R&G Ref: P/68763.GB01/SJNG/AC

UNITED KINGDOM PATENT APPLICATION

Application No: GB1215080.1

Filing date: 23 August 2012

Priority Date: N/A

Applicant: Thermal Integration Limited

Applicant's Reference: N/A

Working Title: Pre-Heating Apparatus

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PRE-HEATING APPARATUS

The invention relates to an apparatus or system for pre-heating a fluid heater, such a boiler, and a method for the same.

Background to the invention

In domestic and industrial water heating systems, it is known to heat water using a heater, such as boiler. The hot water generated can be used to heat water in a storage vessel and this transfer of heat energy can take place at a heat exchanger, such as a plate heat exchanger. Typically, the storage vessel water is stratified such that hotter water is maintained at the upper end of the vessel and colder water is maintained at the bottom. During heating, the storage vessel water is circulated from the lower end of the vessel, which is cooler, heated in the heat exchanger and delivered to the upper end of the vessel, which is hotter.

Bio fuel-based boilers or generators often require pre-heating to a minimum temperature before they can begin generating heat. For example, a boiler that uses vegetable oil may only ignite effectively over a certain temperature. However, once such boilers begin generating heat, this can be used to heat the water in the storage vessel. The water in the storage vessel can then be used as a source of heat for a number of applications, such as heating mains-pressure water or providing central heating.

Summary of the invention

This invention provides an apparatus, a method for pre-heating a fluid heater and a kit, as defined in the appended independent claims to which reference should now be made. Advantageous or preferred features are set forth in dependent claims.

The invention may thus provide an apparatus or system for pre-heating a fluid heater, comprising: a fluid store for storing a first fluid; a fluid heater for heating a second fluid; a heat exchanger for transferring heat between the first and

second fluids; and a second-fluid circuit for circulating the second fluid between the fluid heater and the heat exchanger. The apparatus may be configured such that, in use, the first fluid can heat the second fluid at the heat exchanger and the heated second fluid can be circulated to the fluid heater. Circulation of the second fluid may be controlled to permit the first fluid to heat the second fluid and delivery of the heated second fluid to the fluid heater. The apparatus may comprise a controller or control system for controlling this.

The apparatus may thus permit the heating of the second fluid to a pre-determined or a desired temperature. The predetermined temperature may be the temperature at, or above which, the fluid heater needs to be pre-heated in order for it to start or ignite effectively. The pre-determined temperature is preferably at least 50°C, but this will depend on the type of fluid heater.

In some circumstances, the fluid heater may be off and may not have been running for a period of time. For example, it may have been switched off overnight. Having been inactive for such a period, the second fluid may cool down significantly. In contrast, the first fluid in the fluid store may retain its heat more effectively, such that the temperature of the first fluid, or at least a fraction of the first fluid, is greater than the temperature of the second fluid. In addition, there could be other fluid heaters or other heat sources supplying heat to the first fluid in the fluid store, maintaining its high temperature.

Advantageously, the hot fluid present in the fluid store may be used to pre-heat the second fluid and the second fluid, once circulated to the fluid heater, may pre-heat the fluid heater to the desired temperature. The first fluid may provide an easily accessible source of heat that can heat the fluid heater quickly and effectively. The fluid heater may thus be one that requires or prefers pre-heating before it can begin heating the second fluid. For example, the fluid heater may be a bio-fuel-based boiler or generator, such as a boiler that uses vegetable oil as a fuel. The fluid heater may be a CHP (combined- heat-and-power) plant.

The present invention appears counterintuitive because it is desirable to maintain the heat in first fluid so that it can be used over an extended period of

time, for a variety of useful applications e.g. to heat mains-pressure water or provide central heating. Hot water systems are typically designed to ensure that heat loss from the first fluid in the fluid store is minimised unless it is being used for such applications. However, use of the first fluid to heat the second fluid would result in the first fluid losing heat energy, without the heat energy being lost to such useful applications.

The apparatus may be controlled such that the second fluid can circulate through the second-fluid circuit independently of the fluid heater being able to heat the second fluid. For example, the second fluid may circulate even if the fluid heater is not on. The control system may enable a user to initiate a pre-heat program, when the user wishes to pre-heat the fluid heater. Alternatively or additionally, the control system may initiate the pre-heat program on a timer.

