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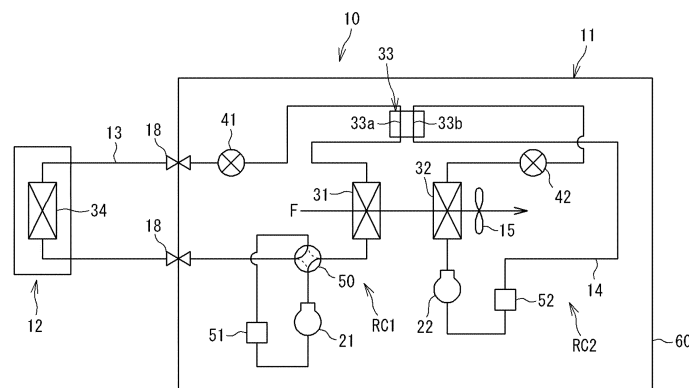
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(54) **REFRIGERATION DEVICE**

(57) The disclosure provides a refrigeration apparatus 10 including: a first refrigerant circuit RC1 including a first compressor 21, a first heat exchanger 31, a first expansion valve 41, and a utilization-side heat exchanger 34, and using a first refrigerant R1; a second refrigerant circuit RC2 including a second compressor 22, a second heat exchanger 32, and a second expansion valve 42, and using a second refrigerant R2; a third heat exchanger 33 configured to cause heat exchange be-

tween the first refrigerant R1 and the second refrigerant R2; and a fan 15, in which the first heat exchanger 31 includes a heat transfer tube being a circular tube 31a, the second heat exchanger 32 includes a heat transfer tube being a flat multi-hole tube 32a, and the second heat exchanger 32 is disposed leeward of the first heat exchanger 31 in an air flow direction F of an air flow generated by the fan 15.

FIG. 1



Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] There is disclosed a refrigeration apparatus including a unit having a first refrigerant circuit configured to exhibit main cooling capability, a second refrigerant circuit configured to assist the first refrigerant circuit in the cooling capability, and a heat exchanger configured to cause heat exchange between a first refrigerant in the first refrigerant circuit and a second refrigerant in the second refrigerant circuit (see PATENT LITERATURE 1). The first refrigerant and the second refrigerant are different from each other in terms of refrigerant types in the refrigeration apparatus. 10

CITATION LIST

[PATENT LITERATURE]

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

SUMMARY OF THE INVENTION

[TECHNICAL PROBLEM] 15

[0004] In the unit of the refrigeration apparatus, a first air heat exchanger included in the first refrigerant circuit and a second air heat exchanger included in the second refrigerant circuit may be aligned windward and leeward in an air flow direction of air subject to heat exchange. When the second air heat exchanger is disposed windward of the first air heat exchanger, the second air heat exchanger is disposed at an outermost location in the unit. In the unit thus configured, external force or the like is likely to be applied to the second air heat exchanger during conveyance, and the second air heat exchanger is thus likely to be damaged. 20

[0005] It is an object of the present disclosure to provide a refrigeration apparatus including a unit having first and second air heat exchangers, and reduce risk of damage to the second air heat exchanger. 25

[SOLUTION TO PROBLEM]

[0006]

(1) A refrigeration apparatus according to the present disclosure includes: a first refrigerant circuit including a first compressor, a first heat exchanger, a first expansion valve, and a utilization-side heat exchanger, and using a first refrigerant; a second refrigerant circuit including a second compressor, a 30

second heat exchanger, and a second expansion valve, and using a second refrigerant; a third heat exchanger configured to cause heat exchange between the first refrigerant and the second refrigerant; and a fan, in which the first heat exchanger includes a heat transfer tube being a circular tube, the second heat exchanger includes a heat transfer tube being a flat multi-hole tube, and the second heat exchanger is disposed leeward of the first heat exchanger in an air flow direction of an air flow generated by the fan. 35

[0007] The refrigeration apparatus according to the present disclosure includes the first heat exchanger adopting the circular tube as a heat transfer tube, and the second heat exchanger adopting the flat multi-hole tube as a heat transfer tube. The flat multi-hole tube is weaker against external force than the circular tube. In the refrigeration apparatus according to the present disclosure, the first heat exchanger is disposed windward of the second heat exchanger in the air flow direction, to dispose the first heat exchanger outside the second heat exchanger. In the refrigeration apparatus according to the present disclosure, the first heat exchanger including the circular tube as a heat transfer tube is disposed windward of the second heat exchanger including the flat multi-hole tube as a heat transfer tube in the air flow direction, so as to reduce risk of damage to the second heat exchanger when external force is applied to a unit including the first heat exchanger and the second heat exchanger. 40

[0008] (2) In the refrigeration apparatus according to (1) described above of the present disclosure, preferably, the second heat exchanger is constituted by a heat exchanger including a plurality of the flat multi-hole tubes, and a fin meanderingly disposed between the flat multi-hole tubes adjacent to each other. 45

[0009] In the heat exchanger thus configured, the flat multi-hole tubes and the fin are flush with each other and the flat multi-hole tubes are thus not protected by the fin. Accordingly, the flat multi-hole tubes are likely to directly receive external force to be damaged in the heat exchanger configured as described above. The refrigeration apparatus according to the present disclosure can reduce risk of damage to the flat multi-hole tubes when the heat exchanger configured as described above is adopted as the second heat exchanger. The refrigeration apparatus according to the present disclosure adopts the heat exchanger configured as described above to reduce used quantity of the second refrigerant. 50

[0010] (3) In the refrigeration apparatus according to (1) or (2) described above of the present disclosure, preferably, the fan is disposed leeward of the second heat exchanger in the air flow direction, and the second heat exchanger is fixed to a support configured to support the fan. 55

[0011] In the refrigeration apparatus thus configured, the fan is disposed leeward of the second heat exchanger in the air flow direction. The refrigeration apparatus ac-

according to the present disclosure can accordingly fix the second heat exchanger with use of the support configured to fix the fan.

[0012] (4) In the refrigeration apparatus according to any one of (1) to (3) described above of the present disclosure, preferably, the first heat exchanger includes a first region overlapped with the second heat exchanger when viewed in the air flow direction, and a second region not overlapped with the second heat exchanger when viewed in the air flow direction.

[0013] In the refrigeration apparatus including the first heat exchanger and the second heat exchanger, in a case where outer shapes of the heat exchangers are dimensionally equal and positionally identical when viewed in the air flow direction, the two heat exchangers can be easily supported by a common support. In another case where the outer shapes of the two heat exchangers are dimensionally different from each other and misaligned when viewed in the air flow direction, the two heat exchangers are difficult to be supported by a common support. Even if the first heat exchanger includes the first region overlapped with the second heat exchanger and the second region not overlapped with the second heat exchanger when viewed in the air flow direction, the refrigeration apparatus according to the present disclosure can fix the second heat exchanger with use of the support configured to fix the fan.

[0014] (5) In the refrigeration apparatus according to any one of (1) to (3) described above of the present disclosure, preferably, when the first heat exchanger and the second heat exchanger are viewed in the air flow direction, an area of a fourth region zoned by an outer shape of the second heat exchanger is smaller than an area of a third region zoned by an outer shape of the first heat exchanger, and the third region includes the fourth region.

[0015] In the refrigeration apparatus including the first heat exchanger and the second heat exchanger, in a case where the outer shapes of the two heat exchangers are dimensionally equal to each other, the two heat exchangers can be easily supported by a common support. In another case where the outer shapes of the two heat exchangers are dimensionally different from each other, the heat exchanger dimensionally larger can be easily supported by a frame of a case accommodating this heat exchanger, but the heat exchanger dimensionally smaller is difficult to be supported by the frame of the case. In the refrigeration apparatus according to the present disclosure, even if the second heat exchanger is dimensionally smaller in outer shape than the first heat exchanger when viewed in the air flow direction and the outer shape of the first heat exchanger accommodates the second heat exchanger, the second heat exchanger can be fixed by the support configured to fix the fan.

BRIEF DESCRIPTION OF DRAWINGS

[0016]

FIG. 1 is an explanatory view of refrigerant circuits in a refrigeration apparatus according to an embodiment of the present disclosure.

FIG. 2 is an explanatory sectional plan view of a heat source-side unit in the refrigeration apparatus.

FIG. 3 is an explanatory sectional side view of the heat source-side unit in the refrigeration apparatus.

FIG. 4 is an explanatory sectional side view depicting a state where a second heat exchanger is supported in another embodiment.

FIG. 5 is a schematic view of a first heat exchanger in the refrigeration apparatus.

FIG. 6 is a schematic view of the second heat exchanger in the refrigeration apparatus.

FIG. 7 is a partial schematic sectional view depicting heat transfer tubes and fins constituting the second heat exchanger.

FIG. 8A is an explanatory view in an air flow direction, depicting a disposition relationship between a first heat exchanger and a second heat exchanger according to a first embodiment.

FIG. 8B is an explanatory view in an air flow direction, depicting a disposition relationship between a first heat exchanger and a second heat exchanger according to a second embodiment.

