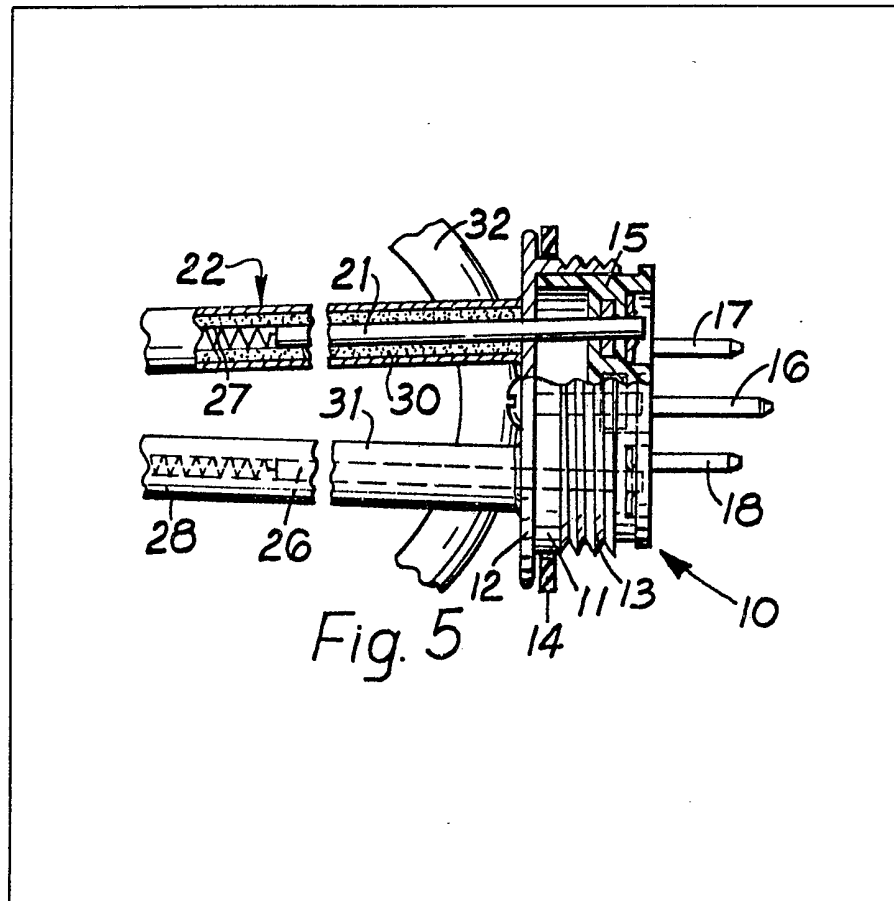


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(54) **Electric liquid-heating assembly**

(57) To maintain the response of a thermally-sensitive cut-out actuated by bimetal and to minimise heat transfer from heating coil 27 to insulator 15 within body 10, in an electric liquid-heating assembly such as one used in an electric kettle, the cold length of heating element 22, as represented by low-resistance

conductors 21, 26 is extended, as compared with conventional arrangements to a total of 100 mm or at least 19% of the overall length of the element 22, and the heat transfer area between the sheath 30 of the element 22 and backplate 12 of the body 10, in register with the bimetal, is minimised so as to be not more than 8% of the total area of the backplate 12 or not to extend over more than 25 mm of the length of the element 22.



