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(54) **HYBRID HEATING SYSTEMS**

(57) The present invention pertains to an improved hybrid heating system design, incorporating a flow control unit that manages fluid flows between a primary heat source and a secondary heat source. The system efficiently manages heat and ensures anti-icing protection, making it uniquely applicable in domestic hot water production, closed-loop circuit for heating or cooling applications.

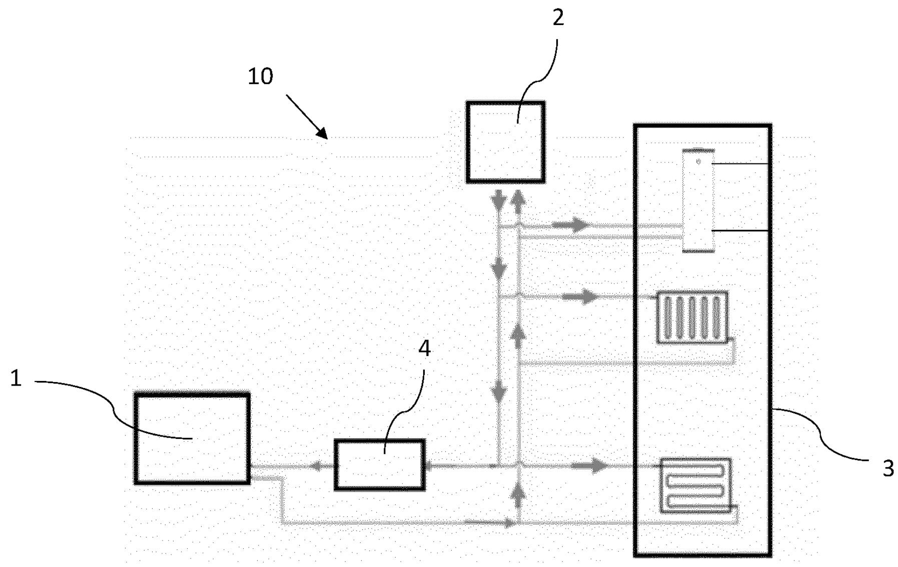

FIG. 1C

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Description

[0001] The present invention pertains to an improved hybrid heating system design, incorporating a flow control unit that manages fluid flows between a primary heat source and a secondary heat source. The system efficiently manages heat and ensures anti-icing protection of the primary heat source, making it uniquely applicable in domestic hot water production, closed-loop circuit for heating or cooling applications.

[0002] Traditional heating installations involve several heating devices connected in parallel mode on the same closed-circuit hydraulic heating circuit, such as a heat pump unit and other water heating devices like boilers or electrical water heaters. However, managing the heating control between different devices proves to be a challenge. The key issue being the risk of icing on the refrigerant/water heat exchanger from the primary heat source, which could result in the increase of the internal volume of the circuit, risk of breaking the exchanger, leaking refrigerant, leading to fire hazards or environmental pollution.

[0003] With these traditional installations, as long as there is access to the control parameters of the heating devices the issue of icing can be prevented by properly controlling each device. However, typically one of the devices was already installed well before installing any secondary device. Most of the times there is no access to the control parameters of the device that was already installed. Often this is circumvented by adding a decoupling tank to allow for different water flow in each heating circuit. This obviously requires additional modification of the installation and adding an additional tank to the installation.

[0004] As such, proper management of the heating control cannot be realized based on control parameters of the earlier device without having to modify and add an additional tank to the installation.

[0005] Hence, the need for a novel solution that can facilitate efficient and safe heat management in hybrid heating installations where there is no access to the control parameters of one of the heating devices or no possibility to add a decoupling tank easily to the installation.

[0006] The present invention pertains to an improved hybrid heating system design, incorporating a flow control unit that manages fluid flows between a primary heat source and a secondary heat source. The system efficiently manages heat and ensures anti-icing protection of the primary heat source, making it uniquely applicable in domestic hot water production, closed-loop circuit for heating or cooling applications.

[0007] In an embodiment, a flow control unit for a hybrid heating system is provided comprising a primary fluid connection configured to allow a primary fluid flow from a primary heat source to a closed-loop circuit and a secondary fluid connection configured to allow a secondary partial fluid flow from a secondary heat source to a primary heat source in an opposite direction to the primary fluid flow, wherein the flow rate for the primary fluid flow is greater than the flow rate for the secondary partial fluid flow, or wherein the minimal cross-sectional area of the primary fluid flow is bigger than the minimal cross-sectional area of the secondary partial fluid flow, and wherein the primary heat source is a heat pump.

