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(54) **HEATING SYSTEM**

(57) Heating system for heating a home, comprising a heat pump provided with a first fluid circuit, configured to heat a first fluid in the first fluid circuit; a buffer tank, comprising at least one inlet for receiving a second fluid and at least one outlet for delivering the second fluid; and comprising a buffer fluid; a second fluid circuit extending between the inlet and the outlet of the buffer tank; wherein the first fluid circuit extends at least partially into the buffer tank, to heat the buffer fluid; and wherein the first and second fluid circuits are at least partially in heat exchanging contact within the buffer tank.

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Description

[0001] The present invention relates to a heating system, in particular a sustainable heating system.

[0002] Traditionally heating systems are based on fossil fuels and for a long period of time households relied upon natural gas for heating, for cooking and for domestic hot water. The last years tremendous improvement is reached in an attempt to reduce our dependency on these fossil fuels, both to reduce the environmental impact as to reduce our dependency on the providers of those fossil fuels.

[0003] One of the alternatives for the burning of fossil fuel to provide energy or heat has been the heat pump. In a nutshell, heat pumps extract heat from its surroundings and provides that heat to another circuit which in turn heat the house or for domestic hot water. Heat pumps are able to do this to an extent, as a consequence of which the amount of heating is limited and for optimal efficiency these heat pumps need to be combined with low temperature heating systems, which are typically not provided for in older houses. When replacing oil or gas boilers with heat pumps, the complete heating system of a household would need to be replaced, reducing the desirability of these heat pumps. Moreover, alternative heating solutions typically require a large amount of additional feature and, more importantly, a large amount of additional space to function.

[0004] It is therefore a goal of the present invention to provide an improvement to the drawbacks mentioned above, in particular to provide a solution to replace existing conventional oil or combi gas boilers in existing heating systems.

[0005] The invention thereto provides a heating system according to claim 1. The system uses a heat pump to heat a body of water. This heated body of water is subsequently used to provide heating in a house or hot water for example. The heat pump for example extracts heat from the air, such as ambient air, or it pulls air from a warm place in a home, such as an attic. This heat is used to warm a fluid in the fluid circuit of the heat pump. This heat can for example be absorbed by the fluid circuit of the heat pump. Preferably, the fluid of the heat pump is a refrigerant, more preferably a natural refrigerant. For example, the fluid of the heat pump is propane or carbon dioxide based. This heated fluid then gives off its heat along its fluid circuit, in this case it will give off heat in the buffer tank and heat up the buffer fluid. The heated fluid in the fluid circuit of the heat pump can for example give off its heat by means of a (coiled) heat exchanger or condenser. The buffer tank also houses a further fluid circuit, which is in heat exchanging contact with the heat pump circuit. Optionally, the further fluid circuit is a (coiled) heat exchanger. Typically the heat exchanging contact is an indirect contact, where the heat exchanger heats up the buffer fluid and the buffer fluid heats up the further fluid circuit. The further fluid in the further fluid circuit can be water. By directly heating the buffer fluid with the heat pump, a very compact heating system may be designed. Moreover, it allows the integration of the two components in a single unit. This has the large benefit that the system can be wired up and connected beforehand, in a controlled environment and installing the system is almost plug and play. The invention may thus provide a heating system for heating a home, comprising a heat pump provided with a first fluid circuit, configured to heat a first fluid in the first fluid circuit; a buffer tank, comprising at least one inlet for receiving a second fluid and at least one outlet for delivering the second fluid; and comprising a buffer fluid; a second fluid circuit extending between the inlet and the outlet of the buffer tank; wherein the first fluid circuit extends at least partially into the buffer tank, to heat the buffer fluid; and wherein the first and second fluid circuits are at least partially in heat exchanging contact within the buffer tank.

[0006] The heat pump preferably comprises an air extractor, to extract heat from ambient air and/or an air exhaust, to exhaust air from the heat pump to the surroundings. The heat pump may thus use the surrounding heat, for example in a house or ventilation air, to extract heat from and transfer the heat to the fluid in its fluid circuit. The used air may then be expelled from the system via the exhaust. The temperature of the used air may be lower than the temperature of the extracted ambient air and/or air exhaust, in particular the temperature of the expelled used air may be lower than the temperature of the extracted ambient air and/or air exhaust.

[0007] The buffer tank may comprise an opening allowing at least a part of the first fluid circuit to access the interior of the buffer tank. The opening may be an inlet and/or an outlet allowing at least a part of the first fluid circuit to return and leave the interior of the buffer tank. Although the heat pump may be arranged close to the buffer tank, the connection between the two still needs to be made. In an alternative arrangement the buffer tank and the heat pump are integrated, forming a single unit.

[0008] The heating system may further comprise a third fluid circuit extending between a third inlet and a third outlet of the buffer tank comprising the buffer fluid, wherein the third fluid circuit optionally comprises a heating element, such as a radiator, in heat exchanging contact with the buffer fluid in the third fluid circuit. This way the heating system may be used to heat not only the buffer tank or domestic hot water (DHW), but also for example rooms in the house.

[0009] The buffer tank may comprise a phase changing material, which is used to store heat upon a phase change. The use of such material allows heat to be efficiently stored in a relatively small volume, decreasing the size of the buffer device needed to store or provide a set amount of energy. The phase changing material also provides heat upon changing is phase, in particular to heat fluid in the system, more in particular to heat the buffer fluid in the system.

[0010] In a preferred embodiment the phase changing

material has a phase changing temperature between 30 and 90 degrees Celsius, in particular between 40 and 80, more in particular between 60 and 75 degrees Celsius, more in particular between 48 and 58 degrees Celsius. Phase Changing Materials are known in the art and use heat needed or provided by changing phase, such that the materials may be considered as some form of thermal battery or storage for the present heating system. Since the melting temperature of these materials is higher it is possible to obtain a high specific energy density. By incorporating the phase changing materials in the buffer device basically the effective volume used for heat storage can be improved or, the other way around, the volume needed to store a specific amount of energy can be reduced. Less volume means a smaller buffer device can be used, which allows to use heating systems according to the invention in a broader range of applications.

