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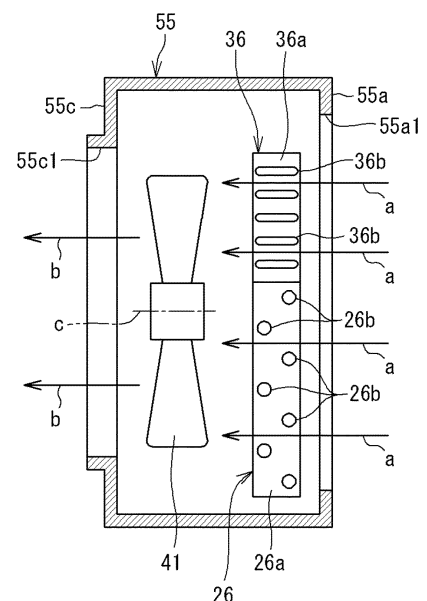
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(54) **REFRIGERATION DEVICE**

(57) A refrigeration apparatus (10) includes: a first refrigerant circuit that circulates a first refrigerant; a second refrigerant circuit that circulates a second refrigerant different from the first refrigerant; and a third heat exchanger that exchanges heat between the first refrigerant and the second refrigerant. The first refrigerant circuit includes a first heat exchanger (26) having a heat transfer tube (26b) having a circular tube shape. The second refrigerant circuit (22) includes a second heat exchanger (36) having a flat multi-hole tube (36b). The first heat exchanger (26) and the second heat exchanger (36) are vertically aligned. The second heat exchanger (36) is disposed above the first heat exchanger (26).

FIG. 3



Description**TECHNICAL FIELD**

[0001] The present disclosure relates to a refrigeration apparatus. 5

BACKGROUND ART

[0002] PATENT LITERATURE 1 discloses a binary refrigeration apparatus having a lower-stage refrigeration cycle and a higher-stage refrigeration cycle. The lower-stage refrigeration cycle is used to adjust the temperature of an indoor load device, for example, a showcase. Therefore, in the lower-stage refrigeration cycle, a refrigerant circuit may be opened due to rearrangement of a showcase or the like, and refrigerant leakage may occur. Therefore, a refrigerant having a low global warming potential, such as carbon dioxide, is used. In contrast, the higher-stage refrigeration cycle is used to further cool the refrigerant cooled by the radiator in the lower-stage refrigeration cycle. Since the refrigerant circuit of the higher-stage refrigeration cycle is not opened unlike the refrigerant circuit of the lower-stage refrigeration cycle, a refrigerant such as R32 having a higher global warming potential but higher heat exchange efficiency than the refrigerant of the lower-stage refrigeration cycle is used. 10 15 20 25

CITATION LIST

[PATENT LITERATURE] 30

[0003] PATENT LITERATURE 1: WO 2014/181399 A 35

SUMMARY OF THE INVENTION

[TECHNICAL PROBLEM]

[0004] Since the refrigerant such as R32 used in the higher-stage refrigeration cycle may be flammable and toxic, it is desirable to reduce the amount used as much as possible. Therefore, it is conceivable to use a heat exchanger including flat multi-hole tubes capable of efficient heat exchange with a smaller amount of refrigerant than a heat exchanger including a general circular tube-shaped heat transfer tube. However, this heat exchanger has drainage problems due to the tendency for water to accumulate on the flat multi-hole tubes. 40 45

[0005] An object of the present disclosure is to address the problem of drainage in heat exchangers in a refrigeration apparatus including two refrigerant circuits using different refrigerants. 50

[SOLUTION TO PROBLEM] 55

[0006]

(1) A refrigeration apparatus according to the present disclosure includes:

a first refrigerant circuit that circulates a first refrigerant;
a second refrigerant circuit that circulates a second refrigerant different from the first refrigerant; and
a third heat exchanger that exchanges heat between the first refrigerant and the second refrigerant, in which the first refrigerant circuit includes a first heat exchanger having a heat transfer tube having a circular tube shape,
the second refrigerant circuit includes a second heat exchanger having a flat multi-hole tube, the first heat exchanger and the second heat exchanger are vertically aligned, and the second heat exchanger is disposed above the first heat exchanger.

This configuration prevents water from dripping from the first heat exchanger onto the flat multi-hole tube of the second heat exchanger because the second heat exchanger is disposed above the first heat exchanger. Therefore, it is possible to suppress accumulation or freezing of water on the flat multi-hole tube.

(2) In the refrigeration apparatus according to (1) above, the second heat exchanger preferably includes a plurality of the flat multi-hole tubes arranged vertically at intervals, and a meandering fin disposed between the flat multi-hole tubes vertically adjacent to each other.

In the second heat exchanger, if water enters the fin, it is difficult to drain, and the accumulated water can freeze and damage the adhesion area between the fin and the flat multi-hole tube. In the refrigeration apparatus having the above configuration, the second heat exchanger is disposed above the first heat exchanger, and the water generated in the first heat exchanger does not drip onto the second heat exchanger. Therefore, the possibility of water entering the fin is reduced, and the occurrence of problems such as freezing of the water can be suppressed.

(3) In the refrigeration apparatus according to (1) or (2) above, preferably, a vertical spacing between the first heat exchanger and the second heat exchanger is 10 mm or less.

With this configuration, it is possible to suppress an increase in the overall size of the first heat exchanger and the second heat exchanger.

(4) In the refrigeration apparatus according to any one of (1) to (3) above, preferably, the heat transfer tube is formed from a material containing copper as a main component, and the flat multi-hole tubes are formed from a material containing aluminum as a main component.

Since copper has a higher potential than aluminum, electrolytic corrosion may occur on aluminum when water generated on copper comes into contact with aluminum. The above configuration prevents water generated in the first heat exchanger from dripping onto the second heat exchanger. Therefore, it is possible to suppress the occurrence of electrolytic corrosion of the flat multi-hole tubes formed from a material containing aluminum as a main component. (5) The refrigeration apparatus according to any one of (1) to (4) above preferably further includes:

a casing that houses the first heat exchanger and the second heat exchanger; and
a fan that is disposed above the second heat exchanger and generates an air flow passing through the first heat exchanger and the second heat exchanger.

With the above configuration, by operating the fan, the flow velocity of air passing through the second heat exchanger disposed on the upper side can be increased relative to the air flow passing through the first heat exchanger disposed on the lower side, and the water adhering to the second heat exchanger can be easily removed with the air flow having a high flow velocity.

(6) The refrigeration apparatus according to any one of (1) to (5) above preferably further includes a coupling member that couples the first heat exchanger and the second heat exchanger.

(7) In the refrigeration apparatus according to (6) above, preferably, in a top view, the first heat exchanger has an end in a longitudinal direction, the end of the first heat exchanger being disposed near an end of the second heat exchanger in a longitudinal direction, and

the coupling member includes a first coupling member that couples the end of the first heat exchanger to the end of the second heat exchanger.

(8) In the refrigeration apparatus according to (6) or (7) above, the coupling member includes a second coupling member that couples longitudinal intermediate portions of the first heat exchanger and the second heat exchanger to each other in a top view.

[0007] With the above configuration, even if vibration due to transportation or the like is transmitted to the refrigeration apparatus, the longitudinal intermediate portion of the first heat exchanger and the longitudinal intermediate portion of the second heat exchanger are less likely to swing in different directions, and rubbing or collision between the two is suppressed.

BRIEF DESCRIPTION OF DRAWINGS

[0008]

FIG. 1 is a refrigerant circuit diagram of a refrigeration apparatus according to a first embodiment of the present disclosure.

FIG. 2 is a plan view illustrating the interior of an outdoor unit in the refrigeration apparatus.

FIG. 3 illustrates the interior of the outdoor unit as viewed in a direction of arrows B-B in FIG. 2.

FIG. 4 illustrates the interior of the outdoor unit as viewed in a direction of arrows C-C in FIG. 2.

FIG. 5 illustrates the interior of the outdoor unit as viewed in a direction of arrows D-D in FIG. 2.

FIG. 6 is an explanatory diagram schematically illustrating a first outdoor heat exchanger in the refrigeration apparatus.

FIG. 7 is an explanatory diagram schematically illustrating a second outdoor heat exchanger in the refrigeration apparatus.

FIG. 8 is an enlarged cross-sectional view of the second outdoor heat exchanger.

FIG. 9 is an explanatory diagram schematically illustrating the arrangement of the first outdoor heat exchanger and the second outdoor heat exchanger.

FIG. 10 is a sectional view taken along line A-A of FIG. 9.

FIG. 11 is a Mollier chart for explaining a refrigeration cycle of a first refrigerant circuit during cooling operation.

FIG. 12 is a side view illustrating the interior of an outdoor unit in a refrigeration apparatus according to a second embodiment of the present disclosure.

DETAILED DESCRIPTION

[0009] Embodiments of the present disclosure will be described in detail hereinafter with reference to the accompanying drawings.

[First embodiment]

(Overall configuration of refrigeration apparatus)

[0010] FIG. 1 is a refrigerant circuit diagram of a refrigeration apparatus according to a first embodiment of the present disclosure.

[0011] As illustrated in FIG. 1, a refrigeration apparatus 10 according to the present embodiment is an air conditioner that adjusts the temperature of air in a room, which is a space to be air-conditioned, to a predetermined target temperature. The refrigeration apparatus 10 according to the present embodiment performs indoor cooling and heating. However, the refrigeration apparatus 10 may be dedicated to cooling. The refrigeration apparatus 10 may be a refrigerator, freezer, or the like that cools the air inside the refrigerator.

[0012] The refrigeration apparatus 10 has an outdoor unit 11 (heat source unit) and an indoor unit 12 (utilization unit). The refrigeration apparatus 10 has, for example, one outdoor unit 11 and one indoor unit 12 connected to

the outdoor unit 11. However, the refrigeration apparatus 10 may have a plurality of the indoor units 12 connected in parallel to the outdoor unit 11. The refrigeration apparatus 10 may include a plurality of the outdoor units 11.

[0013] The refrigeration apparatus 10 has a first refrigerant circuit 21 and a second refrigerant circuit 22. The first refrigerant circuit 21 circulates a first refrigerant, and the second refrigerant circuit 22 circulates a second refrigerant. In the present embodiment, carbon dioxide is used as the first refrigerant. In the present embodiment, a flammable or toxic refrigerant or a refrigerant having a high global warming potential (GWP) is used as the second refrigerant. For example, R290 (propane) is used as the second refrigerant. The refrigeration apparatus 10 also has an auxiliary heat exchanger 27 and a control device 51.

