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(54) **AIR CONDITIONING UNIT**

(57) An air conditioning unit includes an electric component unit (420), a first heat exchanger (12), a second heat exchanger (23), a fan (44), a casing (41), and a partition plate (46). The first heat exchanger (12) exchanges heat between a combustible first refrigerant and air. The second heat exchanger (23) exchanges heat between a non-combustible second refrigerant and air. The fan (44) causes air to flow to the first heat exchanger (12) and the second heat exchanger (23). The partition plate (46) partitions an inside of the casing (41) into a first chamber (S1) in which the first heat exchanger (12), the second heat exchanger (23), and the fan (44) are disposed, and a second chamber (S2) in which the electric component unit (420) is disposed. The partition plate (46) is provided with a communication hole (461) that communicates the first chamber (S1) and the second chamber (S2) above a first brazed portion (120) located uppermost among a plurality of brazed portions (121) of the first heat exchanger (12).

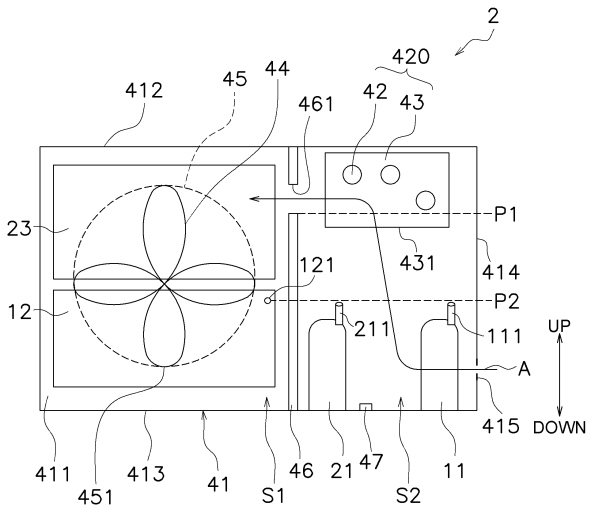

FIG. 2A

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an air conditioning unit.

BACKGROUND ART

[0002] Patent Literature 1 (JP 5430604 B2) discloses a binary refrigeration apparatus including a low-temperature refrigeration cycle using a carbon dioxide refrigerant and a high-temperature refrigeration cycle that assists heat radiation of the low-temperature refrigeration cycle. In the binary refrigeration apparatus disclosed in Patent Literature 1, a cascade condenser exchanges heat between a high-temperature side evaporator and a low-temperature side condenser, and an auxiliary radiator and the high-temperature side condenser installed upstream in a low-temperature refrigeration cycle of the cascade condenser are integrated to form an integrated radiator.

SUMMARY OF THE INVENTION

<Technical Problem>

[0003] However, Patent Literature 1 discloses that an HC refrigerant, an HFC refrigerant, an HFO refrigerant, or the like is used for the high-temperature refrigeration cycle. When a flammable refrigerant leaks from the high-temperature side condenser, there is a possibility that the refrigerant is ignited with an electric component unit as an ignition source.

<Solution to Problem>

[0004] An air conditioning unit according to a first aspect includes an electric component unit, a first heat exchanger, a second heat exchanger, a fan, a casing, and a partition plate. The first heat exchanger exchanges heat between a first refrigerant that is combustible and air. The second heat exchanger exchanges heat between a second refrigerant that is non-combustible and air. The fan causes air to flow to the first heat exchanger and the second heat exchanger. The casing accommodates the electric component unit, the first heat exchanger, the second heat exchanger, and the fan. The partition plate partitions an inside of the casing into a first chamber in which the first heat exchanger, the second heat exchanger, and the fan are disposed, and a second chamber in which the electric component unit is disposed. The partition plate is provided with the communication hole that communicates the first chamber and the second chamber above the first brazed portion located uppermost among the plurality of brazed portions of the first heat exchanger.

[0005] In the air conditioning unit according to the first aspect, the communication hole provided in the partition plate and the fan disposed in the first chamber allow air to flow from the second chamber in which the electric component unit is disposed to the first chamber in which the first heat exchanger through which the first refrigerant flows is disposed. Since the communication hole is provided at a position higher than the first brazed portion at a highest position in the first heat exchanger through which the combustible first refrigerant flows, even if the first refrigerant leaks in the first chamber, the first refrigerant can be prevented from flowing above the communication hole. Therefore, the possibility of ignition with the electric component unit in the second chamber as an ignition source can be reduced.

[0006] An air conditioning unit according to a second aspect is the air conditioning unit according to the first aspect, in which the communication hole is a hole that guides air around the electric component unit to the fan.

[0007] In the air conditioning unit according to the second aspect, since the air around the electric component unit serving as an ignition source is guided to the first chamber, even if the first refrigerant leaks, the first refrigerant can be suppressed from flowing around the electric component unit.

[0008] An air conditioning unit according to a third aspect is the air conditioning unit according to the first or second aspect and further includes a bell mouth. The bell mouth is disposed in the first chamber and has a cylindrical portion surrounding the fan. A lower end of the electric component unit is located above a lower end of the cylindrical portion.

[0009] In the air conditioning unit according to the third aspect, the fan is disposed inside the cylindrical portion of the bell mouth. In general, the first refrigerant is heavier than air. Therefore, even if the first refrigerant leaks, the first refrigerant stays below the lower end of the cylindrical portion. Here, since a lower end of a substrate to which the electric component unit is attached is located above the lower end of the cylindrical portion, the first refrigerant can be further prevented from flowing to the electric component unit.

[0010] An air conditioning unit according to a fourth aspect is the air conditioning unit according to any of the first to third aspects, in which a lower end of the electric component unit is located above the first brazed portion.

[0011] In the air conditioning unit according to the fourth aspect, even if the first refrigerant leaks, the first refrigerant stays below the first brazed portion. Here, since the lower end of a substrate to which the electric component unit is attached located above the first brazed portion, the first refrigerant can be further prevented from flowing to the electric component.

[0012] An air conditioning unit according to a fifth aspect is the air conditioning unit according to any of the first to fourth aspects, in which the first heat exchanger is located below the second heat exchanger.

[0013] In the air conditioning unit according to the fifth aspect, the first heat exchanger through which the combustible refrigerant flows is disposed below the second

heat exchanger through which the non-combustible refrigerant flows. Accordingly, even if the first refrigerant leaks, the first refrigerant is likely to stay below, the air conditioning unit that prevents the first refrigerant from flowing to the electric component unit can be easily achieved.

[0014] An air conditioning unit according to a sixth aspect is the air conditioning unit according to any of the first to fifth aspects and further includes a first compressor, a second compressor, and a bell mouth. The first compressor is disposed in the second chamber and compresses the first refrigerant. The second compressor is disposed in the second chamber and compresses the second refrigerant. The bell mouth is disposed in the first chamber and has a cylindrical portion surrounding the fan. A terminal of the first compressor and a terminal of the second compressor are located above a lower end of the cylindrical portion.

[0015] In the air conditioning unit according to the sixth aspect, even if the first refrigerant leaks, the first refrigerant stays below the lower end of the cylindrical portion of the bell mouth. Here, since the terminal is located above the lower end of the cylindrical portion, the possibility of ignition with the terminal of the second chamber as an ignition source can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a schematic configuration diagram of a binary refrigeration cycle apparatus including an outdoor unit according to an embodiment of the present disclosure.

FIG. 2A is a schematic sectional view of the outdoor unit.

FIG. 2B is a schematic plan view of the outdoor unit.

FIG. 3 is a diagram illustrating motion in a cooling operation of the binary refrigeration cycle apparatus.

FIG. 4 is a diagram illustrating motion in a heating operation of the binary refrigeration cycle apparatus.

FIG. 5 is a diagram illustrating a plurality of brazed portions.

DESCRIPTION OF EMBODIMENTS

(1) Configuration of binary refrigeration cycle apparatus

[0017] As illustrated in FIG. 1, a binary refrigeration cycle apparatus 1 employing an outdoor unit 2 according to an embodiment of the present disclosure is an apparatus used for cooling and heating an indoor space in an office building or the like by performing a vapor compression refrigeration cycle operation.