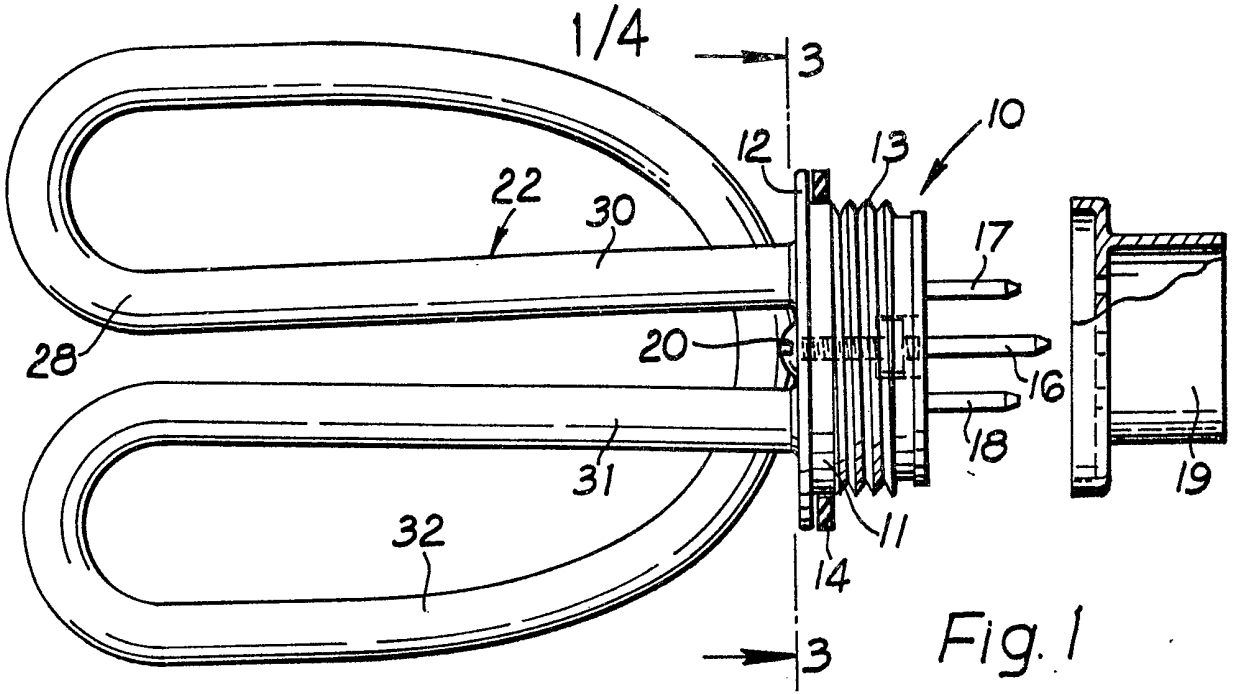


Fig. 1

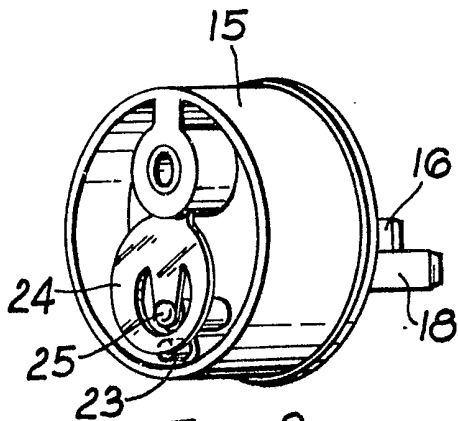


Fig. 2

