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(56) Documents Cited:
GB 2363908 A **GB 2336986 A**
US 5790010 A

(58) Field of Search:
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INT CL **H01H**
Other:

(54) Abstract Title: **Improvements relating to thermal control units**

(57) A liquid heating vessel comprises an element plate and a thermal actuator. The thermal actuator 10 comprises a thermally responsive component 12, such as bimetal, capable of a snap transformation from a first configuration to a second configuration at an operating temperature, and a mounting portion 14 operable to retain the thermally responsive component 12. The mounting portion 14 is fixed to the element plate 34. A fulcrum may also be provided, about which the bimetal may be tilted by the mounting portion 14.

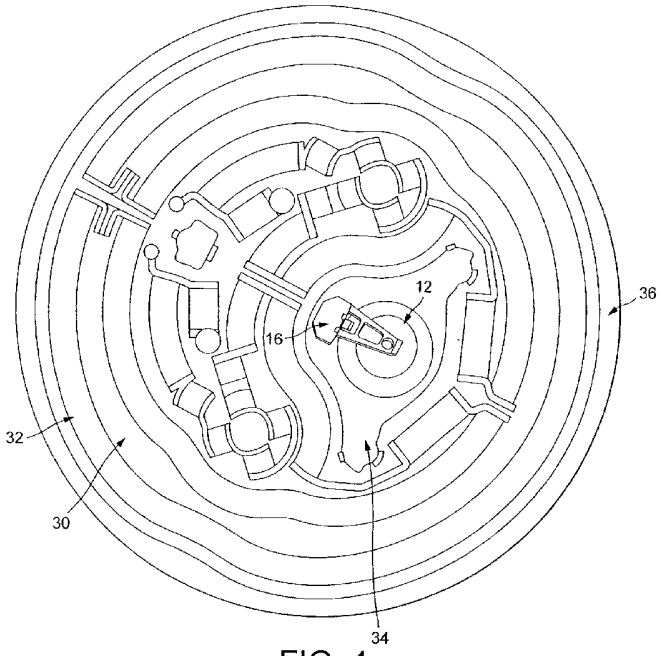

FIG. 1

GB 2 431 516 A

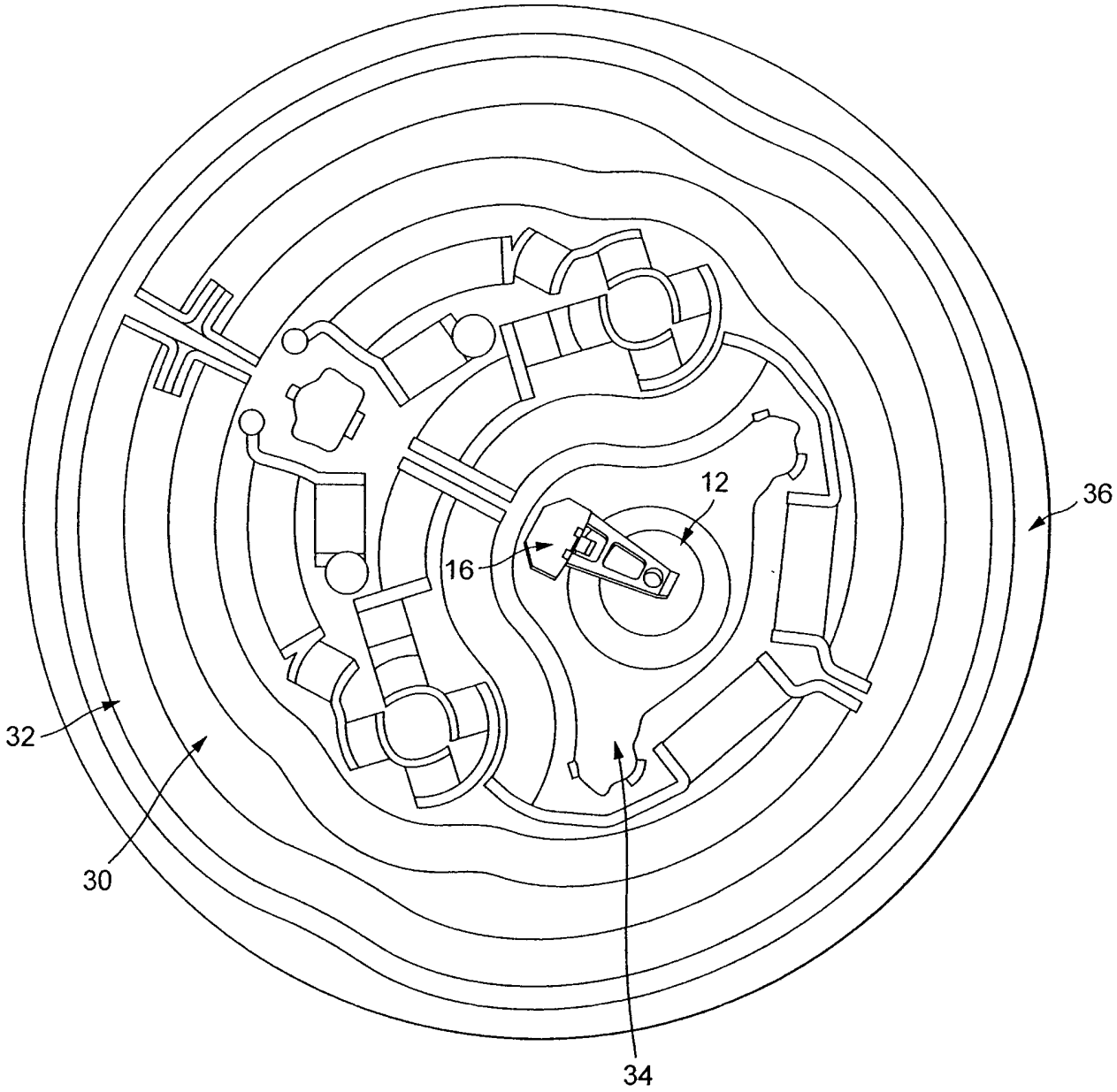

FIG. 1

