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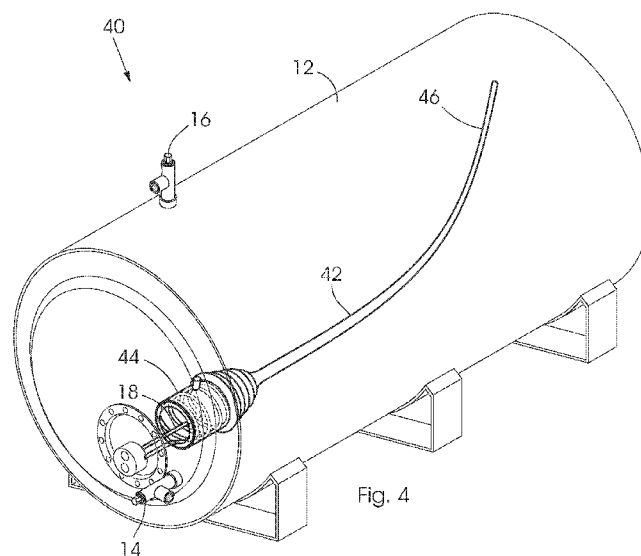
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(54) Title: DEVICE FOR IMPROVING THE EFFICIENCY OF A WATER HEATER, AND A WATER HEATER INCLUDING SUCH DEVICE



(57) Abstract: This invention concerns a device for conveying heated water in a water heater from a first position located at or proximate a heating element of the water heater to a second position. The device includes a water impervious conduit which has a first end for connection to the heating element and a second end which is, in use, a free end located at the second position. At least a portion of the conduit is buoyant so that, in use, the second position is above the first position such that the device conveys heated water from the first position to the second position by means of thermosiphoning. The invention also concerns a water heater including such device and a method of manufacturing such device.

WO 2017/013613 A1

**DEVICE FOR IMPROVING THE EFFICIENCY OF A WATER HEATER,  
AND A WATER HEATER INCLUDING SUCH DEVICE**

**BACKGROUND TO THE INVENTION**

This invention relates to a water heater. In particular, but not exclusively, the invention relates to a device for improving the efficiency of a water heater by improving the heat conductivity inside the geyser.

Water heaters in the form of geysers are well-known and many variations in design are available. One of the most popular designs currently available in the market includes a water tank and a water inlet through which water is fed into the tank and an outlet through which hot water is dispensed from the tank. In this known design the water inlet is located near the bottom of the tank while the outlet is located near the top of the tank. To heat the water in the tank the geyser typically includes an element such as an electrical element. The heating element is located inside the water tank and normally located towards the bottom of the tank. The drawback with this known geyser design is that it takes a considerable amount of time to heat

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the water in the top of the tank as a result of the position of the heating element. The water in the top of the tank is heated by conduction. As a result of the geyser design the entire volume of water inside that tank has to be heated even if only a fraction of the volume is required for use. Due to these inefficiencies in this known geyser design its operational costs are high. For example, the electrical energy consumption of the geyser is high as a result of the continuous heating of the entire volume of water inside the water tank.

Another known water geyser has two electrical heating elements which are vertically spaced apart inside the water tank. The one heating element is located near the top of the tank and the other one is located near the bottom of the tank. By including two spaced apart heating elements this known geyser design aims to address some of the drawbacks of the known geyser design discussed above. In use, the second heating element is used to heat the water in the top of the water tank to avoid having to heat the entire water volume using only the heating element located at the bottom of the tank. Whenever a small volume of water is required only the top heating element is switched on. Although this second known geyser design address some of the drawbacks of the known design discussed above, one problem with this second known geyser design is that it is more expensive due to the inclusion of the second heating element. The inclusion of the second heating element requires a more complicated control system for efficient controlling of the two heating elements.

Other methods of improving the efficiency of water heaters have been proposed. For example, see WO2011/077428 which discloses an accelerator for horizontal water heaters. The accelerator includes rigid body which an inlet through which cold water is drawing, an element which heats the water inside the body and an outlet which directs water to the top of its reservoir. Not only is this accelerator only useable in horizontal water heaters it is also limited in respect of retrofitability. It is of complex, rigid construction which requires existing water heaters to be modified in order to

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accommodate the accelerator. The accelerator also needs to be directed at an appropriate angle and then fixed in position.

It is an object of this invention to alleviate at least some of the problems experienced with known water heaters.

It is a further object of this invention to provide a device for improving the efficiency of a water heater that will be a useful alternative to existing devices.

### **SUMMARY OF THE INVENTION**

In accordance with the first aspect of the invention there is provided a device for conveying heated water in a water heater from a first position located at or proximate a heating element of the water heater to a second position, the device including a water impervious conduit which has a first end for connection to the heating element and a second end which is, in use, a free end located at the second position, wherein at least a portion of the conduit is buoyant so that, in use, the second position is above the first position such that the device conveys heated water from the first position to the second position by means of thermosiphoning.

The conduit is preferably flexible.

The conduit may be in the form of a sleeve or sock which fits at least partially over the element.

Preferably, the securing element is in the form of a lip extending from a cylindrical section forming an attachment formation of the sleeve for attachment to the element.

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The conduit may include insulation for reducing the heat transfer between the heated water inside the conduit and the water around the conduit.

The conduit may further include flotation means which is at least located in a region towards its second, free end, thereby causing the free end of the conduit to float, in use, to the second position. The conduit preferably includes flotation means located along substantially its entire length.

In one embodiment the conduit comprises gas bubbles trapped in its sidewall, preferably forming insulation and flotation means.

The device may include a body which tapers down towards an end region located at the second end. The end region preferably carries markings corresponding to different lengths required for different water heaters in which the device can be installed.

The conduit includes a deformable section which is capable of expanding and contracting. The deformable section may include concertinaed rings.

The device may further include a thermostat holding formation for, in use, holding a thermostat of the water heater, the conduit carrying an opening to allow the thermostat to pass through its sidewall when held in the holding formation.

The device may be manufacture as a single, unitary product.

According to a second aspect of the invention there is provided a water heater including:

- a tank for housing a volume of water to be heated, the tank having an inlet for feeding water to the tank and an outlet for dispensing water from the tank;

- a heating element located in the tank; and

- a device according to the first aspect of the invention.

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According to a third aspect of the device there is provided a method of manufacturing a device according to the first aspect of the invention, wherein the device is manufactured using a dip moulding process.

The method may include the step of blowing a gas over the device while moulding the device so as to trap gas bubbles in sidewall of the device.

According to another aspect of the invention there is provided a method of conveying water inside a water heater using the device according to the first aspect of the invention.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

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

**Figure 1** shows a perspective view of a water heater in accordance with a first embodiment of the invention;

**Figure 2** shows a partial cross-sectional front view of the water heater of Figure 1;

**Figure 3** shows a perspective view of a water heater in accordance with a second embodiment of the invention;

**Figure 4** shows a perspective view of a water heater in accordance with a third embodiment of the invention;

**Figure 5** shows a side view of the water heater of Figure 4;

**Figure 6** shows a cross-sectional side view of the water heater of Figure 4 in which its sidewall is shown in detail;

**Figure 7** shows a partial perspective view of the water heater of Figure 4 in use;

**Figure 8** shows a schematic representation of experimental results obtained when heating water in a geyser using the water heater of Figure 4 in comparison to results obtained when heating water in the same geyser without using the water heater of Figure 4; and

**Figure 9** shows a graphical representation of the results of Figure 8.

#### **DESCRIPTION OF THE ILLUSTRATED EMBODIMENT**

Referring to the drawings, in which like numerals indicate like features, a non-limiting example of water heater in accordance with a first embodiment of the invention is generally indicated by reference numeral 10.

