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(54) HEAT EXCHANGE CIRCUIT, METHOD FOR OPERATING SUCH CIRCUIT

(57) Dual mode heat exchange circuit, comprising: a first and a second heat exchanger each operable in a first mode wherein heat is released, and in a second mode wherein heat is absorbed; a compressor and/or expander, arranged between the first heat exchanger and the second heat exchanger; a first valve arranged between the heat exchangers at a first heat exchanger side; a second valve arranged between the heat exchangers at a second heat exchanger side; an expansion valve for regulating a flow rate in the circuit, arranged between the first and second valves; a pump; and a buffer container arranged between the first valve and the expansion valve, wherein the circuit is selectively operable in a heat pump mode or a Rankine cycle mode. Advantageously, circulating working fluid charge can be regulated and/or modulated so as to optimize performance in both the heat pump mode and the Rankine cycle mode.

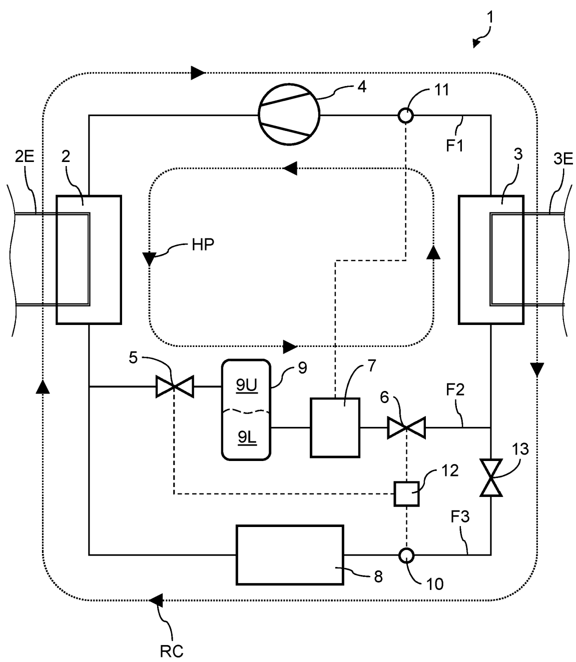

Fig. 1

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Description

[0001] The invention relates to a dual mode heat exchange circuit and to a method for operating said circuit.

[0002] Dual mode heat exchange circuits have recently been developed as a combination of a heat pump circuit and of a Rankine cycle circuit. Such a dual mode circuit is also referred to as a reversible heat pump/Rankine cycle circuit or as an inverted cycle circuit.

[0003] The heat pump circuit typically comprises four major components: a condenser, an evaporator, a compressor and an expansion valve. First, the compressor increases the pressure and temperature of the working fluid. The working fluid in vapor state is then cooled down, condensed and subcooled in the condenser, releasing heat to a heat sink. The working fluid then flows into the expansion valve, which decreases its pressure from the condensing pressure down to the evaporating pressure. The working fluid is then evaporated and eventually superheated in the evaporator, absorbing heat from the heat source. For the use of heat pumps in buildings, the heat source is typically outside air or water (coming for instance from a geothermal borehole field). Usually, the heat sink is the heating network of the building, e.g. hot water network supplying radiators or hot air to be pulsed into the rooms.

[0004] A Rankine cycle power system, or an organic Rankine cycle power system is also known. While the heat pump system is used for a refrigeration cycle, the (organic) Rankine cycle system describes a power cycle: heat from a low temperature heat source (typically below 250°C) is converted into useful work. The Rankine cycle system typically comprises four main components: condenser, evaporator, expander and pump. First, the pump imposes a given refrigerant flow that increases the pressure of the working fluid. Then, it passes through an evaporator, where the working fluid is vaporized using the thermal energy from the heat source. Following that, the working fluid flows into an expander where the useful work is produced. At the end, the working fluid is then sent back to the pump after being condensed using the low temperature of the heat sink.

[0005] Recently, a proposal has been made, "Investigation of a heat pump reversible into an organic Rankine cycle and its application in the building sector" by Olivier Dumont, University of Liège, September 2017 to combine the heat pump cycle and the Rankine cycle based on the joint components in both circuits. There is a desire to develop this proposal further to better exploit its potential in the building sector and potentially elsewhere.

[0006] Thereto, the invention provides for a dual mode heat pump circuit according to claim 1.