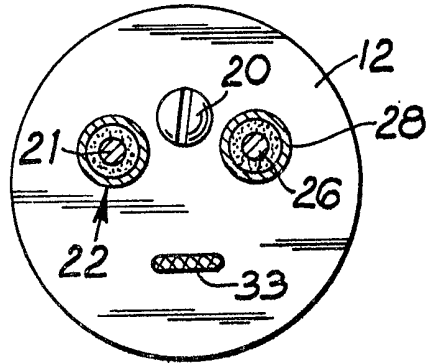


Fig. 3

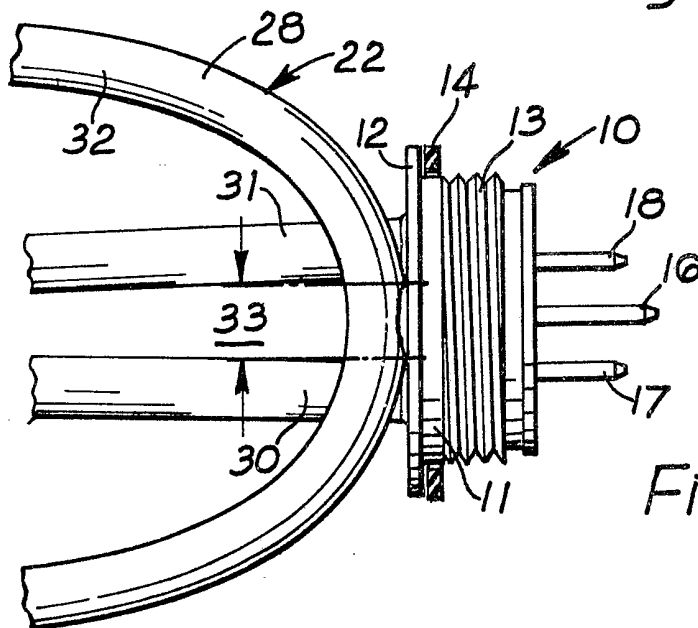


Fig. 4