Advantageously, the apparatus may be configurable, between two states. In the first state, the fluid heater may be off, or at least unable to heat the second fluid. In the first state, the temperature of the first fluid may be greater than the temperature of the second fluid, such that the circulation of the second fluid to the heat exchanger causes the first fluid to pre-heat the second fluid. In the second state, the fluid heater may be on, or at least able to heat the second fluid. Thus, the temperature of the second fluid may be greater than the temperature of the first fluid, such that the circulation of the second fluid to the heat exchanger heats, or re-heats, the first fluid (re-heating refers to the transfer of heat to the first fluid to, for example, replace heat used to pre-heat the fluid heater). It is particularly advantageous if the apparatus can perform both of these functions. Preferably, the control system can initiate the first and/or second state. The control system may permit switching between the states. The first state may be referred to as a pre-heat program, and the second state may be referred to as a re-heat program (i.e. heating or re-heating the first fluid in the fluid store).

Pre-heating and re-heating may utilise the same second-fluid circuit.

In a first aspect, the apparatus may be arranged such that pre-heating the second fluid uses a portion, quantity or volume of the first fluid that is

substantially at, or from, the bottom of the fluid store. The pre-heating of the second fluid may use the first fluid that is at, or from, the bottom half, the bottom third or the bottom quarter of the fluid store. The position in the store is in reference to the internal length, or height of the fluid store.

In the first aspect, the heat exchanger may be situated within the fluid store, and is preferably a coil or a coiled heat exchanger. The coil is preferably situated substantially at the bottom of the fluid store. It may be situated in the bottom half, the bottom third or the bottom quarter of the fluid store.

Alternatively, the apparatus may comprise a first-fluid circuit for circulating the first fluid through the heat exchanger from a lower section of the fluid store to a higher section of the fluid store. The first-fluid circuit may circulate the first fluid from substantially the bottom of the fluid store to substantially the top of the fluid store. The first-fluid circuit may circulate the first fluid from the bottom half, third or quarter of the fluid store. The first-fluid circuit may circulate the first fluid to the top half, third or quarter of the fluid store. The first-fluid circuit may also comprise a pump for pumping the first fluid through the heat exchanger from the lower section of the fluid store to the higher section of the fluid store. Preferably, the heat exchanger is a plate heat exchanger and is outside, or external to, the fluid store.

However, the first aspect is less preferred than a second aspect (described below), because fluid from the bottom of the fluid store is less likely to be at a temperature sufficient to heat the first fluid at the heat exchanger. In addition, hot water systems often operate to maintain a temperature differential within the fluid store, such that the coolest fluid is at the bottom. For example, this may increase efficiency of heat exchange hen heat is delivered from the fluid store. The first aspect described above may require all the fluid in the store to be sufficiently hot to permit the pre-heating of the boiler, because as hot fluid (within the store) rises by convection, it may not be possible to heat just the fluid at the bottom of the store.

Thus, in the more preferred second aspect, the heat exchanger is arranged such that pre-heating the second fluid uses a portion, quantity or volume of the

first fluid substantially at, or from, the top of the fluid store. The pre-heating may use the first fluid at, or from, the top half of the fluid store, the top third of the fluid store or the top quarter of the fluid store. The heat transfer may thus use a portion of the first fluid that is above the desired temperature, or at least at a temperature sufficient to pre-heat the second fluid and the fluid heater up to the desired temperature.

In the second aspect, the heat exchanger is preferably inside the fluid store and is preferably a coil heat exchanger. The heat exchanger may be substantially at the top of the store. The heat exchanger may be in the top half of the fluid store, the top third of the fluid store or the top quarter of the fluid store. The heat exchanger is preferably exclusively or only situated at such a position within the fluid store, such that, for example, the heat exchanger does not extend between the top half and the bottom half of the fluid store.

In an alternative aspect of the second embodiment, the apparatus may comprise a first-fluid circuit for circulating the first fluid through the heat exchanger. A pump may drive the circulation. The heat exchanger may be external to the thermal store and may be a plate heat exchanger. The apparatus may be arranged or controlled to permit circulation of the first fluid from a higher section of the fluid store to a lower section of the fluid store e.g. from substantially the top of the fluid store to substantially the bottom.

In one embodiment, the apparatus comprises: an additional heat exchanger; a first-fluid circuit for circulating the first fluid through the additional heat exchanger from a lower section of the fluid store to a higher section of the fluid store; and an additional second-fluid circuit for circulating the second fluid between the boiler and the additional heat exchanger. The first-fluid circuit may circulate the fluid from a lower part of the fluid store to a higher part of the fluid store. The first-fluid circuit may circulate the fluid from substantially the bottom of the fluid store to substantially the top of the fluid store. The circulation may be from the bottom half, third or quarter of the fluid store. The circulation may be to the top half, third or quarter of the fluid store. The first-fluid circuit may comprise a pump for pumping the first fluid through the additional heat exchanger. The additional heat exchanger is preferably a plate heat exchanger

and may be outside, or external to, the fluid store. The additional heat exchanger may permit the transfer of heat from the second fluid to the first fluid. It may heat cooler water from a lower part of the store, such that the heated water is delivered to a higher part of the store. The store may thus heat from the top-down.