(Configuration of first refrigerant circuit 21)

[0014] The first refrigerant circuit 21 circulates the first refrigerant between the indoor unit 12 and the outdoor unit 11. The first refrigerant circuit 21 includes a first compressor 24, a four-way switching valve 25, a first outdoor heat exchanger (heat source heat exchanger; first heat exchanger) 26, a first expansion valve 28, a first shutoff valve 29, an indoor heat exchanger (utilization heat exchanger) 30, a second shutoff valve 31, a first accumulator 32, a refrigerant pipe 40 connecting these components, and the like.

[0015] The outdoor unit 11 includes the first compressor 24, the four-way switching valve 25, the first outdoor heat exchanger 26, the first expansion valve 28, the first shutoff valve 29, the second shutoff valve 31, and the first accumulator 32 that constitute the first refrigerant circuit 21. The indoor unit 12 includes the indoor heat exchanger 30 constituting the first refrigerant circuit 21. The outdoor unit 11 is provided with an outdoor fan 41 that draws outdoor air into the outdoor unit 11 and supplies the outdoor air to the first outdoor heat exchanger 26. The indoor unit 12 is provided with an indoor fan 42 that draws indoor air into the indoor unit 12 and supplies the indoor air to the indoor heat exchanger 30.

[0016] The first compressor 24 sucks in low-pressure gaseous first refrigerant and discharges high-pressure gaseous first refrigerant. The first compressor 24 includes a motor, the operating speed of which can be adjusted by inverter control. The first compressor 24 is of a variable displacement type (variable capacity type), the displacement (capacity) of which can be changed by the inverter control of the motor. However, the first compressor 24 may be of a fixed displacement type. There may be a plurality of the first compressors 24. In this case, the first compressors may include both variable displacement and fixed displacement compressors.

[0017] The four-way switching valve 25 reverses the flow of the first refrigerant in the refrigerant pipe 40, and switches and supplies the first refrigerant discharged from the first compressor 24 to either the first outdoor

heat exchanger 26 or the indoor heat exchanger 30. As a result, the refrigeration apparatus 10 can switch between cooling operation and heating operation.

[0018] The first outdoor heat exchanger 26 is a cross-fin tube heat exchanger. The first outdoor heat exchanger 26 exchanges heat between the outdoor air drawn in by the outdoor fan 41 and the first refrigerant, and causes the first refrigerant to release heat or evaporate.

[0019] The first expansion valve 28 is a decompressor that decompresses and expands the first refrigerant. The first expansion valve 28 is constituted by an electric valve capable of adjusting the refrigerant flow rate and the like. The first expansion valve 28 decompresses and expands the high-pressure gaseous first refrigerant from which heat has been released by the first outdoor heat exchanger 26 and the auxiliary heat exchanger 27 to be described later, thereby turning the first refrigerant into a low-pressure gas-liquid two-phase refrigerant. As the decompressor, a capillary tube may be used instead of the first expansion valve 28.

[0020] The first shutoff valve 29 is a manual on-off valve. The first shutoff valve 29 blocks the flow of the first refrigerant in the refrigerant pipe 40 when closed, and allows the flow of the first refrigerant in the refrigerant pipe 40 when open.

[0021] The indoor heat exchanger 30 is, for example, a cross-fin tube or microchannel heat exchanger. The indoor heat exchanger 30 exchanges heat between the indoor air drawn in by the indoor fan 42 and the first refrigerant, and causes the first refrigerant to release heat or evaporate.

[0022] The second shutoff valve 31 is a manual on-off valve. The second shutoff valve 31 blocks the flow of the first refrigerant in the refrigerant pipe 40 when closed, and allows the flow of the first refrigerant in the refrigerant pipe 40 when open.

[0023] The first accumulator 32 is provided in the suction pipe of the first compressor 24. The first accumulator 32 temporarily stores the low-pressure first refrigerant before being sucked into the first compressor 24, and separates the first refrigerant into gas refrigerant and liquid refrigerant. The first refrigerant that is the gas refrigerant separated by the first accumulator 32 is sucked into the first compressor 24.

(Configuration of second refrigerant circuit 22)

[0024] The second refrigerant circuit 22 circulates the refrigerant inside the outdoor unit 11. The second refrigerant circuit 22 uses R290 (propane) as the second refrigerant. The second refrigerant circuit 22 includes a second compressor 34, a second outdoor heat exchanger (second heat exchanger) 36, a second expansion valve 38, a second accumulator 39, a refrigerant pipe 50 connecting these components, and the like.

[0025] The second compressor 34 sucks in low-pressure gaseous second refrigerant and discharges high-pressure gaseous second refrigerant. The second com-

pressor 34 includes a motor, the operating speed of which can be adjusted by inverter control. The second compressor 34 is of a variable displacement type (variable capacity type), the displacement (capacity) of which can be changed by the inverter control of the motor. However, the second compressor 34 may be of a fixed displacement type. There may be a plurality of the second compressors 34. In this case, the second compressors may include both variable displacement and fixed displacement second compressors.

[0026] The second outdoor heat exchanger 36 is a microchannel heat exchanger. The second outdoor heat exchanger 36 exchanges heat between the outdoor air supplied by the outdoor fan 41 and the refrigerant, and causes the refrigerant to release heat (condense).

[0027] The second expansion valve 38 is a decompressor that decompresses and expands the second refrigerant. The second expansion valve 38 according to the present embodiment is constituted by an electric valve capable of adjusting the refrigerant flow rate and the like. The second expansion valve 38 decompresses and expands the high-pressure second refrigerant from which heat has been released by the second outdoor heat exchanger 36, thereby turning the second refrigerant into a low-pressure gas-liquid two-phase refrigerant. As the decompressor, a capillary tube may be used instead of the second expansion valve 38.

[0028] The second accumulator 39 temporarily stores the low-pressure second refrigerant before being sucked into the second compressor 34, and separates the second refrigerant into gas refrigerant and liquid refrigerant. The second accumulator 39 is provided in the suction pipe of the second compressor 34. The second refrigerant that is the gas refrigerant separated by the second accumulator 39 is sucked into the second compressor 34.

(Configuration of auxiliary heat exchanger (third heat exchanger) 27)

[0029] The auxiliary heat exchanger 27 further releases heat from the first refrigerant from which heat has been released by the first outdoor heat exchanger 26. The auxiliary heat exchanger 27 evaporates the second refrigerant that has been heat-released by the second outdoor heat exchanger 36 and decompressed by the second expansion valve 38.

[0030] Specifically, the auxiliary heat exchanger 27 has a first heat transfer tube 27a and a second heat transfer tube 27b. One end of the first heat transfer tube 27a is connected to a refrigerant pipe that extends to the first outdoor heat exchanger 26. The other end of the first heat transfer tube 27a is connected to a refrigerant pipe that extends to the first expansion valve 28. One end of the second heat transfer tube 27b is connected to a refrigerant pipe that extends to the second expansion valve 38. The other end of the second heat transfer tube 27b is connected to a refrigerant pipe that extends to the

second accumulator 39.

[0031] The auxiliary heat exchanger 27 exchanges heat between the first refrigerant flowing through the first heat transfer tube 27a and the second refrigerant flowing through the second heat transfer tube 27b. The first refrigerant (gaseous refrigerant) from which heat has been released by the first outdoor heat exchanger 26 flows into the first heat transfer tube 27a. The second refrigerant (gas-liquid two-phase refrigerant) decompressed and expanded by the second expansion valve 38 flows into the second heat transfer tube 27b.

[0032] Therefore, the auxiliary heat exchanger 27 exchanges heat between the first refrigerant that passes through the first outdoor heat exchanger 26 and flows through the first heat transfer tube 27a and the second refrigerant that passes through the second expansion valve (decompressor) 38 and flows through the second heat transfer tube 27b. The auxiliary heat exchanger 27 causes the first refrigerant flowing through the first heat transfer tube 27a to release heat and the second refrigerant flowing through the second heat transfer tube 27b to evaporate.

[0033] As described above, the auxiliary heat exchanger 27 is included in the first refrigerant circuit 21 and the second refrigerant circuit 22. Therefore, the auxiliary heat exchanger 27 can also be said to be a component of the first refrigerant circuit 21 and the second refrigerant circuit 22.

(Configuration of control device 51)

[0034] The control device 51 controls the operation of the first compressor 24, the four-way switching valve 25, the first expansion valve 28, the outdoor fan 41, the indoor fan 42, the second compressor 34, the second expansion valve 38, and the like. The control device 51 includes a processor and a memory. The processor of the control device 51 includes a central processing unit (CPU), an application specific integrated circuit (ASIC), a gate array, a field programmable gate array (FPGA), or the like. The ASIC, or a programmable logic device such as a gate array or FPGA, is configured so as to be capable of processing similar to the control program. The memory of the control device 51 includes a volatile memory such as a static random access memory (SRAM) or a dynamic random access memory (DRAM), and a nonvolatile memory such as a flash memory, a hard disk, or a read only memory (ROM). The nonvolatile memory stores a control program, which is a computer program, and control data.

[0035] The control device 51 performs various functions when the processor executes the control program. Specifically, the control device 51 performs cooling operation and heating operation.

(Cooling operation)

[0036] When the refrigeration apparatus 10 is in the

cooling operation, the control device 51 drives both the first refrigerant circuit 21 and the second refrigerant circuit 22. The four-way switching valve 25 is held in a state indicated by a solid line in FIG. 1. The first compressor 24 of the first refrigerant circuit 21 discharges high-temperature and high-pressure gaseous first refrigerant. The first refrigerant flows through the four-way switching valve 25 into the first outdoor heat exchanger 26. The first refrigerant according to the present embodiment is carbon dioxide, and is boosted to a pressure exceeding the critical point by the first compressor 24. With the operation of the outdoor fan 41, the first refrigerant exchanges heat with the outdoor air and releases heat. In addition, the first refrigerant flows into the auxiliary heat exchanger 27.

[0037] Meanwhile, the second compressor 34 of the second refrigerant circuit 22 discharges high-temperature and high-pressure gaseous second refrigerant. The second refrigerant flows into the second outdoor heat exchanger 36 and, with the operation of the outdoor fan 41, exchanges heat with the outdoor air and releases heat (condenses). Further, the second refrigerant flows into the second expansion valve 38 and is decompressed to a predetermined low pressure. Then the second refrigerant flows into the auxiliary heat exchanger 27.

