

(54) Title of the Invention: Water heater

(51) INT CL: F24H 1/18 (2022.01) F24D 3/10 (2006.01) F24D 11/00 (2022.01) F24D 17/00 (2022.01)
F24H 1/20 (2022.01) F24H 9/12 (2022.01)

(21) Application No: 1906108.4
(22) Date of Filing: 01.05.2019
(43) Date of A Publication: 30.12.2020

(72) Inventor(s):
James Kenneth McAlpine
(73) Proprietor(s):
James Kenneth McAlpine
23 Woodside Place, Glasgow, G3 7QF,
United Kingdom

(56) Documents Cited:
WO 2016/110721 A2 CN 206113297 U
CN 106440337 A US 6847782 B1

(74) Agent and/or Address for Service:
Murgitroyd & Company
Murgitroyd House, 165-169 Scotland Street,
GLASGOW, G5 8PL, United Kingdom

(58) Field of Search:
As for published application 2584989 A viz:
INT CL F24D, F24H
Other: WPI, EPODOC
updated as appropriate

Additional Fields
Other: None

Figure 2

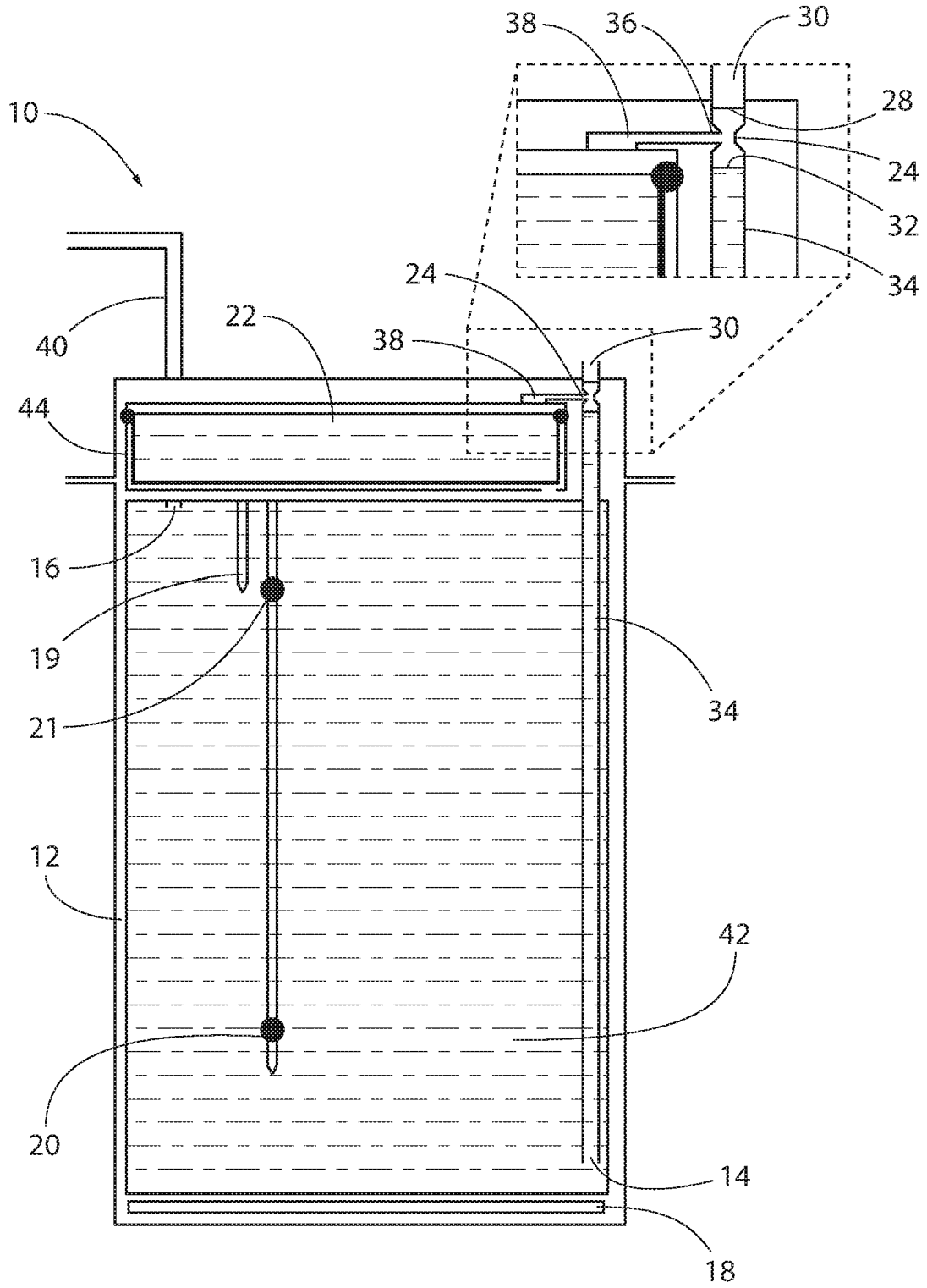


Figure 1

03 08 20



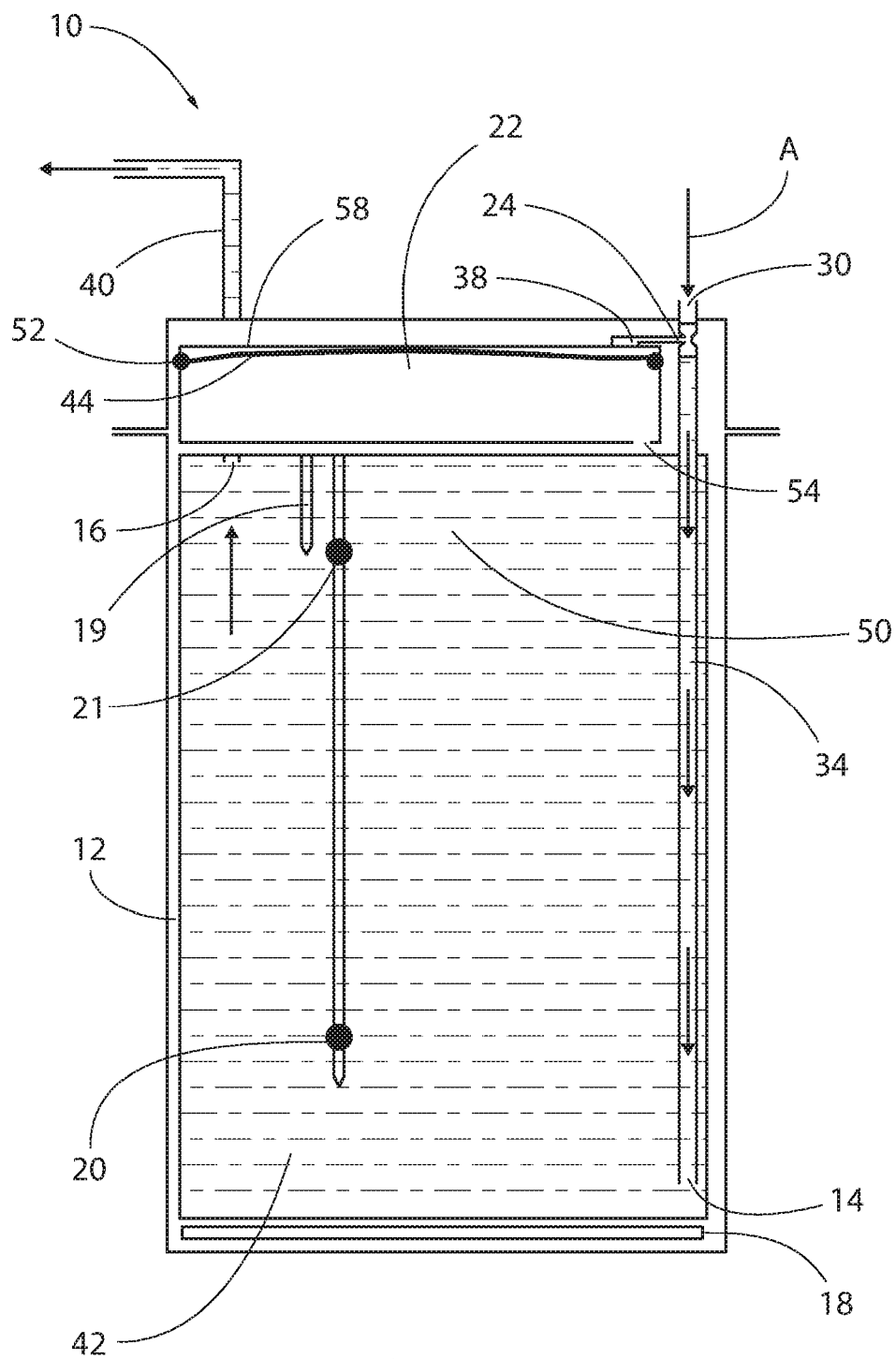


Figure 5



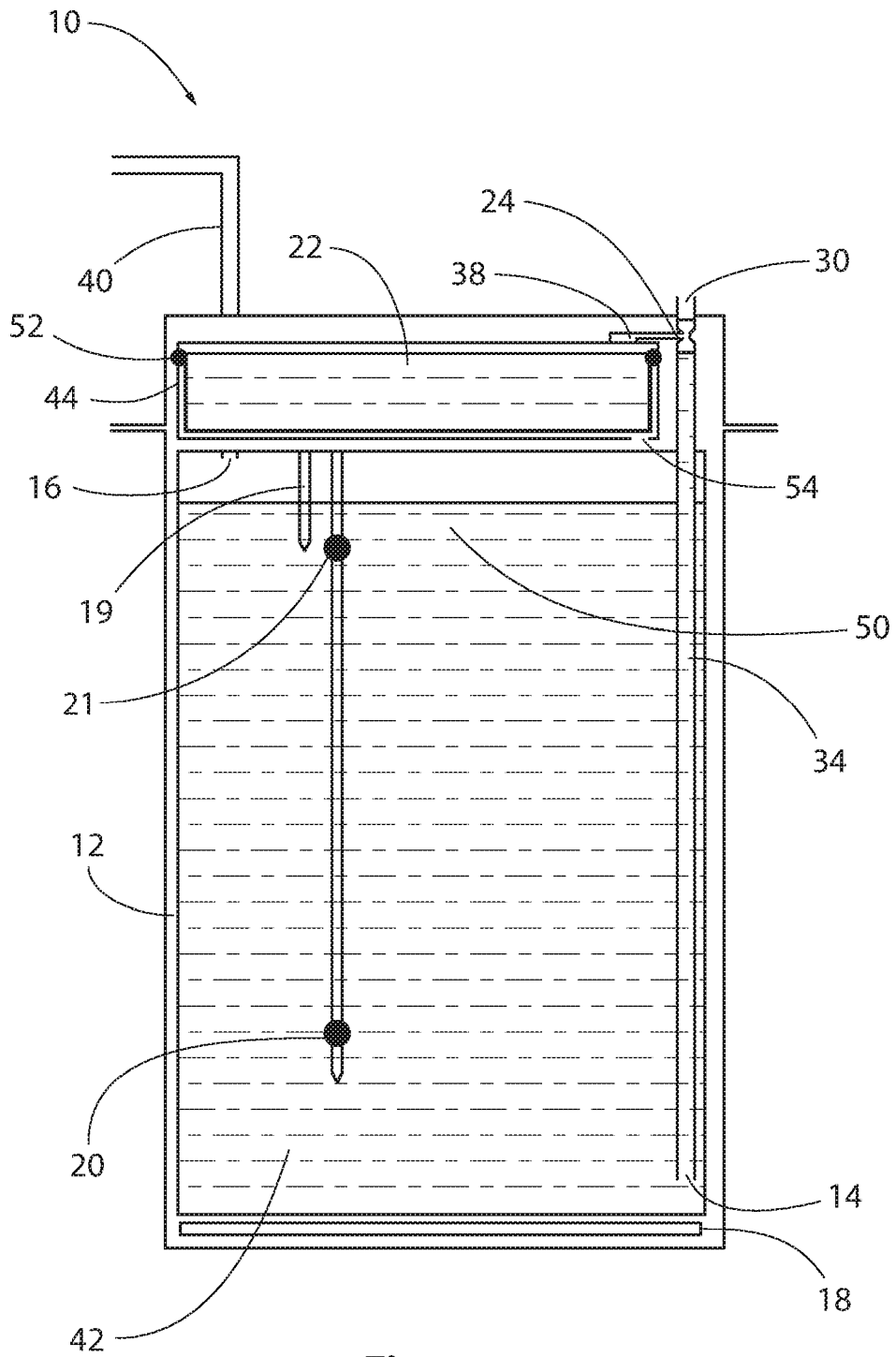


Figure 7

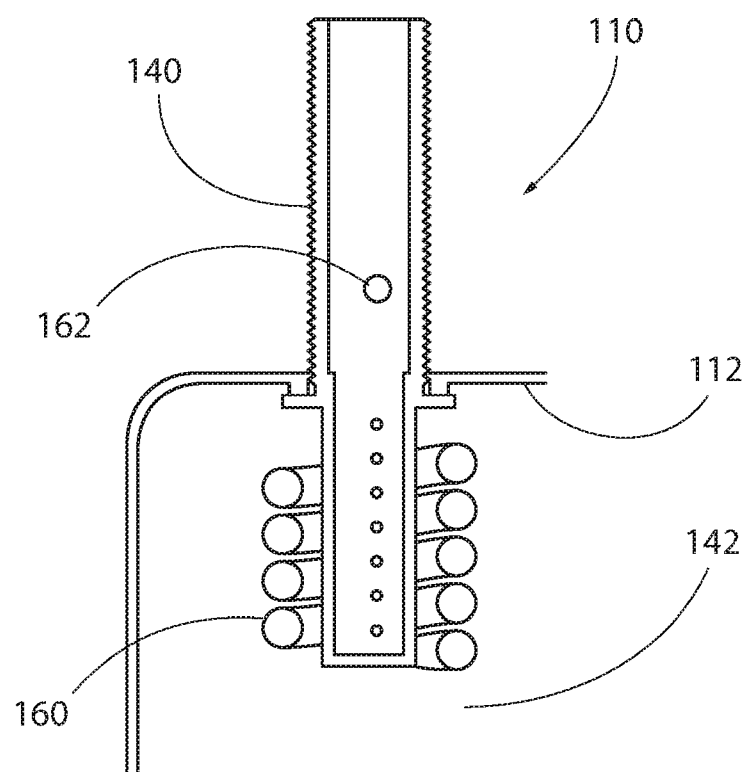


Figure 8

Water Heater

FIELD

The present invention relates to the field of hot water systems, in particular, to an apparatus for providing instant hot water.

BACKGROUND

There are many situations in which an instant and prolonged supply of hot water is desirable. For example, large residential buildings, hotels, catering facilities, changing rooms of sporting facilities, etc.

A common solution adopted to meet this hot water demand is to heat large quantities of water and keep it in large insulated water tanks. Instant demand of hot water is then met by supplying it from the tank.

This solution requires a large space for installing a large water container to be dedicated to this purpose and significant quantities of energy might be lost due to the fact that hot water in the tank cools down if it is not used a short time after it has been heated. To overcome this problem, there are thermostatically controlled water tanks that keep water hot at all times, even when it is not needed. This amounts to a waste of energy due to heat loss through the tank walls and still requires a large space for the tank. However, if the water is heated on demand, there can be a substantial delay from when that demand arises until the water is actually supplied at the required temperature.

