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(54) Fluid-containment vessel

(57) A fluid-containment vessel (10) for use with a hot water and central heating system comprises first and second chambers (12,22) separated by a plate-like partition (32). The first chamber (12) defines a fluid inlet (14) for permitting water to be stored to be received within the chamber (12) from a water source, and a separate fluid outlet (16) for permitting stored water to be delivered from the first chamber (12). The first chamber (12) also incorporates heater means (20) for heating water stored therein. The second chamber (22) defines a fluid inlet (26) for receiving heating water into said chamber (22) and a separate fluid outlet (28) for delivering heating water from the second chamber (22) to be circulated in a central heating system. A header region (29) is provided within the second chamber (22) for storing air surmounting the heating water, wherein the first chamber (12) is in fluid communication with the header region (29) by means of a fluid transmitting passageway (34) such that said header region (29) accommodates thermal expansion of the water stored in the first chamber (12) and the heating water within the second chamber (22).

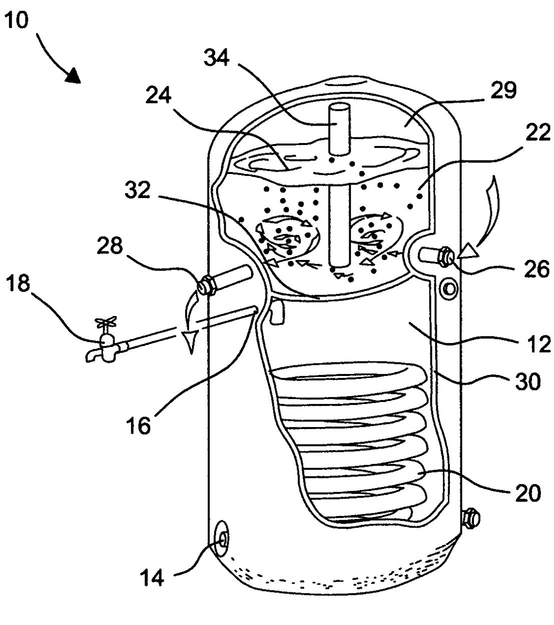


Fig 2.

EP 1 684 019 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an enclosed fluid-containment vessel for use with a hot water and central heating system, and in particular to a fluid-containment vessel incorporating means for accommodating fluid expansion.

BACKGROUND TO THE INVENTION

[0002] Numerous hot water and central heating systems currently exist. One common form comprises a boiler for heating water to be used in a space heating circuit including one or more radiators, conventionally termed the primary heating circuit or system, and an indirect hot water storage vessel within which water for domestic use may be stored, wherein the hot water system is conventionally termed the secondary heating system. The secondary water within the storage vessel may be indirectly heated from the primary central heating water which has been heated in the boiler and which flows through a coil within the vessel. Alternatively, or additionally, the secondary water may be heated by electrical heating means such as an immersion heater extending into the vessel.

[0003] Regulations exist which call for heating systems to incorporate measures for accommodating expansion of both the primary and secondary water during heating. Known measures include the use of individual expansion vessels integrated into the primary and secondary systems, or the use of individual atmospheric venting arrangements. Both arrangements, however, generally require the provision of additional components and pipework which require dedicated space which in conventional domestic environments may be limited.

[0004] Systems exists which seek to combine hot water storage and expansion arrangements into a single vessel. A known form of such a vessel is disclosed in EP-A-260989 and comprises an arrangement of chambers forming an indirect secondary hot water cylinder and expansion tank and a further chamber forming a primary heating system expansion tank, the further chamber being formed by the provision of two spaced disc-like partition walls welded to the interior of the vessel in an upper region thereof. When the primary and secondary systems are initially commissioned and filled with water, an air bubble becomes trapped in an upper portion of the chambers which accommodates for expansion of both the primary and secondary water.

[0005] A similar vessel arrangement is disclosed in International patent publication no. WO 91/08423, with the exception that the vessel comprises a single disc-like partition wall welded to the interior of the vessel to form two separate chambers, a first chamber defining an indirect secondary hot water cylinder and expansion tank, and a second chamber defining a primary heating system expansion tank. As in the vessel of EP-A-260989, expansion is accommodated by an air bubble trapped in an upper portion of the chambers.

[0006] As noted above, it is known to establish an air bubble within a cylinder to accommodate the expansion of water contained therein. Such cylinders may conventionally be termed "bubble top" hot water cylinders. In such bubble top cylinders it is essential that a sufficient air bubble is achieved and preserved for correct and safe operation such that adequate capability is maintained to accommodate expansion of the primary and secondary water when heated. However, the air bubble may be depleted by, for example, entrainment of air into the water outlet or by being dissolved in the water contained within the cylinder. The air bubble is also affected by temperature and pressure, as discussed in detail below. Many systems therefore require periodic manual rejuvenation of the air bubble which may involve drawing air into the vessel from atmosphere. This procedure, however, is time consuming and in many cases may be inadvertently overlooked such that the cylinder may be operating in a faulty or inadequate condition. In view of this, many bubble top cylinders are still supplied with a separate conventional expansion vessel or vessels.

[0007] In many cases, a bubble formed within a water cylinder will be pressurised by the water, whcrcin the pressure achieved will at least be equal to the static pressure of the water feeding the cylinder, which may be from a mains or a cistern supply. A pressurised air bubble will therefore act in combination with the inlet pressure of the water feeding the cylinder to force water stored therein towards a fluid outlet when a demand for the water is created, for example by turning on a hot water tap. It has therefore been assumed that increasing the pressure of the bubble and water inlet pressure results in a corresponding and directionally proportional increase in the pressure and thus flow rate of water flowing out of the cylinder, and in view of this bubble top cylinders exist which seek to create and maintain an air bubble at largely elevated pressures. This, however, has been shown to be an incorrect assumption as can be demonstrated by the results of tests performed by the British Board of Agrément (BBA). In this regard reference is made to Figure 1 of the drawings in which there is shown a graph, representing results of tests carried out by the BBA, of the flow rate of water out of a system cylinder against flow rate of water into the system cylinder, at various static supply pressures. In the case of a supply pressure of 1.5 bar with an entry flow rate of 25 litres/min, an outlet flow rate of 20 litres/min is achieved. If the supply pressure is doubled to 3.0 bar with the same entry flow rate, the outlet flow rate achieved is 22.5 litres/min. This therefore demonstrates that, in this case, a 100% increase in supply pressure results in only a slight increase in the outlet flow rate of 12.5%. In view of this, extensive efforts to achieve and preserve relatively high pressures within a water storage vessel may only provide a disproportionate and relatively small improvement in the flow rate of water from the vessel.

[0008] As previously noted, the air bubble within a water storage vessel will be affected by temperature and pressure. Specifically, it is common general knowledge that oxygen and nitrogen (principal constituents of air) are soluble in water and it is known that public water generally caries a specific quantity of air. It is common for a public water supply to have approximately 2.27 litres of air for every 113.65 litres of water (0.5 gallons of air for every 25 gallons of water). It is also common general knowledge that the level of solubility of air in water is dependent on temperature and pressure. That is, the concentration of air increases with rising pressure and falling temperature. Accordingly, in a bubble top cylinder, it is to be expected that an increase in the water temperature will result in air being released from the water which will then form part of the air bubble. However, as noted above, many bubble top cylinders seek to achieve and maintain relatively large pressures, such as 3.0 bar and above. These high pressures therefore act to cause air from the air bubble to become dissolved in the water. In view of this, seeking to maintain an air bubble at an elevated pressure may actually result in the air bubble being depleted, particularly when the water is in an unheated state. This may therefore require periodic manual rejuvenation of the air bubble, or the provision of conventional expansion vessels located outside the water storage vessel.

[0009] It is preferred in the art that primary water within a central heating system be circulated around the system by a pump. In view of this, it is favourable that the level of dissolved air within the primary water is minimised in order to assist smooth and quiet operation of the pump and also to minimise the possibility and occurrence of pump cavitation. Additionally, reducing the level of dissolved air within the primary water will assist to prevent or minimise the occurrence of airlocks within the central heating system which would adversely affect system efficiency and space heating capacity. It is known in the art to incorporate air eliminators or de-aerators into heating systems but this generally requires additional equipment necessitating the availability of dedicated space and increasing the overall cost of the system. In fact, in some territories, regulations are in place which require air eliminators to be provided.

[0010] Where primary heating systems are intended to be directly filled from a mains water supply, regulations are in place which call for the use of a temporary connection between the mains water supply and the primary system. This temporary connection therefore requires manual initial commissioning and filling of the primary system and further requires continual manual maintenance to ensure that the primary system contains an adequate volume of primary water for safe operation. This is time consuming and requires additional components and connections which will increase the overall cost.

[0011] An alternative to heating systems which operate on the principle of storing heated water is the combination or "combi" heating system. Such systems operate by heating water for space heating or domestic use on demand. All components for the system are generally contained within a single housing, including the boiler, central heating pump, valves, controller and the like. The single combi unit is installed in the desired location and coupled to a mains water source, central heating circuit and domestic hat water. However, as all components are contained within a single housing, the unit tends to be very large and heavy, especially when operating within a large heating circuit, which thus requires considerable dedicated accessible space, which in a domestic environment may be problematic.

[0012] It is an object of the present invention to obviate or at least mitigate the aforementioned and other problems by providing an improved fluid-containment vessel for use with a hot water and central heating system.