[0007] During further research and prototyping following the above-mentioned proposal, the inventors found that the combination of the heat pump cycle and of the Rankine cycle as proposed entails some problems. In both modes, the heat pump mode and in the Rankine cycle mode, the combined circuit operates in a closed circuit. However, each mode poses different requirements to the closed circuit in the said mode, e.g. as to the amount of circulating working fluid in the circuit. This problem and other problems are overcome by the present invention.

[0008] The dual mode heat exchange circuit comprises: a first heat exchanger operable in a first mode wherein heat is exchanged externally out of the circuit to release heat to a heat sink, and in a second mode wherein heat is exchanged from externally into the circuit to absorb heat from a heat source; a second heat exchanger operable in a first mode wherein heat is exchanged externally out of the circuit, and in a second mode wherein heat is exchanged from externally into the circuit; a compressor and/or expander that is operable in compressor mode or in expander mode, arranged between the first heat exchanger and the second heat exchanger; a first valve arranged between the first heat exchanger and the second heat exchanger at a first heat exchanger side; a second valve arranged between the first heat exchanger and the second heat exchanger at a second heat exchanger side; an expansion valve for regulating a flow rate in the circuit, arranged between the first valve and the second valve; a pump; and a buffer container arranged between the first valve and the expansion valve.

[0009] When the first heat exchanger is operating in the first mode, the second heat exchanger is operating in the second mode and vice versa. Preferably, the first heat exchanger is a high pressure heat exchanger and/or the second heat exchanger is a low pressure heat exchanger.

[0010] The circuit is selectively operable in a heat pump mode or a Rankine cycle mode. In the heat pump mode, flow is circulated through the circuit via the first heat exchanger operating in first mode, the first valve, the buffer container, the expansion valve, the second valve, the second heat exchanger operating in second mode and the compressor/expander operable in compressor mode. In the Rankine cycle mode, flow is circulated through the circuit via the pump, the first heat exchanger operating in second mode, the compressor/expander operating in expander mode, and the second heat exchanger operating in first mode. It shall be appreciated that where the present disclosure refers to 'compressor and/or expander', or briefly 'compressor/expander', this may comprise one or more compressors and/or one or more expanders, which may or may not be integrated and may be arranged e.g. in parallel and/or in series.

[0011] By providing the buffer container, variations in required circulating working fluid, also known as circulating working fluid charge or circulating refrigerant charge, can be easily accommodated. Thus, the invention advantageously enables a regulation and/or modulation of the circulating working fluid charge, in particular so as to optimize performance in both the heat pump mode and the Rankine cycle mode. In the present context, the term working fluid refers to fluid circulating and/or stored within the closed circuit, also referred to as refrigerant. It shall be appreciated that separate fluid flows, e.g. referred to as hot fluid or cold fluid as opposed to working fluid, may flow through the first heat exchanger and the second heat exchanger.

[0012] Optionally, the buffer container is filled with saturated liquid in its lower part and filled with vapor in its upper part, having an inlet in the vapor filled upper part, and an outlet in the liquid filled lower part.

[0013] In this way, the buffer container can be of a relatively simple yet effective design, reducing complexity, in particular since a dedicated pressure source may thereby be obviated.

[0014] Optionally, the first valve is arranged in a flow path between the first and the second heat exchanger at the opposite side of the compressor and/or expander.

[0015] Thereby, an effective circuit arrangement can be formed.

[0016] Optionally, the pump is fluidly connected with the first heat exchanger and with the second heat exchanger in a further flow path between the first and the second heat exchanger.

[0017] Such a pump arrangement enables an effective circulation in the circuit, depending on the selected mode. Although the compressor and/or expander may already provide for some circulation, the pump arrangement advantageously can make operation of the circuit less or not dependent on the compressor and/or expander.

[0018] Optionally, a pressure and/or temperature sensor is provided between a pump inlet and the second heat exchanger.

[0019] Such a pressure and/or temperature sensor, preferably a pressure sensor and a temperature sensor or a combined pressure-temperature sensor, can enable monitoring of the pressure and/or temperature of the working fluid flowing to the pump, based on which a subcooling can be calculated. Depending on the level of subcooling, working fluid may be extracted from the buffer container so as to have an optimal amount of working fluid in the rest of the circuit for optimum subcooling. At optimum subcooling, the Rankine cycle circuit operates most efficiently and robustly. Subcooling is generally defined as the temperature difference between the calculated saturated temperature and the measured temperature, or briefly 'saturated temperature minus measured temperature', which may be calculated via the pressure sensor measurement.