In order to solve these problems, instant hot water dispensers have been developed. Instant hot water dispensers might keep a smaller amount of water in

a smaller tank and heat water after a certain amount of hot water in the tank has been used, or if the temperature of the water in the tank falls below a certain level. These instant hot water dispensers usually require less space than the traditional hot water systems described above but are more energy intensive,
5 that is, they require a more intense energy input because of the increased rate of heating.

One of the issues with hot water dispensers of this type is there is generally a substantial time lag between opening the water faucet or tap on the dispenser and water at the required temperature flowing from the faucet or tap.

10 A further problem with instant hot water dispensers is that they are not able to supply a constant flow of water at the desired temperature, and the water temperature falls substantially after the dispenser has been supplying water at the desired temperature for a few seconds.

15 SUMMARY

The present invention provides an apparatus for dispensing hot water, the apparatus comprising:

- a tank having a tank inlet and a tank outlet;
- at least one heating element disposed inside or adjacent to the tank;
- 20 at least one thermistor for measuring the temperature of water within the tank;
- an expansion chamber;
- a Venturi valve comprising a Venturi entrance port in fluid communication with a cold water supply, a Venturi exit port in fluid communication with the tank

inlet and a Venturi suction port in fluid communication with the expansion chamber; and

5 a discharge pipe connecting the tank outlet to a faucet or tap, wherein the discharge pipe includes a further heating element and a temperature monitoring device;

wherein the further heating element is operable to heat water as it leaves the tank outlet and the temperature monitoring device measures discharged water temperature; and

10 wherein at least a portion of the expansion chamber is disposed above the tank.

In at least one embodiment of the present invention, providing an expansion chamber with at least a portion of the chamber being disposed above the tank, ensures that the tank remains filled to a higher level than a conventional tank. This means the hot water in the tank has less distance to travel to
15 dispense, reducing the waiting time for a user between requesting heated water and water being delivered at the desired temperature.

The Venturi valve may be configured such that a flow of fluid from the Venturi entrance port to the Venturi exit port creates a suction pressure at the Venturi suction port. This suction pressure drawing, in use, fluid through the
20 Venturi suction port and into the flow of fluid flowing from the Venturi entrance port to the Venturi exit port.

The expansion chamber may be wholly disposed above the tank.

The expansion chamber may be oriented in a horizontal plane.

The expansion chamber may incorporate a diaphragm, the diaphragm being movable between a chamber full position in which the expansion chamber is substantially filled with water and a chamber empty position in which the water
5 is substantially expelled from the chamber.

The diaphragm may be biased to the chamber full position. By biasing the diaphragm to the chamber full position, the diaphragm can apply a suction force when moving from the chamber empty position to the chamber full position.

The diaphragm may be configured such that gravity may assist in moving
10 the diaphragm from the chamber empty position to the chamber full position.

In moving from the chamber empty position to the chamber full position liquid from the tank may be drawn into the expansion chamber through the Venturi valve.

When the chamber is filled with water and the diaphragm is in the
15 chamber full position, the diaphragm may be between the liquid in the chamber and the liquid in the tank.

The Venturi suction port may be in fluid communication with an expansion chamber exit port.

The expansion chamber exit port may be located on a portion of the
20 expansion chamber which is distal to the tank.

The expansion chamber exit port may be located on an upper portion of the expansion chamber.

When the expansion chamber is located in a horizontal plane, the expansion chamber exit port may be defined by the top of the expansion chamber.

In at least one embodiment, when there is a flow of fluid from the Venturi entrance port to the Venturi exit port, water is sucked from the top of the expansion chamber into the Venturi valve.

In the chamber full position the diaphragm may follow the contour defined by an internal surface of a portion of the expansion chamber.

In the chamber empty position the diaphragm may be crumpled or crushed.

In moving from the chamber full position to the chamber empty position, the diaphragm may be configured not to invert. By not inverting, the diaphragm remains biased to the chamber full position.