[0008] In the present application, the term " minimal cross-sectional area" should be understood as the smallest passage surface of the flow inside the flow control unit. To identify the minimal cross-sectional area of the primary fluid flow and of the secondary partial fluid flow in the flow control unit, the minimum cross-sections through which the fluid passes in both directions should be identified. In each direction, this corresponds to the smallest cross-sectional area orthogonal to the wall through which the fluid passes. Here, the cross-sectional area of the primary fluid flow corresponds to surface area allowed by the passage of the fluid through the check-valve and the flow control valve, while the minimal cross-sectional area of the secondary partial fluid flow is only by the passage of the fluid through the flow control valve. Several methods can be used to measure these cross-sectional areas if the drawings of the flow control unit are not available, for instance tomography can be used.

[0009] The flow control unit allows full flow or passage of fluid, such as water, in the direction from the primary heat source to the closed-loop circuit when the first heat source is operated, said flow being called primary fluid flow. Moreover, the flow control unit allows a limited flow or passage of the same fluid in the direction from the secondary heat source towards the primary heat source when the secondary hear source is operated, said limited flow being called secondary partial fluid flow. This allows a partial circulation of the fluid from the secondary heat source towards the primary heat source to prevent icing at the primary heat source by using a limited amount of the heated fluid coming from the secondary heat source. Remaining flow coming from the secondary heat source when the secondary heat source is operated, and which is not part of the secondary partial fluid flow, goes directly to the closed-loop circuit, said remaining flow being called secondary left fluid flow. As such, the main secondary fluid flow is equal to secondary partial fluid flow and the secondary left fluid flow. The flow rate may be calculated by the formula $Q = A*v$, wherein A is the cross-sectional area of the flow and v is its average velocity. As an example for residential heat pump applications, a flow factor Kv of the primary fluid flow should preferably be larger than 6 when the first heat source is operated. A flow factor Kv of the secondary partial flow should, in this example, preferably be around 0.15 when the second heat source is operated. Thus, the ratio of the Kv measurable of the flow control unit should be larger than 40, where the ratio is calculated by dividing the flow factor Kv of the primary fluid flow by the flow factor Kv of the secondary partial fluid flow. Preferably, the ratio of the Kv for any heat pump application ranges from 40 to 100.

The flow control unit thus preferably has a valve or valve configuration to facilitate different flow rates in the two fluid flow directions.

[0010] In the present application, the term " fluid" can be water, brine, or a glycol-water mixture.

[0011] The closed-loop circuit may comprise at least one radiator, one heating and/or cooling floor, or one tank for sanitary applications such as a hot water tank, or any other heat emitters. Preferably the closed-loop circuit may comprise various type of heat emitters.

[0012] In an embodiment, the flow control unit is a unidirectional flow control valve. The flow control unit is a singular device which allows the flow control as described above. The unidirectional flow control valve may consist of multiple parts operating as a single valve allowing the same result as having a check-valve and a flow control valve. For instance, the flow control unit may be a traditional check-valve which as a small passage way, such as a small hole in its door, to allow a small amount of water to pass through the check-valve in an opposite direction of normal operation. Such a check-valve could be considered leaking.

[0013] In an embodiment, the flow control unit comprises a check-valve and a flow control valve wherein the flow control valve is a by-pass connection or is an additional valve situated on such a by-pass connection. For instance, the flow control unit may be a traditional check-valve that does not leak, so there is no small hole or passage in the check-valve present, and additionally has a small by-pass tube combing from the front of the check-valve to the back of the check-valve. The by-pass tube may act as a valve or may have an additional valve mounted to it.