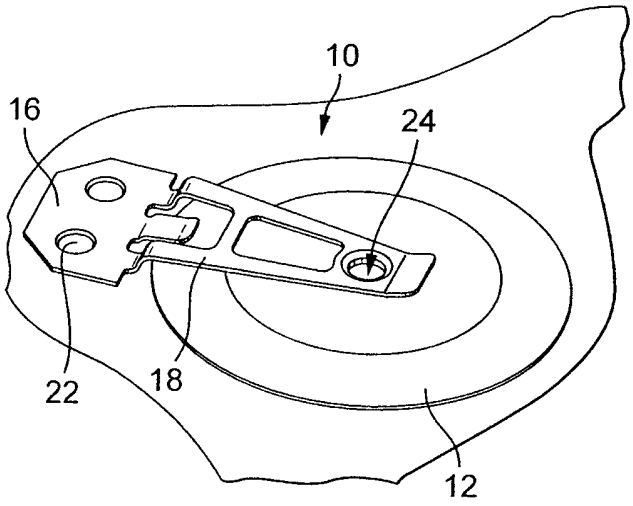

FIG. 2

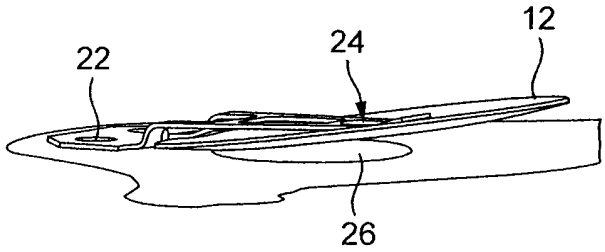

FIG. 3

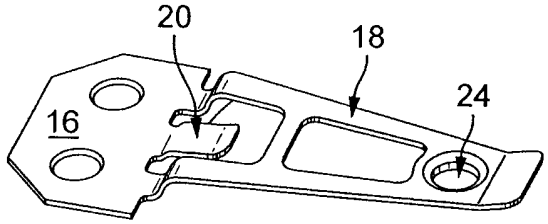

FIG. 4

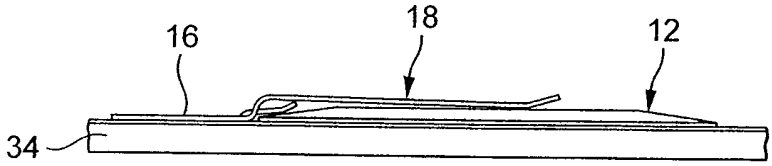

FIG. 5A

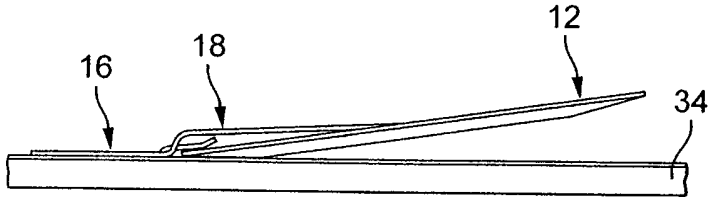

FIG. 5B

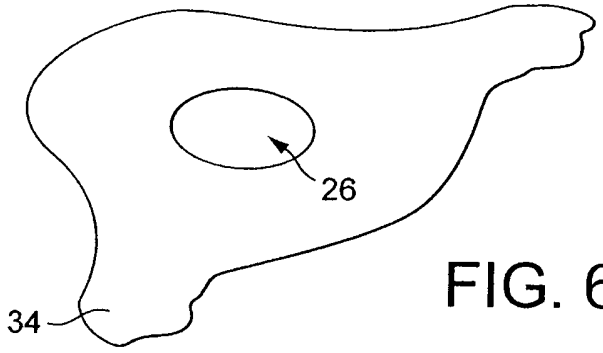

FIG. 6

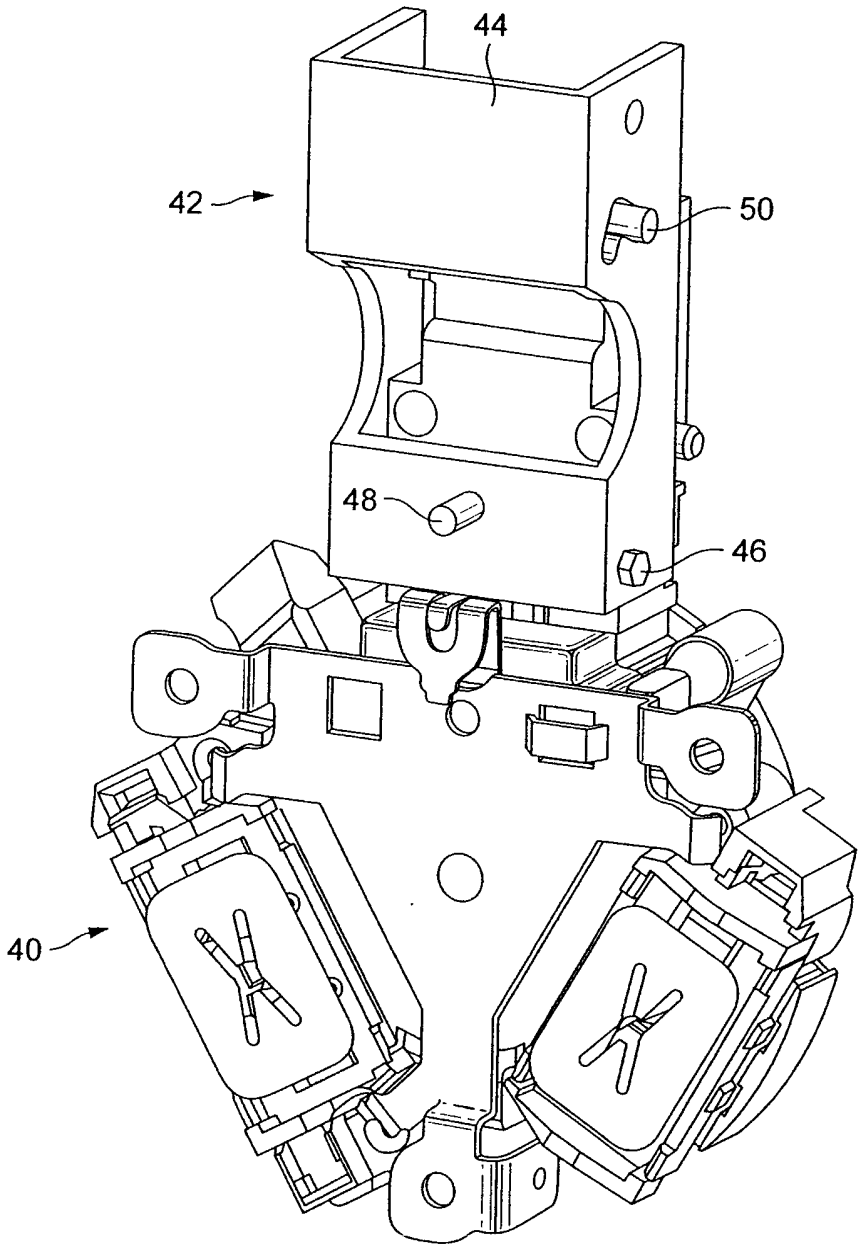

FIG. 7

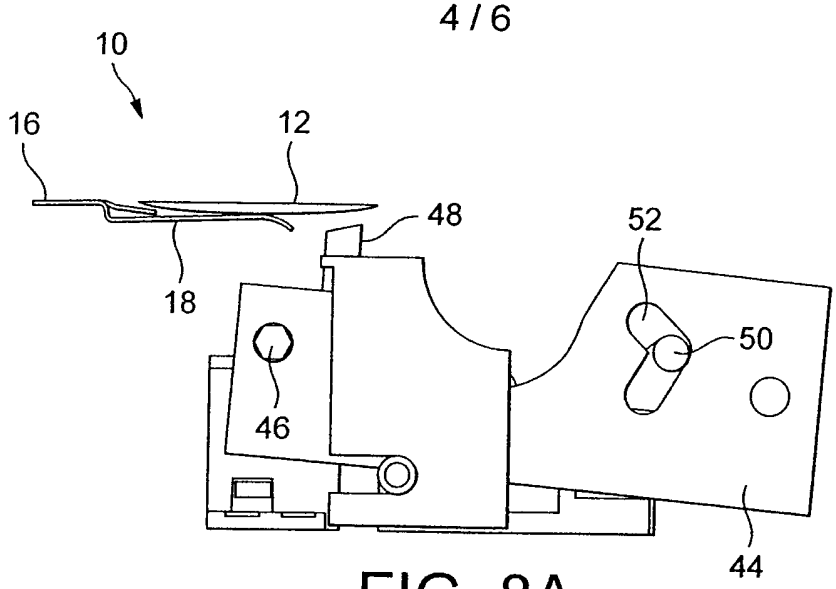

FIG. 8A

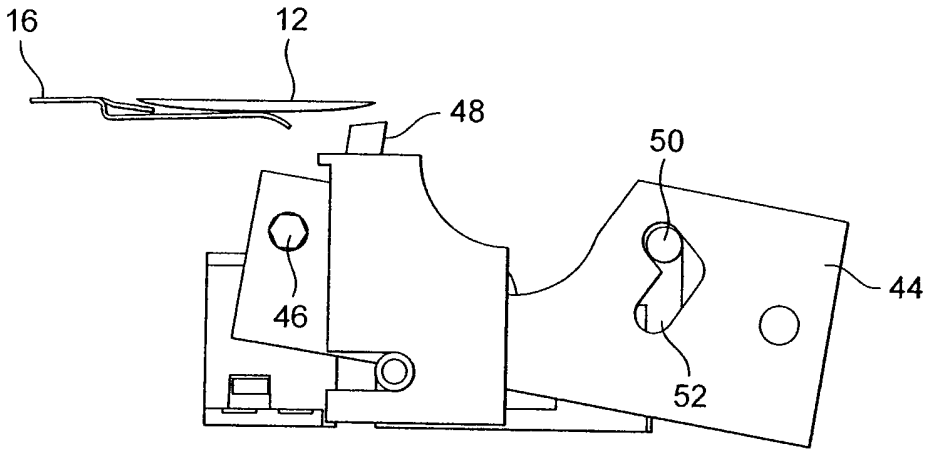

FIG. 8B

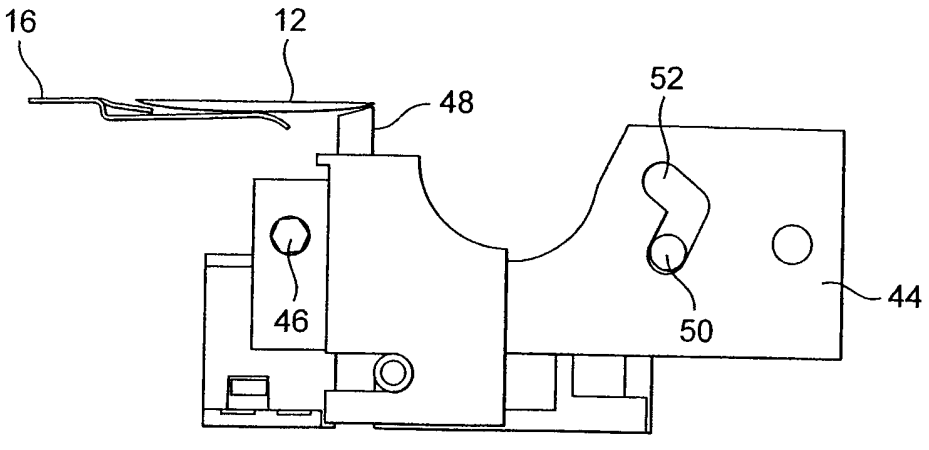

FIG. 8C

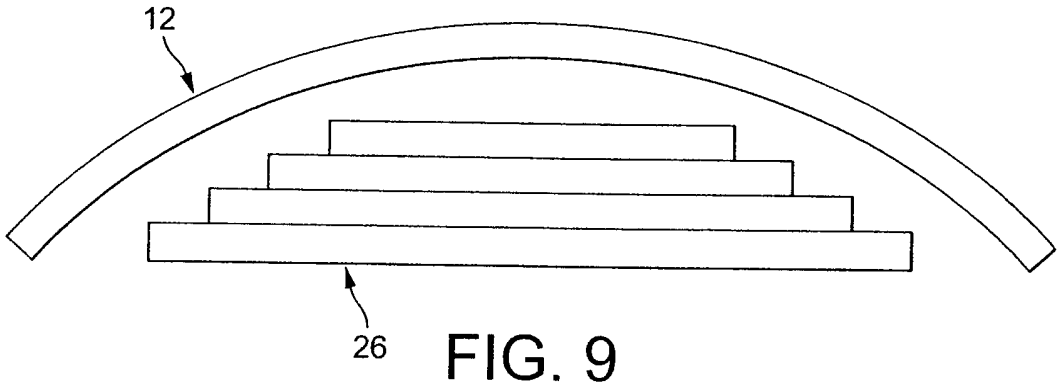

FIG. 9

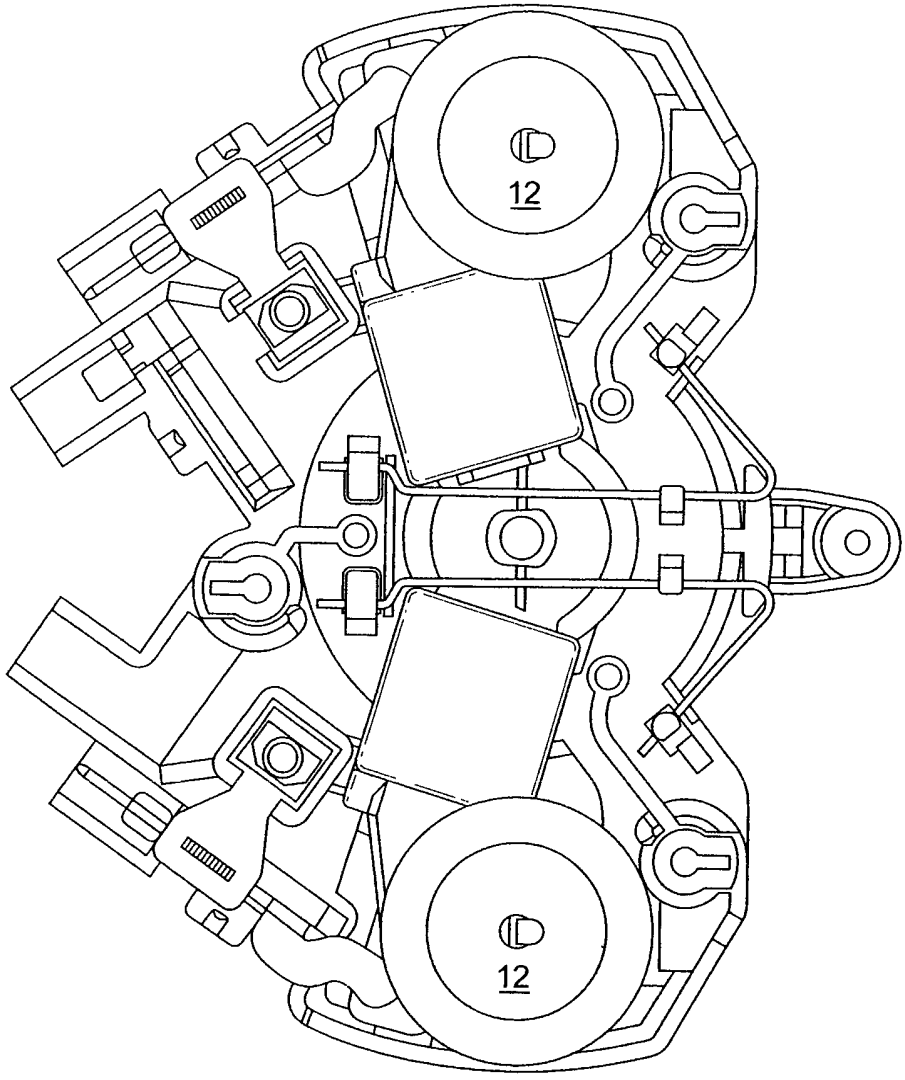

FIG. 10

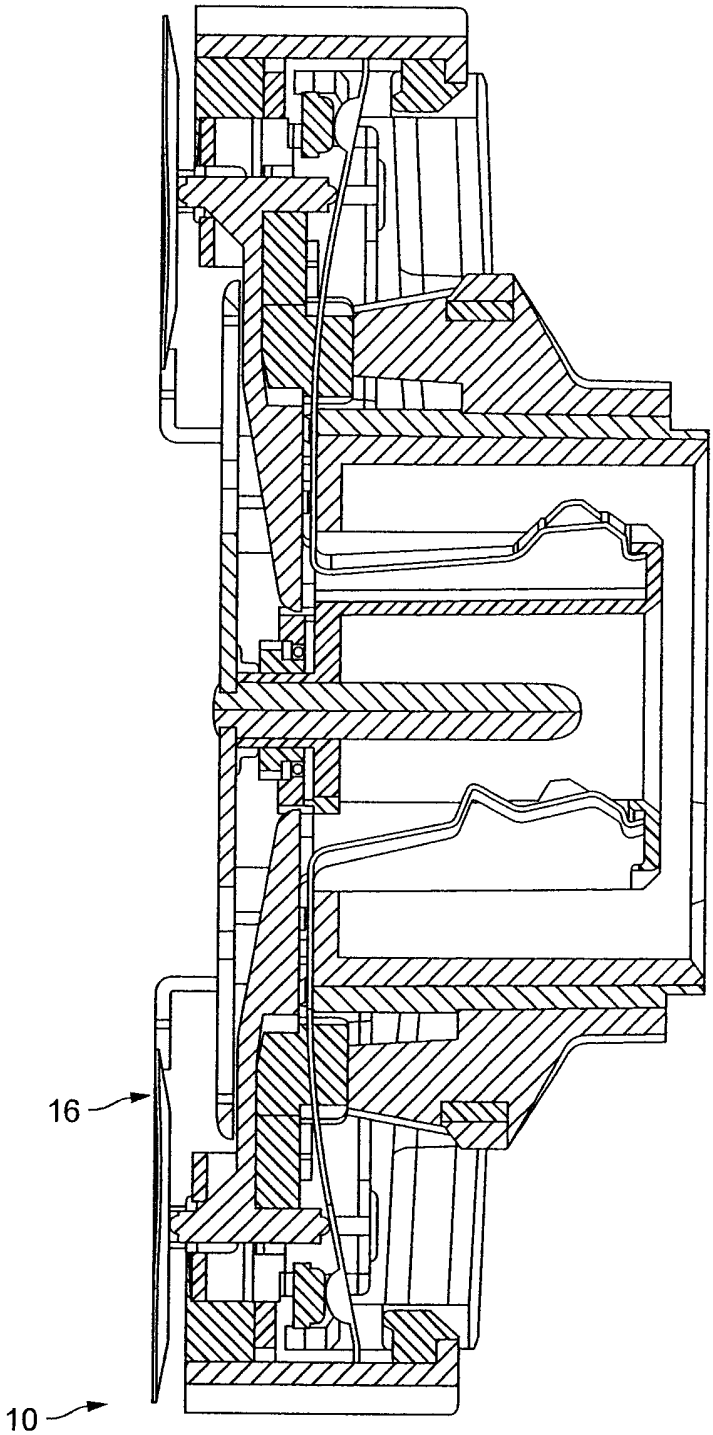

FIG. 11

IMPROVEMENTS RELATING TO THERMAL CONTROL UNITS

The present invention concerns improvements relating to thermal control units in general, and particularly - but not exclusively - to thermal control units for liquid heating vessels such as kettles, jugs and the like.