[0018] The binary refrigeration cycle apparatus 1 includes a first cycle 10 and a second cycle 20. The binary refrigeration cycle apparatus 1 according to the present embodiment includes a binary refrigerant circuit including the vapor compression first cycle 10 and the vapor compression second cycle 20, and performs a binary refrigeration cycle.

[0019] In the first cycle 10, a combustible first refrigerant circulates. The first refrigerant has, for example, a critical point of 40°C or higher. The first refrigerant is, for example, a hydrocarbon refrigerant, R1234yf, R1234ze, R32, or the like, and is R290 in the present embodiment. The specific gravity of the first refrigerant is larger than the specific gravity of air.

[0020] In the second cycle 20, a non-combustible second refrigerant circulates. The second refrigerant has, for example, a critical point of less than 40°C. The second refrigerant includes, for example, carbon dioxide, and is a single refrigerant of carbon dioxide in the present embodiment.

[0021] The first cycle 10 and the second cycle 20 are thermally connected via a cascade heat exchanger 30.

[0022] The binary refrigeration cycle apparatus 1 includes the outdoor unit 2 and an indoor unit 3. The binary refrigeration cycle apparatus 1 is configured such that the outdoor unit 2 and the indoor unit 3 are connected to each other via connection pipes 4 and 5.

(1-1) First cycle

[0023] The first cycle 10 constitutes a subcooling circuit during a cooling operation. The first cycle 10 includes a first compressor 11, a first heat exchanger 12, a first expansion mechanism 13, and the cascade heat exchanger 30.

[0024] The first compressor 11 is configured to compress the first refrigerant and includes, for example, a scroll type or other positive displacement compressor whose operating capacity can be varied by controlling an inverter for a compressor motor.

[0025] As illustrated in FIG. 2, the first compressor 11 includes a first terminal 111. A power supply wire is connected to the first terminal 111. Here, the first terminal 111 is a harness connection portion.

[0026] The first heat exchanger 12 is configured to exchange heat between the first refrigerant and outdoor air. In the first heat exchanger 12, the first refrigerant acquires cooling energy or heating energy from the outdoor air. The first heat exchanger 12 includes, for example, a fin-and-tube heat exchanger including a large number of heat transfer tubes and fins.

[0027] The first expansion mechanism 13 is configured to decompress the first refrigerant, and is, for example, an electric expansion valve.

[0028] The cascade heat exchanger 30 is configured to perform heat exchange between the first refrigerant and the second refrigerant without mixing the refrigerants. The cascade heat exchanger 30 includes, for example, a plate heat exchanger. The cascade heat exchanger 30 includes a first flow path 31 belonging to the first cycle 10 and a second flow path 32 belonging to the second cycle 20. The first flow path 31 has a gas side

connected to the first compressor 11, and a liquid side connected to the first expansion mechanism 13.

[0029] When the first heat exchanger 12 is used as a condenser and the second heat exchanger 23 (described later) of the second cycle 20 is used as a radiator, the cascade heat exchanger 30 is intended to subcool the second refrigerant cooled by the second heat exchanger 23 and plays a role of assisting the second cycle 20.

(1-2) Second cycle

[0030] The second cycle 20 includes a second compressor 21, a switching mechanism 22, the second heat exchanger 23, the cascade heat exchanger 30, a second expansion mechanism 24, and a third heat exchanger 25.

[0031] The second compressor 21 is configured to compress the second refrigerant and includes, for example, a scroll type or other positive-displacement compressor whose operating capacity can be varied by controlling an inverter for a compressor motor.

[0032] As illustrated in FIG. 2, the second compressor 21 includes a second terminal 211. A power supply wire is connected to the second terminal 211. Here, the second terminal 211 is a harness connection portion.

[0033] The switching mechanism 22 is configured to switch between a first state (see the solid lines in the switching mechanism 22 in FIG. 1) in which the second heat exchanger 23 functions as a radiator for the second refrigerant and the third heat exchanger 25 functions as an evaporator for the second refrigerant, and a second state (see the broken lines in the switching mechanism 22 in FIG. 1) in which the second heat exchanger 23 functions as an evaporator for the second refrigerant and the third heat exchanger 25 functions as a radiator for the second refrigerant. The switching mechanism 22 is, for example, a four-way switching valve. Then, in the first state, the switching mechanism 22 connects a discharge side of the second compressor 21 and a gas side of the second heat exchanger 23, and connects a suction side of the second compressor 21 and a gas side of the third heat exchanger 25. In the second state, the switching mechanism 22 connects the discharge side of the second compressor 21 and the gas side of the third heat exchanger 25, and connects the suction side of the second compressor 21 and the gas side of the second heat exchanger 23.

[0034] The second heat exchanger 23 is configured to exchange heat between the second refrigerant and outdoor air. In the second heat exchanger 23, the second refrigerant acquires cooling energy or heating energy from the outdoor air. The second heat exchanger 23 includes, for example, a fin-and-tube heat exchanger including a large number of heat transfer tubes and fins.

[0035] The second cycle 20 includes the second flow path 32 of the cascade heat exchanger 30. In the second state, the second flow path 32 has a gas side connected to the second heat exchanger 23, and a liquid side connected to the third heat exchanger 25.

[0036] The second expansion mechanism 24 is configured to decompress the second refrigerant, and is, for example, an electric expansion valve.

[0037] The third heat exchanger 25 is configured to exchange heat between the second refrigerant and indoor air, and includes, for example, a fin-and-tube heat exchanger including a large number of heat transfer tubes and fins.

(1-3) Outdoor unit

[0038] In the following description, expressions indicating directions such as "up", "down", "front", and the like are appropriately used, and these expressions indicate directions in a state where the outdoor unit 2 is attached outdoors and is normally used. In the present embodiment, an up-down direction is a vertical direction.

[0039] The outdoor unit 2 is disposed in a space different from a space in which the indoor unit 3 is disposed. Here, the outdoor unit 2 is installed outdoors (on a roof of a building, near an outer wall surface of the building, or the like).

[0040] The outdoor unit 2 includes the first cycle 10, a part of the second cycle 20, a casing 41, an electric component unit 420 including an electric component 42 and a substrate 43, a fan 44, a bell mouth 45, a partition plate 46, and a refrigerant leak sensor 47. Specifically, the outdoor unit 2 includes the first compressor 11, the first heat exchanger 12, the first expansion mechanism 13, the second compressor 21, the switching mechanism 22, the second heat exchanger 23, the second expansion mechanism 24, and the cascade heat exchanger 30 which are illustrated in FIG. 2, and the casing 41, the electric component 42, the substrate 43, the fan 44, the bell mouth 45, the partition plate 46, and the refrigerant leak sensor 47 which are illustrated in FIG. 2.

[0041] The casing 41 accommodates the first compressor 11, the first heat exchanger 12, the first expansion mechanism 13, the second compressor 21, the switching mechanism 22, the second heat exchanger 23, the second expansion mechanism 24, the cascade heat exchanger 30, the electric component 42, the substrate 43, the fan 44, the bell mouth 45, the partition plate 46, and the refrigerant leak sensor 47.

[0042] The casing 41 illustrated in FIG. 2 has a substantially rectangular parallelepiped shape. Specifically, the casing 41 includes a front panel 411, a top panel 412, a bottom plate 413, and a side plate 414.

[0043] The front panel 411 is a plate-shaped member constituting a front surface of the casing 41. The front panel 411 is provided with a blow-out port. The blow-out port is an opening through which outdoor air taken into the casing 41 from outside is blown out of the casing 41.

[0044] The top panel 412 is a plate-shaped member constituting an upper surface of the casing 41. The bottom plate 413 is a plate-shaped member constituting a lower surface of the casing 41. The top panel 412 and the bottom plate 413 face each other.

[0045] The side plate 414 is a plate-shaped member constituting a side surface of the casing 41. A lower portion of the side plate 414 is fixed to the bottom plate 413.