[0020] Optionally, the circuit further comprises a pressure and/or temperature sensor arranged between the compressor and/or expander and the second heat exchanger, which pressure and/or temperature sensor is operably connected to the expansion valve.

[0021] Depending on the pressure at the inlet of the compressor in heat exchanger mode, more or less working fluid (e.g. vapor at the compressor inlet) may be needed, to which end the expansion valve may be adjusted. Adjustment of the expansion valve increases or decreases the flow rate, thus influencing the operation of the compressor. Meanwhile, even though the amount of working fluid in the buffer container may vary depending on the flow rate, the total amount of working fluid in the circuit remains the same. The operable connection between the pressure and/or temperature sensor and the expansion valve can advantageously provide a thermostat-like arrangement. The operable connection and/or the expansion valve may then advantageously be free from electronics and the like, merely relying on a pressure driven direct mechanism. Such a thermostat-like valve arrangement free from electronics is known as such as an autonomous valve.

[0022] Optionally, the expansion valve and the second valve may be mutually integrated, e.g. being incorporated into a single combined valve.

[0023] Thereby, the circuit may be simplified.

[0024] Optionally, the circuit further comprises a control unit, wherein the control unit is configured to control the first valve and/or the second valve, e.g. electronically, depending on the pressure and/or temperature measured by the pressure and/or temperature sensor provided between the pump inlet and the second heat exchanger.

[0025] Such a control unit can advantageously enable automatic or semiautomatic regulation of the subcooling as explained above.

[0026] A further aspect provides a method for operating the circuit as described herein; the method comprising: selecting one of the operational modes: the heat pump mode or the Rankine cycle mode; if the heat pump mode is selected: opening the first and the second valves, and operating the compressor/expander in compressor mode, such that any surplus working fluid is buffered in the buffer container; if the Rankine cycle mode is selected: closing the first and the second valve, operating the compressor/expander in expander mode, and operating the pump to pump around a working fluid in the circuit.

[0027] Such a method provides advantages as described above.

[0028] Optionally, for operation in the Rankine cycle mode, the amount of working fluid in the circuit outside the buffer container is adjusted by opening the second valve to allow extracting working fluid from the buffer container.

[0029] Thereby, the relevant amount of working fluid can advantageously be optimized for the selected mode.

[0030] Optionally, prior to opening the second valve, the first valve is opened to increase the amount of working fluid in the buffer container, and then the first valve is closed prior to opening the second valve.

[0031] By first opening the first valve, while the second valve is still closed, the pressure in the buffer container may be temporarily increased. This allows, when the first valve is closed and the second valve is opened, that outputting of the working fluid into the rest of the circuit in Rankine cycle mode is easier, in particular without detriment to the flow through the compressor/expander and the second heat exchanger

[0032] Optionally, in the heat pump mode, the expansion valve is operated in dependency of a pressure measured at a compressor inlet.

[0033] Such an operation of the expansion valve can promote optimal compressor performance, since the flow rate at the compressor plays an important role in optimal performance of the compressor.

[0034] Optionally, the method further comprises, in Rankine cycle mode, measuring the pressure and/or temperature upstream of the pump, calculating a subcooling with the measured pressure and/or temperature value, if the subcooling is different from a predefined subcooling, when additional working fluid is required to reach the predefined subcooling, at least the second valve is temporarily opened to introduce additional working fluid into the circuit outside the buffer container, when less working fluid is required to reach the predefined subcooling, the first valve is opened to allow excess working fluid to enter the buffer container.

[0035] Subcooling is important, as it allows the circuit in Rankine cycle mode to operate more efficiently, more robustly, and with optimized performance. Optimal subcooling requires a predefined amount of working fluid in the circuit outside the buffer container, which can be obtained by adding or retracting working fluid to/from the buffer container. Subcooling

[0036] Optionally, the second valve is closed when the subcooling has reached the predefined subcooling, as measured by the pressure and/or temperature sensor.

