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(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

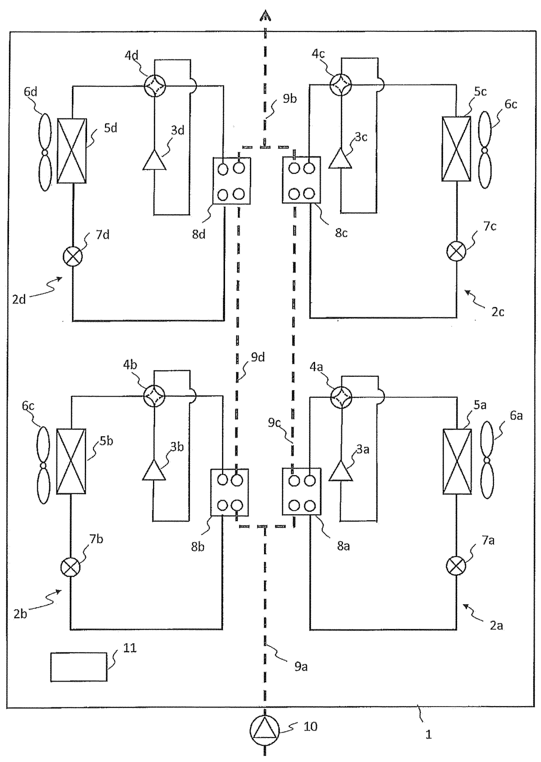
(72) Inventors:
- **ITO, Takuya**
Tokyo 100-8310 (JP)
- **ISHIDA, Kazuyuki**
Tokyo 100-8310 (JP)
- **OOKOSHI, Yasushi**
Tokyo 100-8310 (JP)
- **HIKONE, Takahito**
Tokyo 100-8310 (JP)

(74) Representative: **Moore, Graeme Patrick et al**
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London EC2V 5DE (GB)

(54) REFRIGERATION CYCLE APPARATUS

(57) A refrigeration cycle apparatus according to the invention can continue the operation regardless of failure of any of multiple refrigerant circuits. The refrigeration cycle apparatus can also stabilize the temperature of the refrigerant to be cooled regardless of a defrosting operation of any of the refrigerant circuits during heating operations of the other refrigerant circuits. A water-side heat exchanger (8a) and a water-side heat exchanger (8c) are connected in series with a water pipe. A water-side heat exchanger (8b) and a water-side heat exchanger (8d) are connected in series with another water pipe. The water-side heat exchanger (8a) and the water-side heat exchanger (8c), which are connected in series, are connected in parallel to the water-side heat exchanger (8b) and the water-side heat exchanger (8d), which are connected in series, with other water pipes.

FIG. 1



EP 3 228 951 A1

Description

Technical Field

[0001] The present invention relates to a refrigeration cycle apparatus.

Background Art

[0002] Traditionally, techniques for anti-freezing of water refrigerant have been proposed for a heat exchanger connected to multiple refrigerant circuits. One such apparatus of this technique is configured as follows, for example. Temperatures of a medium to be cooled, such as water refrigerant, circulating in a plate heat exchanger detected at the entry and exit and operation capacities of individual refrigeration circuits are used as data inputs. By being provided with a temperature estimating unit that calculates the temperature of water refrigerant at the exit of a water refrigerant passage in each use-side heat exchanging unit connected to the refrigerant circuit, the refrigeration apparatus prevents freezing of water refrigerant (see Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2007-187353 (Claim 1)

Summary of Invention

Technical Problem

[0004] Unfortunately, in the apparatus disclosed in Patent Literature 1 that includes the multiple refrigerant circuits connected to the single plate heat exchanger, failure of any refrigerant circuit causes stop of operation of the other normal refrigerant circuits.

[0005] An object of the invention is to overcome the above problem, and is to provide a refrigeration cycle apparatus that can continue the operation regardless of failure of any of multiple refrigerant circuits.

Solution to Problem

[0006] A refrigeration cycle apparatus according to an embodiment of the invention includes: a plurality of refrigeration cycles allowing refrigerant to circulate therein, each of the refrigeration cycles comprising a compressor, a refrigerant flow switching device, an air-side heat exchanger, a pressure reducing device, and a heat medium-side heat exchanger connected in sequence with refrigerant pipes, the heat medium-side heat exchangers allowing a heat medium and the refrigerant to exchange heat with each other; a first heat medium passage to which the heat medium-side heat exchanger of one or more of the refrigeration cycles is connected; and a second heat medium passage to which the heat medium-side heat exchangers of two or more of the refrigeration cycles are connected in series along a flow of the heat medium, the first heat medium passage and the second heat medium passage being connected in parallel.

Advantageous Effects of Invention

[0007] The refrigeration cycle apparatus according to an embodiment of the invention includes multiple refrigeration cycles connected in series and in parallel and thus can continue the operation regardless of failure of any of the refrigerant circuits. Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a schematic diagram illustrating the configuration of a refrigeration cycle apparatus according to Embodiment 1 of the invention.

[Fig. 2] Fig. 2 is a flowchart illustrating an operation of a heat source controller in a defrosting mode according to Embodiment 1 of the invention.

[Fig. 3] Fig. 3 is a schematic diagram illustrating an example variation in the circuit configuration of a refrigeration cycle apparatus according to Embodiment 1 of the invention.

[Fig. 4] Fig. 4 is a schematic diagram illustrating the configuration of a refrigeration cycle apparatus according to Embodiment 2 of the invention.

[Fig. 5] Fig. 5 is a schematic diagram illustrating the configuration of a refrigeration cycle apparatus according to Embodiment 3 of the invention. Description of Embodiments

[0009] The refrigeration cycle apparatus according to embodiments of the invention will now be described with reference to the accompanying drawings. The embodiments illustrated in the drawings are mere examples and should not be construed to limit the invention. The components having the same reference signs in the drawings are same or correspond to each other throughout the specification. The relative sizes of the components in the drawings may differ from the actual relative sizes.

Embodiment 1

[Configuration of Heat Source Device 1]

[0010] Fig. 1 is a schematic diagram illustrating an example partial configuration of a refrigeration cycle apparatus according to Embodiment 1 of the invention. With reference to Fig. 1, a heat source device 1, which constitutes a part of the refrigeration cycle apparatus, includes refrigeration cycles 2a, 2b, 2c, and 2d having a same circuit configuration and a same specification and a heat source controller 11. The refrigeration cycles 2a, 2b, 2c, and 2d having an identical configuration may be collectively referred to as "refrigeration cycles 2."