In an alternative embodiment, the additional heat exchanger may be a coil heat exchanger. It may be inside the fluid store. The additional heat exchanger is preferably substantially at the bottom of the fluid store. It may thus be in the bottom half of the fluid store, the bottom third of the fluid store or the bottom quarter of the fluid store. If the additional heat exchanger is at the bottom of the fluid store, it may be able to heat greater quantities of fluid than a similar heat exchanger at the top of the fluid store. It may be able to heat substantially all the fluid in the fluid store.

Preferably, the apparatus is configured or controlled such that the additional heat exchanger and additional second-fluid circuit do not provide a pre-heat function for the fluid heater. Consequently, in use, circulation through the additional heat exchanger may only occur, or be driven, when the fluid heater is active and able to heat the second fluid.

The apparatus may comprise a valve or valves for diverting flow of the second fluid to the second-fluid circuit or the additional second-fluid circuit. The valve may divert the fluid accordingly when the apparatus switches from the pre-heat program to the re-heat program.

The fluid store may comprise a heating element, such as an electric immersion heater. Preferably, the heating element is substantially at the top of the store, to heat a fraction of the first fluid, at the top of the store, rapidly. The heating element may be in the top half, the top third or top quarter of the fluid store. The heating element may provide a means for heating the first fluid such that the first fluid can be used to heat the second fluid and so to pre-heat the fluid heater. In some circumstances, the first fluid may not be warm enough to pre-heat the second fluid and the fluid heater to the desired temperature. In that case, the heating element could provide a boost of heat to the boiler. The

heating element could be situated substantially at the bottom of the fluid store, rather than at or near the top, but this would take a longer time to heat the first fluid up to a suitable temperature for pre-heating the fluid heater.

The apparatus may be configured or controlled such that the heating element can switched on manually and/or can be switched on under the control of a thermostat in the fluid store detecting when the first fluid temperature falls below a certain level.

Preferably, the first fluid and/or second fluid is water.

The fluid store may be any means capable of storing the fluid such that the fluid can maintain its heat for an extended period. Fluid stores are generally insulated such that hot fluid can be stored for an extended period, without losing its heat. The fluid store may be a water cylinder or may be a thermal store. It may be vented or pressurised.

The fluid store preferably has outlets or connections for supplying the first fluid to appliances or other heat exchangers.

The fluid store may thus have an outlet and an inlet for connecting to the first-fluid circuit. Preferably, the outlet is substantially at the bottom of the fluid store and the inlet is substantially at the top of the fluid store.

The second-fluid circuit, and where applicable the additional second-fluid circuit, may have a pump for pumping the second fluid through the circuit.

The invention may provide a method for pre-heating a fluid heater, comprising: circulating a second fluid through a heat exchanger; heating the second fluid at the heat exchanger using a first fluid from a fluid store; and delivering the heated second fluid to the fluid heater.

In a first aspect, the method may comprise using a portion or quantity of the first fluid at or from substantially the bottom of the fluid store to heat the second fluid.

In a second aspect, the method may comprise using a portion or quantity of the first fluid at or from substantially the top of the fluid store to heat the second fluid, as described above.

The invention may provide a kit comprising one or more of the following: a fluid store for storing a first fluid; a fluid heater for heating a second fluid; a heat exchanger for transferring heat between the first and second fluids; a second-fluid circuit for circulating the second fluid between the fluid heater and the heat exchanger, or a means for assembling the second fluid circuit.

The kit may also comprise one or more of the following: an additional heat exchanger; a first-fluid circuit (or means for its assembly), for circulating the first fluid through the additional heat exchanger from a lower section of the fluid store to a higher section of the fluid store; and an additional second-fluid circuit (or means for its assembly) for circulating the second fluid between the fluid heater and the additional heat exchanger.

The kit may comprise a set of instructions for assembling an apparatus as defined in any form above.