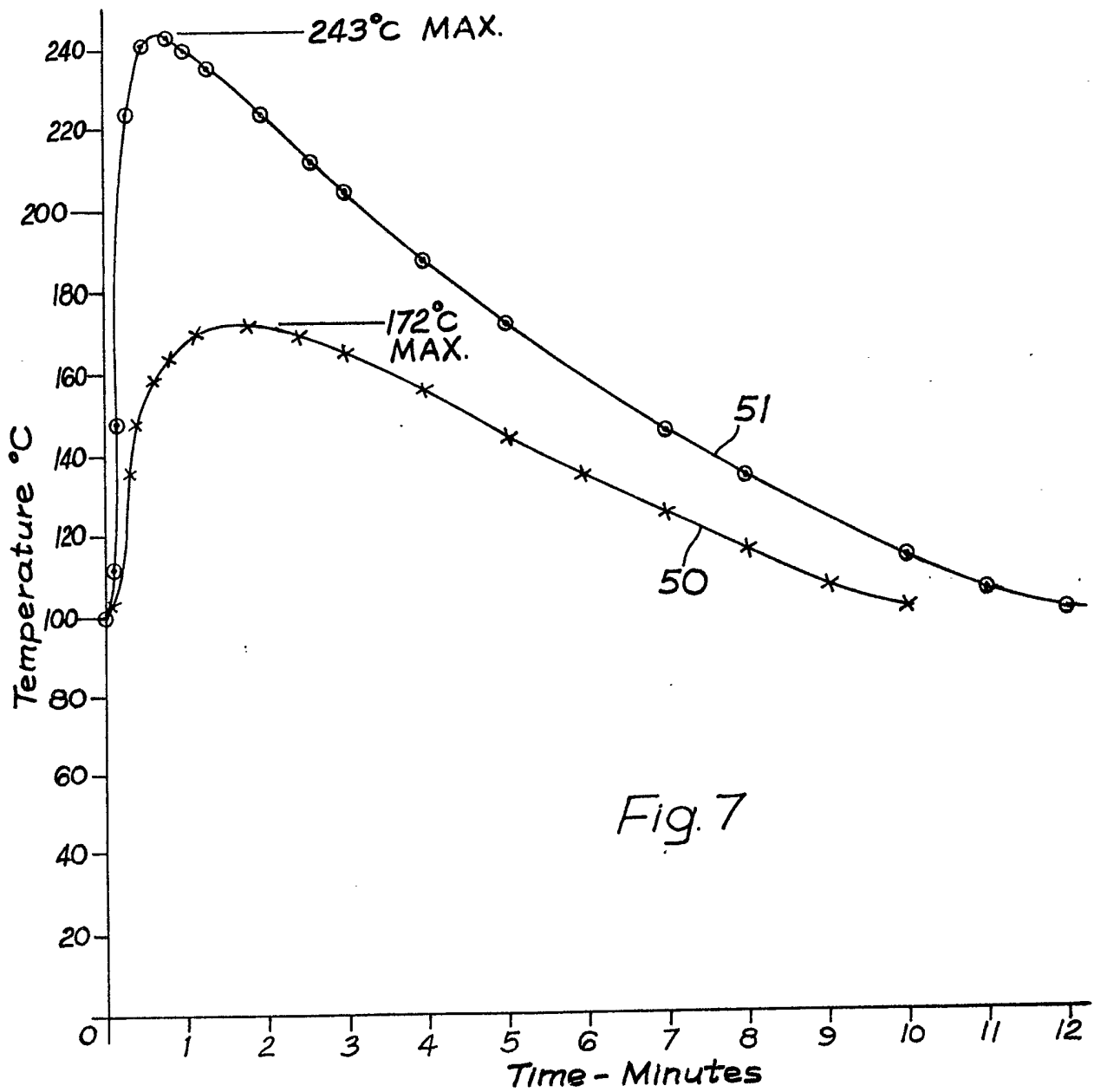
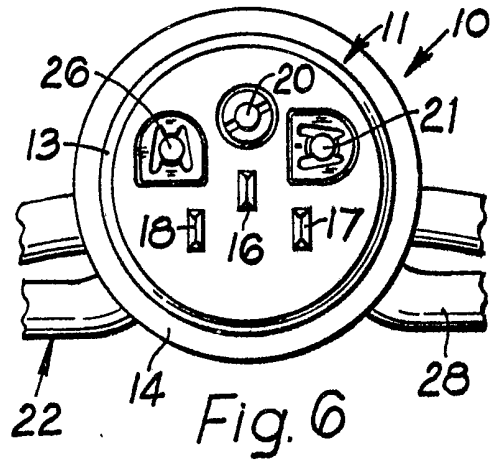
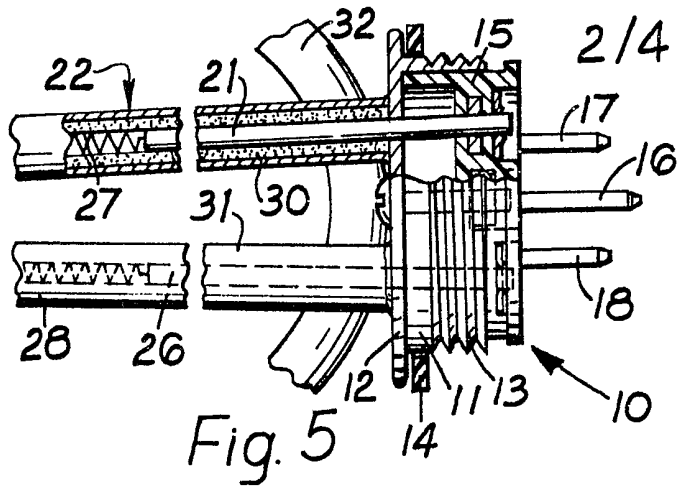
