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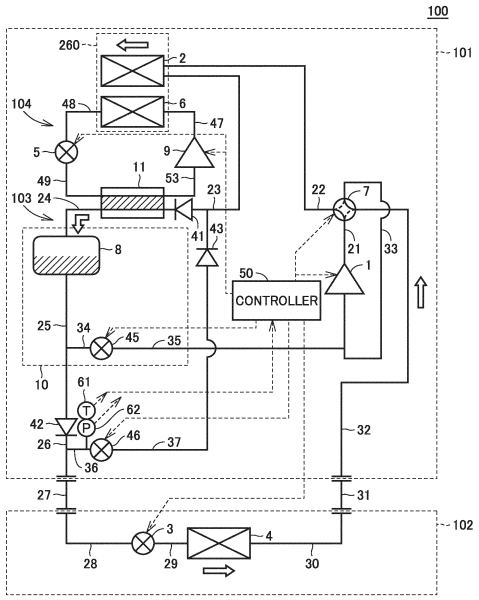
(54) OUTDOOR UNIT FOR REFRIGERATION DEVICE AND REFRIGERATION DEVICE COMPRISING SAME

(57) An outdoor unit (101) for a refrigeration apparatus having a refrigeration mode and a defrosting mode includes a first refrigeration cycle device (103) configured to circulate a first refrigerant between the first refrigeration cycle device (103) and an indoor unit (102), a second refrigeration cycle device (104) configured to circulate a second refrigerant, and a cascade heat exchanger (11) configured to exchange heat between the first refrigerant and the second refrigerant. The first refrigeration cycle device (103) has a first compressor (1), a second heat exchanger (2), and a four-way valve (7) configured to switch a flow path direction of the first refrigerant between the refrigeration mode and the defrosting mode. The second refrigeration cycle device (104) has a second compressor (9), a third expansion valve (5), and a third heat exchanger (6). The second heat exchanger (2) has an arrangement configuration to absorb exhaust heat of the third heat exchanger (6).

FIG.1



EP 4 184 080 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to an outdoor unit for a refrigeration apparatus and a refrigeration apparatus including the same.

BACKGROUND ART

[0002] A refrigeration apparatus has a defrosting mode for melting frost on an air conditioner. A known example of the defrosting method is a reverse hot gas defrosting method of changing a refrigerant circulation direction so as to blow a high-temperature gas from a compressor to an air conditioner, normally serving as an evaporator, by a four-way valve.

[0003] Japanese Patent No. 5595245 (PTL 1) discloses a refrigeration apparatus that performs defrosting by the reverse hot gas defrosting method in a low-temperature-side cycle of two-stage cycle.

[0004] In the low-temperature-side cycle described in PTL 1, a low-temperature-side compressor, a low-temperature-side four-way valve, a low-temperature-side intermediate cooler, a second low-temperature-side throttle device, a low-temperature-side condenser, a first low-temperature-side throttle device, and a low-temperature-side evaporator are connected in series by a pipe to constitute a refrigerant circulation circuit. During a defrosting operation, the low-temperature-side evaporator and the low-temperature-side condenser function as a condenser, and the low-temperature-side intermediate cooler functions as an evaporator.

CITATION LIST

PATENT LITERATURE

[0005] PTL 1: Japanese Patent No. 5595245

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] In reverse defrosting of the indoor unit of the refrigeration apparatus, the low-temperature-side heat exchanger needs to capture heat from the outside air. At a low outside air temperature (e.g., at an outside air temperature of not higher than 0°C), however, the low-temperature-side heat exchanger fails to capture a sufficient amount of heat from the outside air. In this case, the defrosting effect cannot be achieved sufficiently.

[0007] The present disclosure has been made to solve the above problem. An object of the present disclosure is to provide an outdoor unit for a refrigeration apparatus which is capable of achieving a defrosting effect even at a low outside air temperature and a refrigeration apparatus including the outdoor unit.

SOLUTION TO PROBLEM

[0008] The present disclosure relates to an outdoor unit for a refrigeration apparatus having a refrigeration mode and a defrosting mode. The outdoor unit includes: a first refrigeration cycle device configured to circulate a first refrigerant between the first refrigeration cycle device and an indoor unit in which a first expansion valve and a first heat exchanger are connected in series; a second refrigeration cycle device configured to circulate a second refrigerant; and a cascade heat exchanger configured to exchange heat between the first refrigerant and the second refrigerant. The first refrigeration cycle device has a first compressor, a second heat exchanger, and a four-way valve configured to interchange a connection destination of a discharging port of the first compressor and a connection destination of a suction port of the first compressor so that in the refrigeration mode, the first refrigerant flows in a positive direction in which the first refrigerant flows toward the first expansion valve through the first compressor and the second heat exchanger, and in the defrosting mode, the first refrigerant flows in a reverse direction in which the first refrigerant flows from the first compressor to the first heat exchanger and returns from the first expansion valve to the first compressor through the second heat exchanger. The second refrigeration cycle device has a second compressor, a third expansion valve, and a third heat exchanger. The second refrigeration cycle device is configured to circulate the second refrigerant in order of the second compressor, the third heat exchanger, the third expansion valve, and the cascade heat exchanger. The second heat exchanger has an arrangement configuration to absorb exhaust heat of the third heat exchanger.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009] According to the present disclosure, the second heat exchanger has the arrangement configuration to absorb the exhaust heat of the third heat exchanger. Such an arrangement configuration can guarantee the function of the second heat exchanger as an evaporator in the defrosting mode, thus achieving the defrosting effect even at a low outside air temperature.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 shows a configuration of a refrigeration apparatus.

Fig. 2 shows a configuration of a controller that controls the refrigeration apparatus.

Fig. 3 shows a refrigerant flow in a defrosting mode of the refrigeration apparatus.

Fig. 4 shows a configuration of an integrated heat exchanger used in the refrigeration apparatus.

Fig. 5 shows a configuration of pipes of the integrated

heat exchanger used in the refrigeration apparatus.
Fig. 6 is a flowchart for illustrating control performed by the controller.
Fig. 7 shows Variation 1 of the integrated heat exchanger.
Fig. 8 shows Variation 2 of the integrated heat exchanger.

DESCRIPTION OF EMBODIMENTS

[0011] Embodiments of the present disclosure will now be described in detail with reference to the drawings. The same or corresponding parts in the drawings are designated by the same references, and description thereof will not be repeated.

[0012] Fig. 1 shows a configuration of a refrigeration apparatus 100 according to the present embodiment. Refrigeration apparatus 100 includes an outdoor unit 101, an indoor unit 102, and pipes 27, 31 connecting outdoor unit 101 to indoor unit 102.