The invention may provide a fluid store as described in any form above. The fluid store may thus comprise a first heat exchanger, such as a coil, substantially at the top of the fluid store and it may comprise a second heat exchanger, such as a coil, substantially at the bottom of the fluid store. The fluid store may have a fluid outlet, substantially at the bottom of the fluid store and a fluid inlet substantially at the top of the fluid store. The fluid store may also comprise a heating element, preferably located substantially at the top of the fluid store. The fluid store may comprise a thermostat.

Description of specific embodiments

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a system according to a first embodiment of the invention, in operation.

Figure 2 is a schematic diagram of a system according to a second embodiment of the invention, in operation.

Figure 3 is a schematic diagram of a system according to a third embodiment of the invention, in operation.

A system 1 as shown in figure 1 has fluid store in the form of a water cylinder 3 containing storage water 9. The cylinder has a heat exchanger 5, in the form of a coil, situated at the bottom. The coil is part of a boiler-water circuit or piping 11, which runs between a bio-fuel-based boiler (not shown) and the cylinder. The boiler water circuit contains a two-way valve 35. The cylinder 3 has a thermostat, 33, positioned at the bottom.

The storage water 9 is stratified into layers according to its temperature. Hot water 27, typically at or above 60°C, is at the top and cool water 31, typically at 50°C or below or about 30°C or below, is at the bottom. A layer of water 29 at an intermediate temperature is between the hot water and cool water layers.

In use, the biofuel-based boiler must be pre-heated to a minimum temperature before ignition, typically about 50°C. To pre-heat the boiler, boiler water in the boiler-water circuit 11 is circulated through the coil 5 at the bottom of the cylinder 3 by a pump (not shown). As the boiler water passes through the coil, the storage water at the bottom of the cylinder heats the boiler water. The boiler water then passes through the boiler, heating the boiler to the required temperature.

Once the boiler has been pre-heated and subsequently ignited, the system can begin re-heating the storage fluid 9 in the cylinder 3. Hot boiler water (heated by the boiler) circulates through the boiler water circuit 11 using the pump (not shown) and through the coil 5 at the bottom of the cylinder 3. Transfer of heat from the boiler water to the heat exchanger heats the boiler water in the cylinder up to the required temperature.

The two-way valve 35, affects flow of the boiler water through the boiler water circuit 11 and can restrict or prevent boiler water flow through the boiler water circuit. This valve may provide overheat protection by, for example, restricting boiler water flow in response to a sensed water temperature in the cylinder 3.

The thermostat 33, is configured to detect when all the storage water 9 has reached a desirable temperature, and then turn off the boiler when this has occurred. It could also affect operation of the valve 35.

A system 1 as shown in figure 2 has a water cylinder 3 containing storage water 9. The cylinder has a first heat exchanger 5, in the form of a coil, situated within the cylinder, at the top. The coil is part of a first boiler-water circuit or piping 11, which runs between a bio fuel-based boiler (not shown) and the cylinder.

The cylinder 3 also has an electric immersion heater 19 at the top, situated just underneath the coil 5, and a thermostat, 33, positioned at the bottom.

The storage water 9 in the cylinder 3 is stratified into layers according to its temperature. Hot water 27, typically at 60-65°C, is at the top and cool water 31, typically at 50°C or below, is at the bottom. A layer of water 29 at an intermediate temperature is between the hot water and cool water layers.

There is a second heat exchanger 7, in the form of a plate heat exchanger, situated on the outside of the cylinder 3. A storage water circuit or piping 15 runs between a storage water outlet 21 at the bottom of the cylinder, to a storage water inlet 22 at the top of the cylinder, and passes through the plate heat exchanger. The storage water circuit has a pump 17 situated between the fluid outlet 21 and the plate heat exchanger. A second boiler-water circuit or piping 13 also passes through the heat exchanger, running between the boiler and the plate heat exchanger.

A three-way valve 25 connects the first boiler-water circuit 11 and the second boiler-fluid circuit 13.

In use, before igniting the biofuel-based boiler, it must be pre-heated to a minimum temperature, typically 50°C. To pre-heat the boiler, boiler water in the first boiler-water circuit 11 is circulated through the coil 5 in the cylinder by a pump (not shown). The valve 25 is configured such that water circulates through the first boiler-water circuit rather than the second boiler-water circuit 13. As the boiler water passes through the coil 5, the hotter storage water 27 at the top of the cylinder heats the boiler water. The heated boiler water then passes through the boiler, heating the boiler to the required temperature. The hotter water at the top of the cylinder may be residual storage water heated by the boiler, when the boiler was previously running. Alternatively, if there is not sufficient residual hot water, the immersion heater 19 is used to heat the water at the top of the cylinder.