In the accompanying drawings the water heater 10 is illustrated as a hot water geyser which is typically used for domestic applications. The invention is however not limited to this particular application and could be used in any application in which water is heated. Returning to the illustrated embodiment of the invention, the geyser 10 has a water tank 12 for housing a volume of water to be heated or to be maintained at a predetermined temperature. The tank 12 has an inlet 14 for feeding water into the tank 12 and an outlet 16 for dispensing water from the tank 12. In use, the inlet 14 is typically connected to cold water piping for continuous supply of cold water. The outlet 16 is, in turn, typically connected to hot water piping for use on demand at one or more locations downstream of the geyser 10.

The geyser 10 in accordance with the invention further includes a heating element 18 located in the tank 12, in use. The heating element 18 is an

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electrical element typically powered off the mains power. When connected to the tank 12 the heating element 18 is submerged in the volume of water in the tank so as to heat the water when required.

The water geyser 10 has at least one heat conducting means in the form of a water impervious conduit 20 located in the water tank 12 as shown in the accompanying drawings. From Figure 1, which shows a perspective view of the geyser 10, it can be seen that three conduits 20 are located inside the water tank 12 and acts like a conveying device for conveying water inside the tank. Although three conduits 20 are shown in the drawings the invention is not limited to any particular number of conduits. It is envisaged that any number of conduits 20 could be used. The number of conduits 20 would typically depend on factors such as the application in which the geyser 10 is used, the volume of the water tank 12 and the heating capacity of the heating element, for example.

In the illustrated embodiment each conduit 10 is in the form of a flexible pipe. The pipe 20 is elongate and has a first, operatively lower end 22 and a second, operatively upper end 24. The first and second ends are clearly visible in Figure 2. Each pipe 20 has a central passage running between its first and second ends 22, 24 for conveying water.

In use, the pipes 20 are mounted inside the water tank 12 such that their first ends 22 are located proximate to the heating element 18. At least part of each pipe 20 is buoyant such that, in use, their second ends 24 are located in a position above their first ends 22. The orientation of the pipes 20 in use are illustrated in Figure 2.

In order to achieve the desired buoyancy each pipe 20 carries flotation means 26 which is located at least in a region towards its second end 24, thereby causing the second end to rise to the top of the tank 12, in use. As a result of the first end 22 being fixed and the second free end 24 being buoyant, the pipes 20 curve upwards in use when the tank 12 is filled with water. Due to this upward curve the pipes 20 convey hot water from a first

position, which is proximate to the heating element 18, to a second position, which is above the first position. To allow water to enter the pipes 20, each pipes has at least one opening located in its sidewall in a region towards its first end 22. In the accompanying drawings the pipes 20 have a number of openings 28 in their sidewalls through which hot water, in use, passes to enter their internal passages. In an alternative embodiment of the invention the inlet openings in the sidewalls of the pipes 20 could also be in the form of slits.

From the above description it should be clear that, in use, the pipes 20 convey hot water from the first location located proximate the heating element 16 to the second position located at the top of the tank 12 by means of thermosiphoning. The pipes 20 allow the hot water from the first position to be conveyed to the second position without coming into contact with the colder water located in the central and top regions of the tank 12. It is envisaged that the pipes 20 could be insulated so as to reduce heat loss through their sidewalls when conveying hot water from the first to the second position.

It is further envisaged that the pipes 20 could also be retrofitted to existing geyser installations in an attempt to improve the efficiencies of the existing installations.

Referring now in particular to Figure 3 a non-limiting example of a water heater in accordance with a second embodiment of the invention is generally indicated by reference numeral 30. Again, like numerals indicate like features.

The water heater 30 is substantially similar to the water heater 10 in accordance with the first embodiment of the invention. However, instead of a conduit in the form of a pipe, the water heater 30 includes a conduit in the form of a sock or sleeve. In Figure 3 the conduit is indicated by the reference numeral 32.

In the embodiment of Figure 3 only one sleeve 32 is located in the tank 12. The sleeve 32 is elongate and has a first, operatively lower end 34 and a second, operatively upper end 36. The first and second ends are clearly visible in Figure 3. The sleeve 32 again has a central passage running between its first and second ends 34, 36 for conveying water.

In use, the sleeve 32 is mounted on the heating element 18 such that its first end 34 is located at the heating element 18. In this second embodiment the first end 34 of the sleeve 30 is enlarged so that it fits over at least a part of the heating element 18. It is envisaged that the first end 34 could be elastic so as to secure the sleeve 32 in place on the heating element 18.

Similarly to the first embodiment, in this second embodiment at least part of the sleeve 32 is buoyant such that, in use, its second end 36 is located in a position above its first ends 34. In order to achieve the desired buoyancy the sleeve 32 again carries flotation means 26 which is located at least in a region towards its second end 36, thereby causing the second end to rise to the top of the tank 12, in use. The means by which the sleeve 32 in use conveys water is substantially similar to that of the first embodiment and will therefore not be described again in any detail.

It is envisaged that the sleeve 32 could be fitted to a number of different heating elements. In order to fit the sleeve 32 to the heating element it may be necessary to modify the design of its first end 34 slightly. For example, the width of the opening of the first end 34 may be modified to fit over a heating element that is smaller or larger than the one illustrated in Figure 3.

Referring now to Figures 4 to 7 a non-limiting example of water heater in accordance with a third embodiment of the invention is generally indicated by reference numeral 40. Again, like numerals indicate like features.

The water heater 40 is substantially similar to the water heater 30 in accordance with the first embodiment of the invention. Again, the conveying

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means for conveying hot water from the first position to the second position is in the form of a sock or sleeve that fits at least partially over the element 18. In Figures 4 to 7 the conveying means is indicated by the reference numeral 42.

In this third embodiment again only one sleeve 42 is located in the tank 12 and wrapped over a portion of the element 18. The sleeve 42 is again elongate and has a first, operatively lower end 44 and a second, operatively upper end 46. The first and second ends 44, 46 are clearly visible in Figure 4 in which the sleeve is shown in use mounted on the element 18 and running from the first position where its first end 44 is located to the second position where its second end 46 is located. The sleeve 42 again has a central, internal passage running between its first and second ends 34, 36 for conveying water.

Referring still to Figure 4 it can be seen that the sleeve 42 is mounted on the heating element 18 such that its first end 34 is located at the heating element 18. The first end 44 of the sleeve 40 is again enlarged so that it fits over at least a part of the heating element 18. Turning now to Figures 5 and 6 it can be seen that the sleeve 42 has an elongate body 48 located substantially between the first and second ends 44, 46. The elongate body 48 tapers down in a direction from the first end 44 towards the second end 46.

In this third embodiment of the invention the body 48 tapers down until it reaches a substantially cylindrical end region 50 located at the second end 46 of the sleeve. In this particular embodiment the end region 50 carries a number of markings 52 indicating cutting lines at which the sleeve could be cut to specification. It is envisaged that the markings could correspond to optimised lengths for different water heater designs or models. Similarly to the first and second embodiments of the conveying means, the sleeve 42 is intentionally designed to be retrofitted to existing water heaters. Instead of manufacturing different sleeves 42 for different water heater designs and models, one sleeve could be cut to size to fit different models using the

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markings 52. The length of the sleeve 42 is of importance to ensure optimised performance. For example, if the sleeve 42 is too long and the second end 46 comes into contact with the tank 12 the sleeve could fold onto itself to throttle or block the flow of heated water out the second end 46. The throttling of water flow due to the constriction in the sleeve 42 will result in an increase in the temperature of the water being dispensed from the second end 46. For the sake of safety and efficiency the water exiting the second end 46 of the sleeve 42 should remain within the designed parameters, which is typically between 55 and 60°C. Accordingly, the sleeve 42 should be free from constrictions which will affect the flow of heated water inside sleeve 42.