SUMMARY OF THE INVENTION

[0013] According to a first aspect of the present invention, there is provided a fluid-containment vessel for use with a hot water and central heating system, said vessel comprising:

> a first chamber with associated heater means for heating water stored therein, said first chamber defining a fluid inlet for permitting water to be stored to be received within the chamber from a water source, and a separate fluid outlet for permitting stored water to be delivered from the first chamber;
> a second chamber adjacent said first chamber and defining a fluid inlet for receiving heating water into the second chamber and a separate fluid outlet for delivering heating water from the second chamber to be circulated in a central heating system; and
> a header region within the second chamber for storing air surmounting the heating water, wherein the first chamber is in fluid communication with the header region by means of a fluid transmitting passageway such that said header region accommodates thermal expansion of the water stored in the first chamber and the heating water within the second chamber.

[0014] Advantageously, in use, the action of the heating water flowing through the second chamber between the fluid inlet and the fluid outlet releases dissolved air from the heating water and into the header region.

[0015] Conveniently, the header region has a volumetric capacity which is greater than that required to accommodate thermal expansion of the stored water in the first chamber and the heating water within the second chamber. Accordingly, this particular arrangement accommodates thermal expansion of the water in both chambers which may eliminate the requirement for separate expansion means such as expansion vessels or chambers.

[0016] For the avoidance of doubt, it should be understood that the header region in accommodating for thermal expansion of the heating water within the second chamber inherently accommodates thermal expansion of the heating water being circulated in the central heating system.

[0017] Advantageously, the first and second chambers are formed by the walls of the vessel on opposite sides of a disc-like partition secured to the vessel walls. Preferably, the disc-like partition is welded to the vessel walls, for example by laser welding. Advantageously, the partition may be corrugated to accommodate thermal expansion and contraction and to minimise stress imposed between the partition and the vessel.

[0018] Advantageously, the disc-like partition provides an additional heat transfer path between the heating water within the second chamber and stored water within the first chamber. This additional heat transfer capability supplements the heating of the stored water within the first chamber providing improved system efficiency.

[0019] Preferably, the fluid transmitting passageway extends between the first and second chambers through the disc-like partition. Alternatively, the fluid transmitting passageway may extend along the exterior of the vessel. More preferably, the first chamber is in fluid communication with the header region via a tube mounted on and projecting from the partition.

[0020] Preferably, the fluid transmitting passageway opens into the header region at a level which is above that attained by thermal expansion of the heating water. This arrangement therefore prevents heating water within the second chamber from flowing into the first chamber via the fluid transmitting passageway, while permitting water from the first chamber to flow into the second chamber via the fluid transmitting passageway. Accordingly, water received by the first chamber through the associated fluid inlet may flow into the second chamber and thus into the central heating system. This arrangement advantageously enables the central heating system to be filled and initially commissioned without the requirement for a separate filling source such as a cistern supply or a temporary connection with a mains supply.

[0021] In a preferred embodiment of the present invention, the second chamber comprises auto air vent means arranged to enable venting of both the first and second chambers to the exterior of the vessel when the level of the heating water within the second chamber is less than a preset level. Accordingly, when in use, water from the fluid source enters the first chamber via the associated fluid inlet, fills the first chamber, flows into the second chamber via the fluid transmitting passageway to fill the central heating system with heating water, wherein the auto air vent means permits air within the first and second chambers to be displaced therefrom to atmosphere. Upon the level of water within the second chamber reaching the preset level, the auto air vent means is closed preventing further air from being vented from the vessel such that residual air becomes trapped within the header region. Continued filling of the second chamber will therefore compress the trapped air within the header region until a pressure is achieved which is substantially equal to the pressure of the fluid entering the first chamber through the associated inlet, at which stage entry of water into the vessel will be terminated. Advantageously, the air within the header region, when pressurised, acts in combination with the pressure of water entering the first chamber through the associated fluid inlet to force stored water from the first chamber through the associated fluid outlet when a demand for the stored water from outside of the vessel is created. The demand may be created by, for example, turning on a water tap or the like.

[0022] When heating water passing through the second chamber is heated within the central heating system, thermal expansion will be accommodated by the header region resulting in further compression of the air contained therein. Additionally, when stored water within the first chamber is heated by the heater means, thermal expansion will cause a portion of the stored water to spill into the second chamber via the fluid transmitting passageway, increasing the level of water within the second chamber resulting in further compression of the air within the header region.

[0023] Preferably, the second chamber comprises pressure relief means adapted to permit water within the header region to be released from the vessel when the pressure of the air exceeds a pre-selected limit. Conveniently, the pressure relief means may permit expansion water to escape to waste in the event of malfunction by loss of air within the header region. The pressure relief means may comprise a pressure relief valve or the like. In one embodiment the pressure relief means may be adapted to provide relief when a pressure of, for example, 3.0 bar is achieved. Advantageously, the first chamber may comprise pressure relief means. Advantageously also, the first chamber may comprise temperature relief means such as a pressure/temperature relief valve. Conveniently, where both the first and second chambers comprise pressure relief means, a single tundish may be provided.

[0024] Conveniently, heating of the heating water and the stored water causes dissolved air from the water to be released into the header region. Accordingly, the action of heating the water within the vessel may assist to rejuvenate and preserve a sufficient level of air within the header region.

[0025] Advantageously, heating water entering the second chamber via the associated fluid inlet is circulated within the chamber prior to exiting the chamber via the associated fluid outlet. The action of the circulating heating fluid causes air dissolved therein to be released into the header region. This, in combination with air released from the heating water by heating, assists to maintain the air within the header region. This arrangement advantageously eliminates the requirement for periodic manual rejuvenation of the volume of air within the header region.

[0026] Conveniently, circulation of the heating fluid may be caused by the action of the heating fluid entering and exiting the second chamber via the associated respective fluid inlet and outlet. Alternatively, or additionally, the heating water may be circulated within the second chamber by circulating means such as turbulation, an agitator or stirrer or the like.

[0027] Beneficially, permitting heating water to flow through the second chamber prevents stagnation of water such that the possibility of bacterial growth within the chamber is minimised.

[0028] In a preferred embodiment of the present invention, the air within the header region is adapted to be maintained at a pressure of around 1.5 bar. At this pressure the header region will occupy approximately 40% of the volume of the vessel with the remaining volume accordingly being occupied by water. It has been discovered by experiment by the British Board of Agrément (BBA) that at a pressure of 1.5 bar and a temperature of 50°C, a state of equilibrium is achieved between air which can be released from water and air which can be held in solution. Beneficially, the vessel of the present invention may be adapted to contain water at a temperature of approximately 50/60°C with an air pressure within the header region of approximately 1.5 bar. Consequently, continual release of air from heated water within the vessel will be achieved which will assist to maintain an appropriate volume of air within the header region.

[0029] Advantageously, the water source may be a mains water supply or alternatively may be a cistern supply. Where a cistern supply is provided, the first chamber may comprise an atmospheric vent to further accommodate thermal expansion of the stored water within the first chamber.

[0030] Preferably, water is permitted to flow from the water source into the first chamber via the associated fluid inlet at a pre-selected pressure. The pre-selected pressure may be achieved by use of pressure regulating means such as a pressure regulating valve or the like. Alternatively, or additionally, the pre-selected pressure may be achieved by locating the water source at an elevated location relative to the vessel in order to create a static head. Such an arrangement may be utilised where the water source is a cistern supply. Advantageously, the pre-selected pressure of the fluid inlet of the first chamber assists to establish the pressure level of air within the header region when both the stored water and heating water in the chambers arc in an unexpanded or unheated state.

[0031] Advantageously, the fluid inlet of the first chamber may comprise means for preventing the backflow of fluid from the first chamber therethrough towards the water source, which may occur in situations where the pressure of the air within the header region exceeds the pre-selected fluid inlet pressure of the first chamber and of the water supply. Such means may be a valve such as a non-return valve or the like.

[0032] Preferably, the heater means associated with the first chamber comprises a coil through which heating water may flow. The coil may spiral around an axis which is substantially parallel to a central longitudinal axis of the vessel. Alternatively, the coil may spiral around an axis which is substantially perpendicular to a central longitudinal axis of the vessel. The stored water within the first chamber may be indirectly heated by heating water which itself has been heated by the central healing system. Advantageously, the heater means may additionally, or alternatively, comprise electrical heater means such as an immersion heater or the like.

[0033] The heater means associated with the first chamber is preferably located within the first chamber. Alternatively, the heater means may be positioned separately of the first chamber, with water stored within the first chamber being circulated from the first chamber towards the heater means.

[0034] Beneficially, the central heating system comprises a heating unit adapted to heat the heating water, and at least one space heating means such as a radiator for receiving heating water which has been heated by the heating unit. In a preferred embodiment of the present invention, the heating unit is located upstream of the vessel so as to heat the heating water prior to entering the second chamber through the associated fluid inlet. The heating unit may comprise a boiler, such as a condenser type boiler commonly used in the art. Advantageously, the boiler is adapted to deliver heating water to be circulated around the central heating system at a flow temperature of approximately 60°C, and receive heating water which has been circulated around the central heating at a return temperature of around 40°C. This arrangement advantageously provides a mean operating temperature of 50°C which assists to allow the boiler to operate in a consistent condensing mode, providing efficiency benefits. Furthermore, by maintaining the heating water within this temperature range, the stored water is ultimately heated to a suitable temperature for domestic applications and which minimises the risk of scalding, which is known to occur at around 43°C.

[0035] In an alternative embodiment the heating unit may comprise a heat pump. Heat pumps operate essentially in a reverse refrigeration cycle to produce a heat output from a lower temperature heat source. In the present invention the heat source may be air, or in a more preferred arrangement a ground heat source may be used.