[0011] The refrigeration cycle 2a includes a compressor 3a, a refrigerant flow switching device 4a (e.g., a four-way valve), an air-side heat exchanger 5a, a main expansion valve 7a, and a water-side heat exchanger 8a, which are connected in an annular manner with refrigerant pipes. The refrigeration cycle 2a is further provided with an air-side heat exchanger fan 6a (air-sending device 6a for the air-side heat exchanger 5a) in the vicinity of the air-side heat exchanger 5a. The refrigeration cycles 2b, 2c, and 2d each have the same configuration as that of the refrigeration cycle 2a.

[0012] The compressors 3a, 3b, 3c, and 3d suck low-temperature low-pressure refrigerant and generate high-temperature high-pressure refrigerant through compression. A typical example of the compressors 3a, 3b, 3c, and 3d is an inverter compressor having a controllable capacity. The compressors 3a, 3b, 3c, and 3d having an identical configuration may be collectively referred to as "compressors 3."

[0013] The refrigerant flow switching devices 4a, 4b, 4c, and 4d switch the flow of refrigerant upon the switching between a cooling mode and a heating mode. As the refrigerant flow switching devices 4a, 4b, 4c, and 4d, elements having an identical configuration may be collectively referred to as, in this case, "refrigerant flow switching devices 4."

[0014] The air-side heat exchangers 5a, 5b, 5c, and 5d function as condensers in the cooling mode and as evaporators in the heating mode. The air-side heat exchangers 5a, 5b, 5c, and 5d allow the refrigerant and the air supplied by the air-side heat exchanger fans 6a, 6b, 6c, and 6d to exchange heat with each other, for example. As the air-side heat exchangers 5a, 5b, 5c, and 5d, elements having an identical configuration may be collectively referred to as "air-side heat exchangers 5." Also, as the air-side heat exchanger fans 6a, 6b, 6c, and 6d, elements having an identical configuration may be collectively referred to as "air-side heat exchanger fans 6."

[0015] The main expansion valves 7a, 7b, 7c, and 7d serve as pressure reducing valves or expansion valves, and decompress to expand the refrigerant. A typical example of the main expansion valves 7a, 7b, 7c, and 7d is an electronic expansion valve having a controllable opening degree. The main expansion valves 7a, 7b, 7c, and 7d having an identical configuration may be collectively referred to as "main expansion valves 7."

[0016] The heat source controller 11 receives data on the pressures and temperatures of refrigerant in the refrigeration cycles 2 and the temperatures of water (heat medium) from various sensors (not shown). The heat source controller 11 then controls individual actuators based on operational information on the heat source device 1 and instructions about an operation from a user of the refrigeration cycle apparatus, i.e., activates or inactivates the compressors 3 or controls the rotation speeds of the compressors 3, controls the opening degrees of the main expansion valves 7, and controls the rotation of the air-side heat exchanger fans 6.

[Configuration of Water Pipes 9]

[0017] The water-side heat exchangers 8a, 8b, 8c, and 8d allow the refrigerant flowing in the respective refrigeration cycles 2 and the water (heat medium) to exchange heat with each other. The water inlets of the water-side heat exchanger 8a and the water-side heat exchanger 8b are connected in parallel with a water pipe 9a. The water outlets of the water-side heat exchanger 8c and the water-side heat exchanger 8d are connected in parallel with a water pipe 9b. The water outlet of the water-side heat exchanger 8a and the water inlet of the water-side heat exchanger 8c are connected in series with a water pipe 9c. The water outlet of the water-side heat exchanger 8b and the water inlet of the water-side heat exchanger 8d are connected in series with a water pipe 9d. The water-side heat exchangers 8a, 8b, 8c, and 8d correspond to the "heat medium-side heat exchangers" in the present invention. The water pipes 9c and 9d correspond to the "first heat medium passage" and "second heat medium passage," respectively, in the present invention. As the water-side heat exchangers 8a, 8b, 8c, and 8d, elements having an same configuration may be collectively referred to as "water-side heat exchangers 8."

[0018] The flow of water (heat medium) will now be described. The part of the water pipe 9a outside the heat source device 1 is provided with a cold water pump 10. As indicated by the broken arrow in Fig. 1, the cold water pump 10 transfers water (heat medium) such that the water flows through the water pipe 9a and branches into the water-side heat exchanger 8a and the water-side heat exchanger 8b. The water introduced in the water-side heat exchanger 8a flows through the water pipe 9c and enters the water-side heat exchanger 8c. The water introduced in the water-side heat exchanger 8b flows through the water pipe 9d and enters the water-side heat exchanger 8d. The water from the water-side heat exchanger 8c and the water from the water-side heat exchanger 8d join each other in the water pipe 9b and the joined water is discharged from the heat source device 1. The illustrated configuration of Embodiment 1, in which the cold water pump 10 is disposed outside the heat source device 1, should not be construed to limit the invention. The cold water pump 10 may also be disposed inside the heat source device 1.

[Cooling Operation of Refrigeration Cycle Apparatus]

[0019] The cooling operation of the refrigeration cycle apparatus will now be explained. In the refrigeration cycle 2a, the high-temperature high-pressure gas refrigerant generated through compression in the compressor 3a exits the compressor 3a, enters the air-side heat exchanger 5a, and then exchanges heat with the air supplied by the air-side heat exchanger fan 6a to condense into liquid. This high-pressure liquid refrigerant exits the air-side heat exchanger 5a, and is then decompressed in the main expansion valve 7a into two-phase gas-liquid refrigerant. The refrigerant then evaporates in the water-side heat exchanger 8a serving as an evaporator and thus removes heat from water (heat medium) to generate cooled water. The low-temperature low-pressure refrigerant exits the water-side heat exchanger 8a and then enters the compressor 3a.

[0020] Although the above explanation focuses on the cooling operation of the refrigeration cycle 2a, the refrigeration cycles 2b, 2c, and 2d perform the cooling operation same as that of the refrigeration cycle 2a. The same holds for a defrosting operation and a heating operation described below.

[Heating Operation of Refrigeration Cycle Apparatus]

[0021] The heating operation of the refrigeration cycle apparatus will now be explained. In the heating mode, the refrigerant flow switching device 4a switches the flow of the refrigerant from that in the cooling mode. In the refrigeration cycle 2a, the high-temperature high-pressure gas refrigerant generated through compression in the compressor 3a exits the compressor 3a, enters the water-side heat exchanger 8a, and then exchanges heat with water (heat medium) to condense into liquid. The water (heat medium) is thereby heated to a higher temperature. The high-pressure liquid refrigerant exiting the water-side heat exchanger 8a is then decompressed in the main expansion valve 7a into two-phase gas-liquid refrigerant. The refrigerant then evaporates in the air-side heat exchanger 5a serving as an evaporator and thus removes heat from the surrounding air to be turned into low-temperature low-pressure refrigerant. The low-temperature low-pressure refrigerant exiting the air-side heat exchanger 5a then enters the compressor 3a.