It has been found that in order to deliver heated water at the second end 46 of the sleeve 42 the width of the opening at the second end should be in the region of about 8mm to 15mm, and preferably around 10 to 11mm. In the preferred embodiment of the sleeve 42 the end region 50 is cylindrical so that the width of the opening at the second end 42 is effectively the diameter of the opening. In the sleeve 42 the diameter of the sleeve in the end region 50 remains substantially constant so that the size of the dispensing opening at the second end 42 remains constant in order to deliver water at the desired temperature irrespective of marking 42 where the sleeve is cut.

It is however envisaged that, instead of providing a cylindrical end region 50, the end region could taper down. In this alternative embodiment the temperature at which the water is being dispensed could be altered by cutting the sleeve 42 at different markings 52. In other words, the markings could also be used to indicate different temperatures at which heated water is delivered from the second end 46 of the sleeve 42. The end region could either taper at the same taper angle as the body 48 or at a different taper angle.

Referring still to Figures 5 and 6, the sleeve 42 includes means 54 for preventing the sleeve 42 and in particular the body 50 from creating a

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constriction in the internal passage through the sleeve by, for example, collapsing on itself. The means 54 for preventing the constriction is in the form of a deformable section which is capable of expanding and contracting. The expansion and contraction are achievable as a result of concertinaed rings 56 of the deformable section 54. It should be clear that the deformable section 54 is substantially similar to bellows.

In use when the sleeve 42 is curved or bent upwardly from the first position to the second position, a portion of the deformable section 54, which is the upper portion, is typically compressed or contracted while another portion, which is the lower portion, is expanded. The expansion and contraction of the concertinaed side of the deformable section allows the sleeve 42 to curve upward as shown in Figure 4 without creating constrictions in the internal water flow passage through the sleeve 42.

From Figures 5 and 6 it can further be seen that the concertinaed rings 56 reduce in diameter from the first end 44 towards the second end 46 of the sleeve 42. The larger end of the deformable section 54 is therefore located adjacent the first end 44 which connects the sleeve 42 to the element 18. The sleeve 42 has a substantially cylindrical portion 58 at its first end 44. The cylindrical portion 44 is primarily responsible for attaching the sleeve 42 to the element 18. Accordingly, the cylindrical portion is elastic so that it may expand to receive the element inside the sleeve 42 and contract around to element 18 to attach the sleeve to the element. In other words, the cylindrical portion 58 is stretched in order to place it over the element 18 and then released to return to its original state in order to wrap itself around the element, thereby attaching the sleeve 42 to the element. Although the cylindrical portion 58 is primarily used to attach the sleeve 42 to the element 18 it is envisaged that the deformable section 54 could also be used to attach the sleeve 42 to the element 18 or at least assist with such attachment. It should be clear that the deformable section 54 could therefore also be elastic.

Referring now in particular to Figure 6, the sleeve 42 and in particular the cylindrical portion 58 carries a securing element in the form of an annular lip 60 located at the first end 44 of the sleeve 42. The annular lip 60 serves to secure the sleeve 42 onto the element 18 by trapping the element inside the sleeve. As shown in Figure 7 the lip 60 extends over or around the element 18, in particular the end coil of the element, to secure the sleeve about the element. It should be understood that, in use, a forcing acting to pull sleeve 42 off the element 18 is created due to the flow of water through the sleeve. The lip 60 acts to prevent this pulling force from removing the sleeve 42 from the element.

The sleeve 42 further makes provision for a thermostat (not shown in the accompanying drawings) to pass through it. In the illustrated embodiment of Figures 4 to 7 the sleeve 42 carries a holding formation 62 located at the first end 42 of the sleeve 42. The holding formation 62 is in the form of a tube extending from the cylindrical portion 58. Best seen in Figures 5 and 6 the holding tube 62 extends from the cylindrical portion 58 of the sleeve 42 at angle transverse to the sleeve's longitudinal centre axis 64. The holding tube 62 is open to the internal volume of the sleeve 42 in order to allow the thermostat to pass through the sidewall of the sleeve and into the tank 12. By allowing the thermostat to pass through the sleeve 42 and into the volume of the tank 12 that is outside the sleeve 42 a more accurate reading of the temperature of the water inside the tank 12 is achieved. As a result of the temperature of the water inside the sleeve 42 at its first end being significantly higher than the water outside of the sleeve during operation of the element, i.e. when heating the water in the tank, it is necessary to measure the water outside of the sleeve.

Returning to Figure 7, which shows an enlarged view of the first end 44 of the sleeve 42 during operating of the water heater 40, it can be seen that the heated water around the element 18 acts to expand the sleeve 42 radially outwardly. This is possible as a result of the deformability of the sleeve 42. As shown in Figure 7 at least the cylindrical portion 54 of the sleeve 42 expands radially to move the sidewall of the sleeve 42 away from

the element 18. In use, this expansion essentially moves the sidewall of the sleeve 42 out of contact with the element 18. Although the sleeve 42 is typically made from a material that can withstand the temperature of the element 18 by moving the sidewall out of contact with the element 18 the overall safety is improved. For example, the risk of the sleeve 42 burning due to contact with the element 18 is reduced as a result of the expansion of the sleeve.

Similarly to the first and second embodiments at least a portion of the sleeve 42 is buoyant such that, in use, its second end 46 is located in a position above its first ends 44. In this third embodiment the sleeve 42 is made from a material, such as PVC plastisol, in a dip moulding process. As a result the sleeve 42 is buoyant. It has also been found that, in order to improve the buoyancy of the sleeve 42, a gas such as CO<sub>2</sub> for example can be blown over the sleeve 42 during the dip moulding process. As shown in the detail view of Figure 6, CO<sub>2</sub> bubbles 66 are trapped inside the sidewall of the sleeve 42 which improves the overall buoyancy of the sleeve. Although substantially the entire sleeve 42 is buoyant it is envisaged that only a part thereof could be manufactured to be buoyant. From the above description it should be clear that the part of the sleeve 42 that is buoyant should include the second end 46 or at least be arranged to cause the second end 46 to be in a position above the first end 44 in use.

Another advantage of the CO<sub>2</sub> bubbles 66 being trapped inside the sidewall of the sleeve 42 is that they improve insulation, in addition to the insulation provided by the material from which the sleeve 42 is made. Due to the added benefit of improved insulation it is preferred to manufacture the sleeve 42 such that CO<sub>2</sub> bubbles are trapped along substantially the entire length of its side wall, thereby improving insulation characteristics of the sleeve 42. It has been found that very little heat transfer takes place between the water flowing through the sleeve 42 and the water outside the sleeve. It is believed that the decreased thermal conductivity of the sleeve 42 results in an increase in effectiveness of the sleeve 42 and according the efficiency of the water heater 40 in which the sleeve is installed.