[0013] Outdoor unit 101 includes a first refrigeration cycle device 103 on a low temperature side (low stage side) and a second refrigeration cycle device 104 on a high temperature side (high stage side). First refrigeration cycle device 103 and second refrigeration cycle device 104 constitute a two-stage refrigeration cycle device. In first refrigeration cycle device 103, a first refrigerant circulates. In second refrigeration cycle device 104, a second refrigerant circulates. The first refrigerant is, for example, CO_2. The second refrigerant is, for example, CO_2 or propane. The first refrigerant on the first refrigeration cycle device 103 side and the second refrigerant on the second refrigeration cycle device 104 side exchange heat by a cascade heat exchanger 11. Cascade heat exchanger 11 may be a heat exchanger included in first refrigeration cycle device 103 or a heat exchanger included in second refrigeration cycle device 104.

[0014] Indoor unit 102 includes a first expansion valve 3 and a first heat exchanger 4. A pipe 28 extending from first expansion valve 3 is connected to a pipe 27 extending toward outdoor unit 101. First expansion valve 3 and first heat exchanger 4 are connected in series by a pipe 29. First expansion valve 3 may be, for example, a thermal expansion valve controlled based on a temperature of a refrigerant outlet of first heat exchanger 4. A pipe 30 extending from first heat exchanger 4 is connected to a pipe 31 extending toward outdoor unit 101.

[0015] First refrigeration cycle device 103 includes a first compressor 1, a second heat exchanger 2, a four-way valve 7, a refrigerant amount adjustment mechanism 10, and a controller 50. Refrigerant amount adjustment mechanism 10 includes a liquid receiver 8, refrigerant exhaust pipes 34, 35, and a flow regulating valve 45. First compressor 1 and second heat exchanger 2 are connected so that the first refrigerant circulates between indoor unit 102, and first compressor 1 and second heat exchanger 2.

[0016] The discharge side of first compressor 1 and four-way valve 7 are connected by a pipe 21. The suction side of first compressor 1 and four-way valve 7 are connected by a pipe 33. A pipe 32 extending from four-way valve 7 is connected to a pipe 31 extending toward indoor unit 102. Second heat exchanger 2 and four-way valve 7 are connected by a pipe 22. A check valve 41 is provided between second heat exchanger 2 and cascade heat exchanger 11. Second heat exchanger 2 and check valve 41 are connected by a pipe 23. Cascade heat exchanger 11 and liquid receiver 8 are connected by a pipe 24.

[0017] Second refrigeration cycle device 104 includes a second compressor 9, a third heat exchanger 6, and a third expansion valve 5. Second refrigeration cycle device 104 is configured so that the second refrigerant circulates in order of second compressor 9, third heat exchanger 6, third expansion valve 5, and cascade heat exchanger 11. Second compressor 9 and third heat exchanger 6 are connected by a pipe 47. Third heat exchanger 6 and third expansion valve 5 are connected by a pipe 48. Third expansion valve 5 and cascade heat exchanger 11 are connected by a pipe 49. Cascade heat exchanger 11 and second compressor 9 are connected by a pipe 53.

[0018] Cascade heat exchanger 11 exchanges heat between the first refrigerant and the second refrigerant that are discharged from second heat exchanger 2 and flow into liquid receiver 8. Third heat exchanger 6 functions as a condenser and dissipates heat. Since the refrigerant that flows into liquid receiver 8 is cooled in cascade heat exchanger 11, a rise in the pressure in liquid receiver 8 can be suppressed.

[0019] Fig. 2 shows a configuration of controller 50 that controls the refrigeration apparatus. Referring to Fig. 2, controller 50 includes a processor 51, a memory 52, a communication interface (not shown), and the like. Processor 51 controls an operation frequency of first compressor 1, the connection of four-way valve 7, and the like according to data stored in memory 52 and information obtained via the communication interface.

[0020] Memory 52 is composed of, for example, a read only memory (ROM), a random access memory (RAM), and a flash memory. In the flash memory, an operating system, an application program, and various data are stored. Controller 50 shown in Fig. 1 is implemented as processor 51 executes the operating system and the application program stored in memory 52. In the execution of the application program, the various data stored in memory 52 are referred to.

[0021] Refrigeration apparatus 100 has a refrigeration mode and a defrosting mode as its operation mode. In the refrigeration mode, the refrigerant flows in the direction indicated by the arrow in Fig. 1. Fig. 3 shows a refrigerant flow in the defrosting mode of refrigeration apparatus 100.

[0022] Four-way valve 7 switches the connection destination of the discharging port of first compressor 1 and the connection destination of the suction port of first com-

pressor 1 between the refrigeration mode and the defrosting mode. In the refrigeration mode shown in Fig. 1, four-way valve 7 connects first compressor 1 so that the first refrigerant flows in the positive direction in which the first refrigerant flows toward first expansion valve 3 through first compressor 1 and second heat exchanger 2. Second refrigeration cycle device 104 continuously operates when the operation mode is both the refrigeration mode and the defrosting mode.

[0023] In the defrosting mode shown in Fig. 3, four-way valve 7 connects first compressor 1 so that the first refrigerant flows in the reverse direction in which the first refrigerant flows from first compressor 1 to first heat exchanger 4 and returns from first expansion valve 3 to first compressor 1 through second heat exchanger 2. In the defrosting mode, first heat exchanger 4 on the indoor unit 102 side functions as a condenser. Thus, first heat exchanger 4 is defrosted. In the defrosting mode, also, second heat exchanger 2 on the outdoor unit 101 side functions as an evaporator and provides heat to the second refrigerant flowing to the suction side of first compressor 1.

[0024] In the defrosting mode, second heat exchanger 2 needs to capture heat from the outside air. At a low outside air temperature (e.g., not higher than 0°C), however, second heat exchanger 2 itself may be frosted. Even when second heat exchanger 2 is not frosted, at a low outside air temperature, second heat exchanger 2 may fail to obtain a sufficient amount of heat from the outside air. In the present disclosure, thus, second heat exchanger 2 has an arrangement configuration to absorb exhaust heat of third heat exchanger 6. Specifically, second heat exchanger 2 is provided in the vicinity of third heat exchanger 6 of second refrigeration cycle device 104. Since second heat exchanger 2 is provided in the vicinity of third heat exchanger 6, the exhaust heat of third heat exchanger 6 can be absorbed by second heat exchanger 2 that functions as an evaporator (heat capture device) in the defrosting mode. Even at a low outside air temperature, thus, second heat exchanger 2 can effectively function as an evaporator. For example, in the present embodiment, second heat exchanger 2 and third heat exchanger 6 constitute an integrated heat exchanger 260.