[0022] In the refrigeration cycle apparatus in the heating mode, a high humidity of the air and a low temperature equal to or lower than 0 degrees C at the heat transferring surfaces of the air-side heat exchangers 5 cause the water vapor in the air to condense and freeze and thus generate frost on the heat transferring surfaces. The frost on the air-side heat exchangers 5 increases the wind resistance thereof, resulting in insufficient performance of the air-side heat exchangers 5. This problem requires a defrosting operation for melting the frost on the air-side heat exchangers 5, which needs a heat source for melting the frost.

[0023] A typical defrosting technique involves switching of the flow of refrigerant to the direction in the cooling mode with the refrigerant flow switching devices 4, operating the compressors 3, and then removing the frost from the air-side heat exchangers 5 by the heat of the water flowing through the water-side heat exchangers 8. In this case, if one or more refrigeration cycles 2 conduct the defrosting operation while the other refrigeration cycles 2 perform the heating operation, the water (heat medium) heated by the heating operation is cooled again by the defrosting operation. In Embodiment 1, such a decrease in the temperature of water (heat medium) can be reduced by the following measure.

[Defrosting Operation of Refrigeration Cycle Apparatus]

[0024] The defrosting operation of the refrigeration cycle apparatus will now be explained. The defrosting operation differs from the cooling operation in that the operation of the air-side heat exchanger fan 6a is halted in the defrosting mode. In the refrigeration cycle 2a, the high-temperature high-pressure gas refrigerant generated through compression in the compressor 3a exits the compressor 3a, enters the air-side heat exchanger 5a, and then transfers its heat to the frost on the air-side heat exchanger 5a to condense into liquid. This high-pressure liquid refrigerant exiting the air-side heat exchanger 5a is then decompressed in the main expansion valve 7a into two-phase gas-liquid refrigerant. The refrigerant then evaporates in the water-side heat exchanger 8a serving as an evaporator and thus removes heat from water (heat medium) to generate cooled water. The low-temperature low-pressure refrigerant exiting the water-side heat exchanger 8a then enters the compressor 3a.

[Control of Heat Source Controller 11]

[0025] The heat source device 1 according to Embodiment 1 is equipped with the four refrigeration cycles 2a, 2b, 2c, and 2d. The heat source controller 11 can suppress a decrease in water temperature by controlling these independent four refrigeration cycles 2a, 2b, 2c, and 2d so as not to simultaneously perform defrosting operations. In another situation, the heat source controller 11 can reduce the decreasing time of the temperature of water (heat medium), rather than suppression of a decrease in the temperature of the water (heat medium), by conducting simultaneous defrosting operations of the four refrigeration cycles 2a, 2b, 2c, and 2d. The heat source controller 11 can select either of these controls preset in the heat source controller 11.

[0026] Fig. 2 is a flowchart illustrating an operation of the heat source controller 11 in the defrosting mode according to Embodiment 1 of the invention. The steps of control of the heat source controller 11 illustrated in Fig. 2 will now be explained with reference to Fig. 1.

(Step S1)

[0027] The heat source controller 11 determines whether simultaneous defrosting operations of the four refrigeration cycles 2a, 2b, 2c, and 2d are available in the preliminary setting. If the simultaneous defrosting operations of the four refrigeration cycles 2a, 2b, 2c, and 2d are available; then the process goes to Step S2; otherwise the process goes to Step S4.

(Step S2)

[0028] The heat source controller 11 determines whether any one or more of the four refrigeration cycles 2a, 2b, 2c, and 2d is to conduct the defrosting operation. If any one or more of the refrigeration cycles are to conduct the defrosting operation; then the process goes to Step S3; otherwise the process goes to Step S1.

(Step S3)

[0029] The heat source controller 11 conducts the simultaneous defrosting operations of the four refrigeration cycles 2a, 2b, 2c, and 2d. The process then goes to Step S1.

(Step S4)

[0030] The heat source controller 11 determines whether any one of the four refrigeration cycles 2a, 2b, 2c, and 2d is to conduct the defrosting operation. If any one of the refrigeration cycles is to conduct the defrosting operation; then the process goes to Step S5; otherwise the process goes to Step S1.

(Step S5)

[0031] The heat source controller 11 determines whether only at least one refrigeration cycle 2 is in the defrosting mode. If only the at least one refrigeration cycle 2 is in the defrosting mode; then the process goes to Step S6; otherwise the process goes to Step S1.

(Step S6)

[0032] The heat source controller 11 conducts the defrosting operation of the refrigeration cycle 2 being a target. The process then goes to Step S1.

[0033] As described above, even if any water-side heat exchanger 8 is punctured by freezing of water, for example, the other refrigeration cycles 2 can continue the operation for the moment because of the independence of water-side heat exchangers 8 in the refrigeration cycles 2.

[0034] In a traditional apparatus including a single water-side heat exchanger 8 connected to two refrigeration cycles 2 in the heating mode, the defrosting operation of one of the refrigeration cycles 2 varies the water temperature in the water-side heat exchanger 8. This variation affects the operational state of the other refrigeration cycle 2 performing the heating mode, resulting in an unstable water temperature. In contrast, the water-side heat exchangers 8 according to Embodiment 1 are independent from each other disposed in the respective refrigeration cycles 2a, 2b, 2c, and 2d. This configuration can reduce the effects of the refrigeration cycle 2 in the defrosting mode on the other refrigeration cycles 2 performing the heating mode, and thus can stabilize the heating operations.

[0035] The configuration according to Embodiment 1 that includes the heat source device 1 equipped with the four refrigeration cycles 2 should not be construed to limit the present invention. The configuration only requires at least three refrigeration cycles 2. The same holds for Embodiments 3 and 4 described below.

[0036] Fig. 3 is a schematic diagram illustrating an example variation in the circuit configuration of the refrigeration cycle apparatus according to Embodiment 1 of the present invention. In the refrigeration cycle apparatus according to Embodiment 1, the water pipes 9 can be rearranged. The following description focuses on an example configuration of the water pipes 9 after rearrangement in the refrigeration cycle apparatus.

[Configuration of Water Pipes 9]

[0037] With reference to Fig. 3, the water inlet of the water-side heat exchanger 8a is connected with a water pipe 9h. The water outlet of the water-side heat exchanger 8a and the water inlet of the water-side heat exchanger 8b are connected in series with a water pipe 9i. The water outlet of the water-side heat exchanger 8b and the water inlet of the water-side heat exchanger 8d are connected in series with a water pipe 9j. The water outlet of the water-side heat exchanger 8d and the water inlet of the water-side heat exchanger 8c are connected in series with a water pipe 9k. The water outlet of the water-side heat exchanger 8c is connected with a water pipe 91. The water-side heat exchangers 8a, 8b, 8c, and 8d are thus sequentially connected in series.

