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(71) Applicant: **STRIX LIMITED** [GB/GB]; Forrest House, Ronaldsway, Isle of Man IM9 2RG (GB).

(72) Inventors: **CHAN, Tom**; c/o Strix Limited, Forrest House, Ronaldsway, Isle of Man IM9 2RG (GB). **WANG, Dennis**; c/o Strix Limited, Forrest House, Ronaldsway, Isle of Man IM9 2RG (GB). **HOWITT, James**; c/o Strix Limited, Forrest House, Ronaldsway, Isle of Man IM9 2RG (GB).

(74) Agent: **DEHNS**; St Bride's House, 10 Salisbury Square, London Greater London EC4Y 8JD (GB).

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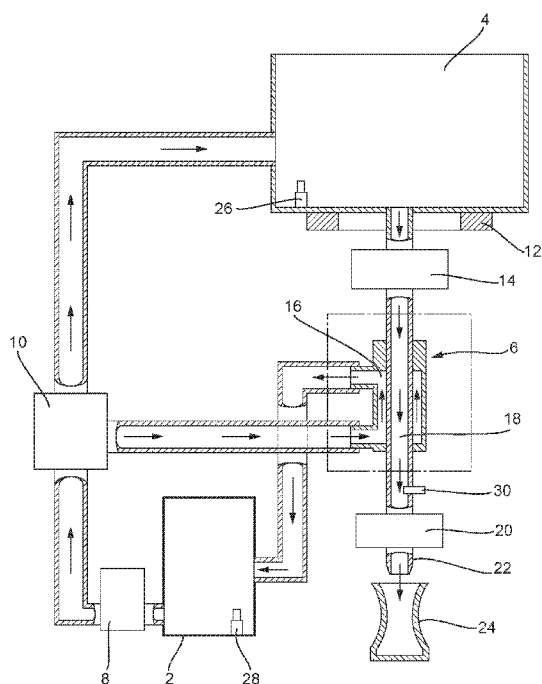
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(54) Title: METHOD AND APPARATUS FOR DISPENSING STERILISED AND COOLED WATER

Fig. 1



(57) Abstract: An apparatus for dispensing liquid includes a liquid reservoir (2); a boil chamber (4) with an electrical heating element (12), a heat exchanger (6), with a first portion (16) for cooling liquid and a second portion (18) for the liquid to be cooled; and an outlet (22). The apparatus further comprises a first flow path and a second flow path. The first flow path includes a pump (8), and connects the reservoir (2) to an inlet to the first portion (16) of the heat exchanger, passes through the first portion (16) and connects an outlet from the first portion (16) to the reservoir (2). The second flow path connects the reservoir (2) to an inlet to the boil chamber (4), connects an outlet from the boil chamber (4) to the second portion (18) of the heat exchanger (6), passes through the second portion (18) and connects an outlet from the second portion (18) to the outlet (22).

Method and Apparatus for Dispensing Sterilised and Cooled Water

BACKGROUND

5 This invention relates to an apparatus for dispensing liquid. It is desirable that liquid dispensed from a liquid dispenser has been sterilised, however in many cases the preferred consumption temperature is much lower than the temperature required for sterilisation. For example, there are known apparatuses for preparing a beverage from sterilised water and a formula, such as for preparing baby milk.

10

Dispensing liquid at sterilisation temperature is undesirable in these cases as it must then be left to cool to the preferred consumption temperature, which is time consuming. It is therefore desirable to provide an apparatus which sterilises liquid and then cools it to a preferred consumption temperature before it is dispensed.

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WO 2007/135608, and WO 2007/135611, both Philips applications claiming the same priority date, disclose an apparatus for preparing a beverage from sterilised water which has been cooled down to a temperature suitable for consumption. The cooling device in the apparatus uses water from the water supply system as cooling liquid.

20

In the disclosed system, water that is first used as cooling liquid is then subsequently heated to boiling. Some of the boiled water is then cooled, and optionally mixed with heated water which bypasses the cooling system, to fine tune the final temperature before being dispensed.

25

Such known systems are complex and require a large number of components. The present invention seeks to address these shortcomings by providing a simple system for dispensing liquid that has been heated and subsequently cooled.

30

SUMMARY

From a first aspect, the invention provides an apparatus for dispensing liquid comprising:

a liquid reservoir;

- 2 -

a boil chamber, comprising an electrical heating element for heating liquid in the chamber to boiling;

a heat exchanger, comprising a first portion through which cooling liquid flows and a second portion through which liquid to be cooled flows; and

5 an outlet for dispensing cooled liquid from the heat exchanger;

wherein the apparatus further comprises:

a first flow path for cooling liquid; connecting the reservoir to an inlet to the first portion of the heat exchanger, passing through the first portion and connecting an outlet from the first portion to the reservoir, wherein the first flow path further
10 comprises a pump; and

a second flow path; connecting the reservoir to an inlet to the boil chamber, connecting an outlet from the boil chamber to the second portion of the heat exchanger, passing through the second portion and connecting an outlet from the second portion to the outlet for dispensing cooled liquid.

15

Preferred embodiments may relate to an apparatus for dispensing sterilised and cooled liquid, in particular water.

Thus the invention provides an apparatus in which the same reservoir provides both a
20 supply of water to be sterilised in the boil chamber, as well as the cooling liquid for the heat exchanger, and in which separate flow paths supply the boil chamber and the heat exchanger (with cooling liquid). In this arrangement the flow of cooling liquid through the heat exchanger can be controlled independently of the flow of liquid to the boil chamber.

25

It is possible that the flow in both flow paths is controlled as one; however it is preferable that the pump in the first flow path controls the flow rate through the first path independently of the flow rate through the second path. The pump can thereby control heat dissipation in the heat exchanger by controlling the flow rate of the cooling
30 liquid through the first portion of the heat exchanger, which is in the first flow path, whilst leaving the flow rate through the second portion of the heat exchanger unaltered.

In a preferred embodiment the independent control of the flow in the first and second
35 flow path can be achieved by the apparatus further comprising a two-way valve

- 3 -

connected to an outlet from the reservoir to split the flow out of the reservoir between the first and second flow paths. Preferably in this embodiment, the two-way valve is located downstream of the pump and thereby controls flow to both the boil chamber and to the first portion of the heat exchanger.

