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(54) HEATING SYSTEM

(57) The present invention relates to a heating system, comprising a buffer device, comprising an first inlet for receiving a first fluid and a first exit for delivering the first fluid; a heat pump, a first circuit extending from the first exit of the buffer device, via the heat pump, to the first inlet of the buffer device; wherein the buffer device comprises a second inlet for receiving a second fluid, and a second exit for delivering the second fluid, a second fluid circuit extending between the second inlet and the second exit of the buffer device; wherein the second fluid circuit is at least partially in heat exchanging contact with the first fluid of the buffer device; wherein the buffer device comprises a third inlet for receiving the first fluid and a third exit for delivering the first fluid; a third fluid circuit extending between the third inlet and the third exit of the buffer device; wherein the third fluid circuit comprises a heating element, in heat exchanging contact with the first fluid in the third fluid circuit; wherein the buffer device comprises at least two sections, wherein a first section comprises the first inlet, the second outlet, the third inlet and the third exit; and wherein a second section comprises the first exit and the second inlet; wherein the buffer device comprises a phase changing material, arranged to be in heat exchanging contact with the first fluid of the buffer device; wherein the phase changing material is preferably arranged in at least one of the two sections.

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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. With the heating system according to the invention basically three flows of fluid are provided. The first one through a heat pump and circulating through a buffer device and back to the heat pump. The second one from a municipal drinking water network through the buffer corrugated coil heat exchangers and out to a hot water tap. The third one through a heating system by means of radiators and circulating through the buffer device and heating up the house for instance The heat pump increases the temperature of the fluid running through, this increasing the temperature of the buffer device as a whole. The first flow of fluid is partly in heat exchanging contact with the third flow. The third flow of fluid is heated by the first flow and the heat exchange from the phase changing spheres between its travel from inlet to outlet.

[0006] The present invention aims to prevent that the relative warm flows of fluid from the third flow thus from the heating system, is warming up the return to the heat pump in the first section of the buffer device. An extra cooling takes place in the combined heating and domestic hot water mode in the second section of the buffer device. Such configuration is especially useful when using CO2 heat pumps, which operate particularly efficient with relative high temperature differences or deltaT between the return inlet and supply outlet, opposed to more traditional heat pumps. The relatively high temperatures are contained in the first section of the buffer device. When the second section of the buffer device is provided with cold water from the municipal drinking water network the first flow of fluid is cooled down to lower temperatures. The first section may be larger compared to the second section to provide sufficient volume relating to the heating component of the system. The second section may thus be arranged to have a lower average temperature compared to the first section.

[0007] The buffer device, and preferably the first section thereof, comprises phase changing material, which is used to store heat upon a phase change. The use of such material allows heat to be stores in efficiently 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.

[0008] In a preferred embodiment the phase changing material has a phase changing temperature between 30 and 90 degrees Celsius, more in particular between 40 and 80, more in particular between 60 and 75 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.

[0009] 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. 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 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 in buffer devices with a maximum volume of 500L. Additionally the phase changing material is separated from the rest, in particular the fluid, of the buffer device to prevent any unwanted interactions or reactions between the phase changing material and the rest.

[0010] 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.

[0011] The heating system according to the invention is configured to provide relatively high temperatures, in particular in the first section of the buffer device, such that the system can be used to replace conventional heating systems without replacement of the complete existing heating infrastructure.

[0012] The third exit and/or first inlet may be arranged near the top of the buffer device and the first exit and/or second inlet may be arranged near the bottom of the buffer device. This way warm water is fed into the buffer device from the top and colder water is extracted from the buffer device from the bottom.

[0013] The buffer device may be placed in an upright position, with its longitudinal axis along a vertical. It is also possible to place the buffer device in a flat position, with its longitudinal position along a horizontal, which allows the buffer device to be placed in other areas such as under roofing and other more difficult accessible parts of a house.