[0037] To this end, for example, continuous or intermittent monitoring of the subcooling may be performed, wherein the second valve may be closed once the monitoring indicates that the predefined subcooling has been reached. The closing of the second valve will then result in the flow of working fluid out of the buffer container into the rest of the circuit to be stopped, so that the subcooling can be maintained at or about the predefined subcooling. Although closing of the second valve preferably happens relatively quickly once optimal subcooling is reached, it shall be appreciated that in practice a small time delay, e.g. of less than 1 second, may occur between reaching optimal subcooling and closing of the second valve.

[0038] In the following, the invention will be explained further using exemplary embodiments and drawings. The drawings are schematic and merely show examples. In the drawings, corresponding elements have been provided with corresponding reference signs. In the drawings, Fig. 1 shows a diagram of an example of a heat exchange circuit.

[0039] Fig. 1 shows a dual mode heat exchange circuit 1. The circuit 1 comprises a first heat exchanger 2, here a high pressure heat exchanger, operable in a first mode wherein heat is exchanged externally out of the circuit 1 to release heat to a heat sink, and in a second mode wherein heat is exchanged from externally into the circuit 1 to absorb heat from a heat source. The circuit 1 comprises a second heat exchanger 3, here a low pressure heat exchanger, operable in a first mode wherein heat is exchanged externally out of the circuit 1, and in a second mode wherein heat is exchanged from externally into the circuit 1. When the first heat exchanger 2 is operating in the first mode, the second heat exchanger 3 is operating in the second mode, and vice versa. To facilitate such heat exchange by the heat exchangers 2, 3, the heat exchangers 2, 3 are normally connected to respective external circuits 2E, 3E during use, such external circuits 2E, 3E being fluidly separate from the circuit 1. It shall be appreciated that elements associated with heat sinks and/or heat sources as indicated above would normally connect to such external circuits 2E, 3E.

[0040] The circuit 1 comprises a compressor and/or expander, here a combined compressor-expander 4, that is operable in compressor mode or in expander mode, arranged between the first heat exchanger 2 and the second heat exchanger 3. As indicated elsewhere herein, multiple compressors and/or expanders could be used, e.g. in series and/or in parallel.

[0041] The circuit 1 comprises a first valve 5 arranged between the first heat exchanger 2 and the second heat exchanger 3 at a first heat exchanger side, and a second valve 6 arranged between the first heat exchanger 3 and the second heat exchanger 3 at a second heat exchanger side.

[0042] The circuit 1 comprises an expansion valve 7 for regulating a flow rate in the circuit 1, arranged between the first valve 5 and the second valve 6.

[0043] The circuit 1 comprises a pump 8.

[0044] The circuit 1 comprises a buffer container 9 arranged between the first valve 5 and the expansion valve 7.

[0045] The circuit 1 is selectively operable in a heat pump mode or a Rankine cycle mode.

[0046] In the heat pump mode, as indicated by dotted line and arrow HP, flow is circulated through the circuit 1 via the first heat exchanger 2 operating in first mode, the first valve 5, the buffer container 9, the expansion valve 7, the second valve 6, the second heat exchanger 3 operating in second mode and the compressor and/or expander 4operable in compressor mode.

[0047] In the Rankine cycle mode, as indicated by dotted line and arrow RC, flow is circulated through the circuit 1 via the pump 8, the first heat exchanger 2 operating in second mode, the compressor and/or expander 4 operating in expander mode, and the second heat exchanger 3 operating in first mode.

[0048] The buffer container 9 may be filled with saturated liquid in its lower part 9L and filled with vapor in its upper part 9U, having an inlet in the vapor filled upper part 9U, and an outlet in the liquid filled lower part 9L.

[0049] In the shown example, the first valve 5 is arranged in a flow path F2 between the first 2 and the second 3 heat exchanger at the opposite side of the compressor and/or expander 4. In other words, the flow path F2 in which the first valve 5 is arranged here connects to opposite flow-wise sides or ends of the heat exchangers 2, 3, compared to where a flow path F1 connects in which the compressor and/or expander 4 is arranged.

[0050] The pump 8 is here fluidly connected with the first heat exchanger 2 and with the second heat exchanger 3, in a further flow path F3 between the first 2 and the second 3 heat exchanger. A further valve 13 may be provided in the further flow path F3 to regulate flow through the further flow path F3, in particular to selectively close off the further flow path F3 in the heat pump mode.

[0051] A pressure and/or temperature sensor, here a combined pressure-temperature sensor 10, is here provided between a pump inlet of the pump 8 and the second heat exchanger 3.