[0046] The casing 41 is provided with an opening 415 for allowing outdoor air to flow through a communication hole 461 of the partition plate 46 described later. Here, the opening 415 is formed in the side plate 414 that defines a second chamber S2 described later. The opening 415 is not required to be formed in the side plate 414, and can be provided in any member that partitions the second chamber S2 and the outside of the casing 41.

[0047] In the electric component unit 420, the electric component 42 (electric part) is mounted on the substrate 43.

[0048] The electric component 42 controls control targets such as the first compressor 11, the second compressor 21, the first expansion mechanism 13, the switching mechanism 22, and the second expansion mechanism 24. The electric component 42 includes, for example, an element to be cooled such as a power element, a reactor, a capacitor, a wire connection portion, and the like.

[0049] The electric component 42 is attached to the substrate 43. The substrate 43 is, for example, a printed circuit board. The substrate 43 extends in the up-down direction. Here, a plurality of electric components 42 is attached to the substrate 43.

[0050] The fan 44 causes air to flow to the first heat exchanger 12 and the second heat exchanger 23. In the present embodiment, the fan 44 causes outdoor air to flow to both the first heat exchanger 12 and the second heat exchanger 23. Here, the fan 44 guides the outdoor air to the first heat exchanger 12 and the second heat exchanger 23 to generate an air flow that exchanges heat with the first refrigerant flowing through the first heat exchanger 12, exchanges heat with the second refrigerant flowing through the second heat exchanger 23, and then, is discharged to outdoors. The fan 44 is driven by a fan motor. Note that a fan that flows air to the first heat exchanger 12 and a fan that flows air to the second heat exchanger 23 may be separately provided.

[0051] The bell mouth 45 is disposed on a blow-out side of the fan 44. The bell mouth 45 has a cylindrical portion surrounding the fan 44. The cylindrical portion forms an opening. The fan 44 is disposed inside the cylindrical portion.

[0052] In FIG. 2, the fan 44 and the bell mouth 45 overlap the first heat exchanger 12 and the second heat exchanger 23 when viewed from the front. The bell mouth 45 faces the blow-out port (not illustrated) formed in the front panel 411 of the casing 41.

[0053] The refrigerant leak sensor 47 detects a leak of the first refrigerant. The refrigerant leak sensor 47 is disposed in a lower part of the casing 41. The refrigerant leak sensor 47 may further detect a leak of the second refrigerant.

[0054] The partition plate 46 is a plate-shaped member extending in the up-down direction. A lower portion of the partition plate 46 is fixed to the bottom plate 413 of the casing 41.

[0055] The partition plate 46 partitions the inside of casing 41 into the first chamber S1 and the second chamber S2. Each of the first chamber S1 and the second chamber S2 is a space defined by the front panel 411, the top panel 412, the bottom plate 413, the side plate 414, and the partition plate 46 of the casing 41.

[0056] Here, the first chamber S1 is an air blowing chamber, and is an air guiding path through which air sucked from a suction port of the outdoor unit 2 flows to the blow-out port. The second chamber S2 is a machine chamber.

[0057] In the present embodiment, the first heat exchanger 12, the second heat exchanger 23, the fan 44, and the bell mouth 45 are disposed in the first chamber S1. In the second chamber S2, the first compressor 11, the second compressor 21, the switching mechanism 22, the first expansion mechanism 13, the second expansion mechanism 24, the electric component unit 420 including the electric component 42 and the substrate 43, and the refrigerant leak sensor 47 are disposed.

[0058] The partition plate 46 is provided with the communication hole 461. As illustrated in FIG. 5, the communication hole 461 is provided above a first brazed portion 121 disposed uppermost among a plurality of brazed portions 120 of the first heat exchanger 12.

[0059] The brazed portion 120 is a portion where the first refrigerant may leak from the first heat exchanger 12 in the first chamber S1. The brazed portion 120 according to the present embodiment is a joint portion between heat transfer tubes constituting the first heat exchanger 12, a joint portion between a heat transfer tube and a fin, or the like. The heat transfer tube includes a U-shaped tube, a branch tube, and the like. Here, the plurality of brazed portions 120 are joint portions between a hairpin-shaped tube and a U-shaped tube or a branch tube. When the heat transfer tubes and the fins are brazed to each other as in a microchannel heat exchanger or the like, the portions brazed to each other also serve as brazed portions.

[0060] In FIG. 2A, a height position of the communication hole 461 in the up-down direction is indicated by P1, and a height position of the first brazed portion 121 in the up-down direction is indicated by P2. The height position P1 of the communication hole 461 in the up-down direction is a lowermost end of the communication hole 461. Therefore, the height position P1 of the lowermost end of the communication hole 461 is higher than the height position of the first brazed portion 121 in the up-down direction.

[0061] The communication hole 461 is a hole for guiding outdoor air flowing into the second chamber S2 from the opening 415 of the casing 41 to the first chamber S1. The communication hole 461 according to the present embodiment is a hole for guiding air around the electric component unit 420 including the electric component 42 and the substrate 43 to the fan 44. In other words, the communication hole 461 is a hole for guiding outdoor air

around the electric component unit 420 including the electric components 42 and the substrate 43 in the second chamber S2 to the fan 44 in the first chamber S 1.

[0062] In FIG. 2, the communication hole 461 is located above an upper end of the first heat exchanger 12. The height position P1 of the communication hole 461 overlaps with the second heat exchanger 23.

[0063] The communication hole 461 is located above a lower end 451 of the cylindrical portion of the bell mouth 45. The communication hole 461 is located above the first terminal 111 of the first compressor 11 and the second terminal 211 of the second compressor 21.

[0064] Furthermore, the communication hole 461 is located above a lower end 431 of the electric component unit 420 (here, the substrate 43). Here, the height position P1 of the lowermost end of the communication hole 461 is located above the electric component 42 disposed lowermost among the plurality of electric components 42.

[0065] Here, the arrangement of various devices accommodated in the casing 41 of the outdoor unit 2 will be described.

[0066] In the first chamber S1, the first heat exchanger 12 is located below the second heat exchanger 23. In other words, at least a part of the first heat exchanger 12 is located below the second heat exchanger 23. The entire first heat exchanger 12 may be located below the second heat exchanger 23, and a part of the first heat exchanger 12 may be located below the second heat exchanger 23.

[0067] For example, the first heat exchanger 12 and the second heat exchanger 23 may be separated or may be integrated. For example, the size of the first heat exchanger 12 may be about the same as or may be smaller in a height direction in the up-down direction than the size of the second heat exchanger 23.

[0068] In the second chamber S2, the electric component unit 420 including the electric component 42 and the substrate 43 is disposed above the first compressor 11 and the second compressor 21.

[0069] In the casing 41, the lower end 431 of the electric component unit 420 (here, the substrate 43) is located above the lower end 451 of the cylindrical portion of the bell mouth 45. In other words, a height position of the lower end 431 of the electric component unit 420 (here, the substrate 43 to which the electric component 42 is attached) in the up-down direction is higher than the opening lower end 451 of the bell mouth 45 disposed on the blow-out side of the fan 44.

[0070] Here, the electric component 42 located lowermost among the plurality of electric components 42 is located above the lower end 451 of the cylindrical portion of the bell mouth 45.

[0071] The lower end 431 of the electric component unit 420 (here, the substrate 43) is located above the first brazed portion 121. In other words, a height position of the electric component unit 420 (here, the substrate 43 to which the electric component 42 is attached) is higher than the height position P1 of the first brazed portion 121.

[0072] Here, the electric component 42 located lowermost among the plurality of electric components 42 is located above the first brazed portion 121.

[0073] The first terminal 111 of the first compressor 11 and the second terminal 211 of the second compressor 21 are located above the lower end 451 of the cylindrical portion of the bell mouth 45. Here, a lower end of the first terminal 111 of the first compressor 11 and a lower end of the second terminal 211 of the second compressor 21 are located above the lower end 451 of the cylindrical portion of the bell mouth 45.

(1-4) Indoor unit

[0074] The indoor unit 3 is installed indoors (inside the building). As described above, the indoor unit 3 is connected to the outdoor unit 2 via the connection pipes 4 and 5, and constitutes a part of the second cycle 20.