[0025] Refrigerant amount adjustment mechanism 10 is configured to adjust a circulation amount of the first refrigerant in both the refrigeration mode and the defrosting mode. Liquid receiver 8 is arranged between second heat exchanger 2 and first expansion valve 3. Refrigerant exhaust pipes 34, 35 connect the outlet of liquid receiver 8 to the suction port of first compressor 1. Flow regulating valve 45 regulates a flow rate of the first refrigerant that circulates through refrigerant exhaust pipes 34, 35. In the present disclosure, at least refrigerant amount adjustment mechanism 10 is not an indispensable component.

[0026] Outdoor unit 101 further includes bypass flow paths 36, 37 that flow the first refrigerant from first expansion valve 3 toward second heat exchanger 2 without through liquid receiver 8 in the defrosting mode shown in Fig. 3.

[0027] Outdoor unit 101 further includes a second expansion valve 46 provided in bypass flow paths 36, 37, and a check valve 43 that is provided in bypass flow path 37 and restricts the refrigerant circulation direction to the direction in which the refrigerant flows from second expansion valve 46 toward second heat exchanger 2. Second expansion valve 46 is an expansion valve for defrosting which functions in the defrosting mode. Controller 50 controls second expansion valve 46 to be closed in the refrigeration mode. On the other hand, controller 50 opens first expansion valve 3 on the indoor unit 102 side in the defrosting mode.

[0028] When four-way valve 7 is switched to the state shown in Fig. 3, the refrigerant circulates in the direction indicated by the arrow in Fig. 3 because of check valves 41 to 43. When the refrigeration mode is switched to the defrosting mode, a sufficient amount of refrigerant is stored in liquid receiver 8 of refrigerant amount adjustment mechanism 10. In the defrosting mode, an amount of refrigerant circulating is added as flow regulating valve 45 is opened. Thus, it suffices that flow regulating valve 45 is closed when the amount of refrigerant reaches an appropriate amount in order to set the amount of refrigerant circulating in the defrosting mode to an appropriate amount. Since check valve 42 is provided between pipe 25 and pipe 26 after refrigerant exhaust pipe 34 branches off, the refrigerant from first expansion valve 3 does not flow backward to the liquid receiver 8 side even when flow regulating valve 45 is opened in the defrosting mode.

[0029] Also after the operation mode is switched from the refrigeration mode to the defrosting mode, second refrigeration cycle device 104 continuously operates. The first refrigerant flowing from second expansion valve 46 to pipe 23 is divided into a flow in the second heat exchanger 2 direction and a flow in the cascade heat exchanger 11 direction. The first refrigerant flowing in the cascade heat exchanger 11 direction is cooled by cascade heat exchanger 11, and a part of the first refrigerant is stored in liquid receiver 8. Controller 50 controls flow regulating valve 45 to regulate a flow rate of the first refrigerant.

[0030] Fig. 4 shows configurations of second heat exchanger 2 and third heat exchanger 6 used in the refrigeration apparatus. Fig. 5 shows configurations of pipes of second heat exchanger 2 and third heat exchanger 6 used in the refrigeration apparatus.

[0031] Referring to Fig. 4, second heat exchanger 2 and third heat exchanger 6 constitute integrated heat exchanger 260. In integrated heat exchanger 260, second heat exchanger 2 of first refrigeration cycle device 103 is arranged above third heat exchanger 6 of second refrigeration cycle device 104. Integrated heat exchanger 260 includes a plurality of fins 80. On the side of fins 80 which faces away from the viewer in the figure, a fan 70 used in common by second heat exchanger 2 and third

heat exchanger 6 is provided. Rotation of fan 70 generates an air flow from fins 80 to the side facing away from the viewer in the figure. Referring to Fig. 5, pipe 38 of second heat exchanger 2 and pipe 39 of third heat exchanger 6 are firmly fixed to fins 80 while meandering.

[0032] Since integrated heat exchanger 260 has a configuration in which second heat exchanger 2 is arranged above third heat exchanger 6, second heat exchanger 2 can easily capture the warmth of the air that is discharged from third heat exchanger 6 and rises. Further, since fins 80 are used in common by second heat exchanger 2 and third heat exchanger 6, the exhaust heat of third heat exchanger 6 can be transferred to second heat exchanger 2 quickly and efficiently. Even at a low outside air temperature, thus, the function of second heat exchanger 2 as an evaporator in the defrosting mode can be guaranteed, achieving the defrosting effect.

[0033] Although fins 80 are common to second heat exchanger 2 and third heat exchanger 6 in integrated heat exchanger 260, instead, fins may be provided separately for second heat exchanger 2 and third heat exchanger 6. In such a case, the heat transfer action owing to common fins cannot be achieved. However, with the configuration in which second heat exchanger 2 is arranged above third heat exchanger 6, second heat exchanger 2 can easily capture the warmth of the air that is discharged from third heat exchanger 6 and rises. Even at a low outside air temperature, thus, the function of second heat exchanger 2 as an evaporator in the defrosting mode can be guaranteed, achieving the defrosting effect.

[0034] Fig. 6 is a flowchart for illustrating control performed by a controller. The process of this flowchart is repeatedly performed every time a certain period of time elapses or a predetermined condition is satisfied during the operation of the refrigeration apparatus. For example, when defrosting is performed for each certain period of time, controller 50 performs the process of the flowchart of Fig. 6 after a lapse of a certain period of time from the last defrosting of first heat exchanger 4. The determination to shift to the defrosting mode may be made based on the detection of the refrigerant temperature or how frost adheres to first heat exchanger 4.

[0035] Referring to Fig. 6, when a condition for switching to the defrosting mode is satisfied, at step S1, controller 50 switches four-way valve 7 from the state of Fig. 1 to the state of Fig. 3.

[0036] At step S2, controller 50 then monitors outputs of temperature sensor 61 and pressure sensor 62 and determines whether a subcool (SC) of the first refrigerant in bypass flow path 36 before second expansion valve 46 is lower than a determination value.

[0037] When the SC is less than the determination value (YES at S2), controller 50 opens flow regulating valve 45 to add an amount of refrigerant circulating. On the other hand, when the SC is not less than the determination value (NO at S2), an amount of refrigerant circulating is sufficient, and accordingly, controller 50 closes flow regulating valve 45.

[0038] Processing of step S2 to processing of step S4 are repeated until completion of defrosting is determined at step S5. As a result, an amount of refrigerant circulating in the defrosting mode is adjusted to an appropriate amount.

[0039] When completion of defrosting is determined (YES at S5), at step S6, controller 50 returns four-way valve 7 to the state in the refrigeration mode of Fig. 1.

[0040] Refrigeration apparatus 100 can appropriately maintain a circulation amount of refrigerant during defrosting, and accordingly, can avoid a decrease in defrosting ability and an excessive rise in high pressure due to lack of refrigerant. Thus, frost can be melted reliably in a short period of time, and a design pressure can be reduced.