It should be clear that the heated water is delivered into the tank 12 at the second position where the sleeve outlet 46 is located so as to provide hot water in the top of the tank 12 where its outlet 16 is located. An advantage of using the sleeve 42 is that the water volume at the top of the tank 12 is heated first. As a result the water heater 40 is capable of providing a usable volume of water at the desired temperate quicker. Experimental results illustrating the rapid heating of the water inside water heater due to the use of the sleeve 42 is illustrated in Table 1 below. These results are also illustrated graphically in Figures 8 and 9. The experimental results of Table 1 were obtained using a vertical water heater as opposed to a horizontal heater illustrated in Figures 4 to 7. The water heater has a total capacity of 150 litres and the water temperature at the start of the experiment was 15°C, i.e. prior to switching on its heating element.

Time Lapsed (hours)	Temperature of available water without sleeve 42 (°C)	Temperature of available water using the sleeve 42 (°C)	Volume of available water using the sleeve 42 (litres)
0	15	15	0
0.5	28	50	30
1	37	55	65
2	45	56	120
3	60	60	150

**Table 1: Experimental Results of Water Temperature in the Geyser at the Second Position**

From the experimental results it can be seen that water is heated more rapidly by using the sleeve 42. This is a significant advantage seeing that heated water is available a lot quicker to the user after switching on the water heater 40.

It is envisaged that a control system could be used to regulate the volume of heated water that is available to the user at a pre-set water temperature. For example, the water heater 40 could include multiple thermostats located at different positions in the tank 12. The different positions of the thermostats will typically correspond with different volumes of water. For example, the thermostats will be spaced apart vertically so that the volume of water between the outlet 16 of the tank 12 and each thermostat increases from the top of the tank to the bottom of the tank. The control system could then be set to regulate the operation of the water heater 40 according to the required volume of water. For example, using the data from Table 1 above, the thermostats could be placed at positions in the tank 12 corresponding to 30, 65, 120 and 150 litres of water. The control system could then be set to heat 30, 65, 120 or 150 litres of water to the pre-set temperature. By way of example, if the control system is set to heat 30 litres of water to 55°C the switching of the heating element 18 will be regulated based on the temperature reading at the first thermostat, thereby ensuring that 30 litres of hot water is available for use. The control system can then be used to switch between different settings for providing different volumes of hot water according to the user's needs.

From the above description it should be understood that the use of the sleeve 42 translates into an energy saving on the operation of the water heater 40. Not only is the water at the top of the tank 12, i.e. the hot water that will be dispensed first, heated more rapidly, it is heated first prior to heating the rest of the water in the tank 12. A further advantage of the invention is that pre-set volumes of water could be heated according to user requirements and demand, thereby reducing operating time of the element 18. The reduction in operating time of the element 18 results in an energy saving and, accordingly, a saving on operating costs.

A significant advantage of the sleeve 42 is that it can be retrofitted easily to existing water heaters. Although the first end 44 of the sleeve 42 has been illustrated in the accompanying drawings to fit over a spiral element 18, the sleeve could be adapted to fit over a differently shaped element without

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departing from the scope of the invention. The simplicity of the sleeve 42 not only assist with the retrofitting thereof to existing water heater but also makes the sleeve 42 an affordable energy saving option to users.

It should also be understood that although the device 42 has been mainly illustrated in use on a horizontal water heater it can also be used on vertical water heaters. For example, in the experimental setup of Figure 8 the device 42 is used in a vertical water heater. A further advantage of the device 42 is that it can be retrofitted to both horizontal and vertical water heaters.

**CLAIMS**

1. A device for conveying heated water in a water heater from a first position located at or proximate a heating element of the water heater to a second position, the device including a water impervious conduit which has a first end for connection to the heating element and a second end which is, in use, a free end located at the second position, wherein at least a portion of the sleeve is buoyant so that, in use, the second position is above the first position such that the device conveys heated water from the first position to the second position by means of thermosiphoning.
2. A device according to claim 1, wherein the conduit is flexible.
3. A device according to claim 2, wherein the conduit is in the form of a sleeve or sock which fits at least partially over the element.
4. A device according to claim 3, wherein the sleeve has a securing element for securing the sleeve on the element.
5. A device according to claim 4, wherein the securing element is in the form of a lip extending from a cylindrical section forming an attachment formation of the sleeve for attachment to the element.
6. A device according to any one of claims 1 to 5, wherein the conduit includes insulation for reducing the heat transfer between the heated water inside the conduit and the water around the conduit.
7. A device according to any one of claims 1 to 6, wherein the conduit includes flotation means which is at least located in a region towards its second, free end, thereby causing the free end of the conduit to float, in use, to the second position.
8. A device according to claim 7, wherein the conduit includes flotation means located along substantially its entire length.

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9. A device according to any one of claims 1 to 8, wherein the conduit comprising gas bubbles trapped in its sidewall.
10. A device according to claim 9, wherein the gas bubbles form insulation and flotation means.
11. A device according to any one of claims 1 to 12, including a body which tapers down towards an end region located at the second end.
12. A device according to any one of claims 1 to 13, wherein the end region carries markings corresponding to different lengths required for different water heaters in which the device can be installed.
13. A device according to any one of claims 1 to 14, wherein the conduit includes a deformable section which is capable of expanding and contracting.
14. A device according to claim 13, wherein the deformable section includes concertinaed rings.
15. A device according to any one claims 1 to 14, including a holding formation for, in use, holding a thermostat of the water heater, the conduit carrying an opening to allow the thermostat to pass through its sidewall when held in the holding formation.
16. A device according to any one of claims 1 to 15, wherein the device is of unitary design.
17. A water heater including:
  - a tank for housing a volume of water to be heated, the tank having an inlet for feeding water to the tank and an outlet for dispensing water from the tank;
  - a heating element located in the tank; and
  - a device according to any one of claims 1 to 16.

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18. A method of manufacturing a device according to any one of claims 1 to 16, wherein the device is manufactured using a dip moulding process.
19. A method according to claim 18, including the step of blowing a gas over the device while moulding the device so as to trap gas bubbles in sidewall of the device.