[0036] Alternatively further, the heating unit may comprise electrical heating means, or may comprise a renewable heating source such as solar or geothermal heat sources.

[0037] Advantageously, the central heating system further comprises pump means for circulating heating water. Preferably, the pump means comprises a pump located downstream of the second chamber so as to act to pull heating fluid from the second chamber through the associated fluid outlet and subsequently circulate the heating fluid around the central heating system.

[0038] Conveniently, the central heating system further comprises valve means adapted to selectively deliver heating fluid to specified portions or zones of the central heating system. Advantageously, the valve means may comprise a first zone valve for selectively permitting heating water to be circulated through at least one radiator positioned within a first zone of the central heating system, and at least one further zone valve for selectively permitting heating water to be circulated through at least one radiator positioned within at least one further zone of the central heating system. This arrangement assists to maximise the efficiency of the central heating system by permitting only selected zones to become heated by the heating water in accordance with the preference of a user. Preferably, the central heating system further comprises valve means for selectively permitting heating fluid to be delivered to the heater means within the first chamber.

[0039] The central heating valve means may be electronically controlled motorised valves or the like. Conveniently, the valve means may be located on or within close proximity to the vessel.

[0040] Preferably also, the central heating system further comprises by-pass valve means for use in permitting the heating water to be returned to the heating unit while by-passing the space heating means of the central heating system and the heater means within the first chamber. Preferably, the by-pass means comprises an automatic by-pass valve which opens automatically, to permit free circulation of the heating water while the central heating valves are closed.

[0041] Conveniently, the heating water to be circulated within a central heating system and through the second chamber may be termed the primary water. Additionally, the stored water within the first chamber may be termed the secondary water, wherein the secondary water is advantageously for use as a domestic hot water supply.

[0042] Preferably, the fluid inlet of the first chamber is located in a lower portion of the chamber, and the fluid outlet is located within an upper portion of the first chamber. Advantageously, the fluid outlet comprises a tubular member in the form of a dip-pipe of predetermined length, directed downwardly towards the bottom of the first chamber. This arrangement advantageously prevents air from the header region escaping through the fluid outlet of the first chamber when stored water is initially drawn through the associated fluid outlet and before the fluid inlet to the first chamber can react to once again fill the chamber. This arrangement of the fluid outlet of the first chamber assists to meet the dynamic effect of severe down-feed discharge at the fluid outlet of the first chamber. For example, down-feed discharge may occur if the vessel is positioned in an elevated location, such as a roof space, and the outlet such as a tap is situated substantially below the first chamber.

[0043] Advantageously, the various fluid inlets and outlets and other required ports which extend through the walls of the vessel are positioned within a common segment area of the vessel such that access for installation, commissioning and maintenance is readily achieved.

[0044] Preferably, all electrical connections and components associated with the vessel and the hot water and central heating system are positioned at a location on the vessel removed from the various fluid ports in order to prevent or minimise exposure of the electrical components to water which may leak from the vessel and associated pipework and the like. The electrical components may comprise a central heating system controller, thermostats, immersion heaters and the like. In one embodiment, a heating controller may be located remotely from the vessel and in communication with a central control unit mounted on or adjacent the vessel. The heating controller may be in communication via wires, or alternatively my be in communication via radio frequency or other suitable wireless connection.

[0045] In a preferred embodiment of the present invention, the vessel is manufactured from stainless steel. Alternatively, the vessel may be manufactured from copper or other metal or metal alloy. Alternatively further, the vessel may be manufactured from a plastic or a composite material or the like. Advantageously, the vessel may comprise an inner body and an outer body with a suitable insulating material provided therebetween.

[0046] According to a second aspect of the present invention there is provided a central heating and hot water system comprising:

a heating unit for heating central heating water;
at least one space heating means for receiving central heating water from the boiler; and
a fluid containment vessel comprising:

a first chamber with associated heater means for heating water stored therein to provide domestic hot water, said first chamber defining a fluid inlet for permitting water to be stored to be received within the chamber from a water source, and a separate fluid outlet for permitting stored water to be delivered from the first chamber;
a second chamber adjacent said first chamber and defining a fluid inlet for receiving the central heating water into the second chamber and a separate fluid outlet for delivering the central heating water from the second chamber to be circulated in the at least one space heating means; and
a header region within the second chamber for storing air surmounting the central heating water, wherein the first chamber is in fluid communication with the header region by means of a fluid transmitting passageway such that said header region accommodates thermal expansion of the water stored in the first chamber and the heating water within the second chamber.

[0047] Advantageously, in use, the action of the central heating water flowing through the second chamber between the fluid inlet and the fluid outlet releases dissolved air from the heating water and into the header region.

[0048] The heating unit may comprise a boiler, such as a condensing boiler. In an alternative embodiment the heating unit may comprise a heat pump. Heat pumps operate essentially in a reverse refrigeration cycle to produce a heat output from a lower temperature heat source. In the present invention the heat source may be air, or in a more preferred arrangement a ground heat source may be used.

[0049] Alternatively further, the heating unit may comprise electrical heating means, or may comprise a renewable heating source such as solar or geothermal heat sources.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] These and other aspects of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a graph, representing results of tests carried out by the BBA, of the flow rate of water out of a system cylinder against flow rate of water into the system cylinder, at various static supply pressures;

Figure 2 is a part cut-away view of a fluid-containment vessel in accordance with an embodiment of the present invention;

Figure 3 is a part cut-away view of an upper portion of the fluid-containment vessel of Figure 2;

Figure 4 is a part cut-away view of the fluid-containment vessel of Figure 2 shown being fed from a cistern supply;

Figure 5 is a part cut-away view of the fluid-containment vessel of Figure 2 shown being fed from a mains supply;

Figures 6A to 6F are diagrammatic cross-sectional views of an upper portion of the fluid-containment vessel of Figure 2, shown in various stages of operation;

Figure 7 is a diagrammatic representation of a fluid containment vessel in accordance with an alternative embodiment of the present invention;

Figure 8 is a diagrammatic representation of a hot water and central heating system in accordance with an embodiment of an aspect of the present invention, incorporating the fluid-containment vessel shown in Figure 7; and

Figure 9 is a diagrammatic representation of a hot water and central heating system shown located within a house.

DETAILED DESCRIPTION OF THE DRAWINGS

[0051] Reference is first made to Figure 2 of the drawings in which there is shown a part cutaway view of a fluid-containment vessel, generally indicated with reference numeral 10, for use with a hot water and central heating system. The vessel 10 is manufactured from stainless steel and comprises a first chamber 12 for storing and heating domestic hot water, wherein the chamber 12 includes a fluid inlet 14 for supplying water from a fluid source (not shown) and a fluid outlet 16 for delivering water from the chamber 12 when a demand is created, for example by turning on a tap 18. The chamber 12 includes heater means in the form of a coil 20 through which heated water from a central heating system flows to indirectly heat water stored within the first chamber 12. The coil in the embodiment shown spirals or winds generally in a horizontal plane. However, in alternative embodiments a coil may be utilised which winds in a generally vertical plane. The vessel 10 further comprises a second chamber 22 through which central heating water 24 flows via a fluid inlet 26 and a fluid outlet 28. The chamber 22 is supplied with the central heating water 24 directly from a heating source (not shown), such as a boiler, via the fluid inlet 26, and the central heating fluid 24 is drawn from the chamber 22 via the fluid outlet by action of a central heating pump (not shown), wherein the central heating water 24 is then circulated around a central heating circuit comprising radiators, for example. Furthermore, arrangements are made to permit central heating water 24 from the second chamber 22 to flow through the coil 20 to indirectly heat the water stored in the first chamber 12.

[0052] The first and second chambers are defined by the walls 30 of the vessel 10 and a disc-like partition 32 which is welded to the walls 30. Secured to the partition 32 is a tube 34 extending upwards therefrom and terminating within a header region 29 provided within the second chamber 22, wherein the header region 29 stores air surmounting the central heating fluid 24. The tube 34 provides a fluid transmitting passageway between the first chamber 12 and the header region 29. In use, the air within the header region 29 accommodates for thermal expansion of both the water stored within the first chamber 12 and the central heating water 24, as will be described in detail below.

[0053] Reference is now additionally made to Figure 3 in which there is shown a part cut-away view of an upper portion of the vessel 10 of Figure 2. As central heating water 24 from the boiler (not shown) passes through the chamber 22 via the fluid inlet 26 and outlet 28, the water 24 is caused to circulate which results in air dissolved within the water 24 from being released into the header region. Removal of dissolved air from the central heating water is advantageous in that it assists to permit the central heating pump (not shown) to operate smoothly and quietly, and also assists to prevent the creation of airlocks within the central heating system. It is known in the art that the process of heating water will also cause or induce the release of dissolved air. Accordingly, air released from the central heating water 24 by the circulating motion and by heating, and also air released from the stored water within the first chamber 12 upon heating will assist to rejuvenate and maintain the level of air within the header region 29, and as such ensure that the header region 29 will continue to safely accommodate thermal expansion of the water in both chambers 12, 22.

[0054] Referring still to Figure 3 it should be noted that the disc-like partition 32 provides an additional heat transfer path between the central heating water 24 and the water stored within the first chamber 12. This additional heat transfer capability supplements the heating of the water within the first chamber 12 by the coil 20 and thus provides improved efficiency.

[0055] Reference is now made to Figure 4 in which the vessel 10 of Figure 2 is shown being supplied by a cistern 36 containing cold water. Water from the cistern 36 is supplied to the fluid inlet 14 of the first chamber 12 via supply pipe 38. A non-return valve 40 is provided which in use prevents the backflow of water from within the chamber 12 towards the cistern 36. Backflow may be caused by elevated pressures within the vessel forcing water back through the fluid inlet 14. A hot water expansion vent 42 is provided which extends between the first chamber 12 of the vessel and towards the cistern 36. Accordingly, the vessel 10 may be utilised as a vented hot water cylinder.