[0075] As illustrated in FIG. 1, the indoor unit 3 includes the third heat exchanger 25. Here, the indoor unit 3 is installed by being embedded in or being suspended from a ceiling on an indoor space of a building or the like, or by being hung on a wall surface in the indoor space, or the like.

(1-5) Connection pipes

[0076] The connection pipes 4 and 5 are refrigerant pipes constructed on the site when the binary refrigeration cycle apparatus 1 is installed at an installation location such as a building. One end of the liquid-side connection pipe 4 is connected to a liquid-side end of the outdoor unit 2, and the other end of the connection pipe 4 is connected to a liquid-side end of the third heat exchanger 25 of the indoor unit 3. One end of the gas-side connection pipe 5 is connected to a gas-side end of the outdoor unit 2, and the other end of the connection pipe 5 is connected to a gas-side end of the third heat exchanger 25 of the indoor unit 3.

(1-6) Control unit

[0077] The constituent devices of the outdoor unit 2 and the indoor unit 3 are controlled by the control unit 6. The control unit 6 is configured by communicably connecting the electric component 42, the substrate 43, and the like provided in the outdoor unit 2, a control board and the like (not illustrated) provided in the indoor unit 3, and the like. In FIG. 1, the control unit 6 is illustrated at a position apart from the outdoor unit 2, the indoor unit 3, and the like for convenience. The control unit 6 controls the constituent devices of the binary refrigeration cycle apparatus 1 (here, the outdoor unit 2 and the indoor unit 3). In other words, the control unit 6 controls the operation of the entire binary refrigeration cycle apparatus 1.

[0078] The control unit 6 is implemented by a computer. The control unit 6 includes a control calculation device and a storage device. A processor such as a CPU or a

GPU can be used for the control calculation device. The control calculation device reads a program stored in the storage device, and executes predetermined image processing and calculation processing in accordance with this program. Furthermore, the control calculation device can write a calculation result to the storage device and read information stored in the storage device in accordance with the program.

(2) Motion of binary refrigeration cycle apparatus

[0079] Motion of the binary refrigeration cycle apparatus 1 will be described with reference to FIGS. 1 to 4. The binary refrigeration cycle apparatus 1 can perform a cooling operation for cooling indoor air and a heating operation for heating indoor air for indoor air conditioning. In the cooling operation and the heating operation, the operation of the binary refrigeration cycle apparatus 1 is controlled by the control unit 6.

(2-1) Cooling operation

[0080] As illustrated in FIG. 3, during the cooling operation, the switching mechanism 22 is switched to the first state (the switching mechanism 22 is in a state indicated by the solid lines) such that the second heat exchanger 23 functions as a radiator for the second refrigerant and the third heat exchanger 25 functions as an evaporator for the second refrigerant.

[0081] In the second cycle 20, the second refrigerant discharged from the second compressor 21 is sent to the second heat exchanger 23 through the switching mechanism 22. The second refrigerant sent to the second heat exchanger 23 exchanges heat with the outdoor air supplied by the fan 44 and is cooled to radiate heat. The second refrigerant having radiated heat in the second heat exchanger 23 is sent to the second flow path 32 of the cascade heat exchanger 30. The second refrigerant sent to the second flow path 32 exchanges heat with the first refrigerant flowing through the first flow path 31 in the cascade heat exchanger 30 to be further cooled. The second refrigerant further cooled by the cascade heat exchanger 30 is decompressed by the second expansion mechanism 24 and then flows out of the outdoor unit 2.

[0082] The second refrigerant having flowed out of the outdoor unit 2 flows into the indoor unit 3 via the liquid-side connection pipe 4. In the indoor unit 3, the second refrigerant is sent to the third heat exchanger 25. The second refrigerant sent to the third heat exchanger 25 exchanges heat with indoor air and is heated to evaporate. The second refrigerant having evaporated in the third heat exchanger 25 flows out of the indoor unit 3.

[0083] The second refrigerant having flowed out of the indoor unit 3 flows into the outdoor unit 2 via the gas-side connection pipe 5. In the outdoor unit 2, the second refrigerant is again sucked into the second compressor 21 through the switching mechanism 22.

[0084] In the first cycle 10, the first refrigerant discharged from the first compressor 11 is sent to the first heat exchanger 12. The first refrigerant sent to the first heat exchanger 12 exchanges heat with the outdoor air supplied by the fan 44 and is cooled to be condensed. The first refrigerant condensed in the first heat exchanger 12 is decompressed by the first expansion mechanism 13 and then sent to the first flow path 31 of the cascade heat exchanger 30. The first refrigerant sent to the first flow path 31 exchanges heat with the second refrigerant flowing through the second flow path 32 in the cascade heat exchanger 30 and is heated to evaporate. The first refrigerant having evaporated in the cascade heat exchanger 30 is sucked into the first compressor 11 again.

(2-2) Heating operation

[0085] As illustrated in FIG. 4, during the heating operation, the switching mechanism 22 is switched to the second state (the switching mechanism 22 is in a state indicated by the broken lines) such that the second heat exchanger 23 functions as an evaporator for the second refrigerant and the third heat exchanger 25 functions as a radiator for the second refrigerant. In the heating operation, the first compressor 11 is not activated, and the first refrigerant in the first cycle 10 is not circulated.

[0086] In the second cycle 20, the second refrigerant discharged from the second compressor 21 flows out of the outdoor unit 2 through the switching mechanism 22.

[0087] The refrigerant having flowed out of the outdoor unit 2 flows into the indoor unit 3 via the gas-side connection pipe 5. In the indoor unit 3, the second refrigerant is sent to the third heat exchanger 25. The second refrigerant sent to the third heat exchanger 25 exchanges heat with indoor air and is cooled to radiate heat. The second refrigerant having radiated heat in the third heat exchanger 25 flows out of the indoor unit 3.

[0088] The second refrigerant having flowed out of the indoor unit 3 flows into the outdoor unit 2 via the liquid-side connection pipe 4. In the outdoor unit 2, the second refrigerant is sent to the second heat exchanger 23 through the second expansion mechanism 24 and the second flow path 32 of the cascade heat exchanger 30. The second refrigerant sent to the second heat exchanger 23 exchanges heat with the outdoor air supplied by the fan 44 and is heated to evaporate. The second refrigerant having evaporated in the second heat exchanger 23 is again sucked into the second compressor 21 through the switching mechanism 22.

(3) Flow of first refrigerant at time of refrigerant leak

[0089] As indicated by arrow A in FIG. 2A, in the outdoor unit 2, the outdoor air flows from the opening 415 of the side plate 414 of the casing 41 to the second chamber S2, further passes through the communication hole 461 of the partition plate 46, and flows to the first chamber S1. Here, the outdoor air having passed through the communication hole 461 flows to the fan 44. While the fan 44

is being driven, the outdoor air flows from the first chamber S1 to outside of the casing 41.

[0090] The second refrigerant which is non-combustible has a lower risk in leakage. However, when the first refrigerant which is combustible flows into the electric component unit 420 (in particular, the electric component 42) serving as an ignition source, there is a possibility that the first refrigerant is ignited. The first refrigerant is highly likely to leak from the plurality of brazed portions of the first heat exchanger 12. In the present embodiment, since the communication hole 461 is located above the first brazed portion 121 located uppermost among the plurality of brazed portions 120, even if the first refrigerant which is heavier than air leaks, the first refrigerant is prevented from flowing above the communication hole 461.

[0091] Furthermore, while the fan 44 is being driven, the first refrigerant having leaked is prevented from flowing into the second chamber S2 by the outdoor air flowing from the communication hole 461 to the second chamber S2.

[0092] When the electric component unit 420 (here, the electric component 42) is located in an upper part as in the present embodiment, since the communication hole 461 is located in the upper part in the casing 41, the outdoor air flowing into the second chamber S2 passes around the electric component unit 420 (here, the electric component 42). Therefore, the outdoor air around the electric component unit 420 (here, the electric component 42) can be promoted to flow to the first chamber S1. Accordingly, the leaked first refrigerant is prevented from flowing around the electric component 42.

