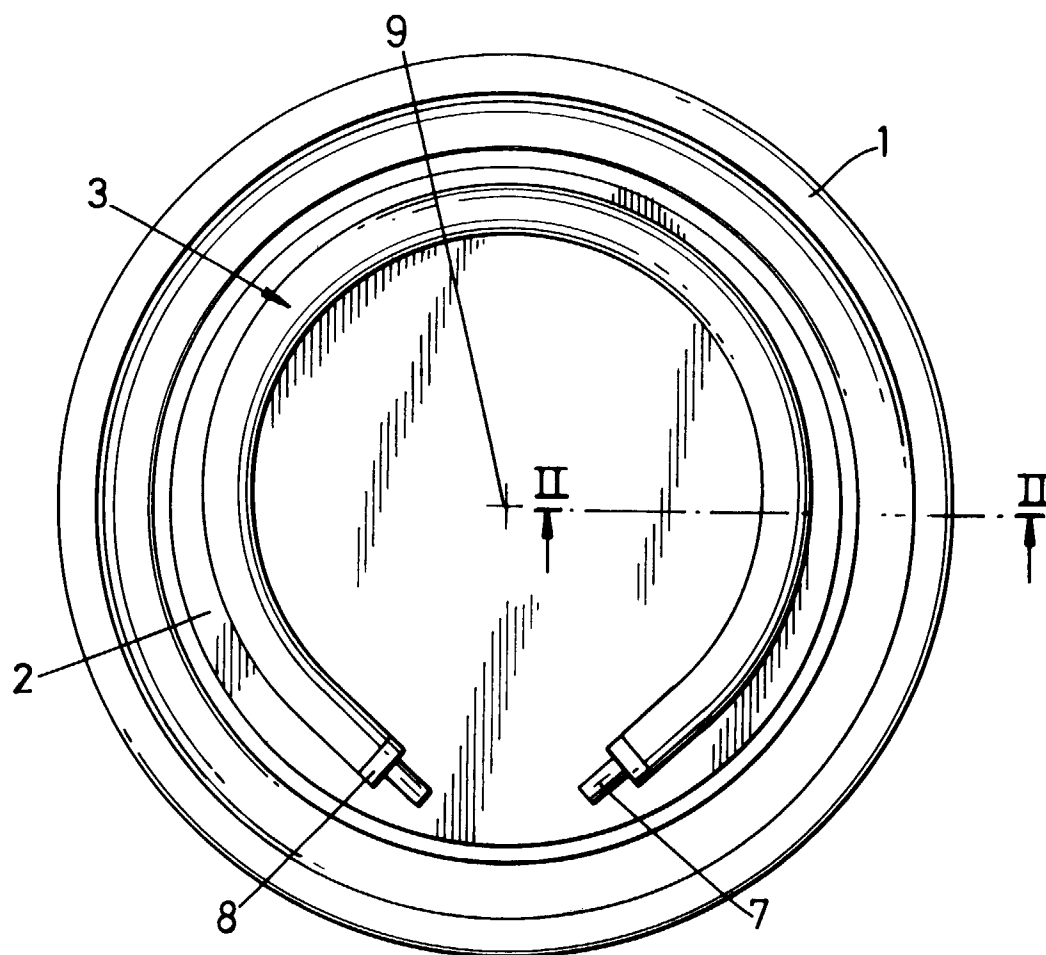


Fig. 1

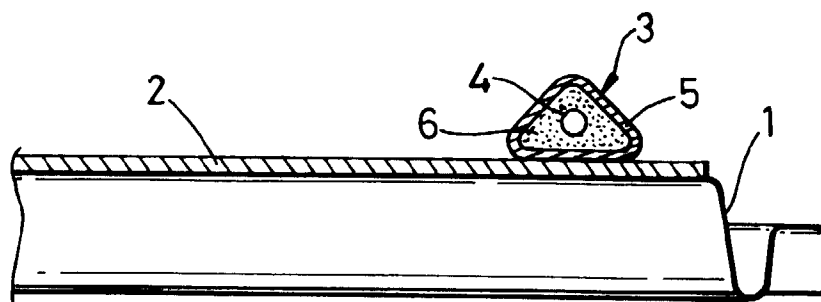


Fig. 2

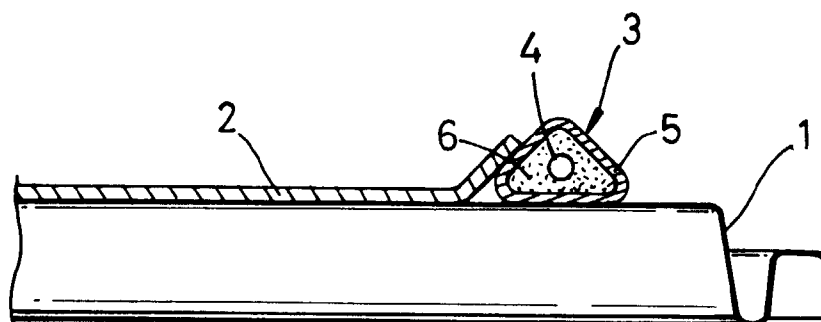


