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(54) HEAT EXCHANGER

(57) Provided is a heat exchanger capable of causing a refrigerant to be branched and flow so as to minimize an imbalance in the ratio between a gas phase refrigerant and a liquid phase refrigerant. An outdoor heat exchanger (11) comprises a liquid header (60) and a plurality of heat transfer tubes (28) connected to the liquid header (60). The liquid header (60) includes a first flow path (A), a second flow path (B), and a third flow path (C) which are connected to each other at a connecting portion (P). The first flow path (A) extends in a first direction which is the vertical direction, the second flow path (B) extends in a second direction, and the third flow path (C) extends in a third direction. The second direction and the third direction have symmetry with respect to a virtual plane including a line extending in the vertical direction from the connecting portion (P) and a line extending in a direction in which the flat tubes (28) extend from the connecting portion. The first flow path includes a first narrowed portion (81).

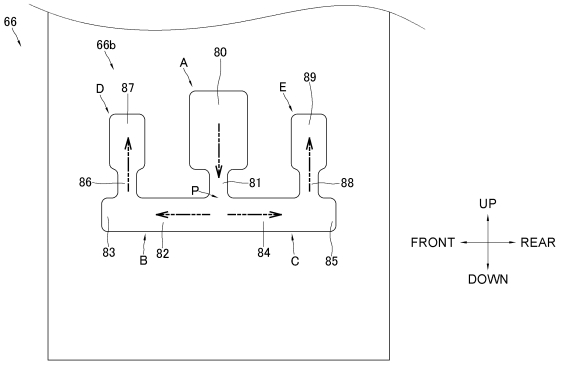


FIG. 10

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Description

Technical Field

[0001] The present invention relates to a heat exchanger.

Background Art

[0002] Conventionally, in a heat exchanger used in a refrigeration cycle apparatus, a plurality of heat transfer tubes are connected to a header in which a refrigerant is split and distributed to the heat transfer tubes.

[0003] For example, in a heat exchanger described in PTL 1 (International Publication No. 2015/049727), it is proposed to provide a plurality of locations where the refrigerant flow path is branched inside the header, so that the refrigerant flow is divided into a plurality of flows and sent to the respective heat transfer tubes.

Summary of Invention

Technical Problem

[0004] However, in the above-described heat exchanger, for example, when refrigerants having different specific gravities, such as a gas-phase refrigerant and a liquid-phase refrigerant, flow together inside the header, an imbalance may occur in the amount of refrigerant between the refrigerants after being branched inside the header.

Solution to Problem

[0005] A heat exchanger according to a first aspect includes a header and a plurality of heat transfer tubes. The plurality of heat transfer tubes are connected to the header. The header includes a first flow path, a second flow path, and a third flow path. The first flow path, the second flow path, and the third flow path are connected at a connecting portion. The first flow path extends in a first direction which is a vertical direction. The second flow path extends in a second direction. The third flow path extends in a third direction. The second direction and the third direction have symmetry with respect to a virtual plane including a line extending in the vertical direction from the connecting portion and a line extending in a direction in which the heat transfer tubes extend from the connecting portion. The first flow path includes a first narrowed portion.

[0006] In this heat exchanger, since the refrigerant flowing through the first flow path of the header is branched into the second flow path and the third flow path with the flow speed of the refrigerant increased when passing through the first narrowed portion, it is possible to suppress an imbalance in the amount of the refrigerant in the branch flow paths.

[0007] A heat exchanger according to a second aspect is the heat exchanger according to the first aspect, wherein the second direction and the third direction are horizontal directions.

[0008] In this heat exchanger, it is possible to minimize an imbalance in the amount of refrigerant due to the influence of gravity between the refrigerant branched and flowing through the second flow path and the refrigerant branched and flowing through the third flow path.

[0009] A heat exchanger according to a third aspect is the heat exchanger according to the first aspect or the second aspect, wherein the first narrowed portion is connected to the connecting portion.

[0010] In this heat exchanger, it is possible to cause the refrigerant to be branched and flow through the second flow path and the third flow path immediately after the flow speed of the refrigerant is increased in the first narrowed portion. Therefore, it is possible to further suppress the imbalance in the amount of refrigerant in the branch flow paths.

