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(54) **HEAT EXCHANGER AND REFRIGERATION DEVICE**

(57) A heat exchanger and a refrigeration apparatus capable of integrating a liquid header portion and a gas header portion are provided. The heat exchanger includes a plurality of flat tubes (28) arranged in the up-down direction, and an inlet/outlet header (40) to which the flat tubes (28) are connected. The inlet/outlet header (40) includes a gas header portion (50) and a liquid header portion (60) arranged in the up-down direction. The inlet/outlet header (40) includes: one or a plurality of gas members including a gas space-forming member (51); one or a plurality of liquid members including a first liquid member (61), a second liquid member (62), a third

liquid member (63), a fourth liquid member (64), and a fifth liquid member (65); and a first common member (41) extending over the gas header portion (50) and the liquid header portion (60). The first common member (41) and the gas space-forming member (51) form the gas header portion (50). The first common member (41) and the liquid members (61 to 65) form the liquid header portion (60). The first common member (41) integrates a first predetermined number of gas members and a second predetermined number of liquid members, the second predetermined number being different from the first predetermined number.

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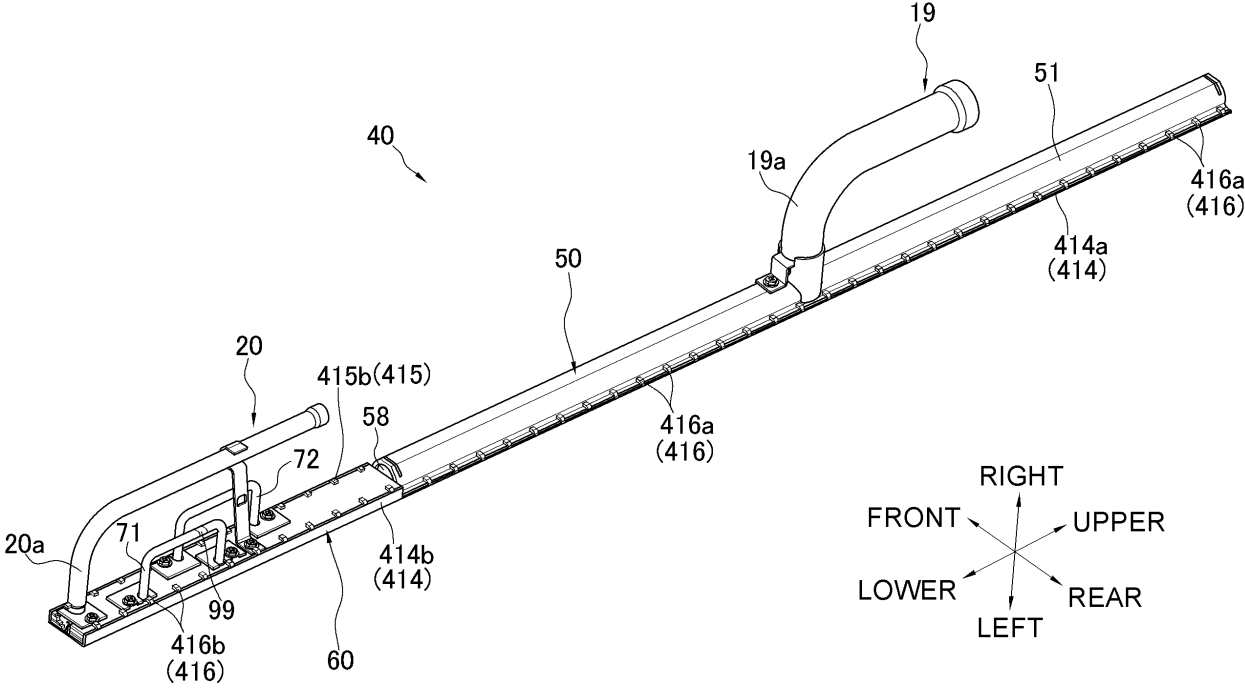


FIG. 6

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a heat exchanger and a refrigeration apparatus.

BACKGROUND ART

[0002] Conventionally, a heat exchanger has been proposed in which a header is configured by stacking a plurality of plate-shaped members, as described PTL 1 (Japanese Unexamined Patent Application Publication No. 2022-043207), for example.

SUMMARY OF INVENTION

<Technical Problem>

[0003] In one such heat exchanger, a gas header through which refrigerant in a gaseous state flows and a liquid header through which refrigerant in a liquid state or a gas-liquid two- phase state flows are provided in a direction in which flat tubes are arranged. Here, the functions required of the gas header and the liquid header are different because the states of the refrigerant that flows are different between them. Thus, the number of members constituting the gas header and the number of members constituting the liquid header may be different from each other. When the number of the members constituting the gas header is thus different from the number of the members constituting the liquid header, the gas header and the liquid header cannot be easily integrated.

<Solution to Problem>

[0004] A heat exchanger according to a first aspect includes a plurality of flat tubes and a header. The plurality of flat tubes are arranged in a first direction. The flat tubes are connected to the header. The header includes a gas header portion and a liquid header portion. The gas header portion and the liquid header portion are arranged in the first direction. The header includes one or more gas members, one or more liquid members, and a first member. The first member extends over the gas header portion and the liquid header portion. The first member and the gas member form a gas header portion. The first member and the liquid member form a liquid header portion. The first member integrates a first predetermined number of gas members and a second predetermined number of liquid members, the second predetermined number being different from the first predetermined number.

[0005] In this heat exchanger, even when the number of gas members and the number of liquid members are different from each other, the gas member and the liquid member can be integrated by the first member.

[0006] A heat exchanger according to a second aspect is the heat exchanger of the first aspect, wherein the first member and the gas member are disposed stacked in a second direction. The second direction is a direction in which the flat tubes extend. The first member and the liquid member are disposed stacked in the second direction.

[0007] In this heat exchanger, the gas header portion and the liquid header portion can be provided in the second direction with respect to the flat tubes.

[0008] A heat exchanger according to a third aspect is the heat exchanger of the second aspect, wherein the header further includes one or more intermediate members. The intermediate member extends between the first member and the gas member and between the first member and the liquid member.

[0009] In this heat exchanger, a part of the gas header portion can be constituted by a part of the intermediate member, and a part of the liquid header portion can be constituted by another part of the intermediate member.

[0010] A heat exchanger according to a fourth aspect is the heat exchanger of the third aspect, wherein the first member integrates the gas member, the liquid member, and the intermediate member.

[0011] In this heat exchanger, even when the number of gas members and the number of liquid members are different from each other, the gas member, the liquid member, and the intermediate member can be integrated by the first member.

[0012] A heat exchanger according to a fifth aspect is the heat exchanger of the third aspect or the fourth aspect, wherein the one or more intermediate members include a second member. The second member has a plurality of first openings. When viewed in the second direction, the contour of the first opening has a portion overlapping the contour of the flat tubes.

[0013] In this heat exchanger, when the flat tubes are inserted into the header, the flat tubes cannot pass through the first opening, and therefore the insertion position of the flat tubes can be defined.

[0014] A heat exchanger according to a sixth aspect is the heat exchanger of the fifth aspect, wherein the one or more intermediate members further include a third member. The third member is stacked between the first member and the second member in the second direction. The third member has a plurality of second openings. When viewed in the second direction, the contour of the second opening is positioned outside the contour of the flat tubes.

[0015] In this heat exchanger, when the flat tubes are inserted into the header, the flat tubes can be passed through the second opening.

[0016] A heat exchanger according to a seventh aspect is the heat exchanger of any of the second aspect to the sixth aspect, wherein the first member has a first part, a pair of first clamping portions, and a pair of second clamping portions. The first part is a part extending in a plane orthogonal to the second direction. The pair of first clamping portions extends from the first part in the sec-

ond direction. The pair of second clamping portions extends from the first part in the second direction. When a direction intersecting both the first direction and the second direction is defined as a third direction, the first clamping portions clamp the first predetermined number of gas members in the third direction. The second clamping portions clamp the second predetermined number of liquid members in the third direction. The length of the first clamping portions in the second direction is different from the length of the second clamping portions in the second direction.

[0017] In this heat exchanger, even when the number of gas members and the number of liquid members are different from each other, the first member has a shape corresponding to the length of the first predetermined number of gas members in the second direction and the length of the second predetermined number of liquid members in the second direction. Therefore, the gas members and the liquid members are easily integrated.

[0018] A heat exchanger according to an eighth aspect is the heat exchanger of the seventh aspect, wherein the first clamping portions have a first crimping portion at an end portion on the side opposite to the first part side in the second direction. The second clamping portions have a second crimping portion at an end portion on the side opposite to the first part side in the second direction.

[0019] In this heat exchanger, the gas member and the liquid member can be crimped and integrated by the first crimping portion and the second crimping portion.

[0020] A heat exchanger according to a ninth aspect is the heat exchanger of any of the second aspect to the eighth aspect, wherein the gas member includes a gas space-forming member. The gas space-forming member includes a protruding portion that protrudes toward a side away from the connection part between the flat tubes and the first member in the second direction when viewed in the first direction.

[0021] In this heat exchanger, by using the gas space-forming member having the protruding portion, it is easy to ensure a space in which the gas refrigerant flows.

[0022] A heat exchanger according to a tenth aspect is the heat exchanger of the eighth aspect, wherein the gas member includes a gas space-forming member. The gas space-forming member includes a protruding portion that protrudes toward a side away from the connection part between the flat tubes and the first member in the second direction when viewed in the first direction. The gas space-forming member has a flat part extending in a plane orthogonal to the second direction. The flat part is crimped by the first crimping portion and the second crimping portion.

[0023] In this heat exchanger, by using the gas space-forming member having the protruding portion, it is easy to ensure a space in which the gas refrigerant flows. Further, by stacking the flat part of the gas space-forming member on another gas member, it is possible to increase the mutual fixing strength when crimped by the first crimping portion and the second crimping portion.

[0024] A heat exchanger according to an eleventh aspect is the heat exchanger of any of the first aspect to the tenth aspect, wherein the gas member and the liquid member include a plate-shaped part.

[0025] In this heat exchanger, the gas member and the liquid member are easily stacked on the first member.

[0026] A heat exchanger according to a twelfth aspect is the heat exchanger of any of the first aspect to the eleventh aspects, further comprising a return header. The return header is connected to an end portion of the flat tubes on the side opposite to the end portion on the side of the gas header portion and the liquid header portion side. The return header guides the refrigerant that has passed through the gas header portion to the liquid header portion side, or guides the refrigerant that has passed through the liquid header portion to the gas header portion side.

[0027] In this heat exchanger, the refrigerant can be turned back and caused to flow in the return header.

[0028] A refrigeration apparatus according to a thirteenth aspect includes the heat exchanger according to any one of the first aspect to the twelfth aspects.

[0029] This refrigeration apparatus can perform a refrigeration cycle using the heat exchanger in which the gas member and the liquid member are integrated by the first member.

BRIEF DESCRIPTION OF DRAWINGS

[0030]

[Fig. 1] Fig. 1 is a schematic configuration diagram of an air-conditioning apparatus.

[Fig. 2] Fig. 2 is a schematic perspective view of an outdoor heat exchanger.

[Fig. 3] Fig. 3 is a partially enlarged view of a heat exchange portion of the outdoor heat exchanger.

[Fig. 4] Fig. 4 is a schematic view showing a state in which a heat transfer fin is attached to flat tubes in the heat exchange portion.

[Fig. 5] Fig. 5 is a schematic explanatory view showing how a refrigerant flows when the outdoor heat exchanger is caused to function as a radiator or a condenser of the refrigerant.

[Fig. 6] Fig. 6 is an external perspective view of an inlet/outlet header.

[Fig. 7] Fig. 7 is a schematic exploded perspective view of a gas header portion.

[Fig. 8] Fig. 8 is a schematic horizontal cross-sectional configuration diagram of a gas header portion.

[Fig. 9] Fig. 9 is a schematic exploded perspective view of a liquid header portion.

[Fig. 10] Fig. 10 is a schematic horizontal cross-sectional configuration diagram of a liquid header portion.

[Fig. 11] Fig. 11 is a schematic configuration diagram of a fourth liquid member as viewed in the plate thickness direction.

[Fig. 12] Fig. 12 is a schematic exploded perspective view of a liquid header portion of another embodiment C.

DESCRIPTION OF EMBODIMENTS

[0031] Hereinafter, embodiments of a heat exchanger of the present disclosure and a refrigeration apparatus employing the heat exchanger will be described.

(1) Configuration of air-conditioning apparatus

[0032] Hereinafter, an air-conditioning apparatus 1 which is an embodiment of the refrigeration apparatus will be described with reference to the drawings.

[0033] Fig. 1 is a schematic configuration diagram of the air-conditioning apparatus 1 having a heat exchanger according to an embodiment of the present disclosure as an outdoor heat exchanger 11.

[0034] The air-conditioning apparatus 1 is an apparatus that cools and heats a space to be air-conditioned by performing a vapor-compression refrigeration cycle. The space to be air-conditioned is, for example, a space in a building such as an office building, a commercial facility, or a residence. The air-conditioning apparatus is merely an example of a refrigeration cycle apparatus, and the heat exchanger of the present disclosure may be used in other refrigeration cycle apparatuses, such as a refrigerator, a freezer, a water heater, and a floor heater. The refrigerant used in the air-conditioning apparatus 1 is not particularly limited, and may include, for example, R290, CO₂, R32, and the like.

[0035] As shown in Fig. 1, the air-conditioning apparatus 1 mainly includes an outdoor unit 2, an indoor unit 9, a liquid-refrigerant connection pipe 4 and a gas-refrigerant connection pipe 5, and a control unit 3 that controls devices constituting the outdoor unit 2 and the indoor unit 9. The liquid-refrigerant connection pipe 4 and the gas-refrigerant connection pipe 5 are refrigerant connection pipes that connect the outdoor unit 2 and the indoor unit 9. In the air-conditioning apparatus 1, the outdoor unit 2 and the indoor unit 9 are connected via the liquid-refrigerant connection pipe 4 and the gas-refrigerant connection pipe 5, thus constituting a refrigerant circuit 6.

[0036] In Fig. 1, while the air-conditioning apparatus 1 includes one indoor unit 9, the air-conditioning apparatus 1 may include a plurality of indoor units 9 connected in parallel to each other with respect to the outdoor unit 2 by the liquid-refrigerant connection pipe 4 and the gas-refrigerant connection pipe 5. Further, the air-conditioning apparatus 1 may include a plurality of outdoor units 2. In addition, the air-conditioning apparatus 1 may be an integrated air-conditioning apparatus in which the outdoor unit 2 and the indoor unit 9 are integrally formed.

(1-1) Outdoor Unit

[0037] The outdoor unit 2 is installed outside the space

to be air-conditioned, for example, on the roof of a building or near a wall surface of the building.

[0038] The outdoor unit 2 mainly includes an accumulator 7, a compressor 8, a four-way switching valve 10, an outdoor heat exchanger 11, an outdoor expansion valve 12, a liquid-side shutoff valve 13, a gas-side shutoff valve 14, and an outdoor fan 16.

[0039] The outdoor unit 2 mainly includes a suction pipe 17, a discharge pipe 18, a first gas refrigerant pipe 19, a liquid refrigerant pipe 20, and a second gas refrigerant pipe 21 as refrigerant pipes that connect various devices constituting the refrigerant circuit 6. The suction pipe 17 connects the four-way switching valve 10 and the suction side of the compressor 8. The suction pipe 17 is provided with the accumulator 7. The discharge pipe 18 connects the discharge side of the compressor 8 and the four-way switching valve 10. The first gas refrigerant pipe 19 connects the four-way switching valve 10 and the gas side of the outdoor heat exchanger 11. The liquid refrigerant pipe 20 connects the liquid side of the outdoor heat exchanger 11 and the liquid-side shutoff valve 13. The liquid refrigerant pipe 20 is provided with the outdoor expansion valve 12. The second gas refrigerant pipe 21 connects the four-way switching valve 10 and the gas-side shutoff valve 14.

[0040] The compressor 8 is a device that sucks in a low-pressure refrigerant in the refrigeration cycle from the suction pipe 17, compresses the refrigerant with a compression mechanism (not shown), and discharges the compressed refrigerant to the discharge pipe 18.

[0041] The four-way switching valve 10 is a mechanism that changes the state of the refrigerant circuit 6 between a cooling operation state and a heating operation state by switching the flow direction of the refrigerant. When the refrigerant circuit 6 is in the cooling operation state, the outdoor heat exchanger 11 functions as a radiator or a condenser of the refrigerant, and the indoor heat exchanger 91 functions as an evaporator of the refrigerant. When the refrigerant circuit 6 is in the heating operation state, the outdoor heat exchanger 11 functions as the evaporator of the refrigerant, and the indoor heat exchanger 91 functions as a radiator or a condenser of the refrigerant. When the four-way switching valve 10 sets the state of the refrigerant circuit 6 to the cooling operation state, the four-way switching valve 10 allows the suction pipe 17 to communicate with the second gas refrigerant pipe 21, and allows the discharge pipe 18 to communicate with the first gas refrigerant pipe 19 (see the solid lines inside the four-way switching valve 10 in Fig. 1). When the four-way switching valve 10 sets the state of the refrigerant circuit 6 to the heating operation state, the four-way switching valve 10 allows the suction pipe 17 to communicate with the first gas refrigerant pipe 19, and allows the discharge pipe 18 to communicate with the second gas refrigerant pipe 21 (see the broken lines inside the four-way switching valve 10 in Fig. 1).