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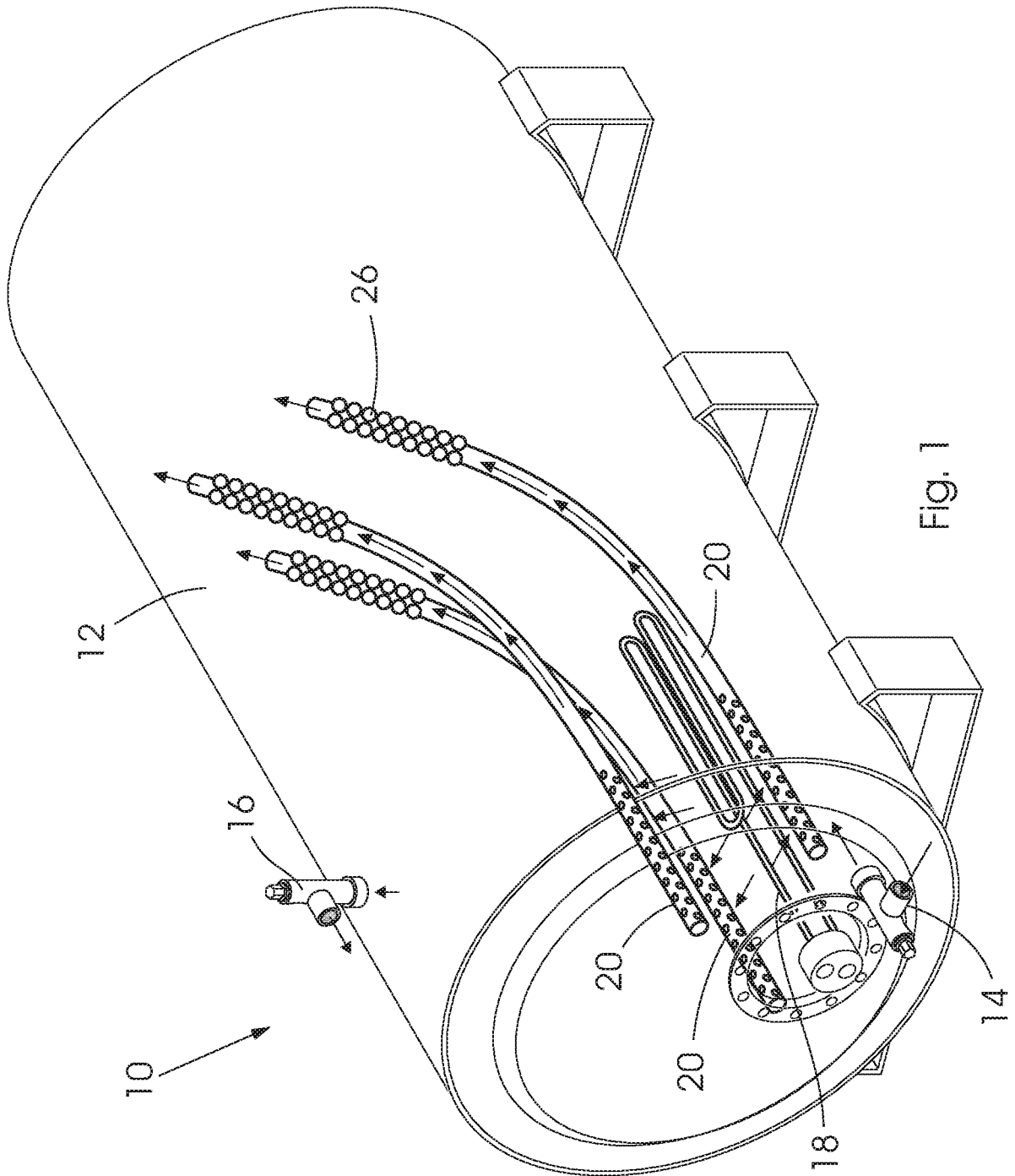