[0038] The flow of water (heat medium) will now be described. As indicated by the broken arrow in Fig. 3, the cold water pump 10 transfers water (heat medium) such that the water flows through the water pipe 9h into the water-side heat exchanger 8a. The water from the water-side heat exchanger 8a flows through the water pipe 9i and enters the water-side heat exchanger 8b. The water from the water-side heat exchanger 8b flows through the water pipe 9j and enters the water-side heat exchanger 8d. The water from the water-side heat exchanger 8d flows through the water pipe 9k and enters the water-side heat exchanger 8c. The water from the water-side heat exchanger 8c flows through the water pipe 91 and is discharged from the heat source device 1.

[0039] The range of the flow rate of water in the heat source device 1 is defined by the conditions such as the freezing, a decrease in performance, or the restriction of oscillation due to pulsation in the water-side heat exchangers 8. In comparison of the heat source devices 1 between Embodiments 1 and 3, the heat source device 1 according to Embodiment 1 has higher maximum and minimum flow rates of water because of the bifurcation in the water pipe 9a (see Fig. 1), whereas the heat source device 1 according to Embodiment 3 has lower maximum and minimum flow rates of water because of no bifurcation in the water pipe 9h (see Fig. 3).

[0040] In general, the work of refrigerant pipes after the installation of a heat source device 1 accompanies the reconstruction of the high-pressure gas circuits, and thus requires large tasks, such as collection of refrigerant and other reconstructing works and procedures. To solve this problem, the water-side heat exchangers 8 are individually disposed in the respective refrigeration cycles 2. Accordingly, the configuration of the water pipes 9 in the heat source device 1 according to Embodiment 1 can be changed into the configuration of the water pipes 9 in the heat source device 1 according to Embodiment 3 and vice versa, for example, by only the rearrangement of the water pipes 9. That is, only the rearrangement of the water pipes 9 can vary the maximum and minimum flow rates of water in the water pipes 9.

[0041] As described above, in the heat source device 1, the maximum and minimum flow rates of water in the water pipes 9 can be readily varied by only the rearrangement of the water pipes 9 without work of the refrigerant pipes in the heat source device 1.

Embodiment 2

[0042] Fig. 4 is a schematic diagram illustrating the configuration of the refrigeration cycle apparatus according to Embodiment 2 of the invention. The basic configuration of the heat source device 1 according to Embodiment 2 is same as that of the heat source device 1 according to Embodiment 1. The following description of Embodiment 2 thus focuses on the difference from Embodiment 1, i.e., the configuration of the water pipes 9.

[Configuration of Water Pipes 9]

[0043] With reference to Fig. 4, the water inlets of the water-side heat exchanger 8a and the water-side heat exchanger 8b are connected in parallel with a water pipe 9e. The water outlets of the water-side heat exchanger 8c and the water-side heat exchanger 8d are connected in parallel with a water pipe 9f. The water outlets of the water-side heat exchanger 8a and the water-side heat exchanger 8b are connected in parallel with a water pipe 9g. The water outlets of the water-side heat exchanger 8c and the water-side heat exchanger 8d are connected in parallel with the water pipe 9g. The water-side heat exchanger 8a and the water-side heat exchanger 8b, which are connected in parallel, are connected in series to the water-side heat exchanger 8c and the water-side heat exchanger 8d, which are connected in parallel, with the water pipe 9g. The water pipes 9e, 9f, and 9g correspond to the "heat medium passages" in the present invention.

[0044] The flow of water (heat medium) will now be described. As indicated by the broken arrow in Fig. 4, the cold water pump 10 transfers water (heat medium) such that the water flows through the water pipe 9e and branches into the water-side heat exchanger 8a and the water-side heat exchanger 8b. The water introduced in the water-side heat exchanger 8a and the water introduced in the water-side heat exchanger 8b join each other in the water pipe 9g. The joined water then branches in the downstream part of the water pipe 9g into the water-side heat exchanger 8c and the water-side heat exchanger 8d. The water from the water-side heat exchanger 8c and the water from the water-side heat exchanger 8d join each other in the water pipe 9f and the joined water is discharged from the heat source device 1.

[0045] As described above, the water-side heat exchangers 8 according to Embodiment 2 are individually disposed in the respective refrigeration cycles 2a, 2b, 2c, and 2d. Even if any water-side heat exchanger 8 is punctured by freezing of water, for example, the other refrigeration cycles 2 can continue the operation for the moment because of the independent water-side heat exchangers 8.

[0046] The configuration can also reduce the effects of the refrigeration cycle 2 in the defrosting mode on the other refrigeration cycles 2 in the heating mode, and thus can stabilize the heating operations.

[0047] In the case of the defrosting operation of the refrigeration cycle 2a or the refrigeration cycle 2b, the water from the refrigeration cycle 2a and the water from the refrigeration cycle 2b join each other in the water pipe 9g. This configuration can suppress a decrease in the temperature of the water entering the refrigeration cycle 2c and the refrigeration cycle 2d and thus can stabilize the heating operations of the refrigeration cycle 2c and the refrigeration cycle 2d.

[0048] The configuration according to Embodiment 2 that includes the heat source device 1 equipped with the four refrigeration cycles 2 should not be construed to limit the invention. The configuration only requires at least four refrigeration cycles 2.

Embodiment 3

[0049] Fig. 5 is a schematic diagram illustrating the configuration of the refrigeration cycle apparatus according to Embodiment 3 of the invention. The basic configuration of the heat source device 1 according to Embodiment 4 is same as that of the heat source device 1 according to Embodiment 1. The following description of Embodiment 2 thus focuses on the difference from Embodiment 1, i.e., the configuration of the water pipes 9 and additional valves 12 in the water pipes 9.

[Configuration of Water Pipes 9]

[0050] With reference to Fig. 5, the water inlets of the water-side heat exchanger 8a and the water-side heat exchanger 8b are connected in parallel with a water pipe 9m. The water outlets of the water-side heat exchanger 8c and the water-side heat exchanger 8d are connected in parallel with a water pipe 9n. The water outlet of the water-side heat exchanger 8a and the water inlet of the water-side heat exchanger 8c are connected in series with a water pipe 9o. The water outlet of the water-side heat exchanger 8b and the water inlet of the water-side heat exchanger 8d are connected in series with a water pipe 9p. The water outlet of the water-side heat exchanger 8a and the water inlet of the water-side heat exchanger 8b are connected in series with a water pipe 9q. The water outlet of the water-side heat exchanger 8d and the water inlet of the water-side heat exchanger 8c are connected in series with a water pipe 9r.