[0038] In the auxiliary heat exchanger 27, the first refrigerant in the first refrigerant circuit 21 exchanges heat with the second refrigerant in the second refrigerant circuit 22 and releases heat. Then the first refrigerant is decompressed and expanded by the first expansion valve 28, and flows into the indoor heat exchanger 30 of the indoor unit 12. In the indoor unit 12, the first refrigerant exchanges heat with indoor air in the indoor heat exchanger 30 and evaporates. The indoor air cooled by the evaporation of the first refrigerant is blown into the room by the indoor fan 42 to cool the room. The first refrigerant evaporated in the indoor heat exchanger 30 returns to the outdoor unit 11 through the refrigerant pipe 40, and is sucked into the first compressor 24 through the four-way switching valve 25 and the first accumulator 32.

[0039] In the auxiliary heat exchanger 27, the second refrigerant in the second refrigerant circuit 22 exchanges heat with the first refrigerant in the first refrigerant circuit 21 and evaporates. Then the second refrigerant is sucked into the second compressor 34 through the second accumulator 39.

(Heating operation)

[0040] When the refrigeration apparatus 10 is in the heating operation, the control device 51 drives the first refrigerant circuit 21 and stops the second refrigerant circuit 22. The four-way switching valve 25 is held in a state indicated by a broken line in FIG. 1. The high-temperature and high-pressure gaseous first refrigerant discharged from the first compressor 24 passes through the four-way switching valve 25 and flows into the indoor heat exchanger 30 of the indoor unit 12. In the indoor heat

exchanger 30, the first refrigerant exchanges heat with indoor air to release heat. The indoor air heated by heat release from the first refrigerant is blown into the room by the indoor fan 42 to heat the room.

[0041] Then the first refrigerant returns to the outdoor unit 11 through the refrigerant pipe 40, is decompressed to a predetermined low pressure by the first expansion valve 28, passes through the auxiliary heat exchanger 27, and flows into the first outdoor heat exchanger 26. Since the second refrigerant circuit 22 is not driven, there is no heat exchange between the first refrigerant and the second refrigerant in the auxiliary heat exchanger 27. The first refrigerant flowing into the first outdoor heat exchanger 26 exchanges heat with outdoor air and evaporates. The first refrigerant evaporated and vaporized by the first outdoor heat exchanger 26 is sucked into the first compressor 24 through the four-way switching valve 25.

(Defrost operation)

[0042] The refrigeration apparatus 10 can perform defrost operation for removing frost adhering to the first outdoor heat exchanger 26 during heating operation. The defrost operation can be performed by allowing the high-temperature and high-pressure first refrigerant to flow into the first outdoor heat exchanger 26, for example, as in the cooling operation described above.

(Refrigeration cycle of first refrigerant circuit during cooling operation)

[0043] FIG. 11 is a Mollier chart for explaining the refrigeration cycle of the first refrigerant circuit during the cooling operation. In FIG. 11, L represents an isotherm at an outside air temperature in summer, for example.

[0044] The first refrigerant used in the first refrigerant circuit 21 is carbon dioxide, and is boosted to a pressure exceeding a critical point P by the first compressor 24. Therefore, during the cooling operation, in the first outdoor heat exchanger 26, the first refrigerant is allowed to release heat only up to about the outside air temperature, and only an enthalpy difference Δh_1 illustrated in FIG. 11 can be ensured. In the present embodiment, the first refrigerant is subjected to heat exchange with the second refrigerant having a temperature lower than the outside air temperature in the auxiliary heat exchanger 27, so that the first refrigerant can further release heat and a further enthalpy difference Δh_2 can be ensured. Therefore, the refrigerating capacity H of the refrigeration apparatus 10 using the carbon dioxide refrigerant can be increased.

[0045] In the first refrigerant circuit 21, the refrigerant pipe 40 may be removed, for example, due to the replacement of the indoor unit 12. At this time, the first refrigerant circuit 21 is opened, and there is a possibility of refrigerant leakage. Since carbon dioxide is used as the first refrigerant in the first refrigerant circuit 21, adverse

effects due to leakage are small. In contrast, since the second refrigerant circuit 22 circulates the second refrigerant only inside the outdoor unit 11, the second refrigerant circuit is rarely open. In the present embodiment, R290 (propane), which is flammable, is used as the second refrigerant, but since the second refrigerant circuit 22 is rarely open, the possibility of leakage is low.

[0046] FIG. 2 is a plan view illustrating the interior of the outdoor unit in the refrigeration apparatus. FIG. 3 illustrates the interior of the outdoor unit as viewed in a direction of arrows B-B in FIG. 2. FIG. 4 illustrates the interior of the outdoor unit as viewed in a direction of arrows C-C in FIG. 2. FIG. 5 illustrates the interior of the outdoor unit as viewed in a direction of arrows D-D in FIG. 2.

[0047] The outdoor unit 11 includes a casing 55. The casing 55 has a rectangular parallelepiped shape. As illustrated in FIG. 2, the interior of the casing 55 is partitioned into a machine chamber S1 and a heat exchange chamber S2 by a partition wall 56. Air inlets 55a1 and 55b1 are formed in two adjacent side walls 55a and 55b of the casing 55 on the heat exchange chamber S2 side. An air outlet 55c1 is formed in another side wall 55c adjacent to the side wall 55b, which is one of the two side walls 55a and 55b and in which the air inlet 55b1 is formed.

[0048] The machine chamber S1 in the casing 55 houses the first compressor 24, the second compressor 34, the first accumulator 32, the second accumulator 39, the auxiliary heat exchanger 27, and the like. The heat exchange chamber S2 in the casing 55 houses the first outdoor heat exchanger 26, the second outdoor heat exchanger 36, the outdoor fan 41, and the like. The outdoor fan 41 rotates about a rotation axis c. The outdoor fan 41 draws air into the casing 55 through the air inlets 55a1 and 55b1, and discharges air to the outside of the casing 55 through the air outlet 55c1. In FIG. 2 and FIG. 3, arrow a indicates the direction of the flow of air drawn into the casing 55 through the air inlets 55a1 and 55b1 and passing through the first and second outdoor heat exchangers 26 and 36, and arrow b indicates the direction of the flow of air discharged to the outside of the casing 55 through the air outlet 55c1.

[0049] As illustrated in FIG. 2, the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are formed in a substantially L-shape in top view. The first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are bent near corner d between the two side walls 55a and 55b in which the air inlets 55a1 and 55b1 are formed, and are arranged along the two side walls 55a and 55b. In the top view, the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are formed in substantially the same shape and have substantially the same length.

[0050] As illustrated in FIG. 3 to FIG. 5, the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are aligned in the vertical direction. Specifically, the first outdoor heat exchanger 26 is disposed on the lower side, and the second outdoor heat exchanger 36 is

disposed on the upper side. The common outdoor fan 41 supplies air to both the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36. The vertical height of the first outdoor heat exchanger 26 is greater than the vertical height of the second outdoor heat exchanger 36. Therefore, the area through which air passes in the first outdoor heat exchanger 26 is larger than the area through which air passes in the second outdoor heat exchanger 36.

[0051] FIG. 6 is an explanatory diagram schematically illustrating the first outdoor heat exchanger in the refrigeration apparatus.

[0052] The first outdoor heat exchanger 26 has multiple fins 26a and a heat transfer tube 26b. The multiple fins 26a are formed in a rectangular plate shape in a side view, and are arranged in parallel to each other. The multiple fins 26a have plate surfaces arranged along the vertical direction.

[0053] The heat transfer tube 26b is a cylindrical tube having a circular cross section. The heat transfer tube 26b is formed from a material containing copper as a main component. The heat transfer tube 26b is made of copper or copper alloy. The heat transfer tube 26b has a plurality of straight tube portions 26b1 formed in a linear shape and curved tube portions 26b2 formed in a U shape. The straight tube portions 26b1 extend in the direction in which the multiple fins 26a are arranged and penetrate the fins 26a. The curved tube portions 26b2 are arranged at both ends of the first outdoor heat exchanger 26 in top view, and each connect the two adjacent straight tube portions 26b1 to each other. As illustrated in FIG. 3, the plurality of straight tube portions 26b1 are arranged in a staggered manner in the vertical direction and air flow direction a. Tube plates 26c are provided at both ends of the first outdoor heat exchanger 26 in the top view. The tube plates 26c retain the shape of the first outdoor heat exchanger 26.

[0054] FIG. 7 is an explanatory diagram schematically illustrating the second outdoor heat exchanger in the refrigeration apparatus. FIG. 8 is an enlarged cross-sectional view of the second outdoor heat exchanger.

[0055] The second outdoor heat exchanger 36 has multiple fins 36a, a plurality of heat transfer tubes 36b, and headers 36c and 36d. The heat transfer tubes 36b are formed from a material containing aluminum as a main component. The heat transfer tubes 36b are made of aluminum or aluminum alloy. The plurality of heat transfer tubes 36b are arranged in parallel to each other in the vertical direction. The heat transfer tubes 36b are arranged substantially horizontally.

[0056] The headers 36c and 36d are connected to one end and the other end, respectively, of each of the heat transfer tubes 36b in the longitudinal direction. The headers 36c and 36d include a liquid header 36c through which liquid refrigerant flows and a gas header 36d through which gas refrigerant flows. The headers 36c and 36d divide the second refrigerant flowing in from outside the second outdoor heat exchanger 36 into the

heat transfer tubes 36b or merge the second refrigerant flowing in from the heat transfer tubes 36b to flow out of the second outdoor heat exchanger 36.

[0057] As illustrated in FIG. 8, each of the heat transfer tubes 36b according to the present embodiment is a multi-hole tube having a plurality of refrigerant flow paths 36b1 therein. The plurality of refrigerant flow paths 36b1 are formed in a row along the air flow direction a. The shape of a cross-section of the heat transfer tube 36b taken along a direction orthogonal to the longitudinal direction is formed longitudinally in the air flow direction a which is the direction in which the plurality of refrigerant flow paths 36b1 are arranged. In other words, the heat transfer tube 36b is a flat tube having a length L2 in the air flow direction a (horizontal direction) larger than a length (thickness) L1 in the vertical direction in cross section. Hereinafter, the heat transfer tube 36b of the second outdoor heat exchanger 36 is also referred to as the "flat multi-hole tube". The upper surface and lower surface of the flat multi-hole tube 36b are arranged substantially horizontally.