[0011] A heat exchanger according to a fourth aspect is the heat exchanger according to the third aspect, wherein the first narrowed portion is positioned above the connecting portion.

[0012] In this heat exchanger, since the refrigerant flowing from the first flow path toward the connecting portion passes downward through the first narrowed portion, the flow speed of the refrigerant is likely to increase due to gravity.

[0013] A heat exchanger according to a fifth aspect is the heat exchanger according to any of the first aspect to the fourth aspect, wherein the header is a stacked header in which a plurality of plate members including a first plate member are stacked. The first plate member forms the first flow path, the second flow path, and the third flow path.

[0014] The first plate member may form at least a part of the first flow path, at least a part of the second flow path, and at least a part of the third flow path.

[0015] In this heat exchanger, it is easy to form the first flow path, the second flow path, and the third flow path in the header.

[0016] A heat exchanger according to a sixth aspect is the heat exchanger according to any of the first aspect to the fifth aspect, wherein the second flow path includes a second narrowed portion. The third flow path includes a third narrowed portion.

[0017] In this heat exchanger, it is easy to suppress an imbalance in the amount of refrigerant between the refrigerant that has passed through the second narrowed portion of the second flow path and the refrigerant that has passed through the third narrowed portion of the third flow path.

[0018] A heat exchanger according to a seventh aspect is the heat exchanger according to any of the first aspect to the sixth aspect, wherein the flow path area of the second flow path and the flow path area of the third flow path are the same. The flow path length of the second flow path and the flow path length of the third

flow path are the same.

[0019] In this heat exchanger, the degree of pressure loss when the refrigerant flows through the second flow path and the degree of pressure loss when the refrigerant flows through the third flow path can be made close to each other.

[0020] A heat exchanger according to an eighth aspect is the heat exchanger according to any of the first aspect to the seventh aspect, further comprising a fourth flow path and a fifth flow path. The fourth flow path is connected to the second flow path and extends in a direction different from the direction in which the second flow path extends. The fifth flow path is connected to the third flow path and extends in a direction different from the direction in which the third flow path extends.

[0021] In this heat exchanger, the refrigerant flowing through the second flow path can be guided in a direction different from the direction in which the second flow path extends, and the refrigerant flowing through the third flow path can be guided in a direction different from the direction in which the third flow path extends.

[0022] A heat exchanger according to a ninth aspect is the heat exchanger according to the eighth aspect, wherein both the fourth flow path and the fifth flow path extend upward, or both the fourth flow path and the fifth flow path extend downward.

[0023] In this heat exchanger, by aligning the connection direction of the fourth flow path with respect to the second flow path and the connection direction of the fifth flow path with respect to the third flow path, it is easy to minimize the imbalance in the refrigerant amount between the refrigerant flowing through the fourth flow path and the refrigerant flowing through the fifth flow path.

[0024] A heat exchanger according to a tenth aspect is the heat exchanger according to the eighth aspect or the ninth aspect, wherein the second flow path includes a first protrusion. The first protrusion protrudes toward the opposite side to the connecting portion side with respect to a connection area between the second flow path and the fourth flow path in the direction in which the second flow path extends. The third flow path has a second protrusion. The second protrusion protrudes toward the opposite side to the connecting portion side with respect to a connection area between the third flow path and the fifth flow path in the direction in which the third flow path extends.

[0025] In this heat exchanger, even if a lump of liquid refrigerant is included in the refrigerant flowing through the second flow path, the lump of liquid refrigerant is easily guided to the first protrusion, and thus the lump of liquid refrigerant is suppressed from being sent to the fourth flow path as is. Similarly, even if a lump of liquid refrigerant is included in the refrigerant flowing through the third flow path, the lump of liquid refrigerant is easily guided to the second protrusion, and thus the lump of liquid refrigerant is suppressed from being sent to the fifth flow path as is.

[0026] A heat exchanger according to an eleventh aspect is the heat exchanger according to any of the eighth aspect to the tenth aspect, wherein the fourth flow path includes a fourth narrowed portion. The fifth flow path includes a fifth narrowed portion.