A particularly preferred embodiment of the invention pertains to a thermal actuator which can be incorporated into a liquid heating vessel to permit the user to boil liquid in the vessel, or alternatively to heat that liquid to a preset lower temperature.

It has previously been proposed to provide a control (referred to hereafter as an element protector) which is operable to protect liquid heating vessels from a so-called element overtemperature condition. An illustrative example of one such control is GB 2339088.

It has also been previously proposed to provide a control (referred to hereafter as a boil or steam control) which is operable to switch off a liquid heating element of the vessel when the liquid in the vessel boils. An example of one such control is described in GB 2331848.

Typically, both an element protector and a boil control are provided in a liquid heating vessel.

The above described, and other, element protectors and boil controls enable an automatic liquid boiling vessel (such as a kettle, for example) having full element overtemperature protection to be provided, the vessel switching off when liquid in the vessel boils.

These automatic liquid boiling vessels are suitable for boiling water for tea, but it is considered by some that the flavour of herbal teas and coffee (particularly instant coffee) may be improved by preparing that tea or coffee with water which has been heated to a temperature below boiling.

GB 2255446 discloses a control for a liquid heating vessel which is operable to provide the aforementioned overtemperature protection, to function as a boil control, and to enable the provision of liquid at a preset temperature below boiling.

This arrangement, therefore, provides the user with the option to boil water, for example, or merely to heat that water to a temperature below boiling which is appropriate for the preparation of herbal teas, instant coffee or the like. Further advancements on this premise are disclosed in GB 2409341, which discloses the use of a bimetal disc operable to transform from a first configuration to a second configuration when an operating temperature lower than boiling point is reached.

A mounting means for a bimetal disc is disclosed in GB2397438. In this arrangement a mounting spring with a hooked end is moulded onto the thermal control. The hooked portion acts as means to press the bimetal onto the element plate, and also to support the bimetal when the operating temperature is reached.

However, known arrangements are relatively complex in their construction, and hence tend to be expensive to manufacture, or are difficult to assemble within the liquid heating vessel. Accordingly, it would be desirable to provide a less complex, and hence less expensive arrangement.