[0056] Referring now to Figure 5, the vessel 10 of Figure 1 is shown being supplied by a pressurised mains supply 44. A pressure reducing valve 46 is provided in order to reduce the pressure of water at the inlet 14 to a suitable level. A non-return valve 48 is also provided in order to prevent backflow of water from within the chamber 12 back through the fluid inlet 14 towards the mains supply 44. Additionally, a verifiable double check valve (not shown) is also provided and is located on the inlet side of the pressure reducing valve 46.

[0057] Referring still to Figure 5, the vessel 10 comprises a pressure relief valve 50 extending into the second chamber 22, wherein the pressure relief valve 50 is adapted to permit water 24 to be released from the chamber 22 when a preset chamber pressure is reached. The pressure relief valve 50 is provided as a safety measure to accommodate expansion of the water in conditions where the header region 29 may not be capable of accommodating thermal expansion due to a reduction or loss of air, for example. Water released by the pressure relief valve 50 is flowed to an external disposal location via a tundish 52. It should be noted that the pressure relief valve 50 is not shown in Figures 2. 3 and 4 for the purposes of clarity.

[0058] Still referring to Figure 5, the vessel 10 in the arrangement shown comprises a pressure and temperature relief valve 54 extending into the first chamber 12, wherein valve 54 is adapted to permit water stored within the chamber 12 to be released when a preset chamber temperature or pressure is reached. Thus, the valve 54 is a safety measure to accommodate expansion and excessive rise in temperature of the water within the chamber 12 in conditions where the header region 29 may not be capable of sufficiently accommodating thermal expansion, or rise in temperature. Water released by valve 54 is flowed to an external location via the tundish 52. It should be noted that the pressure and temperature relief valve 54 replaces the hot water expansion vent 42 of Figure 4. Accordingly, the vessel may be utilised as an unvented hot water cylinder.

[0059] Stages of operation of the vessel 10 originally shown in Figure 2 will now be described with reference to Figures 6A to 6F. Referring initially to Figure 6A the vessel 10 is shown during initial filling of both chambers 12, 22 and a central heating system 60. The second chamber 22 comprises an auto air vent 62 which permits venting of air from both the chambers 12, 22 to the exterior of the vessel 10 when the level of heating water within the second chamber 22 is less than a preset level 64. It should be noted that the air vent is not shown in Figures 2 to 5 for the purposes of clarity. Thus, in use, water enters the first chamber 12 via the associated fluid inlet 14 (Figure 2), tills the first chamber 12, flows into the second chamber 22 via tube 34 to fill the central heating system 60 with heating water, wherein the auto air vent 62 permits air from the vessel 10 to be released into the atmosphere. Thus, the central heating system may be directly filled without the requirement for a separate water source or temporary mains connection. Upon the level of water within the second chamber 22 reaching the preset level 64, as shown in Figure 6A, the auto air vent 62 is closed preventing further air from being vented from the vessel 10 such that residual air becomes trapped within the header region 29. At this stage the pressure of the air is equal to atmospheric air pressure at sea level.

[0060] As shown in Figure 6B, continued filling of the second chamber 22 by water spilling over the top of the tube 34 from the first chamber 12 compresses the trapped air within the header region 29 until a pressure is achieved which is substantially equal to the pressure of the water entering the first chamber 12, at which stage entry of water into the vessel 10 will be terminated. In view of this, the inlet pressure of the first chamber may be preset to establish the required air pressure within the header region 29. In Figure 6B the air is compressed to 40% of the original volume shown in Figure 6A which provides a pressure of approximately 1.5 bar. It should be noted that the water contained within the central heating system 60 and the second chamber 22 is termed the primary water, and the water contained within the first chamber 12 is termed the secondary water.

[0061] When the primary water is heated within the central heating system, thermal expansion will be accommodated by the header region 29, as shown in Figure 6C in which the air/water interface level 66 has risen, thus causing the air within header region 29 to be further compressed. Additionally, when the secondary water within the first chamber 12 is heated, thermal expansion will cause a portion of the secondary water to spill into the second chamber 22 via tube 34. It should be noted that the upper end of the tube 34 is positioned so as to be located above the level 66 which may be attained by thermal expansion of the primary water in order to prevent the relatively impure primary water from mixing with the relatively pure secondary water. The air within the header region 29 is compressed until an optimum pressure commensurate with the volume of the system is attained. The expansion relief valve 50 (Figure 5) in the embodiment shown is preset to open at 3.0 bar, and the vessel 10 is designed so that this does not open to discharge water to waste, except in an emergency. When a pressure of 3.0 bar is achieved, as shown in Figure 6C, the air will be compressed to 25% of the original volume represented in Figure 6A.

[0062] Reference is now made to Figure 6D in which both the primary and secondary water is heated and as such is shown in an expanded state, wherein the air within the header region 29 is approximately 30% of the original air volume (Figure 6A), which provides a pressure of around 2.5 bar. This situation may occur when the central heating and hot water system are in operation and secondary water has not been drawn from the first chamber 12 via the fluid outlet 16 for an extended period of time. Referring to Figure 6E, when a demand for secondary fluid is created, for example by turning on a tap, the initial action of water flowing from the chamber 12 through the outlet 16 causes a portion of the pressurised air to be pushed into the first chamber 12 through the tube 34. This will occur until the pressure is reduced to a level which would permit fluid to again flow into the first chamber via the associated fluid inlet 14 (Figure 2). In order to assist to prevent any air from escaping from the vessel 10 the fluid outlet 16 comprises a downwardly facing tubular member 17.

[0063] Once the demand for secondary fluid is terminated, the vessel will again be filled to the required level, as shown in Figure 6F. It should be noted that the second chamber 22 is designed to accommodate the initial decompression of the air, so that the primary water in the second chamber 22 does not spill over the top of tube 34 into the secondary stored water. Normal opening of a tap, throughout the day, optimises the air/water interface.

[0064] Reference is now made to Figure 7 in which there is shown a diagrammatic representation of a fluid-containment vessel 110 in accordance with an alternative embodiment of the present invention. The vessel 110 is similar to that shown in Figures 2 to 6 and as such like features will be identified with like reference numerals, incremented by 100.

[0065] The vessel 110 comprises a first chamber 112 for storing and heating domestic hot water, wherein the chamber 112 includes a fluid inlet 114 for supplying water from a mains water supply 144 via a pressure regulating valve 146 and a non-return valve 148, and a fluid outlet 116 for delivering water from the chamber 112 when a demand is created, for example by turning on a tap 118. A verifiable double check valve (not shown) is also provided and is located on the inlet side of the pressure regulating valve 146. The chamber 112 includes heater means in the form of a coil (not shown) through which coil heated water from a central heating system flows to indirectly heat water stored within the first chamber 112. Heated water enters the coil at inlet 170 and exits coil at outlet 172. The vessel 110 also comprises electrical heating means in the form of an immersion heater 171. A thermostat 173 is provided to ensure that the temperature of stored water within chamber 112 is maintained at a set level selected by a hot water and central heating system control panel 175 electrically coupled to the components of the vessel by way of a wiring box 177. The control panel 175 may be connected to the wiring box via an electrical conductor such as wire, or alternatively may be wirelessly connected, for example via radio frequency communications. It should be understood that in embodiments of the present invention the vessel 110 may be used in a central heating system in which all electrical components and control devices are in wireless communication either with each other or with a central control unit.

[0066] The vessel 110 further comprises a second chamber 122 through which central heating water flows via a fluid inlet 126 and a fluid outlet 128. The chamber 122 is supplied with the central heating water directly from a heating unit (not shown), such as a boiler, via pipe 174 and the fluid inlet 126, and the central heating fluid is drawn from the chamber 122 via the fluid outlet 128 by action of a central heating pump 176. The central heating water is then circulated around a central heating circuit and/or through the heater coil via inlet 170 and outlet 172, wherein central heating water from the outlet 172 may be returned to the heating unit via pipe 188. A themiostat 179 is provided to assist to ensure that the temperature of the water within the second chamber 122 is maintained at a preferred level determined by control panel 175. The thermostat 179 comprises a non-resetable high limit thermostat, preset so that in the event of an overheat of the water in the second chamber 122, the whole system, including the boiler, is shut down and requires to be manually reset. Two motorised valves 178, 180 are provided for selectively permitting central heating water driven by the pump 176 to be circulated around a number of radiators (not shown) located within respective zones of the central heating system, wherein the central heating water is provided to the radiators via pipes 182, 184 and returned to be reheated by the boiler via pipes 186, 188. This arrangement assists to maximise the efficiency of the central heating system by permitting only selected zones to become heated by the central heating water in accordance with the preference of a user. A further motorised valve 190 is provided for selectively permitting central heating water to be flowed through the heater coil within the first chamber 112.

[0067] A by-pass valve 192 is also provided which may be opened to permit central heating fluid to be returned to the boiler via pipe 194 and pipe 188 so as to by-pass the radiators and heater coil within the first chamber 112.

The by-pass valve 192 is an automatic by-pass valve which opens automatically, to permit free circulation of the pumped system, in the event that valves 178, 180 and 190 are in a closed position.

[0068] An auto air vent 162 is provided which is in communication with the second chamber 122 and in use permits air to be vented from the vessel 110 when the water within the second chamber 122 is below a set level. The function of the auto air vent 162 is the same as that shown and described in Figure 6A and as such no further description will be given. It should be noted that the auto air vent 162 also serves as a drain outlet for the maintenance of the second chamber 122.