[0052] A control unit 12 is here provided to control the first valve 5 and/or the second valve 6 depending on the pressure and/or temperature measured by the pressure and/or temperature sensor 10.

[0053] A further pressure and/or temperature sensor 11 may be arranged between the compressor and/or expander 4 and the second heat exchanger 3, which sensor 11 is operably connected to the expansion valve 7, as indicated by a dashed line in Fig. 1.

[0054] Such an operable connection between sensor 11 and expansion valve 7 may for example be electronic, e.g. via a control unit such as the aforementioned control unit 12. Alternatively or additionally, the expansion valve 7 may be an autonomous valve, in which case the pressure and/or temperature sensor 11 can be essentially integrated with the expansion valve 7, in particular as part of a mechanical mechanism so that the expansion valve 7 can be free from electronics and the like.

[0055] A method of operating the circuit 1 comprises selecting one of the operational modes: the heat pump mode (see arrow and dashed line HP) or the Rankine cycle mode (see arrow and dashed line RC).

[0056] If the heat pump mode is selected: the first and second valves 5, 6 are opened, and the compressor/expander 4 is operated in compressor mode, such that any surplus working fluid is buffered in the buffer container 9.

[0057] If the Rankine cycle mode is selected, the first and second valves 5, 6 are closed, the compressor/expander 4 is operated in expander mode, and the pump 8 is operated to pump around the working fluid in the circuit 1.

[0058] For operation in the Rankine cycle mode, the amount of working fluid in the circuit 1 outside the buffer container 9 is adjusted by opening the second valve 6 to allow extracting working fluid from the buffer container 9. Such adjustment may occur prior to, during and/or after initiation of the Rankine cycle mode. Thus, in the Rankine cycle mode, although the second valve 6 is normally closed, it may be opened temporarily if and when needed to adjust the amount of working fluid.

[0059] Prior to opening the second valve 6 for the adjustment, the first valve 5 may be opened to increase the amount of working fluid in the buffer container 9. The first valve 5 is then closed prior to opening the second valve 6.

[0060] In the heat pump mode, the expansion valve 7 is preferably operated in dependency of a pressure measured at a compressor inlet of the compressor 4, e.g. by a suitably arranged pressure sensor 11 which may be integrated with the expansion valve 7.

[0061] The method may further comprise, in Rankine cycle mode, measuring the pressure and/or temperature upstream of the pump 8, e.g. by a pressure and/or temperature sensor 10, and calculating a subcooling with the measured pressure and/or temperature value, e.g. by a control unit 12. If the subcooling is different from a predefined subcooling, when additional working fluid is required to reach the predefined subcooling, at least the second valve 6 may then be temporarily opened, e.g. by the control unit 12, to introduce additional working fluid into the circuit 1 outside the buffer container 9. When less working fluid is required to reach the predefined subcooling, the first valve 5 may be opened, e.g. by the control unit 12, to allow excess working fluid to enter the buffer container 9.

[0062] The second valve 6 may be closed, e.g. by the control unit 12, when the subcooling has reached the predefined subcooling, as measured by the pressure and/or temperature sensor 10. The expansion valve 7 is then automatically opened because of sufficient superheating present at the outlet of the expansion valve 7.

[0063] Although the invention has been explained further herein using exemplary embodiments and drawings, these do not limit the scope of the invention as defined by the claims. Within said scope, many variations, combinations and extensions are possible, as will be appreciated by the skilled person. For example, a further valve may be provided at the compressor and/or expander to regulate flow there. A compressor and/or expander may comprise one or more compressors and/or one or more expanders, which may or may not be integrated and may be arranged e.g. in parallel and/or in series. More generally, elements may be provided in multiple numbers, and additional elements such as valves and sensors may be provided in the circuit, as shall be appreciated by the skilled person having the benefit of the present disclosure.

[0064] For the purpose of clarity and a concise description, features have herein been described as part of the same or different embodiments, but it will be clear that the scope of protection of the invention can comprise embodiments with combinations of all or some of the features described. It will be understood that the embodiments shown have the same or similar components, apart from where they are described as different.

[0065] Many variants are possible that fall within the scope of the following claims.