Once the boiler has been pre-heated and subsequently ignited, the system can begin re-heating the storage fluid 9 in the cylinder 3. The valve 25 is configured such that hot boiler water (heated by the boiler) circulates through the second boiler-water circuit 13 (using a pump – not shown) rather than the first boiler water circuit 11. Consequently, the hot boiler water passes through the plate heat exchanger 7. At the same time, the pump 17 circulates water through the storage water circuit 15 from the bottom of the cylinder, through the storage water outlet 21, through the plate heat exchanger, and into the top of the cylinder at the storage water inlet 22. The boiler water heats the storage water, as the storage water passes through the heat exchanger, typically to at least 60°C. As the cooler storage water is drawn from the bottom of the cylinder and the warmer storage water is delivered to the top of the cylinder, the storage water in the cylinder heats up from the top-down. Consequently, the hot-water layer 27 grows or extends downwardly and the cold-water layer 31 shrinks.

Alternatively, the valve 25 is configured such that hot boiler water (heated by the boiler) circulates through the first boiler-water circuit 11 rather than the second boiler water circuit 13. As the boiler is now in operation, the system is in a re-heating mode, rather than a pre-heating mode. This means that the boiler water passes through the coil 5 in the top of the cylinder 3, and heats the storage water 9 rather than the storage water heating the boiler water. It may

be desirable to re-heat the storage water using the coil 5 if one wishes to heat a small amount of water in the cylinder, quickly. The coil is only able to heat water in the top part of the store.

The thermostat 33, at the bottom of the cylinder 5 is configured to detect when all the storage water 9 has reached a desirable temperature, and then turn off the boiler when this has occurred.

A system 1, as shown in figure 3, is in some ways similar to the system of figure 2. Consequently, similar features have been assigned like reference numerals.

The system 1 has a second heat exchanger 7, in the form of a coil situated at the bottom of the water cylinder 3. The coil replaces the plate heat exchanger 7 of figure 2. In addition, there is no storage water circuit 15 and pump 17, for circulating water from the bottom of the cylinder to the top, through the plate heat exchanger.

In use, pre-heating occurs, as described above for figure 2, by circulating boiler water in the first boiler-water circuit, through the coil 5 at the top of the cylinder 3.

Re-heating of the storage water 9 occurs either by circulating hot boiler water through the coil 5 at the top of the cylinder 3 (as described above), or by circulating hot boiler water through the coil 7, at the bottom of the cylinder. The configuration of the valve 25 determines whether the boiler fluid circulates through the first boiler water circuit 11 or the second boiler water circuit 15.

It may be desirable to re-heat the storage water 9 using the coil at the bottom of the cylinder 3, if one wishes to heat all of the water in the cylinder 3. However, this mode of heating typically requires a long period of time to heat the water to the desired temperature. The user may select the desired mode of heating depending on the circumstances.

Claims

1. An apparatus for pre-heating a fluid heater, comprising:

a fluid store for storing a first fluid;

a fluid heater for heating a second fluid;

a heat exchanger for transferring heat between the first and second fluids; and

a second-fluid circuit for circulating the second fluid between the fluid heater and the heat exchanger,

in which the circulation of the second fluid is controllable to permit the first fluid to heat the second fluid, and to deliver the heated second fluid to the fluid heater, to pre-heat the fluid heater.

2. An apparatus according to claim 1, in which the heat exchanger is arranged such that, in use, a portion of the first fluid at, or from, substantially the bottom of the fluid store, heats the second fluid.

3. An apparatus according to claim 2, in which the heat exchanger is inside the fluid store.

4. An apparatus according to claim 2 or claim 3, in which the heat exchanger is a coil.

5. An apparatus according to any of claims 2 to 4, in which the heat exchanger is substantially at the bottom of the fluid store.

6. An apparatus according to claim 1, in which the heat exchanger is arranged such that, in use, a portion of the first fluid at, or from, substantially the top of the fluid store, heats the second fluid.

7. An apparatus according to claim 6, in which the heat exchanger is inside the fluid store.

8. An apparatus according to claim 7, in which the heat exchanger is substantially at the top of the fluid store.

9. An apparatus according to claim 7 or claim 8, in which the heat exchanger is a coil heat exchanger.

10. An apparatus according to any of claims 6 to 9, comprising

an additional heat exchanger;

a first-fluid circuit circulating the first fluid through the additional heat exchanger from a lower section of the fluid store to a higher section of the fluid store; and

an additional second-fluid circuit for circulating the second fluid between the boiler and the additional heat exchanger

11. A heat exchanger according to claim 10, in which the first-fluid circuit circulates the fluid from substantially the bottom of the fluid store to substantially the top of the fluid store.