Fig. 3

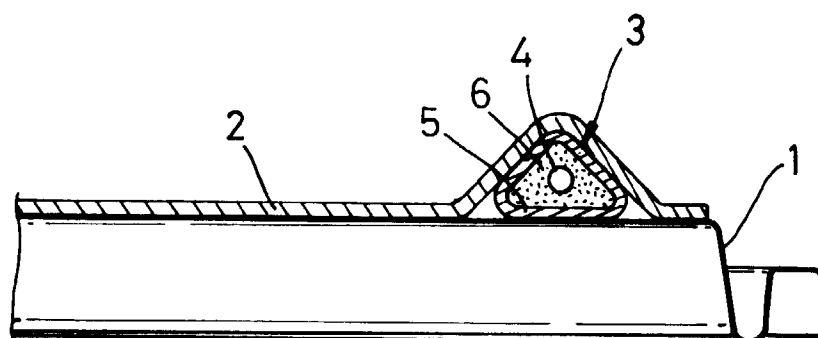


Fig. 4

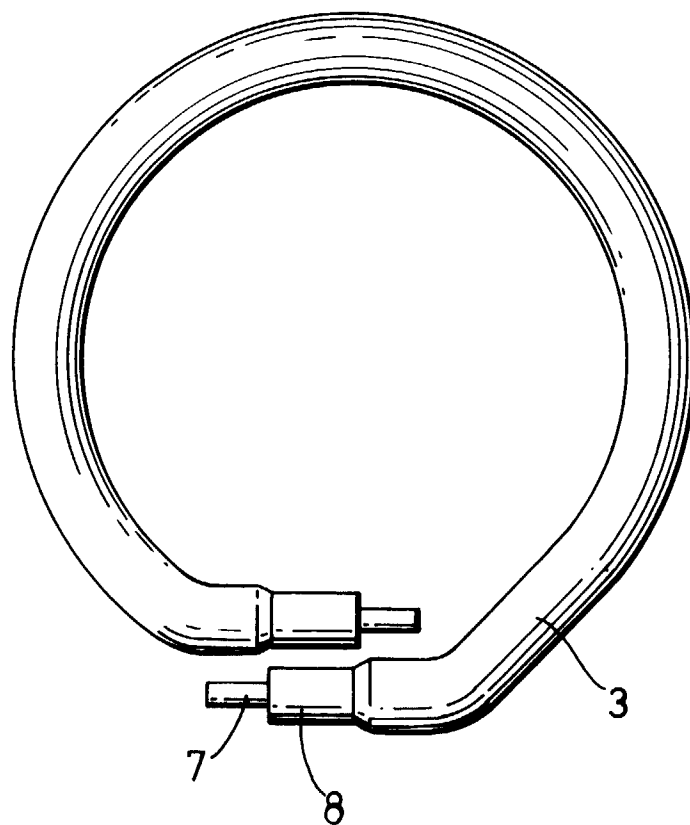


Fig. 5