[0042] The outdoor heat exchanger 11 is a device that performs heat exchange between the refrigerant flowing

inside and a fluid, such as air, at the installation location of the outdoor unit 2. Details of the outdoor heat exchanger 11 will be described later.

[0043] The outdoor expansion valve 12 is disposed between the outdoor heat exchanger 11 and the indoor heat exchanger 91 in the refrigerant circuit 6. In the present embodiment, the outdoor expansion valve 12 is disposed in the liquid refrigerant pipe 20 between the outdoor heat exchanger 11 and the liquid-side shutoff valve 13. The outdoor expansion valve 12 has a mechanism for adjusting the pressure and flow rate of the refrigerant flowing through the liquid refrigerant pipe 20.

[0044] The accumulator 7 is a container having a gas-liquid separation function of separating the inflowing refrigerant into a gas refrigerant and a liquid refrigerant. The accumulator 7 is also a container having a function of storing surplus refrigerant generated in response to variations in operation load or the like.

[0045] The liquid-side shutoff valve 13 is a valve provided at a connecting portion between the liquid refrigerant pipe 20 and the liquid-refrigerant connection pipe 4. The gas-side shutoff valve 14 is a valve provided at a connecting portion between the second gas refrigerant pipe 21 and the gas-refrigerant connection pipe 5. The liquid-side shutoff valve 13 and the gas-side shutoff valve 14 are opened during operation of the air-conditioning apparatus 1.

[0046] The outdoor fan 16 is a fan for sucking in external heat source air into the casing of the outdoor unit 2 (not shown), supplying the air to the outdoor heat exchanger 11, and discharging the air that has exchanged heat with the refrigerant in the outdoor heat exchanger 11 to the outside of the casing of the outdoor unit 2. The outdoor fan 16 is, for example, a propeller fan.

(1-2) Indoor unit

[0047] The indoor unit 9 is a unit installed in a space to be air-conditioned. While the indoor unit 9 is a ceiling-embedded unit, for example, it may be a ceiling-suspended unit, a wall-mounted unit, or a floor-mounted unit. The indoor unit 9 may be installed outside the space to be air-conditioned. For example, the indoor unit 9 may be installed in an attic, a machine chamber, a garage, or the like. In this case, an air passage is installed to supply the air that has exchanged heat with the refrigerant in the indoor heat exchanger 91 from the indoor unit 9 to the space to be air-conditioned. The air passage is, for example, a duct.

[0048] The indoor unit 9 mainly includes an indoor heat exchanger 91, an indoor expansion valve 93, and an indoor fan 92.

[0049] In the indoor heat exchanger 91, heat is exchanged between the refrigerant flowing through the indoor heat exchanger 91 and the air in the space to be air-conditioned. The indoor heat exchanger 91 is, for example, a fin-and-tube heat exchanger having a plurality of heat transfer tubes and fins (not shown). One end

of the indoor heat exchanger 91 is connected to the indoor expansion valve 93 via a refrigerant pipe. The other end of the indoor heat exchanger 91 is connected to the gas-refrigerant connection pipe 5 via a refrigerant pipe.

[0050] The indoor expansion valve 93 is disposed between the indoor heat exchanger 91 and the liquid-refrigerant connection pipe 4 in the refrigerant circuit 6. The indoor expansion valve 93 has a mechanism for adjusting the pressure and flow rate of the refrigerant passing through the indoor expansion valve 93.

[0051] The indoor fan 92 is a mechanism that sucks in air in the space to be air-conditioned into a casing (not shown) of the indoor unit 9, supplies the air to the indoor heat exchanger 91, and blows out the air heat-exchanged with the refrigerant in the indoor heat exchanger 91 to the space to be air-conditioned. The indoor fan 92 is, for example, a turbofan.

(1-3) Control unit

[0052] The control unit 3 is a functional section that controls the actions of various devices constituting the air-conditioning apparatus 1.

[0053] The control unit 3 is configured such that, for example, an outdoor control unit (not shown) of the outdoor unit 2 and an indoor control unit (not shown) of the indoor unit 9 are communicably connected via a transmission line (not shown). The outdoor control unit and the indoor control unit are, for example, units that have a microcomputer or the like including a processor, such as a central processing unit (CPU), memories, such as a ROM and a RAM in which various programs for controlling the air-conditioning apparatus 1 that can be executed by the processor are stored, and the like. In Fig. 1, for the sake of convenience, the control unit 3 is depicted at a position away from the outdoor unit 2 and the indoor unit 9.

[0054] The control unit 3 is electrically connected to various devices of the outdoor unit 2 and the indoor unit 9, including the compressor 8, the four-way switching valve 10, the outdoor expansion valve 12, the outdoor fan 16, the indoor fan 92, and the indoor expansion valve 93. Further, the control unit 3 is electrically connected to various sensors provided in the outdoor unit 2 and the indoor unit 9. The control unit 3 is configured to be able to communicate with a remote controller (not shown) operated by a user of the air-conditioning apparatus 1.

[0055] The control unit 3 controls the operation and deactivation of the air-conditioning apparatus 1 and the actions of various devices constituting the air-conditioning apparatus 1 based on measurement signals of various sensors, commands received from the remote controller (not shown), and the like.

(2) Configuration of outdoor heat exchanger

[0056] The configuration of the outdoor heat exchan-

ger 11 will be described with reference to the drawings.

[0057] Fig. 2 is a schematic perspective view of the outdoor heat exchanger 11. Fig. 3 is a partially enlarged view of a heat exchange portion 27, as will be described later, of the outdoor heat exchanger 11. Fig. 4 is a schematic view showing a state in which a fin 29, as will be described later, is attached to the flat tubes 28 in the heat exchange portion 27. Fig. 5 is a schematic configuration diagram of the outdoor heat exchanger 11. The arrows in the heat exchange portion 27 shown in Fig. 5 indicate the flow of the refrigerant during the cooling operation or the defrosting operation (when the outdoor heat exchanger 11 functions as a radiator or a condenser of the refrigerant). Fig. 6 is an external perspective view of an inlet/outlet header 40.

[0058] In the following description, expressions such as "upper", "lower", "left", "right", "front (front surface)", and "rear (rear surface)" may be used to describe an orientation or a position. These expressions follow the directions of the arrows drawn in Fig. 2 unless otherwise specified. It should be noted that these expressions indicating directions and positions are used for convenience of description, and, unless otherwise specified, the directions and positions of the outdoor heat exchanger 11 as a whole or the configurations of the outdoor heat exchanger 11 are not dictated by the directions and positions of the expressions.

[0059] Hereinafter, an example is described in which the direction in which the plurality of flat tubes 28 are arranged, the longitudinal direction of the inlet/outlet header 40, the longitudinal direction of a gas header portion 50, and the longitudinal direction of a liquid header portion 60 are in the up-down direction (an example of a "first direction"). Also in the example described, the direction in which the connection part of the flat tubes 28 to the inlet/outlet header 40 extends; the direction in which a tube plate portion 411 of a first common member 41, a second common member 42, a third common member 43, and a flat part 51a of a gas space-forming member 51 are stacked; the direction in which the tube plate portion 411 of the first common member 41, the second common member 42, the third common member 43, a first liquid member 61, a second liquid member 62, a third liquid member 63, a fourth liquid member 64, and a fifth liquid member 65 are stacked; the plate thickness direction of the tube plate portion 411, the second common member 42, the third common member 43, and the flat part 51a of the gas space-forming member 51; and the plate thickness direction of the tube plate portion 411, the second common member 42, the third common member 43, the first liquid member 61, the second liquid member 62, the third liquid member 63, the fourth liquid member 64, and the fifth liquid member 65, are in the left-right direction (an example of a "second direction"). A direction perpendicular to both the up-down direction and the left-right direction is described as a front-rear direction (an example of a "third direction").

[0060] The outdoor heat exchanger 11 is a device that

performs heat exchange between the refrigerant flowing inside and the air.

[0061] The outdoor heat exchanger 11 mainly has a plurality of flat tubes 28, a plurality of fins 29, a return header 30, and an inlet/outlet header 40. In the present embodiment, all of the flat tubes 28, the fins 29, the return header 30, and the inlet/outlet header 40 are made of aluminum or an aluminum alloy.

[0062] The flat tubes 28 and the fins 29 fixed to the flat tubes 28 form the heat exchange portion 27. In the outdoor heat exchanger 11, air flows through a ventilation passage formed by the flat tubes 28 and the fins 29 of the heat exchange portion 27, whereby heat exchange is performed between the refrigerant flowing through the flat tubes 28 and the air flowing through the ventilation passage.

(2-1) Flat tube

[0063] As shown in Fig. 3, the flat tubes 28 are flat heat transfer tubes having upper and lower flat surfaces 28a that serve as heat transfer surfaces. As shown in Fig. 3, a plurality of refrigerant passages 28b through which the refrigerant flows are formed in the flat tubes 28. For example, the flat tubes 28 are flat multi-hole tubes in which a large number of refrigerant passages 28b having a small passage cross-sectional area through which the refrigerant flows are formed. In the present embodiment, the plurality of refrigerant passages 28b are arranged in the air flow direction.

[0064] In the outdoor heat exchanger 11, as shown in Fig. 5, the flat tubes 28 extend in the horizontal direction between the return header 30 side and the inlet/outlet header 40 side, and are arranged vertically in a plurality of tiers. Each flat tube 28 is disposed in a posture in which the flat surfaces face upward and downward.

[0065] In the present embodiment, the flat tubes 28 extending between the return header 30 side and the inlet/outlet header 40 side are bent at one location, so that the heat exchange portion 27 configured by the flat tubes 28 is formed in a substantially L-shape in plan view. In the present embodiment, the plurality of flat tubes 28 are arranged at regular intervals vertically.

[0066] When the outdoor fan 16 is driven, an air flow passing through the main surface of the outdoor heat exchanger 11 from the rear to the front side, and an air flow passing through the left side surface part of the outdoor heat exchanger 11 from the left side to the right side are generated.

[0067] The outdoor heat exchanger 11 includes a first flow path group X, a second flow path group Y, and a third flow path group Z arranged in the up-down direction. In the outdoor heat exchanger 11, each of the flat tubes 28 arranged in the up-down direction belongs to one of the plurality of flow path groups X, Y, and Z. The first flow path group X is the lowermost flow path group to which a plurality of first flat tubes 28x belong. The second flow path group Y is a flow path group which is positioned

above the first flow path group X and below the third flow path group Z, and to which a plurality of second flat tubes 28y belong. The third flow path group Z is the uppermost flow path group to which a plurality of third flat tubes 28z belong.

(2-2) Fins

[0068] The plurality of fins 29 are members for increasing the heat transfer area of the outdoor heat exchanger 11. Each of the fins 29 is a plate-shaped member extending in the direction in which the flat tubes 28 are arranged in tiers. The outdoor heat exchanger 11 is used in a manner where the plurality of flat tubes 28 extending in the horizontal direction are arranged in a vertical alignment. Therefore, in a state in which the outdoor heat exchanger 11 is installed in the outdoor unit 2, the fins 29 extend in the up-down direction.

[0069] As shown in Fig. 4, each of the fins 29 is formed with a plurality of notches 29a extending along an insertion direction of the flat tubes 28 so that the plurality of flat tubes 28 can be inserted. The notches 29a extend in a direction orthogonal to the extending direction of the fins 29 and the thickness direction of the fins 29. In a state in which the outdoor heat exchanger 11 is installed in the outdoor unit 2, the notches 29a formed in each fin 29 extend in the horizontal direction. The notches 29a are formed in the fin 29 at intervals corresponding to the arrangement intervals of the flat tubes 28. In the outdoor heat exchanger 11, the plurality of fins 29 are arranged along the direction in which the flat tubes 28 extend. When the flat tubes 28 are inserted into the plurality of notches 29a of the plurality of fins 29, the space between the adjacent flat tubes 28 is partitioned into a plurality of ventilation passages through which air flows.

[0070] Each fin 29 has a continuing portion 29b continuing in the up-down direction on the upstream side or the downstream side in the air flow direction with respect to the flat tubes 28. In the present embodiment, the continuing portion 29b of the fin 29 is positioned on the windward side with respect to the flat tubes 28.

(2-3) Inlet/outlet header

[0071] As shown in Figs. 5 and 6, the inlet/outlet header 40 includes a gas header portion 50 located in the upper part, and a liquid header portion 60 located in the lower part. The gas header portion 50 and the liquid header portion 60 are partitioned from each other due to the fact that openings formed in stacked members are shaped so as not to be continuous with each other between the gas side and the liquid side. The gas header portion 50 has a gas space 50S therein the longitudinal direction of which is in the up-down direction. The liquid header portion 60 has a liquid space 60S therein the longitudinal direction of which is in the up-down direction, as a space isolated from the gas space 50S.

[0072] A gas refrigerant connection pipe 19a constitut-

ing one end of the first gas refrigerant pipe 19 is connected to the liquid header portion 60. In the present embodiment, the gas refrigerant connection pipe 19a is connected to a part on the side of the liquid header portion 60 opposite to the side where the flat tubes 28 are connected.

[0073] A liquid refrigerant connection pipe 20a constituting one end of the liquid refrigerant pipe 20 is connected to the gas header portion 50. In the present embodiment, the liquid refrigerant connection pipe 20a is connected to a part on the side of the gas header portion 50 opposite to the side where the flat tubes 28 are connected.

[0074] As shown in Fig. 5, one end of each flat tube 28 is connected to the gas header portion 50 and the liquid header portion 60 of the inlet/outlet header 40, and the other end of each flat tube 28 is connected to the return header 30. The outdoor heat exchanger 11 is disposed inside a casing (not shown) of the outdoor unit 2 so that the longitudinal direction of the return header 30 and the inlet/outlet header 40 substantially coincides with the vertical direction. Here, the number of the flat tubes 28 connected to the gas header portion 50 is larger than the number of the flat tubes 28 connected to the liquid header portion 60.

[0075] The inlet/outlet header 40 includes a first common member 41, a second common member 42, and a third common member 43. The first common member 41, the second common member 42, and the third common member 43 extend in the up-down direction over the gas header portion 50 and the liquid header portion 60. More specifically, one part of the first common member 41, the second common member 42, and the third common member 43 constitutes a part of the gas header portion 50, and another part thereof constitutes a part of the liquid header portion 60 and is shared by the gas header portion 50 and the liquid header portion 60.

[0076] The first common member 41 includes a tube plate portion 411, a plurality of flat tube connection openings 412, a first side plate portion 413, a second side plate portion 414, a first crimping claw 415, and a second crimping claw 416. The tube plate portion 411 is a plate-shaped member extending in the up-down and front-rear directions. The plurality of flat tube connection openings 412 are openings through the tube plate portion 411 in the plate thickness direction, and are arranged in the up-down direction. The flat tubes 28 are connected to the flat tube connection openings 412. When viewed in the plate thickness direction of the tube plate portion 411, the contour of the flat tube connection openings 412 coincides with the contour of the flat tubes 28. The first side plate portion 413 is a plate-shaped part extending rightward from the front-side end portion of the tube plate portion 411. The second side plate portion 414 is a plate-shaped part extending rightward from the rear end portion of the tube plate portion 411, and faces the first side plate portion 413. A plurality of first crimping claws 415 are provided so as to be arranged in the up-down direc-

tion at the right-side end portion of the first side plate portion 413. A plurality of second crimping claws 416 are provided so as to be arranged in the up-down direction at the right-side end portion of the second side plate portion 414.

[0077] The second common member 42 includes an insertion plate portion 421 and a plurality of insertion openings 422. The insertion plate portion 421 is a plate-shaped member extending in the up-down and front-rear directions, and is stacked so as to be in contact with the tube plate portion 411. The plurality of insertion openings 422 are openings through the insertion plate portion 421 in the plate thickness direction, and are arranged in the up-down direction. When viewed in the plate thickness direction of the insertion plate portion 421, the contour of the insertion openings 422 is positioned outside the contour of the flat tubes 28. The flat tubes 28 are inserted into the insertion openings 422.

[0078] The third common member 43 includes a restriction plate portion 431 and a plurality of restriction openings 432. The restriction plate portion 431 is a plate-shaped member that extends in the up-down and front-rear directions, and is stacked so as to contact the insertion plate portion 421. The plurality of restriction openings 432 are openings through the restriction plate portion 431 in the plate thickness direction, and are arranged in the up-down direction. When viewed in the plate thickness direction of the restriction plate portion 431, the contour of the restriction openings 432 has a part that overlaps the contour of the flat tubes 28. Specifically, both end parts in the longitudinal direction in the cross section of the flat tube 28 overlap both ends in the longitudinal direction of the restriction openings 432. Thus, the restriction openings 432 restrict the insertion of the flat tubes 28, thereby determining the insertion position of the flat tubes 28.

[0079] Each of the first common member 41, the second common member 42, and the third common member 43 has a longitudinal direction in the up-down direction, and has the same length in the up-down direction. The front-rear length of the portion of the tube plate portion 411 of the first common member 41 excluding the first side plate portion 413 and the second side plate portion 414 is the same as the length in the front-rear direction of the third common member 43 and the front-rear length of the second common member 42. The first side plate portion 413, in length in the left-right direction in which the flat tubes 28 extend, includes a first gas side plate portion 413a corresponding to the length of the gas header portion 50 and a first liquid side plate portion 413b corresponding to the length of the liquid header portion 60. The second side plate portion 414, in length in the left-right direction in which the flat tubes 28 extend, includes a second gas side plate portion 414a corresponding to the gas header portion 50 and a second liquid side plate portion 414b corresponding to the liquid header portion 60.