[0014] In a preferred embodiment the heat pump is a CO2 air/fluid heat pump, or CO2 air/water heat pump. This heat pump typically uses or extracts surrounding heat from the environment to heat the fluid running through. A CO2 air/fluid heat pump can operate at relatively low outside temperatures and is efficient when being supplied with relatively cold inlet fluid to heat to high temperatures. These high temperatures can be used in existing heating infrastructure, for instance when the system is replacing conventional oil or gas burners or gas boilers. The heat pump, in particular the CO2 air/fluid heat pump, may be arranged to heat the fluid up to a temperature of 80-90 degrees Celsius.

[0015] CO2 air/fluid heat pumps are preferred over conventional heat pumps as these conventional systems typically use cooling materials like R407C, R410A or R134A, which are very powerful greenhouse gasses with high global warming potential. CO2 has far less impact on global warming compared to the widely used materials. The heat pump may have a power of 3.5 - 10kW, in particular 4 - 8.5kW.

[0016] The first circuit and/or the heat pump may comprise a solar panel for providing electricity to the heat pump. The second and/or third circuit may comprise a thermal solar collector, for warming fluid in the second and/or third circuit. In all three 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 device may comprise at least one, preferably at least two sensors, to monitor temperatures insides the buffer device, which sensors may be arranged at different heights of the buffer device. The buffer device may also comprise a heating element, in the first section of the buffer device, which may be used to heat the fluid in the buffer device in case additional heating is required. This can be necessary when outside temperatures are very low and as a result the heat content is low. Secondly the heating element can be used in case of technical problems as an emergency heater. On top of the buffer device a flange connection may be arranged, to fill up the buffer device with the phase changing material spheres.

[0018] The buffer device may have a total capacity of 200-500L which, when comprising phase changing materials, is sufficient to replace existing conventional systems. Preferably the buffer device is insulated, to maintain as much heat as possible.

[0019] In a preferred embodiment the second fluid circuit comprises a coiled part, preferably at least two coiled parts, at least one per section. The coiled parts are in particular formed by corrugated coil parts. Coiled parts, and corrugated coil circuits in particular, increase the available surface for energy or heat transfer this improving energy transfer and thus a more efficient heating of fluids.

[0020] 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. In practise the temperature at the second inlet may be lowest and the temperature at the first inlet may be highest. The temperature at the third exit may be lower than the temperature at the first inlet, but higher than the temperature at the second inlet. The temperature at the third inlet may be lower than the temperature at the third exit, but higher than the temperature at the second inlet.

[0021] The first fluid circuit, which comprises the heat pump, may comprise a flow controller, between the first exit and the heat pump. The flow controller may be used to control the flow of fluid though the heat pump. Depending on the temperature of the fluid to be heated by the heat pump, the flow of that fluid may be regulated. For example, when the fluid to be heated by the heat pump is colder, the heat pump may require more contact time with the fluid in order to fully heat the fluid and flow may be reduced (and vice versa).

[0022] The second fluid circuit may comprise a flow switch, between a source of the fluid and the second inlet of the buffer device. The flow switch may be used to detect the flow of the second fluid, for instance when tap water is requested by the system.

[0023] The second 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 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 may be arranged to operate within a certain temperature bandwidth. If the controller senses that the temperature in the second section of the buffer device, leading to the heat pump, is outside that bandwidth, the controller could send a signal to turn off the heat pump.

[0026] When the controller for example senses that the flow switch detects flow of second fluid, this fluid needs to be heated. To facilitate this heating the controller may send a signal to the valve of the second fluid circuit to bypass the heating element. This way all heating capacity is used to warm the second fluid. The controller may also turn on the pump of the second fluid circuit, to create a flow of fluid in the first section of the buffer device. This flow increases the heat exchange between the phase changing material and the fluid in the first section and thus the heat exchange between the second fluid and the third fluid.

[0027] 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.