[0011] The phase changing material may comprise spheres or shells, preferably made of a metal and more preferably of stainless steel, wherein the spheres or shells preferably comprise or are at least partially filled with a salt hydrate. Optionally, the phase changing material comprises balls, preferably made of a metal and more preferably of stainless steel, wherein the balls preferably comprise or are at least partially filled with a salt hydrate. Salt hydrates comprise an alloy of inorganic salts and water, which materials are relatively cheap and easily accessible. The change of phase of these salt hydrates comprises hydration and dehydration of the salts, very similar to the process of melting and freezing, wherein salt hydrates have a relatively high latent warmth per mass and thus able to store and give off relative large amounts of warmth. By containing or encapsulating the material in spheres, balls or shells, a large surface is available to exchange heat between the phase changing material and the fluid in the buffer device. Moreover, when use is made of metal or stainless steel a good heat exchange can be obtained. For domestic thermal batteries it is particularly important that there's an optimum between heating surface area and costs. Therefore a diameter is chosen of 63 mm Ø for the stainless steel spheres or balls in buffer tanks with a maximum volume of 500L. Additionally the phase changing material is separated from the rest, in particular the fluid, of the buffer tank to prevent any unwanted interactions or reactions between the phase changing material and the rest.

[0012] The phase changing material may have a heat or warmth storage capacity of 80 to 140 kWh/m3, in particular about 100-120 kWh/m3. In comparison, water has a capacity of about 20-30 kWh/m3. Compared to a volume of water, using these phase change materials is thus much more efficient.

[0013] The buffer tank may be provided with a heating element, such as an electric heating element, to heat up the buffer fluid in the buffer tank. This way the fluid in the buffer tank may be heated regardless of the available heat that can be extracted with the heat pump, and thus allows the heating system to operate even at colder temperatures.

[0014] The buffer tank may have an upper side and a bottom side, wherein the inlet is provided in the bottom side and the outlet is provided in the upper side. A natural heat gradient over the tank will be cold fluid at the bottom and warm fluid at the top. By providing the inlet at the bottom, which inlet is typically cooler as well, a gradual heating of the fluid can be achieved.

[0015] The first and second fluid circuit each may comprise a coiled section, wherein in particular at least a part of the coiled section of the first fluid circuit is provided within the coiled section of the second fluid circuit. Coiled sections, in particular coiled copper tubing, has been used for a long time for it's efficient heat transfer capabilities. By placing the two circuits in close proximity, for instance by having one within the centre space of the other, allows for an improved heat exchange between the two systems or circuits, further improving the efficiency of the system. The coiled sections may be coiled stainless steel or copper tubing.

[0016] The system may optionally comprise a solar panel for providing electricity to the heat pump. Optionally, the system comprises a plurality of (photo voltaic) solar panels. The fluid circuits may, for example the second fluid circuit or each fluid circuit, comprise a thermal solar collector, for warming fluid in the circuit. In all circuits solar energy may thus be used to provide additional electrical input and heat to the system, without relying on further fossil fuels.

[0017] The buffer tank may comprise at least one, preferably at least two sensors, to monitor temperatures insides the buffer tank, which sensors may be arranged at different heights of the buffer tank.

[0018] The buffer tank may be placed in an upright position, with its longitudinal axis along a vertical. This allows the buffer tank to be placed in small areas such as under roofing or other suitable places in the house. It is also possible to place the buffer tank in a flat position, with its longitudinal position along a horizontal, which allows the buffer tank to be placed in other areas such as under roofing and other more difficult accessible parts of a house.

[0019] The heat pump may be provided on top of the buffer tank, preferably directly on top. This way a very compact heating system may be designed. Moreover, it allows the integration of the two components in a single unit. This has the large benefit that the system can be wired up and connected beforehand, in a controlled environment and installing the system is almost plug and play. Preferably the heat pump is housed in a first housing and the buffer tank is housed in a second housing, wherein the two housings are attached to each other, wherein preferably the first housing is arranged directly on top of the second housing.

[0020] The buffer device or buffer tank may have a total capacity of 200-500L which, when comprising phase changing materials, is sufficient to replace existing con-

ventional systems. Preferably the buffer device is well insulated, to maintain as much heat as possible.

[0021] The system may also comprise circulating pumps, for pumping around fluid in the circuits of the system. In this regard each circuit may comprise its own pump, or even multiple pumps per circuit.

[0022] The fluid circuits may each comprise a flow controller, to control the flow of fluid though the circuits. Depending on the temperature of the fluid to be heated by the heat pump, the flow of that fluid may be regulated. The flow controller may be an adjustable flow controller. The second fluid circuit may comprise a flow switch, for example arranged at the inlet of the circuit. The flow switch may be used to detect the flow of the second fluid, for instance when (warm) tap water is requested by the system.

[0023] The third fluid circuit may comprise a valve, in particular a three-way-valve, in between the third exit and the heating element and/or in between the third exit and the third inlet. In a preferred embodiment the valve is arranged such that a normally closed position connects the valve and the heating element or radiator and a normally open position connects the valve and the third inlet. By operating the valve the flow of fluid can be controlled to either pass through the heating element or not. The second fluid circuit may comprise a pump, for instance arranged between the valve and/or heating element on one side, and the third inlet on the other side, for creating a flow in the second fluid circuit.

[0024] The heating system may be provided with a controller, to operate components of the system. The controller is preferably in contact with at least the heat pump and the buffer device, more preferably with at least the heat pump and temperature sensors of the buffer device. In a preferred embodiment the controller is connected to the pumps, valves, flow switch(es) and flow controllers.

[0025] The controller may be configured to control the components of the system depending on measured input. For example, the heat pump of the system or the buffer tank may be arranged to operate within a certain temperature bandwidth. It is furthermore imaginable that controller is configured to control the components of the system depending on predetermined input. For example, the heating system, in particular the heat pump, can be arranged to operate within a predetermined period and/or time frame of the day.