[0069] Referring still to Figure 7, the vessel 110 comprises a pressure relief valve 150 in communication with the second chamber 122, wherein the valve 150 is adapted to permit water to be released from the chamber 122 when a preset chamber pressure is reached. Water released by the pressure relief valve 150 is flowed to an external disposal location through disposal pipe 196 via a tundish 152. A pressure and temperature relief valve 154 is also provided and is in communication with the first chamber 112, wherein the valve 154 is adapted to permit water stored within the first chamber 112 to be released when a preset temperature or pressure is reached. Water released by valve 154 is also disposed through pipe 196 via the tundish 152.

[0070] It should be noted that the various inlets and outlets and other ports extending through the walls of the vessel 110 are positioned within a common segment 200 of the vessel such that access for installation, commissioning and maintenance is readily achieved. Additionally, it should be noted that all electrical components and connections are positioned at a location removed from the various fluid ports in order to prevent or minimise exposure of the electrical components to water which may leak from the vessel and associated pipework and the like.

[0071] Reference is now made to Figure 8 in which the vessel 110 of Figure 8 is shown as part of a hot water and central heating system 202. In use, water heated by a boiler 204 is circulated by the pump 176 via pipe 206 into the second chamber 122 by way of inlet 126 and subsequently through outlet 128. Valves 178, 180 and 190 are controlled by the system controller 175 in order to operate the hot water and central heating system 202 in the required manner. Valve 178 selectively permits the heated water to be circulated around radiators 208, 210 in a first central heating zone via feed pipe 182, and valve 180 selectively permits the heated water to circulate around radiators 212, 214 in a second central heating zone via feed pipe 184. Valve 190 selectively permits heated water from the second chamber 122 to flow through the heating coil (not shown) located within the first chamber 112 in order to heat water stored therein. Stored water within the first chamber may alternatively or additionally be heated by immersion heater 171. Stored heated water within the first chamber 112 may be discharged via outlet 116 towards a domestic hot water outlet such as a tap 118. Water which has circulated around the radiators 208, 210, 212, 214 and/or the heating coil is then returned to the boiler 204 via return pipes 186, 188.

[0072] It should be understood that the vessel 110 shown in Figure 8 may be used in combination with any suitable heating unit and as such the boiler 204 may be replaced with, or used in addition to, a heat pump, for example. The heat pump may utilise ground source heat as a heat source, or alternatively/additionally may use ambient air.

[0073] Reference is now made to Figure 9 in which the vessel 110, or "system cylinder", is positioned within a roof-space 250 of a house 252. In this arrangement the cylinder 110 is provided in combination with a condensing boiler 254 positioned adjacent the cylinder 110, thus forming a modular roof-space unit 256. As shown, the flu discharge 258 of the boiler 254 passes directly through the roof 260 of the house 252. Sitting the cylinder 110 in this location is advantageous insofar as the operating pressure of 1.5 bar is supplemented by the vertical head to a discharge tap positioned below the cylinder 110.

[0074] It should be understood that the embodiments described are merely exemplary of the present invention and various modifications may be made thereto without departing from the scope of the invention.

Claims

1. A fluid-containment vessel for use with a hot water and central heating system, said vessel comprising:

    a first chamber with associated heater means for heating water stored therein, said first chamber defining a fluid inlet for permitting water to be stored to be received within the chamber from a water source, and a separate fluid outlet for permitting stored water to be delivered from the first chamber;
    a second chamber adjacent said first chamber and defining a fluid inlet for receiving heating water into the second chamber and a separate fluid outlet for delivering heating water from the second chamber to be circulated in a central heating system; and
    a header region within the second chamber for storing air surmounting the heating water, wherein the first chamber is in fluid communication with the header region by means of a fluid transmitting passageway such that said header region accommodates thermal expansion of the water stored in the first chamber and the heating water within the second chamber.

2. The vessel of claim 1, wherein the first and second chambers are formed by the walls of the vessel on

opposite sides of a disc-like partition secured to the vessel walls.

3. The vessel of claim 2, wherein the fluid transmitting passageway extends between the first and second chambers through the disc-like partition.

4. The vessel of claim 2 or 3, wherein the first chamber is in fluid communication with the header region via a tube mounted on and projecting from the partition.

5. The vessel of any preceding claim, wherein the fluid transmitting passageway opens into the header region at a level which is above that attained by thermal expansion of the heating water.

6. The vessel of any preceding claim, wherein water received by the first chamber through the associated fluid inlet is adapted to flow into the second chamber and thus into the central heating system.

7. The vessel of any preceding claim, wherein the second chamber comprises auto air vent means arranged to enable venting of both the first and second chambers to the exterior of the vessel when the level of the heating water within the second chamber is less than a preset level.

8. The vessel of claim 7, wherein, in use, water from the fluid source enters the first chamber via the associated fluid inlet, fills the first chamber, flows into the second chamber via the fluid transmitting passageway to fill the central heating system with heating water, wherein the auto air vent means permits air within the first and second chambers to be displaced therefrom to atmosphere.

9. The vessel of claim 8, wherein, in use, upon the level of water within the second chamber reaching the preset level, the auto air vent means is closed preventing further air from being vented from the vessel such that residual air becomes trapped within the header region, and continued filling of the second chamber will compress the trapped air within the header region.

10. The vessel of any preceding claim, wherein the second chamber comprises pressure relief means adapted to permit water within the header region to be released from the vessel when the pressure of the air exceeds a pre-selected limit.

11. The vessel of claim 10, wherein the pressure relief means comprises a pressure relief valve.

12. The vessel of claim 10 or 11, wherein the pressure relief means is adapted to provide relief when a pressure of 3.0 bar is achieved.

13. The vessel of any preceding claim, wherein the first chamber comprises pressure relief means.

14. The vessel of any preceding claim, wherein the first chamber comprises temperature relief means.

15. The vessel of any preceding claim, wherein heating water entering the second chamber via the associated fluid inlet is circulated within the chamber prior to exiting the chamber via the associated fluid outlet.

16. The vessel of claim 15, wherein circulation of the heating fluid is caused by the action of the heating fluid entering and exiting the second chamber via the associated respective fluid inlet and outlet.

17. The vessel of claim 15 or 16, wherein the heating water is circulated within the second chamber by circulating means.

18. The vessel of any preceding claim, wherein the air within the header region is adapted to be maintained at a pressure of around 1.5 bar.

19. The vessel of any preceding claim, wherein the water source is a mains water supply.

20. The vessel of any one of claims 1 to 18, wherein the water source is a cistern supply.

21. The vessel of any preceding claim, wherein water is permitted to flow from the water source into the first chamber via the associated fluid inlet at a pre-selected pressure.

22. The vessel of any preceding claim, wherien the fluid inlet of the first chamber comprises means for preventing the backflow of fluid from the first chamber therethrough towards the water source.

23. The vessel of any preceding claim, wherein the heater means associated with the first chamber comprises a coil through which heating water may flow.

24. The vessel of any preceding claim, wherein the heater means comprises electrical heater means.

25. The vessel of any preceding claim adapted for use in a central heating system comprising a heating unit adapted to heat the heating water, and at least one space heating means such as a radiator for receiving heating water which has been heated by the heating unit.

26. The vessel of claim 25, wherein the heating unit is located upstream of the vessel so as to heat the heating water prior to entering the second chamber through the associated fluid inlet.

27. The vessel of claim 25 or 26, wherein the heating unit comprises a boiler.

28. The vessel of claim 25 or 26, wherein the heating unit comprises a heat pump.

29. The vessel of any one of claims 25 to 28, wherein the central heating system further comprises pump means for circulating heating water.

30. The vessel of claim 29, wherein the pump means comprises a pump located downstream of the second chamber so as to act to pull heating fluid from the second chamber through the associated fluid outlet and subsequently circulate the heating fluid around the central heating system.

31. The vessel of any one of claims 25 to 30, wherein the central heating system further comprises valve means adapted to selectively deliver heating fluid to specified portions or zones of the central heating system.

32. The vessel of any one of claims 25 to 31, wherein the central heating system further comprises bypass valve means for use in permitting the heating water to be returned to the heating unit while bypassing the space heating means of the central heating system and the heater means within the first chamber.

33. The vessel of any preceding claim, wherein the fluid inlet of the first chamber is located in a lower portion of the chamber, and the fluid outlet is located within an upper portion of the first chamber.

34. The vessel of any preceding claim, wherein the fluid outlet of the first chamber comprises a tubular member in the form of a dip-pipe of predetermined length, directed downwardly towards the bottom of the first chamber.

35. The vessel of any preceding claim, wherein the fluid inlets and outlets are positioned within a common segment area of the vessel.

36. The vessel of any preceding claim, wherein said vessel is manufactured from stainless steel.

37. A central heating and hot water system comprising:

a heating unit for heating central heating water;
at least one space heating means for receiving central heating water from the boiler; and
a fluid containment vessel comprising:

a first chamber with associated heater means for heating water stored therein to provide domestic hot water, said first chamber defining a fluid inlet for permitting water to be stored to be received within the chamber from a water source, and a separate fluid outlet for permitting stored water to be delivered from the first chamber;
a second chamber adjacent said first chamber and defining a fluid inlet for receiving the central heating water into the second chamber and a separate fluid outlet for delivering the central heating water from the second chamber to be circulated in the at least one space heating means; and
a header region within the second chamber for storing air surmounting the central heating water, wherein the first chamber is in fluid communication with the header region by means of a fluid transmitting passageway such that said header region accommodates thermal expansion of the water stored in the first chamber and the heating water within the second chamber.