5

Preferably the same pump controls the flow of water through both the first and second flow paths. This arrangement provides the benefit that the system requires only a single pump and therefore the component count is kept low.

10 In an alternative preferred embodiment the second flow path further comprises a second pump. In such a system the first flow path and second flow path are pumped independently by distinct pumps. Whilst such a system requires a minimum of two pumps it offers the benefit that it does not require a two-way valve to be controlled.

15 Since it is desired for the apparatus to dispense liquid at a preferred consumption temperature it is therefore desirable to be able to monitor the temperature of the dispensed liquid at the outlet of the dispenser to ensure that the dispensed temperature is sufficiently close to the preferred consumption temperature. Preferably the apparatus further comprises a temperature sensor between the heat exchanger
20 and the outlet for dispensing cooled liquid from the heat exchanger. It is desirable to also be able to monitor the temperature of the liquid in the boil chamber of the apparatus to ensure that the liquid reaches a temperature sufficient for sterilisation. It is also desirable to monitor the temperature of the liquid in the reservoir as the higher the temperature of the reservoir liquid the less efficient the heat dissipation in the heat
25 exchanger. Preferably the apparatus further comprises a temperature sensor in the boil chamber and/or the reservoir. Accordingly, in a preferred embodiment the apparatus comprises one or more temperature sensors such as negative temperature coefficient (NTC) thermistors arranged in the boil chamber, the reservoir, and at the liquid dispensing outlet.

30

In order to monitor and control the temperature of the dispensed liquid, the apparatus preferably further comprises an electronic controller. The electronic controller preferably receives input from one or more of the temperature sensor(s) and may use these inputs to control one or more components of the apparatus. Preferably the
35 electronic controller is arranged to control one or more of: the pump in the first flow

- 4 -

path and the electrical heating element. In the embodiment described above, in which the apparatus further comprises a two-way valve, the microcontroller is also preferably operable to control this two-way valve based on input from the one or more of the temperature sensor(s). In the alternative embodiment in which the second flow path of the apparatus further comprises a second pump, the microcontroller is preferably also operable to control this second pump.

In the apparatus described above, it is possible to control the flow of cooling liquid through the first portion of the heat exchanger independently of the flow through the second portion. This is sufficient to allow sterilised liquid to be dispensed at a preferred consumption temperature. However, in a preferred embodiment the apparatus further comprises a valve downstream of the boil chamber and upstream of the heat exchanger, such that the flow rate into the second portion of the heat exchanger can also be controlled. This arrangement allows the heat dissipation in the heat exchanger to be more accurately controlled and thereby allows the apparatus to achieve more precisely the preferred consumption temperature of the dispensed liquid.

Preferably, the apparatus further comprises a flow control device, for example a valve or a pump, immediately before the outlet of the system. This allows the dispensing of the sterilised and cooled liquid to be more accurately and independently controlled.

The dispensed liquid can be used for a number of different purposes. In a preferred embodiment the dispensed liquid is water. The dispensed water may be used to prepare baby milk from formula, or it may be used to prepare drinks such as tea or coffee e.g. in regions where the user has concerns about whether the mains water supply is fully sterile. In the case where the user wishes to use the dispensed water to prepare a beverage which requires an additive being mixed with the liquid, the user may manually introduce the additive after the liquid has been dispensed. However, in a preferred embodiment the apparatus may further comprise a mixing or diffusion device upstream of the outlet, e.g. to mix or infuse an additive with the water before it is dispensed. For example the mixing or diffusion device may add baby milk formula, tea or coffee to the sterilised and cooled water before it is dispensed.

From a second aspect, the invention provides a method of sterilising and cooling liquid within a liquid dispensing apparatus, the apparatus comprising:

- 5 -

a liquid reservoir;

a boil chamber, comprising an electrical heating element for heating liquid in the chamber to boiling;

5 a heat exchanger, comprising a first portion through which cooling liquid flows and a second portion through which liquid to be cooled flows; and
an outlet for dispensing cooled liquid from the heat exchanger;

wherein the method comprises:

conveying liquid along a first flow path within the apparatus, out of the reservoir into an inlet to the first portion of the heat exchanger, through the first portion of the
10 heat exchanger, out of the first portion of the heat exchanger and back into the reservoir; and

conveying liquid along a second flow path within the apparatus, out of the reservoir into an inlet to the boil chamber, boiling the liquid, and then conveying the liquid through an outlet from the boil chamber to the second portion of the heat
15 exchanger, passing the liquid through the second portion of the heat exchanger to the outlet, and dispensing the liquid through the outlet.

In one or more embodiments, the method further comprises: controlling the flow rate in the first flow path independently of the flow rate in the second flow path.
20

In one or more embodiments, the method further comprises: controlling a two-way valve connected to an outlet from the reservoir, to split the flow out of the reservoir between the first and second flow paths.

25 In one or more embodiments, the method further comprises: operating a single pump to convey liquid along the first and the second flow path.

In one or more alternative embodiments, the method further comprises: operating a first pump to convey liquid along the first flow path, and operating a second pump to
30 convey liquid along the second flow path.

In one or more embodiments, the apparatus further comprises a temperature sensor in the boil chamber and/or a temperature sensor in the boil chamber and/or a temperature sensor between the heat exchanger and the outlet, and preferably the

- 6 -

method further comprises: controlling the first/second pump in response to input(s) from the temperature sensor(s).

5 Features of any aspect or embodiment described herein may, wherever appropriate, be applied to any other aspect or embodiment described herein. Where reference is made to different embodiments or sets of embodiments, it should be understood that these are not necessarily distinct but may overlap.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Certain preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic diagram of a first embodiment of the present invention;

15 Figure 2 shows a schematic diagram of a second embodiment of the present invention;

Figure 3a and 3b show an example of a counter-flow heat exchanger, used in the embodiments of the present invention;

Figure 4a and 4b show data from testing of an embodiment of the present invention;

20 Figure 5a and 5b show data from testing of an embodiment of the present invention; and

Figure 6a and 6b show data from testing of an embodiment of the present invention.