DETAILED DESCRIPTION

(Regarding entire configuration of refrigeration apparatus)

[0017] A refrigeration apparatus according to each of embodiments of the present disclosure will be described in detail hereinafter with reference to the accompanying drawings. FIG. 1 is an explanatory view of refrigerant circuits in a refrigeration apparatus according to an embodiment of the present disclosure. As depicted in FIG. 1, the present disclosure provides a refrigeration apparatus 10 including a heat source-side unit 11, a utilization-side unit 12, a refrigerant pipe 13 connecting the heat source-side unit 11 and the utilization-side unit 12, and a fan 15. The refrigeration apparatus 10 exemplified in the present embodiment is an air conditioner configured to condition air in a target space with use of the utilization-side unit 12. The refrigeration apparatus 10 is an air conditioner of a separate type separately including the heat source-side unit (outdoor unit) 11 and the utilization-side unit (indoor unit) 12. The present embodiment exemplifies the air conditioner as the refrigeration apparatus 10, although the refrigeration apparatus according to the present disclosure may be a refrigerated case or the like, without being limited to the air conditioner. The refrigerant pipe 13 includes a gate valve 18 disposed at each of portions entering and exiting a case of the heat source-side unit 11.

[0018] The heat source-side unit 11 includes a first compressor 21, a second compressor 22, a first heat exchanger 31, a second heat exchanger 32, a third heat

exchanger 33, a first expansion valve 41, a second expansion valve 42, a four-way switching valve 50, a first accumulator 51, and a second accumulator 52. The utilization-side unit 12 includes a utilization-side heat exchanger 34.

[0019] The refrigeration apparatus 10 includes a first refrigerant circuit RC1 including the first compressor 21, the first heat exchanger 31, the first expansion valve 41, the utilization-side heat exchanger 34, and the refrigerant pipe 13 connecting these devices, and a second refrigerant circuit RC2 including the second compressor 22, the second heat exchanger 32, the second expansion valve 42, and a refrigerant pipe 14 connecting these devices. The first refrigerant circuit RC1 uses a first refrigerant R1 as a refrigerant and is configured to execute refrigeration cycle operation. The second refrigerant circuit RC2 uses a second refrigerant R2 as a refrigerant different from the first refrigerant R1 and is configured to execute refrigeration cycle operation.

[0020] Each of the first compressor 21 and the second compressor 22 sucks a low-pressure gas refrigerant and discharges a high-pressure gas refrigerant. Each of the first compressor 21 and the second compressor 22 includes a motor (not depicted) having a number of operating revolutions adjustable through inverter control. Each of the first compressor 21 and the second compressor 22 is of a variable capacity type (capability variable type) having capacity (capability) variable through inverter control of the motor. Each of the first compressor 21 and the second compressor 22 may alternatively be of a constant capacity type.

[0021] The four-way switching valve 50 is configured to reverse a flow of the first refrigerant R1 in the refrigerant pipe 13 of the first refrigerant circuit RC1, and switchingly supply one of the first heat exchanger 31 and the utilization-side heat exchanger 34 with the first refrigerant R1 discharged from the first compressor 21. The refrigeration apparatus 10 is configured to switch between cooling operation and heating operation by switching a flow direction of the first refrigerant R1 with use of the four-way switching valve 50. The refrigeration apparatus 10 according to the present embodiment may alternatively include no four-way switching valve, and may be used exclusively for cooling.

[0022] The first expansion valve 41 is constituted by a motor valve configured to adjust a flow rate of the first refrigerant R1. During cooling operation, a control device (not depicted) included in the refrigeration apparatus 10 adjusts an opening degree of the first expansion valve 41 to adjust cooling capability exhibited by the first refrigerant circuit RC1. During heating operation, the control device (not depicted) in the refrigeration apparatus 10 maximizes the opening degree of the first expansion valve 41.

[0023] The second expansion valve 42 is constituted by a motor valve configured to adjust a flow rate of the second refrigerant R2. During cooling operation, the control device (not depicted) in the refrigeration apparatus

10 adjusts an opening degree of the second expansion valve 42 to adjust cooling capability exhibited by the second refrigerant circuit RC2.

[0024] The refrigeration apparatus 10 causes heat exchange between the first refrigerant R1 and the second refrigerant R2 in the third heat exchanger 33 to assist cooling capability of the first refrigerant circuit RC1 with cooling capability of the second refrigerant circuit RC2. During cooling operation, the control device (not depicted) in the refrigeration apparatus 10 adjusts the opening degree of the second expansion valve 42 to adjust heat exchange quantity between the first refrigerant R1 and the second refrigerant R2.

15 [Heat source-side unit]

[0025] FIG. 2 is an explanatory sectional plan view of the heat source-side unit in the refrigeration apparatus. FIG. 3 is an explanatory sectional side view of the heat source-side unit in the refrigeration apparatus. The following description includes expressions of up, down, front, rear, left, and right, which follow arrows indicated in FIG. 2 and FIG. 3. Specifically, FIG. 2, FIG. 3 and the like include arrows X, Y, and Z perpendicular to one another. The arrow X indicates a direction (first direction) assumed as a lateral direction, the arrow Y indicates a direction (second direction) assumed as an anteroposterior direction, and the arrow Z indicates a direction (third direction) assumed as a vertical direction. In the following description, the lateral direction will also be referred to as a first direction X, the anteroposterior direction will also be referred to as a second direction Y, and the vertical direction will also be referred to as a third direction Z. These expressions are merely exemplary. Alternatively, the direction X may be assumed as the anteroposterior direction, and the direction Y may be assumed as the lateral direction.

[0026] As depicted in FIG. 1 to FIG. 3, the heat source-side unit 11 includes a case 60. As depicted in FIG. 2 and FIG. 3, the case 60 has a rectangular parallelepiped shape, and has a rectangular shape in a planar view. The case 60 has an interior provided with a sectioning wall 61 zoning a machine chamber S1 and a heat exchange chamber S2. The case 60 includes two adjacent side walls 62 and 63 disposed at the heat exchange chamber S2 and provided with air intake ports 64 and 65, respectively. There is provided another side wall 66 that is disposed adjacent to the side wall 63 having the air intake port 65 and is provided with an air blow-out port 67.

[0027] The machine chamber S1 accommodates the first compressor 21, the second compressor 22, the third heat exchanger 33, the first accumulator 51, and the second accumulator 52. The machine chamber S1 further accommodates, in addition to the above, the four-way switching valve 50 (not depicted), the first expansion valve 41 (not depicted), the second expansion valve 42 (not depicted), an oil separator, and the like. The machine chamber S1 is provided with a control board (not

depicted) configured to control devices constituting the refrigeration apparatus 10.

[0028] The heat exchange chamber S2 accommodates the first heat exchanger 31, the second heat exchanger 32, the fan 15, and a fan motor 16. The fan 15 is connected to a shaft of the fan motor 16, and is rotationally driven by the fan motor 16.

[0029] The first heat exchanger 31 includes a heat transfer tube (a heat transfer tube 31a to be described later) in which the first refrigerant R1 circulating in the first refrigerant circuit RC1 flows. The first heat exchanger 31 is connected to the first compressor 21 in the machine chamber S1 via the refrigerant pipe 13 (see FIG. 1). The second heat exchanger 32 includes a heat transfer tube (a heat transfer tube 32a to be described later) in which the second refrigerant R2 circulating in the second refrigerant circuit RC2 flows. The second heat exchanger 32 is connected to the second compressor 22 in the machine chamber S1 via the refrigerant pipe 14 (see FIG. 1).

[0030] The fan 15 is disposed in a posture to cause a positive pressure surface to face the side wall 66 provided with the air blow-out port 67 and cause a negative pressure surface to face the side wall 62 provided with the air intake port 64. When the fan motor 16 is actuated, the fan 15 rotates to import air to the heat exchange chamber S2 via the air intake ports 64 and 65. The air imported to the heat exchange chamber S2 passes through the first heat exchanger 31 to exchange heat with the first refrigerant R1, then further passes through the second heat exchanger 32 to exchange heat with the second refrigerant R2, and is subsequently exhausted via the air blow-out port 67. The fan 15 generates an air flow passing through the first heat exchanger 31 and the second heat exchanger 32. The refrigerants passing through the first heat exchanger 31 and the second heat exchanger 32 exchange heat with the air passing through the first heat exchanger 31 and the second heat exchanger 32. As depicted in FIG. 1 to FIG. 3, the air flow generated by the fan 15 has a direction indicated by arrow F. In the following description, the direction of the air flow will be referred to as an air flow direction F.

[0031] The first heat exchanger 31 according to the present embodiment has an L shape in a planar view. The first heat exchanger 31 is bent near a corner 68 between the two side walls 62 and 63 provided with the air intake ports 64 and 65, and is disposed along the two side walls 62 and 63. The first heat exchanger 31 included in the refrigeration apparatus 10 according to the present disclosure is not limited to the above, and may alternatively have a rectangular shape or the like in a planar view.

[0032] The second heat exchanger 32 according to the present embodiment has a rectangular shape in a planar view. The second heat exchanger 32 extends along a portion of the first heat exchanger 31 along the side wall 62 and is disposed leeward of the first heat exchanger 31 in the air flow direction F. The second heat exchanger 32 included in the refrigeration apparatus 10 according to

the present disclosure is not limited to the above in terms of its shape.