38. The system of claim 37, wherein the heating unit comprises a boiler.

39. The system of claim 38, wherein the boiler is a condensing boiler.

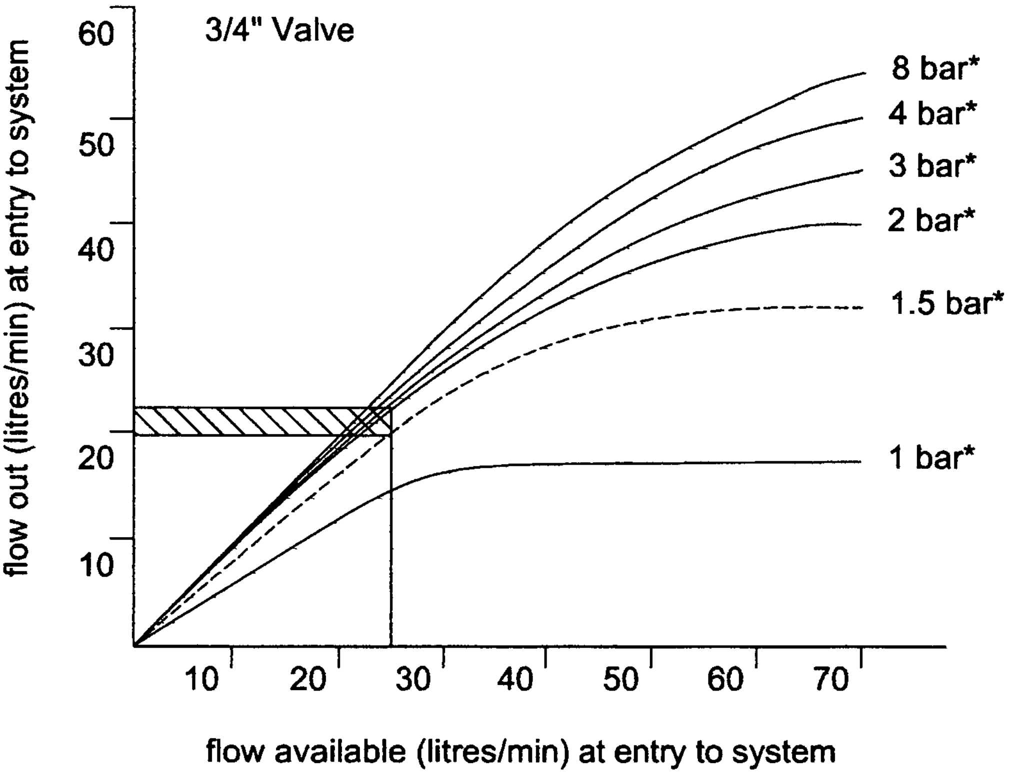
40. The system of claim 37, wherein heating unit comprises a heat pump.

41. The system of claim 40, wherein the heat pump is a ground source heat pump.

42. The system of claim 40 or 41, wherein the heat pump is an air source heat pump.

Notes:
(1) Flow rates shown apply to situations where the supply is capable of supplying an adequate dynamic pressure.

(2) The graph represents the results of tests carried out by the BBA.



* Static supply pressures of incoming water supply

Fig 1.

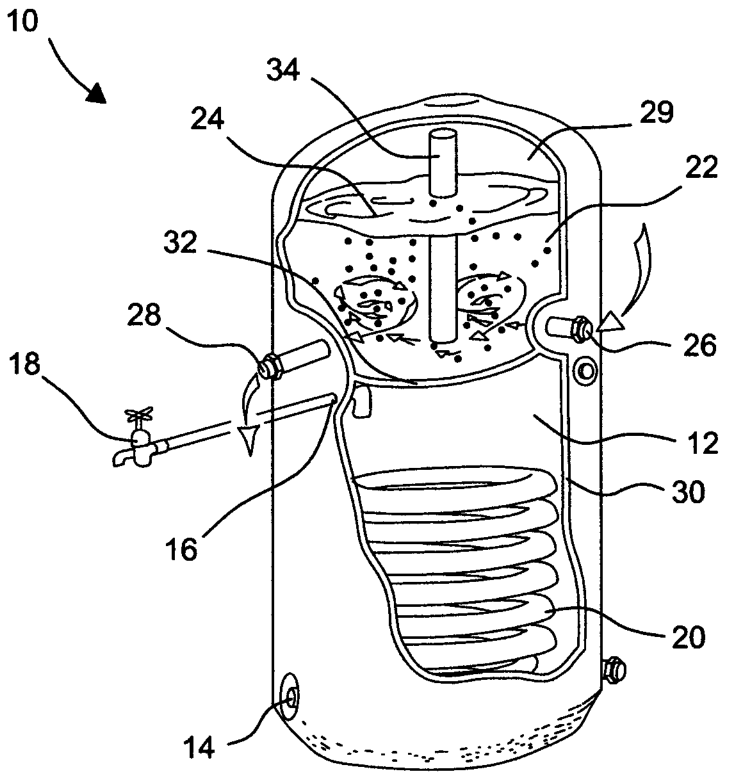

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Fig 2.

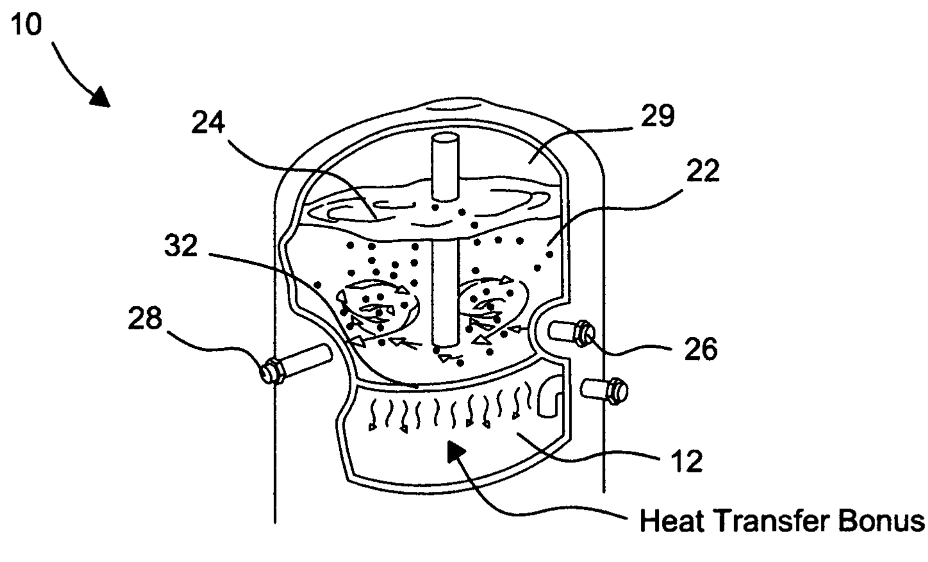
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Fig 3.

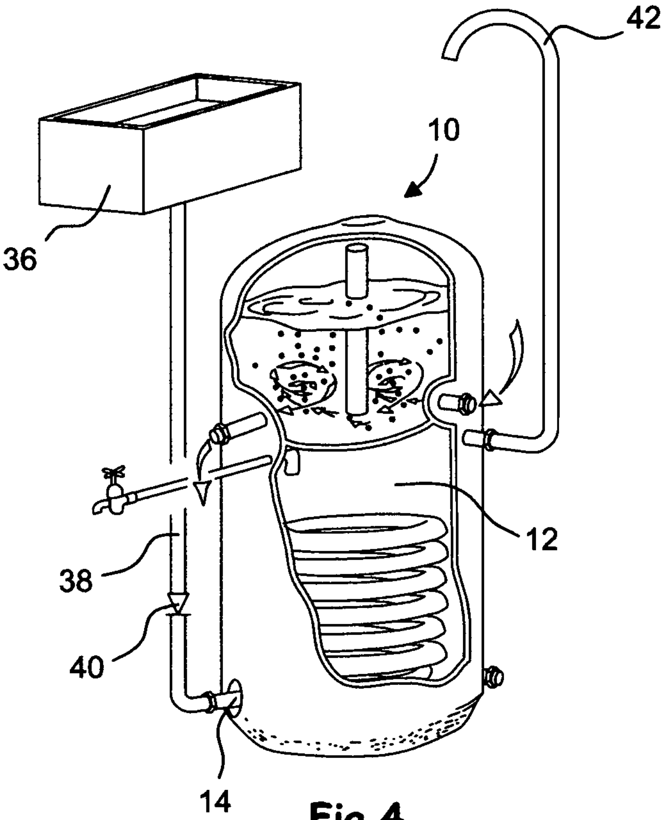

Fig 4.

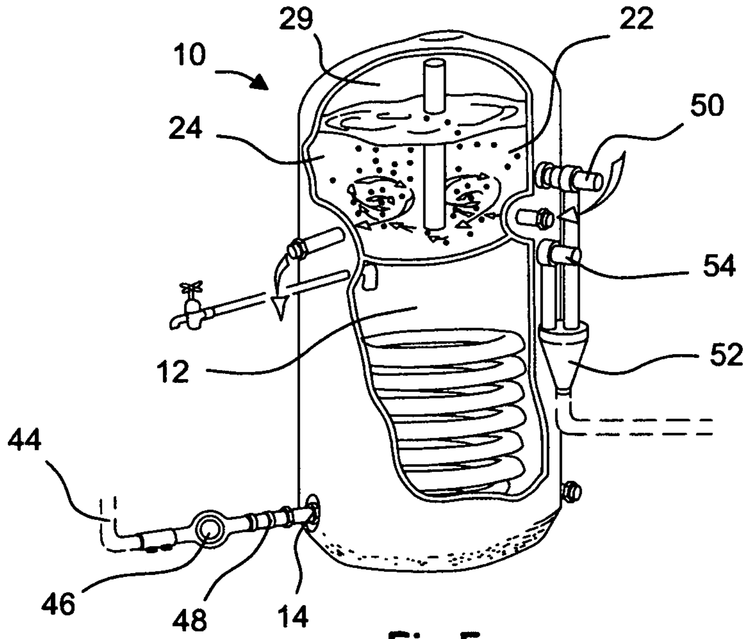

Fig 5.