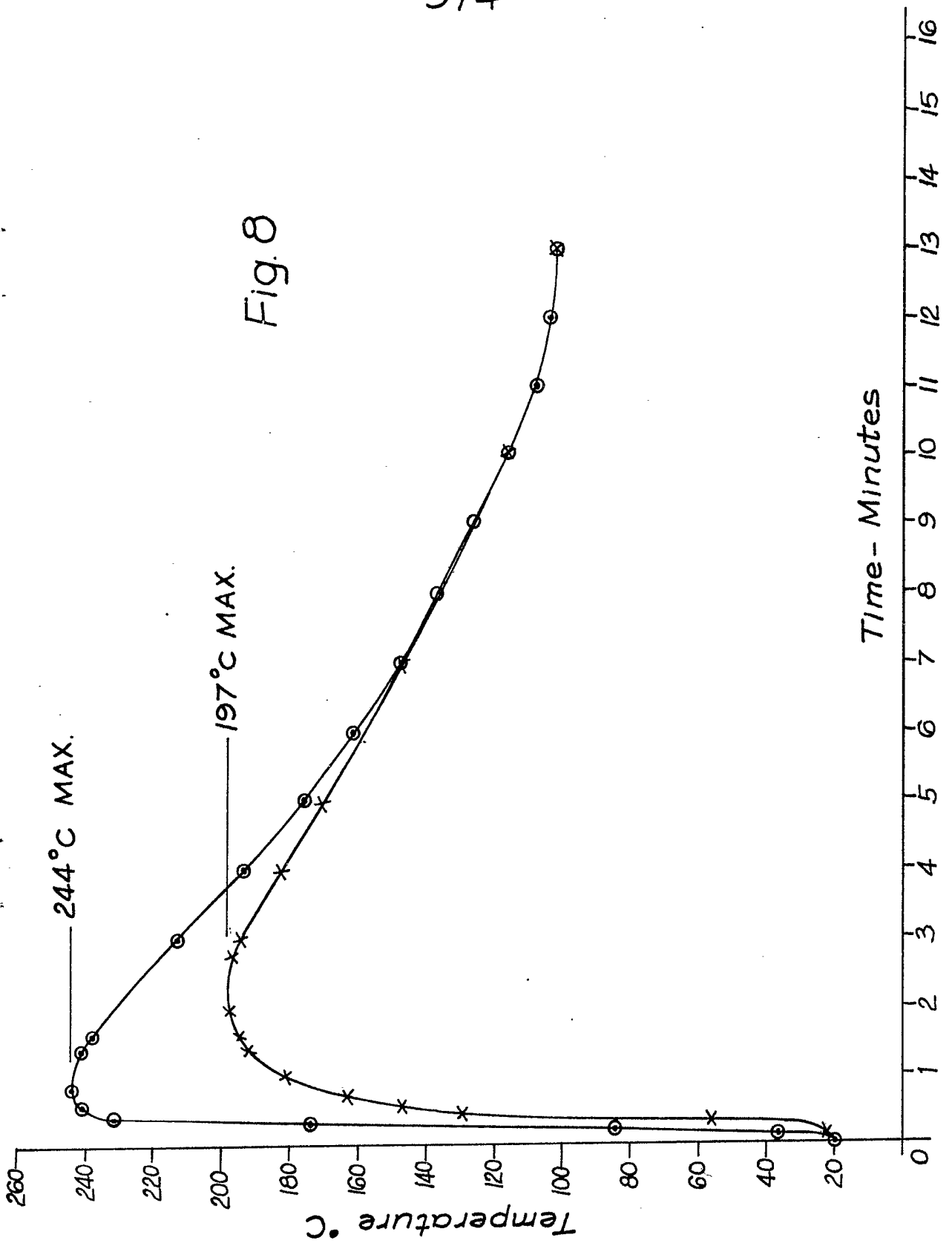
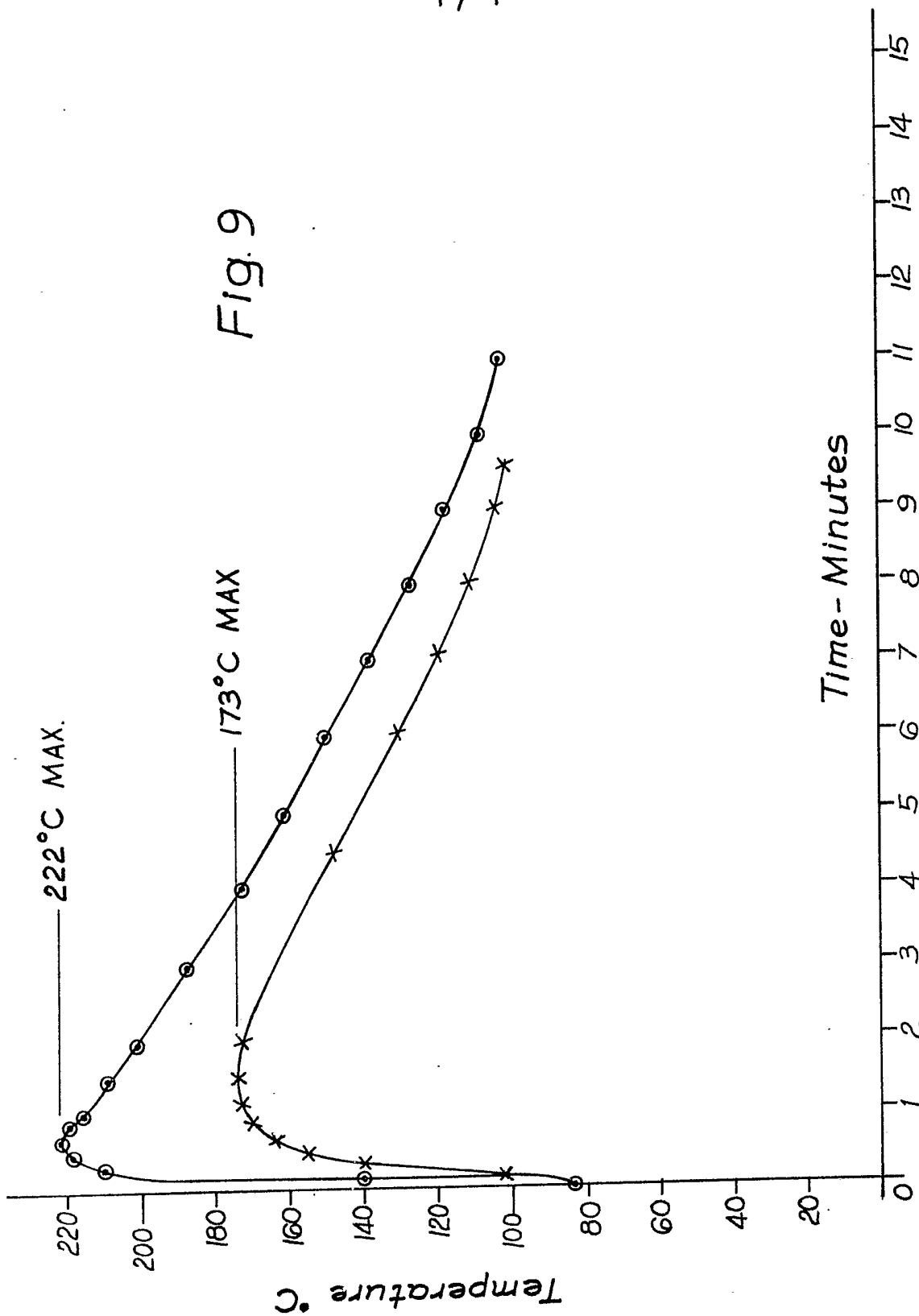