[0080] The inlet/outlet header 40 also includes a gas

space-forming member 51 which is a gas member constituting a part of the gas header portion 50. Further, the inlet/outlet header 40 includes a first liquid member 61, a second liquid member 62, a third liquid member 63, a fourth liquid member 64, and a fifth liquid member 65, which are liquid members constituting a part of the liquid header portion 60. The details thereof will be described later.

10 (2-4) Return header

[0081] End portions of the flat tubes 28 that are different from the end portions of the flat tubes 28 connected to the gas header portion 50 and the liquid header portion 60 of the inlet/outlet header 40 are connected to the return header 30.

[0082] The return header 30 is formed by surrounding and crimping a stack of a plurality of plate-shaped members with a crimping member 31 having a U shape in plan view to which the flat tubes 28 are connected. The plate-shaped members stacked on the crimping member 31 include a member having the same shape as the second common member 42 of the inlet/outlet header 40 and a member having the same shape as the third common member 43. Thus, the members can be used in common.

(3) Various operations and flow of refrigerant in outdoor heat exchanger

[0083] The control unit 3 receives detection information of various sensors or a command from a remote controller or the like, and switches and executes a cooling operation, a heating operation, a defrosting operation, and the like.

[0084] When the air-conditioning apparatus 1 performs a heating operation, the control unit 3 switches the connection state of the four-way switching valve 10 to the state indicated by the broken lines in Fig. 1, and causes the compressor 8 to operate. The refrigerant discharged from the compressor 8 dissipates heat or condenses by exchanging heat with the indoor air in the indoor heat exchanger 91, is decompressed in the indoor expansion valve 93 or the outdoor expansion valve 12, and is then sent to the outdoor heat exchanger 11. The refrigerant sent to the outdoor heat exchanger 11 evaporates by exchanging heat with the outside air, and is sucked into the compressor 8 again.

[0085] Thus, when the outdoor heat exchanger 11 functions as the evaporator of the refrigerant during the heating operation, the refrigerant in liquid state or gas-liquid two-phase state that has reached the liquid header portion 60 from the liquid refrigerant pipe 20 is split into the refrigerant flowing through the first flow path group X and the refrigerant flowing through the second flow path group Y in the internal space of the liquid header portion 60. Thereafter, the split flows of refrigerant respectively flow through the plurality of first flat tubes 28x belonging to the first flow path group X and the plurality of

second flat tubes 28y belonging to the second flow path group Y. The refrigerant flowing through the plurality of first flat tubes 28x and second flat tubes 28y is partially evaporated by heat exchange with the air, and reaches the lower region of the internal space of the return header 30. The refrigerant sent to the lower region of the internal space of the return header 30 is sent to the upper region of the internal space of the return header 30. The refrigerant sent to the upper region of the return header 30 flows through the plurality of third flat tubes 28z belonging to the third flow path group Z connected to the upper region of the return header 30. The refrigerant flowing through the plurality of third flat tubes 28z further evaporates by exchanging heat with the air again, and reaches the gas header portion 50. After the flows of refrigerant that have reached the gas header portion 50 are merged, the refrigerant then flows through the first gas refrigerant pipe 19.

[0086] When the air-conditioning apparatus 1 performs a cooling operation, the control unit 3 switches the connection state of the four-way switching valve 10 to the state indicated by the solid lines in Fig. 1, and causes the compressor 8 to operate. The refrigerant discharged from the compressor 8 dissipates heat or condenses by exchanging heat with the outside air in the outdoor heat exchanger 11, is decompressed in the outdoor expansion valve 12 or the indoor expansion valve 93, and is then sent to the indoor heat exchanger 91. The refrigerant sent to the indoor heat exchanger 91 evaporates by exchanging heat with the indoor air, and is sucked into the compressor 8 again.

[0087] When the air-conditioning apparatus 1 is performing the heating operation, if a predetermined defrosting start condition is satisfied, the control unit 3 switches the connection state of the four-way switching valve 10 to the state indicated by the solid line in Fig. 1 and causes the compressor 8 to operate, to perform a defrosting operation in which a high-temperature, high-pressure discharged refrigerant is supplied to the outdoor heat exchanger 11. By the defrosting operation, frost deposited on the outdoor heat exchanger 11 is melted. A predetermined defrosting end condition is determined by the control unit 3 based on a detection value of a temperature sensor 99, which is described later.

[0088] Thus, when the outdoor heat exchanger 11 functions as a radiator or a condenser of the refrigerant during the cooling operation or the defrosting operation, the refrigerant discharged from the compressor 8 flows into the gas header portion 50 after flowing through the first gas refrigerant pipe 19. The refrigerant in gaseous state that has reached the gas header portion 50 is split in the internal space of the gas header portion 50, and then flows through the plurality of third flat tubes 28z belonging to the third flow path group Z connected to the gas header portion 50. The refrigerant flowing through the plurality of third flat tubes 28z partially dissipates heat or condenses by exchanging heat with the air, and reaches the upper region of the internal space of the return header 30. The

refrigerant sent to the upper region of the internal space of the return header 30 is sent to the lower region of the return header 30. The refrigerant sent to the lower region of the return header 30 is split and flows into the plurality of first flat tubes 28x belonging to the first flow path group X and the plurality of second flat tubes 28y belonging to the second flow path group Y, which are connected to the lower region of the return header 30. The refrigerant flowing through the plurality of first flat tubes 28x and second flat tubes 28y further dissipates heat or condenses by exchanging heat with the air again, and reaches the liquid header portion 60. After the refrigerant that flowed through the plurality of first flat tubes 28x belonging to the first flow path group X and the refrigerant that has flowed through the plurality of second flat tubes 28y belonging to the second flow path group Y are merged in the liquid header portion 60, the refrigerant flows through the liquid refrigerant pipe 20.

(4) Details of gas header

[0089] Fig. 7 is a schematic exploded perspective view of the gas header portion 50. Fig. 8 is a schematic horizontal cross-sectional configuration diagram of the gas header portion 50. Fig. 8 shows a horizontal cross section obtained by horizontally cutting the flat tube 28 in the lowermost tier among the plurality of flat tubes 28 connected to the gas header portion 50 at the center position in the thickness direction (up-down direction). Further, in Fig. 8, a connection member or the like for connecting the gas refrigerant connection pipe 19a and a gas space-forming member 51 described later is omitted.

[0090] The gas header portion 50 is composed of the gas space-forming member 51, a gas side part of the third common member 43, a gas side part of the second common member 42, a gas side part of the first common member 41, a bottom plate 58, and a top panel 59.

[0091] In the gas header portion 50, the gas space-forming member 51, the gas side part of the third common member 43, the gas side part of the second common member 42, the gas side part of the first common member 41, the bottom plate 58, and the top panel 59 are bonded to each other by brazing.

(4-1) Gas space-forming member

[0092] The gas space-forming member 51 is a member stacked so as to be bonded to the right-side surface of a gas restriction plate portion 43 1a of the third common member 43. The length of the gas space-forming member 51 in the front-rear direction is the same as the lengths of the third common member 43 and the second common member 42 in the front-rear direction, and is the same as the length of the portion of the tube plate portion 411 of the first common member 41 excluding the first side plate portion 413 and the second side plate portion 414 in the front-rear direction.

[0093] The gas space-forming member 51 has a flat

part 51a and a protruding portion 51b.

[0094] The flat part 51a includes a plate-shaped part extending in the up-down and front-rear directions in the front-side part of the gas space-forming member 51, and a plate-shaped part extending in the up-down and front-rear directions in the rear-side part of the gas space-forming member 51.

[0095] The protruding portion 51b is a part provided so as to connect the front-side part of the flat part 51a and the rear-side part of the flat part 51a. The protruding portion 51b has a semicircular arc shape protruding to the right when viewed in the longitudinal direction of the gas header portion 50. The protruding portion 51b protrudes toward the side opposite to the third common member 43 side with respect to the flat part 51a. The protruding portion 51b is provided with a connection opening 51x connected to the gas refrigerant connection pipe 19a of the first gas refrigerant pipe 19.

[0096] In the gas space-forming member 51, the front-side part of the flat part 51a is crimped by a first gas crimping claw 415a of the first common member 41, and the rear-side part of the flat part 51a is crimped by a second gas crimping claw 416a.

(4-2) Bottom plate

[0097] The bottom plate 58 is provided at the lower end of the gas space-forming member 51 between the gas space-forming member 51 and the third common member 43. The bottom plate 58 is a plate-shaped member configured in a semicircular arc shape so as to contact the inner periphery of the semicircular arc shape of the protruding portion 51b of the gas space-forming member 51, and to contact the flat surface of the restriction plate portion 431 of the third common member 43 in a plan view. The bottom plate 58 functions as the lower lid of the gas space 50S.

(4-3) Top panel

[0098] The top panel 59 is provided at the upper end of the gas space-forming member 51 between the gas space-forming member 51 and the third common member 43. Similarly to the bottom plate 58, the top panel 59 is a plate-shaped member formed in a semicircular arc shape so as to contact the inner periphery of the semicircular arc shape of the protruding portion 51b of the gas space-forming member 51 and the flat surface of the restriction plate portion 431 of the third common member 43 in a plan view. The top panel 59 functions as the upper lid of the gas space 50S.

(4-4) Gas-side part of third common member

[0099] The third common member 43 includes, as a gas side part of the third common member 43, a gas restriction plate portion 431a constituting a part of the gas header portion 50 in the restriction plate portion 431.

[0100] The gas restriction plate portion 431a is stacked so as to face and be in contact with the right-side surface of the gas insertion plate portion 421a of the second common member 42, and to face and be in contact with the left-side surface of the flat part 51a of the gas space-forming member 51. The gas restriction plate portion 431a has a plurality of gas restriction openings 432a constituting part of the gas header portion 50 among the plurality of restriction openings 432.

[0101] The plurality of gas restriction openings 432a are arranged in the up-down direction, and are openings through the gas restriction plate portion 431a in the plate thickness direction. Front and rear edges of the gas restriction opening 432a are positioned inside the front and rear edges of gas insertion openings 422a when viewed in the plate thickness direction of the gas restriction plate portion 431a. The width of the plurality of gas restriction openings 432a in the front-rear direction is narrower than the width of the flat tubes 28 in the front-rear direction. As a result, the tip-end of the flat tube 28 in the insertion direction abuts the edges of the gas restriction openings 432a, whereby the insertion position is defined. The upper and lower edges of the plurality of gas restriction openings 432a are positioned outside the front and rear edges of the flat tube 28.

[0102] In the flow direction of the refrigerant when the outdoor heat exchanger 11 functions as a radiator or a condenser of the refrigerant, the refrigerant that has flowed into the gas space 50S between the gas space-forming member 51 and the gas restriction plate portion 431a via the gas refrigerant connection pipe 19a branches and flows into the plurality of gas restriction opening 432a.

(4-5) Gas-side part of second common member

[0103] The second common member 42 includes, as a gas side part of the second common member 42, a gas insertion plate portion 421a constituting a part of the gas header portion 50 in the insertion plate portion 421.

[0104] The gas insertion plate portion 421a is stacked so as to face and be in contact with the right-side surface of the gas tube plate portion 411a of the first common member 41, and to face and be in contact with the left-side surface of the gas restriction plate portion 431a. The gas insertion plate portion 421a has a plurality of gas insertion openings 422a constituting a part of the gas header portion 50 among the plurality of insertion openings 422.

[0105] The plurality of gas insertion openings 422a are arranged in the up-down direction, and are openings through the gas insertion plate portion 421a in the plate thickness direction. When viewed in the plate thickness direction of the gas insertion plate portion 421a, the front and rear edges of the gas insertion openings 422a are positioned outside the front and rear edges of gas connection openings 412a, which are openings of the gas header portion 50 among the flat tube connection open-

ings 412. Further, the upper and lower edges of the plurality of gas insertion openings 422a are positioned outside the upper and lower edges of the gas connection openings 412a when viewed in the plate thickness direction of the gas insertion plate portion 421a. When viewed in the plate thickness direction of the gas insertion plate portion 421a, the contour of the gas insertion opening 422a does not overlap the contour of the flat tube 28, and is positioned outside the contour of the flat tube 28. As a result, the tip-end of the flat tube 28 in the insertion direction is inserted so as to pass through the gas insertion opening 422a. Further, even if there is excess brazing material at the time of brazing, a clearance is ensured between the flat tube 28 and the gas insertion opening 422a and the excess brazing material can be guided thereto. Therefore, the flow path of the flat tube 28 is prevented from being blocked by the excess brazing material.

(4-6) Gas-side part of first common member

[0106] The first common member 41 includes, as the gas side parts of the first common member 41: a gas tube plate portion 411a constituting a part of the gas header portion 50 in the tube plate portion 411; a first gas side plate portion 413a constituting a part of the gas header portion 50 in the first side plate portion 413; a second gas side plate portion 414a constituting a part of the gas header portion 50 in the second side plate portion 414; a first gas crimping claw 415a constituting a part of the gas header portion 50 in the first crimping claw 415; and a second gas crimping claw 416a constituting a part of the gas header portion 50 in the second crimping claw 416. The gas side part of the first common member 41 mainly constitutes the periphery of the outer shape of the gas header portion 50 together with the gas space-forming member 51.

[0107] The gas tube plate portion 411a is stacked so as to face and be in contact with the left-side surface of the gas insertion plate portion 421a. The gas tube plate portion 411a has a plurality of gas connection openings 412a constituting a part of the gas header portion 50 among the plurality of flat tube connection openings 412.

[0108] The plurality of gas connection openings 412a are arranged in the up-down direction and are openings through the gas tube plate portion 411a in the plate thickness direction. The contour of the gas connection openings 412a has a shape corresponding to the contour of the flat tubes 28. Thus, the flat tubes 28 are brazed to the gas connection opening 412a in a state in which the tip-end thereof in the insertion direction has passed through the gas connection opening 412a and the outer periphery of the flat tubes 28 is in contact with the inner periphery of the gas connection opening 412a.

[0109] The plate thickness of the gas tube plate portion 411a is smaller than that of the gas insertion plate portion 421a. Accordingly, because the contour of the gas connection opening 412a has a shape that follows the con-

tour of the flat tube 28, even if friction occurs between the circumferential surface of the flat tube 28 and the inner periphery of the gas connection opening 412a when the flat tube 28 is inserted, the degree of the friction is suppressed, and thus the flat tube 28 can be easily inserted. On the other hand, a greater plate thickness is ensured for the gas insertion plate portion 421a stacked on the gas tube plate portion 411a than that of the gas tube plate portion 411a. Accordingly, it is possible to increase the pressure resistance strength of the gas header portion 50 in the insertion portion for the flat tube 28.

[0110] The first gas side plate portion 413a is a plate-shaped part extending from the front-side edge of the gas tube plate portion 411a toward the right side. The second gas side plate portion 414a is a plate-shaped part extending from the rear-side edge of the tube plate portion 411 toward the right side. The first gas side plate portion 413a and the second gas side plate portion 414a are provided so as to face each other in the front-rear direction, thereby clamping the gas insertion plate portion 421a, the gas restriction plate portion 431a, and the flat part 51a of the gas space-forming member 51 in the front-rear direction.

[0111] The first gas crimping claw 415a comprises a plurality of crimping claws provided at predetermined intervals in the up-down direction at the right-side end portion of the first gas side plate portion 413a. The second gas crimping claw 416a comprises a plurality of crimping claws provided at predetermined intervals in the up-down direction at the right-side end portion of the second gas side plate portion 414a. In a state before crimping, the first gas crimping claw 415a extends to the right side on an extension of the first gas side plate portion 413a, and the second gas crimping claw 416a extends to the right side on an extension of the second gas side plate portion 414a. Then, in a state where the gas tube plate portion 411a, the gas insertion plate portion 421a, the gas restriction plate portion 431a, and the flat part 51a of the gas space-forming member 51 are stacked, the first gas crimping claw 415a and the second gas crimping claw 416a are folded so as to approach each other in the front-rear direction, whereby the gas insertion plate portion 421a, the gas restriction plate portion 431a, and the gas space-forming member 51 are crimped and integrated. In this state, brazing is performed in a furnace or the like, whereby the members are bonded and completely fixed to each other by brazing.

[0112] Accordingly, the lengths of the first gas side plate portion 413a and the second gas side plate portion 414a in the left-right direction, in which the flat tubes 28 extend, correspond to the lengths in the front-rear direction in a state where the gas insertion plate portion 421a, the gas restriction plate portion 431a, and the flat part 51a of the gas space-forming member 51 are stacked on the gas tube plate portion 411a.

(5) Details of liquid header

[0113] Fig. 9 is a schematic exploded perspective view of the liquid header portion 60. Fig. 10 is a schematic horizontal cross-sectional configuration diagram of the liquid header portion 60. Note that Fig. 10 shows a horizontal cross-section when the flat tube 28 positioned in the lowermost tier among the plurality of flat tubes 28 connected to the liquid header portion 60 is cut horizontally at the center position in the thickness direction (up-down direction). In Fig. 10, a first connection pipe 71, a second connection pipe 72, and the like, as will be described later, are omitted.

[0114] The liquid header portion 60 is composed of: the first connection pipe 71; the second connection pipe 72; a first liquid member 61; a second liquid member 62; a third liquid member 63; a fourth liquid member 64; a fifth liquid member 65; a liquid-side part of the second common member 42; and a liquid-side part of the first common member 41.

[0115] In the liquid header portion 60, the first connection pipe 71, the second connection pipe 72, the first liquid member 61, the second liquid member 62, the third liquid member 63, the fourth liquid member 64, the fifth liquid member 65, the liquid-side part of the third common member 43, the liquid-side part of the second common member 42, and the liquid-side part of the first common member 41 are bonded to each other by brazing.