[0028] The present invention also relates to a sphere for encapsulating the phase changing material. The diameter of the sphere may be about 40-110mm, more in particular 60-90mm, more in particular about 63mm or 80mm for instance. Towards the top of the sphere an opening may be present to be able to fill the sphere with phase changing material. In the opening a nut may be applied, for instance by welding, which nut is provided with a threaded through opening. In that threaded through opening a bolt with silicon rubber gasket ring may be inserted, to seal or close the threaded through opening. The bolt may be provided with a recess for accommodating a tool, like a bit, for example a torx or hexagonal bit.

[0029] The invention will be elucidated on the basis of non-limitative exemplary embodiments shown in the following figures, wherein

- Figure 1 schematically shows a heating system according to the invention;
- Figure 2 schematically shows the operation of a heating system according to the invention;
- Figure 3 schematically shows the components of a sphere for encapsulating the phase changing material according to the present invention; and
- Figure 4 schematically shows the sphere of figure 3 in assembled condition.

[0030] Figure 1 schematically shows a heating system (1) according to the invention, comprising a buffer device (2) with an first inlet (3) for receiving a first fluid and a first exit (4) for delivering the first fluid. The system (1) further shows a heat pump (5), such as a CO_2 air/water heat pump, arranged to heat the first fluid from a first temperature to a higher second temperature, as well as a first circuit (6) extending from the first exit (4) of the buffer device (2), via the heat pump (5), to the first inlet (3) of the buffer device (2). The buffer device (2) comprises a second inlet (7) for receiving a second fluid, such as tap water, and a second exit (8) for delivering the second fluid, such as heated tap water, as well as a second fluid circuit (9) extending between the second inlet (7) and the second exit (8) of the buffer device (2). The second fluid circuit (9) is at least partially in heat exchanging contact with the first fluid in the buffer device (2) to heat up the second fluid. The buffer device (2) further comprises a third inlet (10) for receiving the first fluid and a third exit (11) for delivering the first fluid with a third fluid circuit (12) extending between the third inlet (10) and the third exit (11) of the buffer device. The third fluid circuit (12) comprises a heating element (13), such as a radiator, in heat exchanging contact with the first fluid in the third fluid circuit (12). The buffer device (2) comprises two sections (14, 15), wherein a first section (14) comprises the first inlet (3), the second exit (8), the third inlet (10) and the third exit (11) and wherein a second section (15) comprises the first exit (4) and the second inlet (7). The buffer device (2) further comprises a phase changing material (16), arranged to be in heat exchanging contact with the first fluid of the buffer device (2). The phase changing material (16) is arranged in spheres or shells of stainless steel filled with a salt hydrate.

[0031] The two sections (14, 15) are connected by a channel (17), wherein the two sections (14, 15) are in fluid contact with each other wherein the first section (14) is larger, in volume, compared to the second section (15).

[0032] The second exit (8) may for instance be used to couple to a hot water outlet (18) or shower head (19). The second inlet (7) may for instance be connected to a cold water supply (20).

[0033] In a preferred embodiment the third exit (11) is arranged near the top of the buffer device (2) and the first exit (4) is arranged near the bottom of the buffer device (2). Although figure 1 shows the buffer device (2) in an upright position, with its longitudinal axis along a vertical it is also possible to place the buffer device (2) in a flat position, with its longitudinal position along a horizontal, which allows the buffer device (2) to be placed in other areas such as under roofing and other more difficult to access portions of a house.

[0034] Figure 1 also schematically shows various sensors (21), to monitor temperatures or pressures insides the buffer device (2), which sensors (21) may be arranged at different heights. Furthermore figure 1 shows a heating element (22), in the top section of the buffer device (2), which can be used to heat the buffer device (2) in case additional heating is required. On top of the buffer device (2) a flange connection (23) is be arranged, to fill up the device (22) with the phase changing material spheres (16) when needed.

[0035] Figure 2 schematically shows a heating system as shown in figure 1, wherein corresponding parts are provided with corresponding reference signs. Figure 2 further shows a thermostat (24) connected to a controller (25). The controller (25) is also connected to the heat pump (5) and to the temperature sensors (21) of the device. A flow switch (26), a flow controller (27), a 3-way valve (28) and pumps (29, 30) are also shown schematically which are all in contact with the controller (25).

