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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Electric Kettle

We, MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD., a corporation organised under the laws of Japan, of 1006 Oaza Kadoma, Kadoma-shi, Osaka, Japan, 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:—

The present invention relates to an electric kettle.

In an electric kettle, it is generally desirous that a switch connecting a kettle to an electric power source be opened after water is boiled, i.e. after maintaining hot water at 100°C. under atmospheric pressure for a few seconds. However, it is not easy to open a switch after maintaining temperature of hot water at 100°C. for a few seconds. In conventional electric kettles of this type, a steam hole is provided at the back portion of the kettle, and a bimetal strip disposed opposite the hole opens a switch by detecting or sensing temperature of steam exhausted from the hole. In another conventional electric kettle, a timer or a time relay is provided to open a switch after elapse of predetermined period of time, by setting the timer at a predetermined time which is needed for boiling water.

An electric kettle according to the invention comprises a main body, a lid detachable from the main body, an electric heating element provided inside the body and a thermal switch actuated upon a predetermined temperature to switch off electric current through the heating element, wherein one portion of the heating element is disposed in the vicinity of the temperature sensitive part of the thermal switch, the temperature sensitive part being housed in an enclosure together with the one portion of the heating element, the enclosure being provided with an outlet or outlets for releasing the steam, produced by the one portion of the heating element, from the enclosure, the substantial part of the water being eliminated from the enclosure by the pressure

of the steam, the temperature sensitive part being heated in a manner as though the kettle were substantially devoid of water, thus to subsequently actuate the thermal switch.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is an elevation view of an electric kettle of this invention partly in section;

Fig. 2 is a sectional view of a heating means for a kettle of this invention;

Fig. 3 is a right side elevation of the heating means shown in Fig. 2;

Fig. 4 is a side elevation of a switching mechanism partly in section;

Fig. 5 is a right side elevation of the switching mechanism shown in Fig. 4;

Fig. 6 is a front view of the movable switch contacts;

Fig. 7 is a temperature characteristic curve of a thermosensitive element of a thermal switch;

Fig. 8 to Fig. 10 illustrate another embodiment of the main part of this invention, wherein Fig. 8 is a side view in section, Fig. 9 is a left side view of that shown in Fig. 8, and Fig. 10 is a right side view of that shown in Fig. 8.

In the following description an embodiment of this invention is explained with reference to Fig. 1 to Fig. 6.

Referring to Fig. 1, a main body 1 of an electric kettle having a spout (2) is indicated. A handle (3) is bolted with bolts (5) to two fixtures (4) secured to the main body (1) at the front portion and back portion thereof respectively to project upwardly. The opening at the upper part of the main body (1) is closed with a detachable lid or cover (6) having a knob (7) and temperature indicating means (8) at the central portion thereof. An electric heating element (9) for heating water within the main body is mounted on the inside of the bottom of the main body (1).

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A part of the back portion of the main body (1) is cut off, and a base plate (10) is fixed inside the body (1) to enclose the cut off portion with a packing (11) ensuring liquid tightness of the kettle. Both ends of the electric heating element (9) extend to the outside of the body (1) through holes at the upper part of the base plate (10), an intermediate portion 9a of element 9 contacting the base plate (10). The heating element (9) is soldered to the base plate (10) at its portion 9a and at the portions that extend through the base plate holes.

On the rear side of the portion of the base plate (10) in contact with the intermediate portion 9a of the heating element (9) a temperature sensitive ferrite piece (12) is mounted by a holding plate (13), and a magnet (14) is supported by a holder 15 oppositely-disposed to the ferrite (12).