Fig. 1

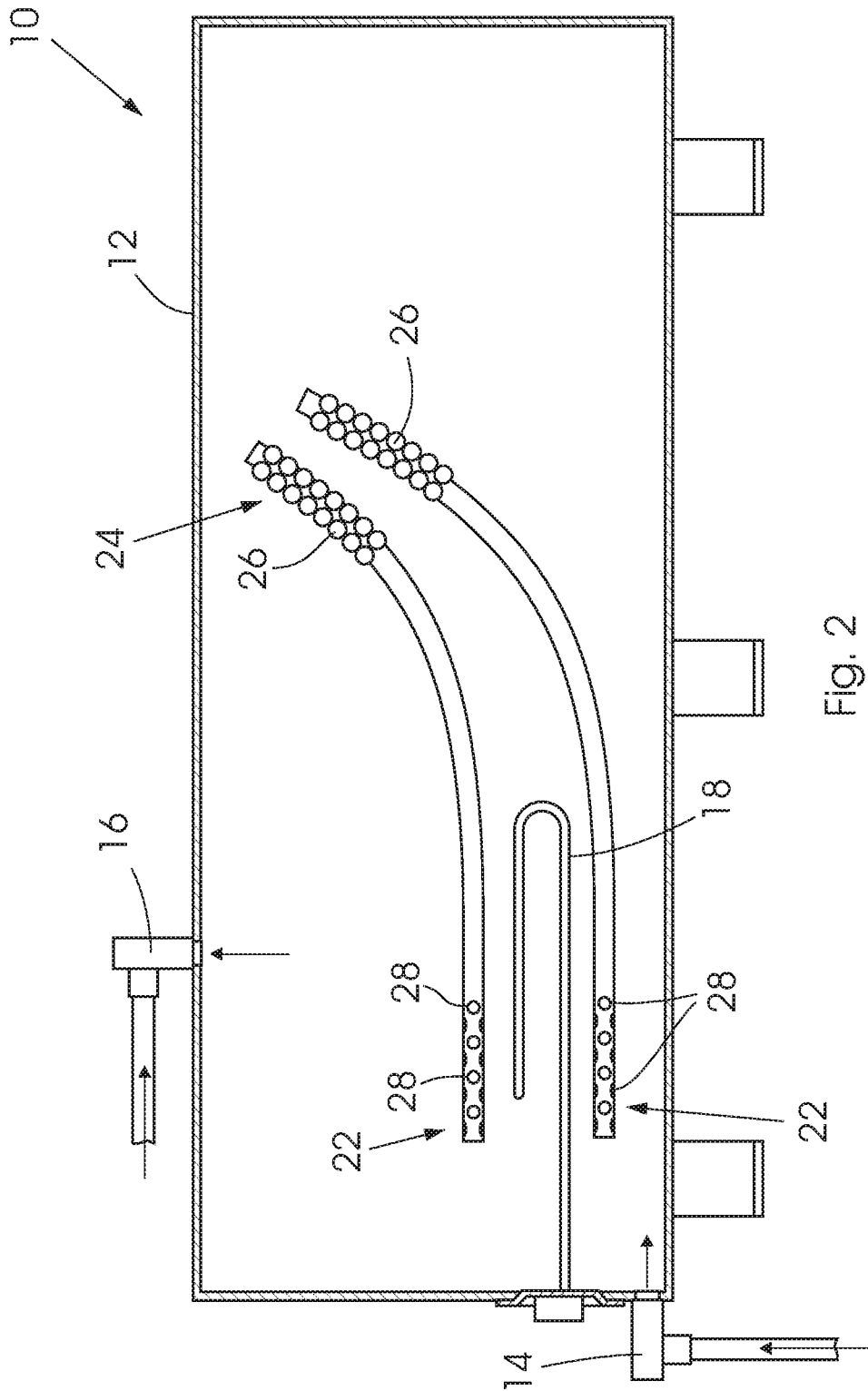


FIG. 2

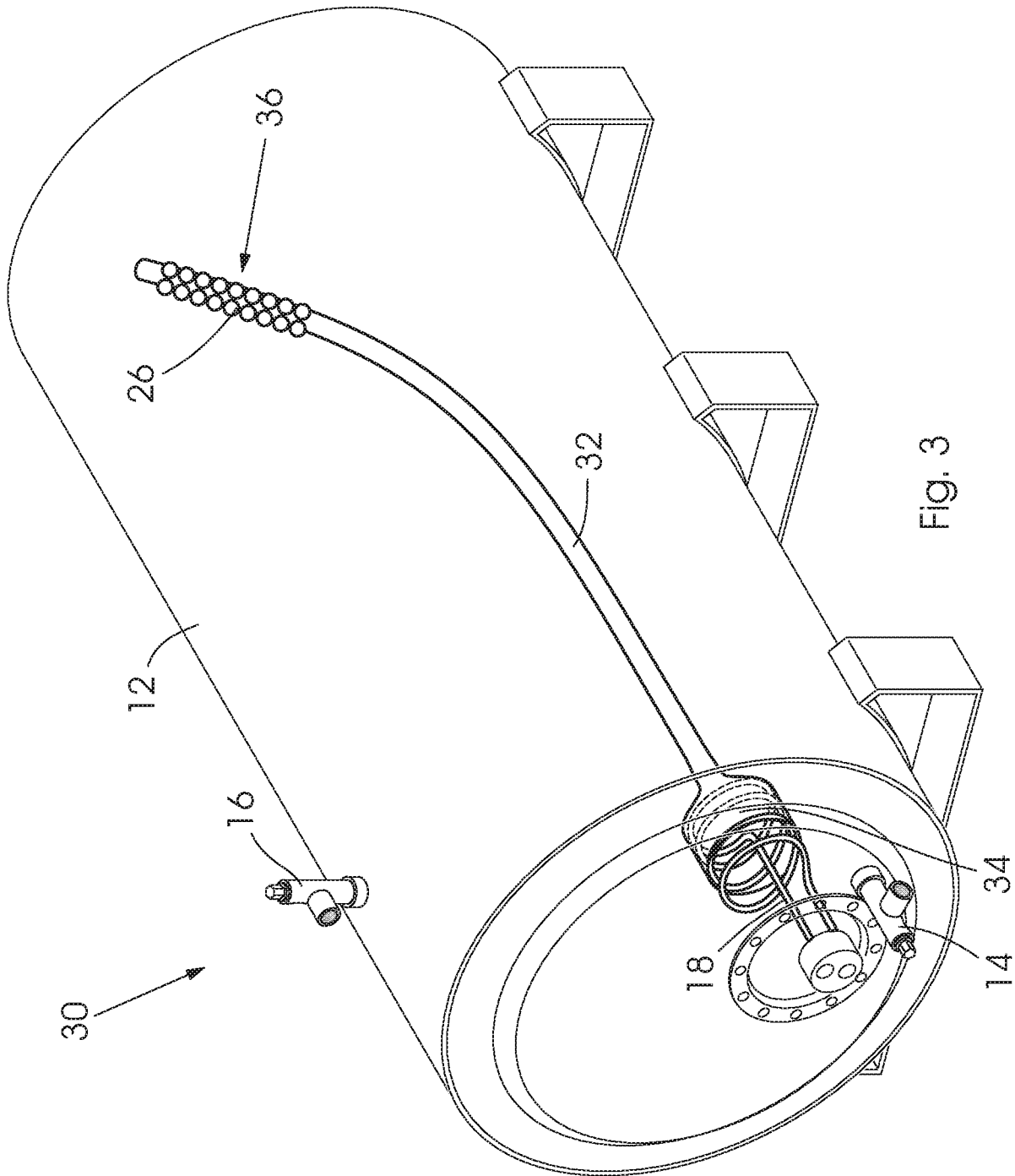