[0058] The length L1 of the flat multi-hole tube 36b in the vertical direction is set in the range of 1 mm to 3 mm, for example. The length L2 of the flat multi-hole tube 36b in the air flow direction a is set in the range of 10 mm to 30 mm, for example. In contrast, the outer diameter of the heat transfer tube 26b in the first outdoor heat exchanger 26 is set in the range of 5-10 mm, for example. Therefore, when viewed from the air flow direction a, the flat multi-hole tube 36b has a smaller vertical length than the heat transfer tube 26b and has less resistance to the air flow.

[0059] The area of each refrigerant flow path 36b 1 of the flat multi-hole tube 36b in the second outdoor heat exchanger 36 is smaller than the area of the refrigerant flow path of the heat transfer tube (cylindrical tube) 26b in the first outdoor heat exchanger 26. Therefore, the second outdoor heat exchanger 36 has more opportunities for the second refrigerant to come into contact with the flat multi-hole tube 36b, and can exchange heat more efficiently than the first outdoor heat exchanger 26. As a result, the amount of the second refrigerant used can be reduced as much as possible. Since R290 (propane), which is flammable, is used as the second refrigerant according to the present embodiment, it is extremely effective to reduce the second refrigerant in order to reduce the risk of leakage. For example, the amount of the second refrigerant used can be 1000 g or less. Preferably, the amount of the second refrigerant used can be 150 g or less.

[0060] The fins 36a of the second outdoor heat exchanger 36 are so-called corrugated fins. Each of the fins 36a is disposed between the flat multi-hole tubes 36b adjacent to each other in the vertical direction. The fin 36a is formed by folding a plate material in a wave shape. Therefore, the fin 36a extends in the longitudinal direction of the flat multi-hole tubes 36b while meandering vertically between the upper and lower flat multi-hole tubes 36b. The upper end and lower end of the fin 36a are joined

by brazing to the flat multi-hole tubes 36b.

[0061] FIG. 9 is an explanatory diagram schematically illustrating the arrangement of the first outdoor heat exchanger and the second outdoor heat exchanger.

[0062] The first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are aligned in the vertical direction. A spacing t is provided between the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36. The spacing t can suppress heat transfer between the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36. Note that a heat insulating material may be provided in the spacing t. Thus, heat transfer between the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 can be further suppressed.

[0063] The spacing t between the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 is set to 10 mm or less. Therefore, it is possible to suppress an increase in the overall size of the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 in the vertical direction. In addition, the larger the spacing t between the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36, the easier it is for the air flow to pass through the spacing t, and the flow rate of air passing through the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 decreases, resulting in lower heat exchange efficiency. In the present embodiment, since the spacing t is set to 10 mm or less, it is possible to suppress a decrease in the heat exchange efficiency of the first and second outdoor heat exchangers 26 and 36.

[0064] Meanwhile, the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are coupled by coupling members 58 and 59. In top view, the longitudinal end of the first outdoor heat exchanger 26 is disposed near the longitudinal end of the second outdoor heat exchanger 36. The coupling members according to the present embodiment include a first coupling member 58 that couples the end of the first outdoor heat exchanger 26 to the end of the second outdoor heat exchanger 36 in the top view. The first coupling member 58 can couple, for example, the tube plates 26c of the first outdoor heat exchanger 26 to the headers 36c and 36d of the second outdoor heat exchanger 36. Alternatively, the first coupling member 58 can be configured by extending the tube plates 26c of the first outdoor heat exchanger 26 upward and coupling the second outdoor heat exchanger 36 to the tube plates 26c.

[0065] The coupling members according to the present embodiment include a second coupling member 59 that couples a longitudinal intermediate portion of the first outdoor heat exchanger 26 to a longitudinal intermediate portion of the second outdoor heat exchanger 36 in the top view. In the present embodiment, the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are coupled together by the second coupling member 59 at a plurality of locations (for example, two locations) in the longitudinal direction.

[0066] FIG. 10 is a sectional view taken along line A-A of FIG. 9. As illustrated in FIG. 10, the second coupling member 59 has a substantially H-shaped cross section. The second coupling member 59 includes a lower fitting portion 59a into which the upper end of the first outdoor heat exchanger 26 is fitted and an upper fitting portion 59b into which the lower end of the second outdoor heat exchanger 36 is fitted. By providing the second coupling member 59, it is possible to suppress misalignment between the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 in the horizontal direction (air flow direction a) or the vertical direction.

[0067] The refrigeration apparatus 10 according to the present embodiment operates only the first refrigerant circuit 21 and stops the second refrigerant circuit 22 during the heating operation. Therefore, the second outdoor heat exchanger 36 is cooled by heat transfer from the first outdoor heat exchanger 26 through the coupling members 58 and 59. If the second outdoor heat exchanger 36 is disposed below the first outdoor heat exchanger 26, the water generated in the first outdoor heat exchanger 26 drips onto the second outdoor heat exchanger 36, and the water accumulates on the flat multi-hole tubes 36b of the second outdoor heat exchanger 36, which may cause freezing. In the present embodiment, since the second outdoor heat exchanger 36 is disposed above the first outdoor heat exchanger 26, the occurrence of such a problem can be suppressed.

[Second embodiment]

[0068] FIG. 12 is a side view illustrating the interior of an outdoor unit in a refrigeration apparatus according to a second embodiment of the present disclosure.

[0069] The present embodiment is different from the first embodiment in the positional relationship between the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 in the outdoor unit 11, and the outdoor fan 41. The outdoor unit 11 according to the present embodiment has the outdoor fan 41 at the top of the casing 55, and the outdoor fan 41 blows air upward. Therefore, the outdoor unit 11 is formed with an air inlet 55d in the side surface of the casing 55, and a blow-out port 55e in the upper surface of the casing 55. The first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 are arranged to face three or four sides of the casing 55, and are arranged so that the air drawn in from the inlet 55d passes therethrough as indicated by arrow a. The air that has passed through the first outdoor heat exchanger 26 and the second outdoor heat exchanger 36 is discharged upward from the blow-out port 55e of the casing 55 as indicated by arrow b.

[0070] In the present embodiment, the outdoor fan 41 is disposed at the top of the casing 55, in other words, at the top of the second outdoor heat exchanger 36. Therefore, the second outdoor heat exchanger 36 is located closer to the outdoor fan 41 than the first outdoor heat exchanger 26, and the flow velocity of air passing through

the second outdoor heat exchanger 36 is higher than the flow velocity of air passing through the first outdoor heat exchanger 26. As a result, even if water is splashed onto the second outdoor heat exchanger 36 and the water accumulates on the flat multi-hole tubes 36b or inside the corrugated fins 36a, the water can be easily discharged by the air flow passing through the second outdoor heat exchanger 36.

[Action and effects of embodiments]

[0071]

(1) The refrigeration apparatus 10 according to the present embodiment includes the first refrigerant circuit 21 that circulates the first refrigerant, the second refrigerant circuit 22 that circulates the second refrigerant different from the first refrigerant, and the third heat exchanger (auxiliary heat exchanger) 27 that exchanges heat between the first refrigerant and the second refrigerant. The first refrigerant circuit 21 includes the first heat exchanger (first outdoor heat exchanger) 26 having the heat transfer tube 26b having a circular tube shape, and the second refrigerant circuit 22 includes the second heat exchanger (second outdoor heat exchanger) 36 having the flat multi-hole tube 36b. The first heat exchanger 26 and the second heat exchanger 36 are vertically aligned, and the second heat exchanger 36 is disposed above the first heat exchanger 26.

In the above configuration, for example, when the heating operation is performed when the outside air temperature is low, such as in winter, and the first heat exchanger 26 is used as an evaporator, frost may adhere to the first heat exchanger 26. Then, when the frost melts due to defrost operation or the like, water droplets may drop downward from the first heat exchanger 26. Meanwhile, since the length L2 of the flat multi-hole tube 36b of the second heat exchanger 36 in the air flow direction a (horizontal direction) in the cross section is larger than the length L1 in the vertical direction, the flat multi-hole tube 36b has a structure in which water tends to accumulate (remain) on the upper surface thereof. In the refrigeration apparatus 10 according to the present embodiment, since the second heat exchanger 36 is disposed above the first heat exchanger 26, water dripping from the first heat exchanger 26 does not splash on the flat multi-hole tube 36b of the second heat exchanger 36. Therefore, it is possible to suppress accumulation or freezing of water on the flat multi-hole tube 36b. Even if water is generated in the second heat exchanger 36 and drips onto the first heat exchanger 26, the water is less likely to be accumulated on the heat transfer tube 26b having a circular tube shape, so that it is possible to suppress freezing of the water.

(2) In the present embodiment, the second heat

exchanger 36 includes the plurality of flat multi-hole tubes 36b arranged vertically at intervals, and the meandering fin 36a disposed between the flat multi-hole tubes 36b vertically adjacent to each other.

In the second heat exchanger 36 having the corrugated fin 36a between the flat multi-hole tubes 36b vertically adjacent to each other, if water enters the corrugated fin 36a, it is difficult to drain, and the accumulated water can freeze and damage the brazed area (adhesion area) between the corrugated fin 36a and the flat multi-hole tube 36b. In the refrigeration apparatus 10 according to the present embodiment, the second heat exchanger 36 is disposed above the first heat exchanger 26, and the water generated in the first heat exchanger 26 does not drip onto the second heat exchanger 36. Therefore, the possibility of water entering the corrugated fin 36a is reduced, and freezing of the water can be suppressed.

(3) In the refrigeration apparatus 10 according to the present embodiment, the vertical spacing t between the first heat exchanger 26 and the second heat exchanger 36 is 10 mm or less.

In the refrigeration apparatus 10 according to the present embodiment, the second heat exchanger 36 is disposed above the first heat exchanger 26, so that the water generated in the first heat exchanger 26 does not drip onto the second heat exchanger 36 and freeze on the flat multi-hole tube 36b. Therefore, the spacing t between the first heat exchanger 26 and the second heat exchanger 36 can be reduced to 10 mm or less, and it is possible to suppress an increase in the overall size of the first and second heat exchangers (in particular, the dimension in the vertical direction). In addition, if the spacing between the first heat exchanger 26 and the second heat exchanger 36 is large, the air flow easily passes through the spacing t , and the heat exchange efficiency of the first heat exchanger 26 and the second heat exchanger 36 may decrease. However, by setting the spacing t to 10 mm or less, the flow rate of air passing therethrough can be reduced, and the heat exchange can be efficiently performed in the first and second heat exchangers 26 and 36.