25 DETAILED DESCRIPTION

Figure 1 shows a schematic diagram of a first embodiment of the present invention. The water dispensing apparatus includes a reservoir 2, in which a supply of unsterilized water is kept, a boil chamber 4, in which water from the reservoir 2 is heated to a temperature sufficient for sterilization (e.g. 100 °C), and a heat exchanger 6, in which the sterilized water from the boil chamber 4 is cooled. The arrows in Figure 1 show the direction of water flow to and from each of these components.

Water is pumped out of the reservoir 2 by a first pump 8 to a two-way valve 10. The two-way valve 10 can supply water to the boil chamber 4 and/or a first portion 16 of the heat exchanger 6.

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- 7 -

The boil chamber 4 is arranged to sterilize the supplied water by heating the water substantially to boiling for a period of time using one or more heating elements 12. A heating element 12 is shown mounted under the base of the boil chamber 4 but an
5 immersed heating element could be provided instead. Ideally the boil chamber 4 is arranged to boil a static volume of water, which can be contrasted to flow heaters that are unable to bring water all the way to boiling point or maintain a simmer.

The flow of water from an outlet of the boil chamber 4 into a second portion 18 of the
10 heat exchanger 6 is controlled by an output valve 14. The control process is described in more detail below. The heat exchanger 6 may be a counter-flow heat exchanger, as shown schematically in Figure 1. The counter-flow heat exchanger 6 comprises a first portion 16 in which cooling liquid flows and a second portion 18 in which heated liquid flows in a direction substantially parallel and in the opposite direction to the cooling
15 liquid which is flowing in the first portion 16. The first and second portions 16, 18 of the heat exchanger 6 are in good thermal contact so as to achieve efficient heat exchange. An exemplary construction is described below with reference to Figs. 3a and 3b.

20 The two-way valve 10 can be controlled to supply water as cooling liquid to the first portion 16 of the heat exchanger 6. To operate the heat exchanger 6, the pump 8 is controlled to pump this water around the first portion 16 of the heat exchanger 6, in the direction shown by the arrow on Figure 1, and then returns this water to the reservoir 2.

25 There are thus two flow paths along which the water from the reservoir 2 can travel. The first flow path is the path in which water acts as the cooling liquid in the heat exchanger 6. The water flows through the two-way valve 10 into the first portion 16 of the heat exchanger 6, then back into the reservoir 2. The second flow path is the path
30 in which the water from the reservoir 2 is transferred by the pump 8 first to the boiling chamber 4, then through the second portion 18 of the heat exchanger 6 to be cooled, then to a dispensing outlet 22.

Downstream of the second portion 18 of the heat exchanger 6, and upstream of the
35 dispensing outlet 22, there may optionally be a second valve or pump 20 in the second

- 8 -

flow path. In the particular example where the liquid dispensing apparatus is used to prepare baby milk formula, in use a bottle 24 is located underneath the outlet 22 to receive the dispensed water, as shown in Figure 1.

5 The two-way valve 10, first pump 8, heating element(s) 12 of the boil chamber 4, output valve 14, and optional second valve/pump 20 are all controlled by a micro-controller unit (MCU) (not shown). The MCU receives input data from three temperature sensors, which can be negative temperature coefficient (NTC) sensors. The first sensor 26 is located in the boil chamber 4, and detects the temperature of the
10 water as it is being heated. The second sensor 28 is located in the reservoir 2 and detects the starting temperature of the water in the reservoir. The third sensor 30, which is located downstream of the outlet of the second portion 18 of the heat exchanger 6, and before the outlet 22 of the liquid dispenser, detects the temperature of the water that is being dispensed.

15

The process of dispensing liquid at the desired temperature begins by supplying a select volume of water to the reservoir 2; this water can be supplied from the mains water supply. For example, a user may manually fill the reservoir 2 or the reservoir 2 may be connected in-line with a mains water supply. Any remaining water from a
20 previous cycle is drained out of the boil chamber 4 by opening the valve 14 and drained out of the heat exchanger 6 by operating the valve/pump 20. The two-way valve 10 is switched to an open position and water is pumped through the second flow path to the boil chamber 4 until the required volume in the boil chamber 4 is reached. The MCU then turns on the heating element(s) 12 of the boil chamber 4 so that the
25 water is heated to boiling. When the first sensor 26 detects that the water has been heated to the required temperature and for the required time period for sterilization, which may be boiling e.g. 100 °C for a minute or more, then the heating element 12 is switched off. At the same time or a later time, the valve 14 is opened and the sterilised water is drained from the boil chamber 4 into the second portion 18 of the heat
30 exchanger 6 to be cooled down.

The MCU controls the two-way valve 10 so that, when cooling of the sterilised water is required, the two-way valve is switched to a closed position so that water from the reservoir 2 is able to be pumped along the first flow path to the first portion 16 of the
35 heat exchanger 6, as the heated water from the boil chamber 4 is flowing through the

- 9 -

second portion 18. The third sensor 30, located just above the dispenser outlet, detects the temperature of the cooled water before it is dispensed. If the temperature is not equal to the desired temperature that has been set then this is detected by the MCU. The difference between the set temperature and the temperature detected by sensor 30 is used to control the pump 8. For example, the voltage of the pump 8 may be controlled to adjust the flow rate of cooling water through the first portion 16. This changes the heat exchange efficiency and hence the temperature of water leaving the second portion 18.

- 10 If the detected temperature exceeds the set temperature then the MCU will control the pump 8 so that the flow rate through the first portion 16 of the heat exchanger 6 will increase, and the heat dissipation from the heated water in the second portion 18 will increase, so that the temperature of the dispensed water decreases.
- 15 Conversely, if the temperature detected by the sensor 30 is lower than the set temperature then the MCU will control the pump 8 so that the flow rate through the first portion 16 of the heat exchanger 6 will decrease and heat dissipation is decreased to increase the temperature of the dispensed water. This control of the pump 8 may also be combined with control of the optional valve/pump 20 to adjust the residence time of
- 20 the water being cooled in the second portion 18 of the heat exchanger 6.