[0041] In the case of the two-stage cycle including first refrigeration cycle device 103 on the low temperature side and second refrigeration cycle device 104 on the high temperature side, the design pressure of first refrigeration cycle device 103 on the low temperature side is set to be low. Thus, adjusting a circulation amount of refrigerant in the defrosting mode by refrigerant amount adjustment mechanism 10 is effective at reducing a pressure of first refrigeration cycle device 103 on the low temperature side, and is effective when carbonic acid gas or the like is used as the second refrigerant.

(Variation 1)

[0042] Fig. 7 shows Variation 1 of the integrated heat exchanger. Referring to Fig. 7, an integrated heat exchanger 261 has a configuration in which second heat exchanger 2 and third heat exchanger 6 are arranged horizontally side by side. Similarly to integrated heat exchanger 260, integrated heat exchanger 261 includes fins 80 that are common to second heat exchanger 2 and third heat exchanger 6. Integrated heat exchanger 261 has fan 70 on one of the second heat exchanger 2 side and the third heat exchanger 6 side, which is closer to second heat exchanger 2.

[0043] Rotation of fan 70 generates an air flow in the direction from third heat exchanger 6 to second heat exchanger 2. Second heat exchanger 2 is located on the leeward side of an air flow with respect to third heat exchanger 6, and accordingly, can easily capture the heat discharged from third heat exchanger 6. Further, fins 80 are used in common by second heat exchanger 2 and third heat exchanger 6, and accordingly, the exhaust heat of third heat exchanger 6 can be transferred to second heat exchanger 2 quickly and efficiently. Second heat exchanger 2 can thus capture heat quickly and efficiently in the defrosting mode.

[0044] In integrated heat exchanger 261, the arrangement of second heat exchanger 2 and third heat exchanger 6 may be reversed. Although second heat exchanger 2 is positioned on the windward side of an air flow with respect to third heat exchanger 6, second heat exchang-

er 2 can absorb the exhaust heat of third heat exchanger 6 via fins 80 because fins 80 are common to second heat exchanger 2 and third heat exchanger 6.

(Variation 2)

[0045] Fig. 8 shows Variation 2 of the integrated heat exchanger. Referring to Fig. 8, an integrated heat exchanger 262 differs from integrated heat exchanger 261 shown in Fig. 7 in that fins are not common to second heat exchanger 2 and third heat exchanger 6. In integrated heat exchanger 262, second heat exchanger 2 and third heat exchanger 6 are arranged horizontally, and second heat exchanger 2 and third heat exchanger 6 are connected by a coupling member 91.

[0046] In integrated heat exchanger 262, rotation of fan 70 generates an air flow in the direction from third heat exchanger 6 toward second heat exchanger 2. Contrary to integrated heat exchanger 261, integrated heat exchanger 262 cannot achieve the heat transfer action owing to common fins. However, second heat exchanger 2 is located on the leeward side of the air flow with respect to third heat exchanger 6, and accordingly, can easily capture the heat discharged from third heat exchanger 6. Even at a low outside air temperature, thus, the function of second heat exchanger 2 as an evaporator in the defrosting mode can be guaranteed, achieving the defrosting effect.

(Summary)

[0047] The present embodiment will be summarized as follows.

[0048] The present disclosure relates to an outdoor unit (101) for a refrigeration apparatus (100) having a refrigeration mode and a defrosting mode. The outdoor unit (101) includes: a first refrigeration cycle device (103) configured to circulate a first refrigerant between the first refrigeration cycle device (103) and an indoor unit (102) in which a first expansion valve (3) and a first heat exchanger (4) are connected in series; a second refrigeration cycle device (104) configured to circulate a second refrigerant; and a cascade heat exchanger (11) configured to exchange heat between the first refrigerant and the second refrigerant. The first refrigeration cycle device (103) has a first compressor (1), a second heat exchanger (2), and a four-way valve (7) configured to interchange a connection destination of a discharging port of the first compressor (1) and a connection destination of a suction port of the first compressor (1) so that in the refrigeration mode, the first refrigerant flows in a positive direction in which the first refrigerant flows toward the first expansion valve (3) through the first compressor (1) and the second heat exchanger (2), and in the defrosting mode, the first refrigerant flows in a reverse direction in which the first refrigerant flows from the first compressor (1) to the first heat exchanger (4) and returns from the first expansion valve (3) to the first compressor (1) through the second heat exchanger (2). The second refrigeration cycle device has a second compressor (9), a third expansion valve (5), and a third heat exchanger (6). The second refrigeration cycle device is configured to circulate the second refrigerant in order of the second compressor (9), the third heat exchanger (6), the third expansion valve (5), and the cascade heat exchanger (11). The second heat exchanger (2) has an arrangement configuration to absorb exhaust heat of the third heat exchanger (6) (see Figs. 4, 5, 7, 8).

[0049] Preferably, the arrangement configuration is a configuration in which a pipe (38) through which the first refrigerant flows in the second heat exchanger (2) and a pipe (39) through which the second refrigerant flows in the third heat exchanger (6) are coupled to each other by a plurality of common fins (80) (see Figs. 5, 7).

[0050] Preferably, the arrangement configuration is a configuration in which the second heat exchanger (2) is arranged above the third heat exchanger (6) (see Fig. 4).

[0051] The outdoor unit (101) further includes a fan (70) configured to blow air to the second heat exchanger (2) and the third heat exchanger (6). The arrangement configuration is a configuration in which the second heat exchanger (2) is arranged on a leeward side of an air flow generated by the fan (70) with respect to the third heat exchanger (6) (see Figs. 7, 8).

[0052] The outdoor unit (101) further includes a refrigerant amount adjustment mechanism (10) configured to adjust a circulation amount of the first refrigerant in the defrosting mode.

[0053] Preferably, the refrigerant amount adjustment mechanism (10) has a liquid receiver (8) arranged between the second heat exchanger (2) and the first expansion valve (3), a refrigerant exhaust pipe (34, 35) connecting an outlet of the liquid receiver (8) to a suction port of the first compressor (1), and a flow regulating valve (45) configured to regulate a flow rate of the first refrigerant that circulates through the refrigerant exhaust pipe (34, 35). The outdoor unit (101) further includes a bypass flow path (36, 37) configured to flow the first refrigerant from the first expansion valve (3) toward the second heat exchanger (2) without through the liquid receiver (8) in the defrosting mode.

[0054] The outdoor unit (101) further includes a second expansion valve (46) provided in the bypass flow path (36, 37), and a check valve (43) provided in the bypass flow path (36, 37) and configured to restrict a refrigerant circulation direction to a direction in which refrigerant flows from the second expansion valve (46) toward the second heat exchanger (2).