The expansion chamber may further comprise a plurality of air vents. Air vents are provided to fill the void behind the diaphragm as it moves from the chamber full position to the chamber empty position.

The Venturi exit port may be in fluid communication with the tank inlet by means of a tank inlet pipe.

The tank inlet pipe may discharge into the bottom of the tank. Such an arrangement allows for a head of water to exist between the expansion chamber and the point of discharge into the tank.

The apparatus may comprise a plurality of thermostatically controlled heating elements.

In one particular embodiment there is a first thermistor and a second thermistor. In this embodiment, the first thermistor takes a reading from an upper portion of the tank and the second thermistor takes a reading from a lower portion of the tank. Such an arrangement allows for more accurate control of the system as the second thermistor can control the heating element to heat water and the first thermistor can ensure the water at the top of the tank is at the dispensed temperature before allowing dispense. This also allows for faster dispense as the tank reacts more quickly to changing circumstances.

Having a heating element in the discharge pipe allows the main body of water within the tank to be kept at a lower temperature than the dispensed temperature, thereby saving energy, the second heating element providing a final boost up to the dispensed temperature during the actual dispense operation.

The expansion chamber maybe assembled using ultrasonic welding. Such an arrangement uses fewer parts and is quicker and faster to manufacture than conventional expansion chambers which are held together by screws.

The apparatus may further comprise a baffle to smooth the flow of water into the tank. A baffle helps reduce the turbulence in the tank as water flows in thus making for more efficient heating of the water and control of the temperature, particularly at the tank outlet.

The apparatus may include an integral pressure relief valve at the Venturi entrance port. A pressure relief valve prevents the apparatus being damaged through over-pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a schematic section of an apparatus for dispensing hot water in accordance with a first embodiment of the present invention;

Figure 2 is an enlarged schematic section of part of the apparatus of Figure 1;

Figures 3 to Figure 7 are a series of schematic sections showing the apparatus of Figure 1 at various stages of the operation cycle; and

Figure 8 is a schematic section of part of an apparatus for dispensing hot water in accordance with a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is first made to Figure 1 a section of a schematic of an apparatus, generally indicated by reference numeral 10, for dispensing hot water in accordance with a first embodiment of the present invention. The apparatus 10 comprises a tank 12, having a tank inlet 14 and the tank outlet 16, a concealed heating element 18 disposed adjacent to the tank 12 and a first thermistor 21 for measuring the temperature of the water at the top of the tank 12 and a second thermistor 20 for measuring the temperature of the water at the bottom of the tank 12.

The apparatus 10 further comprises an expansion chamber 22 and a Venturi valve 24.

The construction of the Venturi valve 24 and its relationship with the expansion chamber 22 will now be described with reference to Figure 2, an
5 enlarged schematic section of part of the apparatus 10 of Figure 1, particularly a section of the Venturi valve 24.

The Venturi valve 24 comprises a Venturi entrance port 28 in fluid communication with a cold water supply (not shown), by a supply pipe 30; a Venturi exit port 32 in fluid communication with the tank inlet 14 by an inlet pipe
10 34; and a Venturi suction port 36 in fluid communication with the expansion chamber 22 via a suction pipe 38. As can be seen the Venturi valve 24 and the expansion chamber 22 are located above the top of the tank 12 and the expansion chamber 22 is wholly contained within the footprint of the tank 12.

The expansion chamber 22 includes a diaphragm 44 which will be
15 discussed in more detail when the operation of the apparatus 10 is described in due course.

Finally, the apparatus 10 further comprises a water level sensor 19 for detecting the presence of water in the tank and to prevent the heating element operating when there is insufficient water, and a discharge pipe 40 connecting
20 the tank outlet 16 to a faucet or tap (not shown).

Figure 2 shows the apparatus 10 in a ready position. There is water 42 within the tank 12, in the inlet pipe 34, in the discharge pipe 40 (adjacent to the tank outlet 16) and the expansion chamber 22.