Claims

1. Dual mode heat exchange circuit, comprising:

- a first heat exchanger operable in a first mode wherein heat is exchanged externally out of the circuit to release heat to a heat sink, and in a second mode wherein heat is exchanged from

externally into the circuit to absorb heat from a heat source;
- a second heat exchanger operable in a first mode wherein heat is exchanged externally out of the circuit, and in a second mode wherein heat is exchanged from externally into the circuit;
- a compressor and/or expander that is operable in compressor mode or in expander mode, arranged between the first heat exchanger and the second heat exchanger;
- a first valve arranged between the first heat exchanger and the second heat exchanger at a first heat exchanger side;
- a second valve arranged between the first heat exchanger and the second heat exchanger at a second heat exchanger side;
- an expansion valve for regulating a flow rate in the circuit, arranged between the first valve and the second valve;
- a pump; and
- a buffer container arranged between the first valve and the expansion valve,

wherein when the first heat exchanger is operating in the first mode, the second heat exchanger is operating in the second mode and vice versa,
wherein the circuit is selectively operable in a heat pump mode or a Rankine cycle mode,
wherein in the heat pump mode, flow is circulated through the circuit via the first heat exchanger operating in first mode, the first valve, the buffer container, the expansion valve, the second valve, the second heat exchanger operating in second mode and the compressor/expander operable in compressor mode,
wherein in the Rankine cycle mode, flow is circulated through the circuit via the pump, the first heat exchanger operating in second mode, the compressor/expander operating in expander mode, and the second heat exchanger operating in first mode.

2. Circuit according to claim 1, wherein the buffer container is filled with saturated liquid in its lower part and filled with vapor in its upper part, having an inlet in the vapor filled upper part, and an outlet in the liquid filled lower part.

3. Circuit according to any of the preceding claims, wherein the first valve is arranged in a flow path between the first and the second heat exchanger at the opposite side of the compressor and/or expander.

4. Circuit according to any of the preceding claims, wherein the pump is fluidly connected with the first heat exchanger and with the second heat exchanger in a further flow path between the first and the second heat exchanger.

5. Circuit according to any of the preceding claims, wherein a pressure and/or temperature sensor is provided between a pump inlet and the second heat exchanger.

6. Circuit according to claim 5, further comprising a control unit, wherein the control unit is configured to control the first valve and/or the second valve depending on the pressure and/or temperature measured by the pressure and/or temperature sensor provided between the pump inlet and the second heat exchanger.

7. Circuit according to any of the preceding claims, further comprising a pressure and/or temperature sensor arranged between the compressor and/or expander and the second heat exchanger, which pressure and/or temperature sensor is operably connected to the expansion valve.

8. Circuit according to any of the claims 5 - 7, wherein the expansion valve is an autonomous valve.

9. Circuit according to any of the preceding claims, wherein the first heat exchanger is a high pressure heat exchanger and/or the second heat exchanger is a low pressure heat exchanger.

10. Method for operating the circuit of any of the claims 1 - 9; the method comprising:

- selecting one of the operational modes: the heat pump mode or the Rankine cycle mode;
- if the heat pump mode is selected:

opening the first and the second valves, and operating the compressor/expander in compressor mode,
such that any surplus working fluid is buffered in the buffer container;

- if the Rankine cycle mode is selected:

closing the first and the second valve,
operating the compressor/expander in expander mode, and
operating the pump to pump around a working fluid in the circuit.

11. Method according to claim 10, wherein, for operation in the Rankine cycle mode, the amount of working fluid in the circuit outside the buffer container is adjusted by opening the second valve to allow extracting working fluid from the buffer container.

12. Method according to claim 11, wherein, prior to opening the second valve, the first valve is opened to increase the amount of working fluid in the buffer container, and then the first valve is closed prior to opening the second valve.

13. Method according to any of the claims 10 - 12, wherein, in the heat pump mode, the expansion valve is operated in dependency of a pressure measured at a compressor inlet.

14. Method according to any of the claims 10 - 13, further comprising, in Rankine cycle mode, measuring the pressure and/or temperature upstream of the pump, calculating a subcooling with the measured pressure and/or temperature value, if the subcooling is different from a predefined subcooling, when additional working fluid is required to reach the predefined subcooling, at least the second valve is temporarily opened to introduce additional working fluid into the circuit outside the buffer container, when less fluid is required to reach the predefined subcooling, the first valve is opened to allow excess working fluid to enter the buffer container.

15. Method according to claim 14, wherein the second valve is closed, when the subcooling has reached the predefined subcooling, as measured by the pressure and/or temperature sensor.