12. An apparatus according to claim 10 or claim 11, in which the first-fluid circuit comprises a pump for pumping the first fluid through the additional heat exchanger.

13. An apparatus according to any of claims 10 to 12, in which the additional heat exchanger is a plate heat exchanger.

14. An apparatus according to any of claims 10 to 13, in which the additional heat exchanger is external to the fluid store.

15. An apparatus according to claim 10, in which the additional heat exchanger is a coil heat exchanger.

16. An apparatus according to claim 10 or 15, in which the additional heat exchanger is inside the fluid store.

17. An apparatus according to claim 16, in which the additional heat exchanger is substantially at the bottom of the fluid store.

18. An apparatus according to any of claims 10 to 11, comprising a valve for diverting flow of the second fluid to the second-fluid circuit and/or the additional second fluid circuit.

19. A method for pre-heating a fluid heater, comprising:

circulating a second fluid through a heat exchanger;

heating the second fluid at the heat exchanger using a first fluid from a fluid store; and

delivering the heated second fluid to the fluid heater.

20. A method according to claim 19, comprising using a portion of the first fluid from substantially the bottom of the fluid store to heat the second fluid.

21. A method according to claim 19, comprising using a portion of the first fluid from substantially the top of the fluid store to heat the second fluid.

22. A kit comprising:

a fluid store for storing a first fluid;

a fluid heater for heating a second fluid;

a heat exchanger for transferring heat between the first and second fluids;

a second-fluid circuit for circulating the second fluid between the fluid heater and the heat exchanger, or a means for assembling the second fluid circuit; and

a set of instructions for assembling an apparatus as defined in any of claims 1 to 18.