[0055] It is to be understood that the embodiments disclosed herein are presented for the purpose of illustration and non-restrictive in every respect. It is therefore intended that the scope of the present disclosure is defined by claims, not only by the embodiments described above, and encompasses all modifications and variations equivalent in meaning and scope to the claims.

REFERENCE SIGNS LIST

[0056] 1 first compressor; 2 second heat exchanger; 3 first expansion valve; 4 first heat exchanger; 5 third expansion valve; 6 third heat exchanger; 9 second compressor; 7 four-way valve; 8 liquid receiver; 10 refrigerant amount adjustment mechanism; 11 cascade heat exchanger; 21 to 33, 38, 39, 47 to 49 pipe; 34, 35 refrigerant exhaust pipe; 36, 37 bypass flow path; 41 to 43 check valve; 45 flow regulating valve; 46 second expansion valve; 50 controller; 51 processor; 52 memory; 61 temperature sensor; 62 pressure sensor; 70, 70a, 70b fan; 80, 80a, 80b fin; 100 refrigeration apparatus; 101 outdoor unit; 102 indoor unit; 103 first refrigeration cycle device; 104 second refrigeration cycle device; 260 to 262 integrated heat exchanger.

Claims

1. An outdoor unit for a refrigeration apparatus having a refrigeration mode and a defrosting mode, the outdoor unit comprising:

a first refrigeration cycle device configured to circulate a first refrigerant between the first refrigeration cycle device and an indoor unit in which a first expansion valve and a first heat exchanger are connected in series;
a second refrigeration cycle device configured to circulate a second refrigerant; and
a cascade heat exchanger configured to exchange heat between the first refrigerant and the second refrigerant,
the first refrigeration cycle device having

a first compressor,
a second heat exchanger, and
a four-way valve configured to interchange a connection destination of a discharging port of the first compressor and a connection destination of a suction port of the first compressor so that

in the refrigeration mode, the first refrigerant flows in a positive direction in which the first refrigerant flows toward the first expansion valve through the first compressor and the second heat exchanger, and
in the defrosting mode, the first refrigerant flows in a reverse direction in which the first refrigerant flows from the first compressor to the first heat exchanger and returns from the first expansion valve to the first compressor through the second heat exchanger,

the second refrigeration cycle device having

a second compressor,
a third expansion valve, and
a third heat exchanger, wherein

the second refrigeration cycle device is configured to circulate the second refrigerant in order of the second compressor, the third heat exchanger, the third expansion valve, and the cascade heat exchanger, and
the second heat exchanger has an arrangement configuration to absorb exhaust heat of the third heat exchanger.

2. The outdoor unit according to claim 1, wherein the arrangement configuration is a configuration in which a pipe through which the first refrigerant flows in the second heat exchanger and a pipe through which the second refrigerant flows in the third heat exchanger are coupled to each other by a plurality of common fins.

3. The outdoor unit according to claim 1 or 2, wherein the arrangement configuration is a configuration in which the second heat exchanger is arranged above the third heat exchanger.

4. The outdoor unit according to claim 1 or 2, further comprising a fan configured to blow air to the second heat exchanger and the third heat exchanger,
wherein the arrangement configuration is a configuration in which the second heat exchanger is arranged on a leeward side of an air flow generated by the fan with respect to the third heat exchanger.

5. The outdoor unit according to any one of claims 1 to 4, further comprising a refrigerant amount adjustment mechanism configured to adjust a circulation amount of the first refrigerant in the defrosting mode.

6. The outdoor unit according to claim 5, wherein

the refrigerant amount adjustment mechanism has

a liquid receiver arranged between the second heat exchanger and the first expansion valve,
a refrigerant exhaust pipe connecting an outlet of the liquid receiver to a suction port of the first compressor, and
a flow regulating valve configured to regulate a flow rate of the first refrigerant that circulates through the refrigerant exhaust pipe, and

the outdoor unit further comprises a bypass flow

path configured to flow the first refrigerant from the first expansion valve toward the second heat exchanger without through the liquid receiver in the defrosting mode.

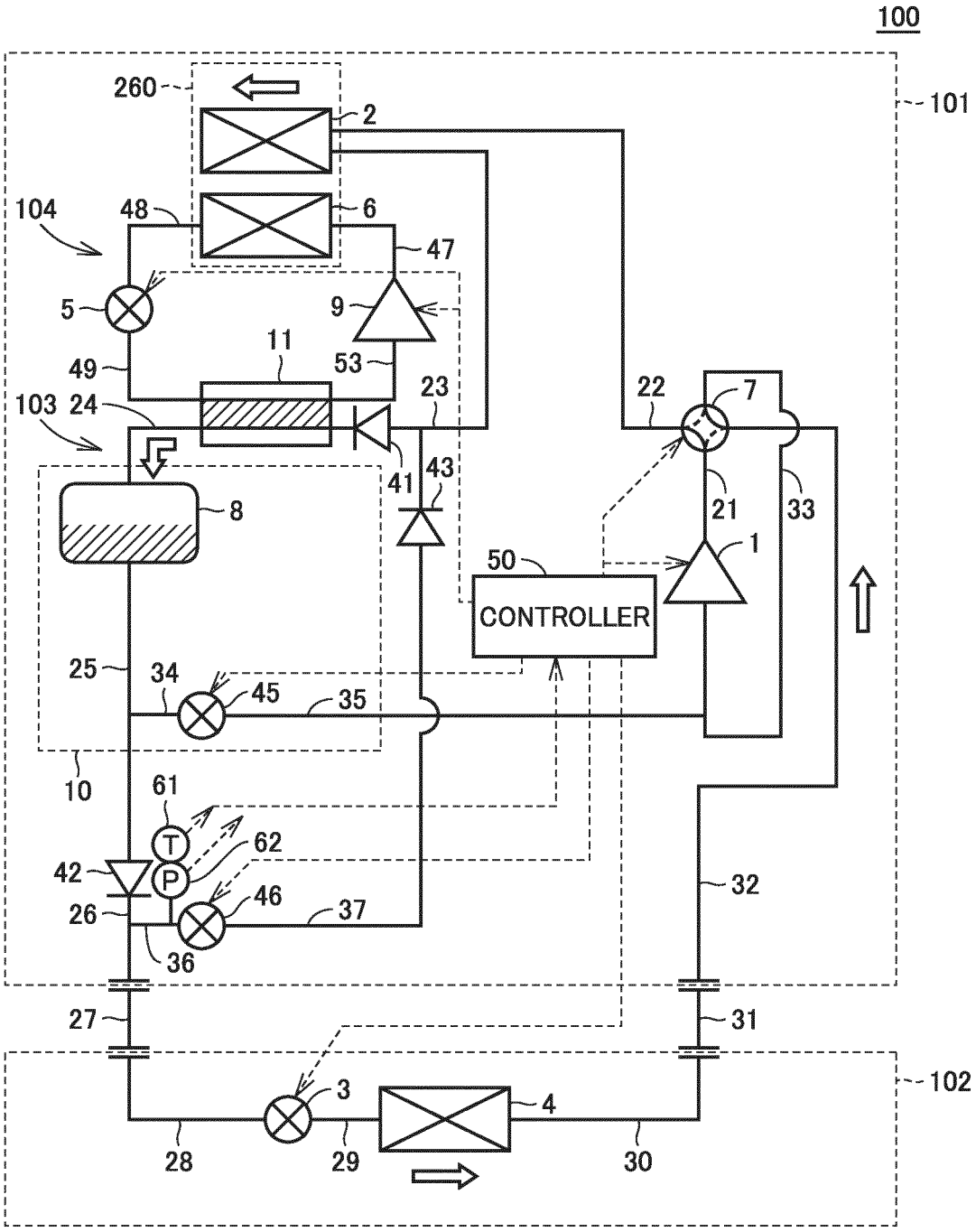
7. The outdoor unit according to claim 6, further comprising:

a second expansion valve provided in the bypass flow path, and
a check valve provided in the bypass flow path and configured to restrict a refrigerant circulation direction to a direction in which refrigerant flows from the second expansion valve toward the second heat exchanger.

8. A refrigeration apparatus comprising:

the outdoor unit according to any one of claims 1 to 7; and
the indoor unit.

FIG.1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30

FIG.2

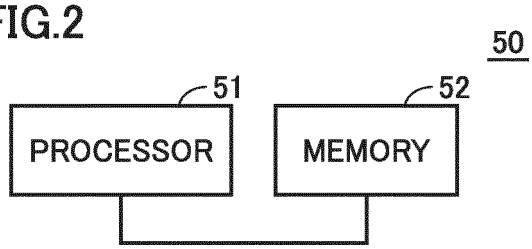


FIG.3

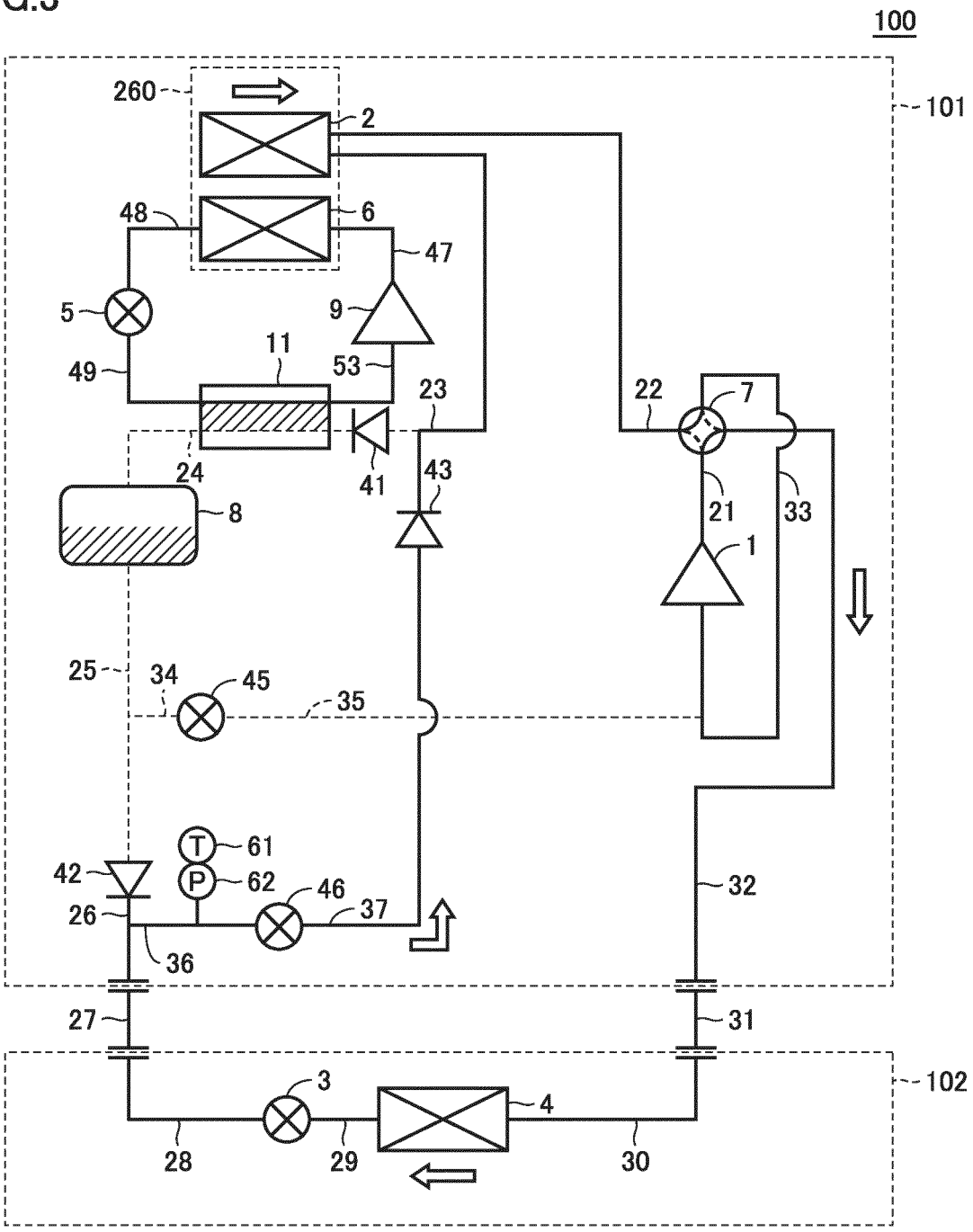

100
101
260
2
48
6
47
5
9
11
53
49
23
22
7
24
41
43
21
33
8
1
25
34
45
35
T
61
42
P
62
46
37
32
26
36
27
31
102
3
4
28
29
30