[0116] The liquid refrigerant connection pipe 20a is connected to the liquid header portion 60.

[0117] In the liquid header portion 60, in the refrigerant flow when the outdoor heat exchanger 11 functions as the evaporator of the refrigerant, the refrigerant that has flowed in via the liquid refrigerant connection pipe 20a passes through a merging flow path C and is then split into a first refrigerant flow path A and a second refrigerant flow path B. The first refrigerant flow path A is a flow path from a connection part with the merging flow path C to the first flat tubes 28x included in the first flow path group X, and includes first flow path portions A1, A2, A3, A4, A5, and A6. The second refrigerant flow path B is a flow path from a connection part with the merging flow path C to the second flat tubes 28y included in the second flow path group Y, and includes second flow path portions B1, B2, B3, B4, B5, B6, and B7. In the refrigerant flow when the outdoor heat exchanger 11 functions as the evaporator of the refrigerant, the refrigerant flows in the order of the first flow path portions A1, A2, A3, A4, A5, and A6 in the first refrigerant flow path A, and the refrigerant flows in the order of the second flow path portions B1, B2, B3, B4, B5, B6, and B7 in the second refrigerant flow path B. Thereafter, the refrigerant that has flowed through the first refrigerant flow path A in the liquid header portion 60 is distributed to the plurality of first flat tubes 28x included in the first flow path group X among the plurality of flat tubes 28. The refrigerant that has flowed through the second refrigerant flow path B in the liquid header portion 60 is distributed to the plurality of second flat tubes 28y in-

cluded in the second flow path group Y among the plurality of flat tubes 28.

(5-1) First liquid member, first connection pipe, and second connection pipe

[0118] The first liquid member 61 is a plate-shaped member constituting an outer wall portion on the right side of the liquid header portion 60, and has the liquid refrigerant connection pipe 20a connected thereto.

[0119] The first liquid member 61 includes a first plate-shaped part 61a, a pipe connection opening 61x, a first outer wall opening 61b, a second outer wall opening 61c, a third outer wall opening 61d, and a fourth outer wall opening 61e. The first plate-shaped part 61a is a plate-shaped member of which the plate thickness direction is in the left-right direction corresponding to the direction in which the flat tubes 28 extend, and which extends in the up-down and front-rear directions. The pipe connection opening 61x is an opening through the first liquid member 61 in the plate thickness direction in the vicinity of the lower end thereof, and has the liquid refrigerant connection pipe 20a connected thereto. The first outer wall opening 61b, the second outer wall opening 61c, the third outer wall opening 61d, and the fourth outer wall opening 61e are openings each provided through the first liquid member 61 in the plate thickness direction.

[0120] The first connection pipe 71 connects the first outer wall opening 61b and the second outer wall opening 61c on the right side of the first liquid member 61. The first connection pipe 71 is provided with a temperature sensor 99 that detects the temperature of the refrigerant flowing therein.

[0121] The second connection pipe 72 connects the third outer wall opening 61d and the fourth outer wall opening 61e on the right side of the first liquid member 61.

[0122] The flow path length of the first connection pipe 71 and the flow path length of the second connection pipe 72 are the same, and the pressure loss of the refrigerant passing through the first connection pipe 71 and the pressure loss of the refrigerant passing through the second connection pipe 72 can be made substantially equal. As a result, the split state of the refrigerant flowing through the first connection pipe 71 and the second connection pipe 72 can be easily adjusted so that, for example, approximately the same amount of refrigerant flows through each. Thus, in the liquid header portion 60 of the present embodiment, it is possible to uniformly distribute the refrigerant to the first flat tubes 28x included in the first flow path group X and the second flat tubes 28y included in the second flow path group Y.

[0123] The first connection pipe 71, the first outer wall opening 61b, and the second outer wall opening 61c constitute the first flow path portion A2 included in the first refrigerant flow path A. The second connection pipe 72, the third outer wall opening 61d, and the fourth outer wall opening 61e constitute the second flow path portion B2 included in the second refrigerant flow path B.

(5-2) Second liquid member

[0124] The second liquid member 62 is provided between the first liquid member 61 and the third liquid member 63 in the plate thickness direction. The second liquid member 62 includes a second plate-shaped part 62a, a branch opening 62b, a first communication opening 62c, and a second communication opening 62d. The second plate-shaped part 62a is a plate-shaped member having a plate thickness direction in the left-right direction and extending in the up-down and front-rear directions. All of the branch opening 62b, the first communication opening 62c, and the second communication opening 62d are openings through the second liquid member 62 in the plate thickness direction.

[0125] The branch opening 62b is one opening that, when viewed from the stacking direction of the first liquid member 61 and the second liquid member 62, i.e., in the plate thickness direction of the second liquid member 62, connects a portion where the pipe connection opening 61x of the first liquid member 61 and the branch opening 62b overlap, a portion where the second outer wall opening 61c of the first liquid member 61 and the branch opening 62b overlap, and a portion where the third outer wall opening 61d of the first liquid member 61 and the branch opening 62b overlap. The branch opening 62b extends upward from the portion overlapping the pipe connection opening 61x of the first liquid member 61 and then branches, in a narrow portion functioning as a nozzle, into a flow path extending toward the portion where the second outer wall opening 61c of the first liquid member 61 and the branch opening 62b overlap each other and a flow path extending toward the portion where the third outer wall opening 61d of the first liquid member 61 and the branch opening 62b overlap each other. Here, of the branch opening 62b, the portion from the portion where the pipe connection opening 61x of the first liquid member 61 and the branch opening 62b overlap each other to the portion functioning as the nozzle is the merging flow path C. Further, of the branch opening 62b, the portion extending from the portion functioning as the nozzle toward the portion where the second outer wall opening 61c of the first liquid member 61 and the branch opening 62b overlap each other constitutes the first flow path portion A1 included in the first refrigerant flow path A. Further, of the branch opening 62b, the portion extending from the portion functioning as the nozzle toward the portion where the third outer wall opening 61d of the second liquid member 62 and the branch opening 62b overlap with each other constitutes the second flow path portion B1 included in the second refrigerant flow path B.

[0126] The first communication opening 62c is an opening which, when viewed in the plate thickness direction of the second liquid member 62, extends from a portion where the first outer wall opening 61b of the first liquid member 61 and the first communication opening 62c overlap each other toward a portion where a third lower opening 63b of the third liquid member 63 and the

first communication opening 62c overlap each other. The first communication opening 62c constitutes a first flow path portion A3 included in the first refrigerant flow path A.

[0127] The second communication opening 62d is an opening which, when viewed in the plate thickness direction of the second liquid member 62, extends from a portion where the fourth outer wall opening 61e of the first liquid member 61 and the second communication opening 62d overlap each other toward a portion where a third upper opening 63c of the third liquid member 63 and the second communication opening 62d overlap each other. The second communication opening 62d constitutes a second flow path portion B3 included in the second refrigerant flow path B.

(5-3) Third liquid member

[0128] The third liquid member 63 is provided between the second liquid member 62 and the fourth liquid member 64 in the plate thickness direction. The third liquid member 63 has a third plate-shaped part 63a, the third lower opening 63b, and the third upper opening 63c. The third plate-shaped part 63a is a plate-shaped member having a plate thickness direction in the left-right direction and extending in the up-down and front-rear directions. Both the third lower opening 63b and the third upper opening 63c are openings through the third liquid member 63 in the plate thickness direction.

[0129] The third lower opening 63b is an opening that, when viewed from the stacking direction of the third liquid member 63 and the fourth liquid member 64, i.e., in the plate thickness direction of the third liquid member 63, overlaps an introduction region of a lower circulation opening 64b of the fourth liquid member 64.

[0130] The third upper opening 63c is an opening in which, when viewed from the stacking direction of the third liquid member 63 and the fourth liquid member 64, i.e., in the plate thickness direction of the third liquid member 63, an introduction region of the upper circulation opening 64c of the third liquid member 63 and the third lower opening 63b overlap each other.

(5-4) Fourth liquid member

[0131] The fourth liquid member 64 is positioned between the third liquid member 63 and the fifth liquid member 65 in the plate thickness direction, and has a fourth plate-shaped part 64a, the lower circulation opening 64b, and the upper circulation opening 64c. The fourth plate-shaped part 64a is a plate-shaped member having a plate thickness direction in the left-right direction and extending in the up-down and front-rear directions. Both the lower circulation opening 64b and the upper circulation opening 64c are openings through the fourth liquid member 64 in the plate thickness direction.

[0132] The plate thickness of the fourth liquid member 64 is thinner than the plate thickness of a liquid insertion plate portion 421b, i.e., the plate thickness of the second

common member 42. Accordingly, when the lower circulation opening 64b and the upper circulation opening 64c are formed in the fourth liquid member 64 by punching, it is possible to suppress breakage of the punch member.

[0133] As shown in a schematic configuration diagram of the fourth liquid member 64 as viewed in the plate thickness direction in Fig. 11, the lower circulation opening 64b includes an introduction region 81b, a narrow region 82b, and a circulation region 83b. In the refrigerant flow when the outdoor heat exchanger 11 functions as the evaporator of the refrigerant, the refrigerant that has flowed into the introduction region 81b from the third lower opening 63b of the third liquid member 63 increases the flow speed when passing through the narrow region 82b, which is a nozzle, and is sent out to the circulation region 83b.

[0134] The introduction region 81b is provided at the rear lower end of the lower circulation opening 64b. As shown in Fig. 11, when viewed in the plate thickness direction of the fourth liquid member 64, the introduction region 81b is provided at a position overlapping the third lower opening 63b of the third liquid member 63.

[0135] The narrow region 82b is provided between the introduction region 81b and an ascending region 831b of the circulation region 83b. The width of the narrow region 82b in the front-rear direction is narrower than the width of the introduction region 81b in the front-rear direction, narrower than the width of the circulation region 83b in the front-rear direction, and narrower than the width of the ascending region 831b in the front-rear direction. Accordingly, the flow speed of the refrigerant passing through the narrow region 82b can be increased, which, when the outdoor heat exchanger 11 is caused to function as the evaporator of the refrigerant, makes it easier to cause the refrigerant sent from the narrow region 82b to the ascending region 831b to reach the vicinity of the upper end of the ascending region 831b. As described above, the plate thickness of the fourth liquid member 64 is thinner than the plate thickness of the liquid insertion plate portion 421b, i.e., the plate thickness of the second common member 42. Accordingly, the width of the narrow region 82b in the left-right direction, which is the direction in which the flat tubes 28 extend, is also reduced, making it possible to further increase the flow rate of the refrigerant passing through the narrow region 82b.

[0136] The circulation region 83b is located above the narrow region 82b, and includes the ascending region 831b, an outgoing region 832b, a descending region 833b, and a return region 834b. Here, when viewed in the plate thickness direction of the fourth liquid member 64, the ascending region 831b is positioned so as to overlap the plurality of liquid split openings 65x provided in the fifth liquid member 65, and thus communicates with the plurality of liquid split openings 65x. The ascending region 831b and the descending region 833b are partitioned in the front-rear direction by a partition portion 64p of the fourth liquid member 64, the partition portion 64p having a longitudinal direction in the up-down direction.

The outgoing region 832b provides communication between the vicinity of the upper end of the ascending region 831b and the vicinity of the upper end of the descending region 833b above the partition portion 64p. The return region 834b provides communication between the vicinity of the lower end of the ascending region 831b and the vicinity of the lower end of the descending region 833b below the partition portion 64p. The partition portion 64p is supported by being connected by a communicating portion 64q of the fourth liquid member 64. The communicating portion 64q extends from the front-side end portion of the descending region 833b toward a part of the partition portion 64p. In order to allow the refrigerant descending in the descending region 833b to reach the lower end of the descending region 833b while avoiding the communicating portion 64q, a descending-side opening 65y is provided in the fifth liquid member 65 on which the fourth liquid member 64 is stacked. With the above configuration, when the outdoor heat exchanger 11 is caused to function as the evaporator of the refrigerant, the refrigerant sent to the introduction region 81b is sent to the circulation region 83b with the flow speed increased in the narrow region 82b. In the ascending region 83b of the circulation region 831b, the refrigerant, while flowing upward, can be split into the plurality of liquid split openings 65x corresponding to the first flow path portion A5 among the plurality of liquid split openings 65x formed in the fifth liquid member 65. Here, even if the refrigerant ascending in the ascending region 831b reaches the vicinity of the upper end of the ascending region 831b without flowing toward the plurality of liquid split openings 65x, the refrigerant can be returned to the ascending region 831b again via the outgoing region 832b, the descending region 833b, and the return region 834b, and can be merged with the refrigerant having a high flow rate that has passed through the narrow region 82b.

[0137] The upper circulation opening 64c has the same shape as the lower circulation opening 64b, and has an introduction region 81c, a narrow region 82c, and a circulation region 83c. In the refrigerant flow when the outdoor heat exchanger 11 functions as the evaporator of the refrigerant, the refrigerant that has flowed into the introduction region 81c from the third upper opening 63c of the third liquid member 63 increases the flow speed when passing through the narrow region 82c, which is a nozzle, and is sent out to the circulation region 83c. Also in the ascending region of the upper circulation opening 64c, the refrigerant, while flowing upward, is split into the liquid split opening 65x corresponding to the second flow path portion B5 among the liquid split openings 65x formed in the fifth liquid member 65.

(5-5) Fifth liquid member

[0138] The fifth liquid member 65 is positioned between the fourth liquid member 64 and the liquid restriction plate portion 431b of the third common member 43 in

the plate thickness direction. The fifth liquid member 65 includes a fifth plate-shaped part 65a, the plurality of liquid split openings 65x, and the descending-side opening 65y. The fifth plate-shaped part 65a is a plate-shaped member having a plate thickness direction in the left-right direction and extending in the up-down and front-rear directions. All of the plurality of liquid split openings 65x are openings through the fifth liquid member 65 in the plate thickness direction.

[0139] The plurality of liquid split openings 65x are provided so as to be arranged in the up-down direction at positions closer to the rear side of the fifth liquid member 65. Here, the rear side of the fifth liquid member 65 corresponds to the windward side of the air flow F when the outdoor fan 16 is driven. Accordingly, because a large amount of refrigerant can be guided to the windward side of the plurality of flat tubes 28, the heat exchange efficiency can be increased.

[0140] The first flow path portion 65x corresponding to the plurality of liquid split openings A5 overlap and communicate with the ascending region 831b of the lower circulation opening 64b corresponding to the first flow path portion A4 in the plate thickness direction of the fifth liquid member 65. The plurality of liquid split openings 65x corresponding to the second flow path portion B5 overlap and communicate with the ascending region 831c of the upper circulation opening 64c corresponding to the second flow path portion B4 in the plate thickness direction of the fifth liquid member 65.

(5-6) Liquid-side part of third common member

[0141] The third common member 43 includes, as a liquid-side part of the third common member 43, the liquid restriction plate portion 431b constituting a part of the liquid header portion 60 of the restriction plate portion 431.

[0142] The liquid restriction plate portion 431b is stacked so as to face and be in contact with the left-side surface of the fifth liquid member 65, and to face and be in contact with the right-side surface of the liquid insertion plate portion 421b of the second common member 42. The liquid restriction plate portion 431b has a plurality of liquid restriction openings 432b constituting a part of the liquid header portion 60 among the plurality of restriction openings 432.

[0143] The plurality of liquid restriction openings 432b are arranged in the up-down direction, and are openings through the liquid restriction plate portion 431b in the plate thickness direction. The front and rear edges of the liquid restriction opening 432b are positioned inside the front and rear edges of the liquid insertion openings 422b when viewed in the plate thickness direction of the liquid restriction plate portion 431b. The width of the plurality of liquid restriction openings 432b in the front-rear direction is narrower than the width of the flat tube 28 in the front-rear direction. As a result, the tip-end of the flat tube 28 in the insertion direction abuts the edges of the liquid re-

striction opening 432b, whereby the insertion position is defined. The upper and lower edges of the plurality of liquid restriction openings 432b are positioned outside the front and rear edges of the flat tube 28.

[0144] The plurality of liquid restriction openings 432b corresponding to the first flow path portion A6 overlap and communicate with the plurality of liquid split openings 65x corresponding to the first flow path portion A5 in the plate thickness direction of the liquid restriction plate portion 431b. In addition, the plurality of liquid restriction openings 432b corresponding to the second flow path portion B6 overlap and communicate with the plurality of liquid split openings 65x corresponding to the second flow path portion B5 in the plate thickness direction of the liquid restriction plate portion 431b.

(5-7) Liquid-side part of second common member

[0145] The second common member 42 includes, as a liquid-side part of the second common member 42, the liquid insertion plate portion 421b of the insertion plate portion 421 constituting a part of the liquid header portion 60.

[0146] The liquid insertion plate portion 421b is stacked so as to face and be in contact with the right-side surface of the liquid tube plate portion 411b of the first common member 41, and to face and be in contact with the left-side surface of the liquid restriction plate portion 431b. The liquid insertion plate portion 421b includes a plurality of liquid insertion openings 422b constituting a part of the liquid header portion 60 among the plurality of insertion openings 422.