(4) In the refrigeration apparatus according to the above embodiment, the heat transfer tube 26b is formed from a material containing copper as a main component, and the flat multi-hole tubes 36b are formed from a material containing aluminum as a main component.

Since copper has a higher potential than aluminum, electrolytic corrosion may occur on aluminum when water generated on copper comes into contact with aluminum. In the present embodiment, since the flat multi-hole tubes 36b of the second heat exchanger 36 on the upper side are formed from a material containing aluminum as a main component, and the heat transfer tube 26b of the first heat exchanger

26 on the lower side is formed from a material containing copper as a main component, the water generated in the first heat exchanger 26 does not drip onto the second heat exchanger 36, and the occurrence of electrolytic corrosion of the flat multi-hole tubes 36b can be suppressed.

(5) In the second embodiment above, the refrigeration apparatus 10 further includes the casing 55 that houses the first heat exchanger 26 and the second heat exchanger 36, and the fan (outdoor fan) 41 that is disposed above the second heat exchanger 36 and generates an air flow passing through the first heat exchanger 26 and the second heat exchanger 36.

With this configuration, by operating the fan 41, the flow velocity of air passing through the second heat exchanger 36 disposed on the upper side can be increased relative to the flow velocity of air passing through the first heat exchanger 26 disposed on the lower side. Therefore, even if rainwater or the like adheres to the second heat exchanger 36, water droplets can be easily discharged with the air flow having a high flow velocity. Therefore, water freezing or the like on the flat multi-hole tubes 36b can be suppressed.

(6) The refrigeration apparatus 10 according to the above embodiment further includes the coupling members 58 and 59 that couple the first heat exchanger 26 and the second heat exchanger 36.

If the first heat exchanger 26 and the second heat exchanger 36 are coupled together by the coupling members 58 and 59, there is a possibility that the heat of the first heat exchanger 26 is transferred to the second heat exchanger 36 through the coupling members 58 and 59. Therefore, when the heating operation is performed when the outside air temperature is low, such as in winter, and the first heat exchanger 26 is used as an evaporator, the heat of the first heat exchanger 26 is transferred to the second heat exchanger 36 through the coupling members 58 and 59, and the second heat exchanger 36 is cooled. Since the water generated in the first heat exchanger 26 does not drip onto the second heat exchanger 36, accumulation of water on the flat multi-hole tubes 36b is suppressed. Therefore, even if the second heat exchanger 36 is cooled, water freezing on the flat multi-hole tubes 36b can be suppressed.

(7) In the refrigeration apparatus 10 according to the above embodiment, in a top view, the end of the first heat exchanger 26 in the longitudinal direction is disposed near the end of the second heat exchanger 36 in the longitudinal direction. Therefore, the coupling member may include the first coupling member 58 that couples the end of the first heat exchanger 26 and the end of the second heat exchanger 36.

(8) In the above embodiment, the coupling member of the refrigeration apparatus 10 includes the second

coupling member 59 that couples the longitudinal intermediate portions of the first heat exchanger 26 and the second heat exchanger 36 to each other in the top view.

[0072] With this configuration, even if vibration due to transportation or the like is transmitted to the refrigeration apparatus 10, the longitudinal intermediate portion of the first heat exchanger 26 and the longitudinal intermediate portion of the second heat exchanger 36 are less likely to swing in different directions, and rubbing or collision between the two is suppressed.

[0073] While the embodiments have been described above, it will be understood that various changes in forms and details can be made without departing from the spirit and scope of the claims.

[0074] For example, in the above embodiment, the second refrigerant used in the second refrigerant circuit 22 is exemplified by R290 (propane), but the present invention is not limited thereto. As the second refrigerant, a flammable or toxic refrigerant, or a refrigerant having a relatively high global warming potential (GWP) (for example, a refrigerant having a GWP of 4 or more but not more than 675, which is higher than that of natural refrigerants) can be used. As the flammable refrigerant, in addition to R290 (propane) described above, R32, R1234yf, R474a, R600a (isobutane), and the like can be used. As the toxic refrigerant, NH₃ (ammonia) or the like can be used. As the refrigerant having a high GWP, R32, R454B, R454C, and the like can be used. Among them, the GWP of R32 is 675 which is the maximum.

[0075] The second outdoor heat exchanger 36 may include fins having a rectangular flat plate shape, similar to the fins 26a of the first outdoor heat exchanger 26, instead of the corrugated fins 36a. In this case, multiple fins may be aligned along the vertical direction, and the flat multi-hole tubes 36b may penetrate the plurality of fins.

REFERENCE SIGNS LIST

[0076]

10	refrigeration apparatus
21	first refrigerant circuit
22	second refrigerant circuit
26	first outdoor heat exchanger (first heat exchanger)
27	auxiliary heat exchanger (third heat exchanger)
36	second outdoor heat exchanger (second heat exchanger)
36a	corrugated fin
36b	flat multi-hole tube
41	outdoor fan
55	casing
58	first coupling member
59	second coupling member

Claims

1. A refrigeration apparatus comprising:

5 a first refrigerant circuit (21) that circulates a first refrigerant;
a second refrigerant circuit (22) that circulates a second refrigerant different from the first refrigerant; and
10 a third heat exchanger (27) that exchanges heat between the first refrigerant and the second refrigerant,
wherein the first refrigerant circuit (21) includes a first heat exchanger (26) having a heat transfer tube (26b) having a circular tube shape,
15 the second refrigerant circuit (22) includes a second heat exchanger (36) having a flat multi-hole tube (36b),
the first heat exchanger (26) and the second heat exchanger (36) are vertically aligned, and
20 the second heat exchanger (36) is disposed above the first heat exchanger (26).

2. The refrigeration apparatus according to claim 1, wherein the second heat exchanger (36) includes a plurality of the flat multi-hole tubes (36b) arranged vertically at intervals, and a meandering fin disposed between the flat multi-hole tubes (36b) vertically adjacent to each other.

3. The refrigeration apparatus according to claim 1 or 2, wherein a vertical spacing between the first heat exchanger (26) and the second heat exchanger (36) is 10 mm or less.

4. The refrigeration apparatus according to any one of claims 1 to 3, wherein the heat transfer tube (26b) is formed from a material containing copper as a main component, and the flat multi-hole tubes (36b) are formed from a material containing aluminum as a main component.

5. The refrigeration apparatus according to any one of claims 1 to 4, further comprising:

45 a casing (55) that houses the first heat exchanger (26) and the second heat exchanger (36); and
a fan (41) that is disposed above the second heat exchanger (36) and generates an air flow passing through the first heat exchanger (26) and the second heat exchanger (36).

6. The refrigeration apparatus according to any one of claims 1 to 5, further comprising a coupling member (58, 59) that couples the first heat exchanger (26) to the second heat exchanger (36).

7. The refrigeration apparatus according to claim 6, wherein

in top view, the first heat exchanger (26) has an end in a longitudinal direction, the end of the first heat exchanger (26) being disposed near an end of the second heat exchanger (36) in a longitudinal direction, and the coupling member includes a first coupling member (58) that couples the end of the first heat exchanger (26) to the end of the second heat exchanger (36).

8. The refrigeration apparatus according to claim 6 or 7, wherein

the coupling member includes a second coupling member (59) that couples longitudinal intermediate portions of the first heat exchanger (26) and the second heat exchanger (36) to each other in a top view.