[0026] The system may also comprise a thermostat, which may be arranged to measure the temperature in a room, which thermostat is in contact with the controller. When the thermostat determines that the temperature is below a set temperature, the controller may control the valve to send fluid through the heating element of the second fluid circuit, to increase the temperature that way.

[0027] The invention will be elucidated on the basis of non-limitative exemplary embodiments shown in the following figures, wherein

- Figures 1 and 2 schematically shows a heating system for heating a home, according to the present invention;
- Figures 3 and 4 schematically show a perspective view on a heating system according to the present invention;
- Figure 5 schematically shows a wireframe view on a heating system according to the present invention;
- Figure 6 schematically shows the components of a sphere for encapsulating the phase changing material according to the present invention;
- Figure 7 schematically shows the sphere of figure 6 in assembled condition; and
- Figure 8 schematically shows a system according to the invention, integrated to a home heating system

[0028] Figures 1 and 2 schematically shows a heating system (1) for heating a home, according to the present invention, comprising a heat pump (2). The heat pump (2) is provided with a first fluid circuit (3) and the heat pump (2) is configured to heat a first fluid in the first fluid circuit (3). The first fluid can be a refrigerant. Shown in figure 1 is also the buffer tank (4), which has been hidden in figure 2, comprising at least one inlet (5) for receiving a second fluid and at least one outlet (6) for delivering the second fluid; and comprising a buffer fluid. A second fluid circuit (7) extends between the inlet (5) and the outlet (6) of the buffer tank (4) as can be seen in figure 2. The first fluid circuit (3) extends at least partially into the buffer tank (4), to heat the buffer fluid and the first (3) and second (7) fluid circuits are at least partially in heat exchanging contact within the buffer tank (4), in the shown embodiment of figure 2 they are in best heat exchanging contact between the outlet (6) and inlet (5). As shown, the heat pump (2) is arranged right on top of the tank (4). The first (3) and second (7) fluid circuit each comprise a coiled section (16, 17), wherein in particular at least a part of the coiled section (16) of the first fluid circuit (3) is provided within the coiled section (17) of the second fluid circuit (7).

[0029] The inlet (5) for example is used to feed, relatively cold, tap water to the circuit (7). Upon travelling towards the outlet (6) this water heats up and exits the circuit (7) as hot water via the outlet (6).

[0030] In the shown embodiment the system (1) comprises a third fluid circuit extending between a third inlet (8) and a third outlet (9) of the buffer tank(4), wherein the third fluid circuit may be used with a radiator, in heat exchanging contact with the buffer fluid in the third fluid circuit. The inlets (5, 8) on the tank (4) are located on the bottom portion of the tank, whereas the outlets (6, 9) are located on upper portions of the tank.

[0031] The heat pump (2) shown comprises an air extractor (10), to extract heat from ambient air and/or an air intake (11) and/or an air exhaust (12), to intake and exhaust air from the heat pump to the surroundings. The buffer tank (4) is also provided with a heating element (13) to heat up the buffer fluid in the buffer tank (4) and a flange (14) allowing access to the inside of the tank (4). The

system (1) is further provided with a controller (15), controlling operation of the system (1). Although not shown in the figures, the inside of the buffer tank (4) may comprise a number of balls filled with phase changing material to increase the buffer capacity of the tank (4).

[0032] Figures 3 and 4 show perspective views on the heating system (1) as shown in figures 1 and 2, in covers. The complete system (1) this way forms an integrated single piece, which needs installing by attaching the inlets (5, 8), outlets (6, 9) and air intake and outtake (11, 12).

[0033] Figure 5 shows a wireframe view on the systems of the previous figures.

[0034] Figure 6 shows an embodiment of the phase changing material according to the invention. Figure 6 schematically shows a sphere (31) which can be filled with phase changing material. The diameter (D) of the sphere (31) may be about 63mm for instance. Towards the top of the sphere (31) an opening (32) is present to be able to fill the sphere with phase changing material (16). In the opening (32) a nut (33) may be applied, for instance by welding, which nut (33) is provided with a threaded through opening (34). In that opening (34) a bolt (35) with silicon rubber gasket ring (37) may be inserted, to seal or close the opening (34). The bolt (35) may be provided with a recess (36) for accommodating a tool, like a bit, for example a torx or hexagonal bit, to operate the bolt (35).

[0035] Figure 7 schematically shows the sphere (31) of figure 6 in assembled condition. The sphere (31) may also be comprise two portions, an upper portion (38) and a lower portion (39) welded together by a welded connection (40). The nut (33) is welded to the sphere (31) by a second welded connection (41).

[0036] Figure 8 schematically shows a system according to the invention, integrated to a home heating system. A cold water source (18) is shown, delivering cold water to the inlet (5). Upon heating in the second fluid circuit (7) hot water exits via the outlet (6) to a hot water point, such as a shower (19). Also shown is a heating device in the form of a radiator (20). Hot fluid leaves the tank (4) via the outlet (9), via a valve (21) to the radiator (20) to give off heat. Fluid that has passed through the radiator (20) is fed back to the inlet (8), in this case via a pump (22). The valve (21) can be used to bypass this heating device loop and send fluid from the outlet (9) to the inlet (8) directly. This would increase heating in the section of the coiled sections (16, 17). For example, when demand for hot water at the outlet (6) is high, the controller of the system may determine to temporarily switch off heating with the radiator (20) and focus on heating tap water (18) for the shower (19). The buffer tank (4) further comprises balls (31) filled with phase changing material arranged to be in heat exchanging contact with the buffer fluid.

[0037] The above-described inventive concepts are illustrated by several illustrative embodiments. It is conceivable that individual inventive concepts may be applied without, in so doing, also applying other details of the described example. It is not necessary to elaborate on examples of all conceivable combinations of the above-described inventive concepts, as a person skilled in the art will understand numerous inventive concepts can be (re)combined in order to arrive at a specific application.

[0038] The verb "comprise" and conjugations thereof used in this patent publication are understood to mean not only "comprise", but are also understood to mean the phrases "contain", "substantially consist of", "formed by" and conjugations thereof.