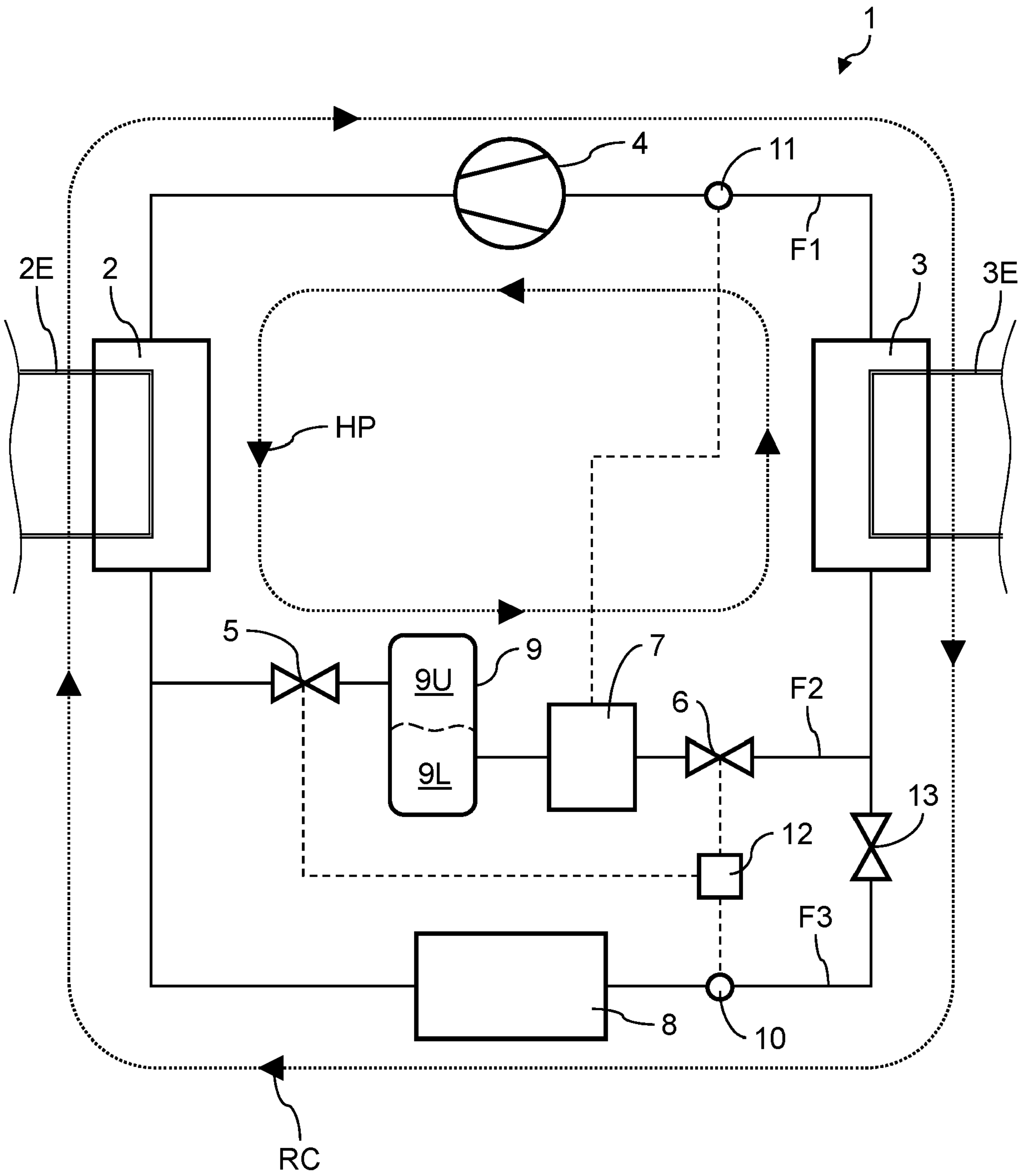

Fig. 1

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 5313

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	JP 2012 247081 A (SHARP KK) 13 December 2012 (2012-12-13) * paragraphs [0012], [0022] - [0047]; figures 1-4 * -----	1-15	INV. F25B30/02 F01K1/00 F25B49/02

TECHNICAL FIELDS SEARCHED (IPC)

F25B
F22G
F01K

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	1 December 2022	Weisser, Meinrad

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 18 5313

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2012247081 A	13-12-2012	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82