[First heat exchanger]

[0033] FIG. 5 is a schematic view of a first heat exchanger in a refrigeration apparatus. As depicted in FIG. 5, the first heat exchanger 31 constituting the refrigeration apparatus 10 according to the present disclosure is a so-called fin-and-tube heat exchanger of a cross-fin type. The first heat exchanger 31 includes the heat transfer tube 31a, a plurality of fins 31b, and a pair of tube plates 31c and 31d. The first heat exchanger 31 causes heat exchange between the first refrigerant R1 in the first refrigerant circuit RC1 and air passing through the first heat exchanger 31.

[0034] The heat transfer tube 31a is a metal circular tube. Examples of the metal constituting the heat transfer tube 31a can include copper, a copper alloy, stainless steel, aluminum, and an aluminum alloy. Hereinafter, the heat transfer tube 31a will also be referred to as a circular tube 31a. The plurality of fins 31b is thin plates made of a metal, has an oblong shape in a side view, and is aligned parallel to each other at predetermined intervals in a width direction (the first direction X). Examples of the metal constituting the fins 31b can include aluminum and an aluminum alloy.

[0035] The circular tube (heat transfer tube) 31a includes a plurality of linear tube portions 31x having a linear shape and a plurality of curved tube portions 31y having a U shape. The linear tube portions 31x penetrate a large number of fins 31b in a direction (the first direction X) in which the fins 31b are aligned. The curved tube portions 31y are disposed at an end portion in a width direction (the first direction X) of the first heat exchanger 31, and each connect the two linear tube portions 31x adjacent to each other.

[0036] The tube plates 31c and 31d are metal boards, have an oblong shape in a side view, and are disposed to be paired on respective sides in the width direction (the first direction X) of the first heat exchanger 31. The tube plates 31c and 31d are connected to respective end portions of the linear tube portions 31x in the circular tube 31a to support the circular tube 31a. As depicted in FIG. 5, the tube plates 31c and 31d are disposed parallel to the fins 31b.

[Second heat exchanger]

[0037] FIG. 6 is a schematic view of a second heat exchanger in a refrigeration apparatus. FIG. 7 is a partial schematic sectional view depicting heat transfer tubes and fins constituting the second heat exchanger. The second heat exchanger 32 constituting the refrigeration apparatus 10 according to the present disclosure is a microchannel heat exchanger. As depicted in FIG. 6 and FIG. 7, the second heat exchanger 32 includes a plurality of heat transfer tubes 32a, a fin 32b, and a pair of headers

32c and 32d. The heat transfer tubes 32a, the fin 32b, and the headers 32c and 32d are made of aluminum or an aluminum alloy. The second heat exchanger 32 causes heat exchange between the second refrigerant R2 in the second refrigerant circuit RC2 and air passing through the second heat exchanger 32.

[0038] As depicted in FIG. 7, the heat transfer tubes 32a are constituted by multi-hole tubes each provided therein with a plurality of refrigerant flow paths 35. The heat transfer tubes 32a each have a section in a flat shape having a short direction and a longitudinal direction. The heat transfer tubes 32a have the longitudinal direction in which the plurality of refrigerant flow paths 35 is aligned. The plurality of refrigerant flow paths 35 is aligned in the air flow direction F. As depicted in FIG. 6 and FIG. 7, the plurality of refrigerant flow paths 35 is aligned in the second direction Y and extends in the first direction X. Hereinafter, the heat transfer tubes 32a will also be referred to as flat multi-hole tubes 32a.

[0039] As depicted in FIG. 6 and FIG. 7, the second heat exchanger 32 includes the plurality of heat transfer tubes 32a aligned in the third direction Z. The headers 32c and 32d are disposed to have longitudinal directions aligned to the third direction Z. Each of the heat transfer tubes 32a has a first end connected to the header 32c, and a second end connected to the header 32d. The fin 32b is disposed meanderingly between the heat transfer tubes 32a and 32a disposed vertically adjacent to each other. In the refrigeration apparatus 10 according to the present embodiment, the second heat exchanger 32 is not limited to the above in terms of its posture, and may be provided in a posture having the third direction Z aligned to the lateral direction.

[0040] As depicted in FIG. 7, the flat multi-hole tubes 32a each have end surfaces in the third direction Z, in other words, upper and lower surfaces that are even surfaces expanding in the first direction X and the second direction Y. Each of the flat multi-hole tubes 32a has respective end surfaces in the first direction X each having a section as a curved surface curved into a semicircular shape.

[0041] The fin 32b is substantially equal in length in the second direction Y to the flat multi-hole tubes 32a. Accordingly in the second heat exchanger 32, the flat multi-hole tubes 32a and the fin 32b are flush with each other in respective end surfaces in the second direction Y.

[0042] Typically, a heat transfer tube constituted by a flat multi-hole tube (the flat multi-hole tube 32a) is more likely to be damaged upon application of external force in comparison to a heat transfer tube constituted by a circular tube (the circular tube 31a). Application of external force to the flat multi-hole tube 32a is thus more likely to cause serious damage in comparison to application of external force to the circular tube 31a. Accordingly, the second heat exchanger 32 including the flat multi-hole tube 32a is more prioritized for protection and is preferably disposed at a location less likely to receive external force in comparison to the first heat exchanger

31 including the circular tube 31a.

[0043] The second heat exchanger 32 according to the present embodiment is a so-called parallel flow heat exchanger in microchannel heat exchangers. The heat transfer tubes constituting the second heat exchanger 32 are the flat multi-hole tubes 32a, and the fin 32b is disposed meanderingly between the flat multi-hole tubes adjacent to each other. The fin 32b is a so-called corrugate fin. When a cross-fin heat exchanger and a parallel flow heat exchanger equal in heat exchange quantity are compared with each other, the parallel flow heat exchanger is typically smaller in volume (internal holding liquid quantity) in the heat exchanger than the cross-fin heat exchanger. The refrigeration apparatus 10 adopting the parallel flow heat exchanger as the second heat exchanger 32 can therefore reduce used quantity of the second refrigerant R2 in comparison to the refrigeration apparatus adopting the cross-fin heat exchanger.

[Third heat exchanger]

[0044] The third heat exchanger 33 constituting the refrigeration apparatus 10 according to the present disclosure is a plate heat exchanger. As depicted in FIG. 1, the third heat exchanger 33 includes a first flow path 33a and a second flow path 33b provided between stacked plates. In the third heat exchanger 33, the first flow path 33a is connected to the first refrigerant circuit RC1, and the first refrigerant R1 flows to the first flow path 33a. In the third heat exchanger 33, the second flow path 33b is connected to the second refrigerant circuit RC2, and the second refrigerant R2 flows to the second flow path 33b. The third heat exchanger 33 causes heat exchange between the first refrigerant R1 flowing in the first flow path 33a and the second refrigerant R2 flowing in the second flow path 33b. The refrigeration apparatus 10 causes heat exchange between the first refrigerant R1 and the second refrigerant R2 with use of the third heat exchanger 33 to assist cooling capability of the first refrigerant circuit RC1 with cooling capability of the second refrigerant circuit RC2.

(Regarding first refrigerant and second refrigerant)

[0045] The refrigeration apparatus 10 according to the present disclosure is preferred to use natural refrigerants as the first refrigerant R1 and the second refrigerant R2. A natural refrigerant includes a substance originally existing in nature, and examples thereof include ammonia (NH₃), carbon dioxide (CO₂), water (H₂O), and hydrocarbon (HC). The refrigeration apparatus 10 according to the present embodiment uses carbon dioxide (CO₂: R744) as the first refrigerant R1, and propane (C₃H₈: R290) as the second refrigerant R2. Carbon dioxide (CO₂) has a global warming potential (GWP) of "1", and propane (C₃H₈) has a global warming potential (GWP) of "3". The first refrigerant R1 used in the refrigeration apparatus according to the present disclosure is

not limited to carbon dioxide (CO₂), and the second refrigerant R2 used in the refrigeration apparatus according to the present disclosure is not limited to propane (C₃H₈). The first refrigerant R1 and the second refrigerant R2 used in the refrigeration apparatus according to the present disclosure may be R32, R1234yf, R474a, R600a (isobutane), R454B, R454C, or the like.

(Regarding disposition of first heat exchanger and second heat exchanger)

[0046] As depicted in FIG. 1 to FIG. 3, the second heat exchanger 32 in the refrigeration apparatus 10 is disposed leeward of the first heat exchanger 31 in the air flow direction F of the air flow generated by the fan 15.

[0047] When the second heat exchanger 32 is disposed leeward of the first heat exchanger 31 in the air flow direction F in the heat source-side unit 11, the first heat exchanger 31 is disposed outside the second heat exchanger 32. If some external force is applied to the heat source-side unit 11 thus configured during conveyance or the like, the external force is mainly applied not to the second heat exchanger 32 but to the first heat exchanger 31 disposed outside. When external force is applied to the heat source-side unit 11 including the first heat exchanger 31 and the second heat exchanger 32, the external force is less likely to be applied directly to the second heat exchanger 32. The refrigeration apparatus 10 can thus reduce risk of damage to the second heat exchanger 32.