Claims

1. Heating system for heating a home, comprising:

a. A heat pump provided with a first fluid circuit, configured to heat a first fluid in the first fluid circuit;
b. A buffer tank, comprising at least one inlet for receiving a second fluid and at least one outlet for delivering the second fluid; and comprising a buffer fluid;
c. A second fluid circuit extending between the inlet and the outlet of the buffer tank;
d. Wherein the first fluid circuit extends at least partially into the buffer tank, to heat the buffer fluid;
e. Wherein the first and second fluid circuits are at least partially in heat exchanging contact within the buffer tank, to heat up fluid in the second fluid circuit.

2. Heating system according to claim 1, wherein the heat pump comprises an air extractor, to extract heat from ambient air and/or an air exhaust, to exhaust air from the heat pump to the surroundings.

3. Heating system according to one of the preceding claims, wherein the buffer tank comprises an opening allowing at least a part of the first fluid circuit to access the interior of the buffer tank.

4. Heating system according to one of the preceding claims, comprising a third fluid circuit extending between a third inlet and a third outlet of the buffer tank comprising the buffer fluid, wherein the third fluid circuit optionally comprises a heating element, such as a radiator, in heat exchanging contact with the buffer fluid in the third fluid circuit.

5. Heating system according to one of the preceding claims, wherein the buffer tank comprises a phase changing material, arranged to be in heat exchanging contact with the buffer fluid, wherein the phase changing material preferably comprises spheres or shells filled with the phase changing material, preferably made of a metal and more preferably stain-

less steel, wherein the spheres or shells preferably comprise a salt hydrate.

6. Heating system according to one of the preceding claims, wherein the buffer tank is provided with a heating element, such as an electric heating element, to heat up the buffer fluid in the buffer tank.

7. Heating system according to one of the preceding claims, wherein the buffer tank has an upper side and a bottom side, wherein the inlet is provided in the bottom side and the outlet is provided in the upper side.

8. Heating system according to any of the preceding claims, wherein the first and second fluid circuit each comprise a coiled section, wherein in particular at least a part of the coiled section of the first fluid circuit is provided within the coiled section of the second fluid circuit.

9. Heating system according to claim 8, wherein the first and second fluid circuits each comprise a coiled tubular section, such as coiled stainless steel or copper tubing.

10. Heating system according to any of the preceding claims, wherein the heat pump is provided on top of the buffer tank.

11. Heating system according to any of the preceding claims, wherein the heat pump is housed in a first housing and the buffer tank is housed in a second housing, wherein the two housings are attached to each other, wherein preferably the first housing is arranged directly on top of the second housing.