Operation of the apparatus 10 will now be described with reference to figures 3 to 7, a series of schematic sections through the apparatus 10 of figure 1, showing the operation cycle.

In figure 3, the faucet or tap (not shown) connected to the discharge pipe 40 has been opened, sends water up the discharge pipe 40 from the tank 12. As the water level 50 within the tank was at the same level as the tank outlet 16 at the end of the discharge pipe 40 was immersed in the water 42 within the tank 12 (figure 2), heated water (as regulated by the thermistors 21, 20) begins dispensing from the faucet almost immediately. This is in contrast to some of the prior art systems where the tank outlet 16 is above the water level 50 and discharge cannot happen until the water level 50 reaches the tank outlet 16.

The opening of the faucet or tap (not shown) causes mains water (indicated by arrow "A") to flow into the Venturi valve 24 via the supply pipe 30. The flow of water 42 through the Venturi valve 24 and into the tank 12 via the inlet pipe 34 creates a pressure drop within the Venturi valve 24 creating a suction into the Venturi valve 24 on the suction pipe 38. The suction pipe 38 is connected to the top of the expansion chamber 22, and the suction, applied by the Venturi valve 24 on the suction pipe 38, sucks water 42 into the pipe 38 (indicated by arrow "B") from the expansion chamber 22.

This water 42 enters the tank 12 through the tank inlet 14, pushing water 42 up the discharge pipe 40. The second thermistor 20 detects that the temperature of the water 42 has dropped in the bottom of the tank 12 will activate the heating element 18 to start heating the water 42.

Referring to figure 4, the continued flow of water 42 through the Venturi valve 24 has caused the water 42 within the expansion chamber 22 to be sucked up and out of the expansion chamber 22 by the suction force applied through the suction pipe 38. As the diaphragm 44 is sealed within the expansion chamber 22 by means of a diaphragm seal 52, the diaphragm 44 deforms under the suction force towards the suction pipe 38. An air vent 54 is provided in the expansion chamber 22 to allow air to flow in behind the deforming diaphragm 44 (as represented by arrow "X").

Figure 5 shows the expansion chamber 22 in a chamber empty position in which all the water 42 within the expansion chamber 22 has been sucked out of the expansion chamber 22 and into the tank 12. Continued drawing of water 42 from the discharge pipe 40 is replaced in the tank 12 by mains water flowing through the supply pipe 30.

In this position the diaphragm 44 is crumpled against an expansion chamber upper surface 58 but has not inverted from the cup shape shown in figure 1.

Referring now to figure 6, the tap or faucet (not shown) has been closed and the suction pressure has been relieved from the Venturi valve 24. The diaphragm 44 starts to recover, sucking water 42 up the inlet pipe 34 from the tank 12 as it does so. The air behind the diaphragm 44 is expelled from the expansion chamber 22 through the air inlet 54 (indicated by arrow "X"). The weight of water 42 on the diaphragm 44, as this is sucked into the expansion chamber 22, increases the rate of recovery of the diaphragm 44 and the water 42

is sucked out of the tank 12, causing the water level 50 within the tank 12 to drop.

Reference is now made to figure 7, the apparatus 10 has now returned to the ready position in which the expansion chamber 22 is full, the water level 50
5 has dropped within the tank 12 to allow expansion of the water 42 within the tank 12 as it heats.

Reference is now made to figure 8, a schematic section of part of an apparatus generally indicated by reference numeral 110 for dispensing hot water in accordance with a second embodiment of the present invention. This
10 apparatus 110 is largely similar to the apparatus 10 of figures 1 to 7 with the difference that the discharge pipe 140 includes a second heating element 160 to heat water as it leaves the tank 112. This allows for the main body of water 142 within the tank 112 to be kept at a lower temperature, thereby saving energy and cost. The discharge pipe 140 also includes a temperature monitoring device 162
15 for ensuring that the dispensed temperature is correct.