[0147] The plurality of liquid insertion openings 422b are arranged in the up-down direction, and are openings through the liquid insertion plate portion 421b in the plate thickness direction. When viewed in the plate thickness direction of the liquid insertion plate portion 421b, the front and rear edges of the liquid insertion openings 422b are positioned outside the front and rear edges of liquid connection openings 412b, which are the openings of the liquid header portion 60 among the flat tube connection openings 412. Further, the upper and lower edges of the plurality of liquid insertion openings 422b are positioned outside the upper and lower edges of the liquid connection openings 412b when viewed in the plate thickness direction of the liquid insertion plate portion 421b. When viewed in the plate thickness direction of the liquid insertion plate portion 421b, the contour of the liquid insertion openings 422b does not overlap the contour of the flat tubes 28, and is positioned outside the contour of the flat tubes 28. As a result, the tip-end of the flat tube 28 in the insertion direction is inserted so as to pass through the liquid insertion opening 422b. Further, even if there is excess brazing material at the time of brazing, a clearance is ensured between the flat tube 28 and the liquid insertion opening 422b, and the excess brazing material can be guided thereto. Therefore, the flow path of the flat tube 28 is prevented from being blocked by the excess

brazing material.

[0148] The plurality of liquid insertion openings 422b corresponding to the first flow path portion A7 overlap and communicate with the plurality of liquid restriction openings 432b corresponding to the first flow path portion A6 in the plate thickness direction of the liquid insertion plate portion 421b. In addition, the plurality of liquid insertion openings 422b corresponding to the second flow path portion B7 overlap and communicate with the plurality of liquid restriction openings 432b corresponding to the second flow path portion B6 in the plate thickness direction of the liquid insertion plate portion 421b.

(5-8) Liquid-side part of first common member

[0149] The first common member 41 includes, as the liquid-side parts of the first common member 41: a liquid tube plate portion 411b constituting a part of the liquid header portion 60 in the tube plate portion 411; a first liquid side plate portion 413b constituting a part of the liquid header portion 60 in the first side plate portion 413; a second liquid side plate portion 414b constituting a part of the liquid header portion 60 in the second side plate portion 414; a first liquid crimping claw 415b constituting a part of the liquid header portion 60 in the first crimping claw 415; and a second liquid crimping claw 416b constituting a part of the liquid header portion 60 in the second crimping claw 416. The liquid-side part of the first common member 41 mainly constitutes the periphery of the outer shape of the liquid header portion 60 together with the first liquid member 61.

[0150] The liquid tube plate portion 411b is stacked so as to face and be in contact with the left-side surface of the liquid insertion plate portion 421b. The liquid tube plate portion 411b has a plurality of liquid connection openings 412b constituting a part of the liquid header portion 60 among the plurality of flat tube connection openings 412.

[0151] The plurality of liquid connection openings 412b are arranged in the up-down direction, and are openings through the liquid tube plate portion 411b in the plate thickness direction. The contour of the liquid connection opening 412b has a shape that follows the contour of the flat tube 28. As a result, the flat tube 28 is brazed to the liquid connection opening 412b in a state where the tip-end of the flat tube 28 in the insertion direction has passed through the liquid connection opening 412b and the outer periphery of the flat tube 28 is in contact with the inner periphery of the liquid connection opening 412b.

[0152] The plate thickness of the liquid tube plate portion 411b is smaller than that of the liquid insertion plate portion 421b. Accordingly, because the contour of the liquid connection opening 412b has a shape that follows the contour of the flat tube 28, even if friction occurs between the circumferential surface of the flat tube 28 and the inner periphery of the liquid connection opening 412b when the flat tube 28 is inserted, the degree of the friction is suppressed, and thus the flat tube 28 is easily

inserted. On the other hand, a greater plate thickness is ensured for the liquid insertion plate portion 421b stacked on the liquid tube plate portion 411b than that of the liquid tube plate portion 411b. Accordingly, it is possible to increase the pressure resistance strength of the liquid header portion 60 in the insertion portion for the flat tube 28.

[0153] The first liquid side plate portion 413b is a plate-shaped part extending from the front-side edge of the liquid tube plate portion 411b toward the right side. The second liquid side plate portion 414b is a plate-shaped part extending from the rear-side edge of the tube plate portion 411 toward the right side. The first liquid side plate portion 413b and the second liquid side plate portion 414b are provided so as to face each other in the front-rear direction, thereby clamping the liquid insertion plate portion 421b, the liquid restriction plate portion 431b, the fifth liquid member 65, the fourth liquid member 64, the third liquid member 63, the second liquid member 62, and the first liquid member 61 in the front-rear direction.

[0154] The first liquid crimping claw 415b comprises a plurality of crimping claws provided at predetermined intervals in the up-down direction at the right-side end portion of the first liquid side plate portion 413b. The second liquid crimping claw 416b comprises a plurality of crimping claws provided at predetermined intervals in the up-down direction at the right-side end portion of the second liquid side plate portion 414b. In a state before crimping, the first liquid crimping claw 415b extends rightward on an extension of the first liquid side plate portion 413b, and the second liquid crimping claw 416b extends rightward on an extension of the second liquid side plate portion 414b. Then, in a state where the liquid tube plate portion 411b, the liquid insertion plate portion 421b, the liquid restriction plate portion 431b, the fifth liquid member 65, the fourth liquid member 64, the third liquid member 63, the second liquid member 62, and the first liquid member 61 are stacked, the liquid insertion plate portion 421b, the liquid restriction plate portion 431b, the fifth liquid member 65, the fourth liquid member 64, the third liquid member 63, the second liquid member 62, and the first liquid member 61 are crimped and integrated by folding the first liquid crimping claw 415b and the second liquid crimping claw 416b so as to approach each other in the front-rear direction. In this state, brazing is performed in a furnace or the like, whereby the members are bonded and completely fixed to each other by brazing.

[0155] Accordingly, the lengths of the first liquid side plate portion 413b and the second liquid side plate portion 414b in the left-right direction in which the flat tubes 28 extend correspond to the lengths in the front-rear direction in a state where the liquid insertion plate portion 421b, the liquid restriction plate portion 431b, the fifth liquid member 65, the fourth liquid member 64, the third liquid member 63, the second liquid member 62, and the first liquid member 61 are stacked on the liquid tube plate portion 411b.

[0156] In the inlet/outlet header 40 of the present embodiment, in the left-right direction, which is the direction in which the flat tubes 28 extend, the lengths of the first gas side plate portion 413a and the second gas side plate portion 414a are different from the lengths of the first liquid side plate portion 413b and the second liquid side plate portion 414b. Specifically, in the left-right direction, which is the direction in which the flat tubes 28 extend, the lengths of the first gas side plate portion 413a and the second gas side plate portion 414a are shorter than the lengths of the first liquid side plate portion 413b and the second liquid side plate portion 414b.

(6) Features of embodiment

[0157] In the inlet/outlet header 40 included in the outdoor heat exchanger 11 of the air-conditioning apparatus 1, the gas header portion 50 positioned above the inlet/outlet header 40 and the liquid header portion 60 positioned below the inlet/outlet header 40 are arranged vertically. In the inlet/outlet header 40, the first common member 41 crimps and integrates a plurality of members constituting the gas header portion 50 and a plurality of members constituting the liquid header portion 60. Thus, the strength of the inlet/outlet header 40 including the gas header portion 50 and the liquid header portion 60 can be increased.

[0158] Here, the gas header portion 50 has a structure in which the refrigerant that has flowed through the single gas refrigerant connection pipe 19a and into the gas space 50S is split into the plurality of flat tubes 28 connected to the gas header portion 50. The liquid header portion 60 has a structure in which the refrigerant that has flowed through the single liquid refrigerant connection pipe 20a and into the liquid space 60S is split into the first refrigerant flow path A and the second refrigerant flow path B before being split into the plurality of flat tubes 28 connected to the liquid header portion 60. Thus, the refrigerant is split into a plurality of tiers, so that it is possible to suppress separation of the refrigerant in a gas-liquid two-phase state into liquid refrigerant and gas refrigerant. Thus, in order to achieve different functions in the gas header portion 50 and the liquid header portion 60, the number of constituent members of the gas header portion 50 is made different from the number of constituent members of the liquid header portion 60. Specifically, the gas header portion 50 is formed by stacking the four members of the gas tube plate portion 411a of the first common member 41, the gas insertion plate portion 421a of the second common member 42, the gas restriction plate portion 431a of the third common member 43, and the gas space-forming member 51. The liquid header portion 60 is formed by stacking the eight members of the liquid tube plate portion 411b of the first common member 41, the liquid insertion plate portion 421b of the second common member 42, the liquid restriction plate portion 431b of the third common member 43, the fifth liquid member 65, the fourth liquid member 64, the third liquid

member 63, the second liquid member 62, and the first liquid member 61.

[0159] Thus, even when the number of constituent members of the gas header portion 50 is different from the number of constituent members of the liquid header portion 60, the gas header portion 50 and the liquid header portion 60 are provided with different lengths by making, for the first common member 41, the lengths of the first gas side plate portion 413a and the second gas side plate portion 414a in the left-right direction correspond to the number of stacked layers in the gas header portions 50, and making the lengths of the first liquid side plate portion 413b and the second liquid side plate portion 414b in the left-right direction correspond to the number of stacked layers in the liquid header portion 60. Accordingly, even when the number of constituent members of the gas header portion 50 and the number of constituent members of the liquid header portion 60 are different from each other, the gas header portion 50 and the liquid header portion 60 can be easily integrated by the first common member 41 as a single member, and an increase in strength can be achieved. Furthermore, because the first common member 41 as a single member enables integration of the gas header portion 50 and integration of the liquid header portion 60, it is possible to reduce the number of components compared to when a member for integrating the gas header portion 50 and a member for integrating the liquid header portion 60 are separately provided.

[0160] In the inlet/outlet header 40, not only the first common member 41 but also the second common member 42 and the third common member 43 are shared between the gas header portion 50 and the liquid header portion 60. Accordingly, the strength of the inlet/outlet header 40 can be further increased.

[0161] In addition, because the gas header portion 50 of the present embodiment uses the gas space-forming member 51 having the protruding portion 51b, the wide gas space 50S can be ensured by means of the single gas space-forming member 51. Thus, in the gas space-forming member 51 having the protruding portion 51b, the flat part 51a that the first gas crimping claw 415a and the second gas crimping claw 416a abut when the gas space-forming member 51 is crimped by the first common member 41 has a shape extending in parallel to the flat part of the gas restriction plate portion 431a. Accordingly, the gas space-forming member 51 can not only ensure a wide gas space 50S with one member, but also easily ensure the fixing strength when crimped by the first common member 41.

[0162] As described above, in the liquid header portion 60, the refrigerant that has flowed in via the liquid refrigerant connection pipe 20a can be split inside the liquid header portion 60 before being split into the plurality of flat tubes 28. Accordingly, it is not necessary to provide a conventionally known flow splitter separately from the liquid header portion 60, so that it is possible to make the installation space compact, reduce component costs,

and eliminate the need for a connecting operation for the conventionally known flow splitter.

(7) Other embodiments

(7-1) Other embodiment A

[0163] In the above embodiment, an example has been described where the outdoor heat exchanger 11 includes the inlet/outlet header 40 in which the single gas header portion 50 and the single liquid header portion 60 are arranged each in the longitudinal direction, and the refrigerant flows while being turned back once in the return header 30.

[0164] However, the outdoor heat exchanger 11 is not limited thereto, and may be, for example, an outdoor heat exchanger in which the refrigerant flows while being turned back twice. In this case, by providing a header portion having a structure corresponding to the return header 30 above the liquid header portion 60 and below the gas header portion 50, it is possible to provide a heat exchanger in which the refrigerant flows while being turned back twice.

(7-2) Other embodiment B

[0165] In the above-described embodiment, the first common member 41 has been described where, as an example, the lengths of the first gas side plate portion 413a and the second gas side plate portion 414a in the left-right direction are shorter than the lengths of the first liquid side plate portion 413b and the second liquid side plate portion 414b in the left-right direction.

[0166] However, the first common member 41 is not particularly limited and, when the stacked portion of the gas header portion 50 is longer than the stacked portion of the liquid header portion 60 in the left-right direction, the lengths of the first gas side plate portion 413a and the second gas side plate portion 414a in the left-right direction may be longer than the lengths of the first liquid side plate portion 413b and the second liquid side plate portion 414b in the left-right direction.

(7-3) Other embodiment C

[0167] In the above-described embodiment, an example has been described where the liquid header portion 60 is provided with the first connection pipe 71 having the temperature sensor 99 and the second connection pipe 72, and the refrigerant flows from the first liquid member 61 toward the side opposite to the connection parts of the flat tubes 28.

[0168] However, as shown in Fig. 12, for example, the first connection pipe 71 having the temperature sensor 99 and the second connection pipe 72 in the above embodiment may be omitted, and the liquid header portion 60 may have a second liquid member 62 in which a branch communication opening 62b' is provided instead

of the branch opening 62b, the first communication opening 62c, and the second communication opening 62d in the above embodiment. The branch communication opening 62b' is a single opening in which the branch opening 62b and the first communication opening 62c of the above-described embodiment are integrally connected (A1' directly connecting A1 and A3 of the first flow path portion is formed), and the branch opening 62b and the second communication opening 62d of the above-described embodiment are integrally connected (B1' directly connecting B1 and B3 of the second flow path portion is formed). In this embodiment, the first liquid member 61 does not have the respective openings of the first outer wall opening 61b, the second outer wall opening 61c, the third outer wall opening 61d, and the fourth outer wall opening 61e, and closes the branch communication opening 62b' of the second liquid member 62 from the right side.

(Additional remark)

[0169] While the embodiments of the present disclosure have been described above, it will be understood that various changes in form or detail may be made thereto without departing from the spirit and scope of the present disclosure as set forth in the appended claims.

REFERENCE SIGNS LIST

[0170]

1 AIR-CONDITIONING APPARATUS (REFRIG-
ERATION APPARATUS)
2 OUTDOOR UNIT
3 CONTROL UNIT
11 OUTDOOR HEAT EXCHANGER (HEAT EX-
CHANGER)
19 FIRST GAS REFRIGERANT PIPE
19a GAS REFRIGERANT CONNECTION PIPE
20 LIQUID REFRIGERANT PIPE
20a LIQUID REFRIGERANT CONNECTION PIPE
27 HEAT EXCHANGE PORTION
28 FLAT TUBE
28x FIRST FLAT TUBE
28y SECOND FLAT TUBE
28z THIRD FLAT TUBE
30 RETURN HEADER
40 INLET/OUTLET HEADER (HEADER)
41 FIRST COMMON MEMBER (FIRST MEMBER)
42 SECOND COMMON MEMBER (INTERMEDI-
ATE MEMBER, THIRD MEMBER)
43 THIRD COMMON MEMBER (INTERMEDIATE
MEMBER, SECOND MEMBER)
50 GAS HEADER PORTION
51 GAS SPACE-FORMING MEMBER
51a FLAT PART
51b PROTRUDING PORTION

58 BOTTOM PLATE
 59 TOP PANEL
 60 LIQUID HEADER PORTION
 61 FIRST LIQUID MEMBER (LIQUID MEMBER)
 62 SECOND LIQUID MEMBER (LIQUID MEMBER) 5
 62b BRANCH OPENING
 63 THIRD LIQUID MEMBER (LIQUID MEMBER)
 64 FOURTH LIQUID MEMBER (LIQUID MEMBER)
 65 FIFTH LIQUID MEMBER (LIQUID MEMBER)
 65x LIQUID SPLIT OPENING 10
 71 FIRST CONNECTION PIPE
 72 SECOND CONNECTION PIPE
 99 TEMPERATURE SENSOR
 411 TUBE PLATE PORTION (FIRST PORTION)
 411a GAS TUBE PLATE PORTION (FIRST PORTION) 15
 411b LIQUID TUBE PLATE PORTION (FIRST PORTION)
 412 FLAT TUBE CONNECTION OPENING
 412a GAS CONNECTION OPENING 20
 412b LIQUID CONNECTION OPENING
 413 FIRST SIDE PLATE PORTION (FIRST CLAMPING PORTION, SECOND CLAMPING PORTION)
 413a FIRST GAS SIDE PLATE PORTION (FIRST CLAMPING PORTION) 25
 413b FIRST LIQUID SIDE PLATE PORTION (SECOND CLAMPING PORTION)
 414 SECOND SIDE PLATE PORTION (FIRST CLAMPING PORTION, SECOND CLAMPING PORTION) 30
 414a SECOND GAS SIDE PLATE PORTION (FIRST CLAMPING PORTION)
 414b SECOND LIQUID SIDE PLATE PORTION (SECOND CLAMPING PORTION)
 415 FIRST CRIMPING CLAW 35
 415a FIRST GAS CRIMPING CLAW (FIRST CRIMPING PORTION)
 415b FIRST LIQUID CRIMPING CLAW (SECOND CRIMPING PORTION)
 416 SECOND CRIMPING CLAW 40
 416a SECOND GAS CRIMPING CLAW (FIRST CRIMPING PORTION)
 416b SECOND LIQUID CRIMPING CLAW (SECOND CRIMPING PORTION)
 421 INSERTION PLATE PORTION 45
 421a GAS INSERTION PLATE PORTION
 421b LIQUID INSERTION PLATE PORTION
 422 INSERTION OPENING (SECOND OPENING)
 422a GAS INSERTION OPENING (SECOND OPENING) 50
 422b LIQUID INSERTION OPENING (SECOND OPENING)
 431 RESTRICTION PLATE PORTION
 431a GAS RESTRICTION PLATE PORTION
 431b LIQUID RESTRICTION PLATE PORTION 55
 432 RESTRICTION OPENING (FIRST OPENING)
 432a GAS RESTRICTION OPENING (FIRST OPENING)

432b LIQUID RESTRICTION OPENING (FIRST OPENING)
 A FIRST REFRIGERANT FLOW PATH
 B SECOND REFRIGERANT FLOW PATH
 C MERGING FLOW PATH

CITATION LIST

PATENT LITERATURE

[0171] PTL 1: Japanese Unexamined Patent Application Publication No. 2022-043207

Claims

1. A heat exchanger (11) comprising:
 - a plurality of flat tubes (28) arranged in a first direction; and
 - a header (40) to which the flat tubes are connected,
 wherein:
 - the header includes a gas header portion (50) and a liquid header portion (60) arranged in the first direction;
 - the header includes one or a plurality of gas members (51), one or a plurality of liquid members (61, 62, 63, 64, 65), and a first member (41) extending over the gas header portion and the liquid header portion;
 - the first member and the gas member form the gas header portion;
 - the first member and the liquid member form the liquid header portion; and
 - the first member integrates a first predetermined number of the gas members and a second predetermined number of the liquid members, the second predetermined number being different from the first predetermined number.
2. The heat exchanger according to claim 1, wherein:
 - the first member and the gas member are arranged stacked in a second direction which is a direction in which the flat tubes extend; and
 - the first member and the liquid member are arranged stacked in the second direction.
3. The heat exchanger according to claim 2, wherein the header further includes one or more intermediate members (42, 43) extending between the first member and the gas member and between the first member and the liquid member.
4. The heat exchanger according to claim 3, wherein the first member integrates the gas member, the

liquid member, and the intermediate member.