The portion of the inner side of the base plate (10), on the outer side of which portion the ferrite (12) is positioned, is enclosed, together with the portion 9a of the heating element (9), by a cover (19) having holes (17) and (18) on the upper part and the lower part thereof respectively, the arrangement defining a chamber C. Metallic terminal fixtures (22) and (23) are fixed to the terminals (20) and (21) of the heating element (9) respectively, each provided with contacts (24) and (25) respectively, forming the fixed contacts of normally closed switches provided with movable contacts (30) and (31) on spring contact plates (28) and (29) secured to terminals (27) of a power connector (26). A supporting plate (32) provided with a supporter (33) at the upper part thereof is secured to the back portion of the main body (1). A supporting base (34), to which a porcelain insulator (35) is secured with a screw (36), is fixed to the lower portion of the supporting plate (32). The terminals (27) are secured to the porcelain insulator (35).

A lever (37) is pivoted at one end rotatably to the supporter (33), and is fixed at the other end to the holder (15). A pair of insulating fingers 38 are secured to the middle portion of the lever (37) opposite to the contact plates (28) and (29) for operating the contact plates (28) and (29) to open contacts 24, 30, and 25, 31, when the magnet (14) is no longer attracted to the ferrite (12). A reset lever (39) is pivoted rotatably at its central portion (40) to the end of the supporter (33), and a rod (41) intervening between the lever (39) and the lever (37) is pivoted at its ends to the lever (39) and the middle portion of the lever (37) respectively. The main body (1) is provided with a cover (44) which covers the switch means provided within the main body (1), except the reset lever (39) which is exposed outside of the cover (44). The cover (44) is fixed to the main body (1) by screws (45) and (46). The

main body (1) is provided at its bottom with legs (47).

The distance between the magnet (14) and the ferrite (12) when the magnet (14) is in the position shown in dotted lines in Fig. 1 is so designed that the magnet (14) is not attracted by the ferrite (12) against the counter force of a spring (16).

When water is poured into the main body (1) and the lever (39) is rocked to the position shown in full lines in Fig. 1, the rod (41), the lever (37) and the holder (15) are moved to the position shown in full lines in Fig. 1 and the ferrite (12) attracts the magnet (14) overcoming the opposing force of the spring (16). In this state, the fingers (38) which are fixed to the lever (37) disengage from the contact plates (28) and (29), and allow the contact (24) and (30), (25) and (31) to contact each other respectively so that the switches are closed. Thus a circuit from one of the terminals (27) of the power supply through the contact plate (28), the contacts (30) and (24), the metallic terminal fixture (22), the terminal (20), the heating element (9), the terminal (21), the terminal fixture (23), the contacts (25) and (31) and the contact plate (29) to the others terminal (27) is closed, supplying power to the heating element (9), as illustrated in Fig. 1.

By supplying power to the heating element (9), water in the main body (1) is heated. The portion 9a of the heating element (9) also heats water within the chamber C.

The temperature of the heating element (9) and the base plate (10) does not exceed 100°C. until water in the main body (1) is boiled, because heat generated in the heating element is absorbed by water, i.e. the heating element is cooled by water. Also the base plate is cooled by water, even though heat is transmitted to the base plate from the heating element.

When water in the main body (1) is heated to boiling point and begins to boil or to evaporate, evaporation within the chamber C increases remarkably, and steam thus evaporated flows out of the hole (17).

When temperature of water reaches 100°C. and evaporation becomes more violent, so that a part of steam cannot flow out of said hole (17) and accordingly accumulates within the chamber C, water within the chamber C decreases owing to pressure of accumulated steam, while accumulated steam reaches near the surface of the heating element portion 9a by depressing the water level within the chamber C, the water being displaced through hole 18. Then heat transmission rate from the heating element (9) to water, or cooling rate of the heating element (9) by water decreases, causing temperature of the base plate (10) to be risen to above 100°C. Namely, the base plate (10) is substantially heated as if the kettle is heated

without containing water therewithin.

Thus, by setting the curie point of the ferrite (12) at about 120°C., the temperature of the base plate or the ferrite (12) exceeds 120°C. only when water is boiled by rapid temperature rise, causing the magnet (14) to move apart from the ferrite (12) by the spring (16) automatically and quickly, and resulting in cut off of power supply by opening the contacts (30) and (31) from the contacts (24) and (25) respectively, through parts 37, 38.