[0051] The valves 12 provided in the water pipes 9 will now be described. With reference to Fig. 5, the water pipe 9m has a bifurcation 13a from which the water pipe 9m branches into the water-side heat exchanger 8a and the water-side heat exchanger 8b. Similarly, the water pipe 9m is provided with a valve 12a between the bifurcation 13a and the refrigerant inlet of the water-side heat exchanger 8b. The water pipe 9n has a bifurcation 13b from which the water pipe 9n branches into the water-side heat exchanger 8c and the water-side heat exchanger 8d. The water pipe 9n is provided with a valve 12b between the bifurcation 13b and the refrigerant outlet of the water-side heat exchanger 8d. The water pipes 9q, 9r, and 9o are provided with valves 12c, 12d, and 12e, respectively. Examples of each valve 12 include a solenoid valve capable of blocking the flow of water and a flow control valve having a controllable opening degree.

[0052] This heat source controller 11 can vary the combination of the water pipes 9 in which water flows by switching the valves 12 depending on the operational mode of the heat source device 1. The heat source controller 11 can also vary the range of the flow rate of water in the heat source device 1.

[0053] As described above, the heat source controller 11 can vary the combination of the water pipes 9 in which water flows and also vary the range of the flow rate of water in the heat source device 1 by switching the valves 12. That is, the range of the flow rate of water in the heat source device 1 can be varied by on-site operations of the heat source controller 11 to transmit signals to the valves 12 for switching the valves 12, without reconstruction of the water pipes 9.

Reference Signs List

[0054] 1 heat source device 2 refrigeration cycle 2a-2d refrigeration cycle 3 compressor 3a-3d compressor 4 refrigerant flow switching device 4a-4d refrigerant flow switching device 5 air-side heat exchanger 5a-5d air-side heat exchanger 6 air-side heat exchanger fan 6a-6d air-side heat exchanger fan 7 main expansion valve 7a-7d main expansion valve 8 water-side heat exchanger 8a-8d water-side heat exchanger 9 water pipe 9a-9r water pipe 10 cold water pump 11 heat source controller 12 valve 12a-12d valve 13a bifurcation 13b bifurcation

Claims

1. A refrigeration cycle apparatus comprising:

a plurality of refrigeration cycles allowing refrigerant to circulate therein, each of the refrigeration cycles comprising a compressor, a refrigerant flow switching device, an air-side heat exchanger, a pressure reducing device, and a heat medium-side heat exchanger connected in sequence with refrigerant pipes, the heat medium-side heat exchangers allowing a heat medium and the refrigerant to exchange heat with each other;
a first heat medium passage to which the heat medium-side heat exchanger of one or more of the refrigeration cycles is connected; and
a second heat medium passage to which the heat medium-side heat exchangers of two or more of the refrigeration cycles are connected in series along a flow of the heat medium,
the first heat medium passage and the second heat medium passage being connected in parallel.

2. A refrigeration cycle apparatus comprising:

a plurality of refrigeration cycles allowing refrigerant to circulate therein, each of the refrigeration cycles comprising a compressor, a refrigerant flow switching device, an air-side heat exchanger, a pressure reducing device, and a heat medium-side heat exchanger connected in sequence with refrigerant pipes, the heat medium-side heat exchangers allowing a heat medium and the refrigerant to exchange heat with each other; and
two or more heat medium passages being connected in series, two or more of the heat medium-side heat exchangers being connected in parallel to each of the heat medium passages.

3. The refrigeration cycle apparatus of claim 1 or 2, further comprising a heat source controller configured to control the compressors, the refrigerant flow switching devices, the pressure reducing devices, and fans for the air-side heat exchangers,
the heat source controller being configured to determine whether the refrigeration cycles conducts defrosting operations

4. The refrigeration cycle apparatus of claim 3, wherein the heat source controller is configured to, if simultaneous defrosting operations of the refrigeration cycles can be conducted, then conduct defrosting operations of all the refrigeration cycles, or otherwise conduct a defrosting operation of a refrigeration cycle being a target of defrosting from among the refrigeration cycles.

5. The refrigeration cycle apparatus of any one of claims 1, 3, and 4, wherein the first heat medium passage and the second heat medium passage are capable of being rearranged.

6. The refrigeration cycle apparatus of any one of claims 1 to 5, further comprising a plurality of valves for switching a flow of the heat medium.