(Disposition relationship according to first embodiment)

[0048] FIG. 8A is an explanatory view in an air flow direction, depicting a disposition relationship between a first heat exchanger and a second heat exchanger according to the first embodiment. In the refrigeration apparatus 10 according to the first embodiment, the first heat exchanger 31 may include a first region A1 overlapped with the second heat exchanger 32 when viewed in the air flow direction F, and a second region A2 not overlapped with the second heat exchanger 32 when viewed in the air flow direction F. In this description, a region indicating the first heat exchanger 31 corresponds to a region between the pair of tube plates 31c and 31d (see FIG. 5), and a region indicating the second heat exchanger 32 corresponds to a region between the pair of headers 32c and 32d (see FIG. 6).

[0049] In a case where outer shapes of the two heat exchangers 31 and 32 are dimensionally different from each other and misaligned when viewed in the air flow direction F as depicted in FIG. 8A, the two heat exchangers 31 and 32 are difficult to be supported by a common support, and a support for the second heat exchanger 32 needs to be prepared separately from a support for the first heat exchanger 31.

[0050] In the refrigeration apparatus 10 according to the present embodiment, the second heat exchanger 32

is disposed leeward of the first heat exchanger 31 in the air flow direction F, and the second heat exchanger 32 can thus be supported by a support 70 (see FIG. 2 and FIG. 3) for the fan 15. Specifically, as depicted in FIG. 3, the second heat exchanger 32 has a lower portion supported by a first stay 71 provided at a lower portion of the support 70. Alternatively as depicted in FIG. 4, the second heat exchanger 32 has an upper portion that may be further supported by a second stay 72 provided at a vertically intermediate portion of the support 70. Accordingly, even if the first heat exchanger 31 includes the first region A1 overlapped with the second heat exchanger 32 and the second region A2 not overlapped with the second heat exchanger 32 when viewed in the air flow direction F, the second heat exchanger 32 can be supported by the support 70 without separate provision of any support for the second heat exchanger 32 in the refrigeration apparatus 10 according to the present embodiment.

(Disposition relationship according to second embodiment)

[0051] FIG. 8B is an explanatory view in an air flow direction, depicting a disposition relationship between a first heat exchanger and a second heat exchanger according to the second embodiment. In the refrigeration apparatus 10 according to the second embodiment, when the first heat exchanger 31 and the second heat exchanger 32 are viewed in the air flow direction F, an area Sa4 of a fourth region A4 zoned by the outer shape of the second heat exchanger 32 may be smaller than an area Sa3 of a third region A3 zoned by the outer shape of the first heat exchanger 31 (Sa3 > Sa4), and the third region A3 may include the fourth region A4.

[0052] When the outer shapes of the two heat exchangers 31 and 32 are dimensionally different from each other as depicted in FIG. 8B, the first heat exchanger 31 dimensionally larger in outer shape can be easily supported by the case 60 accommodating the first heat exchanger 31. Meanwhile, the second heat exchanger 32 dimensionally smaller in outer shape is difficult to be supported by the case 60, and a support for the second heat exchanger 32 needs to be prepared separately from the support for the first heat exchanger 31.

[0053] In the refrigeration apparatus 10 according to the present embodiment, the second heat exchanger 32 is disposed leeward of the first heat exchanger 31 in the air flow direction F, and the second heat exchanger 32 can thus be supported by a support 70 (see FIG. 2 and FIG. 3) for the fan 15. Accordingly, even if the second heat exchanger 32 is dimensionally smaller in outer shape than the first heat exchanger 31 and the second heat exchanger 32 is accommodated in the outer shape of the first heat exchanger 31 when viewed in the air flow direction F, the second heat exchanger 32 can be supported by the support 70 without separate provision of any support for the second heat exchanger 32 in the refrigeration apparatus 10 according to the present em-

bodiment.

[Functional effects of embodiments]

[0054]

(1) The refrigeration apparatus 10 according to the embodiment described above includes the first refrigerant circuit RC1 having the first compressor 21, the first heat exchanger 31, the first expansion valve 41, and the utilization-side heat exchanger 34, and using the first refrigerant R1, the second refrigerant circuit RC2 having the second compressor 22, the second heat exchanger 32, and the second expansion valve 42, and using the second refrigerant R2, the third heat exchanger 33 configured to cause heat exchange between the first refrigerant R1 and the second refrigerant R2, and the fan 15. In the refrigeration apparatus 10, the heat transfer tube constituting the first heat exchanger 31 is the circular tube 31a, and the heat transfer tube constituting the second heat exchanger 32 is the flat multi-hole tube 32a. The second heat exchanger 32 in the refrigeration apparatus 10 is disposed leeward of the first heat exchanger 31 in the air flow direction F of the air flow generated by the fan 15.

[0055] The refrigeration apparatus 10 according to the above embodiment includes the first heat exchanger 31 having the circular tube 31a as a heat transfer tube, and the second heat exchanger 32 including the flat multi-hole tube 32a as a heat transfer tube. The flat multi-hole tube 32a is weaker against external force than the circular tube 31a. In the refrigeration apparatus 10 according to the above embodiment, the first heat exchanger 31 is disposed windward of the second heat exchanger 32 in the air flow direction F, to dispose the first heat exchanger 31 outside the second heat exchanger 32 in the heat source-side unit 11. In the refrigeration apparatus 10 according to the above embodiment, the first heat exchanger 31 including the circular tube 31a is disposed windward of the second heat exchanger 32 including the flat multi-hole tube 32a in the air flow direction F, so as to reduce risk of damage to the second heat exchanger 32 including the flat multi-hole tube 32a weak against external force when the external force is applied to the heat source-side unit 11 including the first heat exchanger 31 and the second heat exchanger 32.

[0056] (2) In the refrigeration apparatus 10 according to the above embodiment, the second heat exchanger 32 is constituted by a heat exchanger (the so-called parallel flow heat exchanger) including the plurality of flat multi-hole tubes 32a and the fin 32b meanderingly disposed between the flat multi-hole tubes 32a and 32a adjacent to each other.

[0057] In the second heat exchanger 32 according to the above embodiment, the flat multi-hole tubes 32a and the fin 32b are flush with each other and the flat multi-hole

tubes 32a are thus not protected by the fin 32b. Accordingly, external force is likely to be applied directly to the flat multi-hole tubes 32a to damage the flat multi-hole tubes 32a in the second heat exchanger 32 configured as described above. The refrigeration apparatus 10 according to the above embodiment can reduce risk of damage to the flat multi-hole tubes 32a when the second heat exchanger 32 is constituted by the parallel flow heat exchanger. The refrigeration apparatus 10 according to the above embodiment can reduce used quantity of the second refrigerant R2 when the second heat exchanger 32 is constituted by the parallel flow heat exchanger.

[0058] (3) In the refrigeration apparatus 10 according to the above embodiment, the fan 15 is disposed leeward of the second heat exchanger 32 in the air flow direction F, and the second heat exchanger 32 is fixed to the support 70 supporting the fan 15.

[0059] In this manner, the refrigeration apparatus 10 according to the above embodiment can fix the second heat exchanger 32 with use of the support 70 configured to fix the fan 15.

[0060] (4) In the refrigeration apparatus 10 according to the above embodiment, the first heat exchanger 31 includes the first region A1 overlapped with the second heat exchanger 32 and the second region A2 not overlapped with the second heat exchanger 32 when viewed in the air flow direction F (see FIG. 8A).

[0061] In a case where there are provided the first heat exchanger 31 and the second heat exchanger 32 and the outer shapes of the heat exchangers 31 and 32 are dimensionally equal and positionally identical when viewed in the air flow direction F, the two heat exchangers 31 and 32 can be easily supported by a common support. In another case where the outer shapes of the two heat exchangers 31 and 32 are dimensionally different from each other and misaligned when viewed in the air flow direction F as depicted in FIG. 8A, the two heat exchangers 31 and 32 are difficult to be supported by a common support. Even if the first heat exchanger 31 includes the first region A1 overlapped with the second heat exchanger 32 and the second region A2 not overlapped with the second heat exchanger 32 when viewed in the air flow direction F, the refrigeration apparatus 10 according to the above embodiment can fix the second heat exchanger 32 with use of the support 70 configured to fix the fan 15.

[0062] (5) In the refrigeration apparatus 10 according to the above embodiment, when the first heat exchanger 31 and the second heat exchanger 32 are viewed in the air flow direction F, the area Sa4 of the fourth region A4 zoned by the outer shape of the second heat exchanger 32 is smaller than the area Sa3 of the third region A3 zoned by the outer shape of the first heat exchanger 31, and the third region A3 includes the fourth region A4 (see FIG. 8B).