[0093] When the first refrigerant leaks, the first refrigerant above the lower end 451 of the cylindrical portion of the bell mouth 45 is discharged to outside of the casing 41 through the cylindrical portion of the bell mouth 45 and the blow-out port of the casing 41.

(4) Characteristics

[0094] (4-1)

The outdoor unit 2 as an air conditioning unit according to the present embodiment includes the electric component unit 420, the first heat exchanger 12, the second heat exchanger 23, the fan 44, the casing 41, and the partition plate 46. The first heat exchanger 12 exchanges heat between the combustible first refrigerant and air. The second heat exchanger 23 exchanges heat between the non-combustible second refrigerant and air. The fan 44 causes air to flow to the first heat exchanger 12 and the second heat exchanger 23. The casing 41 accommodates the electric component unit 420, the first heat exchanger 12, the second heat exchanger 23, and the fan 44. The partition plate 46 partitions the inside of the casing 41 into the first chamber S1 in which the first heat exchanger 12, the second heat exchanger 23, and the fan 44 are disposed, and the second chamber S2 in which the electric component unit 420 is disposed. The partition plate 46 is provided with the communication hole 461 that communicates the first chamber S1 and the second chamber S2 above the first brazed portion 121 located uppermost among the plurality of brazed portions 120 of the first heat exchanger 12.

[0095] In the outdoor unit 2 as an air conditioning unit according to the present embodiment, the communication hole 461 provided in the partition plate 46 and the fan 44 disposed in the first chamber S1 allow air to flow from the second chamber S2 in which the electric component unit 420 is disposed to the first chamber S1 in which the first heat exchanger 12 through which the first refrigerant flows is disposed. Since the communication hole 461 is provided at the position P1 higher than the first brazed portion 121 at the highest position P2 in the first heat exchanger 12 through which the combustible first refrigerant flows, even if the first refrigerant leaks in the first chamber S1, the first refrigerant can be prevented from flowing above the communication hole 461. Therefore, the possibility of ignition with the electric component unit 420 in the second chamber S2 as an ignition source can be reduced. The air conditioning unit is particularly useful for a highly flammable (A3) refrigerant such as R290.

[0096] (4-2)

The outdoor unit 2 serving as the air conditioning unit according to the present embodiment is the outdoor unit 2 according to (4-1), in which the communication hole 461 is a hole that guides air around the electric component unit 420 to the fan.

[0097] Here, since the air around the electric component unit 420 serving as an ignition source is guided to the first chamber S1 through the communication hole 461, even if the first refrigerant leaks, the first refrigerant can be suppressed from flowing around the electric component unit 420.

[0098] (4-3)

The outdoor unit 2 as an air conditioning unit according to the present embodiment is the outdoor unit 2 according to (4-1) or (4-2) and further includes the bell mouth 45. The bell mouth 45 is disposed in the first chamber S1 and has the cylindrical portion surrounding the fan 44. The lower end 431 of the electric component unit 420 is located above the lower end 451 of the cylindrical portion.

[0099] Here, the fan 44 is disposed inside the cylindrical portion of the bell mouth 45. In general, the first refrigerant is heavier than air. Therefore, even if the first refrigerant leaks, the first refrigerant stays below the lower end 451 of the cylindrical portion. In the present embodiment, since the lower end 431 of the electric component unit 420 (specifically, the substrate 43 to which the electric component 42 is attached) is located above the lower end 451 of the cylindrical portion, even if there is a gap between the lower end of the partition plate 46 and the bottom plate 413 of the casing 41 and the first refrigerant flows into the second chamber S2, the first refrigerant accumulated below can be prevented from reaching a height level of the electric component unit 420.

[0100] (4-4)

The outdoor unit 2 serving as an air conditioning unit according to the present embodiment is the outdoor unit 2 according to any of (4-1) to (4-3), in which the electric component unit 420 is located above the first brazed portion 121.

[0101] Here, even if the first refrigerant leaks, the first refrigerant stays below the first brazed portion 121. Here, since the electric component unit 420 is located above the first brazed portion 121, the first refrigerant can be further prevented from flowing to the electric component.

[0102] (4-5)

The outdoor unit 2 serving as an air conditioning unit according to the present embodiment is the outdoor unit 2 according to any of (4-1) to (4-4), in which the first heat exchanger 12 is located below the second heat exchanger 23.

[0103] Here, the first heat exchanger 12 through which the combustible refrigerant flows is disposed below the second heat exchanger 23 through which the non-combustible refrigerant flows. Accordingly, even if the first refrigerant leaks, the first refrigerant is likely to stay below, and a distance between the communication hole 461 and the first brazed portion 121 can be secured. Therefore, the outdoor unit 2 that prevents the first refrigerant from flowing to the electric component unit 420 can be easily achieved.

[0104] (4-6)

The outdoor unit 2 as an air conditioning unit according to the present embodiment is the outdoor unit 2 according to any of (4-1) to (4-5) and further includes the first compressor 11, the second compressor 21, and the bell mouth 45. The first compressor 11 is disposed in the second chamber S2 and compresses the first refrigerant. The second compressor 21 is disposed in the second chamber S2 and compresses the second refrigerant. The bell mouth 45 is disposed in the first chamber S1 and has the cylindrical portion surrounding the fan 44. The first terminal 111 of the first compressor 11 and the second terminal 211 of the second compressor 21 are located above the lower end 451 of the cylindrical portion.

[0105] Here, even if the first refrigerant leaks, the first refrigerant stays below the lower end 451 of the cylindrical portion of the bell mouth 45. Here, since the first terminal 111 and the second terminal 211 are located above the lower end 451 of the cylindrical portion, the possibility of ignition with the first terminal 111 and the second terminal 211 of the second chamber S2 as ignition sources can be reduced.

[0106] (4-7)

The outdoor unit 2 as an air conditioning unit according to the present embodiment is the outdoor unit 2 according to any of (4-1) to (4-5), in which the second refrigerant includes carbon dioxide.

[0107] Since the carbon dioxide refrigerant has a low global warming potential (GWP), the outdoor unit 2 which contributes to reduction in global warming can be achieved.

(5) Modifications

(5-1) Modification 1

[0108] In the above embodiment, the air conditioning unit is the outdoor unit 2 of the binary refrigeration cycle apparatus 1, but the present disclosure is not limited to this configuration. Alternatively, the air conditioning unit of the present disclosure may be an indoor unit or a cascade unit.

(5-2) Modification 2

[0109] In the above embodiment, the binary refrigeration cycle apparatus 1 in which one indoor unit 3 is connected to one outdoor unit 2 has been described as an example. However, the present disclosure is not limited to this example. In the binary refrigeration cycle apparatus of the present modification, a plurality of indoor units is connected to one outdoor unit.

(5-3) Modification 3

[0110] In the above embodiment, the air conditioning unit of the binary refrigeration cycle apparatus 1 that performs the cooling operation and the heating operation has been described as an example. However, the present disclosure is not limited to this example. The binary refrigeration cycle apparatus including the air conditioning unit of the present disclosure may further perform a dehumidifying operation. For example, the binary refrigeration cycle apparatus including the air conditioning unit of the present disclosure may be an air conditioner dedicated to cooling.

[0111] The embodiments of the present disclosure have been described above. It will be understood that various changes to modes and details can be made without departing from the gist and scope of the present disclosure recited in the claims.