23. An apparatus substantially as hereinbefore described with reference to the accompanying drawings.

24. A method substantially as hereinbefore described with reference to the accompanying drawings.

25. A kit substantially as hereinbefore described with reference to the accompanying drawings.

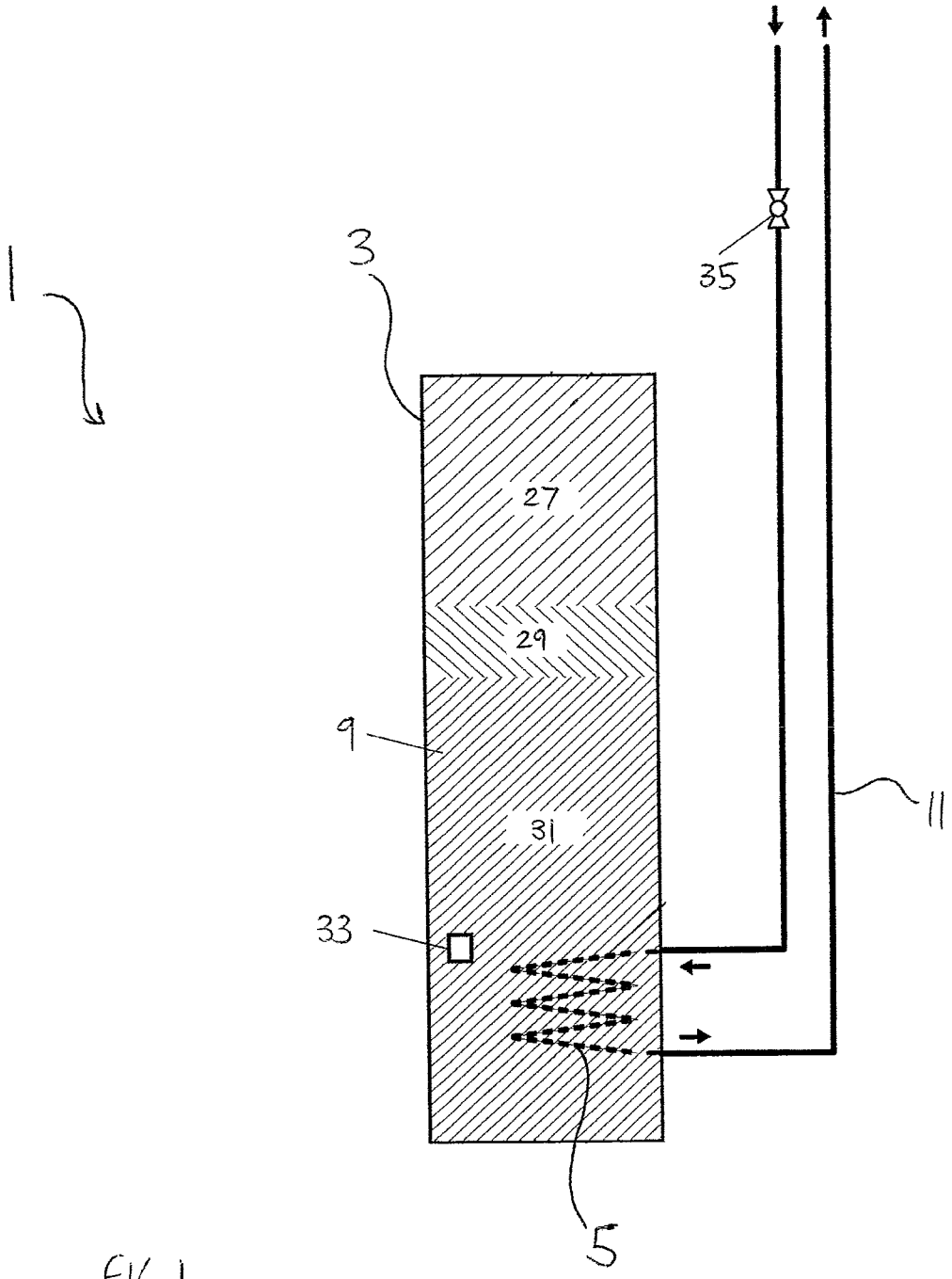


FIG. 1

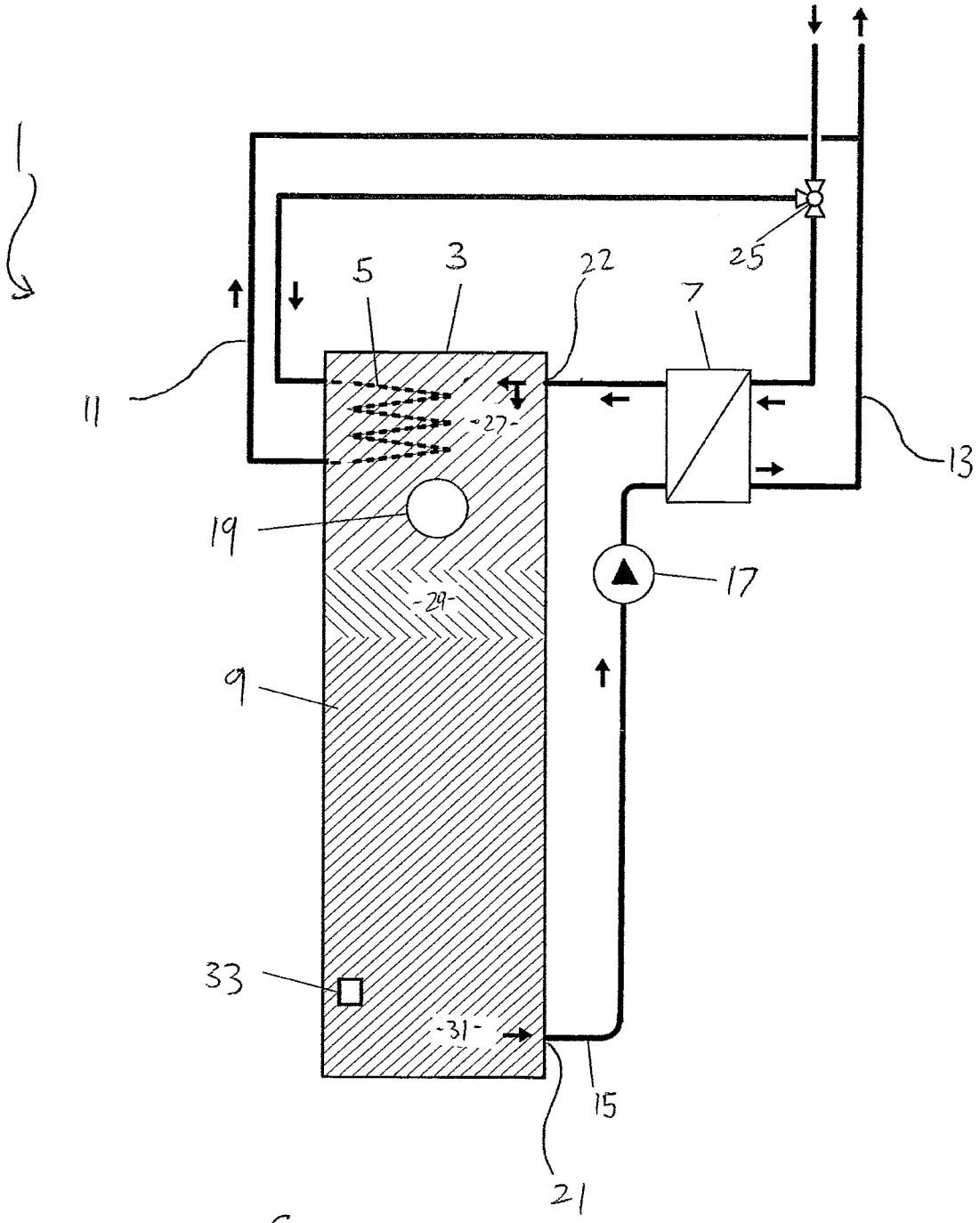


FIG. 2

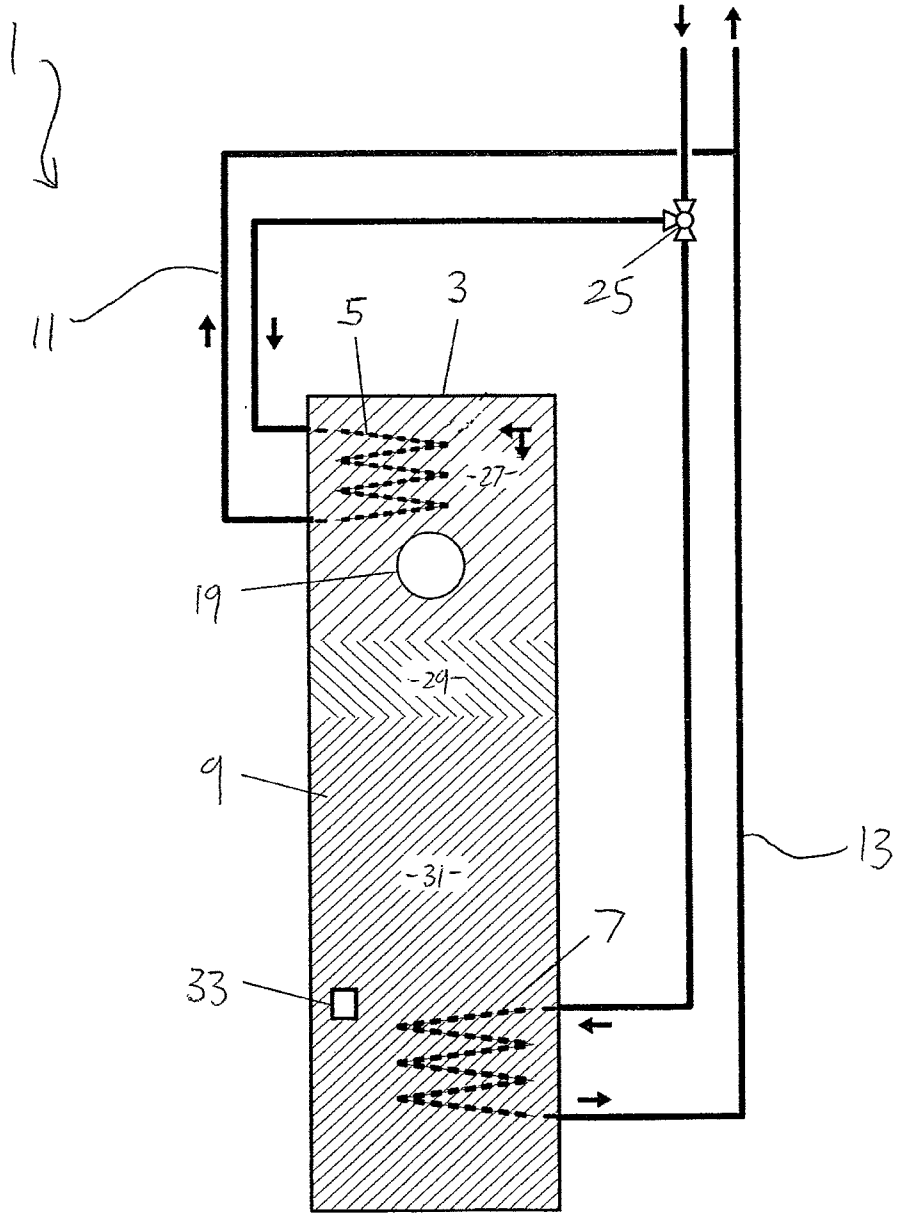


FIG. 3