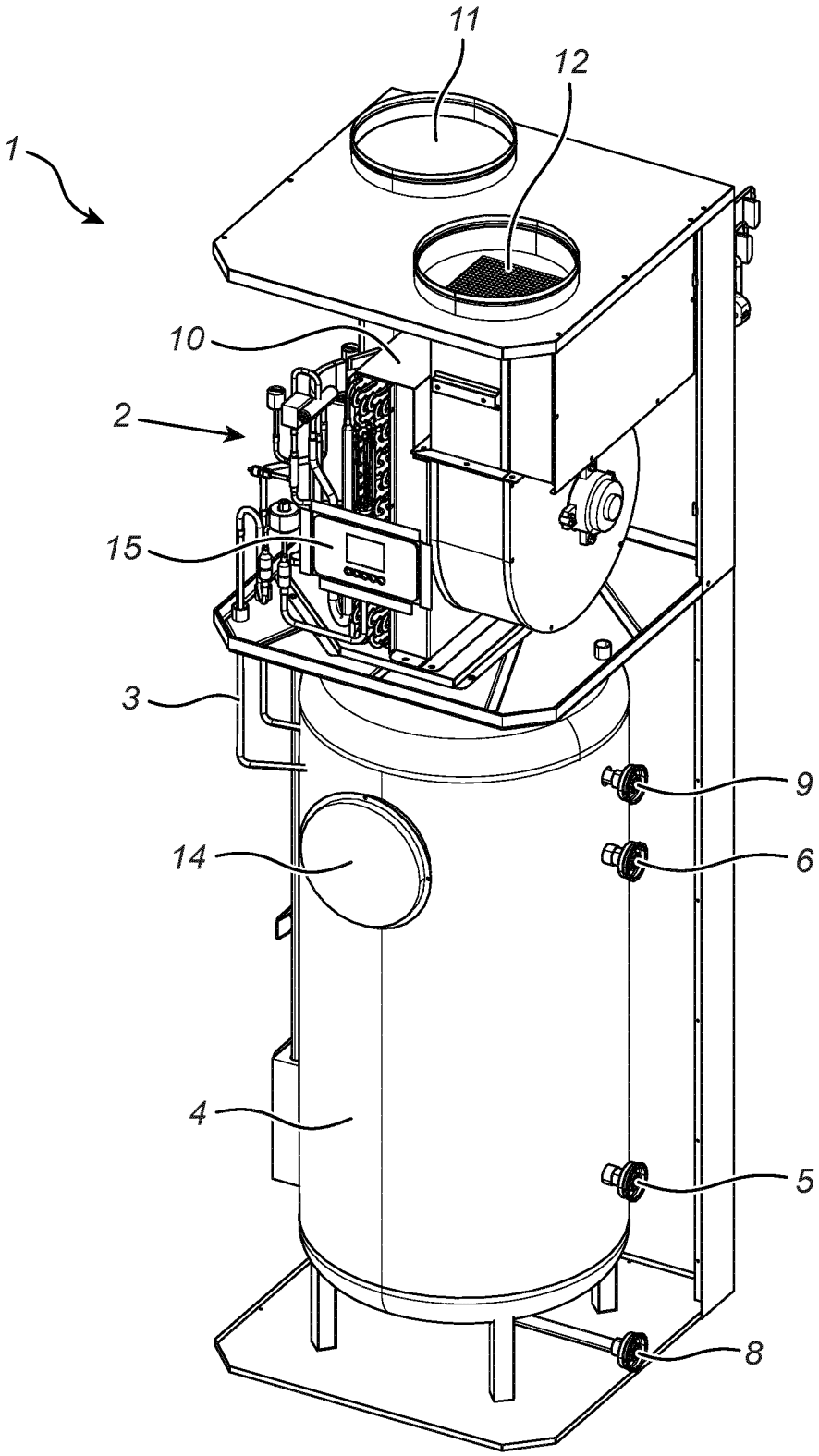

Fig. 1

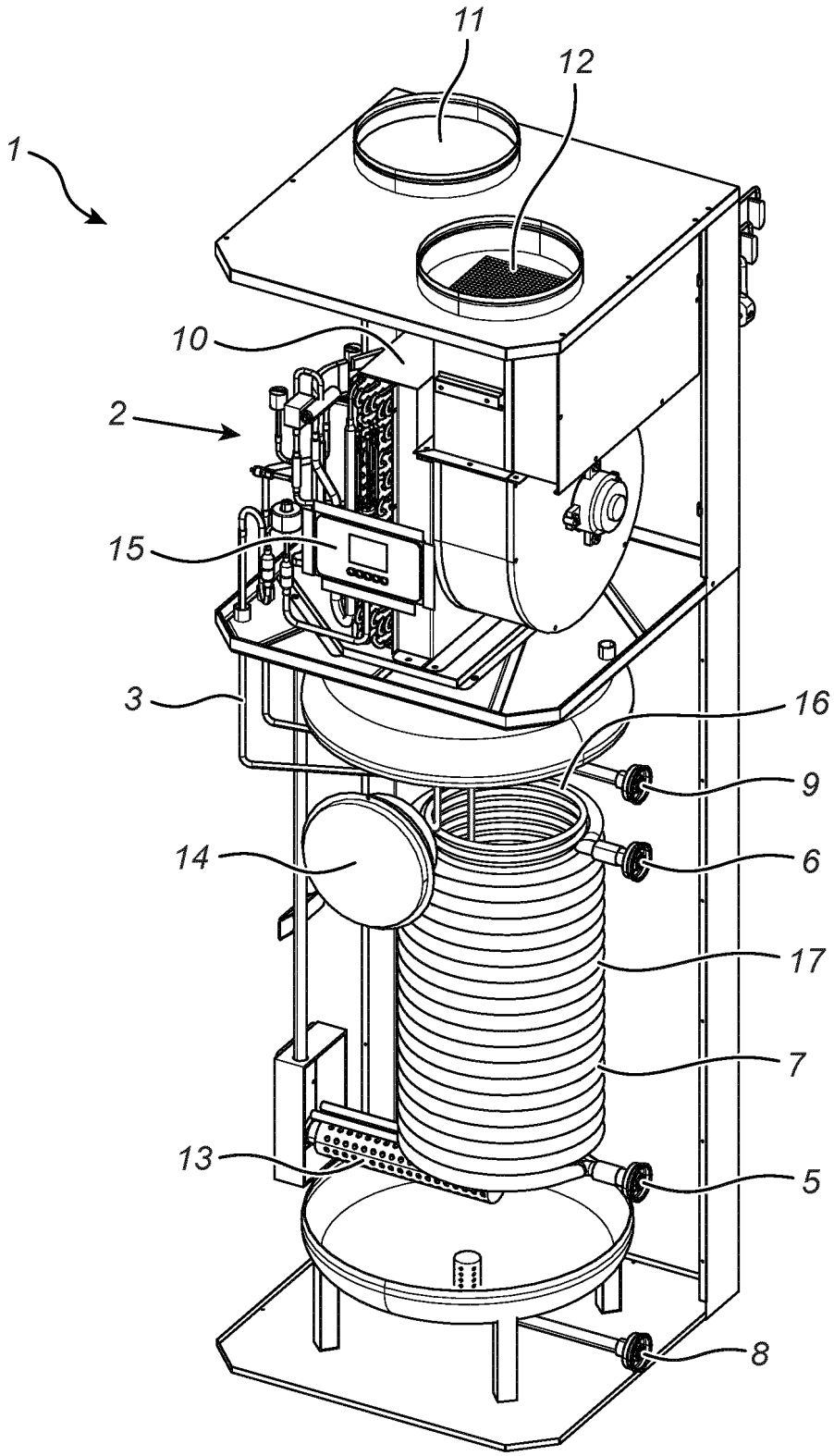

Fig. 2

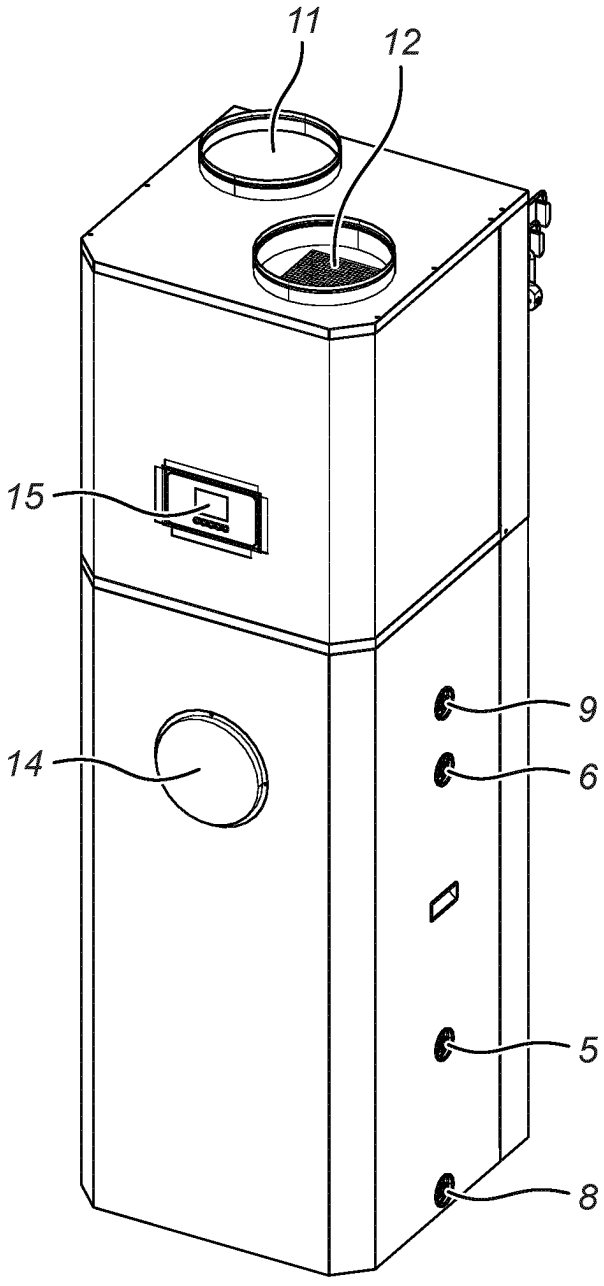

Fig. 3

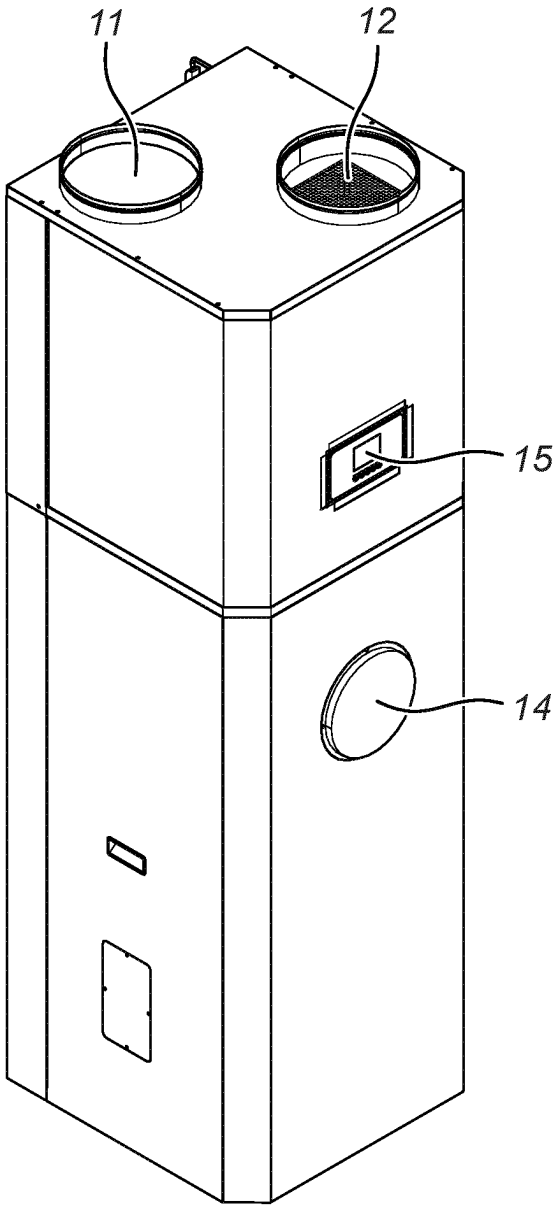