REFERENCE SIGNS LIST

[0112]

1:	Binary refrigeration cycle apparatus
2:	Outdoor unit (air conditioning unit)
3:	Indoor unit
11:	First compressor
12:	First heat exchanger
21:	Second compressor
23:	Second heat exchanger
25:	Third heat exchanger
30:	Cascade heat exchanger
41:	Casing
42:	Electric component
43:	Substrate
44:	Fan
45:	Bell mouth

46: Partition plate
111, 211: Terminal
120: Brazed portion
121: First brazed portion
420: Electric component unit
431, 451: Lower end
461: Communication hole
S1: First chamber
S2: Second chamber

CITATION LIST

PATENT LITERATURE

[0113] Patent Literature 1: JP 5430604 B2

Claims

1. An air conditioning unit (2) comprising:

an electric component unit (420);
a first heat exchanger (12) that exchanges heat between a first refrigerant that is combustible and air;
a second heat exchanger (23) that exchanges heat between a second refrigerant that is non-combustible and air;
a fan (44) that causes air to flow through the first heat exchanger and the second heat exchanger;
a casing (41) that accommodates the electric component unit, the first heat exchanger, the second heat exchanger, and the fan; and
a partition plate (46) that partitions an inside of the casing into a first chamber (S1) in which the first heat exchanger, the second heat exchanger, and the fan are disposed, and a second chamber (S2) in which the electric component unit is disposed, wherein
the partition plate is provided with a communication hole (461) that communicates the first chamber and the second chamber above a first brazed portion (121) located uppermost among a plurality of brazed portions (120) of the first heat exchanger.

2. The air conditioning unit according to claim 1, wherein the communication hole is a hole that guides air around the electric component unit to the fan.

3. The air conditioning unit according to claim 1 or 2, further comprising a bell mouth (45) disposed in the first chamber and having a cylindrical portion surrounding the fan, wherein
a lower end (431) of the electric component unit is located above a lower end (451) of the cylindrical portion.

4. The air conditioning unit according to any one of claims 1 to 3, wherein a lower end (431) of the electric component unit is located above the first brazed portion.

5. The air conditioning unit according to any one of claims 1 to 4, wherein the first heat exchanger is located below the second heat exchanger.

6. The air conditioning unit according to any one of claims 1 to 5, further comprising:

a first compressor (11) that is disposed in the second chamber and compresses the first refrigerant;
a second compressor (21) that is disposed in the second chamber and compresses the second refrigerant; and
a bell mouth (45) disposed in the first chamber and having a cylindrical portion surrounding the fan, wherein
a terminal (111) of the first compressor and a terminal (211) of the second compressor are located above the lower end (451) of a cylindrical portion.

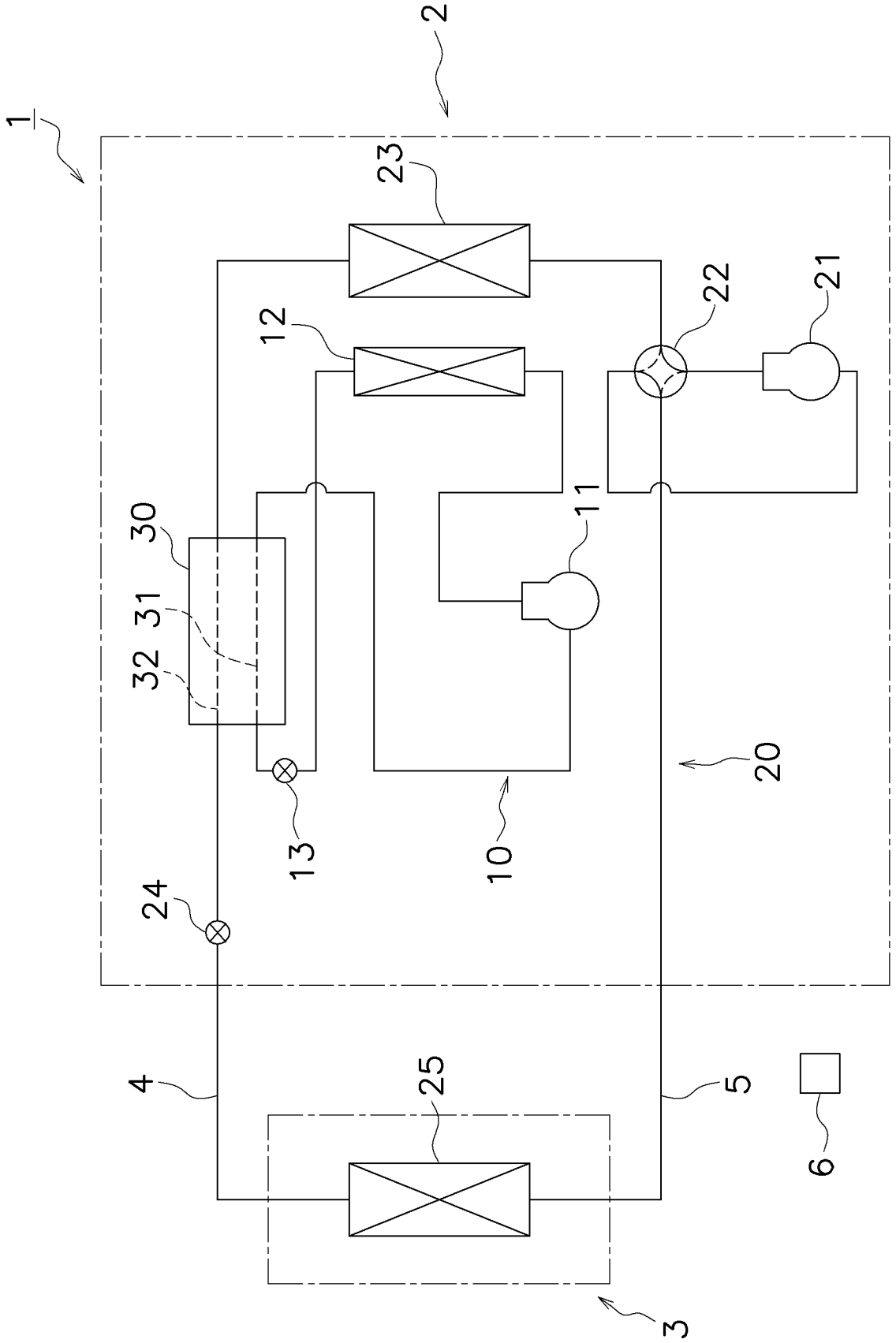

FIG. 1

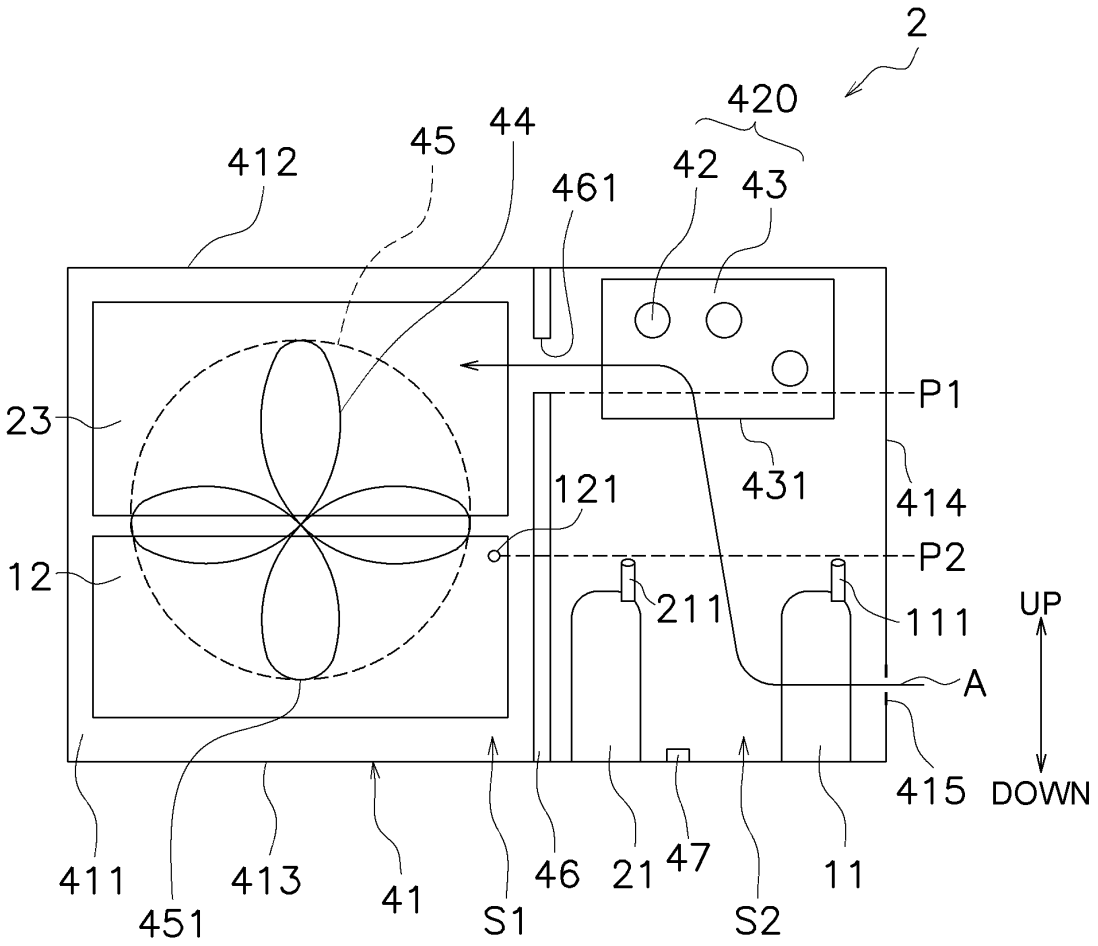
2
420
44
45
412
461
42
43
P1
23
431
414
121
P2
12
211
111
UP
A
415
DOWN
411
451
413
41
S1
46
21
47
S2
11