FIG. 1

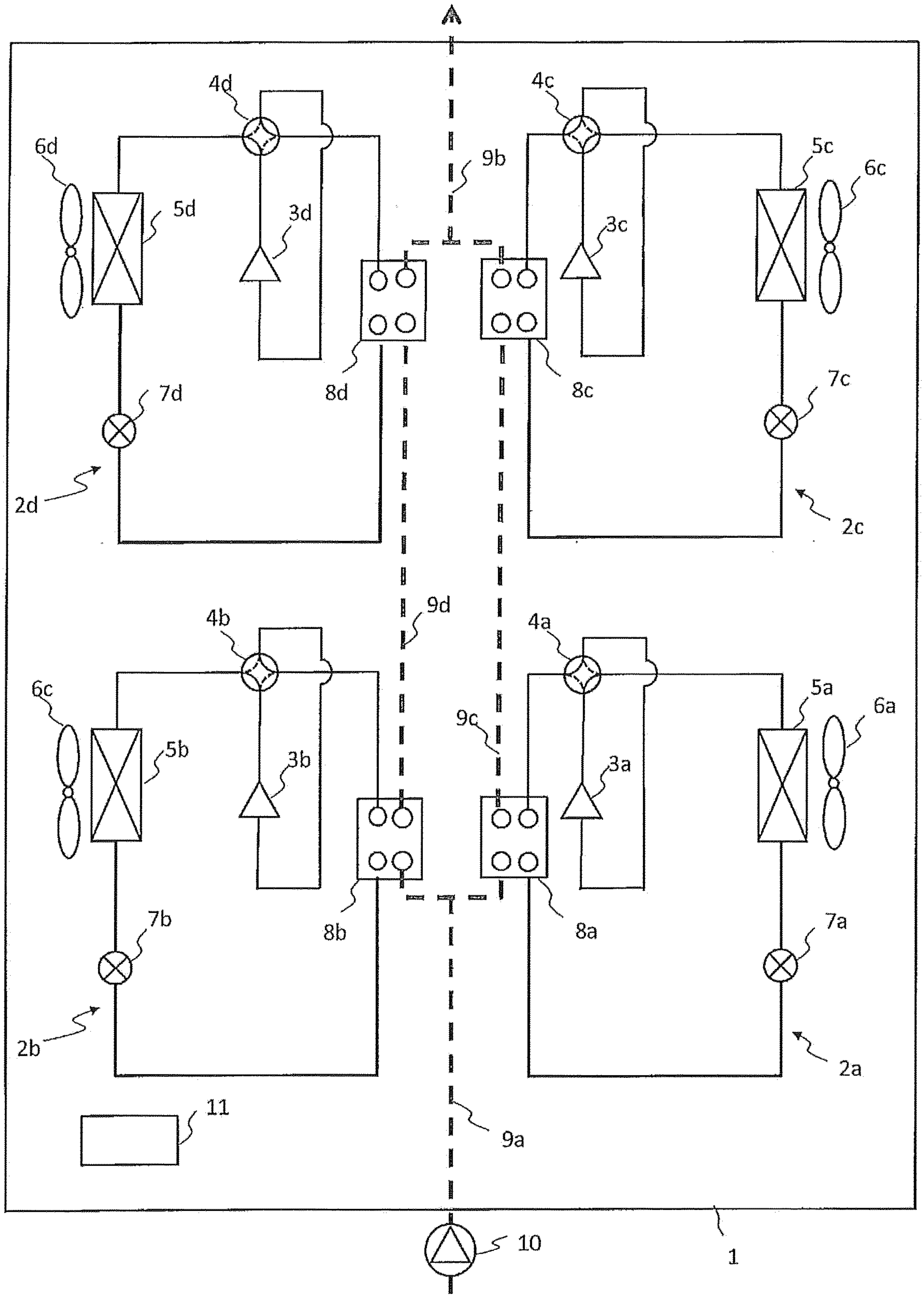

4d
4c
6d
9b
5c
6c
5d
3d
3c
8d
8c
7d
7c
2d
2c
9d
4b
4a
6c
5a
6a
5b
9c
3b
3a
7b
8b
8a
7a
2b
2a
11
9a
10
1

FIG. 2

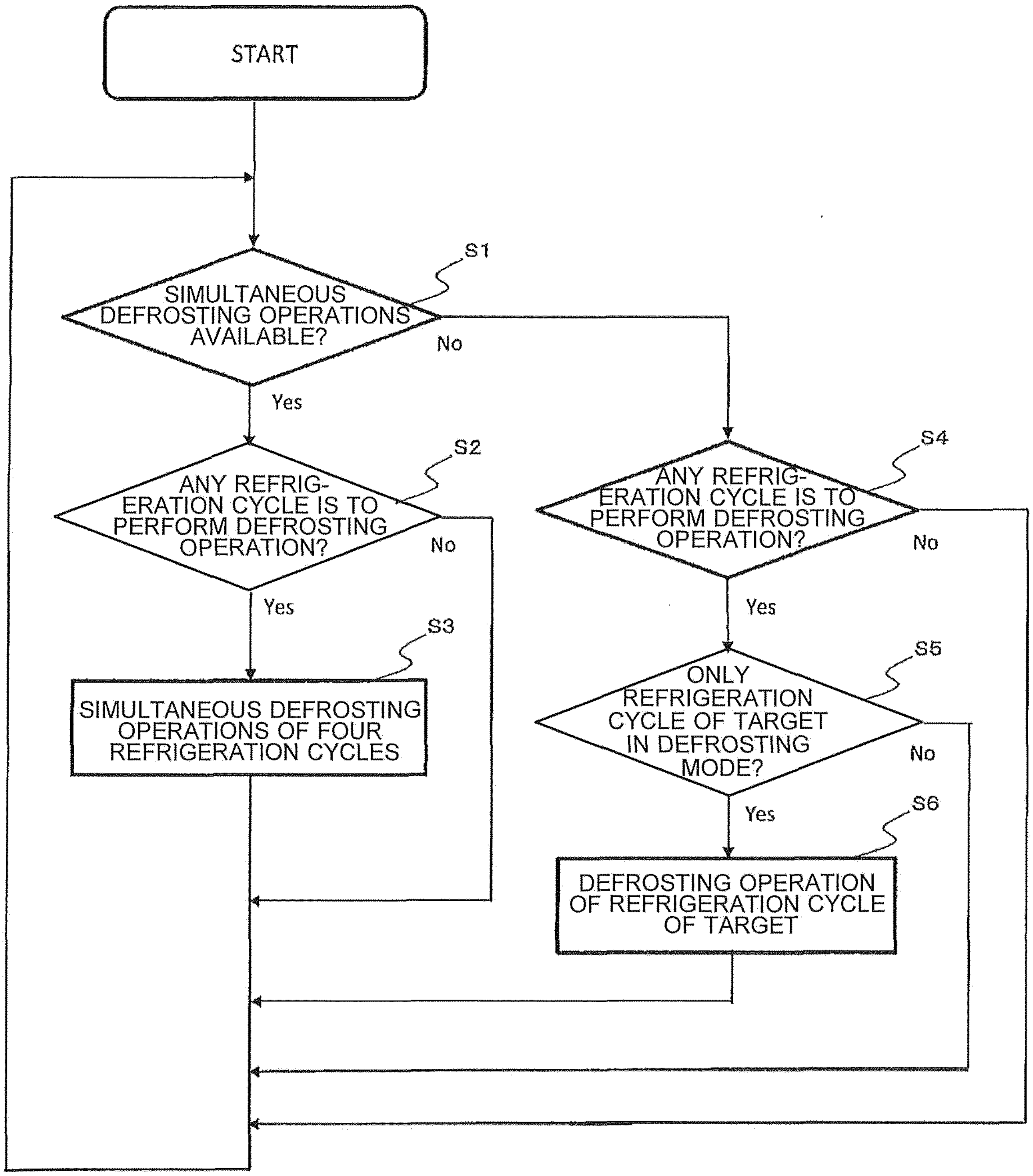

START
S1
SIMULTANEOUS DEFROSTING OPERATIONS AVAILABLE?
No
Yes
S2
ANY REFRIG- ERATION CYCLE IS TO PERFORM DEFROSTING OPERATION?
No
Yes
S3
SIMULTANEOUS DEFROSTING OPERATIONS OF FOUR REFRIGERATION CYCLES
S4
ANY REFRIG- ERATION CYCLE IS TO PERFORM DEFROSTING OPERATION?
No
Yes
S5
ONLY REFRIGERATION CYCLE OF TARGET IN DEFROSTING MODE?
No
Yes
S6
DEFROSTING OPERATION OF REFRIGERATION CYCLE OF TARGET