[0036] When the thermostat (24) indicates that a higher temp is needed, the controller (25) for example opens the three way valve (28), that is normally closed, to the radiator (13) and activates the pump (30). The valve (28) may also be used to bypass the radiator (13) in case the controller (25) requests warm water, such that all heat in the system is used to heat up water, wherein the flow switch (26) is operated as well. When the temperature sensor (21) in the buffer measures that the temperature in the first section (14) of the buffer device (2) is too low, the controller (25) may activate the pump (29), open the flow switch (27) and have fluid flow from the second section (15) through the heat pump (5) and back into the device (2).

[0037] The dotted lines in figure 2 indicate that the components and the controller (25) are in communication with each other or connected with each other.

[0038] Figure 3 schematically shows a sphere (31) which can be filled with phase changing material (16). 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).

[0039] Figure 4 schematically shows the sphere (31) of figure 3 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).

[0040] 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.

[0041] 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, comprising:

a) A buffer device, comprising an first inlet for receiving a first fluid and a first exit for delivering the first fluid;

b) A heat pump, arranged to heat the first fluid from a first temperature to a higher second temperature;

c) A first circuit extending from the first exit of the buffer device, via the heat pump, to the first inlet of the buffer device;

d) Wherein the buffer device comprises a second inlet for receiving a second fluid, such as tap water, and a second exit for delivering the second fluid, such as heated tap water,

e) A second fluid circuit extending between the second inlet and the second exit of the buffer device

f) Wherein the second fluid circuit is at least partially in heat exchanging contact with the first fluid of the buffer device, preferably to heat up the second fluid;

g) Wherein the buffer device comprises a third inlet for receiving the first fluid and a third exit for delivering the first fluid;

h) A third fluid circuit extending between the third inlet and the third exit of the buffer device;

i) Wherein the third fluid circuit comprises a heating element, such as a radiator, in heat exchanging contact with the first fluid in the third fluid circuit;

j) Wherein the buffer device comprises at least two sections,

a. wherein a first section comprises the first inlet, the second outlet, the third inlet and

the third exit; and
b. wherein a second section comprises the first exit and the second inlet

k) Wherein the buffer device comprises a phase changing material, arranged to be in heat exchanging contact with the first fluid of the buffer device; wherein the phase changing material is preferably arranged in at least one of the two sections, more preferably in the first section.

2. Heating system according to claim 1, wherein the two sections are connected by a channel, wherein the two sections are in fluid contact with each other, wherein preferably the first section is larger compared to the second section.

3. Heating system according to any of the preceding claims, wherein the phase changing material comprises spheres or shells filled with the phase changing material, preferably made of a metal and more preferably stainless steel, wherein the spheres or shells preferably comprise a salt hydrate.

4. Heating system according to any of the preceding claims, wherein the second section is arranged to have a lower average temperature compared to the first section.

5. Heating system according to any of the preceding claims, wherein the heat pump is a CO2 air/water heat pump.

6. Heating system according to any of the preceding claims, the third exit and/or first inlet is arranged near the top of the buffer device and the first exit and/or second inlet is arranged near the bottom of the buffer device.

7. Heating system according to any of the preceding claims, wherein the first circuit and/or the heat pump comprises a solar panel for providing electricity to the heat pump.

8. Heating system according to any of the preceding claims, wherein the first, second and/or third circuit comprises a solar collector, for warming fluid in the first or third circuit.

9. Heating system according to any of the preceding claims, wherein the first fluid circuit comprises a flow controller, arranged between the first exit and the heat pump, for controlling the flow of first fluid through the heat pump.

10. Heating system according to any of the preceding claims, wherein the third fluid circuit comprises a flow switch, arranged between a source of the second fluid and the second inlet of the buffer device, for detecting flow of the second fluid.