5. The heat exchanger according to claim 3 or 4, wherein:
the one or more intermediate members include a second member (43);

the second member has a plurality of first openings (432, 432a, 432b); and
a contour of the first opening has a portion overlapping a contour of the flat tubes as viewed in the second direction.
6. The heat exchanger according to claim 5, wherein:
the one or more intermediate members further include a third member (42);

the third member is stacked between the first member and the second member in the second direction, and has a plurality of second openings (422, 422a, 422b); and
a contour of the second opening is positioned outside the contour of the flat tubes when viewed in the second direction.
7. The heat exchanger according to any one of claims 2 to 6, wherein:
the first member includes a first part (411, 411a, 411b) extending on a plane orthogonal to the second direction, and a pair of first clamping portions (413a, 414a) and a pair of second clamping portions (413b, 414b) extending from the first part in the second direction;

when a direction intersecting both the first direction and the second direction is defined as a third direction,
the first clamping portions clamp the first predetermined number of the gas members in the third direction;
the second clamping portions clamp the second predetermined number of the liquid members in the third direction; and
a length of the first clamping portions in the second direction is different from a length of the second clamping portions in the second direction.
8. The heat exchanger according to claim 7, wherein
the first clamping portions include a first crimping portion (415a, 416a) at an end portion on a side opposite to the first part side in the second direction; and
the second clamping portions include a second crimping portion (415b, 416b) at an end portion on a side opposite to the first part side in the second direction.

9. The heat exchanger according to any one of claims 2 to 8, wherein the gas member includes a gas space-forming member (51) having a protruding portion (51b) protruding toward a side away from a connection part between the flat tubes and the first member in the second direction when viewed in the first direction.

10. The heat exchanger according to claim 8, wherein:
the gas member includes a gas space-forming member (51) having a protruding portion (51b) protruding toward a side away from a connection part between the flat tubes and the first member in the second direction when viewed in the first direction;

the gas space-forming member has a flat part extending in a plane orthogonal to the second direction; and
the flat part is crimped by the first crimping portion and the second crimping portion.

11. The heat exchanger according to any one of claims 1 to 10, wherein the gas member and the liquid member include a plate-shaped part.

12. The heat exchanger according to any one of claims 1 to 11, further comprising a return header (30) which is connected to an end portion of the flat tubes on the opposite side to the end portion on the side of the gas header portion and the liquid header portion side, and guides the refrigerant that has passed through the gas header portion to the liquid header portion side or guides the refrigerant that has passed through the liquid header portion to the gas header portion side.