[0027] In this heat exchanger, the refrigerant that has passed through the fourth narrowed portion easily reaches the end part of the fourth flow path, and the refrigerant that has passed through the fifth narrowed portion easily reaches the end part of the fifth flow path.

[0028] A heat exchanger according to a twelfth aspect is the heat exchanger according to any of the eighth aspect to the eleventh aspect, further comprising a first connection pipe having both ends connected to the header, and a second connection pipe having both ends connected to the header. The first connection pipe constitutes at least a part of a flow path connecting the fourth flow path and a sixth flow path which is a flow path inside the header. The second connection pipe constitutes at least a part of a flow path connecting the fifth flow path and a seventh flow path which is a flow path inside the header.

[0029] In this heat exchanger, the refrigerant sent to the fourth flow path can be guided to the sixth flow path, which is a flow path inside the header spaced apart from the fourth flow path, and the refrigerant sent to the fifth flow path can be guided to the seventh flow path, which is a flow path inside the header spaced apart from the fifth flow path.

[0030] A heat exchanger according to a thirteenth aspect is the heat exchanger according to any of the first aspect to the twelfth aspect, wherein the first flow path has a first portion having a flow path cross-sectional area larger than that of the first narrowed portion. The flow path cross-sectional area of the second flow path and the flow path cross-sectional area of the third flow path are smaller than the flow path cross-sectional area of the first portion.

[0031] In this heat exchanger, an imbalance in the amount of refrigerant flowing through the second flow path and the third flow path is suppressed.

[0032] A heat exchanger according to a fourteenth aspect is the heat exchanger according to any of the first aspect to the thirteenth aspect, wherein the header includes a plate-shaped member in which a first opening part and a second opening part are formed. The first opening part forms at least a part of the connecting portion, the first flow path, the second flow path, and the third flow path. The second opening is isolated from the first opening part, and forms an eighth flow path which is a flow path other than the first flow path, the second flow path, and the third flow path.

[0033] In this heat exchanger, it is possible to form the connecting portion, the first flow path, the second flow path, the third flow path, and the eighth flow path, which is a flow path separate from the above, in a single plate-shaped member.

[0034] A heat exchanger according to a fifteenth aspect is the heat exchanger according to any of the first

aspect to the fourteenth aspect, wherein the refrigerant flows from the first flow path toward the connecting portion when the heat exchanger functions as an evaporator of the refrigerant.

[0035] In this heat exchanger, it is possible to improve the performance by suppressing a biased flow of the liquid refrigerant when the heat exchanger is caused to function as an evaporator of the refrigerant.

Brief Description of Drawings

[0036]

[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 a state of a refrigerant flow when the outdoor heat exchanger is made to function as an evaporator of the refrigerant.

[Fig. 6] Fig. 6 is a schematic exploded perspective view of a gas header.

[Fig. 7] Fig. 7 is a schematic horizontal cross-sectional configuration diagram of the gas header.

[Fig. 8] Fig. 8 is a schematic exploded perspective view of a liquid header.

[Fig. 9] Fig. 9 is a schematic horizontal sectional configuration diagram of the liquid header.

[Fig. 10] Fig. 10 shows a partially enlarged view of the vicinity of the lower end of a sixth liquid-side portion in the liquid header.

[Fig. 11] Fig. 11 is an explanatory view of how the refrigerant flows in the liquid header when the outdoor heat exchanger functions as an evaporator of the refrigerant.

[Fig. 12] Fig. 12 is a schematic exploded perspective view of the liquid header according to another embodiment A.

[Fig. 13] Fig. 13 is an explanatory view of how the refrigerant flows in the liquid header when the outdoor heat exchanger according to the other embodiment A functions as an evaporator of the refrigerant.

[Fig. 14] Fig. 14 is a partially enlarged view of the vicinity of the lower end of the sixth liquid-side portion in the liquid header according to another embodiment B.

[Fig. 15] Fig. 15 is a partially enlarged view of the vicinity of the lower end of the sixth liquid-side portion in the liquid header according to another embodiment C.

[Fig. 16] Fig. 16 is a partially enlarged view of the vicinity of the lower end of the sixth liquid-side portion in the liquid header according to another embodiment D.