In practise, a ferrite having a composition of 51% of Fe_2O_3 , 27.5% of Mn_2O_3 and 21.5% of ZnO is used.

Further explanation of the holes (17) and (18) will be made hereinafter. The hole (17) is for the purpose of limiting or controlling steam to obtain a rapid temperature rise of the thermosensitive element (ferrite), and the hole (18) is for the purpose of balancing to determine the operating point of the switch means by controlling supply of water from the cham-

ber C relative to the amount of steam emerging from the hole (17) and the quantity or amount of steam evaporated within the chamber C, and preventing excess flow of water into the chamber C by convection, so that the quantity of water flowing into the chamber C by convection does not exceed the amount desired. The position of the hole (18) is determined by the relative position of the heating element (9) within the cover 19.

The graph in Fig. 7 illustrates the relation between the temperature rise of the thermosensitive part (ferrite) and the temperature rise of water with reference to the following table under the following conditions: amount of water poured into the body 1 is 3.408 litre, ambient temperature is 27°C., temperature of water is 20°C., with supplying power of 2 KW, the diameter of the lower hole 18 being fixed to 2.5 mm, and the diameter of the upper hole 17 being varied from 2 mm to 2.3 mm and 2.4 mm.

Test No.	Diameter of hole 17 mm	Water Temperature (°C.) at which the Sensitive Part responds to open the switch	Temperature of Sensitive Part (°C.) at Boiling Temperature (95°C.) of water	Temperature Rise of Sensitive Part from Boiling Temperature 95°C. of water	Temperature at Saturation °C.
I	2.0	85	128	28	156
II	2.3	93	108	22	130
III	2.4	99	102	14	116

Accordingly, if the curie point of the ferrite (12) is set at 120°C., for example, the switch is opened at 88°C. of water temperature in test case No. I, and at 98°C. in test case II, while the switch is kept closed in test case III. Accordingly, taking into consideration the voltage variation, and other factors, if the temperature actuating the ferrite is about 100°C., boiling water of constant temperature can be obtained.

A single hole of larger diameter may be provided at the side of the cover (19) instead of the two holes (17) and (18), or holes in multiple may be provided at the upper and lower parts as well as at the side of the cover, resulting in the same effect with the above preferred embodiment.

Further, as illustrated in Fig. 8 to Fig. 10, a gap (48) may be provided between the heating element (9) and an aperture in cover 19 through which element 9 penetrates instead of above described holes, resulting in the same effect with above described embodiment.

Thus, in this invention, a thermal switch is to be operated under the condition that the temperature sensitive part of the switch is placed in the state substantially as if water has not been poured into the kettle. The accuracy of work temperature can be obtained satisfactorily with thermal switches which can be produced in a mass quantity. Moreover, only by positioning the temperature sensitive part in the vicinity of a part of a heating element and enclosing said sensitive part with a cover, the switch can be operated always accurately without necessity of a timer which would be required in some of the conventional kettles or a moisture preventing means if steam jet is utilized to detect boiling of the water, as in the conventional kettle, and accordingly construction of an electric kettle of this invention can be remarkably compact.

Furthermore, since a temperature sensitive part of the thermal switch operates when hot water does not contact it, namely e.g., if the kettle is heated without water poured in it, the switch duly operates and opens even when

electric power supply is supplied to a kettle containing only a little water or without water poured into it. Accordingly, the switch can be opened either when water has been boiled or when a kettle is supplied with electric power without water poured into it, though the switch is provided with only one thermostat. Thus the kettle of this invention is quite convenient eliminating the necessity of using a plurality of thermal switches as in the conventional kettle.

So far, a thermal switch using a magnet and a ferrite has been described. However, it is not necessary to limit a thermal switch to such a composition. A snap acting bimetal for example, may be used resulting in the same effect. As there may exist some errors in manufacturing ferrites, bimetal strips do not work uniformly. On the other hand they are needed to have accuracy of a certain degree when they are in use, and such bimetals can not be mass-produced. In this invention, however, since a sensitive part of a bimetal is exposed, to substantial heat without being immersed in water and in this state the temperature of the sensitive part rises rapidly, mass-produced bimetals which do not work accurately can be used.