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FIG. 1

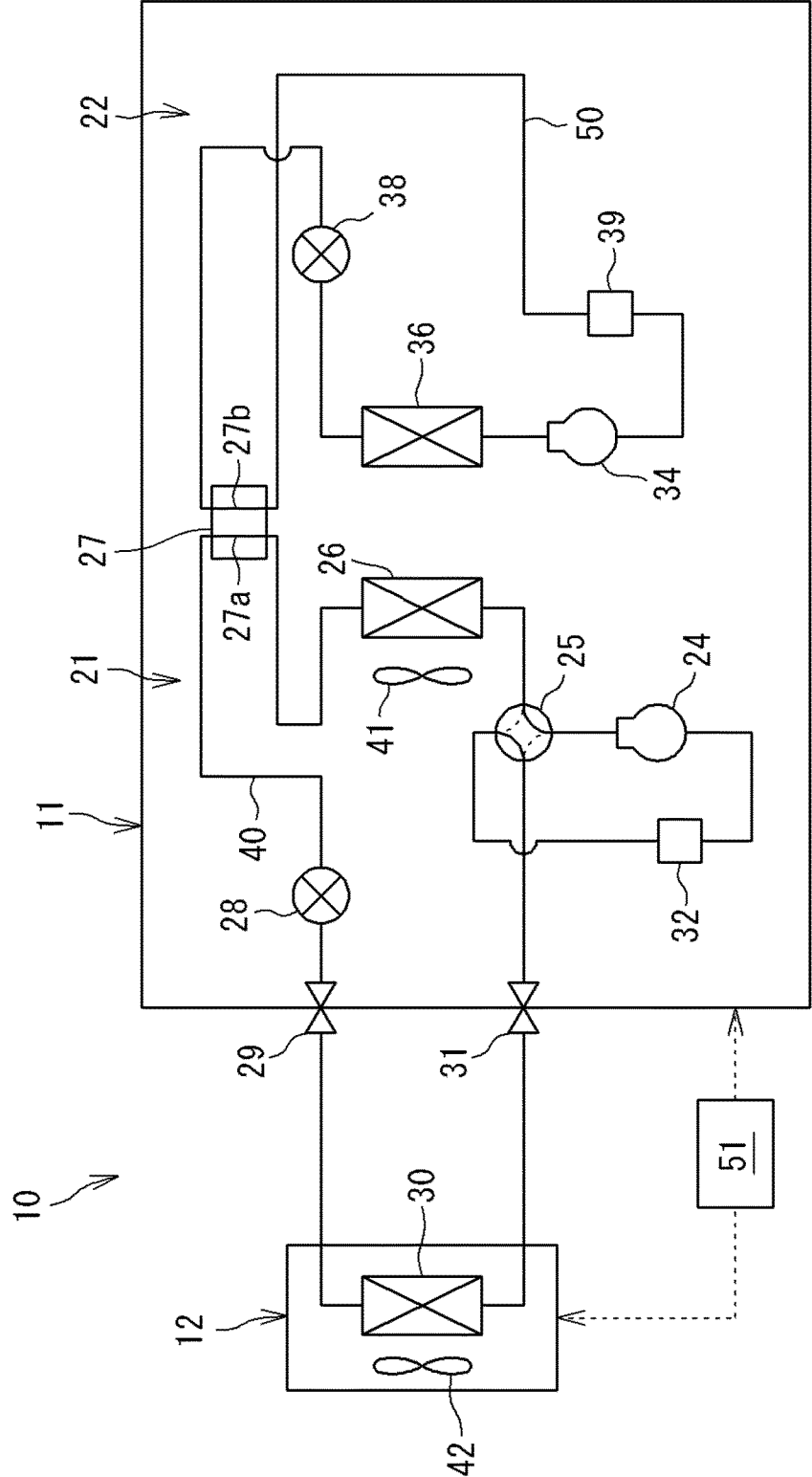


FIG. 2

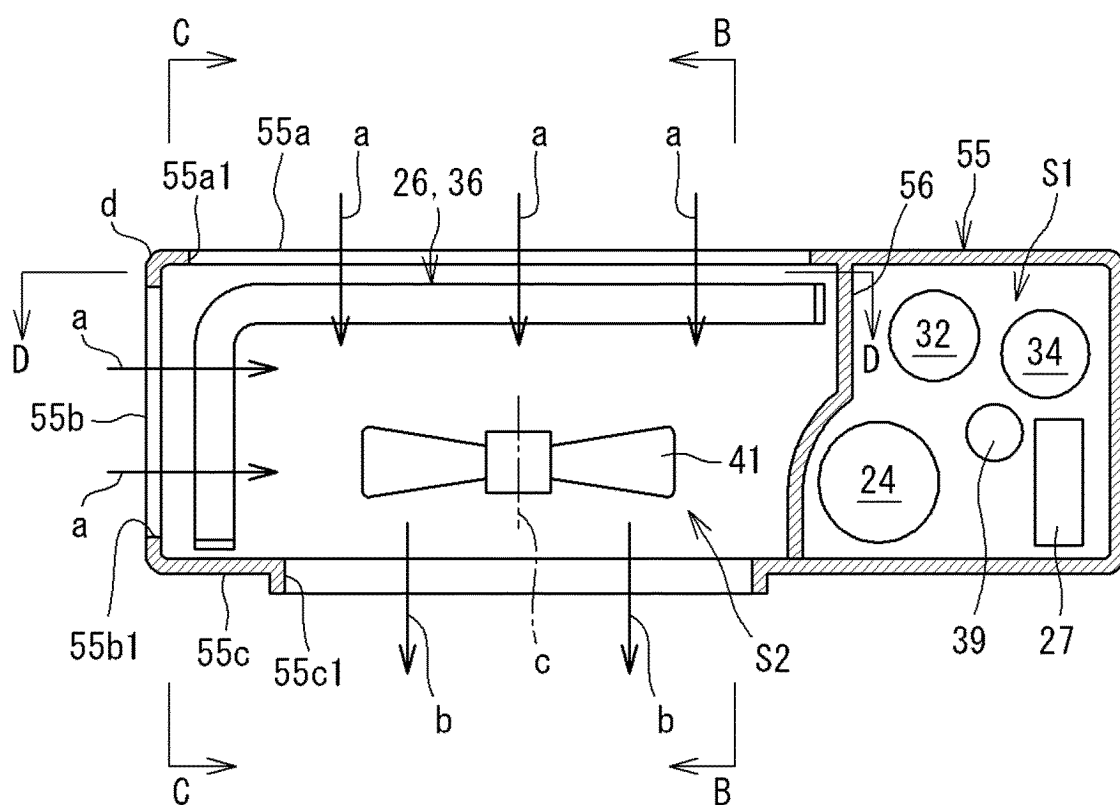


FIG. 3

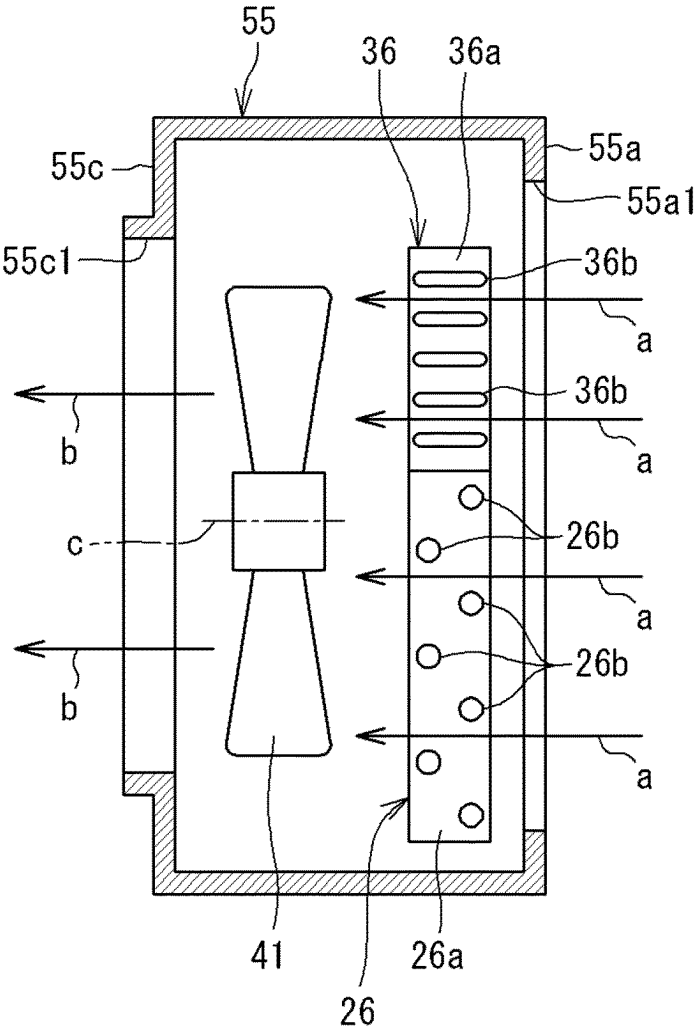


FIG. 4

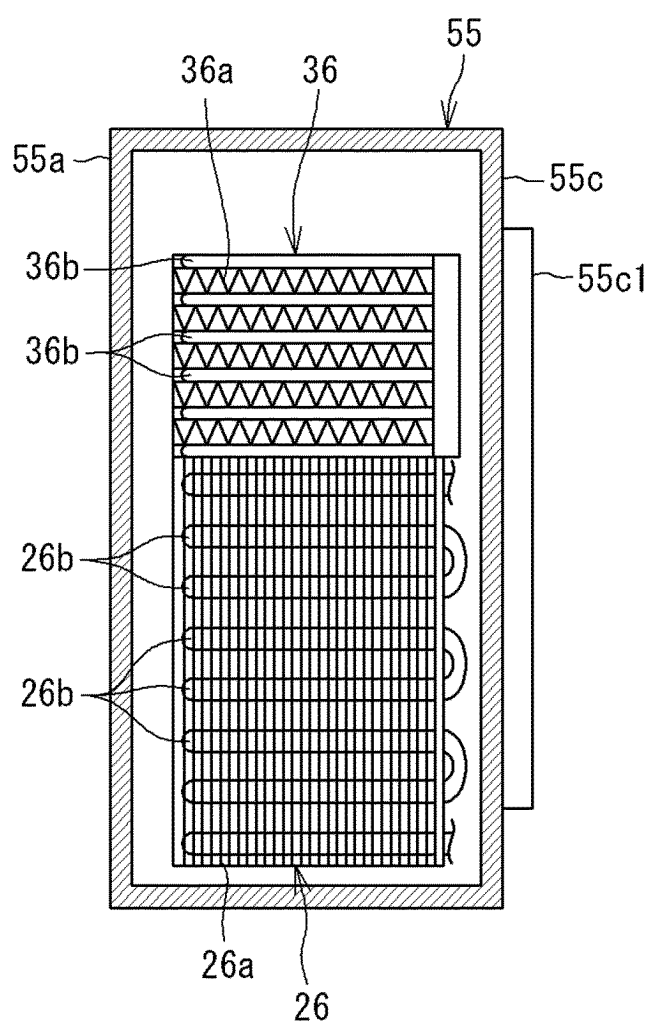


FIG. 5

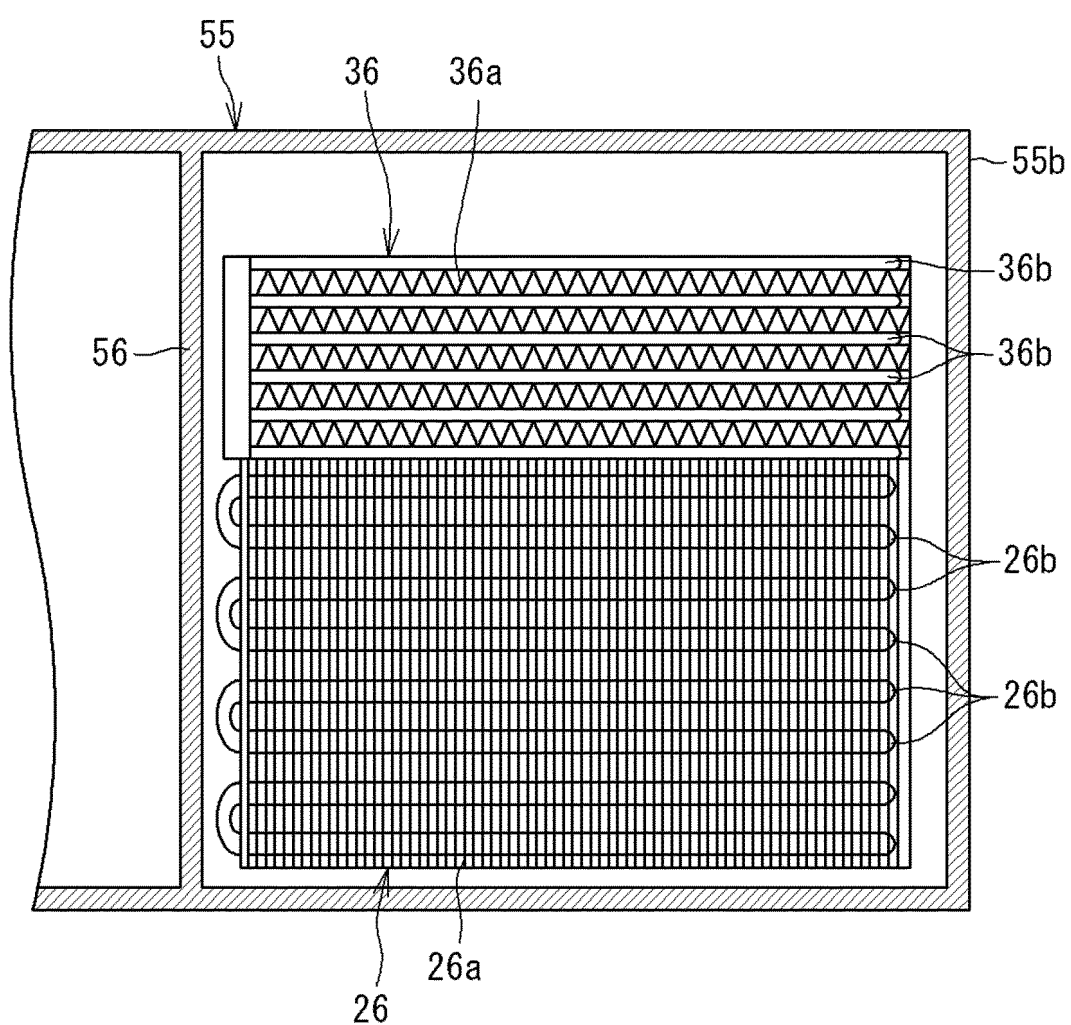


FIG. 6

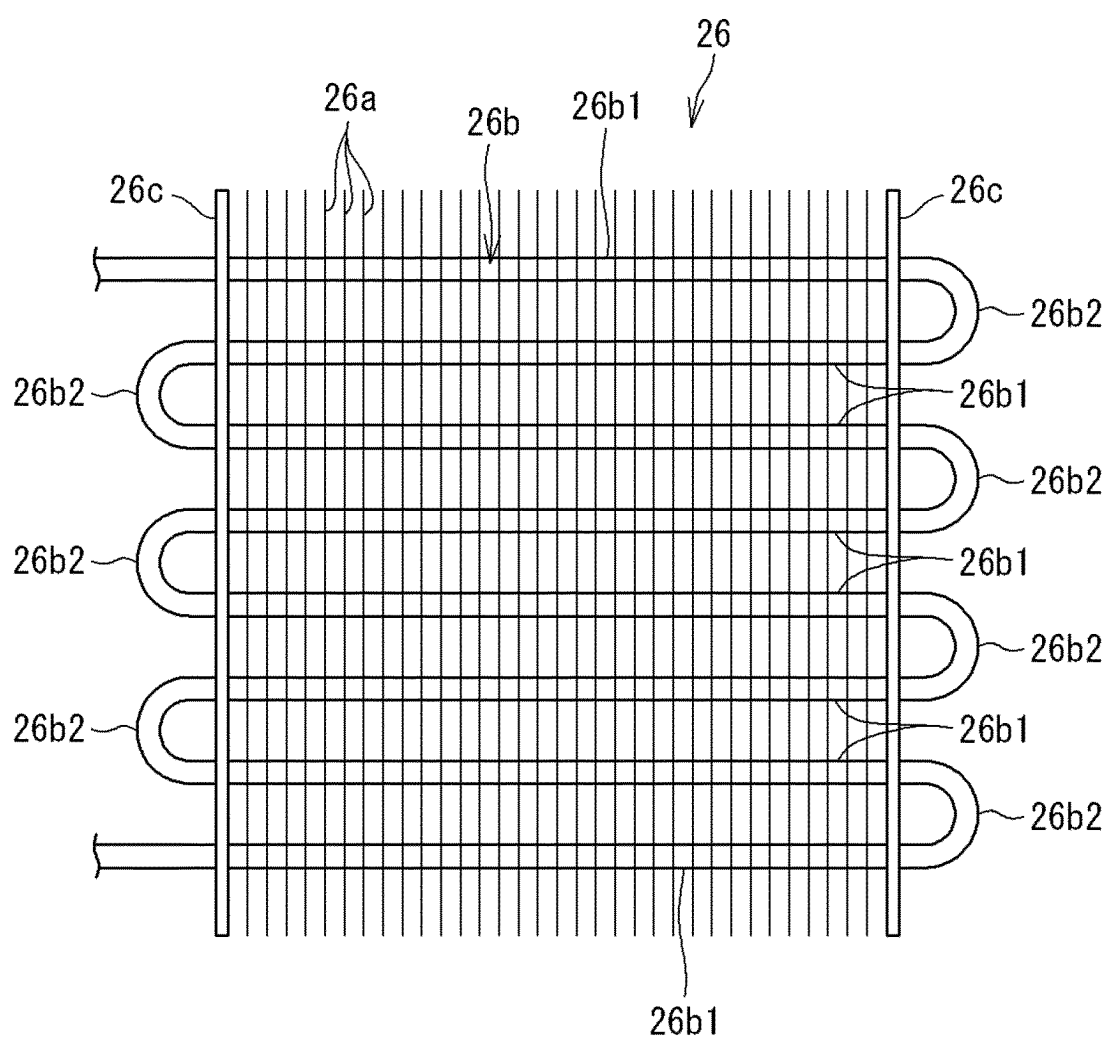


FIG. 7

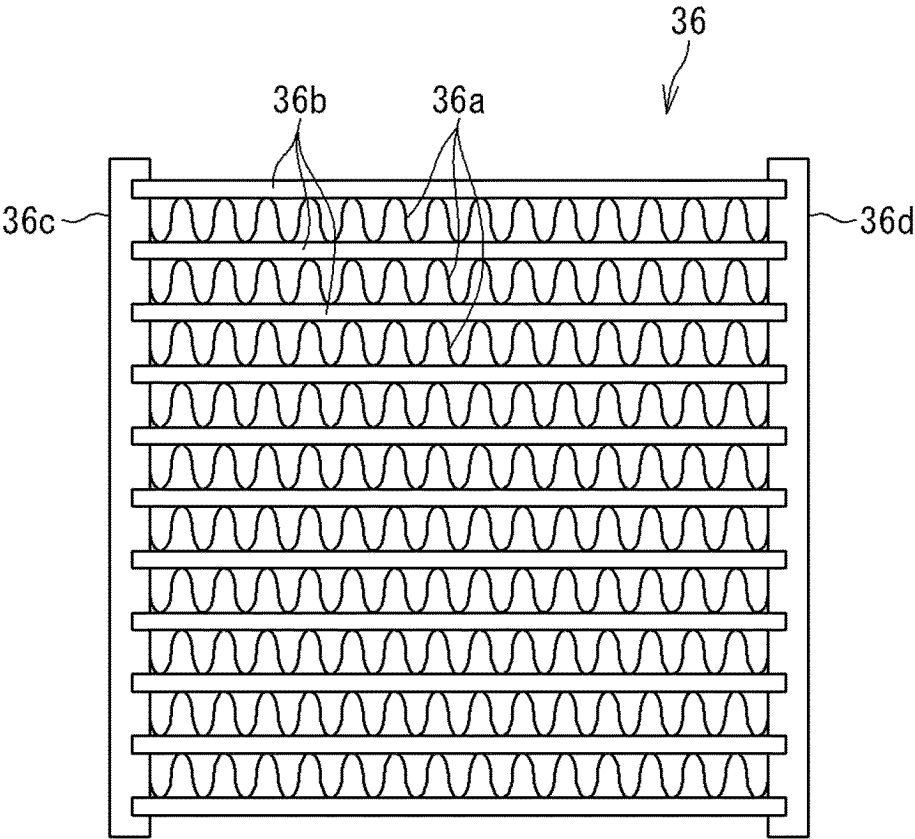


FIG. 8

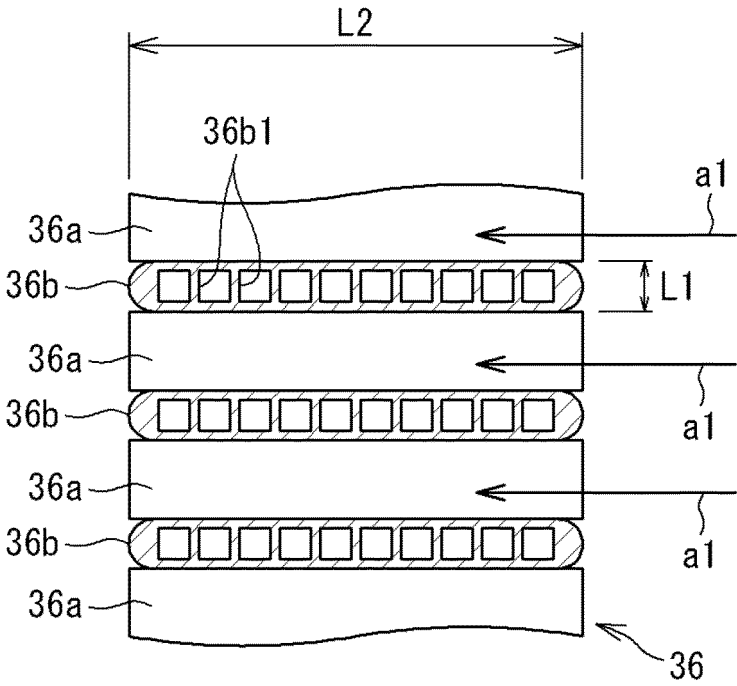


FIG. 9

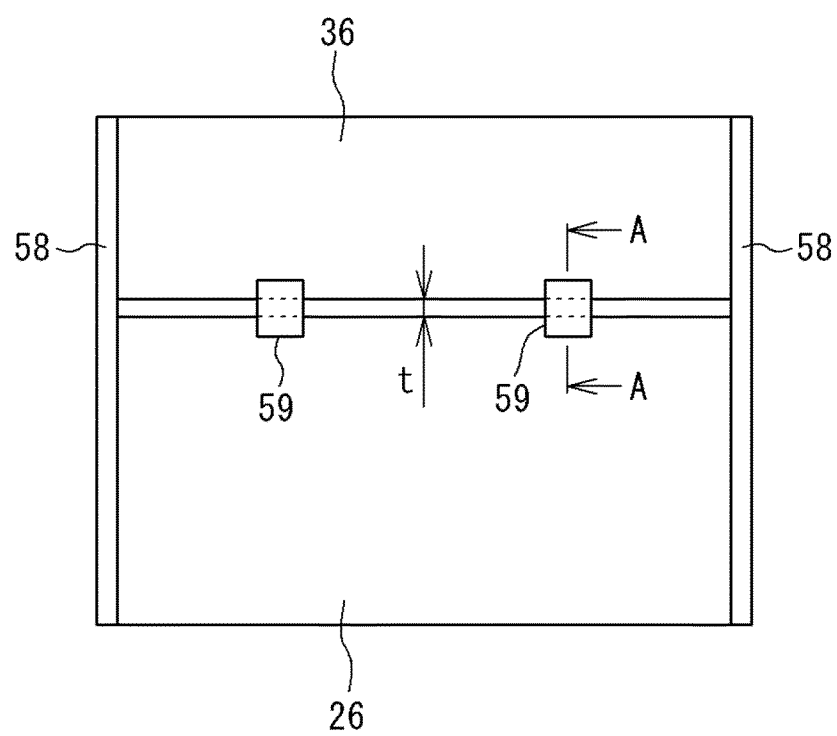


FIG. 10

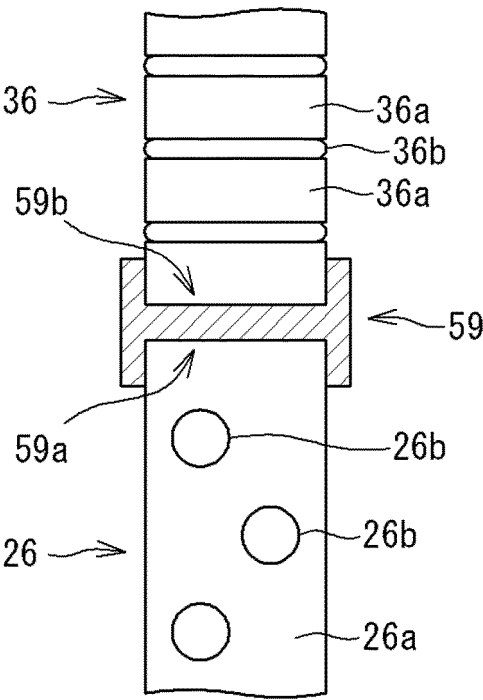


FIG. 11

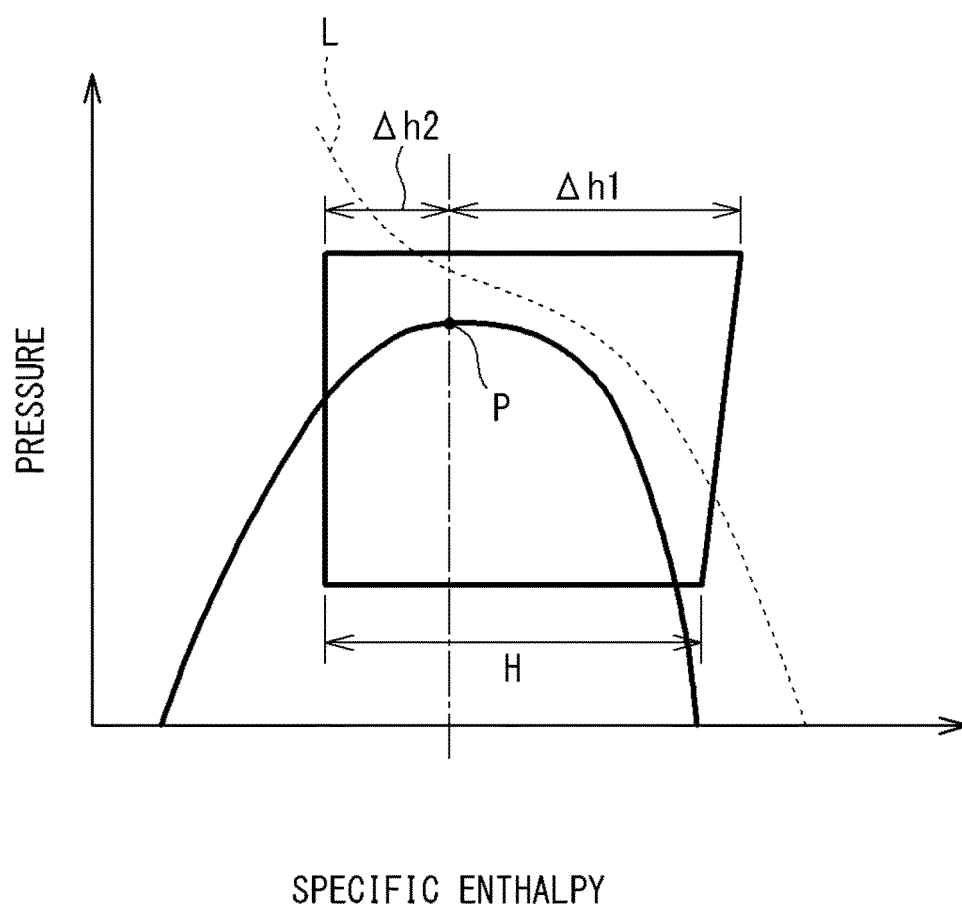
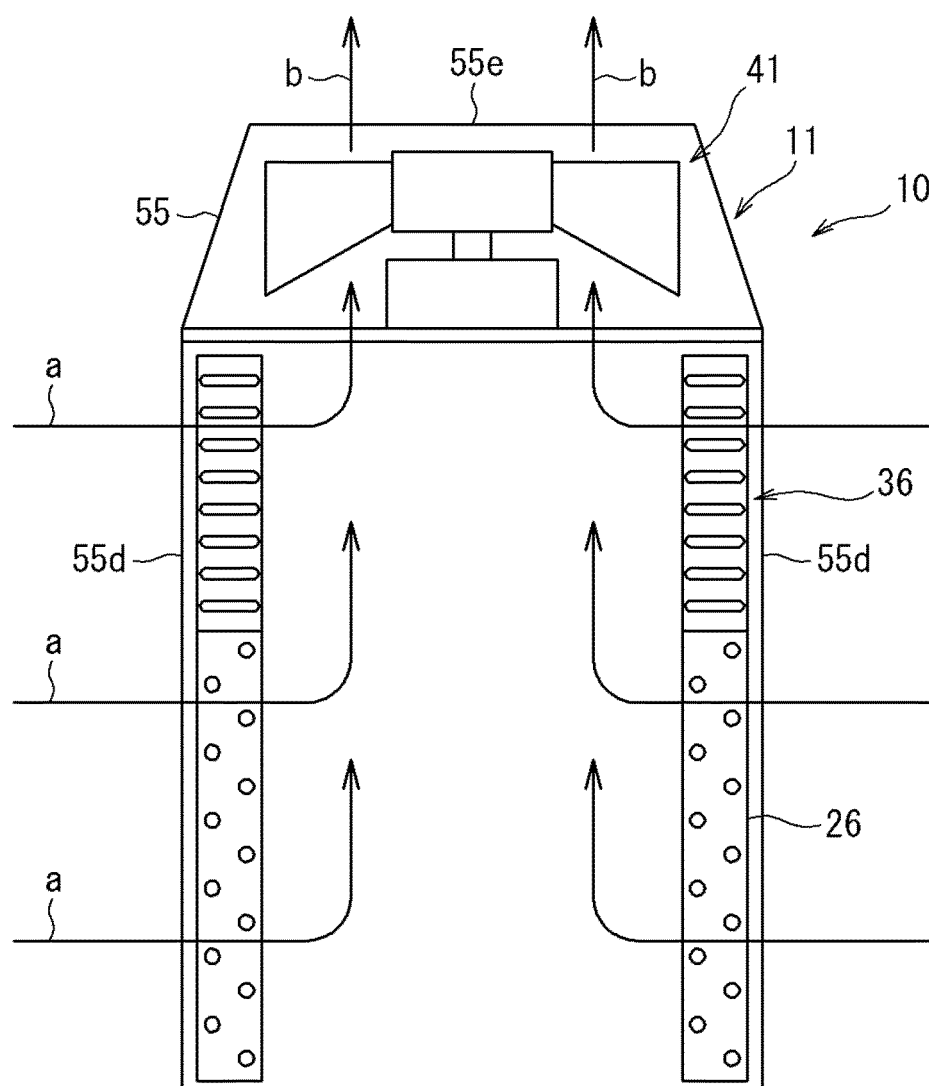


FIG. 12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/020682

A. CLASSIFICATION OF SUBJECT MATTER**F25B 1/00**(2006.01)i; **F25B 39/04**(2006.01)i; **F28F 1/02**(2006.01)i

FI: F25B1/00 397A; F25B39/04 C; F28F1/02 B

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)