Fig. 4

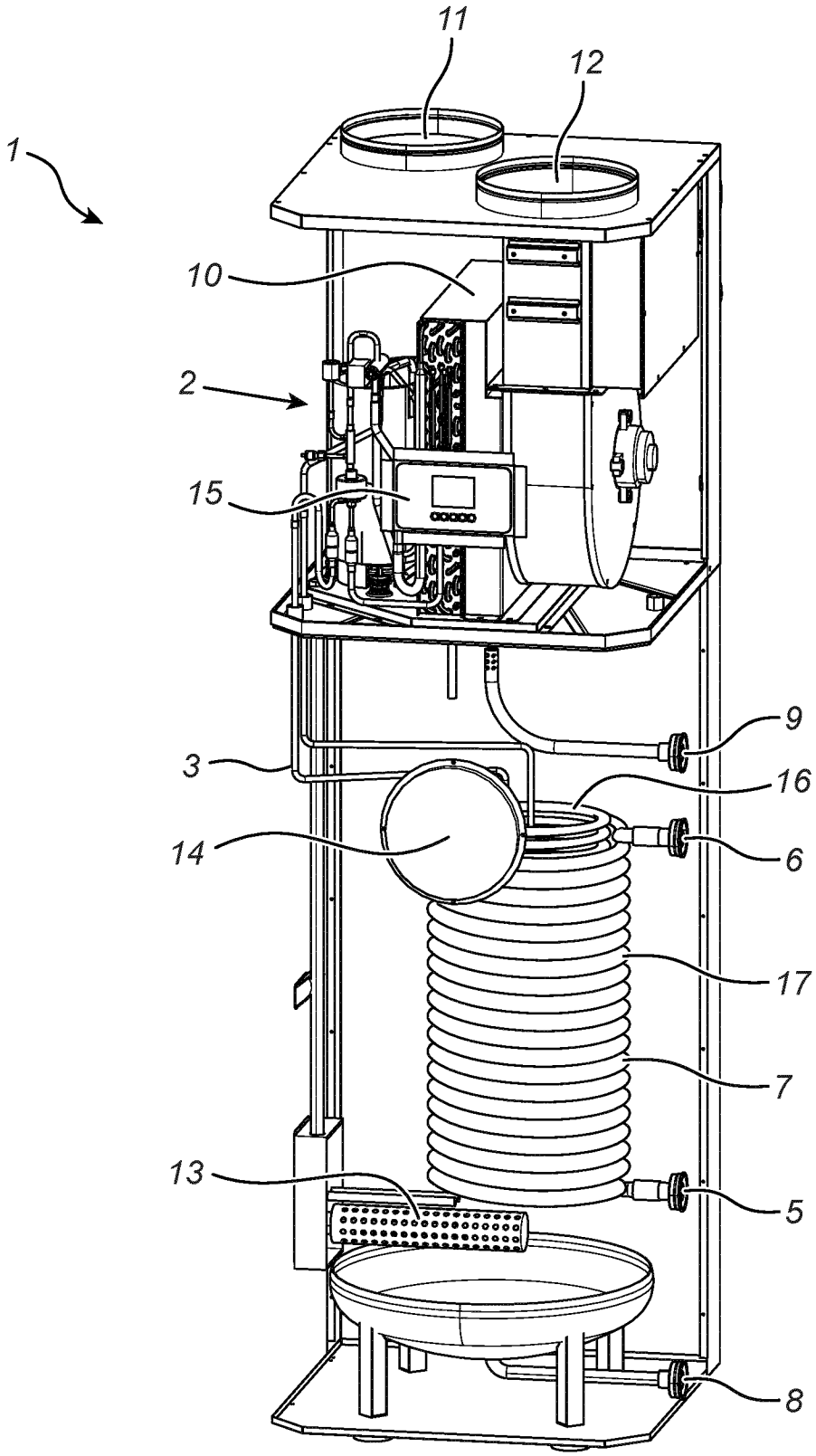

Fig. 5

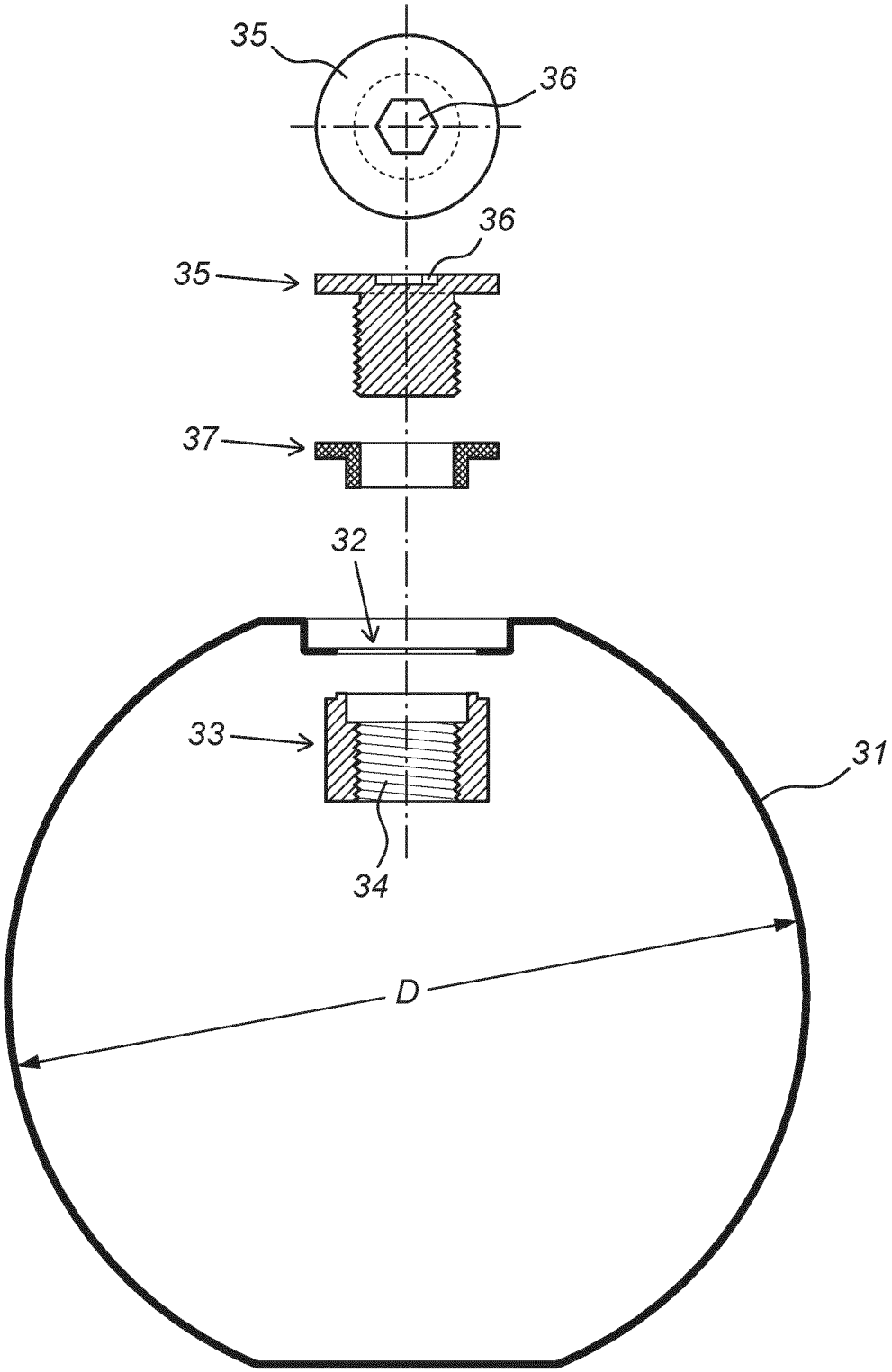

Fig. 6

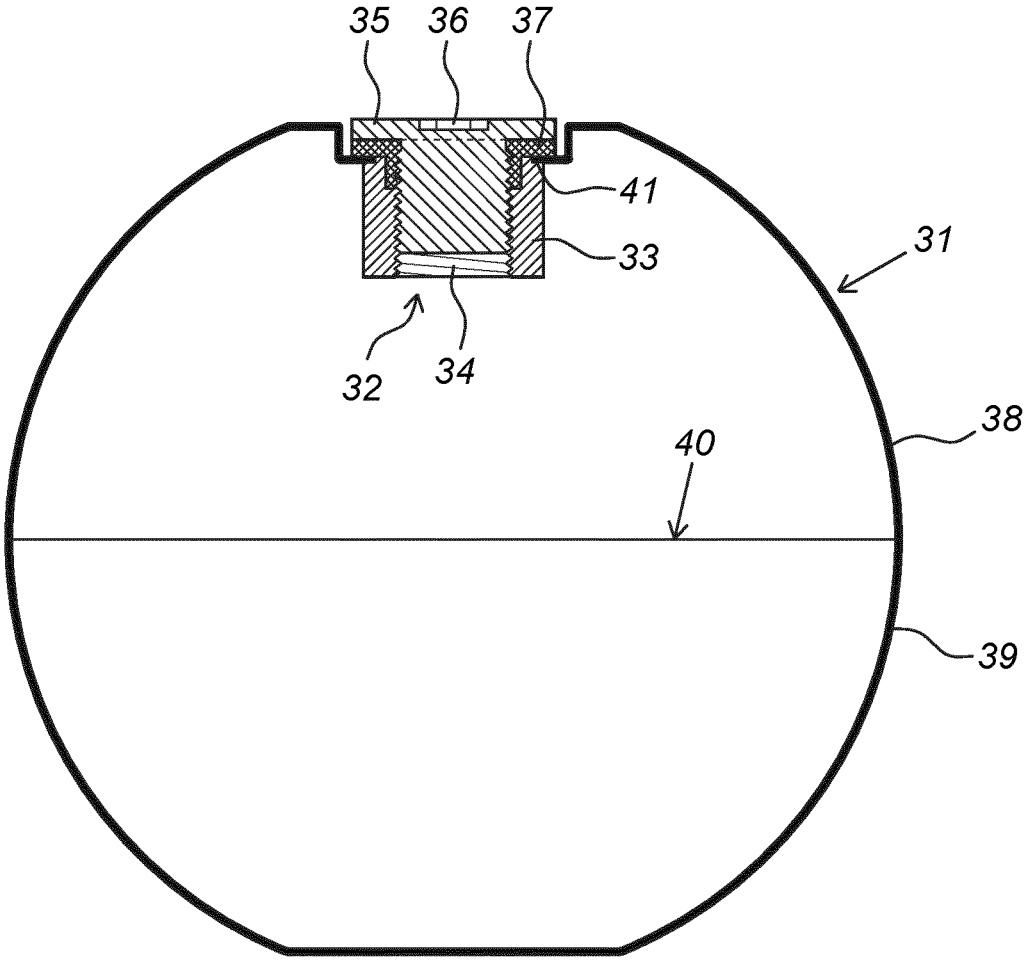

Fig. 7