13. A refrigeration apparatus (1) comprising the heat exchanger according to any one of claims 1 to 12.

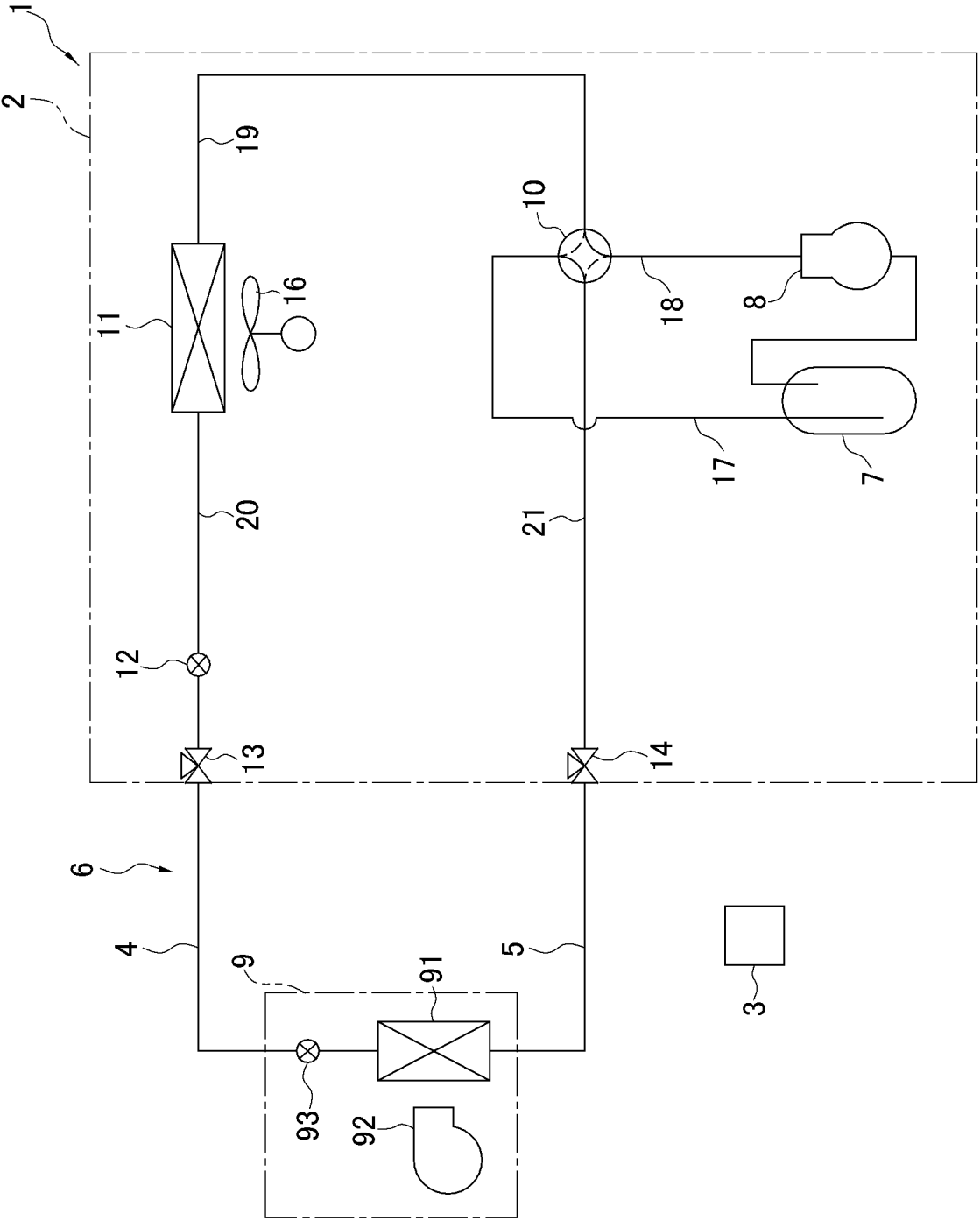


FIG. 1

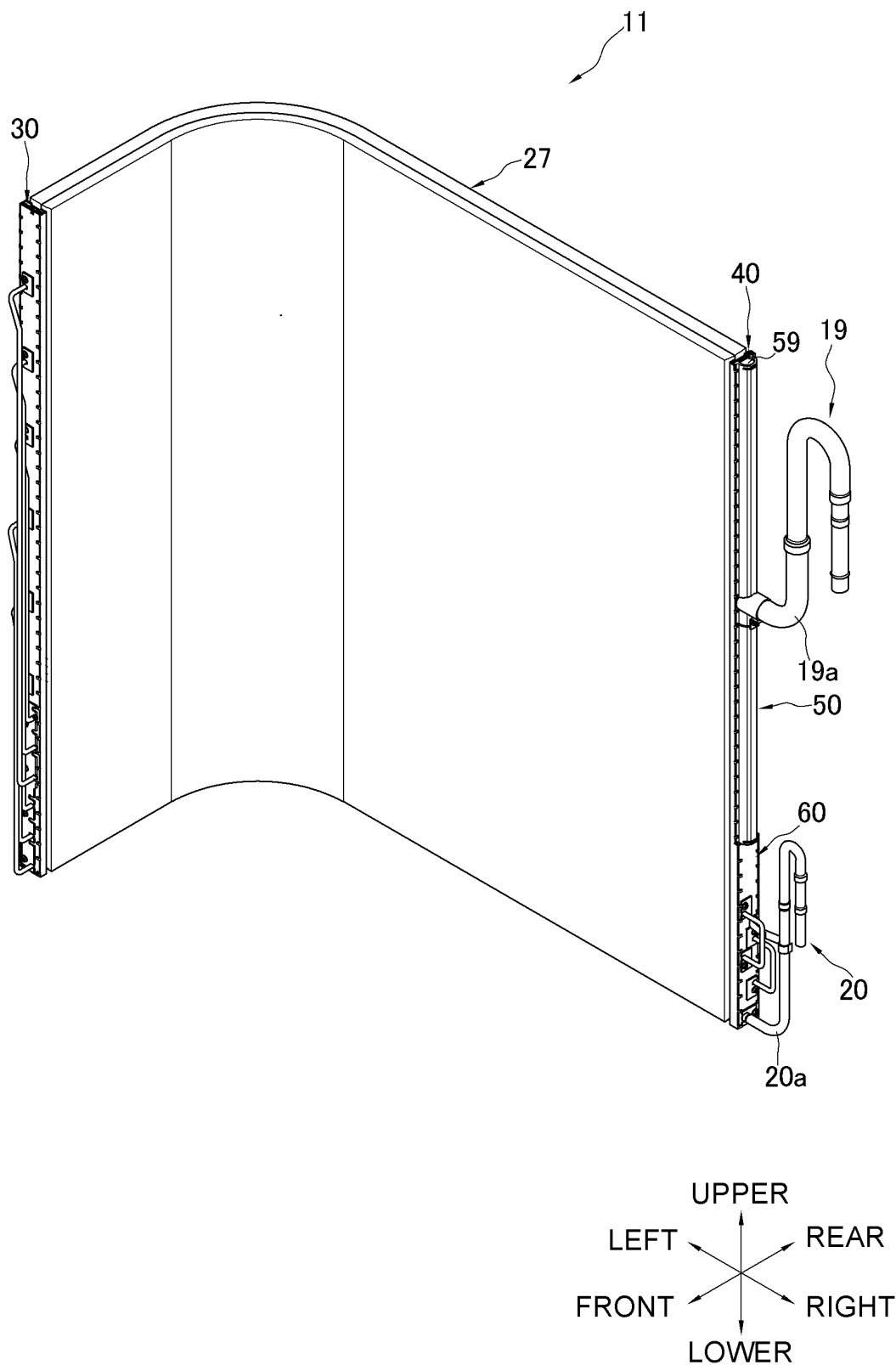


FIG. 2

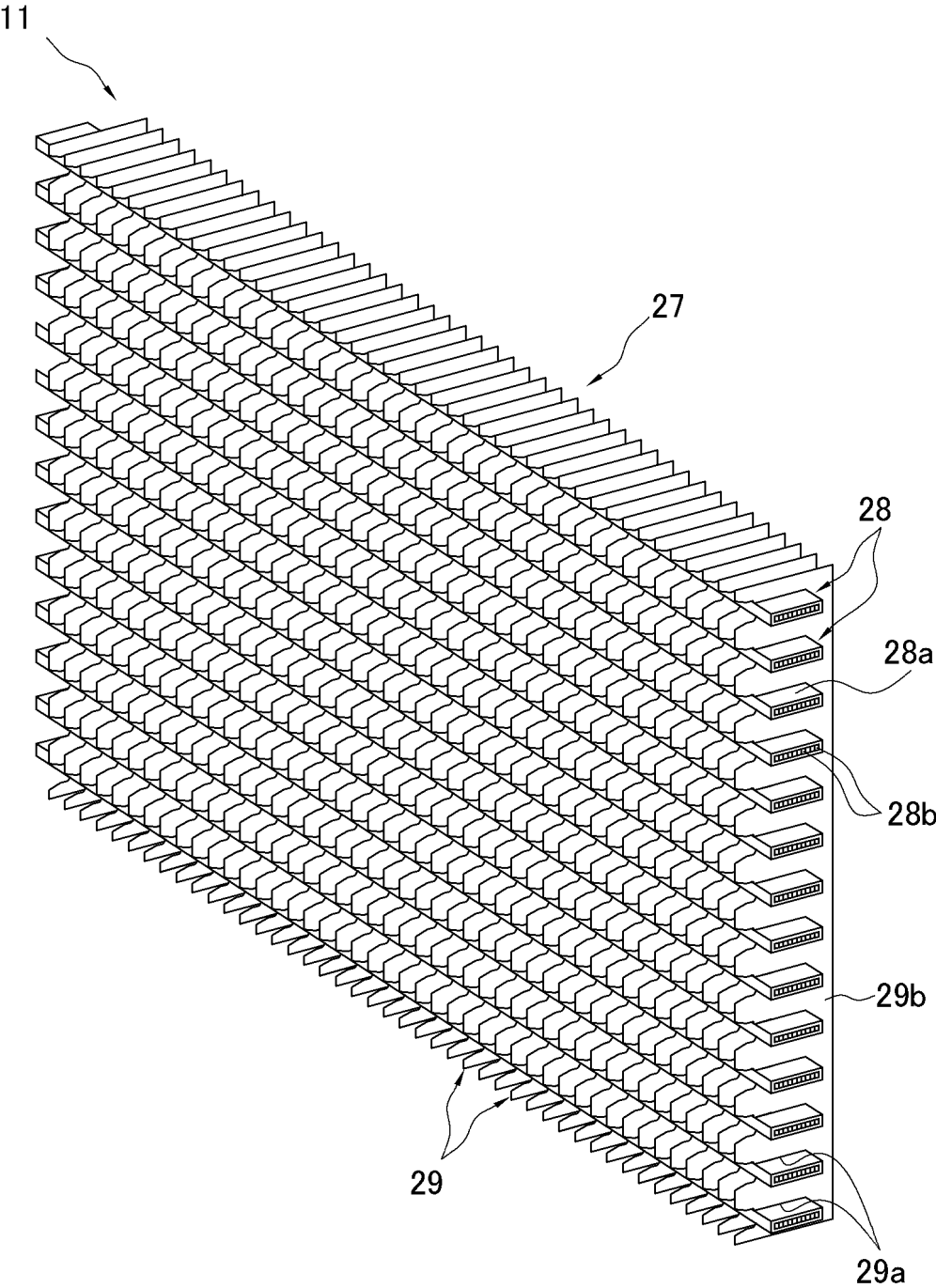


FIG. 3

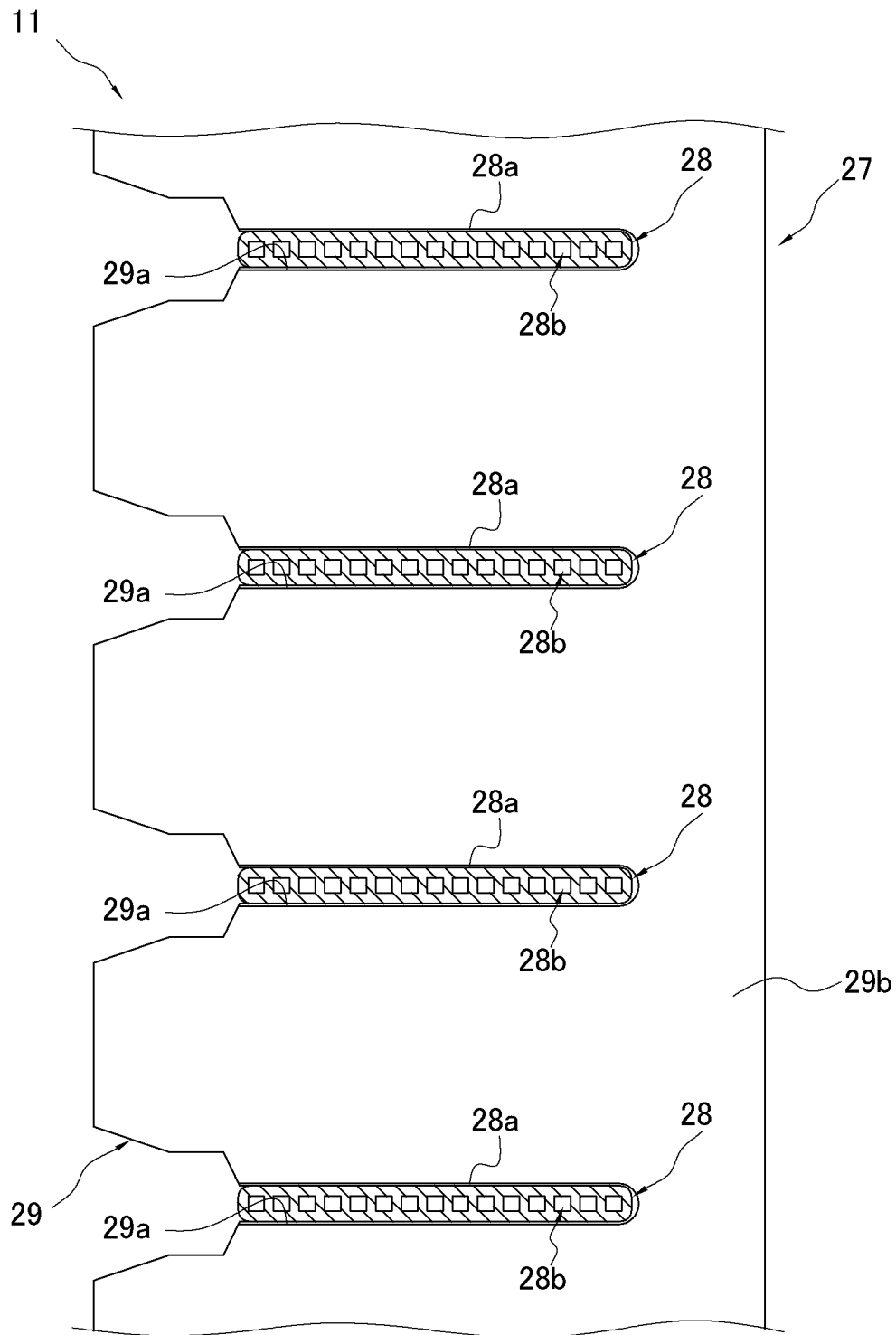


FIG. 4

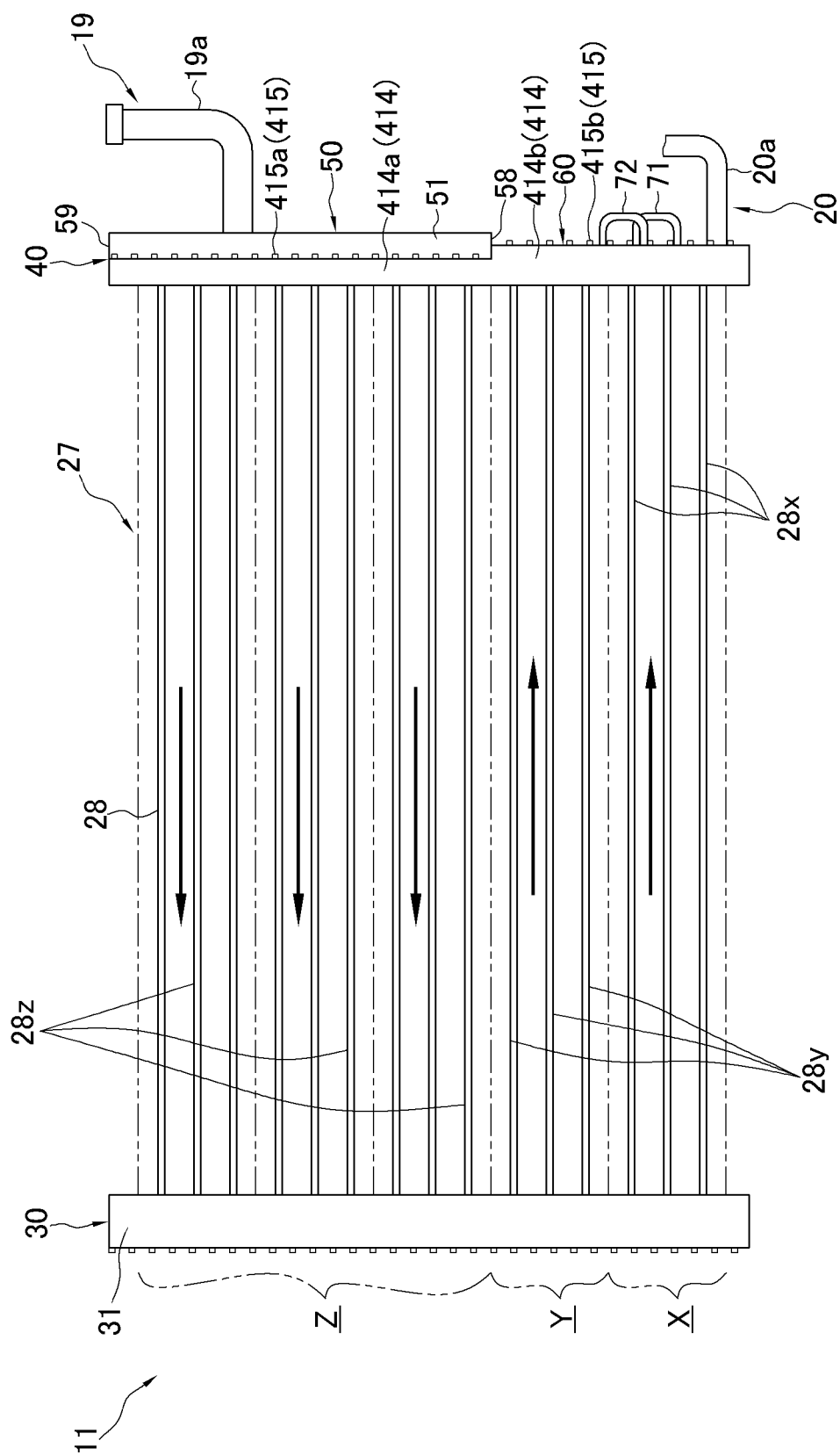


FIG. 5

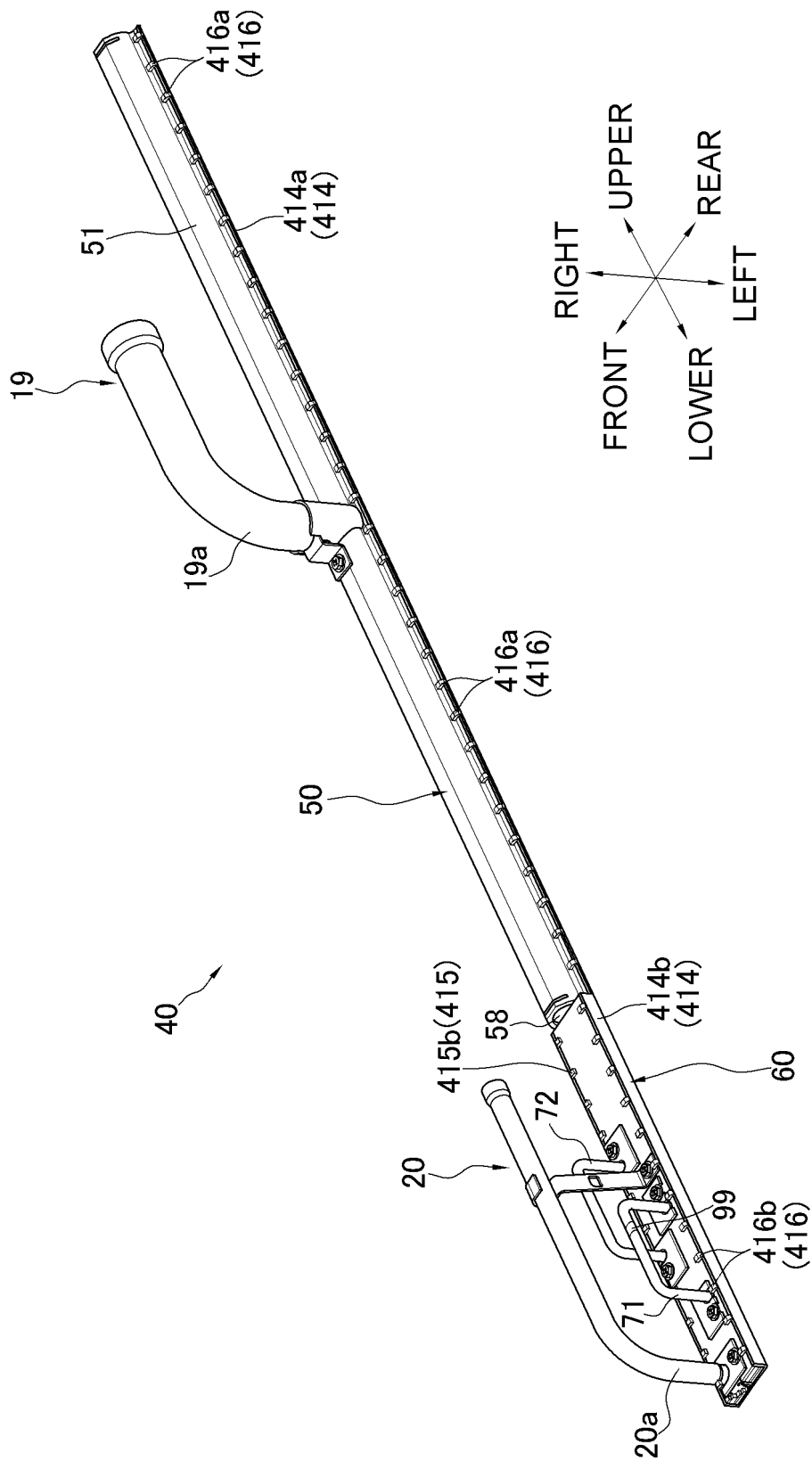


FIG. 6

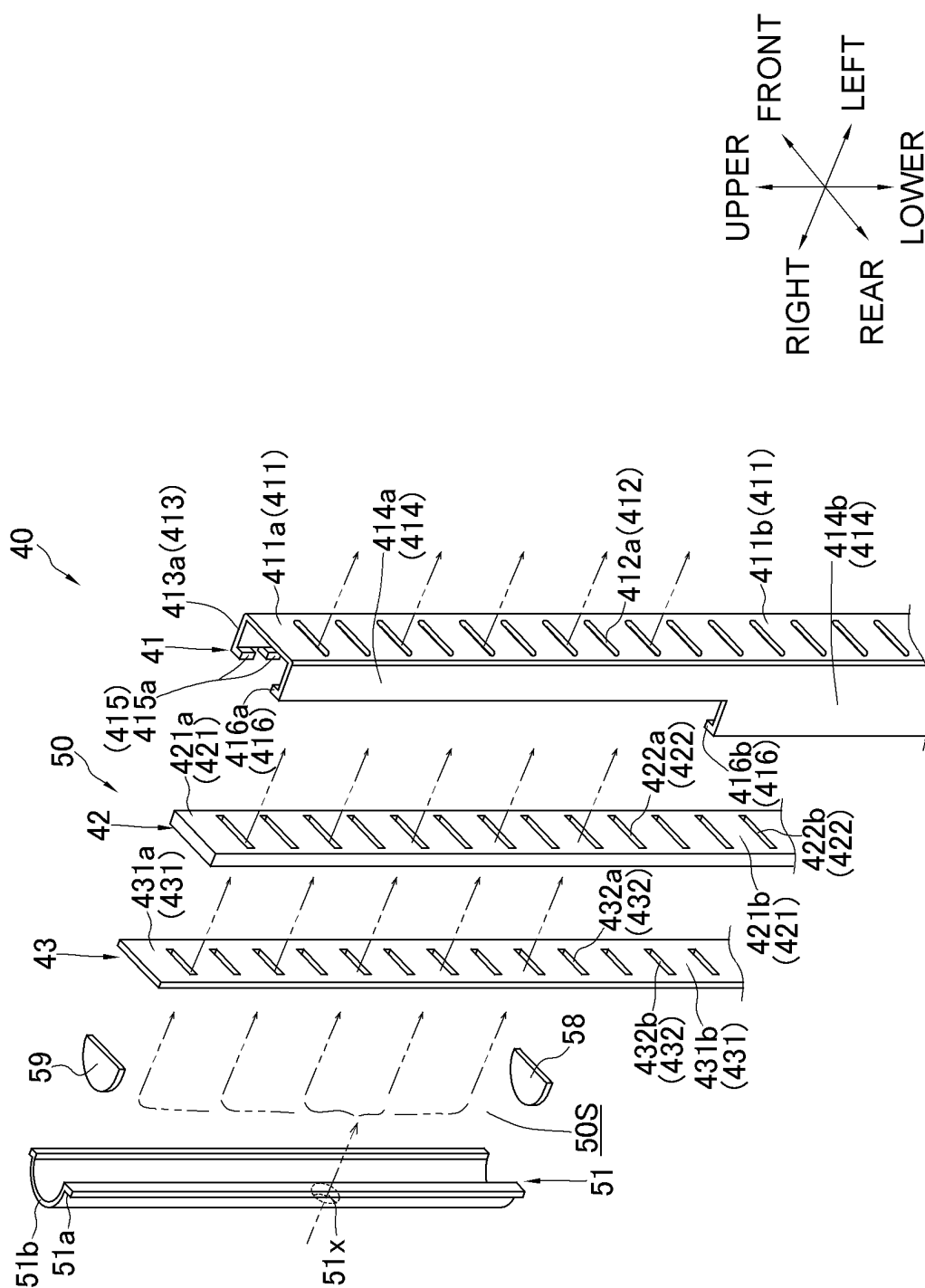


FIG. 7

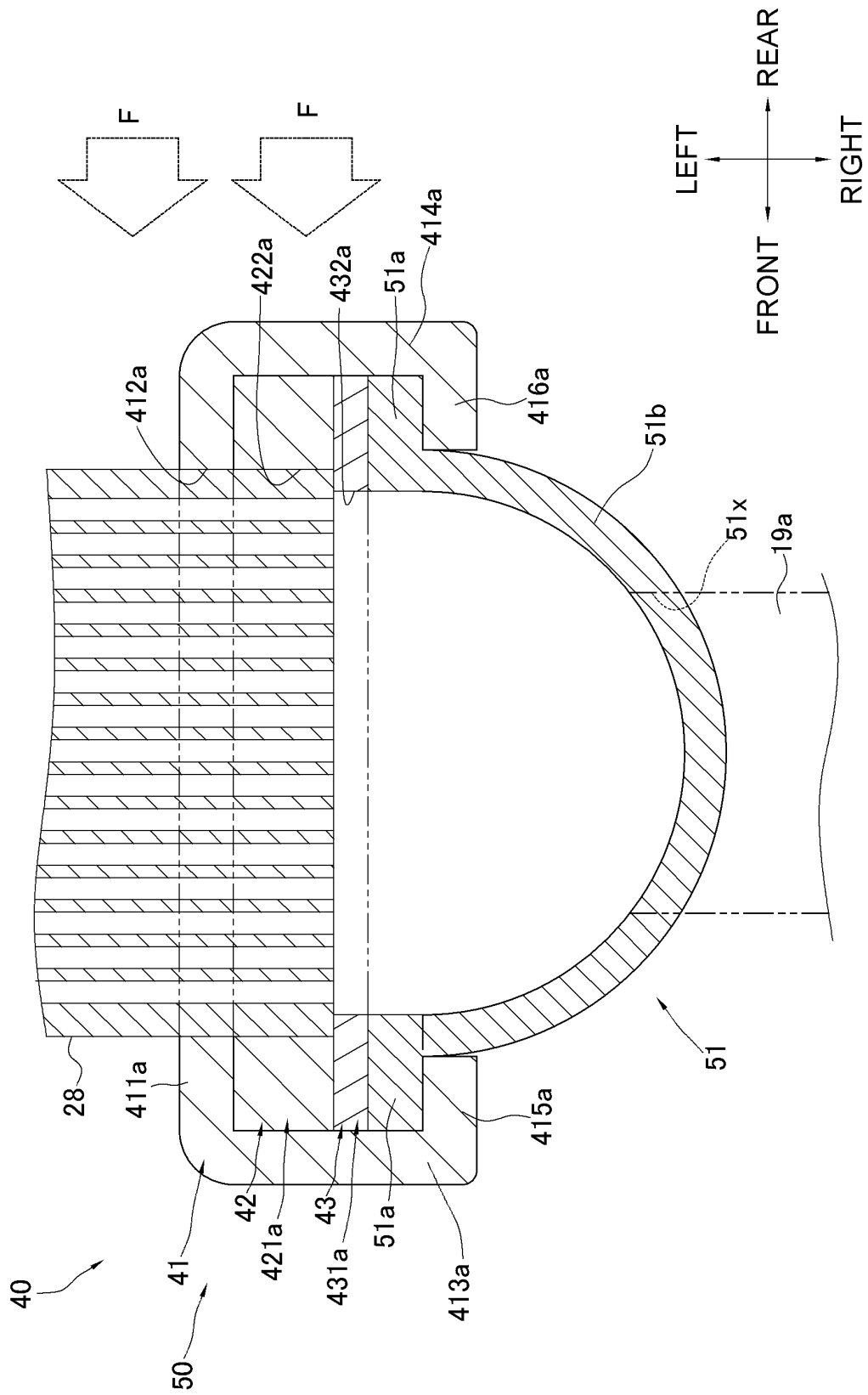


FIG. 8

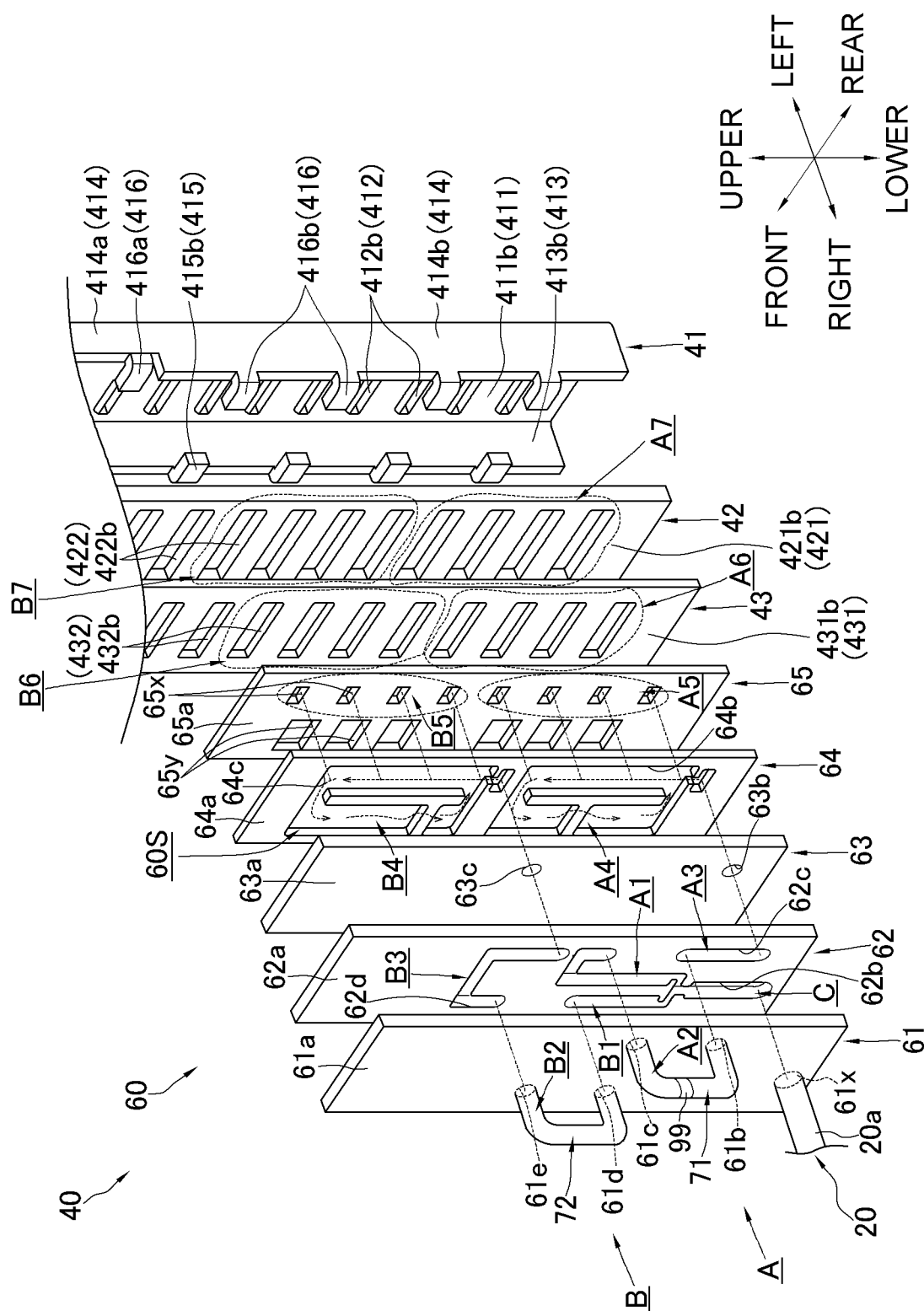


FIG. 9

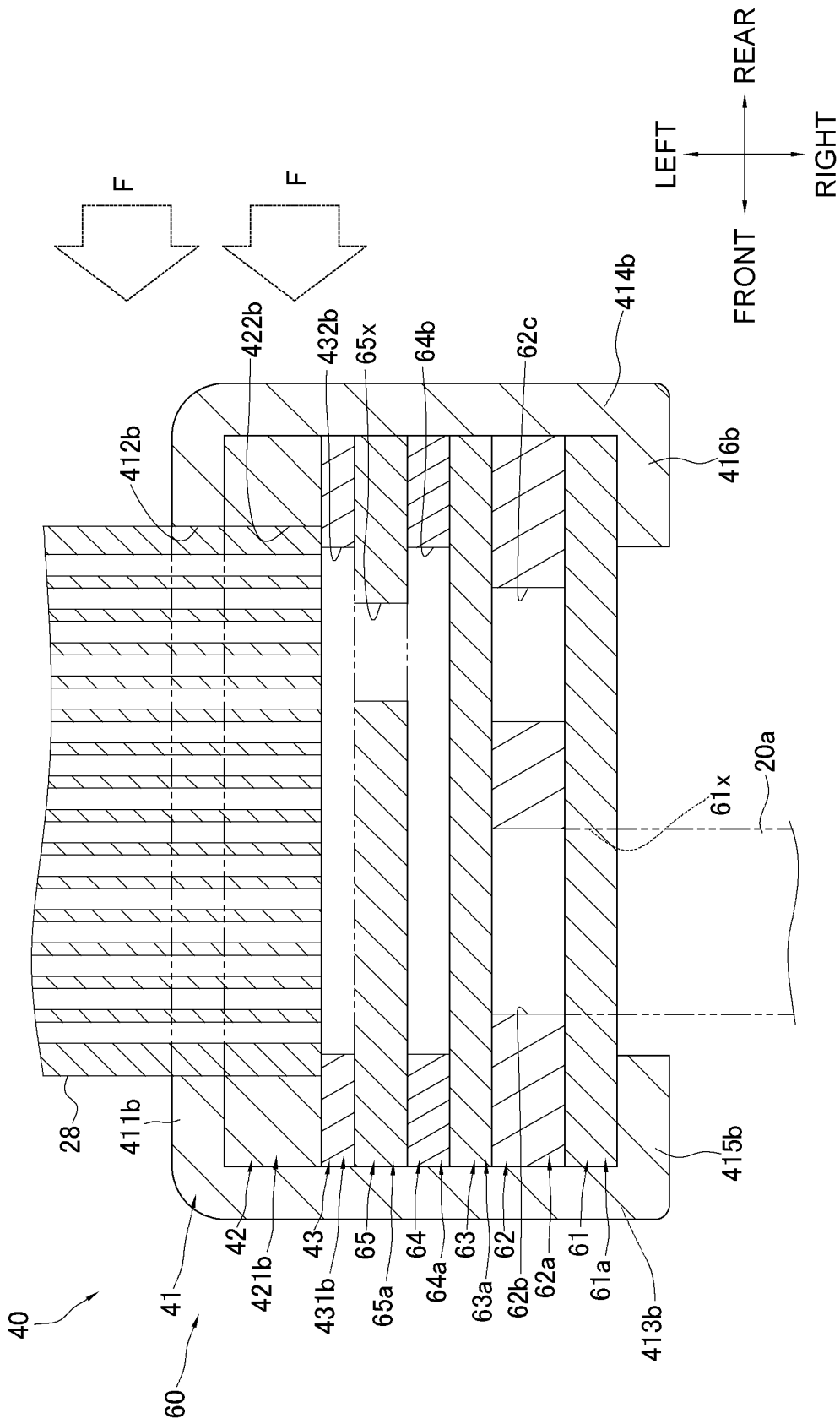


FIG. 10

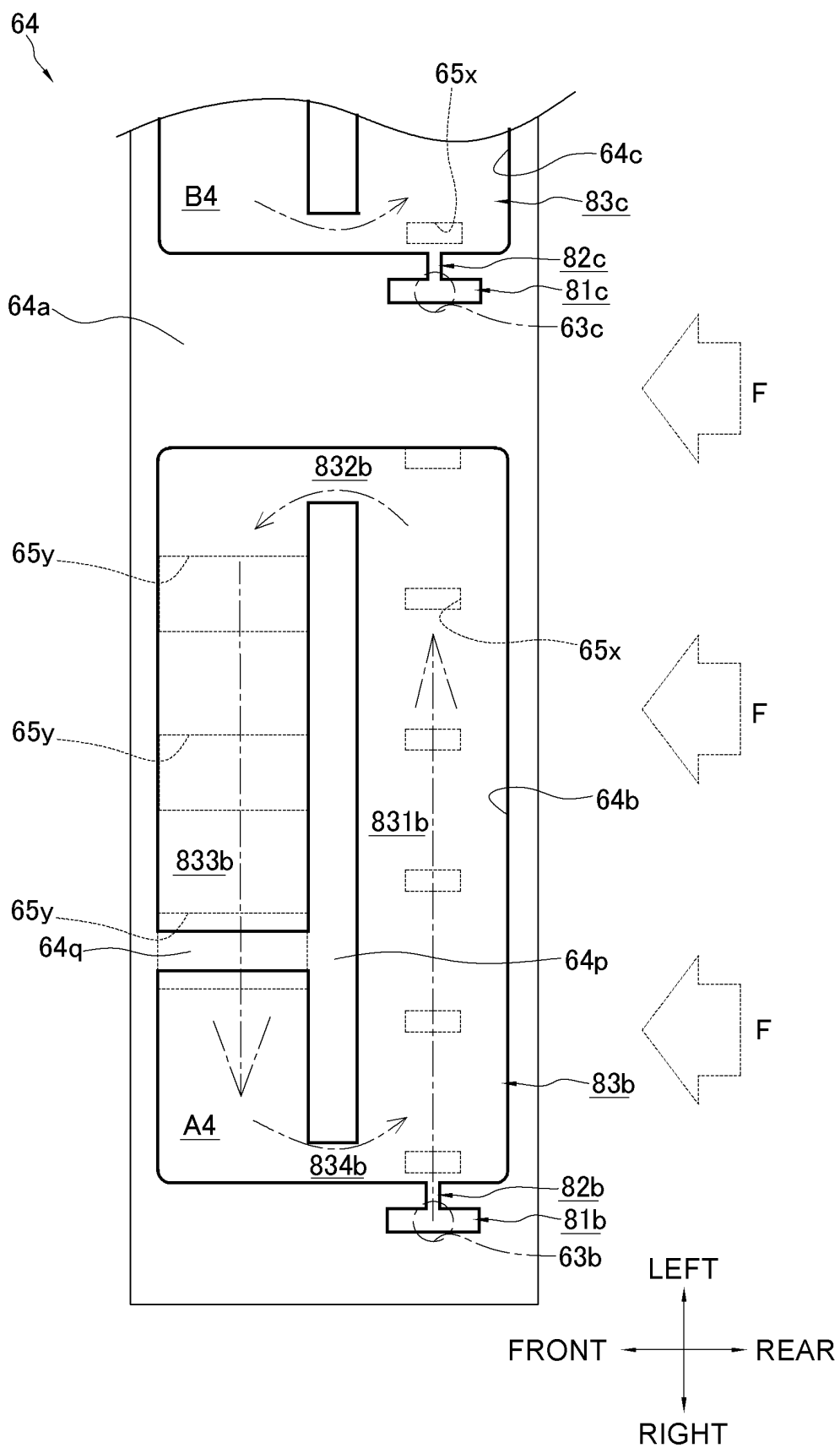


FIG. 11

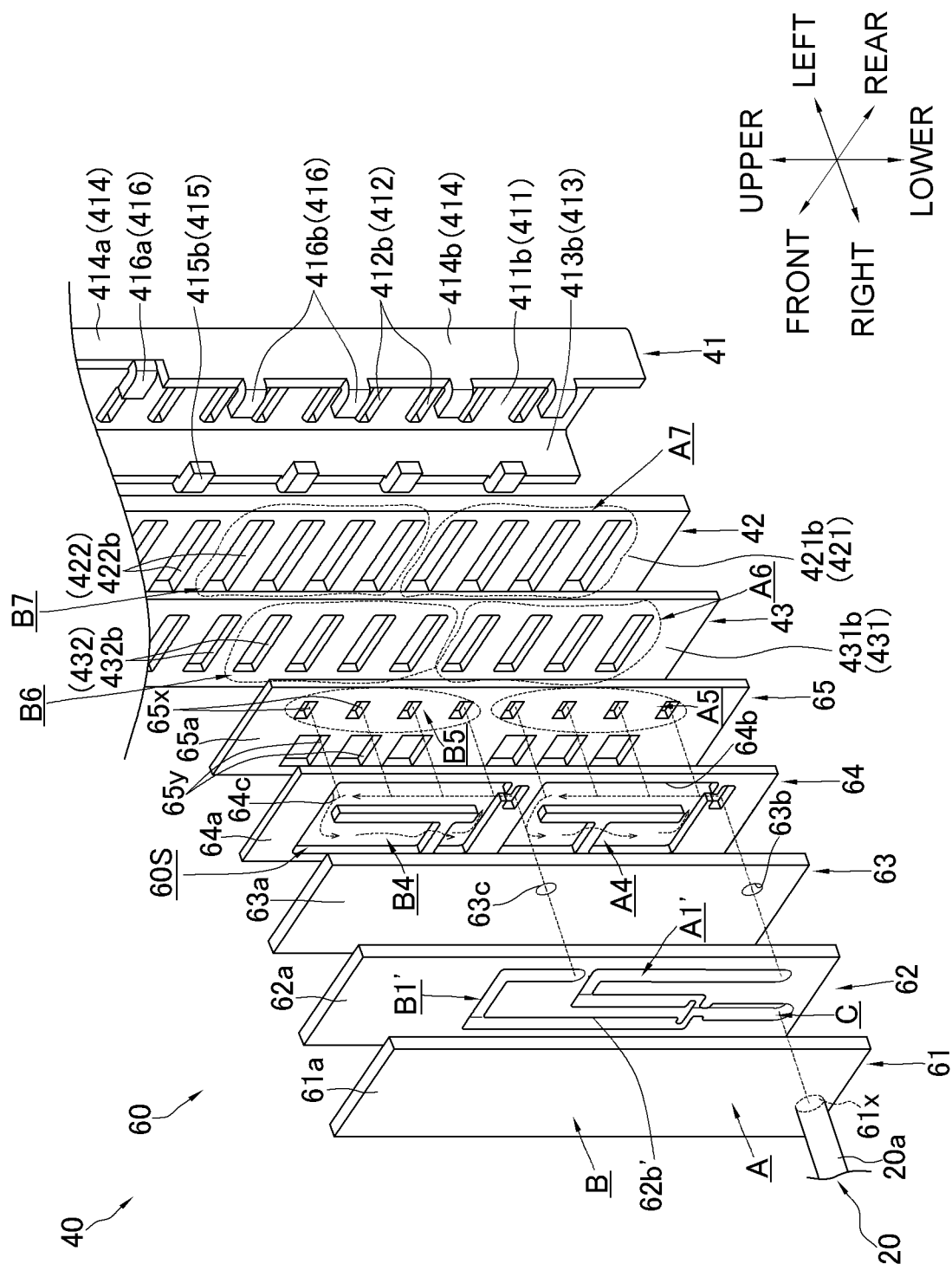


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/034058

A. CLASSIFICATION OF SUBJECT MATTER

F28F 9/02(2006.01)i; **F25B 49/02**(2006.01)i; **F28D 1/053**(2006.01)i; **F28F 1/02**(2006.01)i; **F28F 9/00**(2006.01)i;
F28F 9/22(2006.01)i

FI: F28F9/02 301D; F28F9/02 301J; F25B49/02 510B; F28D1/053 A; F28F1/02 B; F28F9/02 301Z; F28F9/22; F28F9/00 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)

F28F9/02; F25B49/02; F28D1/053; F28F1/02; F28F9/00; F28F9/22

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2024
 Registered utility model specifications of Japan 1996-2024
 Published registered utility model applications of Japan 1994-2024

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2013-15233 A (DAIKIN INDUSTRIES, LTD.) 24 January 2013 (2013-01-24) paragraphs [0001]-[0058], fig. 1-13	1-13
Y	JP 2020-173071 A (MITSUBISHI HEAVY IND THERMAL SYSTEMS LTD.) 22 October 2020 (2020-10-22) paragraphs [0001]-[0091], fig. 1-11	1-13