[0014] In an embodiment, the flow control unit wherein the flow control unit is configured to allow the flow rate of the secondary partial fluid flow to a range of 0.02 to 0.15 m3/h when the secondary heat source is operated, and wherein the flow control unit is configured to allow the flow rate of the primary fluid flow to a range of 0.4 to 1.9 m3/h when the primary heat source is operated. The flow control unit is configured such that the ratio such that the flow rate of the primary fluid flow when the primary heat source is operated, over the flow rate of the secondary partial fluid flow when the secondary heat source is operated, is greater than 10, preferably greater than 20, more preferably equal to, or greater than 40. The flow rate of the secondary partial fluid flow can be measured when the second heat source is operated by placing a flow meter between the primary heat source and the flow control unit, or between the flow control unit and the start of the secondary partial fluid flow namely the point when the secondary main fluid flow splits into secondary partial fluid flow and secondary left fluid flow. The flow rate of the primary fluid flow can be measured when the primary heat source is operated by placing a flow meter between the primary heat source and the flow control unit, between the flow control unit and the closed-loop circuit, or between the closed-loop circuit and the primary heat source.

[0015] In an embodiment, the flow control unit comprises an adjustable setting mechanism configured to vary the secondary partial fluid flow rate when the second heat source is operated.

[0016] In an embodiment, the flow control unit comprises a filter to prevent particulates from entering any of the valves and/or inside the heat exchanger from the primary heat source.

[0017] In an embodiment, the flow control unit or any of the valves therein are made of steel, plastic, a composite material, a non-corrosive material, such as copper or brass, a material with a galvanizing treatment, a material with a cataphoresis treatment, or a material having a zinc or nickel surface treatment. In the present application, the term "composite material" should be understood as a combination of at least two materials, for instance steel and plastic.

[0018] In an aspect of the invention, a hybrid heating system for heating or cooling applications is provided comprising a flow control unit and a primary heating source connected to the flow control unit and a closed-loop circuit via a primary fluid flow when the primary heat source is operated;, and at least one secondary heating source connected to the flow control unit via a secondary partial fluid flow and connected to the closed-loop circuit via a secondary left fluid flow when the secondary heat source is operated, wherein the primary heat source is a heat pump; and wherein the primary fluid flow has a larger minimal cross-sectional area than the secondary partial flow inside the flow control unit or wherein the flow rate for the primary fluid flow is greater than the flow rate for the secondary partial fluid flow inside the flow control unit. The hybrid heating system can be used for heating or cooling a building, an apartment or a room, as well as for heating sanitary water.

[0019] In such a hybrid heating system, two or more heating sources may be provided wherein the flow control unit allows a partial circulation of a fluid from the at least one secondary heat source towards the primary heat source to prevent icing of the heat exchanger at the primary heat source by using a limited amount of the heated fluid coming from the secondary heat source when the secondary heat source is operated.

[0020] In an embodiment, the primary heating source is a heat pump comprising plate heat exchanger.

[0021] In an embodiment, the secondary heating source is a second heat pump, a boiler, a solar panel or an electric water heater. The secondary heating source may also be a combination thereof. The boiler may be a gas-heated boiler, using for instance natural gas or hydrogen gas, or an electrical heated boiler.

[0022] In an embodiment, the closed-loop circuit comprises a radiator, a heating and/or cooling floor, or a tank for sanitary applications such as a hot water tank.

[0023] In an embodiment, the hybrid heating system comprises a control box for electronically connecting the primary heat source and the secondary heat source.

[0024] In the present application, the term "control box" should be understood an electrical unit comprising at least a Human Machine Interface and/or a heating circuit management card allowing for instance the communication between the primary heat source and the secondary heat source. The control box may be connected to fluid temperatures sensors. The control box may be connected to a thermostat and a communication card such as PCB 12.

[0025] In an embodiment, the ratio of the minimal cross-sectional area of the primary fluid flow during operation of the primary heat source during operation of the primary heat source (1), over the minimal cross-sectional area of the secondary partial fluid flow during operation of the secondary heat source, inside the flow control unit is greater than 10, preferably greater than 20, or more preferably greater than 40.

[0026] In another aspect of the invention, a method of preventing icing of a heat exchanger of a primary heat source in a hybrid heating system is provided, wherein the method comprising the steps of operating the secondary heat source and circulating hot fluid from a secondary heat source partially into the primary source using a flow control unit as disclosed above to allow the hot fluid to flow in an opposite direction than the direction of the flow when operating the primary heat source.

[0027] In yet another aspect of the invention, a kit for a hybrid system installation is provided comprising a flow control unit according to any of the previous embodiments and a control box for electronically connecting the primary heat source and the secondary heat source.