FIG.4

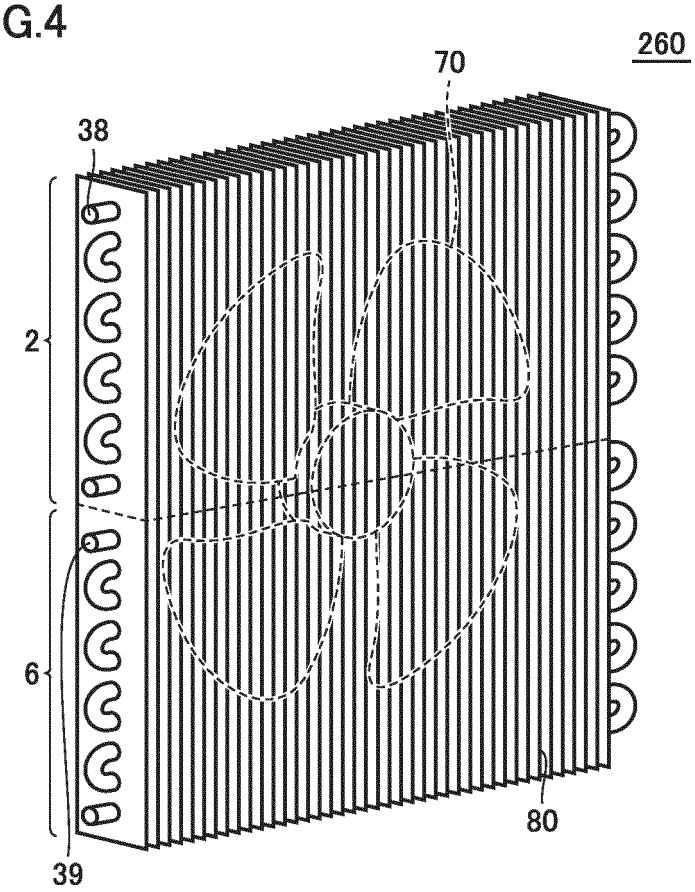


FIG.5

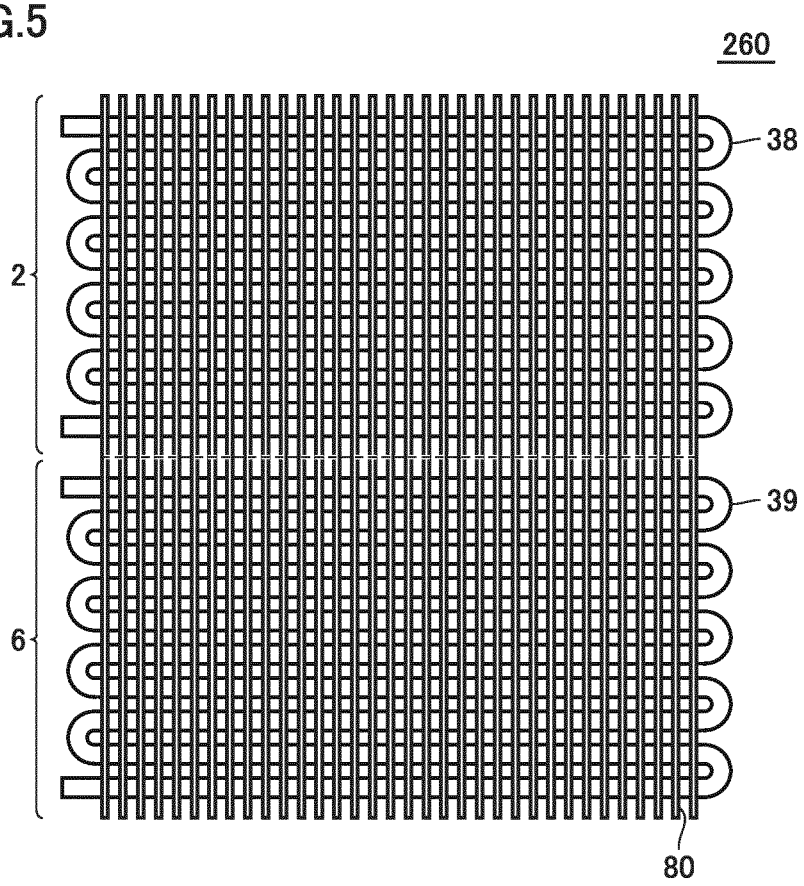


FIG.6

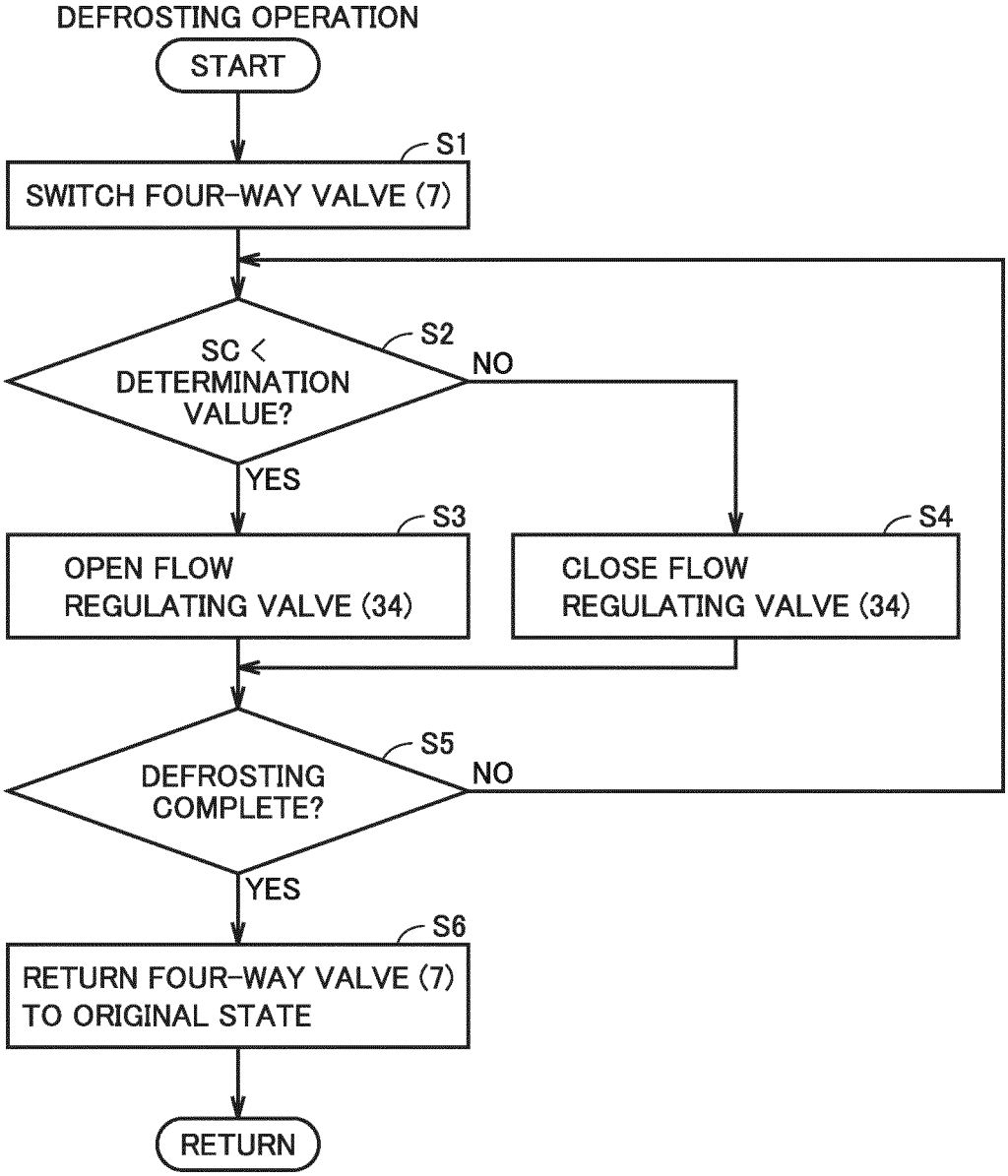

DEFROSTING OPERATION
START
S1
SWITCH FOUR-WAY VALVE (7)
S2
SC < DETERMINATION VALUE?
NO
YES
S3
OPEN FLOW REGULATING VALVE (34)
S4
CLOSE FLOW REGULATING VALVE (34)
S5
DEFROSTING COMPLETE?
NO
YES
S6
RETURN FOUR-WAY VALVE (7) TO ORIGINAL STATE
RETURN

FIG.7

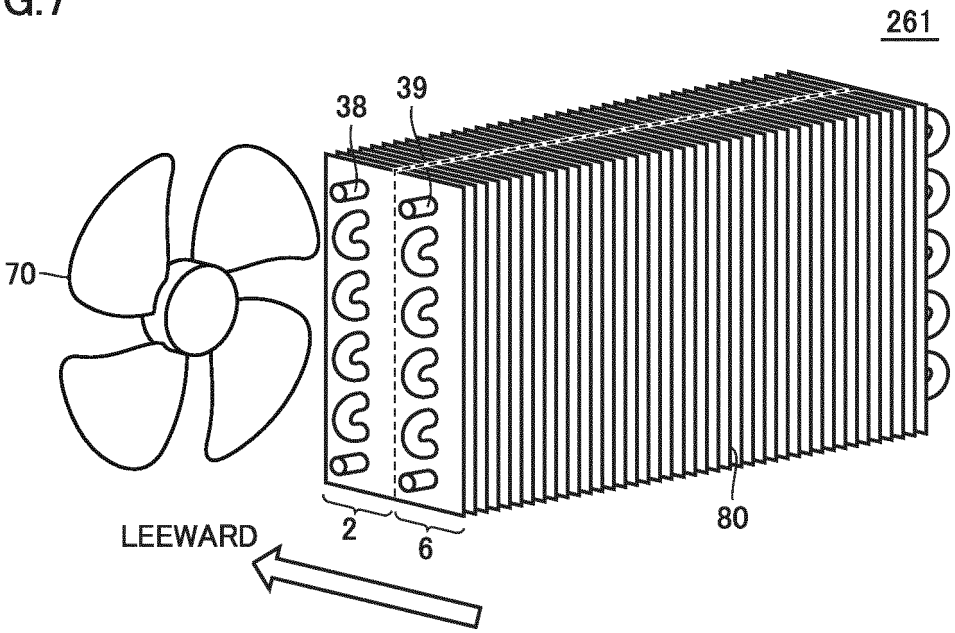
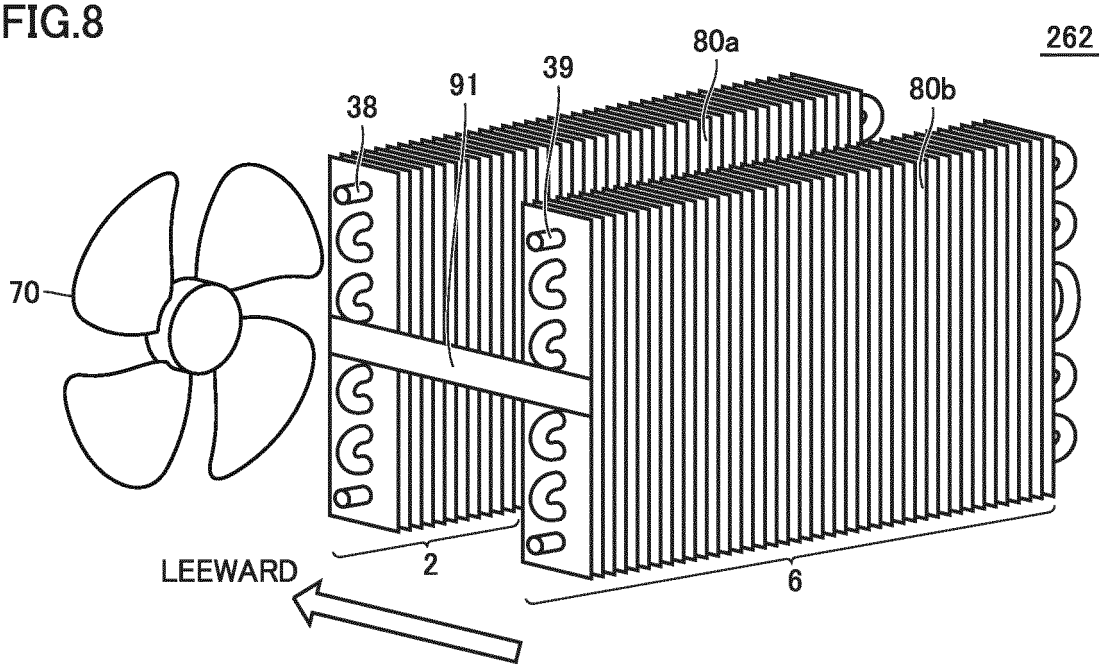


FIG.8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/027522

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F25B7/00(2006.01)i
FI: F25B7/00 D

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)
Int. Cl. F25B7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2020
Registered utility model specifications of Japan 1996-2020
Published registered utility model applications of Japan 1994-2020

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.
Y	US 2015/0338145 A1 (LG ELECTRONICS INC.) 26 November 2015, paragraphs [0020]-[0082], fig. 1-4	1-5, 8
A		6-7
Y	JP 2009-299909 A (HITACHI APPLIANCES, INC.) 24 December 2009, fig. 1-3	1-5, 8
A		6-7
Y	JP 2012-112617 A (MITSUBISHI ELECTRIC CORP.) 14 June 2012, paragraphs [0064]-[0101], fig. 7-10	5
A		6-7

☐ Further documents are listed in the continuation of Box C.
☒ See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23.09.2020	06.10.2020

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

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/027522

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
US 2015/0338145 A1	26.11.2015	EP 2947402 A1 KR 10-2015-0134676 A CN 105091410 A	
JP 2009-299909 A	24.12.2009	(Family: none)	
JP 2012-112617 A	14.06.2012	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5595245 B **[0003] [0005]**