[0063] In a case where there are provided the first heat exchanger 31 and the second heat exchanger 32 and the outer shapes of the heat exchangers 31 and 32 are

dimensionally equal to each other, the two heat exchangers 31 and 32 can be easily supported by a common support. In another case where the outer shapes of the two heat exchangers 31 and 32 are dimensionally different from each other as depicted in FIG. 8B, the first heat exchanger 31 dimensionally larger can be easily supported by the case 60 accommodating the first heat exchanger 31, but the second heat exchanger 32 dimensionally smaller is difficult to be supported by the case 60. In the refrigeration apparatus 10 according to the above embodiment, even if the second heat exchanger 32 is dimensionally smaller in outer shape than the first heat exchanger 31 when viewed in the air flow direction F and the outer shape of the first heat exchanger 31 accommodates the second heat exchanger 32, the second heat exchanger 32 can be fixed by the support 70 configured to fix the fan 15.

[0064] While various embodiments have been described herein above, it is to be appreciated that various changes in form and detail may be made without departing from the spirit and scope presently or hereafter claimed.

REFERENCE SIGNS LIST

[0065]

10	refrigeration apparatus	
15	fan	
21	first compressor	
22	second compressor	
31	first heat exchanger	
31a	circular tube	
32	second heat exchanger	
32a	flat multi-hole tube	
32b	fin	
33	third heat exchanger	
34	utilization-side heat exchanger	
41	first expansion valve	
42	second expansion valve	
70	support	
R1	first refrigerant	
R2	second refrigerant	
RC1	first refrigerant circuit	
RC2	second refrigerant circuit	
F	air flow direction	

Claims

1. A refrigeration apparatus (10) comprising:
 - a first refrigerant circuit (RC1) including a first compressor (21), a first heat exchanger (31), a first expansion valve (41), and a utilization-side heat exchanger (34), and using a first refrigerant (R1);
 - a second refrigerant circuit (RC2) including a second compressor (22), a second heat ex-

changer (32), and a second expansion valve (42), and using a second refrigerant (R2); a third heat exchanger (33) configured to cause heat exchange between the first refrigerant (R1) and the second refrigerant (R2); and a fan (15), wherein the first heat exchanger (31) includes a heat transfer tube being a circular tube (31a), the second heat exchanger (32) includes a heat transfer tube being a flat multi-hole tube (32a), and the second heat exchanger (32) is disposed leeward of the first heat exchanger (31) in an air flow direction (F) of an air flow generated by the fan (15).

2. The refrigeration apparatus (10) according to claim 1, wherein the second heat exchanger (32) is constituted by a heat exchanger including a plurality of the flat multi-hole tubes (32a), and a fin (32b) meanderingly disposed between the flat multi-hole tubes (32a) adjacent to each other.
3. The refrigeration apparatus (10) according to claim 1 or 2, wherein
 - the fan (15) is disposed leeward of the second heat exchanger (32) in the air flow direction (F), and
 - the second heat exchanger (32) is fixed to a support (70) configured to support the fan (15).
4. The refrigeration apparatus (10) according to claim 3, wherein the first heat exchanger (31) includes a first region (A1) overlapped with the second heat exchanger (32) when viewed in the air flow direction (F), and a second region (A2) not overlapped with the second heat exchanger (32) when viewed in the air flow direction (F).
5. The refrigeration apparatus (10) according to claim 3, wherein, when the first heat exchanger (31) and the second heat exchanger (32) are viewed in the air flow direction (F), an area (Sa4) of a fourth region (A4) zoned by an outer shape of the second heat exchanger (32) is smaller than an area (Sa3) of a third region (A3) zoned by an outer shape of the first heat exchanger (31), and the third region (A3) includes the fourth region (A4).