Fig. 8





SPECIFICATION

Electric liquid-heating assembly

This invention relates to electric liquid-heating assemblies, for appliances such as electric kettles and washing machines, of the type (hereinafter referred to as "of the type described") comprising a connector having a body housing a temperature-sensitive cut-out and providing means whereby the assembly can be connected to a power supply and having a substantially flat metal backplate which can be sealed relative to an aperture in the appliance, a metal-sheathed resistance heating element extending from and having its ends sealingly connected to the backplate with a central portion of the sheath in direct thermal transfer relationship with the metal backplate, so that if the assembly has power supplied to it whilst there is little or no water in the appliance the temperature rise at the central portion of the element activates the cut-out which cuts off the power.

Such liquid-heating assemblies generally work well, but there is a drawback. In order to get maximum heat transfer from the element to the backplate, and thus try to ensure speedy cut-off response, it has been normal to arrange for a continuous length of the central portion of the sheath to be brazed right the way across the backplate. In such an assembly it is typical for the cut-out (which normally includes a bimetal) to trip some 12 to 18 seconds after switch-on under completely dry conditions, which conditions can occur if the appliance is accidentally switched on empty or has been switched on full and left to boil dry. During this period of time the element generates a considerable quantity of heat which, after the cut-out has tripped, continues to flow into the backplate from the element. It has been found that the temperature of the body can rise to temperatures between 220°C and 250°C. This temperature is rather high for some of the materials used in the assemblies. The body usually incorporates an insulator of a plastics electrically-insulating material, such as nylon or glass-filled nylon, which is secured to the backplate and mounts the cut-out. Some of these materials can stand temperatures of 180°C to 190°C without deterioration and temperatures up to about 230°C for short periods. Unfortunately, when heated above about 200°C, although remaining apparently unchanged, incipient softening and minor permanent dimensional changes occur. These effects can cause deterioration at the various connections between the insulator and other parts, for example the usual pins for an external plug connection, the backplate and the bimetal of the cut-out. This deterioration can cause loosening of these connections and, thus, a general lowering of the safety standards of the appliance. Of particular importance is the bimetal of the cut out. This is usually secured to the insulator by a fastening in the form of a pin or screw and when it has operated is in a stressed condition which places a load on the fastening. At

low temperatures, the fastening is quite adequate, but above about 200°C, the aforesaid changes in the material of the insulator can strain the fastening sufficiently substantially to increase the trip times. When this happens, the element remains hot for a much longer period with the attendant likelihood of destruction of the element and/or irreparable damage to the appliance.

One quite important factor which affects the temperatures arising in various parts of the body is the fact that the ends of the element tend to act to transmit heat to the backplate at locations away from the cut-out. The end regions are provided by conductors of low resistance material and of quite large cross-section compared with a middle heat-generating section. Whilst these end regions do not themselves generate significant heat, they transmit heat to the backplate and body and affect the final plate temperature. The sum of the lengths of the end portions of the element wherein the conductor has a low resistance is referred to herein, for convenience, as the "cold length" of the element. Typically the "cold length" of the element of such an assembly, in the known constructions, is between 8% and 15% of the total length of the element.

An object of the present invention is to provide an improved electric heating assembly of the type described which has the advantages of reaching lower body temperatures than the prior known construction when the appliance is left switched on and the cut-out switches the element on and off.

With this object in view, the present invention provides an electric liquid-heating assembly of the type described wherein the total cold length of the element is at least 19% of the total length of the element, and wherein the area of thermal contact between the central portion of the sheath of the element is less than 8% of the area of the backplate, said area being located in close proximity to the thermal cut-out.

The "cold length" of the element is a factor which is determined more by the characteristics of the ends of the element and its connection to the backplate and body. Hence, it can alternatively be expressed not as a percentage of the element length but as an actual length. Further, because the sheath diameter is fairly constant from element to element, the width of the thermal contact area (usually a brazed joint between the element and the backplate) is fairly constant only the length changing dependant upon the amount of the central portion of the element which lies alongside the backplate. Thus, again, the invention can alternatively be expressed in terms of the length of the thermal contact area.

Accordingly, differently expressed, the invention provides an electric liquid-heating assembly of the type described wherein the total cold length of the element is at least 100 mm and wherein the length of the heat transfer area is less than 25 mm, the thermal contact area being located in close proximity to the thermal cut out.

As a further equivalent, the invention provides

an electric liquid-heating assembly of the type described, wherein the total cold length of the element is at least 19% of the total length of the element, and wherein the length of the thermal contact area is less than 25 mm, the heat transfer area being located in close proximity to the thermal cut-out.

As a still further equivalent, the invention provides an electric liquid-heating assembly of the type described, wherein the total cold length of the element is at least 100 mm and wherein the area of thermal contact between the central portion of the sheath of the element is less than 8% of the area of the backplate, said area being located in close proximity to the thermal cut-out.

Preferably, the total cold length is 140 mm or more, with a probable practical maximum of 180 mm.

Advantageously the length of the thermal contact area is minimised, down to a lower practical limit of from 5 to 6 mm. This gives an area of about 2% of the backplate area. However, lengths, for instance, giving areas of 4, 5 or 6% of the backplate area may be used.