[Fig. 17] Fig. 17 shows a partially enlarged view of the vicinity of the lower end of the sixth liquid-side portion in the liquid header according to another embodiment E.

[Fig. 18] Fig. 18 is a partially enlarged view of the vicinity of the lower end of the sixth liquid-side portion in the liquid header according to another embodiment F.

[Fig. 19] Fig. 19 is a partially enlarged view of the vicinity of the lower end of the sixth liquid-side portion in the liquid header according to another embodiment G.

[Fig. 20] Fig. 20 is a schematic configuration diagram of the sixth liquid-side portion in the liquid header according to another embodiment H.

Description of Embodiments

[0037] 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

[0038] Hereinafter, an air-conditioning apparatus 1 as an example of a refrigeration cycle apparatus including a heat exchanger according to an embodiment will be described with reference to the drawings.

[0039] Fig. 1 is a schematic configuration diagram of the air-conditioning apparatus 1 having the heat exchanger according to the embodiment of the present disclosure as an outdoor heat exchanger 11.

[0040] 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, CO_2, and R32.

[0041] 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 configuring a refrigerant circuit 6.

[0042] 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 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

[0043] The outdoor unit 2 is installed outside the space to be air-conditioned, such as on the roof of a building or near a wall surface of the building, for example.

[0044] The outdoor unit 2 includes, mainly, an accumulator 7, a compressor 8, a four-way switching valve 10, an outdoor heat exchanger 11 (an example of "heat exchanger"), an outdoor expansion valve 12, a liquid-side shutoff valve 13, a gas-side shutoff valve 14, and an outdoor fan 16.

[0045] 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.

[0046] 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.

[0047] 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 an 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).

[0048] 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.

[0049] 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.

[0050] The accumulator 7 is a container having a gas-liquid separation function of separating the incoming refrigerant into a gas refrigerant and a liquid refrigerant. The accumulator 7 is also a container having a function of storing excess refrigerant generated in response to fluctuations in operation load or the like.

[0051] 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.

[0052] The outdoor fan 16 is a fan for sucking 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

[0053] The indoor unit 9 is a unit installed in a space to be air-conditioned. The indoor unit 9 is, for example, a ceiling-embedded unit, but 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 for supplying 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 is installed. The air passage is, for example, a duct.

[0054] The indoor unit 9 mainly includes an indoor heat exchanger 91, an indoor expansion valve 93, and an indoor fan 92.

[0055] 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, which are 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.

[0056] 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.

[0057] The indoor fan 92 is a mechanism that sucks air in the space to be air-conditioned into the 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

[0058] The control unit 3 is a functional unit that controls the actions of various devices constituting the air-conditioning apparatus 1.

[0059] 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 having a microcomputer or the like including, for example, a processor such as a CPU (Central Processing Unit), and 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 processors are stored. In Fig. 1, for the sake of convenience, the control unit 3 is depicted at a position spaced apart from the outdoor unit 2 and the indoor unit 9.

[0060] 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.

[0061] The control unit 3 controls the operation and shutdown 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

[0062] The configuration of the outdoor heat exchanger 11 will be described with reference to the drawings.

[0063] Fig. 2 is a schematic external perspective view of the outdoor heat exchanger 11. In Fig. 2, pipes and the like connected to the outdoor heat exchanger 11 are not shown. 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 fins 29, as will be described later, are attached to the flat tubes 28 in the heat exchange portion 27. Fig. 5 is a schematic explanatory view showing how the refrigerant flows in the outdoor heat exchanger 11. The arrows of the heat exchange portion 27 shown in Fig. 5 indicate the flow of the refrigerant during the heating operation (when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant).

[0064] In the following description, expressions such as "upper", "lower", "left", "right", "front (front surface)", and "rear (rear surface)" may be used to describe a direction or a position. These expressions follow the directions of the arrows drawn in Fig. 2 unless otherwise specified. It should be noted that the expressions indicating directions and positions are used for convenience of description and, unless otherwise specified, do not specify the directions and positions of the entire outdoor heat exchanger 11 and the components of the outdoor heat exchanger 11 as shown.