[0028] In the figures, the subject-matter of the invention is schematically shown, wherein identical or similarly acting elements are usually provided with the same reference signs.

Fig. 1A	shows a schematic representation of a hydraulic circuit operation when the secondary energy source is running.
Fig.18	shows a schematic representation of a hydraulic circuit operation when the first energy source is running.
Fig. 1C	shows a schematic representation of a hydraulic circuit operation when the secondary energy source is running.
Fig. 2	shows a schematic representation of a flow control unit as a single-piece device being a unidirectional flow control valve.
Fig. 3	show a schematic representation of a flow control unit as a two-part device being a check-valve and a flow control valve by-pass.
Fig. 4	shows a schematic representation of a hybrid heating system.

[0029] Figure 1A shows a hybrid heating system 10 comprising a primary heat source 1, a secondary heat source 2, a flow control unit 4 and a closed-loop heating circuit 3. The flow control unit 4 is connected to the primary heat source 1. Furthermore, the secondary heat source 2 is connected to the closed-loop circuit 3 and is also connected to the flow control unit 4.

[0030] In this Figure, the secondary heat source 2 is being operated and the fluid flows from the secondary heat source 2 being the secondary main fluid flow 7 and then is split in two different flows as indicated by the arrows. One flow being the secondary partial fluid flow 5 which goes through flow control unit 4 into primary heat source 1, the fluid then travels further through primary heat source 1 and back to secondary heat source 2. The second flow being the secondary left fluid flow 6 which goes directly to the closed-loop circuit 3 and back to secondary heat source 2. The flow of secondary partial fluid flow 5 is smaller than the flow of secondary left fluid flow 6. The flow of secondary left fluid flow 6 is smaller than the flow of the secondary main fluid flow 7.

[0031] Figure 1B shows the same hybrid heating system 10 as shown in Figure 1A but in this occasion the primary heat source 1 is being operated and not the secondary heat source 2, where the primary fluid flow 8 flows from the primary heat source 1 though the flow control unit 4 and then directly to the closed-loop heating circuit 3 and back to the primary heat source 1 as indicated by the arrows.

[0032] Figure 1C shows the same hybrid heating system 10 as shown in Figure 1A, including the directions of the flow but where the closed-loop circuit 3 is more detailed. In particular, it is shown that the closed-loop circuit 3 is a closed-loop heating circuit which comprises a floor-heating, a radiator and a hot water tank.

[0033] Figure 2 shows a flow control unit 4 as a singular device wherein a primary fluid connection 1a, coming from a primary heat source 1, and a secondary fluid connection 2a, coming from a secondary heat source 2, are in a fluid connection with the flow control unit 4. The device comprises a check-valve and a flow control valve, in parallel, within a singular unit working as a single unidirectional flow control valve.

[0034] Figure 3 shows a flow control unit 4 wherein the flow control unit 4 is split into two separate parts wherein a first part comprises a check-valve 4a and a second part comprises a flow control valve 4b. Furthermore, the flow control unit 4 comprises a fluid connection 1a, coming from a primary heat source 1, and a secondary fluid connection 2a, coming from a secondary heat source 2

[0035] Figure 4 shows a hybrid heating system 10 comprising a primary heat source 1 being a heat pump, a secondary heat source 2 being a boiler, a closed-loop circuit 3 being a floor heating and a flow control unit 4. Furthermore, the secondary heat source 2 and the first heat source 1 are connected to a control box 13 which is connected to a thermostat 11 and a communication PCB 12.

Reference Signs

[0036]

1	primary heat source
1a	primary fluid connection
2	secondary heat source
2a	secondary fluid connection
3	closed-loop circuit
4	flow control unit
4a	check-valve
4b	flow control valve
5	secondary partial fluid flow
6	secondary left fluid flow
7	secondary main fluid flow
8	primary fluid flow
10	hybrid heating system
11	thermostat
12	communication PCB
13	control box

Claims

1. A flow control unit (4) for a hybrid heating system (10) comprising:

- a primary fluid connection (1a) configured to allow a primary fluid flow (8) from a primary heat source (1) to a closed-loop circuit (3);
- and a secondary fluid connection (2a) configured to allow a secondary partial fluid flow (5) from a secondary heat source (2) to a primary heat source (1), in the opposite direction to the primary fluid flow (8);

wherein the flow rate for the primary fluid flow (8) is greater than the flow rate for the secondary partial fluid flow (5) or wherein the minimal cross-sectional area of the primary fluid flow (8) is bigger than the minimal cross-sectional area of the second partial fluid flow (5), and wherein the primary heat source (1) is a heat pump.