CLAIMS

1. An apparatus for dispensing hot water, the apparatus comprising:
 - a tank having a tank inlet and a tank outlet;
 - at least one heating element disposed inside or adjacent to the tank;
 - at least one thermistor for measuring the temperature of water within the tank;
 - an expansion chamber;
 - a Venturi valve comprising a Venturi entrance port in fluid communication with a cold water supply, a Venturi exit port in fluid communication with the tank inlet and a Venturi suction port in fluid communication with the expansion chamber; and
 - a discharge pipe connecting the tank outlet to a faucet or tap, wherein the discharge pipe includes a further heating element and a temperature monitoring device;
 - wherein the further heating element is operable to heat water as it leaves the tank outlet and the temperature monitoring device measures discharged water temperature; and
 - wherein at least a portion of the expansion chamber is disposed above the tank.
2. The apparatus of claim 1, wherein the Venturi valve is configured such that a flow of fluid from the Venturi entrance port to the Venturi exit port creates a suction pressure at the Venturi suction port, such that, in use, the suction pressure draws fluid through the Venturi suction port and into the flow of fluid flowing from the Venturi entrance port to the Venturi exit port.
3. The apparatus of claim 1 or 2, wherein the expansion chamber is wholly disposed above the tank.
4. The apparatus of any preceding claim, wherein the expansion chamber has an expansion chamber major axis and the tank has a tank major axis,

wherein the expansion chamber major axis is perpendicular to the tank major axis.

5. The apparatus of any preceding claim, wherein the expansion chamber is oriented in a horizontal plane.
6. The apparatus of any preceding claim, wherein the expansion chamber incorporates a diaphragm, the diaphragm being movable between a chamber full position in which the expansion chamber is substantially filled with water and a chamber empty position in which the water is substantially expelled from the chamber.
7. The apparatus of claim 6, wherein the diaphragm is biased to the chamber full position.
8. The apparatus of claim 6 or 7, wherein the diaphragm is configured such that gravity assists in moving the diaphragm from the chamber empty position to the chamber full position.
9. The apparatus of any of claims 6 to 8, wherein the apparatus is arranged such that in moving from the chamber empty position to the chamber full position, liquid from the tank is drawn into the expansion chamber through the Venturi valve.
10. The apparatus of any of claims 6 to 9, wherein the apparatus is arranged such that when the chamber is filled with water and the diaphragm is in the chamber full position, the diaphragm is between the liquid in the chamber and the liquid in the tank.
11. The apparatus of any preceding claim, wherein the Venturi suction port is in fluid communication with an expansion chamber exit port.
12. The apparatus of claim 11, wherein the expansion chamber exit port is located on a portion of the expansion chamber which is distal to the tank.

13. The apparatus of claim 11 or 12, wherein the expansion chamber exit port is located on an upper portion of the expansion chamber.
14. The apparatus of any one of claims 11 to 13, wherein the expansion chamber is located in a horizontal plane and the expansion chamber exit port is defined by the top of the expansion chamber.
15. The apparatus of any preceding claim, wherein the apparatus is arranged such that when there is a flow of fluid from the Venturi entrance port to the Venturi exit port, water is sucked from the top of the expansion chamber into the Venturi valve.
16. The apparatus of any of claims 6 to 10, wherein the apparatus is arranged such that in the chamber full position the diaphragm follows the contour defined by an internal surface of a portion of the expansion chamber.
17. The apparatus of any preceding claim, wherein the Venturi exit port is in fluid communication with the tank inlet by means of a tank inlet pipe.
18. The apparatus of any preceding claim, wherein the inlet pipe is arranged to discharge to the bottom of the tank.
19. The apparatus of any preceding claim, further comprising a plurality of thermostatically controlled heating elements.
20. The apparatus of any preceding claim, further comprising a first thermistor and a second thermistor, wherein the first thermistor is arranged to take a reading from an upper portion of the tank and the second thermistor is arranged to take a reading from a lower portion of the tank.