Preferably the total cold length of the element is about 20% of the total length of the element and advantageously the area of thermal contact is less than 5% of the area of the backplate. The maximum cold length of the element is uncertain, but practical considerations suggest that 90 mm would be a reasonable upper limit for each end portion, giving a total cold length of 180 mm, which in the case of a typical element total length of 575 mm or 640 mm would give a maximum percentage figure of about 30%.

Increase in the "cold length" of the element by itself does not lead to reduction of the reaction time of the cut-out; it does, however, reduce the transmission of heat to the body at regions thereof away from the cut-out. In combination with the reduction in the heat transfer area, in complete contradistinction to normal practice wherein the thermal contactor heat transfer area was maximised as far as the size of the backplate would allow, substantial reduction of the body temperature can be obtained so leading to a reduced final insulator temperature.

With reduction in the thermal contact area to between 2% and 8% of the total area of the backplate and increase of the "cold length" to from 19% to 30% of the total element length, with a typical cut-out set to operate at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$, the final insulator temperatures can be reduced to around 160°C to 190°C . This greatly reduces the possibility of insulator deterioration and its attendant dangers.

The invention will be described further, by way of example, with reference to the accompanying drawings which illustrate a preferred embodiment and its operation, it being understood that the following description is illustrative and not limitative of the scope of the invention. In the drawings:—

Fig. 1 is a part-sectional underneath plan of a preferred embodiment of the liquid-heating

assembly of the invention;

Fig. 2 is a perspective view illustrating an insulator which forms part of the assembly of Fig. 1;

Fig. 3 is a section taken as indicated by the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary plan view showing part of the assembly of Fig. 1;

Fig. 5 is a part-sectional view corresponding to Fig. 4, but showing the assembly with a protective disc removed;

Fig. 6 is an end view corresponding to Fig. 5;

Fig. 7 is a graph illustrating the temperature occurring at the outer edge of the backplate of the assembly of Figs. 1 to 6 during one cycle of operation of the cut-out thereof, after an appliance fitted with the said assembly, initially filled with water, has been left switched on for a period of 18 hours, the temperatures achieved being plotted alongside with equivalents from a conventional assembly for comparison;

Fig. 8 is a graph similar to that of Fig. 7 but illustrating the temperatures involved in the case where the appliance was switched on from cold when empty of water during the first cycle of operation of the cut-out; and

Fig. 9 is a graph illustrating the cycle of operation of the cut-out after the appliance has been left switched on for a period of time in the empty condition, so that it forms a later continuation of the graph of Fig. 8.

The illustrated preferred electric liquid-heating assembly of the invention is of the type described and has a body 10 which includes a metal cup 11 which provides a substantially flat backplate 12 in the form of a disc some 50 mm in diameter. From one side of the disc 12 extends integral side walling 13 of the cup which is externally threaded. The disc 12 extends outwardly of the side walling 13 to provide a sealing flange which can be clamped against the surrounding material of an aperture in the side of a kettle (not shown) with the interposition of a sealing washer 14, by a threaded annulus (not shown) engaging the walling 13 of the cup 11. An insulator 15 (Fig. 2) of nylon nests inside the cup 11 and mounts three pins 16, 17, 18, surrounded by a shroud 19, for engagement by a plug (not shown). The pin 16 is an earth and is connected by way of a screw 20 to the backplate 12. Of the other two pins, the pin 17 is connected to one end of a conductor 21 of an element 22 of the assembly and the other pin 18 is connected to one of a pair of contacts of a cut-out (not visible) which has an actuating button 23 adapted to be depressed by movement of a bimetal 24 (see Fig. 2) attached to the insulator 15 by a pin 25 whose head bears against the backplate 12. The other of the two contacts of the cut-out is connected to the other end of conductor 26 of the element 22.

The element 22 comprises the conductors 21 and 26 and a spiral heating coil 27 therebetween and is enclosed in a tubular metal sheath 28 and separated therefrom by a temperature resistant insulating material 29 such as magnesium oxide.

Each end of the tubular metal sheath 28 is brazed to the backplate 12 and respective apertures in the backplate 12 allow the conductors 21, 26 to penetrate therethrough to the insulator 15. The element 22 is arranged in a general planar disposition, portions 30, 31 adjacent each end extending outwardly and downwardly from the backplate 12, then curving outwardly and back as a loop 32 to the backplate 12 to provide a central curved portion of the sheath 28 in point contact with the backplate 12 directly in register with the bimetal 24. This portion of the sheath 28 is united in heat-transferring relationship with the backplate by brazing, as indicated by the numeral 33 in Figs. 3 and 4, the area of the braze 33 being made as small as possible, consistent with the behaviour of the braze metal and the maximum curvature which can reasonably be applied to the sheath 28 without damaging it or imperilling its insulation. The area of the braze 33 is less than 8% of the area of the backplate 12 and preferably at or below 5%. Typical and effective values which have been achieved and given satisfactory performances, bearing in mind the difficulty in actually measuring the area of the braze, have been between 3% and 5%, being about 12 to 15 mm in length.