FIG. 1

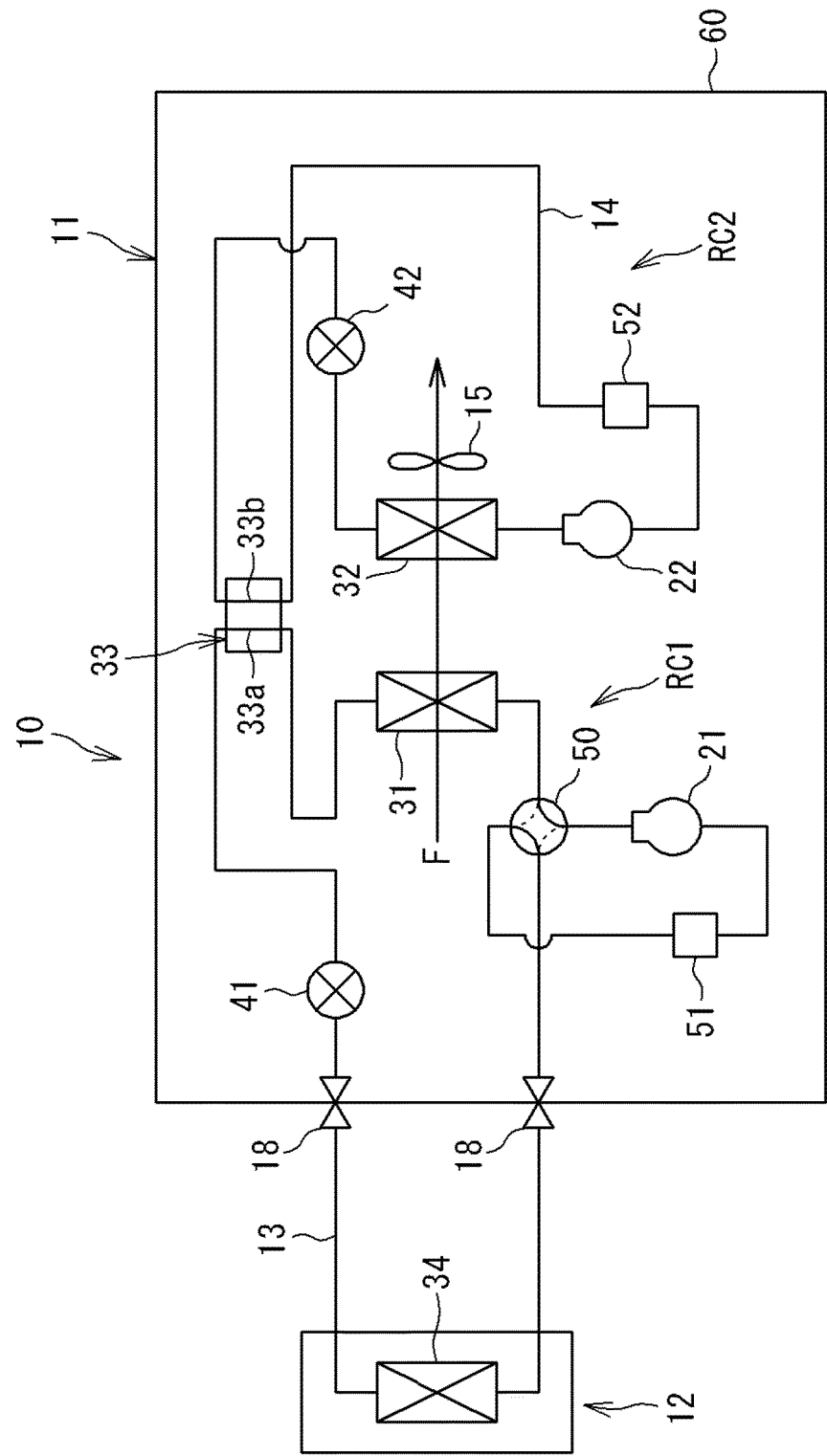


FIG. 2

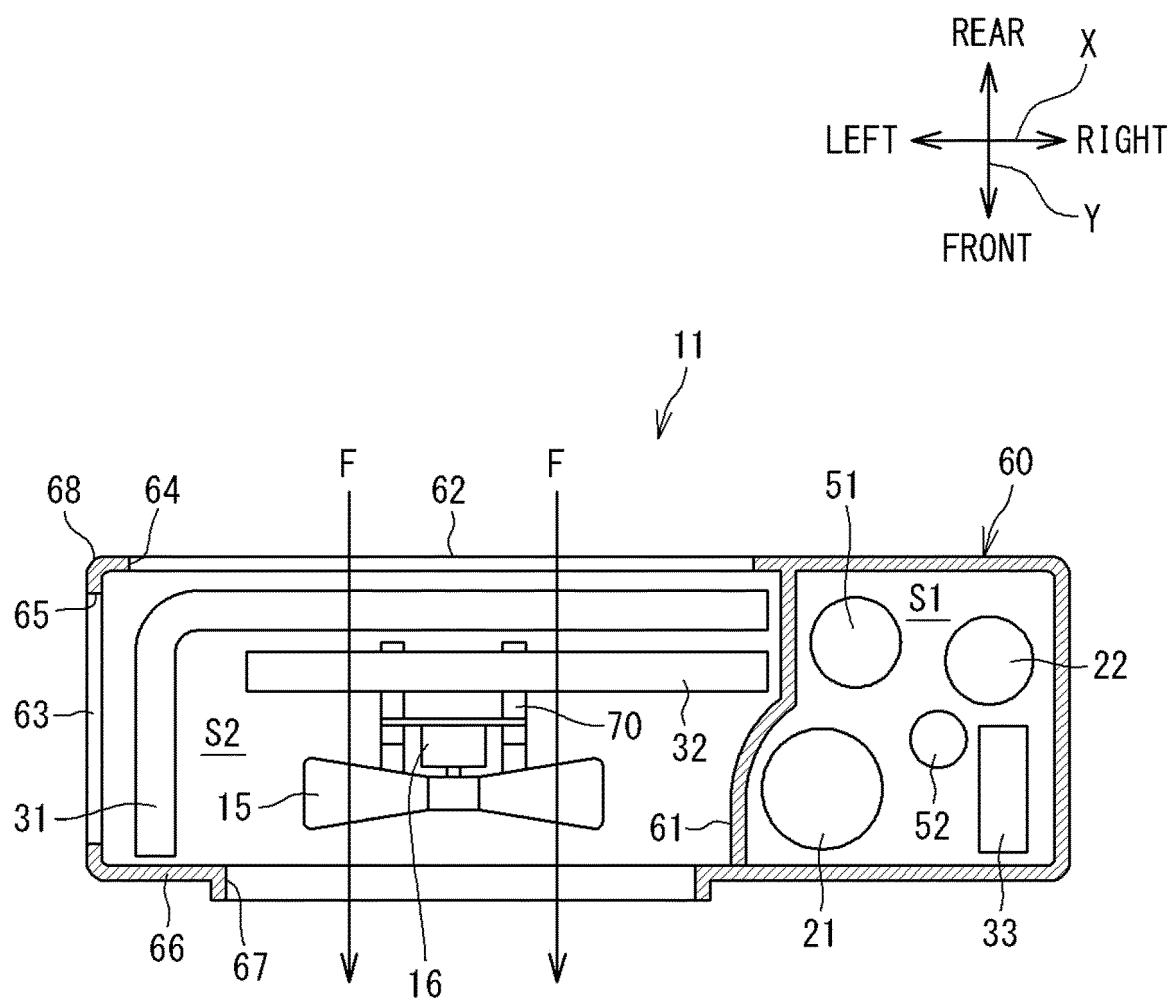


FIG. 3

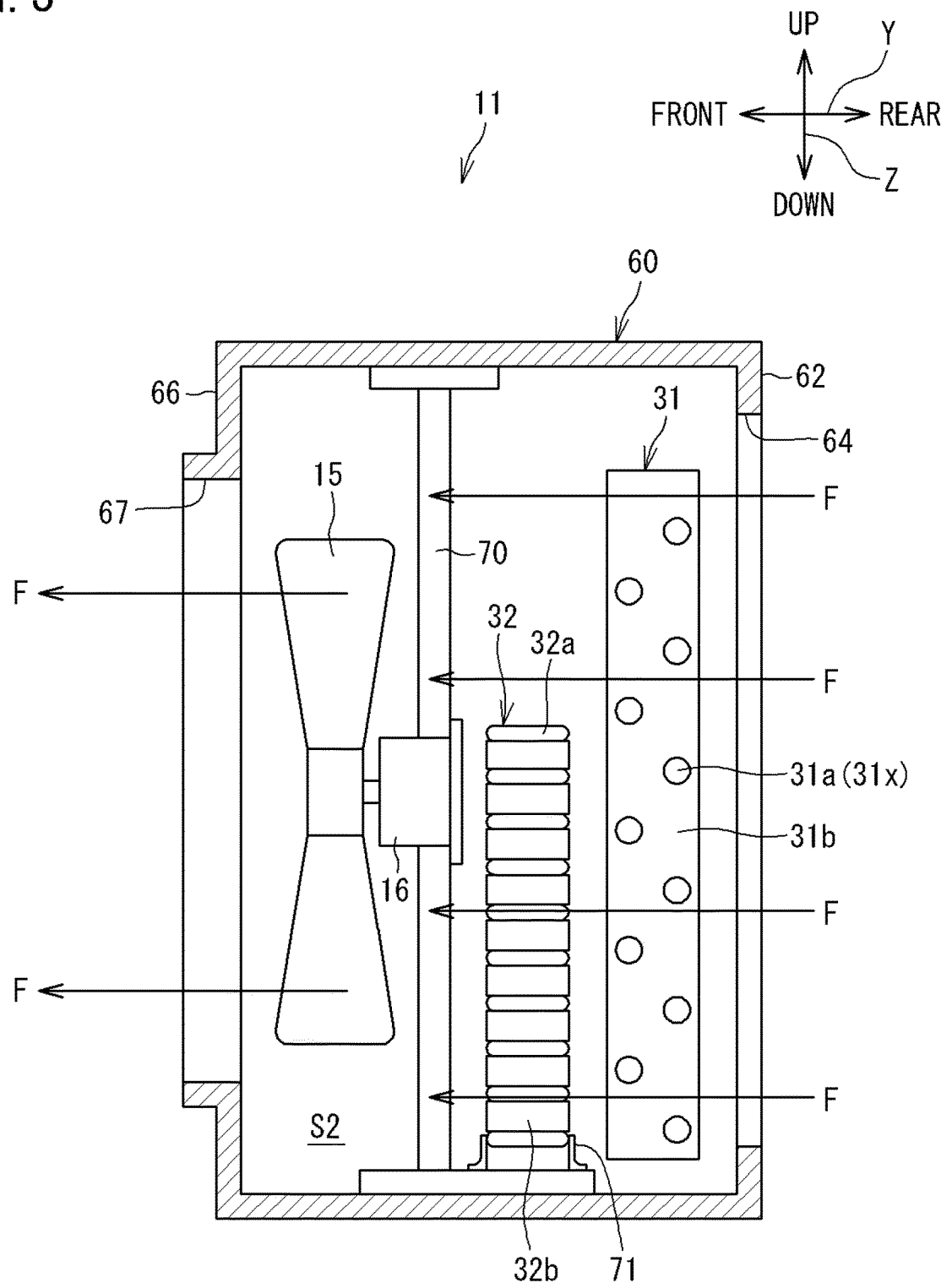


FIG. 4

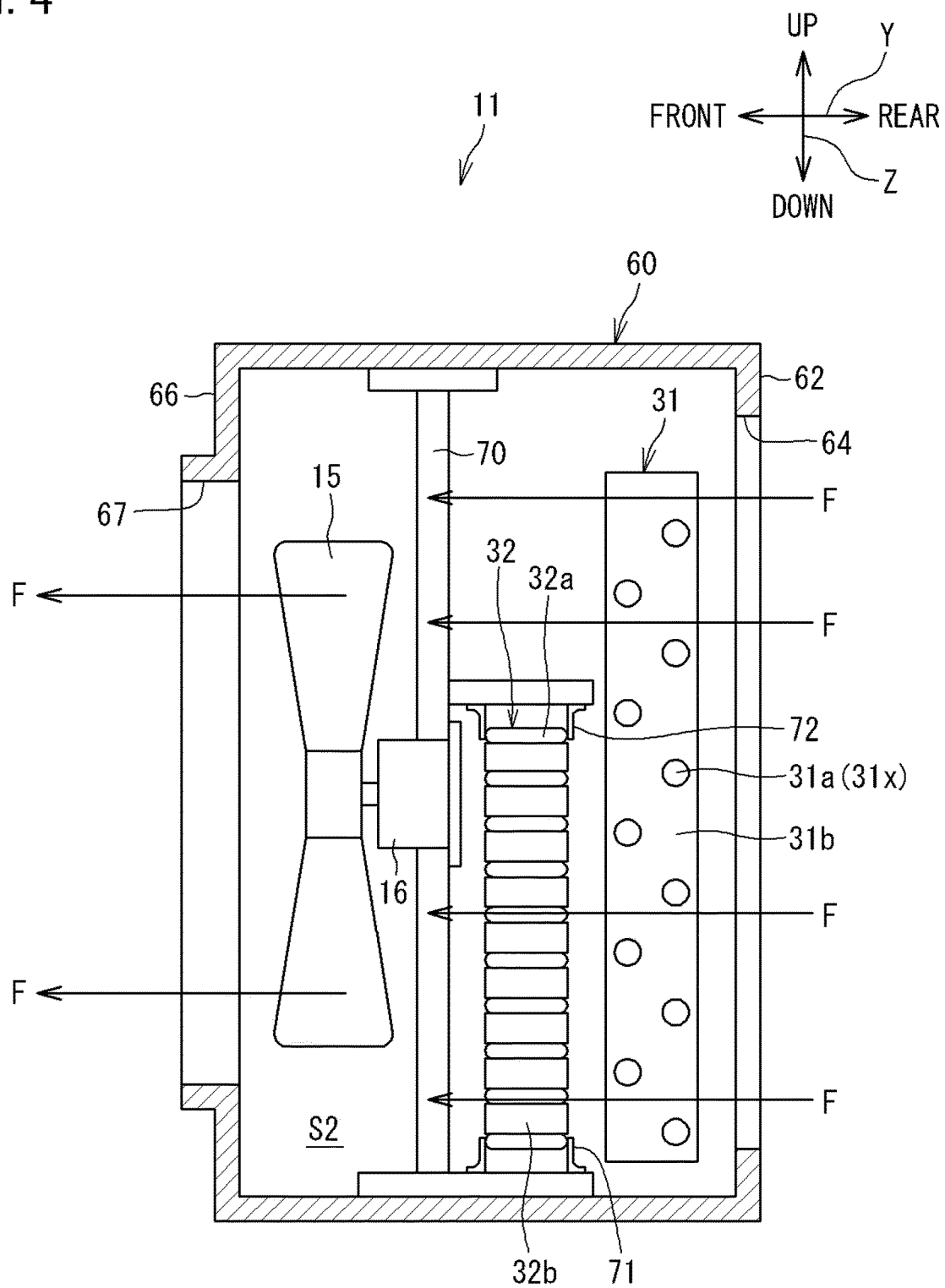


FIG. 5

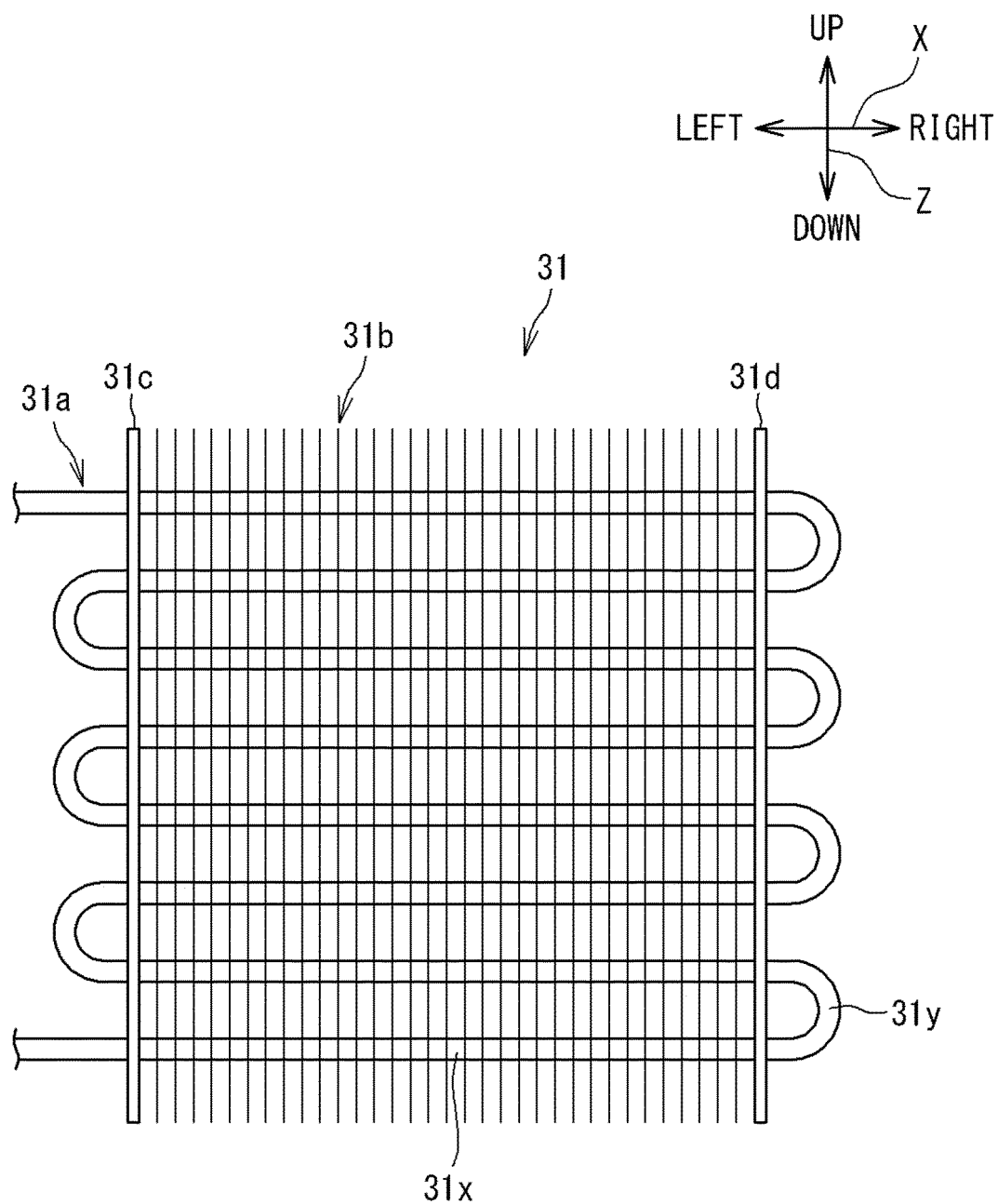


FIG. 6

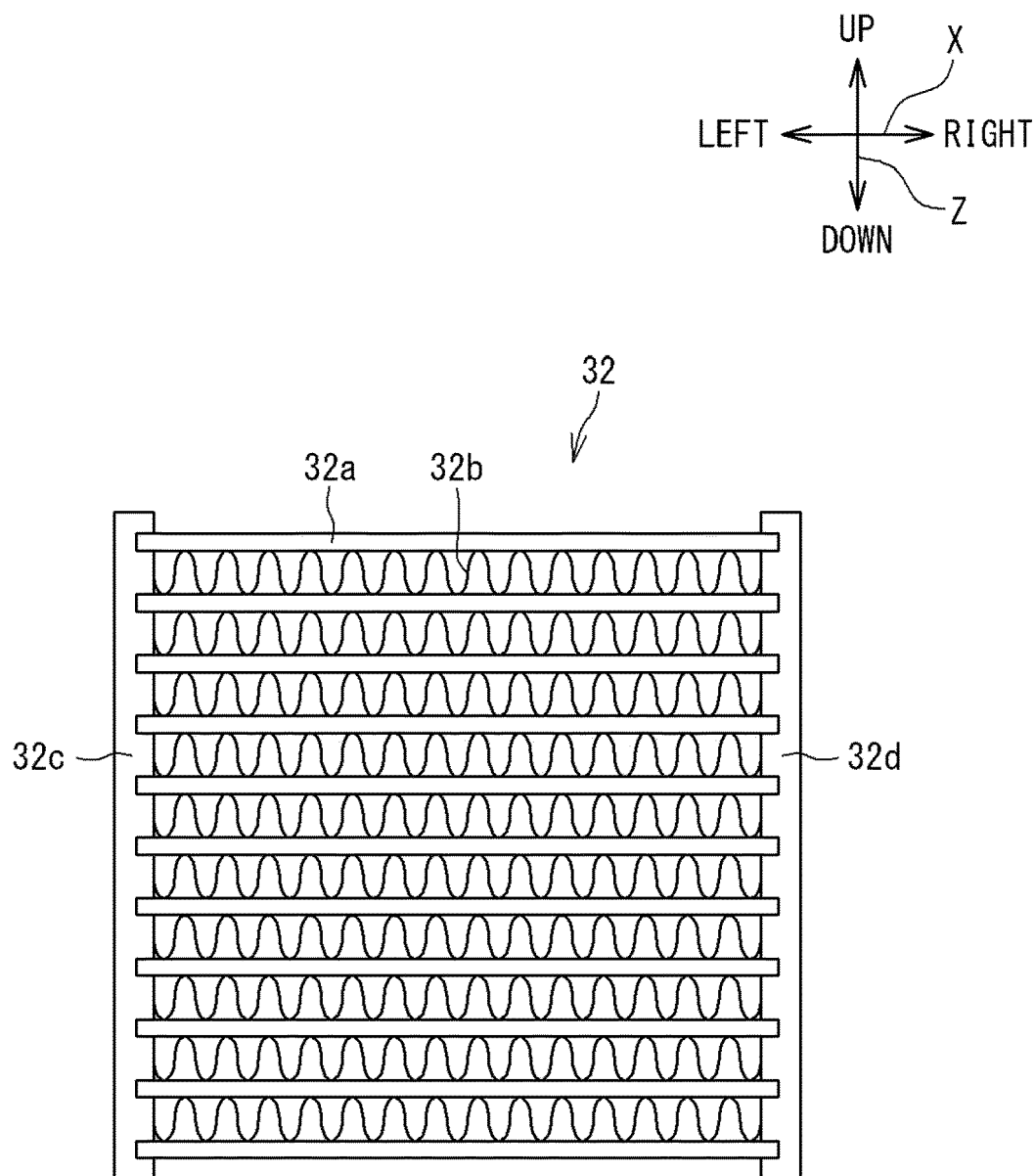


FIG. 7

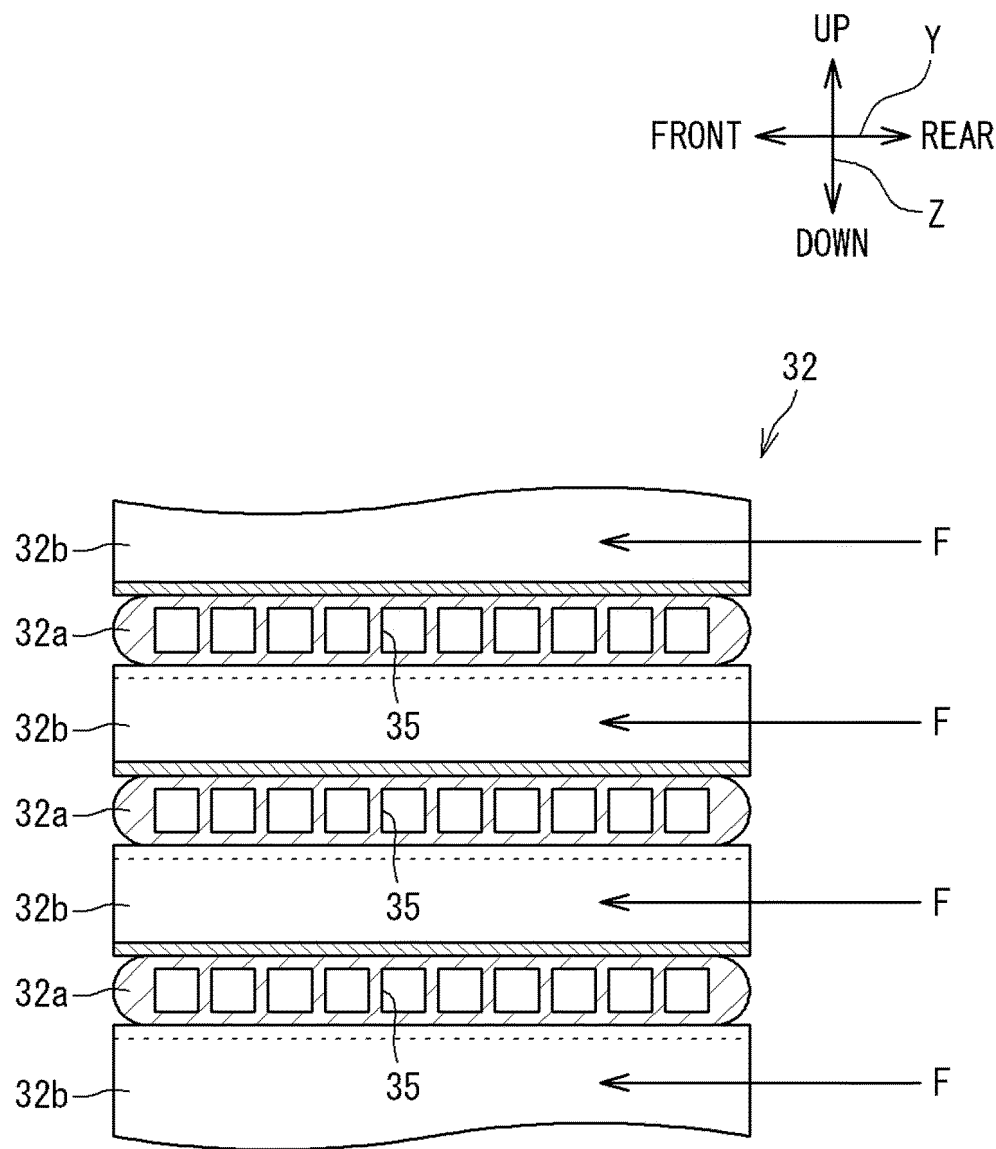


FIG. 8A

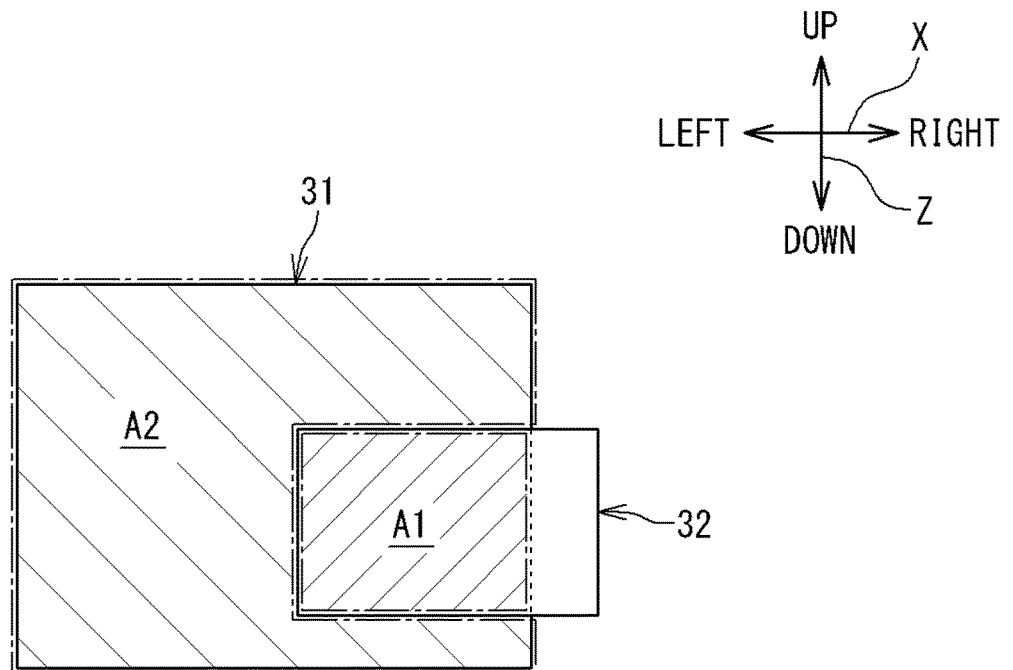
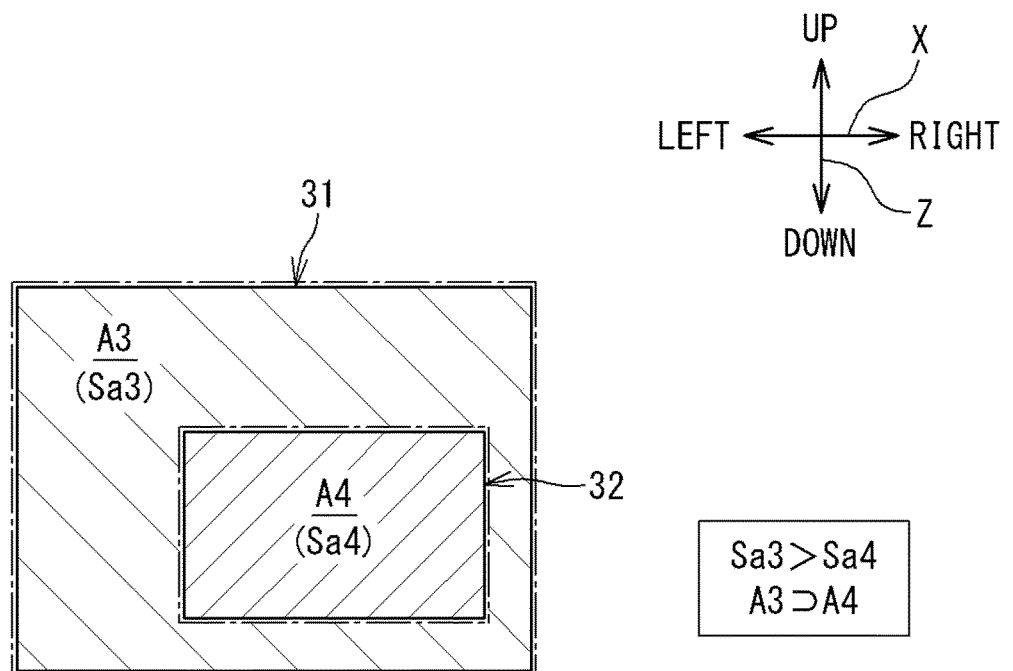


FIG. 8B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/021170

A. CLASSIFICATION OF SUBJECT MATTER

F25B 7/00(2006.01); *F25B 39/00*(2006.01);
FI: F25B7/00 Z; F25B39/00 C; F25B39/00 D

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B1/00; F25B7/00; F25B39/00-39/04