2. The flow control unit (4) of claim 1, wherein the flow control unit (4) is a unidirectional flow control valve.

3. The flow control unit (4) of claim 1, wherein the flow control unit (4) comprises a check-valve (4a) and a flow control valve (4b), wherein the flow control valve (4b) is a by-pass connection or is an additional valve situated on such a by-pass connection.

4. The flow control unit (4) according to any of the preceding claims, wherein the flow control unit (4) is configured to allow the flow rate of the secondary partial fluid flow (5) to a range of 0.02 to 0.15 m3/h when the secondary heat source (2) is operated, and wherein the flow control unit (4) is configured to allow the flow rate of primary fluid flow (8) to a flow range of 0.4 to 1.9 m3/h when the primary heat source (1) is operated.

5. The flow control unit (4) according to any of the preceding claims, wherein the flow control unit (4) further comprising an adjustable setting mechanism configured to vary the secondary partial fluid flow rate (5) when the second heat source (2) is operated.

6. The flow control unit (4) of any of the preceding claims, wherein the flow control unit (4) further comprising a filter configured to prevent particulates from entering any of the valves and/or inside the heat exchanger from the primary heat source.

7. The flow control unit (4) according to any of the preceding claims, wherein the flow control unit (4) or any of the valves therein are made of steel, plastic, a composite material, a non-corrosive material, such as copper or brass, a material with a galvanizing treatment, a material with a cataphoresis treatment, or a material having a zinc or nickel surface treatment.

8. A hybrid heating system (10) for heating or cooling applications comprising a flow control unit (4) according to any of the preceding claims, wherein the hybrid heating system (10) further comprises:

- a primary heating source (1) connected to the flow control unit (4) and a closed-loop circuit (3) via a primary fluid flow (8) when the primary heat source (1) is operated; and
- at least one secondary heating source (2) connected to the flow control unit (4) via a secondary partial fluid flow (5) and connected to the closed-loop circuit (3) via a secondary left fluid flow (6) when the secondary heat source (2) is operated; wherein the primary heat source (1) is a heat pump; and wherein the primary fluid flow (8) has a larger minimal cross-sectional area than the secondary partial flow (5) inside the flow control unit (4) or wherein the flow rate for the primary fluid flow (8) is greater than the flow rate for the secondary partial fluid flow (5) inside the flow control unit (4).

9. The hybrid heating system (10) according to claim 8, wherein the primary heating source (1) is a heat pump comprising a plate heat exchanger.

10. The hybrid heating system (10) according to claims 8 or 9, wherein the secondary heating source (2) is a second heat pump, a boiler, a solar panel or an electric water heater.

11. The hybrid system (10) according to any one of claims 8 to 10, wherein the closed-loop circuit (3) comprises a radiator, a heating and/or cooling floor, or a tank for sanitary applications such as a hot water tank.

12. The hybrid heating system according to any one of claims 8 to 11, wherein the hybrid heating system (10) comprises a control box (13) for electronically connecting the primary heat source (1) and the secondary heat source (2).

13. The hybrid system (10) of any one of claims 8 to 12, wherein the ratio of the minimal cross-sectional area of the primary fluid flow (8), during operation of the primary heat source (1), over the minimal cross-sectional area of the secondary partial fluid flow (5), during operation of the secondary heat source (2), inside the flow control unit (4) is greater than 10, preferably greater than 20, or more preferably greater than 40,

14. A method of preventing icing of a heat exchanger of a primary heat source (1) in a hybrid heating system (10), the method comprising the steps of:

- operating the secondary heat source (2); and
- circulating hot fluid from a secondary heat source (2) partially into the primary source (1) using a flow control unit (4) as claimed in any one of claims 1 to 7 to allow the hot fluid to flow in an opposite direction than the direction of the flow when operating the primary heat source (1).

15. A kit for a hybrid system installation comprising a flow control unit (4) as claimed in any one of claims 1 to 7 and a control box (13) for electronically connecting the primary heat source (1) and the secondary heat source (2).