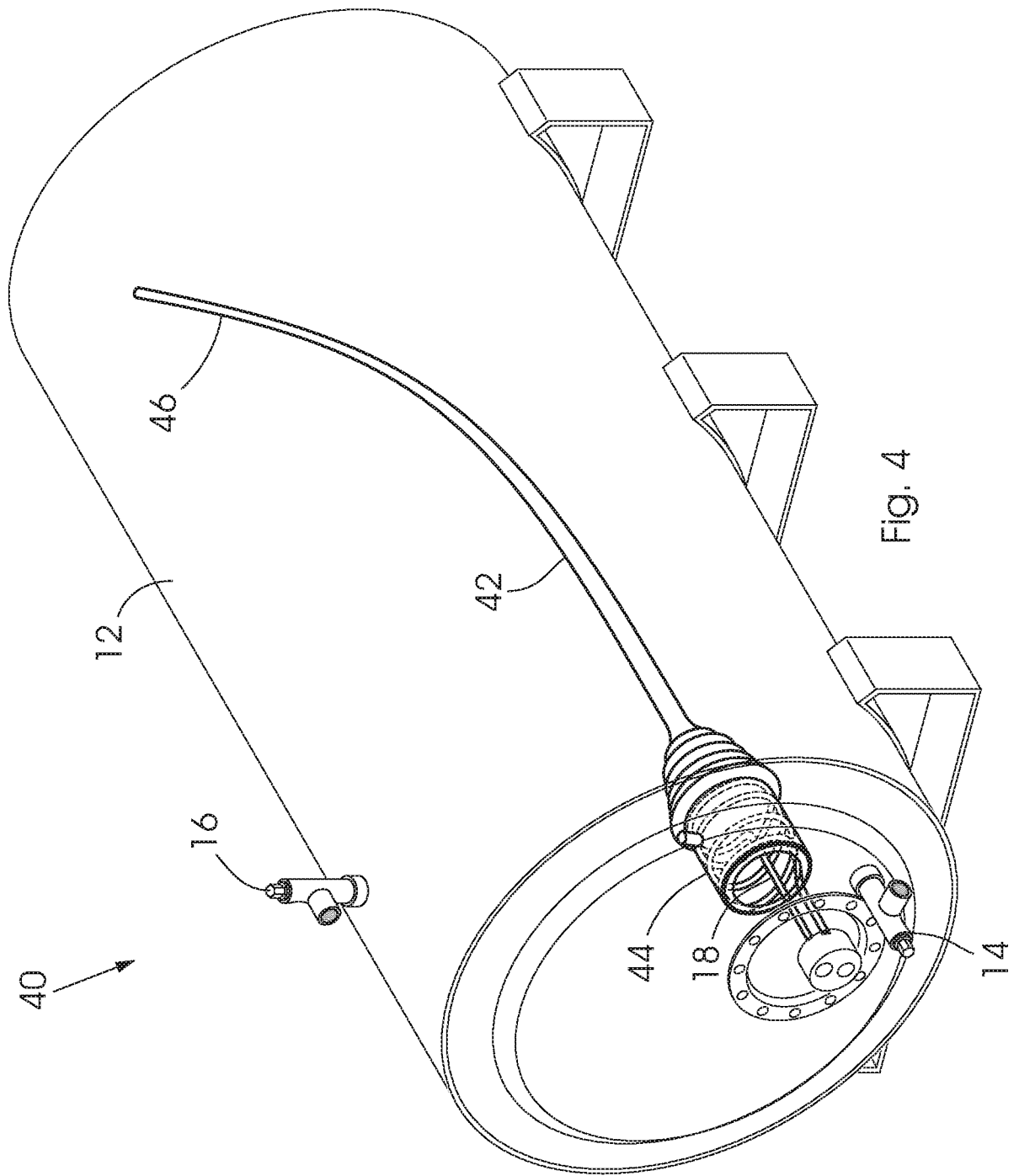
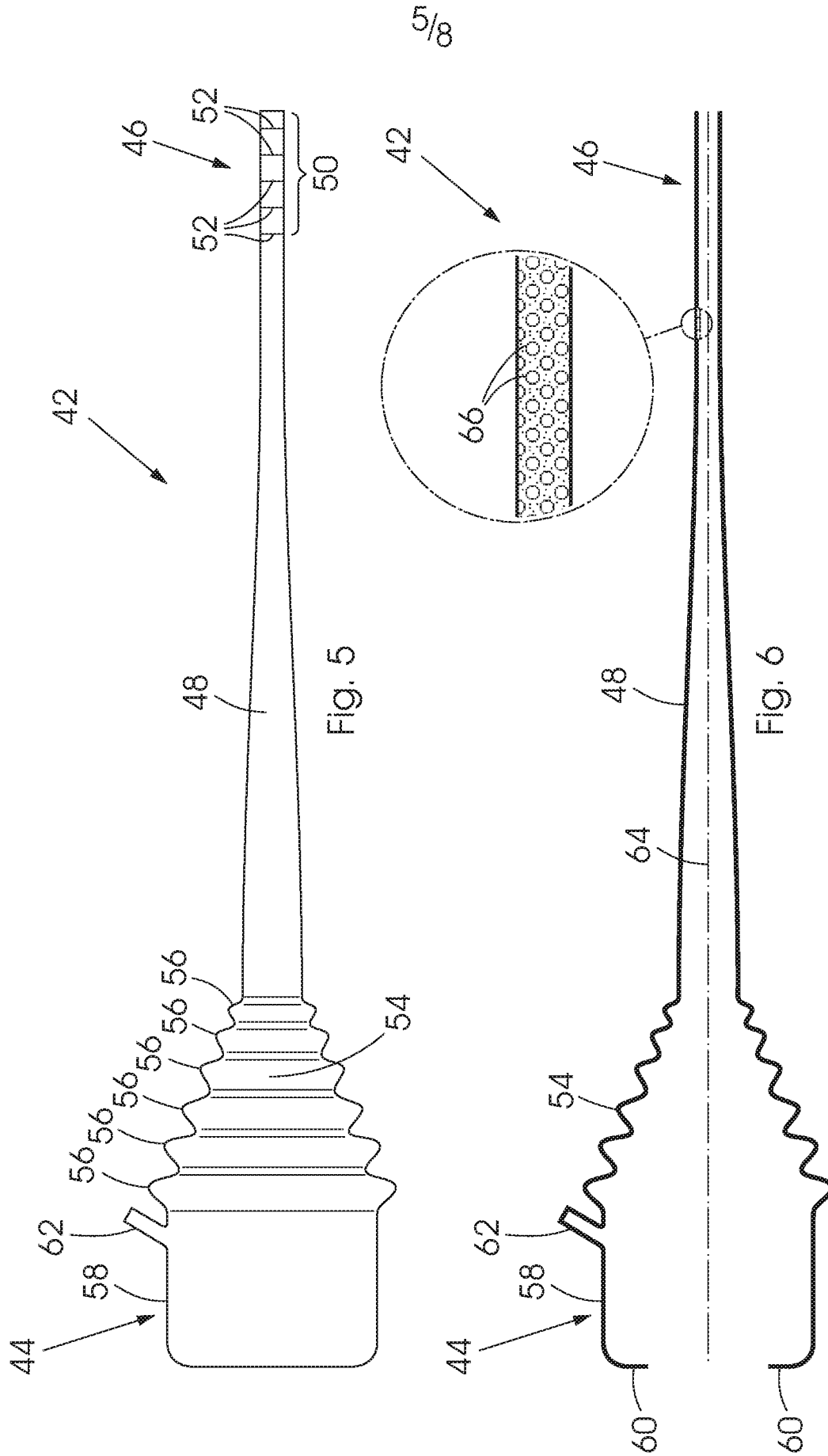