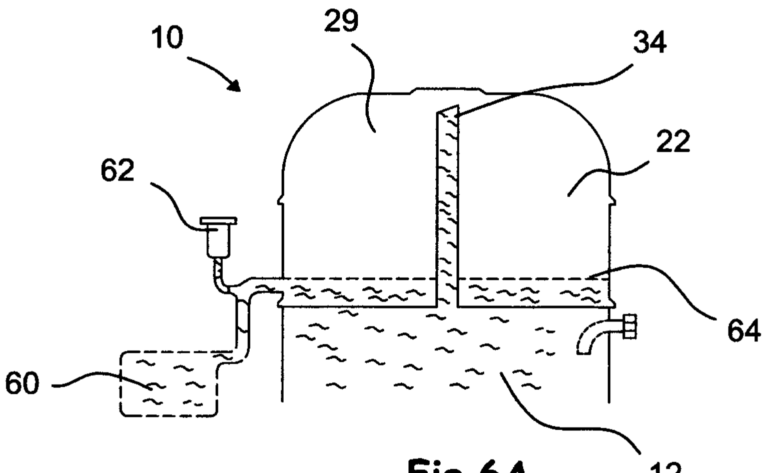

Fig 6A.

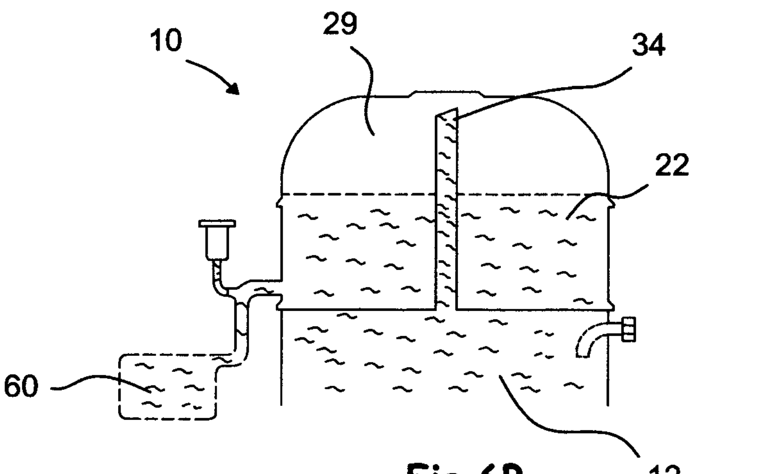

Fig 6B.

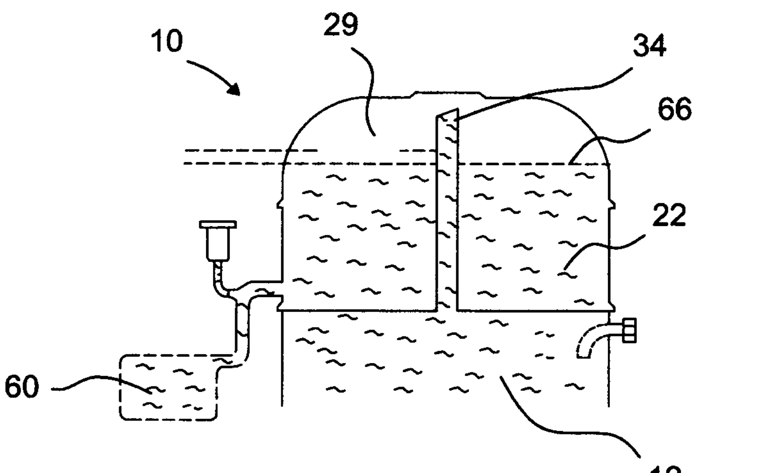

Fig 6C.

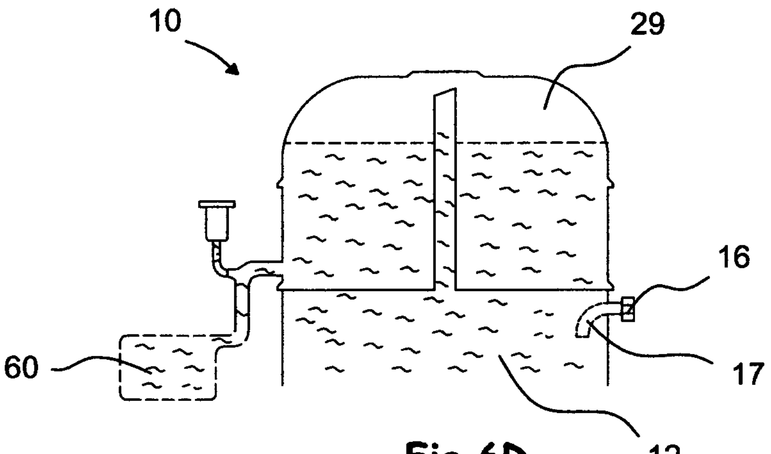

Fig 6D.

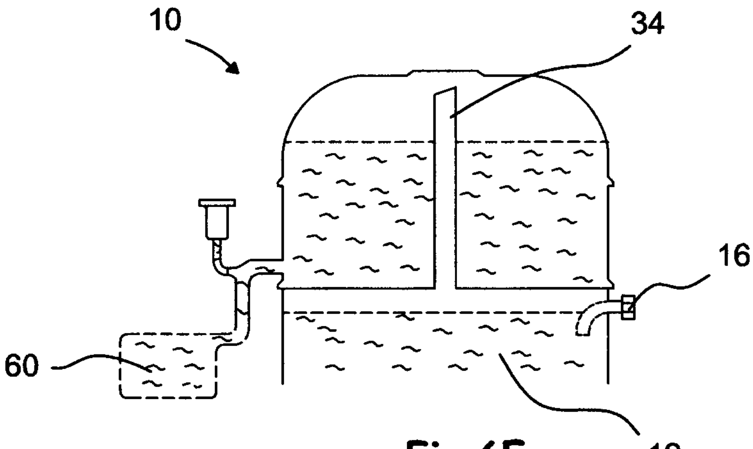

Fig 6E.

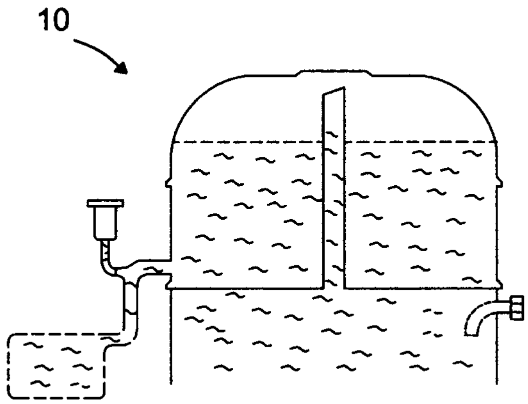

Fig 6F.

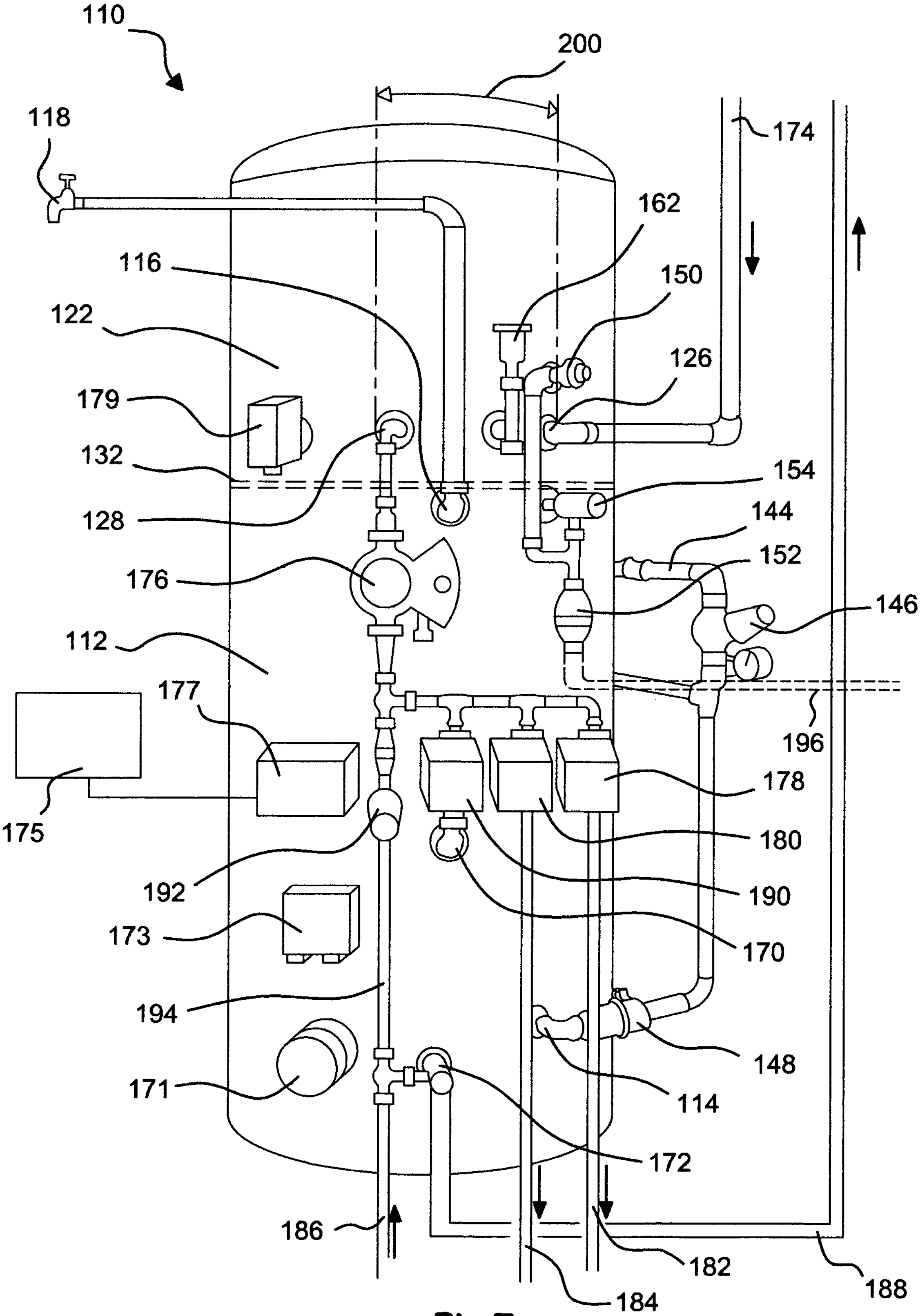
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Fig 7.