Figure 2 shows a schematic diagram of a second embodiment of the present invention. It operates in a similar manner to the embodiment described above, and like components have been labelled with the same reference numerals. However, in the embodiment shown in Figure 2 no two-way valve is present and instead the reservoir 2

25 has a first outlet 25 and a second outlet 27. This system comprises two pumps 21, 23

This embodiment also comprises a reservoir 2 in which a supply of unsterilized water is kept, a boil chamber 4, in which water from the reservoir 2 is heated to a

30 temperature sufficient for sterilization, and a heat exchanger 6, in which the sterilized water is cooled. The arrows in Figure 2 show the direction of water flow to and from each of these components.

In this embodiment the heat exchanger 6 may be again a counter-flow heat

35 exchanger. An example of such a counter-flow heat exchanger is shown in Figures 3a

- 10 -

and 3b. The counter-flow heat exchanger comprises a first portion 16 in which the cooling water flows, a second portion 18 in which the sterilised water flows, and a connector 32 attached to each end of the heat exchanger 6. The first portion 16 may preferably comprise a silicone tube. The second portion 18 may preferably comprise a metal tube. Figure 3a shows a counter-flow heat exchanger which is coiled so as to increase the contact area between the first portion 16 and the second portion 18. Figure 3b shows a cross-sectional view of one end of the heat exchanger of Figure 3a, the arrows in Figure 3b show the direction of the flow of cooling water in the first portion 16, towards the reservoir 2, and the flow of sterilised water in the second portion 18 towards the outlet 22.

Turning back to Figure 2, In the first flow path in this apparatus water is pumped out of the first outlet 25 of the reservoir 2 by a first pump 23 and into the first portion 16 of the heat exchanger 6, in which the water acts as a cooling liquid. The water is pumped through the heat exchanger 6 and then back into the reservoir 2.

In the second flow path in this apparatus water is pumped out of the second outlet 27 of the reservoir 2 by a second pump 21 into the boil chamber 4. However, it will be appreciated that the second pump 21 may be omitted if the reservoir 2 is positioned to provide a gravity flow of water to the boil chamber 4. The water is then heated in this chamber 4 by one or more heating elements 12. Once a first sensor 26 located in the boil chamber 4 determines that the required sterilisation temperature has been reached by the water in the boil chamber 4, the outlet valve 14 is then operated, allowing the sterilised water to pass through the second portion 18 of heat exchanger 6, which cools the water. The water is then dispensed directly through the outlet 22.

The embodiment shown in Figure 2 operates in a manner similar to the first embodiment already described with reference to Figure 1. In this embodiment the first pump 23 can be controlled according to whether the temperature of the dispensed liquid, as measured by a third sensor 30, is higher or lower than the desired temperature. In this embodiment the second pump 21 separately controls the flow of water to the boil chamber 4, and the valve 14 controls the flow of water out of the boil chamber 4, according to the reading of sensors 28 and 30 input to a micro-controller unit (not shown), as described for the first embodiment. In the second embodiment the pumps 21, 23 may be controlled independently of one another. Water may be

- 11 -

pumped through the first and second flow paths at the same time or at different times or at overlapping times. For example, cooling water may be pumped through the second flow path to cool sterilised water during a first dispensing cycle at the same time as fresh water is pumped from the reservoir 2 into the boil chamber 4 for the next
5 sterilisation/dispensing cycle.

In both embodiments the second sensor 28 detects the starting temperature of the water in the reservoir 2. Since the water which is circulated in the heat exchanger 6 as cooling liquid is then returned to the reservoir 2, the temperature of the water in the
10 reservoir 2 is gradually increased. When this temperature increases by a significant amount the heat exchanger 6 can no longer operate effectively and therefore the desired temperature of the dispensed water can no longer be achieved. A key insight of the Applicant is the realisation that, a volume of water which is sufficient for most users can be dispensed at the desired temperature before the temperature of the
15 reservoir approaches a temperatures too high for the heat exchanger to operate effectively, e.g. taking into account the likely gap between dispensing cycles and cooling of the water in the reservoir back to ambient temperature (which is of course sped up by the addition of fresh water into the reservoir).

20 Figures 4a, 4b, 5a, 5b, 6a and 6b show data obtained across a number of cycles from the second sensor 28, which gives the reservoir temperature, and from the third sensor 30, which gives the dispensing temperature.

Figures 4a and 4b show test data obtained using an apparatus for dispensing liquid
25 which is an embodiment of the present invention. In this case the apparatus was set to dispense a volume of 11fl oz at a temperature of 40°C three times in succession.

Figure 4a is a graph showing the temperature (axis 401, in units of degrees Celsius) of the dispensed liquid as measured by third sensor 30 (solid line) and the temperature of
30 the reservoir, as measured by second sensor 28 (dashed line) across three successive dispensing cycles, 402a, 402b, and 402c.

Figure 4b is a table showing the temperature of the dispensed liquid (403) and the reservoir (404) for the three cycles in degrees Celsius, as in Figure 4a. The table also

- 12 -

shows the volume dispensed in millilitres (405) and the time required for the cycle (406) in units of seconds.

Figure 5a and 5b show similar data to Figures 4a and 4b. In this case the apparatus was set to dispense a volume of 8fl oz at a temperature of 40°C four times in succession (502a, 502b, 502c, 502d). As in Figures 4a and 4b, the Figures show dispensing temperature (503) (solid line), reservoir temperature (504) (dashed line), volume dispensed (505) and cycle time (506). Axis 501 gives temperature in degrees Celsius.

Figures 6a and 6b show similar data to Figures 4a, 4b, 5a and 5b. In this case the dispensing apparatus was set to dispense 4fl oz at a temperature of 40°C seven times in succession. Related reference numerals have been used for related parameters.

The data shown in these Figures demonstrates the insight of the Applicant. The reservoir temperature rises over time because the water that has been used as cooling liquid is subsequently returned to the reservoir, however the Applicant has appreciated that this effect is not significant enough to affect the average user. The user of such a device is unlikely to require the apparatus to dispense a large volume of water on one particular occasion, and these Figures show that even when dispensing a quantity of 11oz of water each cycle the apparatus can still carry out at least two dispensing cycles before the reservoir temperature is too high to achieve a satisfactory dispensing temperature. The user is very unlikely to require a quantity of water in excess of this amount on one particular occasion, and before the user requires the dispenser again the reservoir has time to cool or the water in the reservoir can be replaced.