The conductors 21, 26 constitute end portions of low resistance material (to minimise the transmission of heat to or generation of heat in the insulator 15) joined to the central high resistance heating coil 27. The combined lengths of these end portions 21, 26 is known as the "cold length" of the element 22. In the illustrated assembly the "cold length" amounts to about 100 mm in relation to a total element length of about 525 mm, so that is about 19%.

When the assembly of the invention is installed in a kettle and the kettle switched on completely "dry", the cut out has been found to operate after some 12 to 18 seconds with a typical cut-out set to operate at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$, and the final temperature of the insulator has risen to between 160°C and 190°C . Thus, the possibility of damage to the insulator is greatly reduced. There is a further advantage. Heretofore, because of the higher final temperatures reached in the body, the sealing washer 14 had to be of silicone rubber (which can withstand temperatures of up to about 250°C). In the assembly of the invention neoprene rubber (which will withstand temperatures up to 180°C) can safely be used, and neoprene is considerably cheaper than silicone rubber.

Accordingly, it will be appreciated that by increasing the "cold length" and by taking the unusual step of minimising the thermal transfer area between the centre of the element 22 and the backplate 12, significantly lower insulator final temperatures are reached. Thus, if a kettle having the assembly of the invention is switched on and left for a period of time, the cut-out will simply operate periodically as the assembly heats up and then cools, without heat damage to the assembly.

The advantages of the construction of the invention are illustrated graphically in Figs. 7, 8

and 9.

Fig. 7 illustrates, at line 50, one cycle of operation of the cut out of the assembly of Figs. 1 to 6, when fitted to an appliance in the form of a kettle, after the latter, initially filled with water, has been left switched on for a period of 18 hours, in comparison with a conventional assembly, similarly treated, as indicated by line 51. Each of the lines 50, 51 plots the temperature at the outer rim of the backplate 12 against time, and it will be observed that with the arrangement of the invention the maximum temperature involved is 172°C which is over 70°C lower than the corresponding temperature of 243°C reached with the conventional assembly. Temperature stresses in the insulator 15 and overstressing of the bimetal 24 are avoided, and less expensive materials can be used for the sealing ring 14.

Fig. 8 illustrates the behaviour of the same assembly fitted into a kettle, which is switched on from cold with the kettle empty. It will be observed that initial cutting out occurs such that the maximum temperature at the rim of the backplate 12 is 197°C as compared with 244°C with the conventional assembly. Furthermore, as indicated by Fig. 9, which illustrates a cut-out cycle of the same kettle having been left on for some hours, the maximum temperature falls to 173°C , maintaining its same differential of about 50°C below the maximum temperature of the conventional assembly.

CLAIMS

1. An electric liquid-heating assembly of the type described wherein the total cold length of the element is at least 19% of the total length of the element, and wherein the area of thermal contact between the central portion of the sheath of the element is less than 8% of the area of the backplate, said area being located in close proximity to the thermal cut-out.

2. An electric liquid-heating assembly of the type described wherein the total cold length of the element is at least 100 mm and wherein the length of the heat transfer area is less than 25 mm, the thermal contact area being located in close proximity to the thermal cut out.

3. An electric liquid-heating assembly of the type described, wherein the total cold length of the element is at least 19% of the total length of the element, and wherein the length of the thermal contact area is less than 25 mm, the heat transfer area being located in close proximity to the thermal cut-out.

4. An electric liquid-heating assembly of the type described, wherein the total cold length of the element is at least 100 mm and wherein the area of thermal contact between the central portion of the sheath of the element is less than 8% of the area of the backplate, said area being located in close proximity to the thermal cut-out.

5. An electric liquid-heating assembly as claimed in claim 2 or 4 wherein the cold length is from 100 mm to 180 mm in extent.

6. An electric liquid-heating assembly as

claimed in claim 1 or 3 wherein the cold length is from 19% to 30% of the total length of the element.

5 7. An electric liquid-heating assembly as claimed in claim 1 or 2 wherein the area of the thermal contact is from 6% to 2% of the area of the backplate.

10 8. An electric liquid-heating assembly as claimed in claim 3 or 4 wherein the length of the thermal contact area is from 12 mm to 15 mm.

9. An electric liquid-heating assembly substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.