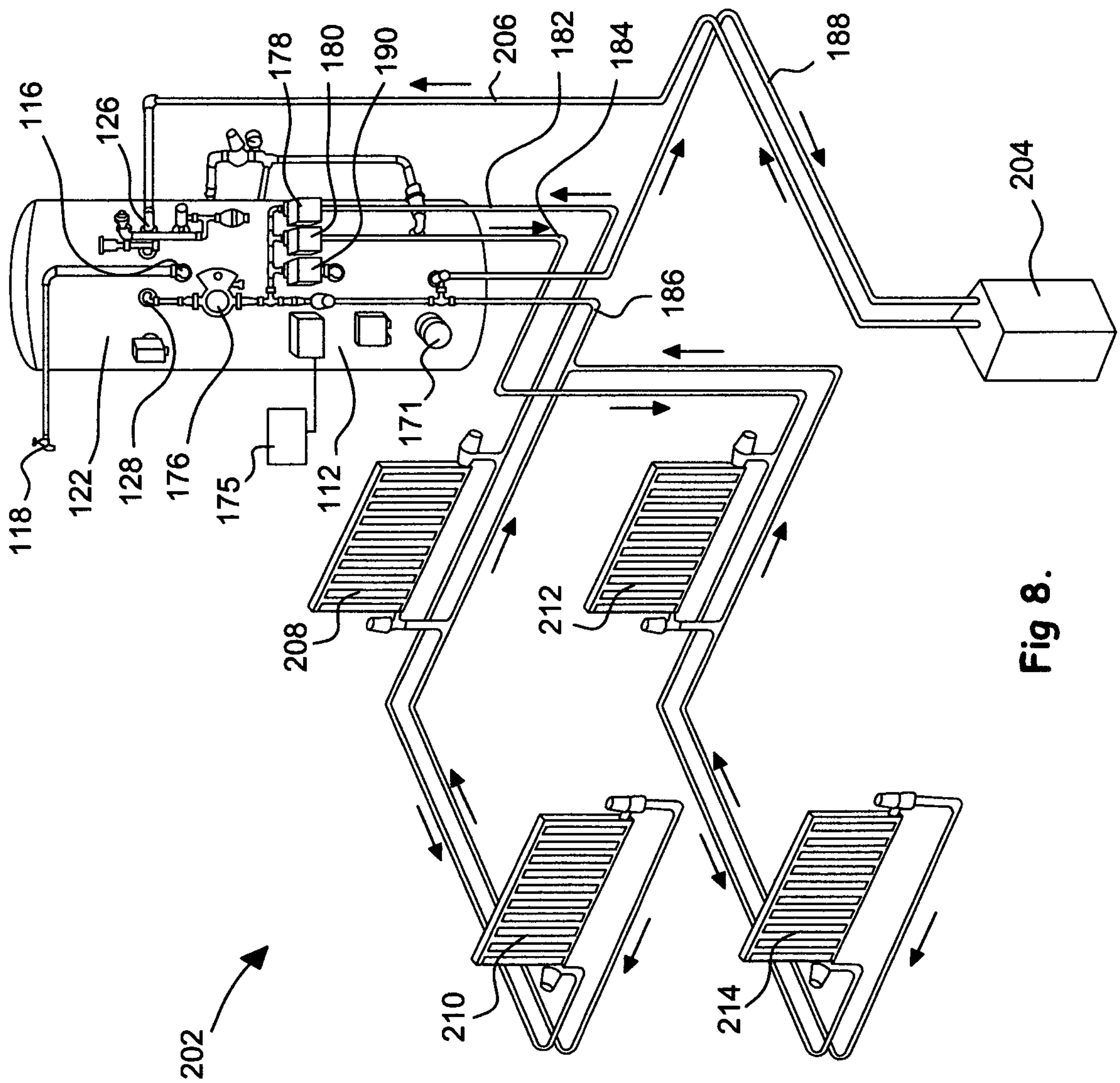
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Fig 8.

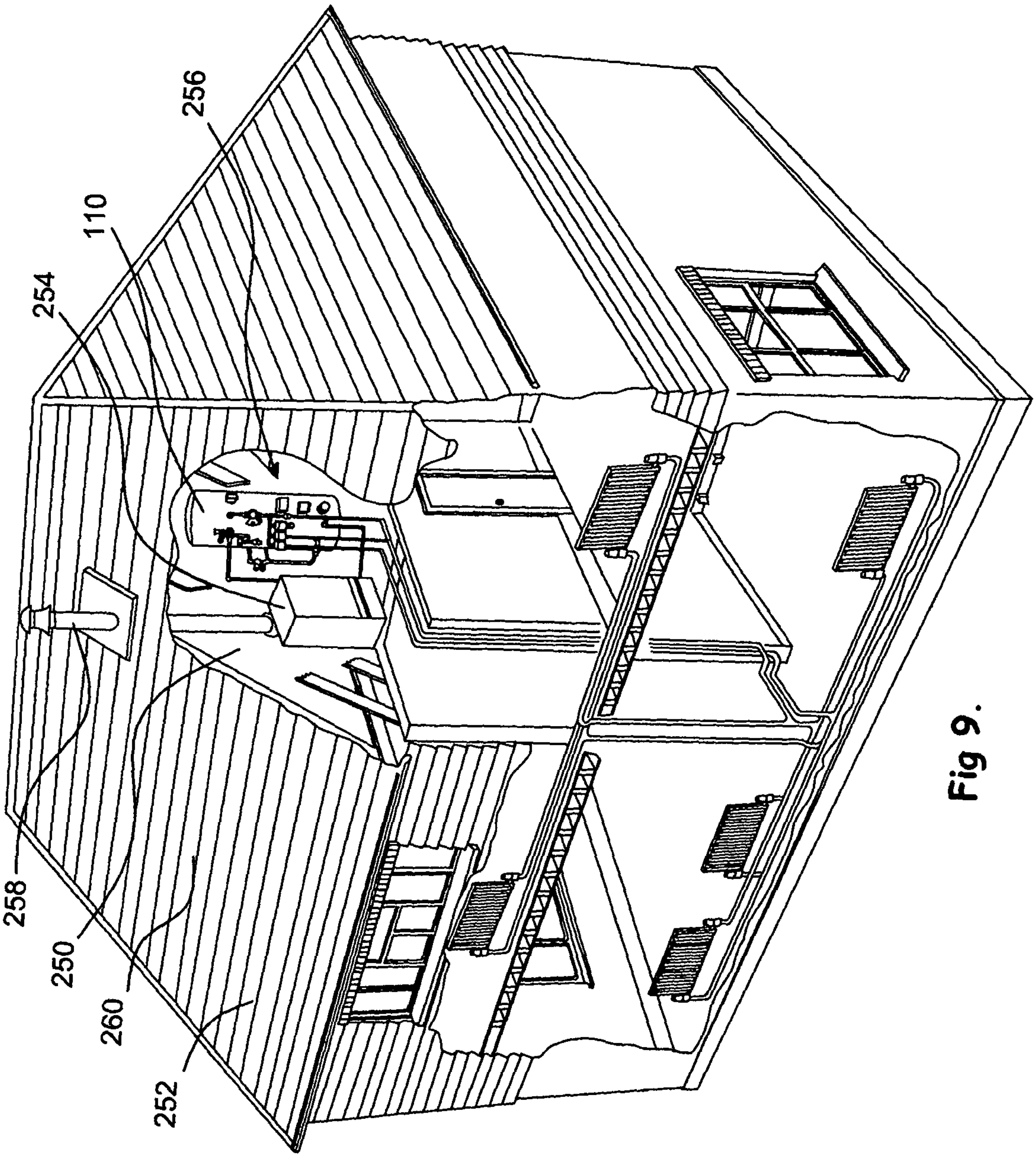

Fig 9.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 7999

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 April 2006	García Moncayo, O

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
....
& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 05 25 7999

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82