11. Heating system according to any of the preceding claims, wherein the third fluid circuit comprises a valve, in particular a three-way-valve, arranged in between the third exit and the heating element and/or in between the third exit and the third inlet.

12. Heating system according to any of the preceding claims, wherein the buffer device comprises a temperature sensor, for measuring the temperature in the buffer device, wherein preferably both the first and second section are provided with a temperature sensor.

13. Heating system according to any of the preceding claims, comprising a controller, 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.

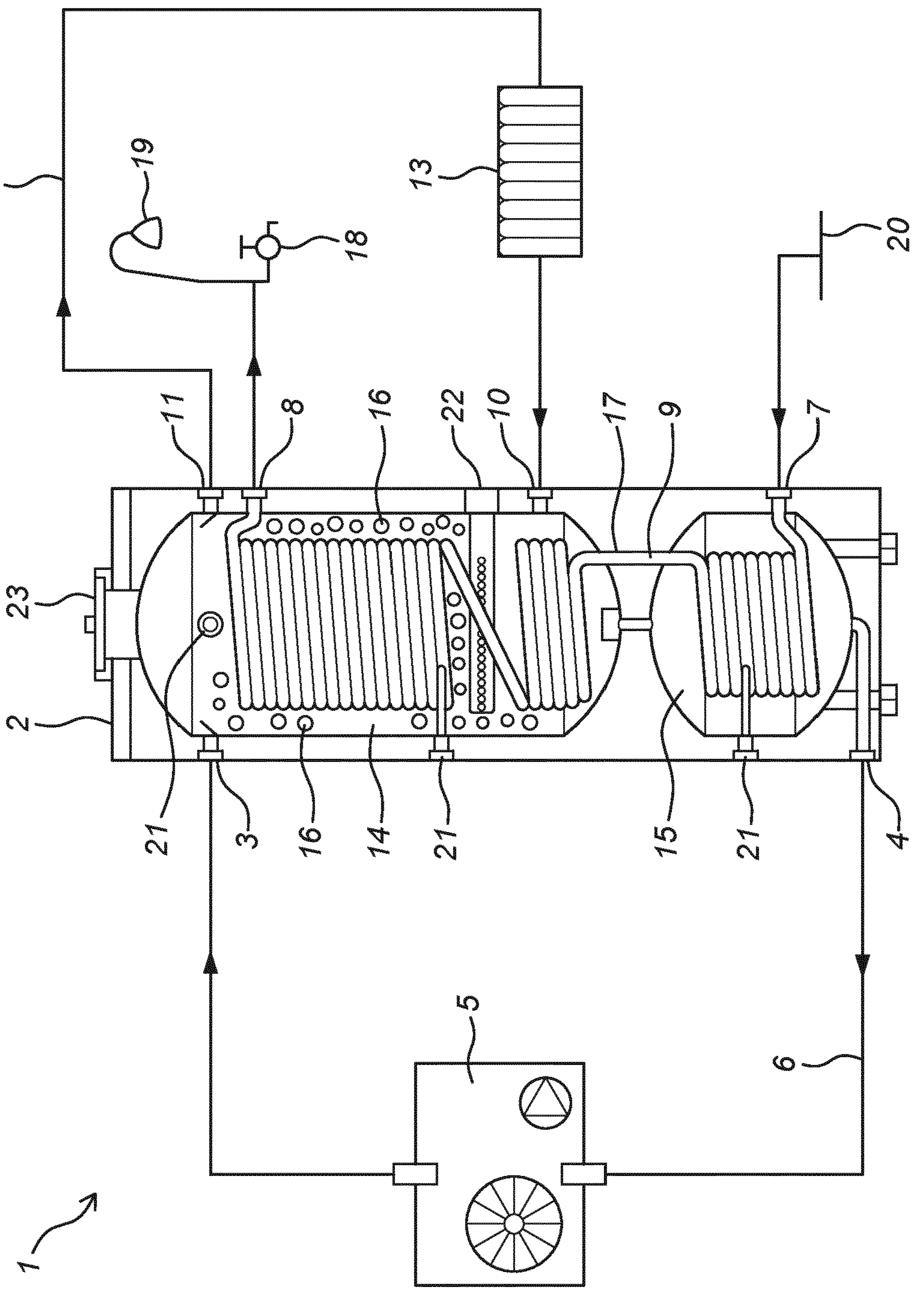

Fig. 1