Fig. 3





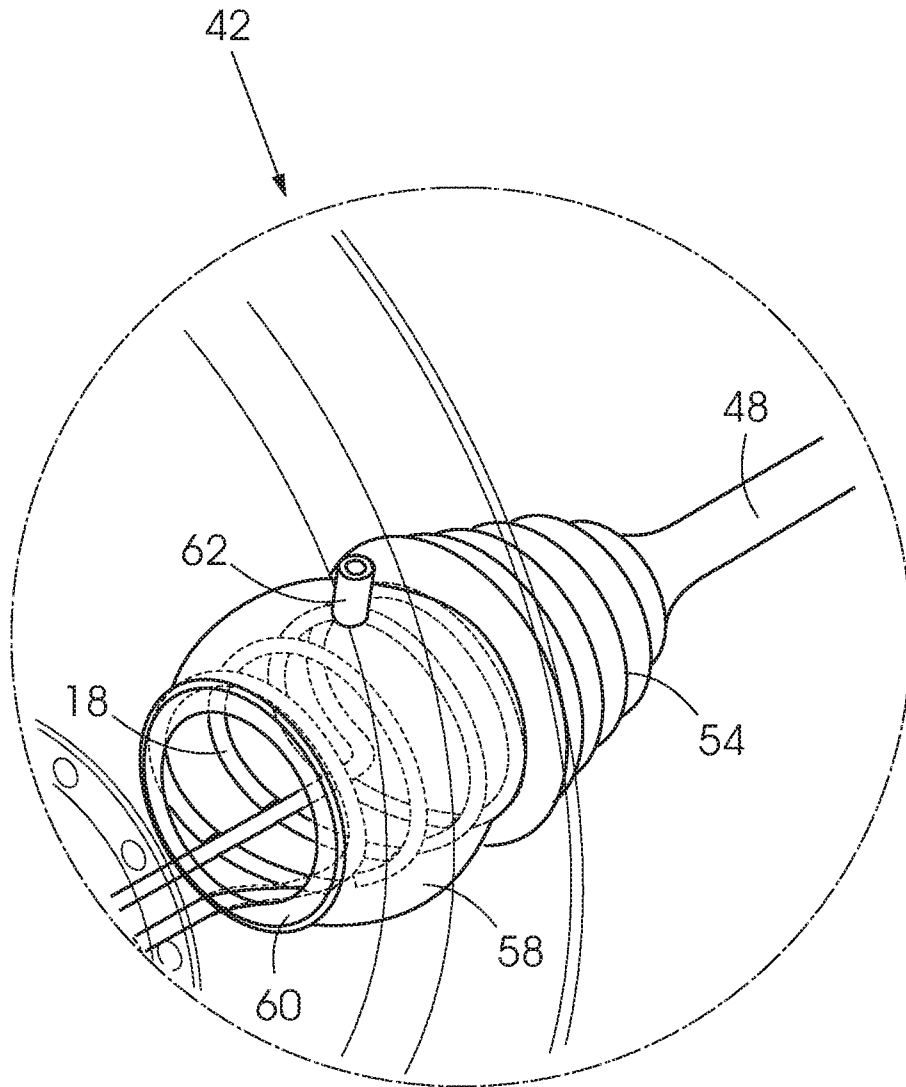


Fig. 7

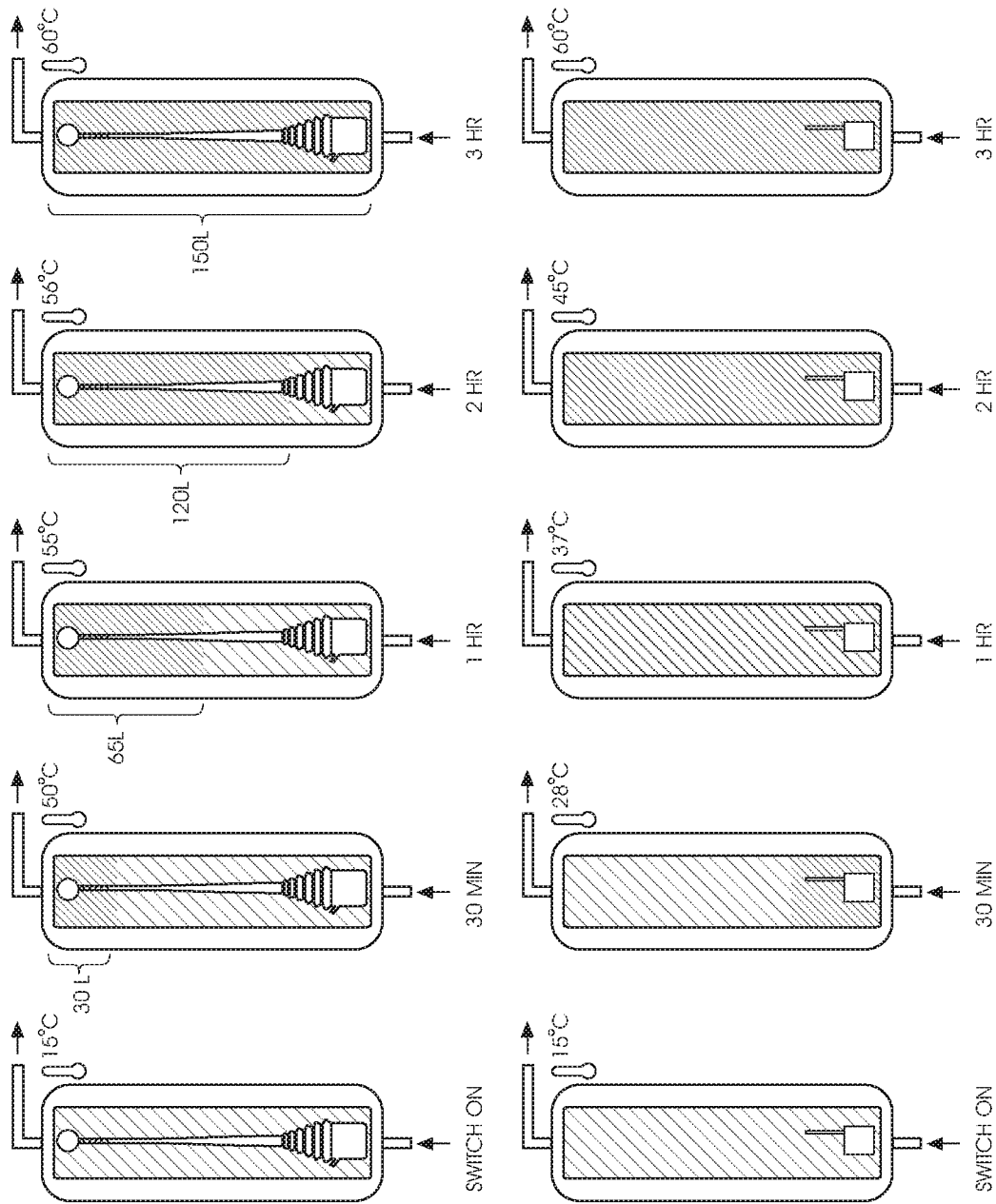


Fig. 8

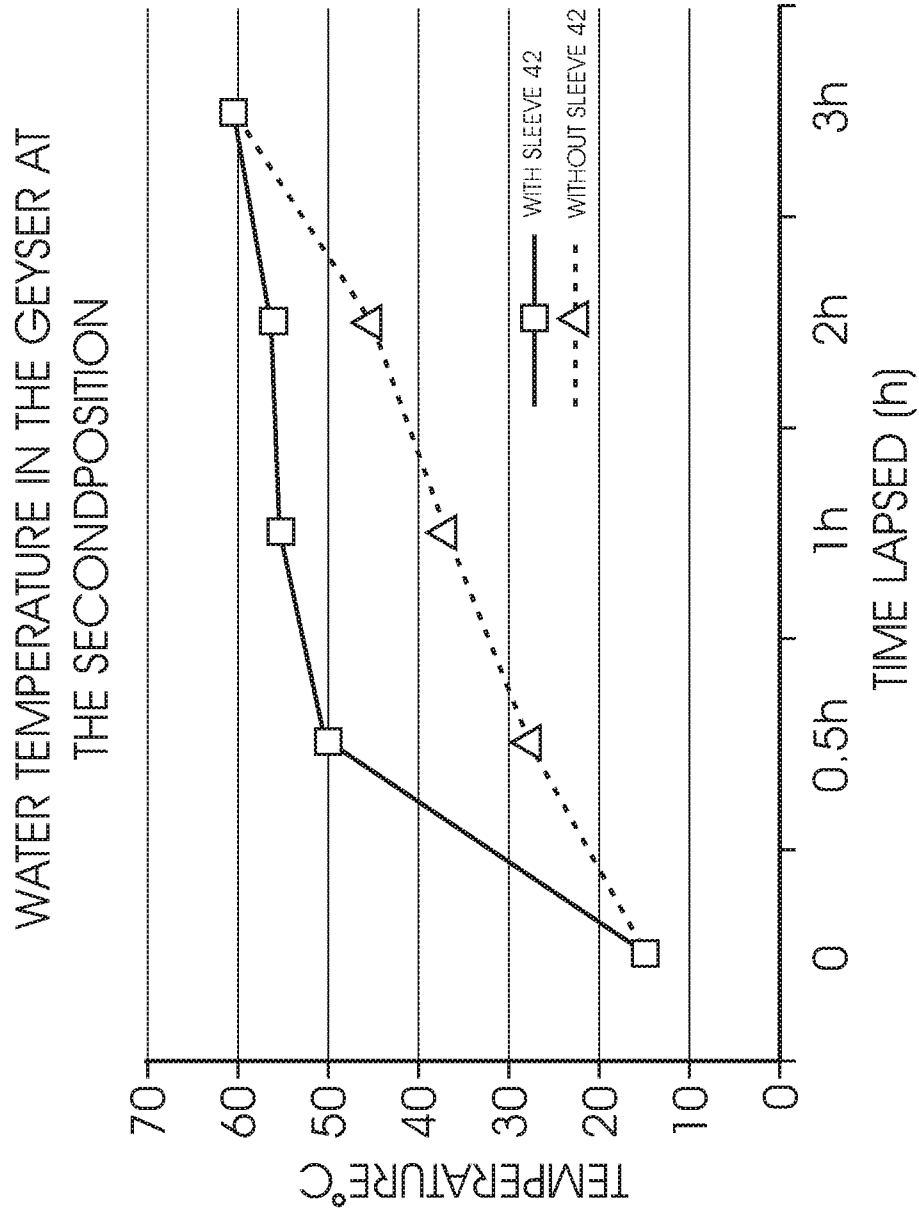


Fig. 9

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/IB2016/054345

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. F24H1/20 F24H9/00  
 ADD.  
 According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**  
 Minimum documentation searched (classification system followed by classification symbols)  
 F24H  
 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
 EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2013/014411 A2 (ISIS INNOVATION [GB]; ARMSTRONG PETER MICHAEL [GB]) 31 January 2013 (2013-01-31) page 35, lines 22-32; figure 36 -----	1-8,12, 13 9,10,14
X A	WO 2011/077428 A2 (GINOSSAR RONI [IL]) 30 June 2011 (2011-06-30) cited in the application page 5, line 105 - page 6, line 145; figures 1-4 -----	1-3,11, 15,17,18 19
X	FR 572 830 A (RAPHELIS-SOISSAN) 13 June 1924 (1924-06-13) page 1, line 1 - page 2, line 42; figure 2 -----	1,3,4,6, 16,17
X	WO 2012/004763 A1 (HUMAN JAN PETRUS [ZA]) 12 January 2012 (2012-01-12) the whole document -----	1,3-5,17

Further documents are listed in the continuation of Box C.       See patent family annex.

\* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  7 October 2016	Date of mailing of the international search report  20/10/2016
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Hoffmann, Stéphanie
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/IB2016/054345
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