FIG. 3

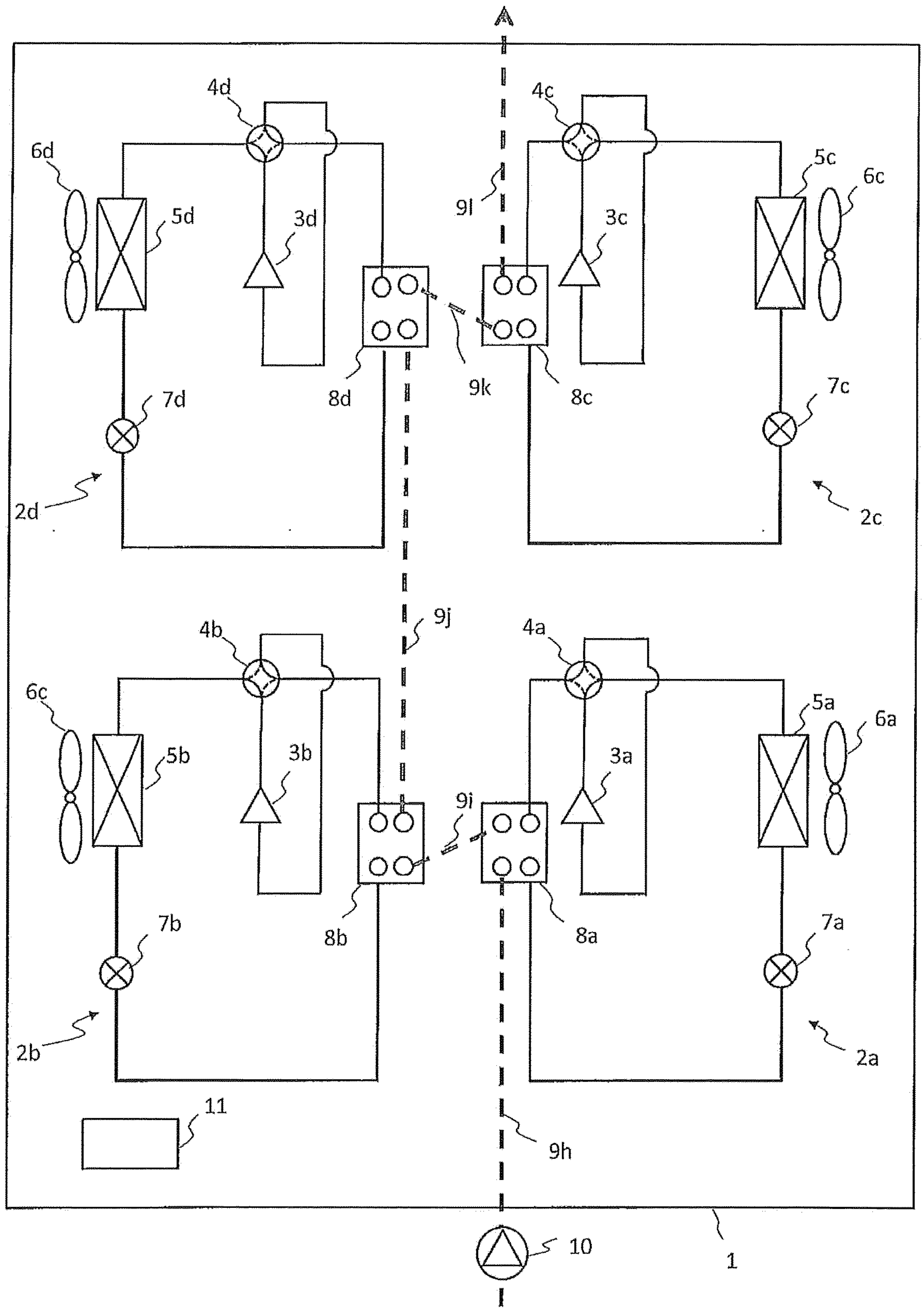

4d
6d
5d
3d
8d
9k
7d
2d
4c
9l
5c
6c
3c
8c
7c
2c
9j
4b
6c
5b
3b
8b
7b
2b
4a
9i
5a
6a
3a
8a
7a
2a
11
9h
10
1