According to the present invention there is provided a thermal actuator comprising a thermally responsive component operable to transform from a first configuration to a second configuration when the temperature of the component reaches an operating temperature, and a mounting portion operable to tilt the thermally responsive component when it is in its second configuration with respect to its first configuration.

It is very preferred that the thermal actuator be used in cooperation with a thermal control within a liquid heating vessel, wherein said liquid heating vessel comprises an element plate. Preferably the mounting portion is arranged to be fixed to the element plate.

It is preferred that a fulcrum, about which said thermally responsive component may be tilted, is located on said element plate. Preferably the fulcrum comprises one or more layers of dielectric, and may also be shaped to conform with the profile of the thermally responsive component.

Other preferred features are set out in the dependent claims.

It will be appreciated from the description that the present invention has particular use in relation to thick film elements for liquid heaters. However, as will be appreciated by those skilled in the art, the present invention may be used in liquid heaters, such as kettles, of types other than the those comprising thick film elements. For example, the thermal actuator may be fixed directly to a planar heating element, such as those that are known in the art that comprise an aluminium plate.

In order that the present invention be more readily understood specific embodiments thereof will now be described with reference to the accompanying drawings. A list describing the drawings is set out below.

Figure 1 shows a layout of a thick film element incorporating a thermal actuator in an embodiment of the invention.

Figure 2 shows a perspective view of the thermal actuator of figure 1 in a first position.

Figure 3 shows a perspective view of the thermal actuator of figure 1 in a second position.

Figure 4 shows a mount, which comprises part of the thermal actuator.

Figure 5a shows a side elevation of the thermal actuator in a first position.

Figure 5b shows a side elevation of the thermal actuator in a second position.

Figure 6 shows a portion of an element plate incorporating a fulcrum.

Figure 7 shows a perspective view of a boil control.

Figures 8a-c show a thermal control comprising the thermal actuator.

Figure 9 shows an emphasised (ie not to scale) cross-sectional view of part of the thermal actuator and the fulcrum, particularly illustrating a preferred aspect of the fulcrum.

Figure 10 shows a top plan view of an example of a further overtemperature control to which the present invention may be applied.

Figure 11 shows a cross-sectional view of the control of figure 9.

Figure 2 shows a perspective view of a thermal actuator 10. The actuator 10 comprises a bi-temperature blade portion 12 and a mount portion 14. In preferred embodiments the bi-temperature blade portion 12 comprises a snap-acting, dished, bimetal disc. The dished bimetal disc 12 is operable to change its curvature in response to rising temperature at an operating temperature below that of the boiling point of the liquid (typically water) in the liquid heating vessel.

The mount portion 14 comprises a base section 16 that is operable to be fixed to an element plate 34. The fixing is typically achieved by laser welds 22, but any suitable means may be used.

The mount portion further comprises a carrying arm 18. The arm is connected at one end to the base section 16. The opposed end supports the bi-temperature blade portion. In a particularly preferred arrangement the arm portion 18 comprises a pip 24 which is operable to be engaged into a central hole in the bimetal disc 10. The mounting portion applies a force through the pip to ensure that the bimetal disc is located in position on the element plate 34 and cannot move from said location. The force is sufficiently light so as not to significantly affect the operating temperature of the bimetal disc 12. This arrangement allows for the operation temperature of the bimetal disc (ie the temperature at which the disc transforms from its first configuration to its second configuration) to be set prior to assembly on the element plate 34. The mounting portion 14 also comprises a back stop 20. In preferred arrangements the backstop 20 comprises a tab attached to the base portion 16. The back stop 20 is, under the usual forces operating within a liquid heating vessel, effectively rigid. In a preferred arrangement the mounting portion 14 is stamped from a sheet of metal and is bent into shape. Accordingly the base section, arm portion and back stop are all an integral piece, and the mounting portion thus comprises a spring clip.

The back stop is arranged to be either just touching, or just clear of the surface of the bimetal disc 10, when the bimetal disc 10 is in its first configuration below the operating temperature. In the figures the backstop is illustrated as a tab or protrusion from the base portion 18. It will be apparent that the back stop 20 may take any shape or configuration, provided it does not interfere with the bimetal disc 12 when the disc 12 is in its first configuration, and that it does engage with the bimetal disc 12 when said disc undergoes its transformation at the operating temperature.

Figures 5a, 5b and 6 shows a mounting area on an element plate 34 onto which the thermal actuator may be attached. In its first configuration the bimetal disc 12 takes the form of a concave bowl; at the operating temperature it undergoes a snap transformation to a convex bowl. A fulcrum 26 is disposed within the mounting area. The fulcrum is typically printed onto the element plate as one or more layers of dielectric, and accordingly is typically about 0.1-0.2mm thick. The fulcrum may be made up of a series of stepped layers of dielectric, so that the profile of the fulcrum 26 matches the underside of the bimetal disc 12 when the disc is in its first configuration. The fulcrum is of such a height that it does not interfere with the bimetal disc 12 when the bimetal is in its first configuration; the rim of the bimetal is able to make contact with the stainless steel element plate along the circumference of its rim. This arrangement is shown in figure 9.

The retaining pip 24 connecting the bimetal disc 12 to the carrying arm 18 of the mounting portion 14 may rest on the fulcrum 26. This arrangement helps ensure that a force just sufficient to ensure that the disc 12 is maintained in thermal contact with the element plate 34 is transmitted to the disc. It is important to ensure good thermal contact so that the thermal actuator 10 can accurately monitor the temperature within a liquid heating vessel, and thus operate a thermal control at the appropriate time.