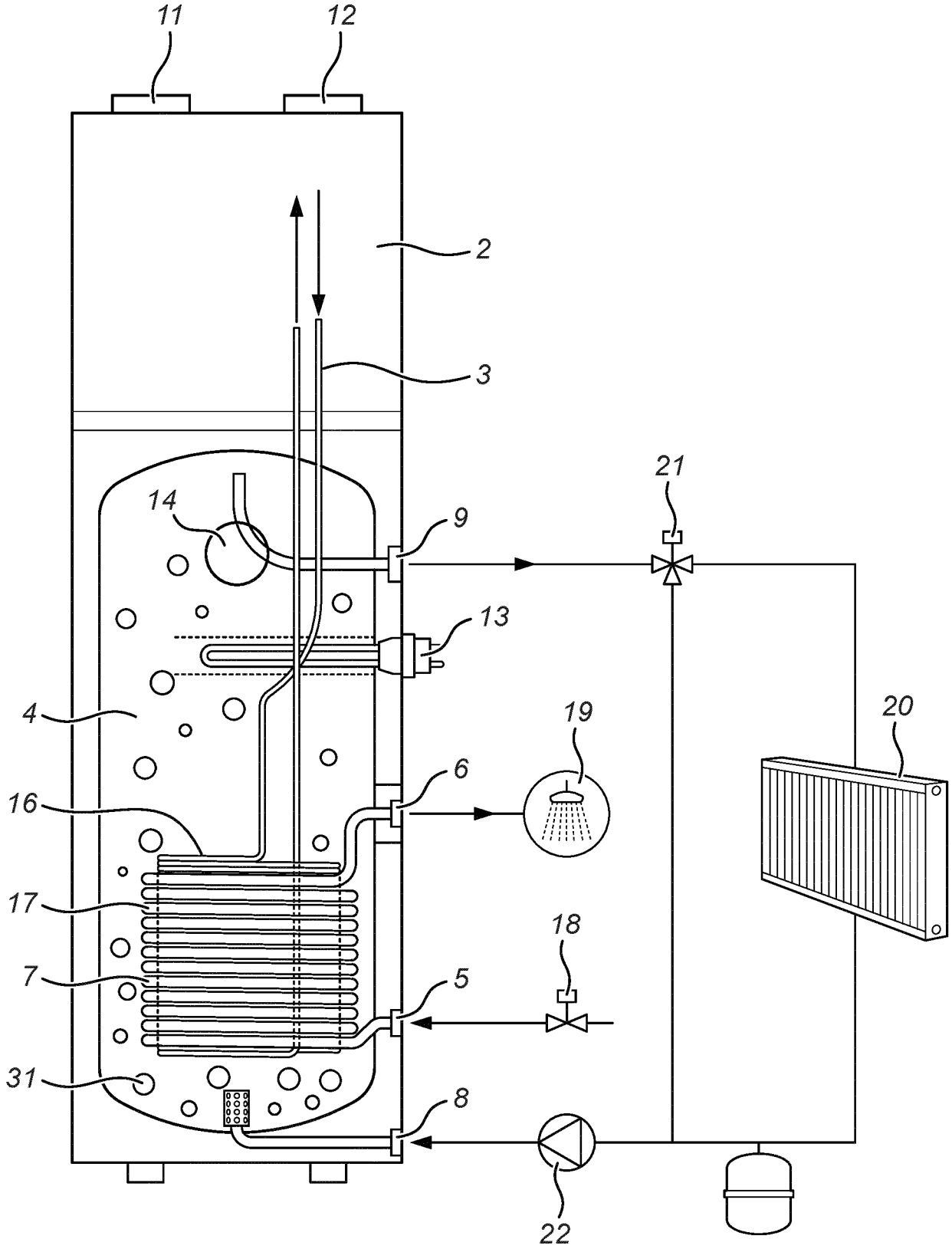

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 3915

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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F24D
F24H
F28D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 January 2024	Hoffmann, Stéphanie

CATEGORY OF CITED DOCUMENTS

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