The fact that there are two separate flow paths in the apparatus, one supplying the boil chamber and the other supplying the cooling liquid to the heat exchanger 6, is advantageous because it allows the flow of cooling liquid through the first portion 16 of the heat exchanger 6 to be controllable independently of the flow speed of the heated liquid through the second portion 18 of the heat exchanger 6. This allows the dispensing temperature to be accurately controlled by the pump (e.g. altering the pump voltage) in accordance with the temperature measured at the outlet sensor 30, without requiring further mixing downstream of the heat exchanger outlet of cooled sterilised water with uncooled sterilised water.

- 13 -

The combination of the pump 8 and the two-way valve 10 as shown in Figure 1 is particularly advantageous because it allows the system to run entirely using one pump, whilst also achieving the advantages described in the previous paragraph. The
5 use of only one pump to achieve this affect is advantageous because it keeps the number of components in the system low and therefore reduces the cost of the system and the chances of a component fault.

It will be appreciated by those skilled in the art that the invention has been illustrated
10 by describing one or more specific embodiments thereof, but is not limited to these embodiments; many variations and modifications are possible, within the scope of the accompanying claims.

Claims

1. An apparatus for dispensing liquid comprising:
a liquid reservoir;
a boil chamber, comprising an electrical heating element for heating liquid in
5 the chamber to boiling;
a heat exchanger, comprising a first portion through which cooling liquid flows
and a second portion through which liquid to be cooled flows; and
an outlet for dispensing cooled liquid from the heat exchanger;
wherein the apparatus further comprises:
10 a first flow path for cooling liquid; connecting the reservoir to an inlet to the first
portion of the heat exchanger, passing through the first portion and connecting an
outlet from the first portion to the reservoir, wherein the first flow path further
comprises a pump; and
a second flow path; connecting the reservoir to an inlet to the boil chamber,
15 connecting an outlet from the boil chamber to the second portion of the heat
exchanger, passing through the second portion and connecting an outlet from the
second portion to the outlet for dispensing cooled liquid.
2. The apparatus of claim 1, wherein the pump in the first flow path controls the
20 flow rate through the first flow path independently of the second flow path.
3. The apparatus of any preceding claim, further comprising a two-way valve
connected to an outlet from the reservoir outlet to split the flow out of the reservoir
between the first and second flow paths.
25
4. The apparatus of claim 3, wherein the two-way valve is located downstream of
the pump.
5. The apparatus of any preceding claim, wherein the pump controls the flow of
30 water through both the first and second flow paths.
6. The apparatus of any of claims 1-4, wherein the second flow path further
comprises a second pump.

- 15 -

7. The apparatus of any preceding claim, wherein the apparatus further comprises a temperature sensor in the boil chamber and/or the reservoir.
8. The apparatus of any preceding claim, wherein the apparatus further comprises a temperature sensor between the heat exchanger and the outlet for dispensing cooled liquid from the heat exchanger.
9. The apparatus of any preceding claim, further comprising an electronic controller which receives input from one or more of the temperature sensor(s).
10. The apparatus of claim 9, wherein the electronic controller is arranged to control one or more of: the pump in the first flow path and the electrical heating element.
11. The apparatus of any preceding claim, further comprising a valve downstream of the boil chamber and upstream of the heat exchanger.
12. The apparatus of any preceding claim, further comprising a flow control device arranged immediately upstream of the outlet for dispensing cooled liquid.
13. The apparatus of any preceding claim, further comprising a mixing or infusion device arranged upstream of the outlet.
14. A method of sterilising and cooling liquid within a liquid dispensing apparatus, the apparatus comprising:
- a liquid reservoir;
 - a boil chamber, comprising an electrical heating element for heating liquid in the chamber to boiling;
 - a heat exchanger, comprising a first portion through which cooling liquid flows and a second portion through which liquid to be cooled flows; and
 - an outlet for dispensing cooled liquid from the heat exchanger;
- wherein the method comprises:
- conveying liquid along a first flow path within the apparatus, out of the reservoir into an inlet to the first portion of the heat exchanger, through the first portion of the

- 16 -

heat exchanger, out of the first portion of the heat exchanger and back into the reservoir; and

conveying liquid along a second flow path within the apparatus, out of the reservoir into an inlet to the boil chamber, boiling the liquid, and then conveying the liquid through an outlet from the boil chamber to the second portion of the heat exchanger, passing the liquid through the second portion of the heat exchanger to the outlet, and dispensing the liquid through the outlet.

15. The method of claim 14, further comprising: controlling the flow rate in the first flow path independently of the flow rate in the second flow path.

16. The method of any claim 14 or 15, further comprising: controlling a two-way valve connected to an outlet from the reservoir, to split the flow out of the reservoir between the first and second flow paths.

17. The method of any of claims 14-16, comprising: operating a single pump to convey liquid along the first and the second flow path.

18. The method of any of claims 14-16, comprising: operating a first pump to convey liquid along the first flow path, and operating a second pump to convey liquid along the second flow path.

19. The method of any of claims 14-18, wherein the apparatus further comprises a temperature sensor in the boil chamber and/or a temperature sensor in the boil chamber and/or a temperature sensor between the heat exchanger and the outlet, the method further comprising: controlling the first/second pump in response to input(s) from the temperature sensor(s).