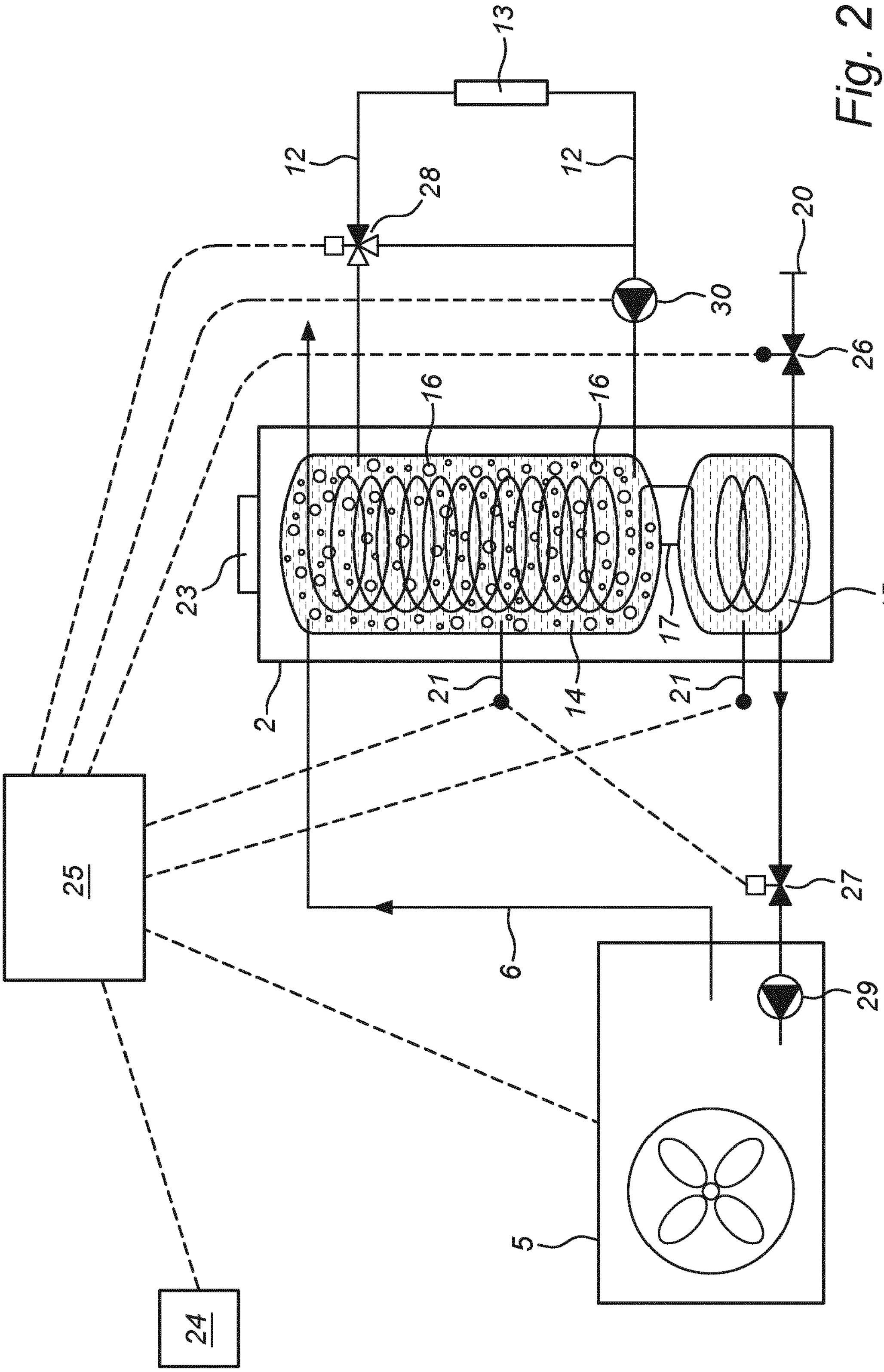

Fig. 2

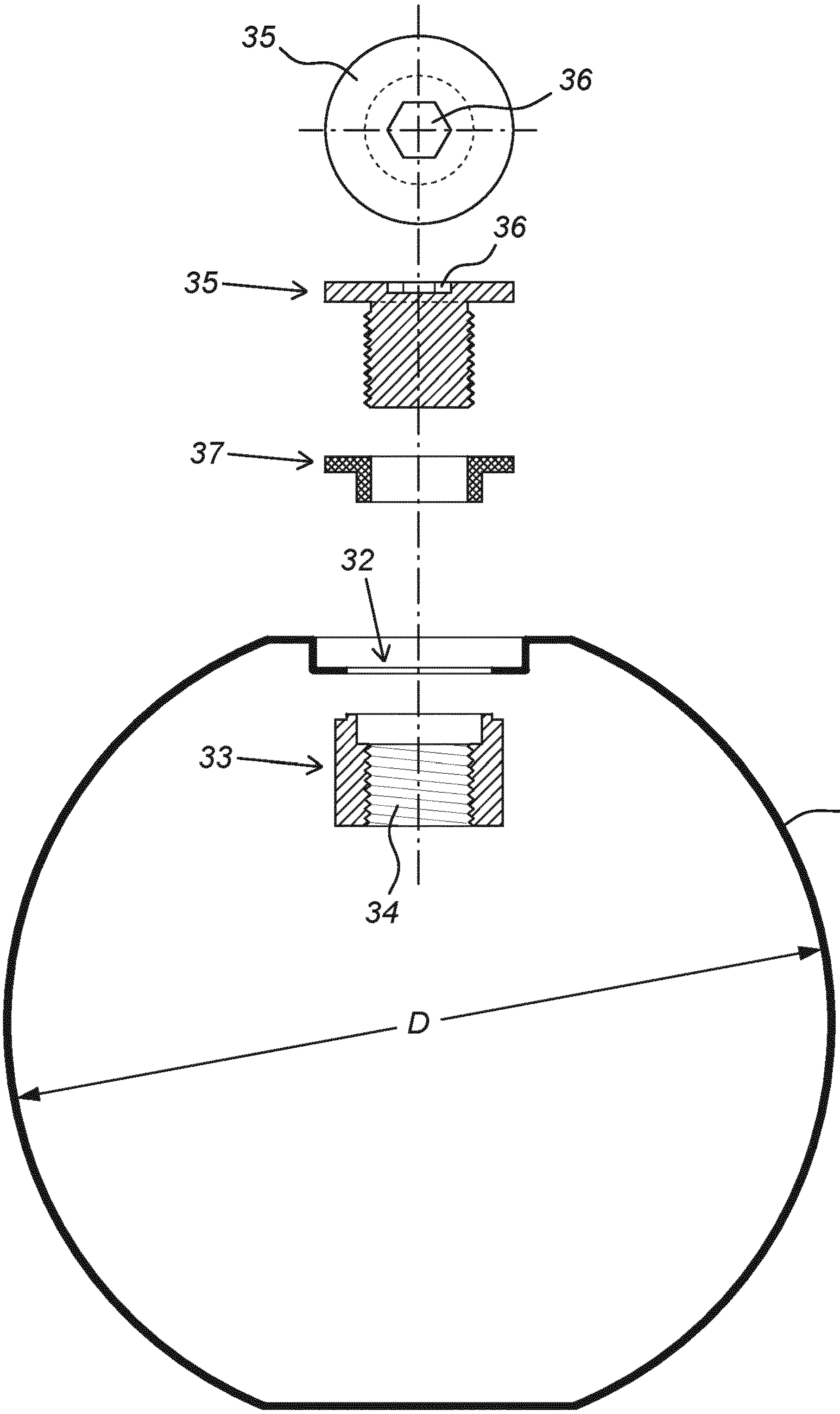

Fig. 3

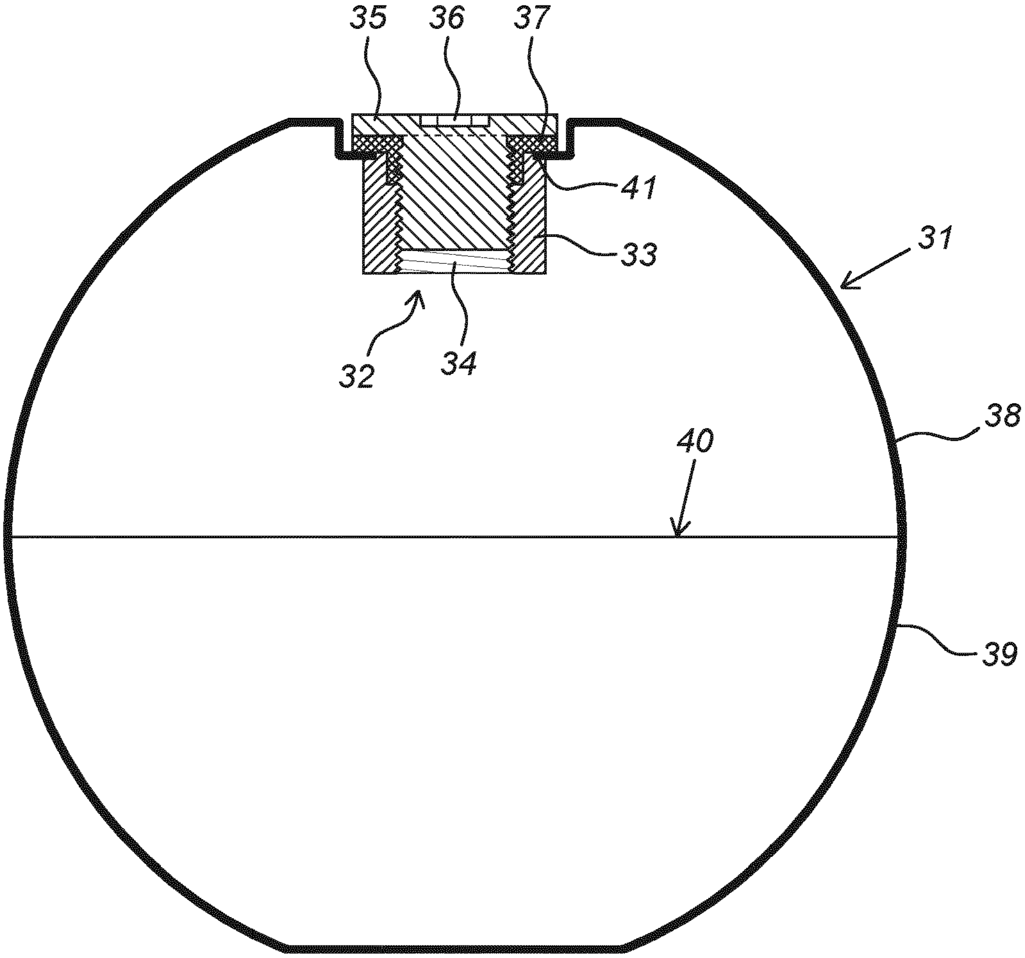

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 4129

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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Y	GB 2 510 375 A (BASIC HOLDINGS [IE]) 6 August 2014 (2014-08-06) * page 2, line 5 - page 12, line 13; figures 1-6 *	1-13	

TECHNICAL FIELDS SEARCHED (IPC)

F24D
F28F
F28D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	4 November 2022	Ast, Gabor

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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

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