Next, a temperature indicating means (8) provided at the central portion of the cover (6) will be explained. A transparent cap-shaped cover (50) made of plastics material contains inside thereof a indicating cylinder (51), and a small hole (52) is provided for introducing air so that the cylinder (51) can move smoothly upwardly and downwardly. At the lower part of the cylinder (51) a projecting part or a rim (53) is formed which fixes a magnet (54) in its position. A soft ferrite (55), of which curie point is at about $70^{\circ}\text{C}.$ — $80^{\circ}\text{C}.$, is placed between the magnet (54) and a further magnet (56). The magnet (56) is similar to the magnet (54), and the adjacent poles of the magnets (54), (56) are of the same polarity. The magnet (56) is embraced in a recess in the ferrite (55), biasing the magnetic flux passage generated by the magnet (54).

Further, by choosing the ferrite (55) so that it does not saturate with the magnetic flux generated by the magnet (54) and passing through the ferrite (55), the magnets (54) and (56) will both attract the ferrite 55 instead of repulsing each other at a temperature under the curie point, even though both magnets are facing with poles of the same polarity. A case (57), to the bottom part of which the magnet (56) and the ferrite (55) are fixed, and the upper opening of which is provided with the cover (50) is fixed to the centre portion of the lid (6) penetrating the lid and being sealed with a packing (58). Accordingly, a part of the indicating cylinder (51) extends from the cover (6) upwardly, and a part of

case (57) extends from the lid (6) downwardly to the inside of the body (1).

When the heater (9) is supplied with electric current and heats water contained in the body (1), the case (57) fixed to the lid (6) is heated according to the temperature rise in water, and the temperature of the case rises as well as that of the water in the body (1). When the temperature of water being heated in the body (1) is raised and steam is evaporated, the ferrite (55) senses the temperature, and when the temperature exceeds the curie point (in this case about $70^{\circ}\text{C}.$ — $80^{\circ}\text{C}.$), then the flux density in the ferrite (55), which biases the flux of the magnet (54), decreases to nearly zero, and then the magnets (54) and (56) repulse each other. According to this repulsion, the magnet (54), together with the indicating cylinder (51) moves upwardly within the lid (6). If the side surface of the indicating cylinder (51) is coloured, such as in red or in blue and so on, the coloured part of the indicating cylinder (51) can be viewed from outside, which position indicates the temperature of water in the body (1).

Thus the temperature inside the body (1) can be discerned by viewing the temperature indicator from outside, protecting people from getting burnt by touching the body (1) with his hand to check the temperature of water.

Further, this temperature indicating means does not use any metals subjected to corrosion such as bimetal strips, and the operation thereof is simple, so that there are no possibilities of failure, and the indicating means can indicate accurately the temperature of water.

When the temperature of water in the body (1) decreases, then the ferrite becomes a magnetic substance again, and the magnet (54) moves downwardly to the original state. Thus, in combination with the thermal switch in this invention, desired hot water can be easily obtained.

WHAT WE CLAIM IS:—

1. An electric kettle comprising a main body, a lid detachable from the main body, an electric heating element provided inside the body and a thermal switch actuated upon a predetermined temperature to switch off electric current through the heating element, wherein one portion of the heating element is disposed in the vicinity of the temperature sensitive part of the thermal switch, the temperature sensitive part being housed in an enclosure together with the one portion of the heating element, the enclosure being provided with an outlet or outlets for releasing the steam, produced by the one portion of the heating element, from the enclosure, the substantial part of the water being eliminated from the enclosure by the pressure of the steam, the temperature sensitive part being heated in a manner as though the kettle were

electric power supply is supplied to a kettle containing only a little water or without water poured into it. Accordingly, the switch can be opened either when water has been boiled or when a kettle is supplied with electric power without water poured into it, though the switch is provided with only one thermostat. Thus the kettle of this invention is quite convenient eliminating the necessity of using a plurality of thermal switches as in the conventional kettle.