1/6

Fig. 1

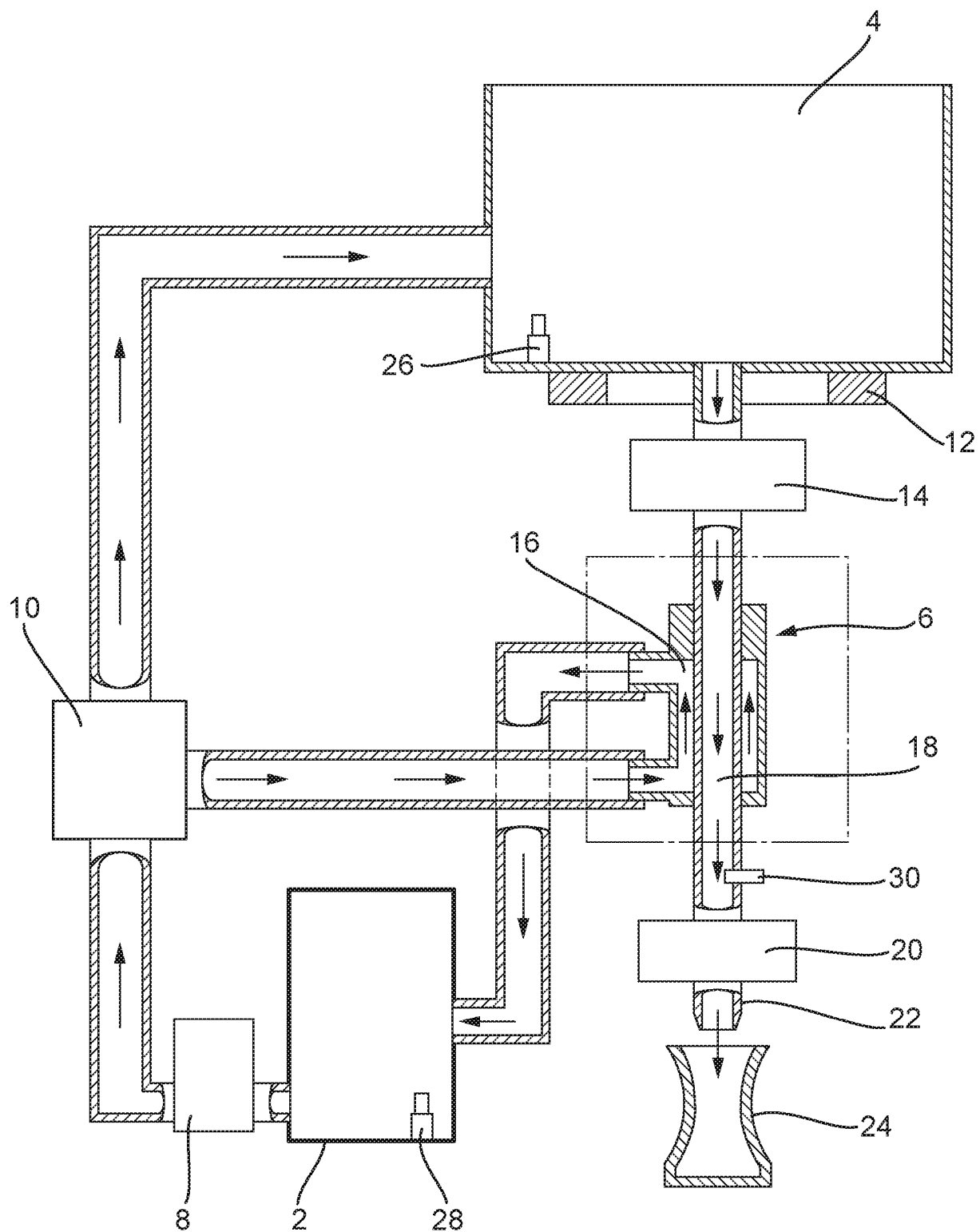
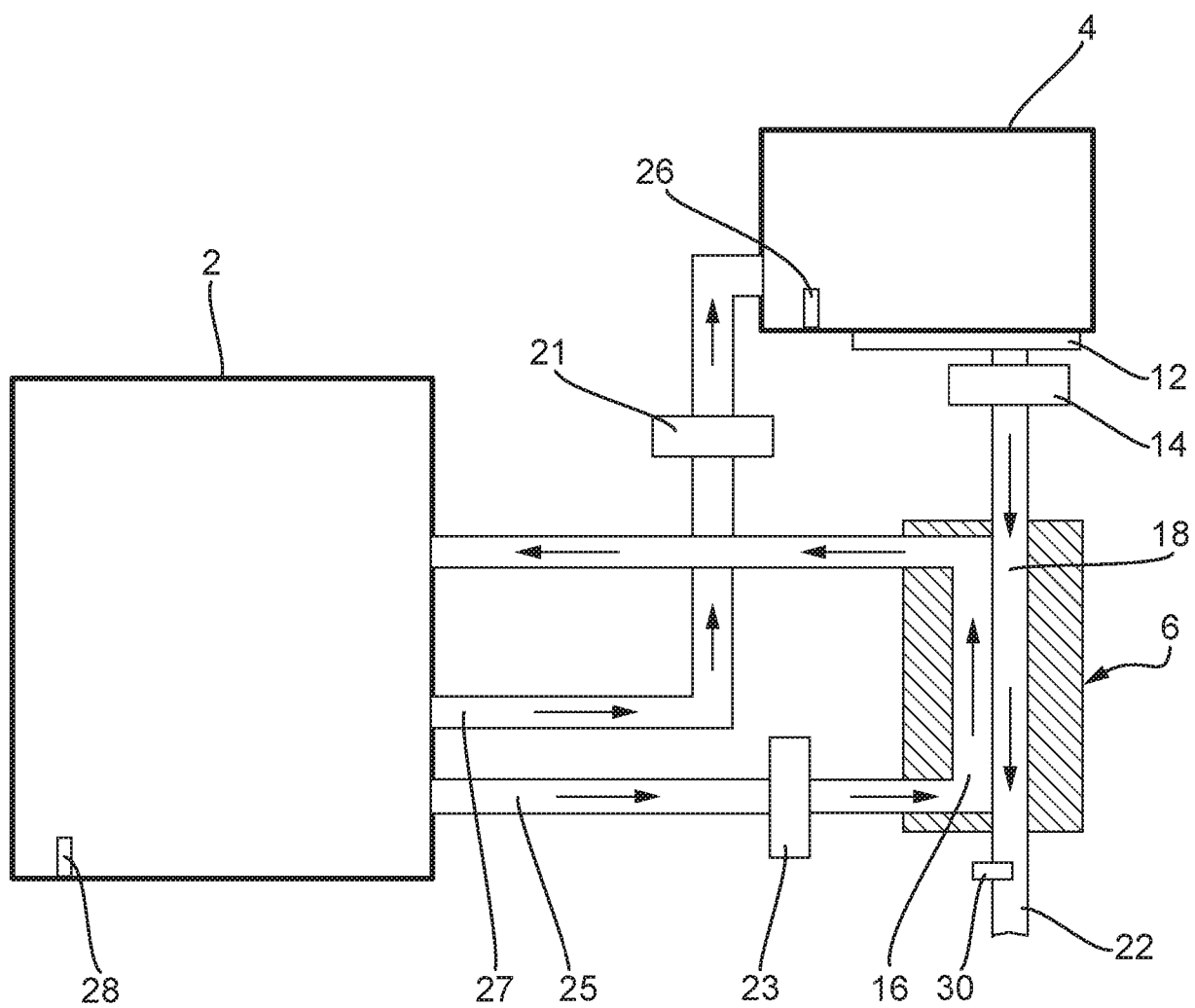