Figure 1 shows a thermal actuator embodying the present arrangement disposed on an element plate 34. Specifically, there is shown a layout of a thick film element. The element plate 34 comprises a stainless steel plate 36

on which is printed a dielectric 30 made of glass or ceramic material. A resistive track 32 is printed on the dielectric 30, and forms the heater part of the heating element. A central portion of the steel plate is left clear of dielectric and heater track to provide a mounting position for the thermal actuator. If the thermal actuator 10 was mounted upon the a dielectric-covered element plate the dielectric would act as a thermal insulator, and may cause the actuator not to function at the desired temperature. The fulcrum 26 is located within the mounting position. The bimetal disc 12 of the thermal actuator 10 is placed in contact with the stainless steel plate. The temperature of the bimetal disc 12 follows the temperature of the liquid in the vessel as it is heated by the heating track. By locating the bimetal disc 12 in a portion away from the heating track the temperature of the bimetal is far more strongly governed by the liquid temperature than that of the heating track, and hence the temperature of the bimetal disc 12 essentially follows the temperature of the water.

Figures 5a and 5b show the thermal actuator in use. Figure 5a shows the arrangement when the temperature is below the operating temperature, and figure 5b shows the actuator 10 when the temperature reaches the operating temperature. It will be apparent that the bimetal disc undergoes a snap transformation and the disc 12 transforms from a dished convex arrangement to a dished concave arrangement.

When the bimetal disc 12 reaches the operating temperature and transforms to the concave dished configuration a portion of the lip of the disc 2 is prevented from lifting by the back stop 18. This has the effect of tilting the bimetal disc. The tilting action is accentuated by the fulcrum. The portion of the bimetal disc 10 retained by the back stop 18 is typically in contact with the element plate 34. A central portion of the bimetal disc 12 pivots about the fulcrum, thus resulting in the portion of the bimetal disc remote from the back stop 18 being tilted away from the element plate 34. The use of series of stepped layers to form the fulcrum 26 allows for the profile of the fulcrum to match the profile of the bimetal disc 12, when said

disc is in its first configuration (ie below the operating temperature). This also has advantage in that the pivot point, about which the thermally responsive component is tilted, is moved nearer to the centre of the thermally responsive component 12.

Thus, it will be apparent that the back stop 20 and the fulcrum 26 allow for the bimetal disc 12 to be tilted when the disc undergoes snap transformation. Thus, the portion of the disc remote from the back stop 22 is moved away from the element plate 34.

The present arrangement is particularly suited for use with a boil control unit. Such units are well described in, for example, GB-A-2409341 (see particularly page 3, line 30 to page 6, line 25). However, to aid understanding a brief description will be made here with reference to figures 7 and 8a-c.

Figure 7 shows an example of a boil control 40 that comprises a mechanism 42 operable to modify the functionality of the boil control 40 to provide a dual temperature heating control. Such a control is well known to a skilled man and hence a detailed description is not included herein.

The mechanism 42 cooperates with the above described thermal actuator 10 to provide this enhanced functionality.

The mechanism 42 comprises a rocking lever 44 that is pivoted on two pegs 46 which extend either side from a trip lever of the boil control 40, and carries a push rod 48 which is operable to transmit motion of the thermal actuator 10 to the rocking lever 44 as described below.

Two lugs 50 are provided as extensions to the cover of the boil control 40, and are configured to engage with a 'V' shaped slot 52 provided in respective sides of the rocking lever 44. Two further pegs are provided on the cover of the boil control which function as means for attachment of the mechanism 42 to the boil control 40, and to maintain the necessary assembly tolerance.

Figures 8a - c show the thermal actuator 10 in combination with a boil control.

Figure 8a shows the boil control 40 in the 'off' state. In this state, the rocking lever 44 is in its central position, and the lugs 50 are each located at the apex of their associated 'V' slots 52. In this position the trip lever of the boil control is pulled forward into its off position by action of the lugs sliding in their respective slots, which pull the pegs to the left as illustrated in the figures. In this position the thermal actuator 10 may be either its first or second configuration (ie depending on the temperature). In either configuration the bimetal disc 12 cannot reach the push rod 48 on the rocking lever 44, and hence the action of the bimetal does not affect the working of the boil control.

Figure 8b shows the boil control in a first of two 'on' states. In this position the rocking lever 44 has been depressed so that the lugs are at the upper end of their respective 'V' slots. In this position the gap between the push rod and the thermal actuator is sufficiently large so that when the bimetal disc 12 changes configuration it does not engage the rocking lever 44. The effect of this is that whilst the thermal actuator 10 will operate at the operating temperature, the boil control 40 is the only component operable to switch off the liquid heating vessel when the liquid boils.

Figure 8c shows the boil control in the second of its two 'on' states. In this position the rocking lever 44 has been lifted upwards so that the lugs are at the lower end of their respective 'V' slots 52. In this position the push rod 48 is brought into close proximity of the thermal actuator 10, so that when the temperature inside the liquid heating vessel reaches the operating temperature the bimetal disc 12 of the thermal actuator 10 will undergo snap transformation, and the disc 12 will be lifted as described earlier and push on the push rod 48. This switches off the boil control and thereby de-energies the heating element, without the liquid in the vessel having been heated to its boiling point. In effect, the thermal actuator 10 operates to switch off the boil control before the liquid in the vessel has reached a sufficient temperature to cause the boil control to operate of its own volition.

As will be apparent, the present has many advantages over the prior art. Particularly the mounting is more compact, which makes incorporating the dual-temperature boil control easier and simpler.

The form of the mount allows for the backstop to be effectively rigid, which allows a greater force to be generated by the edge of the bimetal disc 12.

In the prior arrangement of GB-A-2397438, the backstop is only as rigid as the resilient mount, which is required to take up the tolerance between the control and element surface, and to ensure good thermal contact between the element plate and the thermally responsive component.