[0065] Hereinafter, an example is described where the direction in which a plurality of flat tubes 28 are arranged, the longitudinal direction of a first header 40, the longitudinal direction of a gas header 50, and the longitudinal direction of a liquid header 60 are in the up-down direction or, more specifically, in the vertical direction (an example of "first direction"). Also in the example, the direction in which the connection part of the flat tubes 28 to the first header 40 extends, the direction in which a first gas plate part 51a and a first liquid plate part 61a of a first member 41, a second member 42, a third member 43, a fourth member 44, a fifth member 45, a sixth member 46, and a seventh member 47 are stacked, and the plate thickness direction of the first gas plate part 51a, the first liquid plate part 61a, the second member 42, the third member 43,

the fourth member 44, the fifth member 45, the sixth member 46, and the seventh member 47 are in the left-right direction (an example of "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 "third direction").

[0066] The outdoor heat exchanger 11 is a device that performs heat exchange between the refrigerant flowing inside and the air.

[0067] The outdoor heat exchanger 11 mainly has the plurality of flat tubes 28, a plurality of fins 29, a second header 30, and the first header 40 (an example of "header"). In the present embodiment, all of the flat tubes 28, the fins 29, the second header 30, and the first header 40 are made of aluminum or an aluminum alloy.

[0068] The plurality of flat tubes 28 and the plurality of fins 29 form the heat exchange portion 27. In the heat exchange portion 27, air passes through ventilation passages formed between the plurality of flat tubes 28 and the plurality of fins 29. Thus, heat is exchanged between the refrigerant and the air.

(2-1) Flat tube

[0069] As shown in Fig. 3, the flat tubes 28 are flat heat transfer tubes having upper and lower flat surfaces 28a serving as heat transfer surfaces. In the flat tubes 28, a plurality of refrigerant passages 28b are formed, extending along the direction in which the flat tubes 28 extend and through which the refrigerant flows. The flat tubes 28 are flat multi-hole tubes in which a large number of refrigerant passages 28b are formed. In the present embodiment, the plurality of refrigerant passages 28b are aligned in the air flow direction.

[0070] In the outdoor heat exchanger 11, the flat tubes 28 extending in the horizontal direction so as to connect the second header 30 and the first header 40 are vertically arranged in a plurality of tiers. The plurality of flat tubes 28 are arranged at regular intervals vertically. Note that each flat tube 28 is disposed with the flat surfaces facing up and down.

[0071] Note that, in the present embodiment, each flat tube 28 has one bent portion in a plan view, and is formed in a substantially L-shape.

[0072] 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 portion of the outdoor heat exchanger 11 from the left side toward the right side are generated.

[0073] The outdoor heat exchanger 11 has a first flow path group X and a second flow path group Y arranged in the up-down direction. The plurality of flat tubes 28 belong to either the first flow path group X or the second flow path group Y. The first flow path group X is a flow path group positioned below, and has a plurality of flat tubes 28 belonging thereto. The second flow path group Y is a flow path group positioned above the first flow path group X, and has a plurality of flat tubes 28 belonging thereto.

(2-2) Fins

[0074] 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 up-down direction in which the plurality of flat tubes 28 are arranged, and in the flow direction of the air passing through the outdoor heat exchanger 11.

[0075] As shown in Fig. 4, each of the fins 29 has a plurality of cutouts 29a formed therein extending along the insertion direction of the flat tubes 28 so that the plurality of flat tubes 28 can be inserted. The cutouts 29a extend in a direction orthogonal to both the up-down direction and the thickness direction of the fin 29. In a state in which the outdoor heat exchanger 11 is installed, the cutouts 29a formed in each fin 29 extend horizontally. The cutouts 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 side by side along the direction in which the flat tubes 28 extend. By inserting each flat tube 28 into each of the plurality of cutouts 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.

[0076] Each fin 29 has a communication portion 29b communicating 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 communicating portion 29b of the fin 29 is positioned on the windward side with respect to the flat tubes 28.

(2-3) First header

[0077] As shown in Fig. 5, the first header 40 includes a gas header 50 positioned in the upper portion and a liquid header 60 (an example of "header") positioned in the lower portion.