FIG. 2A

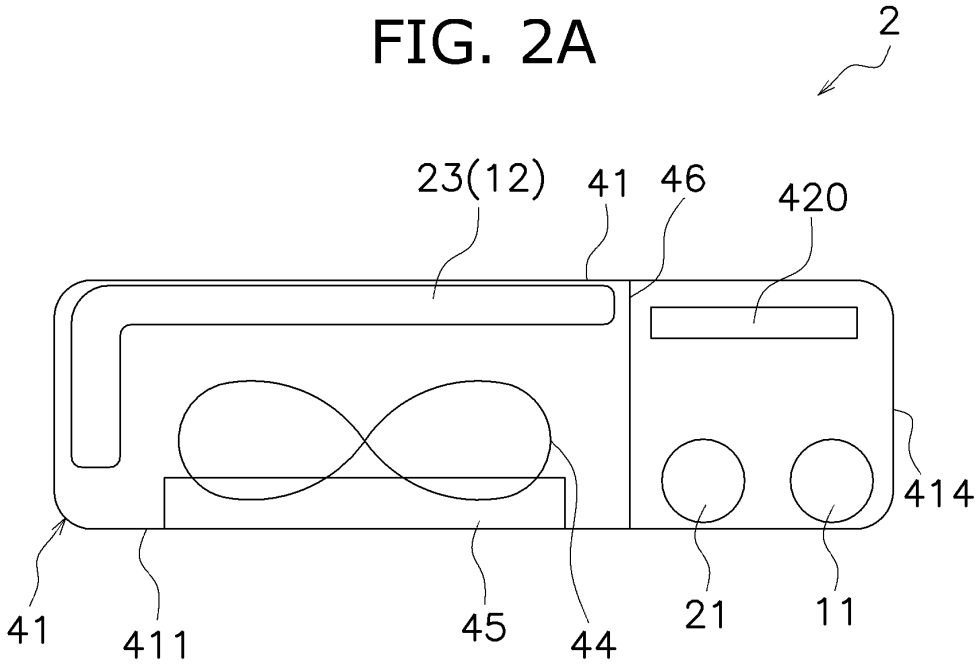
2
23(12)
41
46
420
414
41
411
45
44
21
11