The present arrangement separates the force required for each function, thereby allowing for each of them to be optimised. In particular, the force applied to the centre of the bimetal disc 12 is reduced to such a level where its effect on the operating temperature of the bimetal disc 12 may be ignored. This is the case due to the limited contact area between the bimetal and the carrying arm. Accordingly the operating temperature of the thermal actuator 10 may be accurately set. The contrasts with offset generated by the forces in the arrangement of GB2397438.

Additionally, the use of a dielectric fulcrum 26 allows for the feature to be easily and cheaply added to existing liquid heating vessels.

Figures 10 and 11 show an overtemperature control with which the present invention may be used. A pair of bimetal discs 12 are located thereon, and may be done so using a mounting portion according to the above disclosure. A full disclosure of the workings of the illustrated overtemperature control may be found in GB2397438.

It will be apparent that modification may be made to the particular embodiments described above without departing from the scope of the invention as claimed in the appended claims.

For example, the invention is described above in relation to a thick film type element. However, the invention may be used with a planar heating elements. One kind of planar heating element comprises an aluminium plate

which has cast or clenched to its undersurface a sheathed heating element, such as those comprising a wound electrical resistance wire housed with insulation within a metal sheath. In this arrangement the mounting portion may be fixed directly to the aluminium plate. Furthermore the backstop may be directly formed on the plate.

Claims

1. A thermal actuator comprising a thermally responsive part operable to undergo a snap transformation from a first configuration to a second configuration at a predetermined temperature, and a mounting portion operable to tilt the thermally responsive component when it is in its second configuration, with respect to its first configuration, wherein said thermal actuator is arranged to be incorporated into a liquid heating vessel, said vessel comprising an element plate, wherein said mounting portion is adapted for connection with the element plate.

2. A thermal actuator according to claim 1, wherein said actuator is operable to tilt about a fulcrum, said fulcrum being disposed on said element plate.

3. A thermal actuator comprising a thermally responsive part operable to undergo a snap transformation from a first configuration to a second configuration at a predetermined temperature, and a mounting portion operable to tilt the thermally responsive component when it is in its second configuration, with respect to its first configuration, wherein said thermal actuator is arranged to be incorporated into a liquid heating vessel, said vessel comprising an element plate, wherein said element plate comprises a fulcrum about which said thermally responsive part may be tilted.

4. A thermal actuator according to any preceding claim, wherein the thermally responsive component is a bimetal.

5. A thermal actuator according to any preceding claim, wherein the mounting portion comprises a back stop, said back stop being configured to tilt the thermally responsive component.

6. A thermal actuator according to any preceding claim wherein said element plate is a thick film element.

7. A liquid heating vessel comprising an element plate and a thermal actuator, said thermal actuator comprising a thermally responsive component capable of a snap transformation from a first configuration to a second configuration at an operating temperature, and a mounting portion operable to retain said thermally responsive component, said mounting portion being fixed to said element plate.

8. A liquid heating vessel according to claim 7, wherein said mounting portion is operable to tilt the thermally responsive component when it is in its second configuration with respect to its first configuration.

9. A liquid heating vessel according to claim 7 or 8, wherein the mounting portion comprises a backstop.

10. A liquid heating vessel according to claim 8, wherein said element plate comprises a fulcrum about which the thermally responsive component is tilted.

11. A liquid heating vessel comprising an element plate and a thermal actuator, said thermal actuator comprising a thermally responsive component capable of a snap transformation from a first configuration to a second configuration at an operating temperature, and a mounting portion arranged to tilt said thermally responsive component when in its second configuration about a fulcrum, said fulcrum being attached to said element plate.

12. A liquid heating vessel according to claim 10 or 11, wherein said fulcrum comprises one or more layers of dielectric.

13. A liquid heating vessel according to claim 10, 11 or 12, wherein the fulcrum comprises a series of stepped layers.

14. A liquid heating vessel according to any of claims 11 to 13, wherein said mounting portion is connected to the element plate.

15. A liquid heating vessel according to any of claims 11 to 14, wherein the mounting portion comprises an integral back stop.

16. A liquid heating vessel according to any of claims 7 to 15, wherein said element plate is a thick film element

17. A thermal actuator substantially as hereinbefore described with reference to the accompanying drawings.

18. A thermal actuator comprising a thermally responsive part operable to transform from a first configuration to a second configuration at a predetermined temperature, and a mounting portion operable to move the thermally responsive component from a first position to a second position, when the thermally responsive part is in its second configuration, wherein said thermal actuator is arranged to be incorporated into a liquid heating vessel, said vessel comprising an element plate, wherein said mounting portion is adapted for connection with the element plate.

19. A thermal actuator comprising a thermally responsive part operable to transform from a first configuration to a second configuration at a predetermined temperature, and a mounting portion operable to tilt the thermally responsive component when it is in its second configuration, with respect to its first configuration, wherein said thermal actuator is arranged to be incorporated into a liquid heating vessel, said vessel comprising an element

plate, wherein said element plate comprises a fulcrum about which said thermally responsive part may be tilted.

INVESTOR IN PEOPLE

Application No:	GB0521265.9	**Examiner:**	Damien Huxley
Claims searched:	1 to 19	**Date of search:**	26 January 2006

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 to 5, 7 to 11, 13 to 15, 18 & 19	US 5790010 A (SCHWAB) see the whole disclosure
X	1 to 5, 7 to 11, 14, 15, 18 & 19	GB 2363908 A (OTTER) see the whole document
X	1 to 5, 7 to 11, 13 to 15, 18 & 19	GB2336986 A (STRIX) see the text from line 27 of page 18 onwards, in particular

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

H1N

Worldwide search of patent documents classified in the following areas of the IPC

H01H

The following online and other databases have been used in the preparation of this search report

ONLINE: WPI, EPODOC