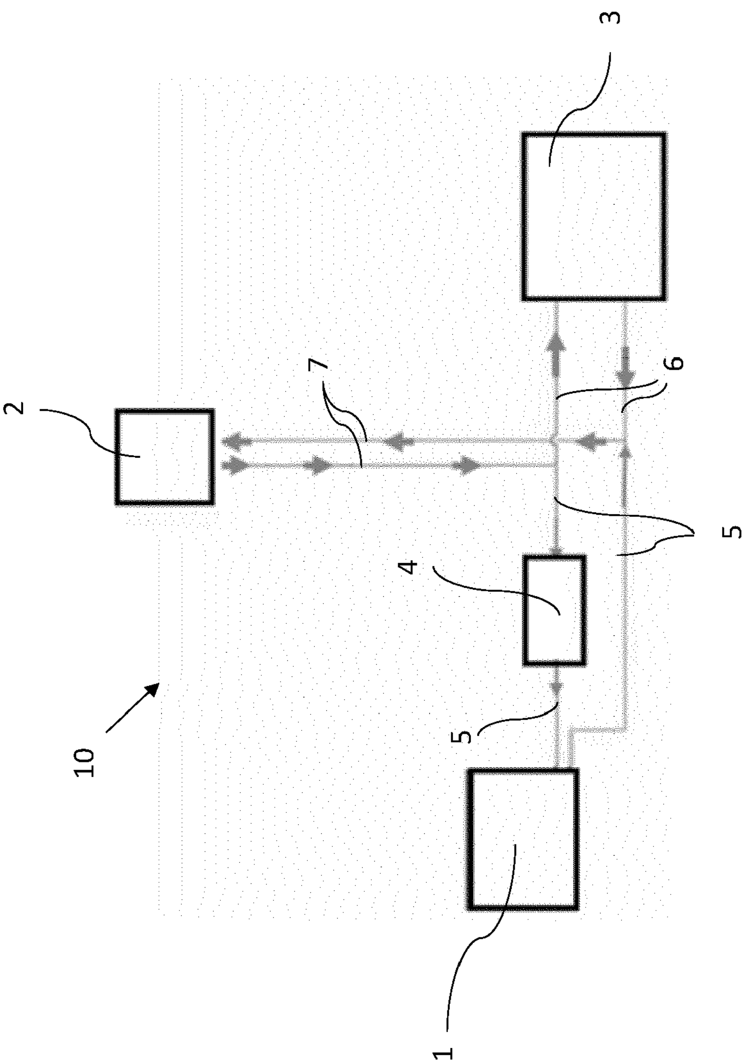

FIG. 1A

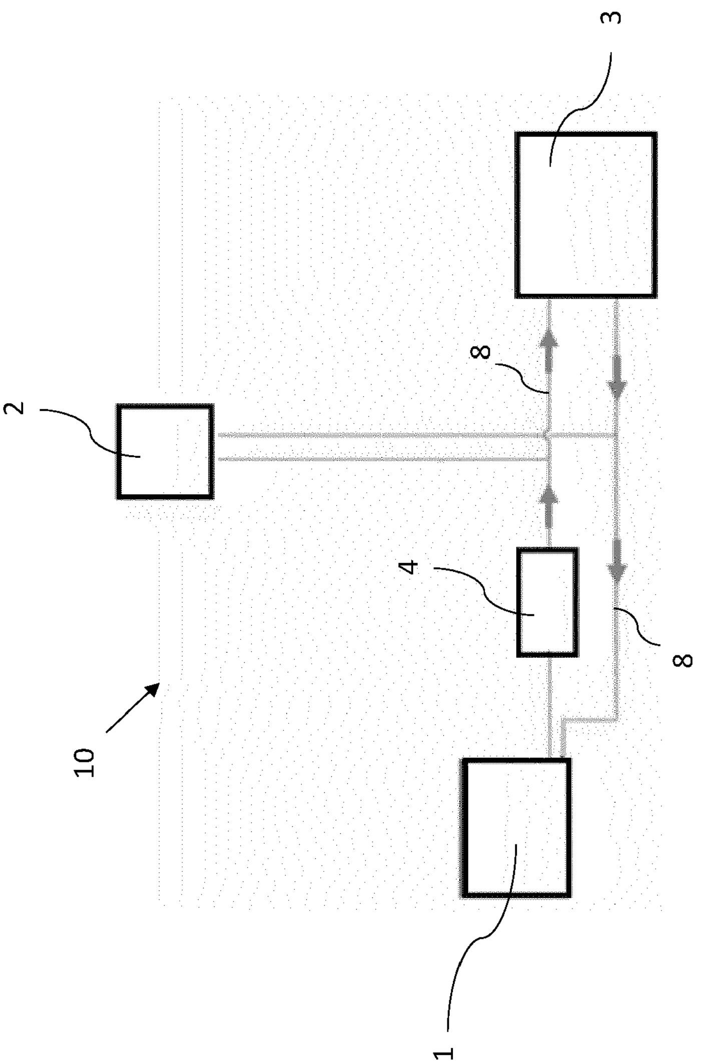

FIG. 1B

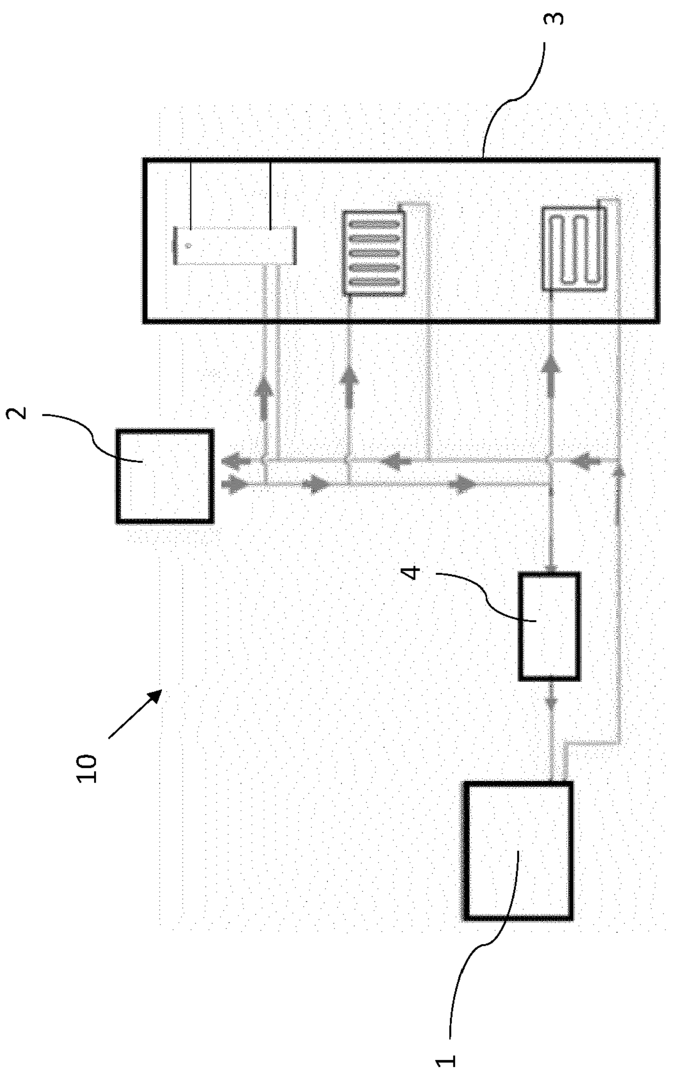

FIG. 1C

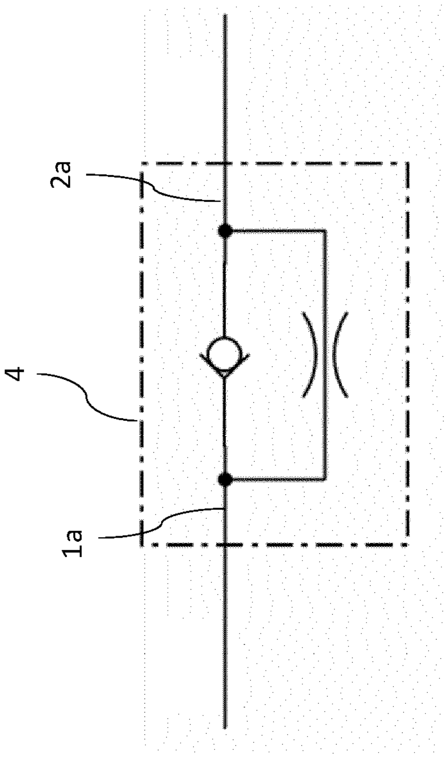

FIG. 2

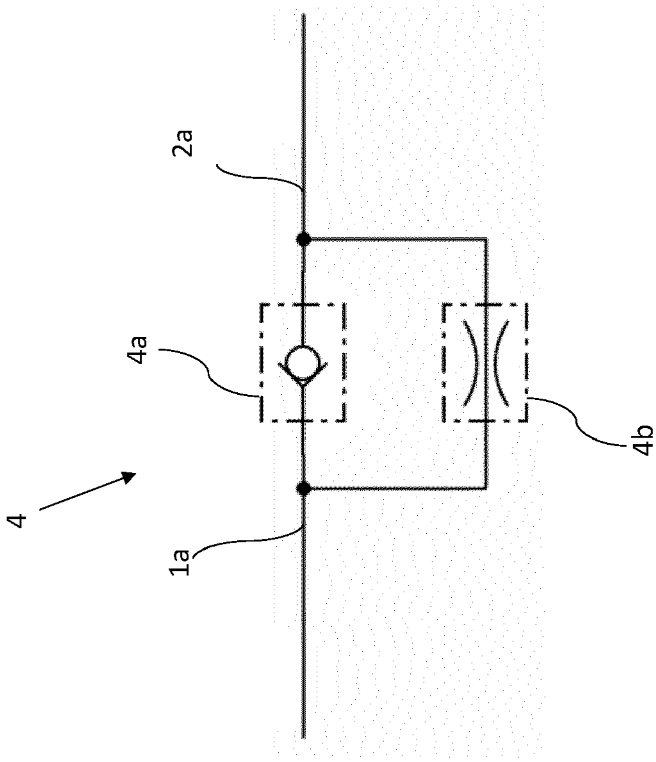

FIG. 3

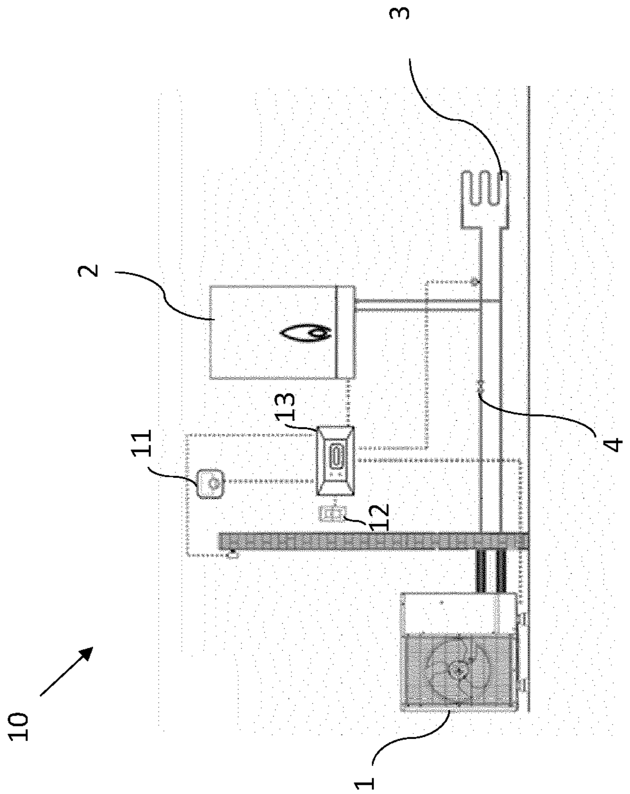

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 8965

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2022/112661 A1 (AURIS ENERGIARATKAISUT OY [FI]; HELMINEN HANNU [FI]) 2 June 2022 (2022-06-02) * page 7, line 22 - page 19, line 2; claims 9,17; figure 1 * -----	1-15	INV. F24D19/10 F24H15/136 F24H15/305
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X	US 4 336 692 A (ECKER AMIR L ET AL) 29 June 1982 (1982-06-29) * column 3, line 44 - column 8, line 6; figure 1 * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F24D F24H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 January 2024	Hoffmann, Stéphanie

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CATEGORY OF CITED DOCUMENTS

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