FIG. 2B

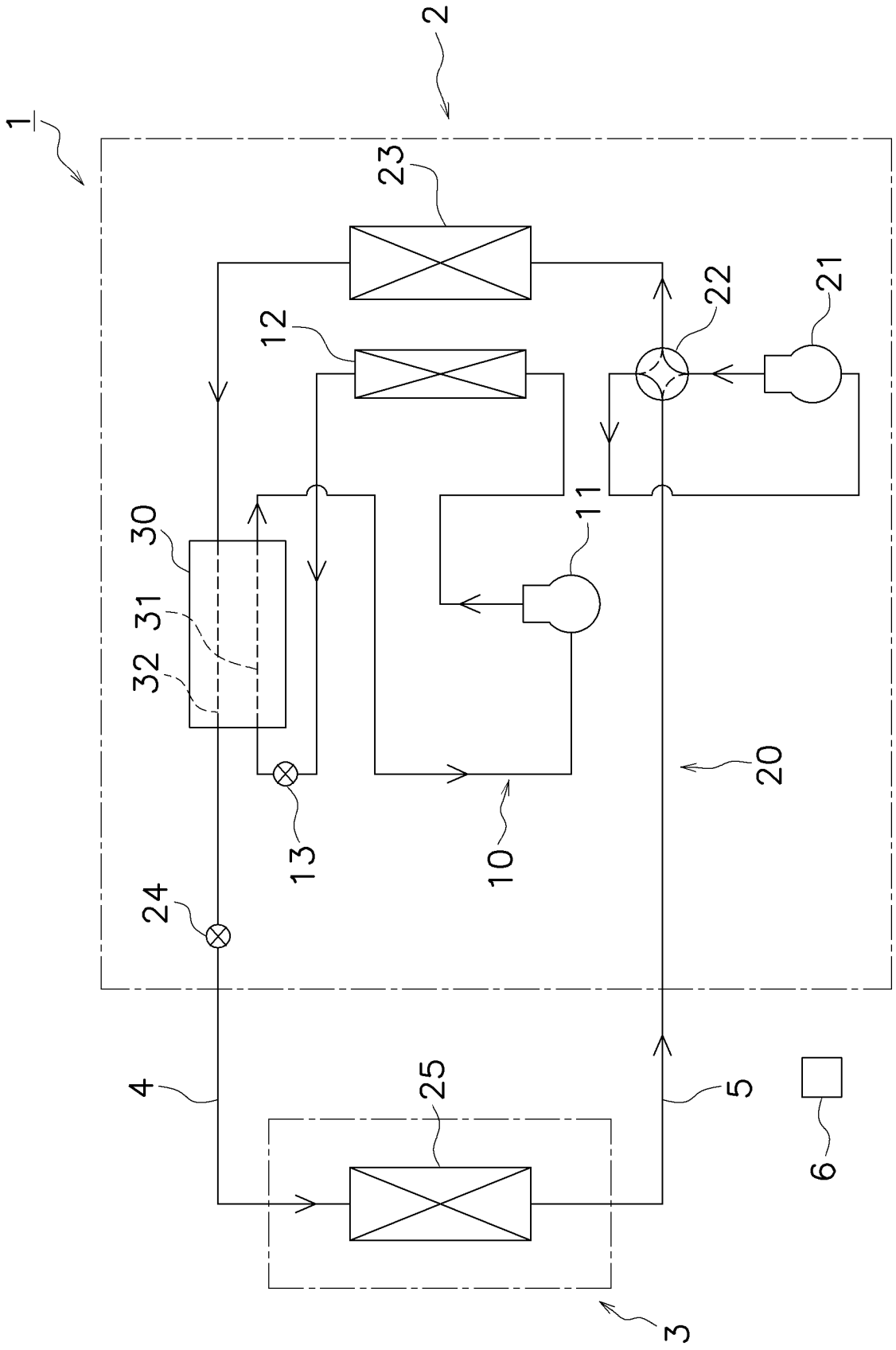

FIG. 3

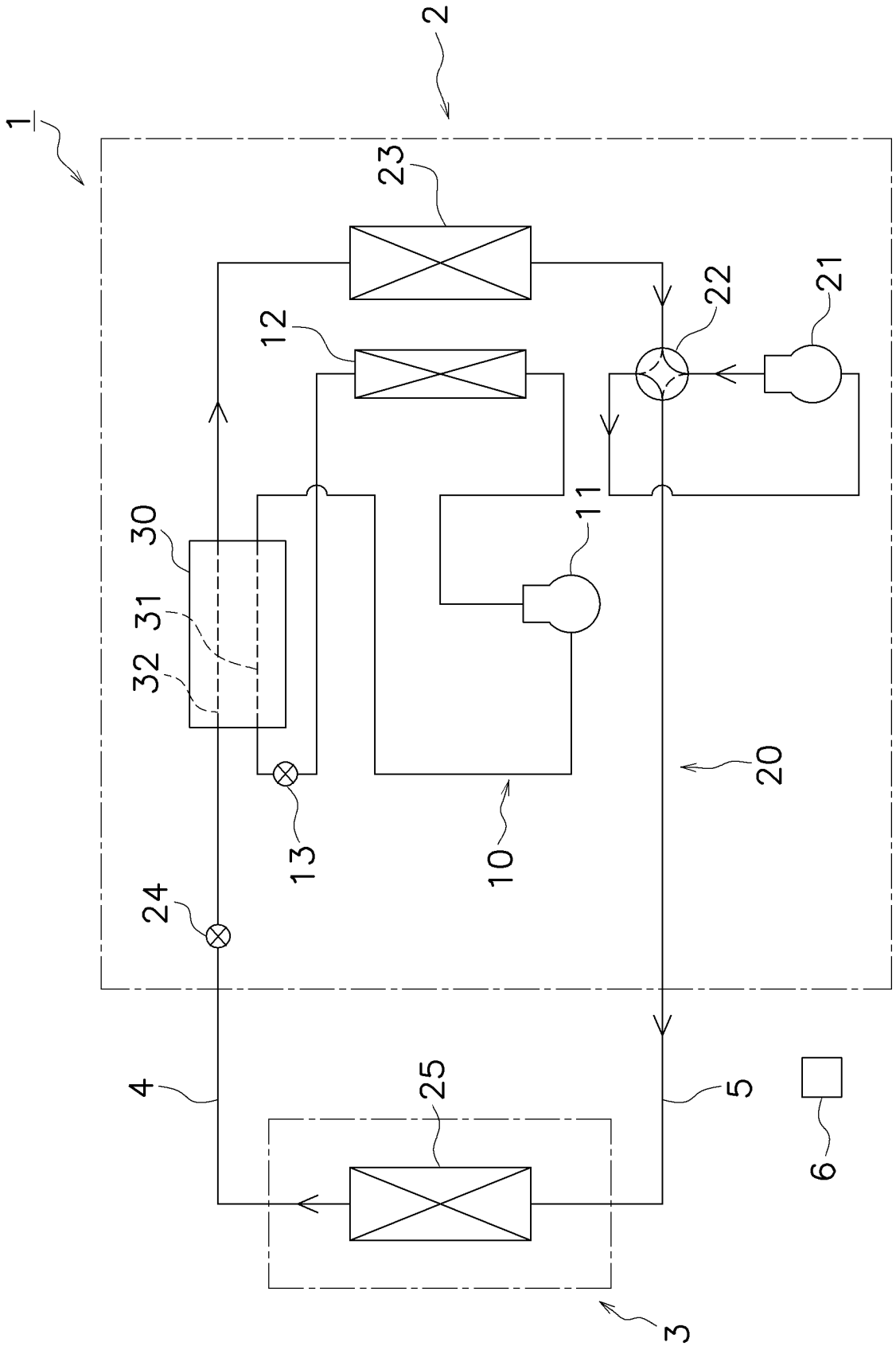

FIG. 4

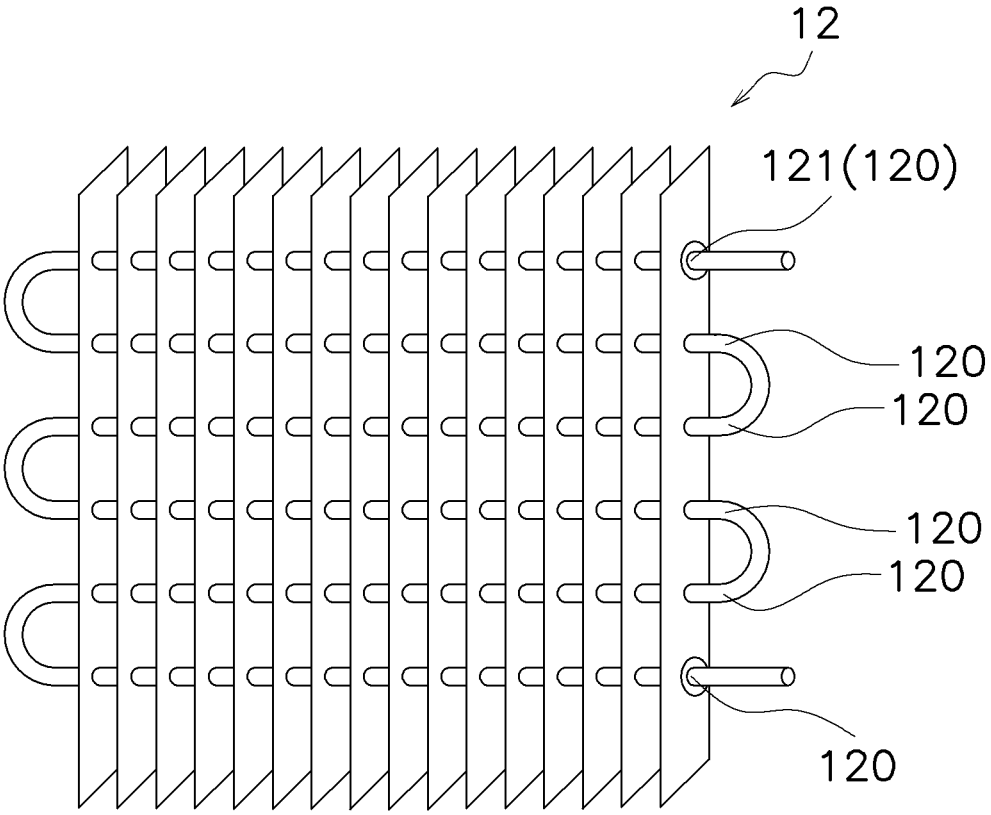

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/041728

A. CLASSIFICATION OF SUBJECT MATTER

F24F 1/24(2011.01)i; ***F24F 1/46***(2011.01)i; ***F24F 1/48***(2011.01)i; ***F25B 1/00***(2006.01)i; ***F25B 7/00***(2006.01)i; ***F25B 49/02***(2006.01)i
FI: F24F1/24; F24F1/48; F24F1/46; F25B1/00 B; F25B7/00 D; F25B49/02 560

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)

F24F1/24; F24F1/46; F24F1/48; F25B1/00; F25B7/00; F25B49/02

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 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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 (2015-11-26) paragraphs [0021]-[0082], fig. 1-4	1-6
Y	WO 2022/013976 A1 (MITSUBISHI ELECTRIC CORP.) 20 January 2022 (2022-01-20) paragraphs [0012]-[0018], [0030]-[0033], fig. 1, 4	1-6
Y	JP 2014-006027 A (MITSUBISHI ELECTRIC CORP.) 16 January 2014 (2014-01-16) paragraphs [0015]-[0045], [0064], fig. 5	1-6
Y	JP 2010-053874 A (PANASONIC CORP.) 11 March 2010 (2010-03-11) paragraphs [0020]-[0025], fig. 1, 4	6
A	JP 2012-172890 A (MITSUBISHI ELECTRIC CORP.) 10 September 2012 (2012-09-10) entire text, all drawings	1-6

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

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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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
28 December 2023	**16 January 2024**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/041728

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2015/0338145 A1	26 November 2015	EP 2947402 A1 paragraphs [0038]-[0110], fig. 1-4 KR 10-2015-0134676 A CN 105091410 A	
WO 2022/013976 A1	20 January 2022	EP 4184080 A1 paragraphs [0012]-[0018], [0030]-[0033], fig. 1, 4 CN 115769032 A	
JP 2014-006027 A	16 January 2014	EP 2679921 A2 paragraphs [0015]-[0045], [0064], fig. 5 CN 203274387 U CN 103512292 A	
JP 2010-053874 A	11 March 2010	(Family: none)	
JP 2012-172890 A	10 September 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 5430604 B **[0002] [0113]**