[0078] The gas header 50 contains a gas space 50S whose longitudinal direction is in the up-down direction. The liquid header 60 contains a liquid space 60S whose longitudinal direction is in the up-down direction, as a space isolated from the gas space 50S. The gas space 50S of the gas header 50 and the liquid space 60S of the liquid header 60 are partitioned from each other due to the shape of openings formed in stacked members that does not allow communication between the gas side and the liquid side.

[0079] A gas refrigerant connection pipe 19a constituting one end of the first gas refrigerant pipe 19 is connected to the gas header 50. The gas refrigerant connection pipe 19a is connected to the right-side part of the gas header 50 opposite to the left side to which the flat tubes 28 are connected in the left-right direction.

[0080] A liquid refrigerant connection pipe 20a constituting one end of the liquid refrigerant pipe 20 is con-

nected to the liquid header 60. The liquid refrigerant connection pipe 20a is connected to the right-side part of the liquid header 60 opposite to the left side to which the flat tubes 28 are connected in the left-right direction.

[0081] One end of each flat tube 28 is connected to the gas header 50 and the liquid header 60 of the first header 40, and the other end of each flat tube 28 is connected to the second header 30. The outdoor heat exchanger 11 is disposed inside a casing, not shown, of the outdoor unit 2 in a posture such that the longitudinal direction of the first header 40 and the second header 30 substantially coincides with the vertical direction. The number of the flat tubes 28 connected to the gas header 50 is larger than the number of the flat tubes 28 connected to the liquid header 60. Each of the flat tubes 28 connected to the gas header 50 communicates with the gas space 50S. Each of the flat tubes 28 connected to the liquid header 60 communicates with the liquid space 60S.

[0082] The first header 40 includes the first member 41 (an example of "plate member"), the second member 42 (an example of "plate member"), the third member 43 (an example of "plate member"), the fourth member 44 (an example of "plate member"), the fifth member 45 (an example of "plate member"), the sixth member 46 (an example of "plate member", an example of "first plate member", an example of "plate-shaped member"), and the seventh member 47 (an example of "plate member"). The first member 41, the second member 42, the third member 43, the fourth member 44, the fifth member 45, the sixth member 46, and the seventh member 47 extend in the up-down direction over the gas header 50 and the liquid header 60. More specifically, the first member 41, the second member 42, the third member 43, the fourth member 44, the fifth member 45, the sixth member 46, and the seventh member 47 each include a part constituting a part of the gas header 50 and another part constituting a part of the liquid header 60, and are shared by the gas header 50 and the liquid header 60.

[0083] Each of the first member 41, the second member 42, the third member 43, the fourth member 44, the fifth member 45, the sixth member 46, and the seventh member 47 has a longitudinal direction in the up-down direction, and has the same length in the up-down direction. The lengths in the front-rear direction of the first gas plate part 51a and the first liquid plate part 61a of the first member 41 except for the first gas side plate part 51c, the first liquid side plate part 61c, the second gas side plate part 51d, and the second liquid side plate part 61d are the same as the lengths of the second member 42, the third member 43, the fourth member 44, the fifth member 45, the sixth member 46, and the seventh member 47. The first gas side plate part 51c and the first liquid side plate part 61c have the same length in the left-right direction, which is the direction in which the flat tubes 28 extend. The second gas side plate part 51d and the second liquid side plate part 61d have the same length in the left-right direction, which is the direction in which the flat tubes 28 extend.

[0084] Further, the fourth member 44, the fifth member 45, the sixth member 46, and the seventh member 47 of the first header 40 form the gas space 50S of the gas header 50 and the liquid space 60S of the liquid header 60.

[0085] The first member 41 has a first gas-side portion 51 and a first liquid-side portion 61. The second member 42 has a second gas-side portion 52 and a second liquid-side portion 62. The third member 43 has a third gas-side portion 53 and a third liquid-side portion 63. The fourth member 44 has a fourth gas-side portion 54 and a fourth liquid-side portion 64. The fifth member 45 has a fifth gas-side portion 55 and a fifth liquid-side portion 65. The sixth member 46 has a sixth gas-side portion 56 and a sixth liquid-side portion 66. The seventh member 47 has a seventh gas-side portion 57 and a seventh liquid-side portion 67.