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Further, by choosing the ferrite (55) so that it does not saturate with the magnetic flux generated by the magnet (54) and passing through the ferrite (55), the magnets (54) and (56) will both attract the ferrite 55 instead of repulsing each other at a temperature under the curie point, even though both magnets are facing with poles of the same polarity. A case (57), to the bottom part of which the magnet (56) and the ferrite (55) are fixed, and the upper opening of which is provided with the cover (50) is fixed to the centre portion of the lid (6) penetrating the lid and being sealed with a packing (58). Accordingly, a part of the indicating cylinder (51) extends from the cover (6) upwardly, and a part of

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Thus the temperature inside the body (1) can be discerned by viewing the temperature indicator from outside, protecting people from getting burnt by touching the body (1) with his hand to check the temperature of water.

Further, this temperature indicating means does not use any metals subjected to corrosion such as bimetal strips, and the operation thereof is simple, so that there are no possibilities of failure, and the indicating means can indicate accurately the temperature of water.

When the temperature of water in the body (1) decreases, then the ferrite becomes a magnetic substance again, and the magnet (54) moves downwardly to the original state. Thus, in combination with the thermal switch in this invention, desired hot water can be easily obtained.

WHAT WE CLAIM IS:—

1. An electric kettle comprising a main body, a lid detachable from the main body, an electric heating element provided inside the body and a thermal switch actuated upon a predetermined temperature to switch off electric current through the heating element, wherein one portion of the heating element is disposed in the vicinity of the temperature sensitive part of the thermal switch, the temperature sensitive part being housed in an enclosure together with the one portion of the heating element, the enclosure being provided with an outlet or outlets for releasing the steam, produced by the one portion of the heating element, from the enclosure, the substantial part of the water being eliminated from the enclosure by the pressure of the steam, the temperature sensitive part being heated in a manner as though the kettle were



substantially devoid of water, thus to subsequently actuate the thermal switch.

2. An electric kettle according to claim 1, wherein the outlet for the release of steam is a hole provided in the top side of said enclosure.

3. An electric kettle according to claim 1, wherein the outlet for the release of steam is the clearance between the heating element and an aperture of the enclosure through which the heating element extends.

4. An electric kettle according to claim 1, wherein the main body includes a supporting member which is provided inside the main body so as to form water-tight seal around an opening thereof, the one portion of the heating element being in contact with the inner surface of the supporting member, and a ferrite piece, which forms the temperature sensitive part of the switch, is attached on the outer surface of the supporting member opposite the one portion of the heating element, and wherein the thermal switch includes a magnet positioned oppositely to the ferrite piece to be attracted thereto, a spring urging the magnet away from the ferrite piece, and switch contacts which open to switch off electric current of the heating element when the magnet is no longer attracted to the ferrite piece.

5. An electric kettle according to claim 1, wherein said thermal switch is of a snap acting type using a bimetallic element.

6. An electric kettle according to claim 1, wherein said kettle is provided with a temperature indicator comprising two magnet

pieces disposed with their ends of the same polarity facing each other, and a ferrite piece disposed between said two magnet pieces so that the temperature is indicated by departure of said magnet pieces from each other when the temperature is higher than the curie point of said ferrite.

7. An electric kettle according to claim 4, wherein said switch contacts comprise a movable contact mounted on a resilient strip supported by one of the power input terminals, a fixed contact mounted on one of the terminals of said heating element, said movable and fixed contacts being disposed oppositely to constitute a set of normally-closed contacts, a lever one end of which is pivoted to a part extending from said main body of the kettle, and the other end of which is connected to said magnet, and which has an insulated element to engage and push away said resilient strip supporting said movable contact for opening said set of normally-closed contacts when said magnet is no longer attracted to the ferrite piece, and means for manually resetting said set of contacts by manipulating said lever in the middle portion thereof.

8. An electric kettle substantially as herein described with reference to Figs. 1 to 6 and as modified with reference to Figs. 8 to 10 of the accompanying drawings.

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