Fig. 2



3/6

Fig. 3a

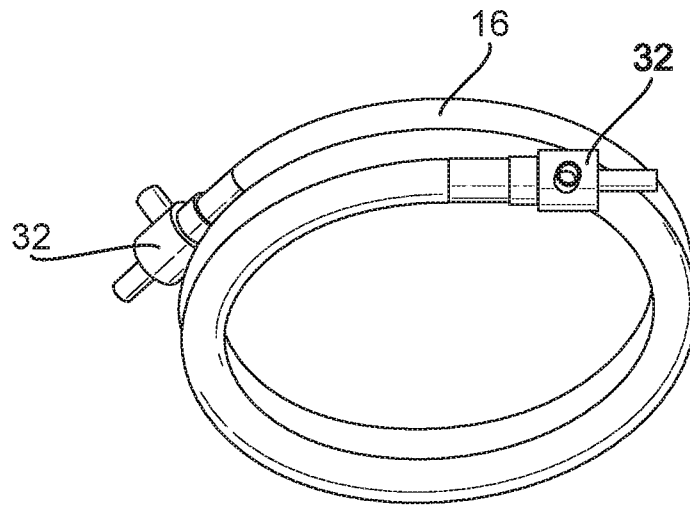
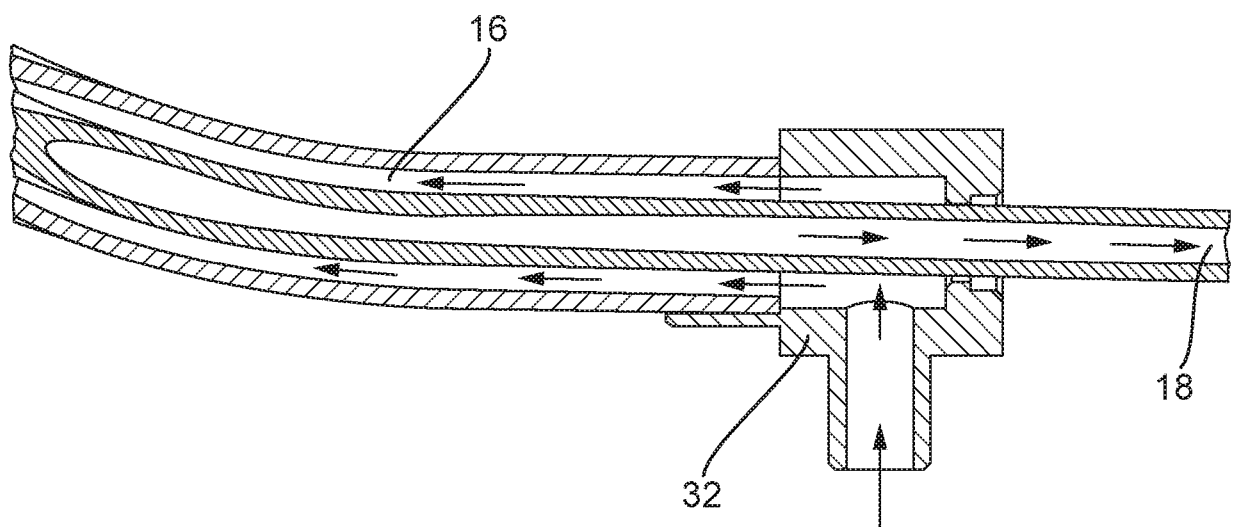


Fig. 3b



4/6

Fig. 4a

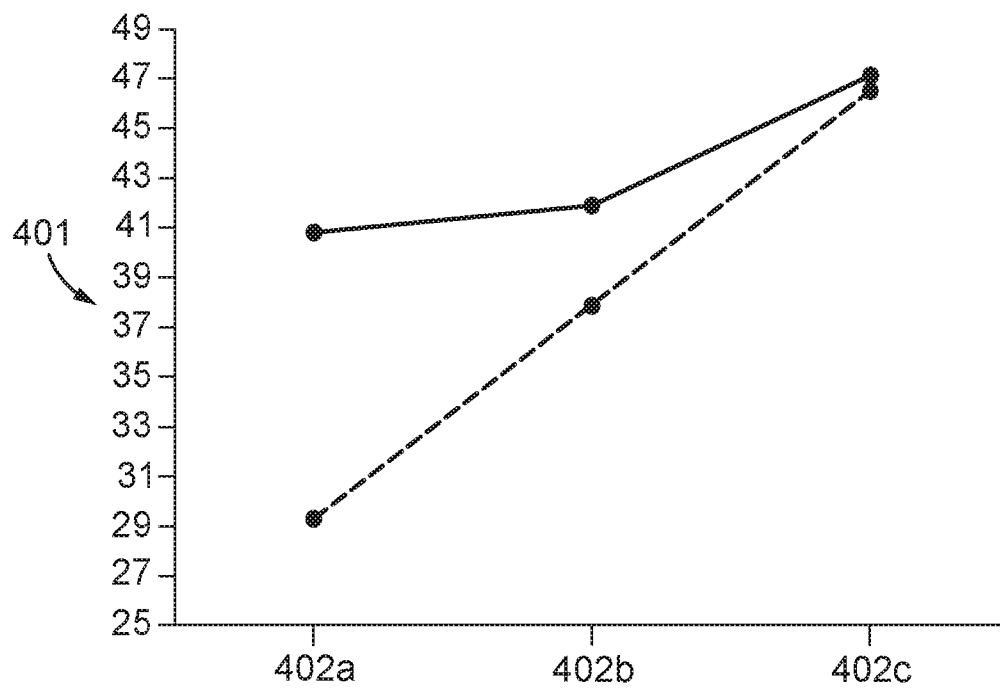


Fig. 4b

	403	404	405	406
402a	40.8	29.3	314	218
402b	41.9	37.9	312	213
402c	47.1	46.5	314	209