F25B1/00-49/04;F28F1/02;F28D1/047

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 1971-2024
 Registered utility model specifications of Japan 1996-2024
 Published registered utility model applications of Japan 1994-2024

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	JP 2009-299909 A (HITACHI APPLIANCES, INC.) 24 December 2009 (2009-12-24) paragraphs [0011]-[0022], fig. 2	1-8
Y	WO 2020/004108 A1 (DAIKIN INDUSTRIES, LTD.) 02 January 2020 (2020-01-02) paragraphs [0022], [0028]	1-8
Y	JP 2007-178090 A (SHARP KABUSHIKI KAISHA) 12 July 2007 (2007-07-12) paragraphs [0010]-[0030], fig. 7	1-8
Y	JP 2022-24603 A (MITSUBISHI ELECTRIC CORPORATION) 09 February 2022 (2022-02-09) paragraphs [0004], [0037], [0053], fig. 3-4	1-8
Y	JP 2015-183850 A (FUJITSU GENERAL LIMITED) 22 October 2015 (2015-10-22) paragraph [0028]	4-8
Y	JP 2021-81079 A (DAIKIN INDUSTRIES, LTD.) 27 May 2021 (2021-05-27) paragraph [0029], fig. 2	5-8

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

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Date of the actual completion of the international search

03 July 2024

Date of mailing of the international search report

16 July 2024

Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)
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Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/020682

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2009-299909	A	24 December 2009	(Family: none)	
WO	2020/004108	A1	02 January 2020	EP 3812662 A1 paragraphs [0022], [0028]	
JP	2007-178090	A	12 July 2007	(Family: none)	
JP	2022-24603	A	09 February 2022	(Family: none)	
JP	2015-183850	A	22 October 2015	(Family: none)	
JP	2021-81079	A	27 May 2021	WO 2021/095452 A1 paragraph [0029], fig. 2	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2014181399 A [0003]