A	JP 2005-273957 A (JAPAN CLIMATE SYSTEMS CORPORATION) 06 October 2005 (2005-10-06) paragraphs [0001]-[0111], fig. 1-17	1-13
A	JP 2019-56544 A (DAIKIN INDUSTRIES, LTD.) 11 April 2019 (2019-04-11) paragraphs [0001]-[0159], fig. 1-20	1-13
A	JP 2006-242432 A (DENSO CORPORATION) 14 September 2006 (2006-09-14) paragraphs [0001]-[0072], fig. 1-7	1-13

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

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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

17 October 2024

Date of mailing of the international search report

05 November 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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2024/034058

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2013-139931 A (DAIKIN INDUSTRIES, LTD.) 18 July 2013 (2013-07-18) paragraphs [0001]-[0081], fig. 1-18	1-13
A	WO 2019/207838 A1 (HITACHI-JOHNSON CONTROLS AIR CONDITIONING, INC.) 31 October 2019 (2019-10-31) paragraphs [0068]-[0069], fig. 16A-16C	1-13

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/034058

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2013-15233	A	24 January 2013	(Family: none)	
JP	2020-173071	A	22 October 2020	(Family: none)	
JP	2005-273957	A	06 October 2005	(Family: none)	
JP	2019-56544	A	11 April 2019	US 2020/0025428 A1 paragraphs [0001]-[0179], fig. 1-20	
				WO 2018/181828 A1	
				EP 3605001 A1	
				CN 110476035 A	
				AU 2018242788 A1	
JP	2006-242432	A	14 September 2006	(Family: none)	
JP	2013-139931	A	18 July 2013	(Family: none)	
WO	2019/207838	A1	31 October 2019	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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