FIG. 4

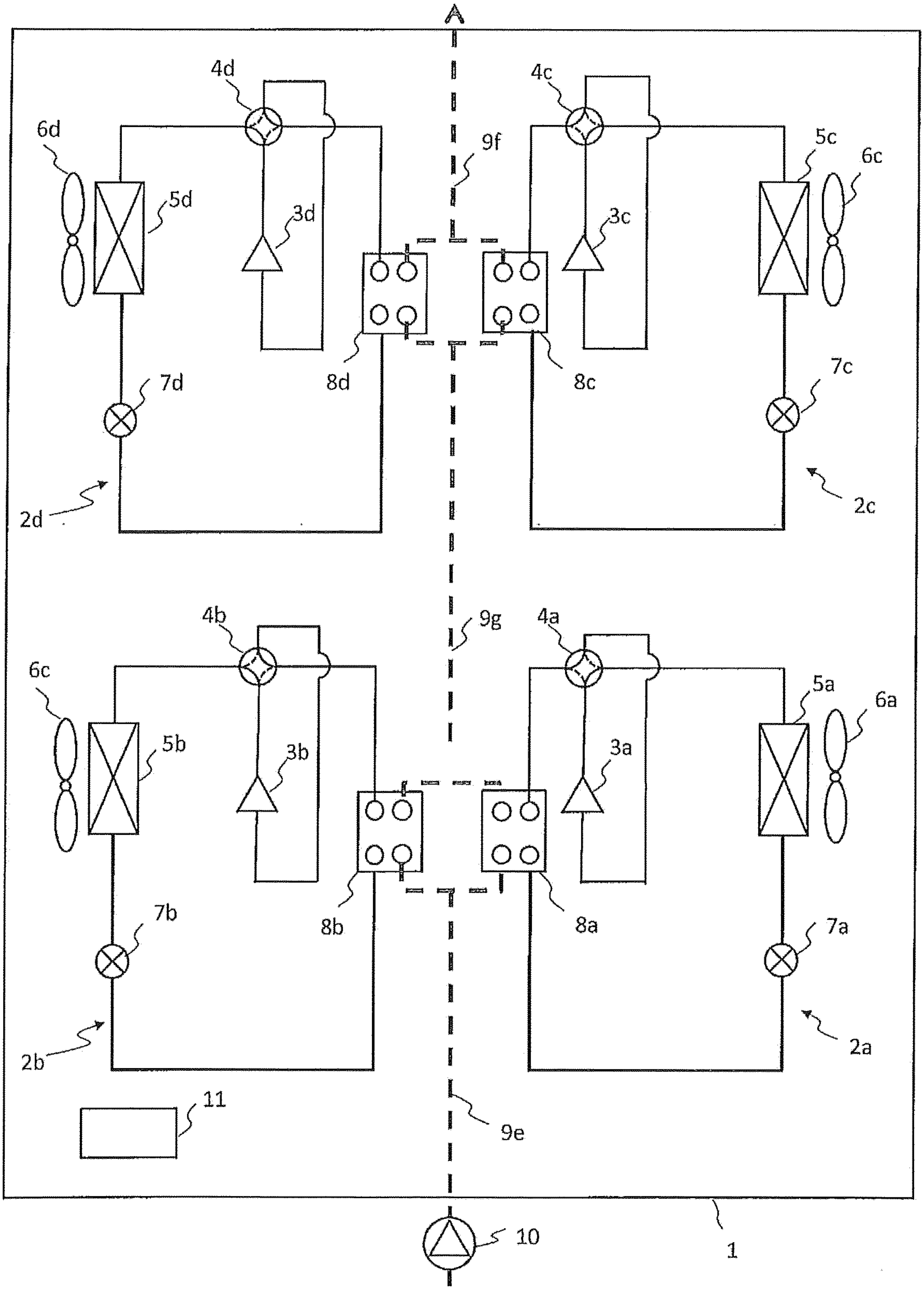
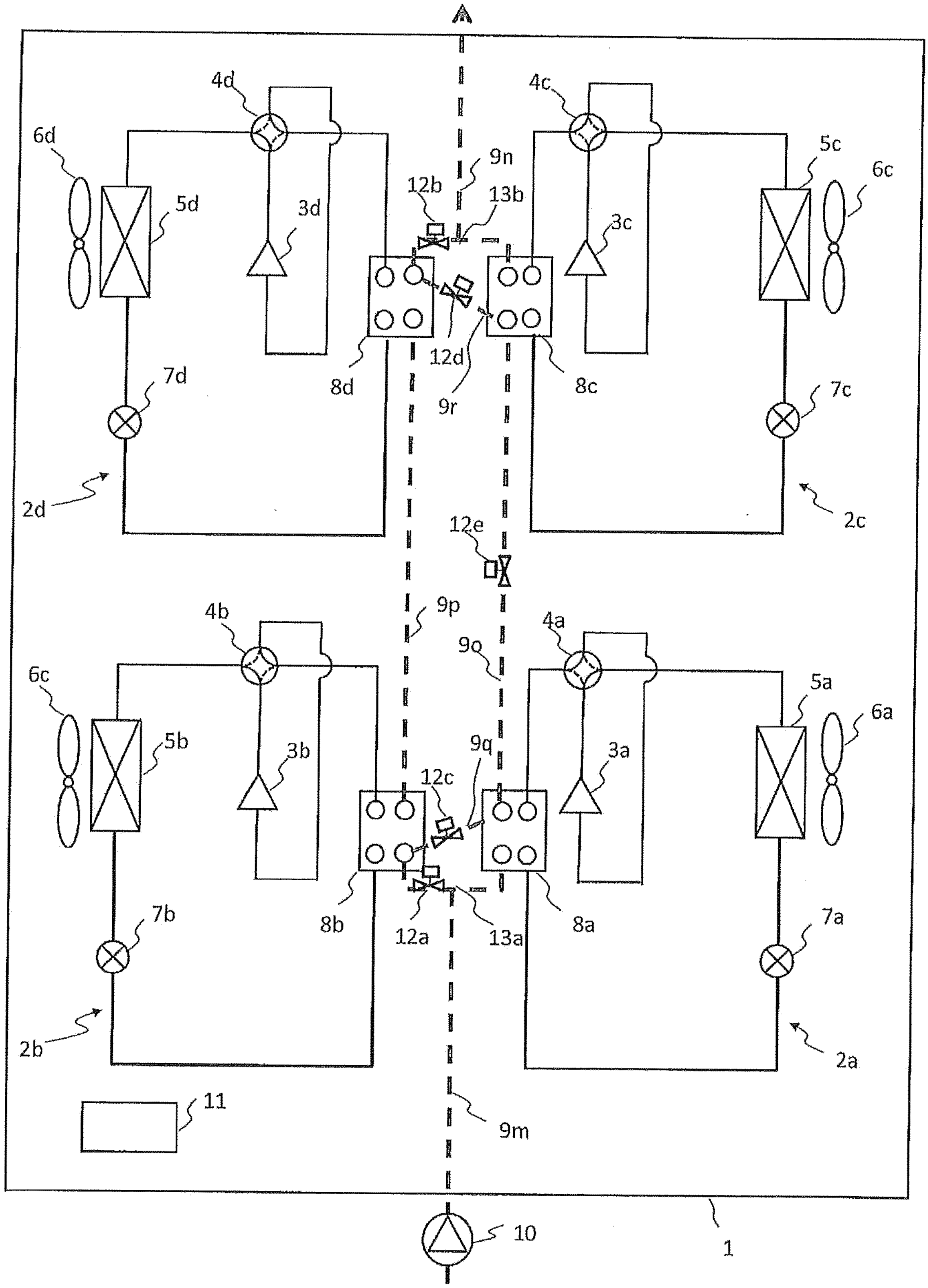

A
4d
4c
6d
9f
5c
6c
5d
3d
3c
8d
8c
7d
7c
2d
2c
4b
9g
4a
6c
5a
6a
5b
3b
3a
7b
8b
8a
7a
2b
2a
11
9e
10
1

FIG. 5



A
4d
6d
5d
3d
12b
9n
13b
4c
5c
6c
3c
12d
8d
9r
8c
7d
7c
2d
2c
12e
9p
4b
9o
4a
6c
5b
3b
9q
5a
6a
3a
12c
8b
12a
13a
8a
7b
7a
2b
2a
11
9m
10
1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/082295

A. CLASSIFICATION OF SUBJECT MATTER
F25B1/00(2006.01)i, *F25B13/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B1/00, F25B13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2002-48359 A (Hitachi, Ltd.), 15 February 2002 (15.02.2002), paragraphs [0010], [0013], [0018]; fig. 4 (Family: none)	1 3-6
X Y	WO 2013/021762 A1 (Toshiba Carrier Corp.), 14 February 2013 (14.02.2013), paragraphs [0156] to [0160]; fig. 16 (Family: none)	2 3-4,6
Y	JP 7-332817 A (Daikin Industries, Ltd.), 22 December 1995 (22.12.1995), paragraph [0016]; fig. 1 to 3 (Family: none)	3-6

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 February 2015 (06.02.15)	17 February 2015 (17.02.15)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2014/082295

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 7-127954 A (Daikin Industries, Ltd.), 19 May 1995 (19.05.1995), paragraph [0015] (Family: none)	4-6
Y	JP 9-196490 A (Matsushita Seiko Co., Ltd.), 31 July 1997 (31.07.1997), paragraphs [0035] to [0036], [0039] to [0040], [0043]; fig. 5, 6 (Family: none)	5-6
Y	JP 2002-195609 A (Matsushita Electric Industrial Co., Ltd.), 10 July 2002 (10.07.2002), paragraph [0019] (Family: none)	5-6
Y	JP 10-267494 A (Mitsubishi Electric Corp.), 09 October 1998 (09.10.1998), paragraphs [0029] to [0030]; fig. 4, 5 (Family: none)	5-6

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REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2007187353 A **[0003]**