5/6

Fig. 5a

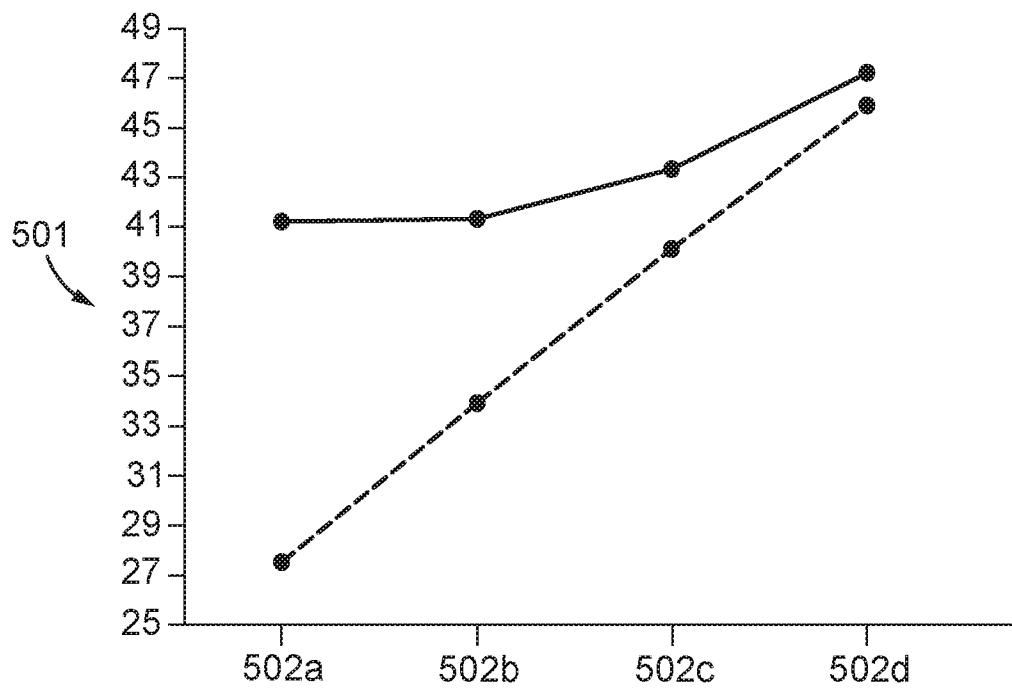


Fig. 5b

	503	504	505	506
502a	41.2	27.5	227	177
502b	41.3	33.9	225	166
502c	43.3	40.1	228	159
502d	47.2	45.9	227	158

6/6

Fig. 6a

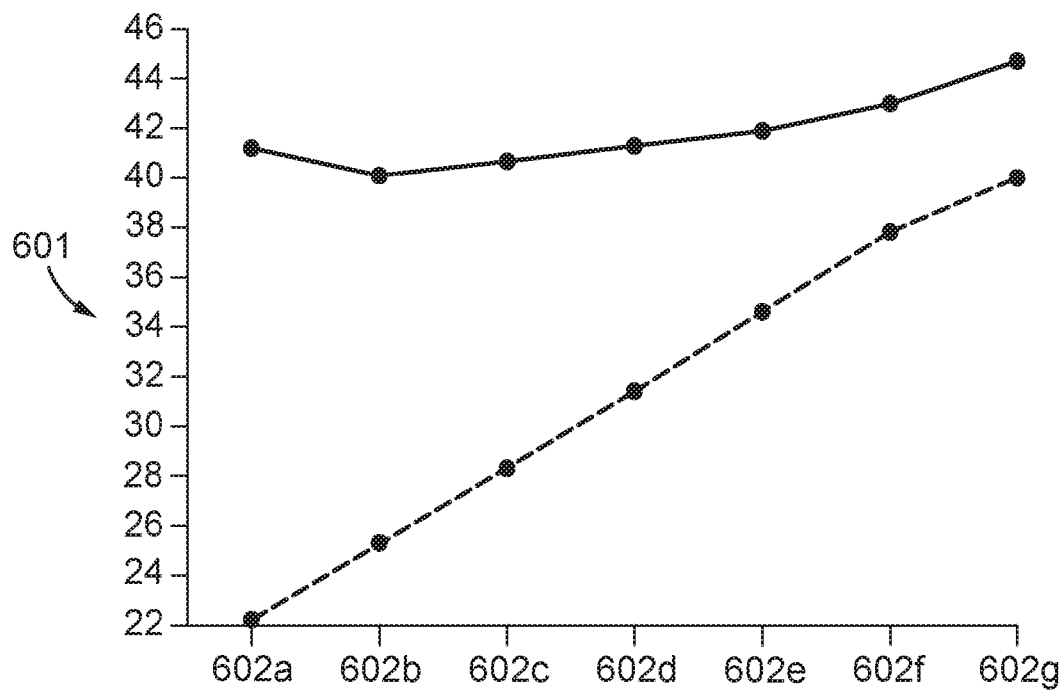


Fig. 6b

	603	604	605	606
602a	41.2	22.2	114	118
602b	40.1	25.3	117	108
602c	40.7	28.3	118	110
602d	41.3	31.4	118	100
602e	41.9	34.6	114	105
602f	43.0	37.8	114	103
602g	44.7	40.0	116	106

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2019/050661

A. CLASSIFICATION OF SUBJECT MATTER

INV. A47J31/40

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)

A47J

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	WO 2007/135608 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; NIJBOER MARIE S [NL] ET AL.) 29 November 2007 (2007-11-29) cited in the application page 6, line 6 - page 9, line 15; figures 1, 2	1-19
A	----- US 2010/300302 A1 (KOOIJKER KLAAS [NL] ET AL) 2 December 2010 (2010-12-02) paragraphs [0023] - [0027], [0030], [0031]; figure 1	1,5,8,9, 12-14, 17,19
A	----- GB 2 457 282 A (DYSON TECHNOLOGY LTD [GB]) 12 August 2009 (2009-08-12) page 6 - page 10; figure 3 -----	1,5,9, 11,14,17



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

4 June 2019

Date of mailing of the international search report

13/06/2019

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

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Novelli, Bruno

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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