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.
A	WO 2022/013976 A1 (MITSUBISHI ELECTRIC CORPORATION) 20 January 2022 (2022-01-20) paragraph [0013], fig. 1, 4, 7-8	1-5
A	WO 2014/181399 A1 (MITSUBISHI ELECTRIC CORPORATION) 13 November 2014 (2014-11-13) paragraphs [0023]-[0024], fig. 10-11	1-5
A	US 2015/0338145 A1 (LG ELECTRONICS INC.) 26 November 2015 (2015-11-26) fig. 1-3	1-5
A	JP 2008-261517 A (MITSUBISHI ELECTRIC CORPORATION) 30 October 2008 (2008-10-30) fig. 1	1-5
A	WO 2019/077744 A1 (MITSUBISHI ELECTRIC CORPORATION) 25 April 2019 (2019-04-25) fig. 1-2, 4	1-5

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

06 August 2024

Date of mailing of the international search report

20 August 2024

Name and mailing address of the ISA/JP

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Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/021170

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012-017915 A (PANASONIC CORPORATION) 26 January 2012 (2012-01-26) fig. 1	1–5

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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JP	2008-261517	A	30 October 2008	(Family: none)	
WO	2019/077744	A1	25 April 2019	US 2020/0224891 A1 fig. 1-2, 4 EP 3699502 A1 CN 111213010 A	
JP	2012-017915	A	26 January 2012	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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