(2-4) Second Header

[0086] The end of each flat tube 28 on the opposite side from the end connected to the first header 40 is connected to the second header 30.

[0087] The second header 30 is configured by surrounding and crimping a plurality of stacked plate-shaped members with a crimping member 31 having a U-shape in plan view to which the flat tubes 28 are connected.

(3) Operations and Flow of Refrigerant in Outdoor Heat Exchanger

[0088] The control unit 3 receives detection information from 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.

[0089] 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 then operates the compressor 8. 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 is evaporated by exchanging heat with the outside air, and is sucked into the compressor 8 again.

[0090] In this way, when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant during the heating operation, the refrigerant in a liquid state or a gas-liquid two-phase state that has reached the liquid header 60 from the liquid refrigerant pipe 20 is split in the internal space of the liquid header 60 and then sent to the flat tubes 28 belonging to the first flow path group X. The refrigerant flowing through the flat tubes 28 of the first flow path group X partly evaporates by exchanging heat with

the air, and reaches the lower region of the internal space of the second header 30. The refrigerant sent to the lower region of the internal space of the second header 30 is sent to the upper region of the internal space of the second header 30. The refrigerant sent to the upper region of the second header 30 flows through the plurality of flat tubes 28 belonging to the second flow path group Y connected to the upper region of the second header 30. The refrigerant flowing through the plurality of flat tubes 28 belonging to the second flow path group Y further evaporates by exchanging heat with the air again, and reaches the gas header 50. The flows of the refrigerant that have reached the gas header 50 merge and the the refrigerant then flows through the first gas refrigerant pipe 19.

[0091] 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 then operates the compressor 8. 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.

[0092] 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 lines in Fig. 1 and operates the compressor 8 to perform a defrosting operation in which a high-temperature and high-pressure discharged refrigerant is supplied to the outdoor heat exchanger 11. The defrosting operation melts frost deposited on the outdoor heat exchanger 11.

[0093] In this way, 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 50 after flowing through the first gas refrigerant pipe 19. The gaseous refrigerant that has reached the gas header 50 is split in the internal space of the gas header 50, and then flows through the plurality of flat tubes 28 belonging to the second flow path group Y connected to the gas header 50. The refrigerant flowing through the plurality of flat tubes 28 belonging to the second flow path group Y partially dissipates heat or condenses by exchanging heat with the air, and reaches the upper region of the internal space of the second header 30. The refrigerant sent to the upper region of the internal space of the second header 30 is sent to the lower region of the second header 30. The refrigerant sent to the lower region of the second header 30 is sent to the plurality of flat tubes 28 belonging to the first flow path group X connected to the lower region of the second header 30. The refrigerant flowing through the plurality of flat tubes 28 of the first flow path group X further dissipates heat or condenses by exchanging heat with the air again, and reaches the liquid header 60. The refrigerant that has reached the liquid header 60 flows out from the outdoor heat exchanger 11 via the liquid refrigerant pipe 20.

(4) Details of Gas Header

[0094] Fig. 6 is a schematic exploded perspective view of the gas header 50. Fig. 7 is a schematic horizontal cross-sectional configuration diagram of the gas header 50. Fig. 7 illustrates a horizontal cross section obtained when the flat tube 28 positioned at the lowermost tier among the plurality of flat tubes 28 connected to the gas header 50 is cut horizontally at the center position in the thickness direction (up-down direction).

[0095] The gas header 50 is configured to include the first gas-side portion 51 of the first member 41, the second gas-side portion 52 of the second member 42, the third gas-side portion 53 of the third member 43, the fourth gas-side portion 54 of the fourth member 44, the fifth gas-side portion 55 of the fifth member 45, the sixth gas-side portion 56 of the sixth member 46, and the seventh gas-side portion 57 of the seventh member 47. Among these, the fourth gas-side portion 54, the fifth gas-side portion 55, the sixth gas-side portion 56, and the seventh gas-side portion 57 form the gas space 50S.

[0096] In the gas header 50, the first gas-side portion 51, the second gas-side portion 52, the third gas-side portion 53, the fourth gas-side portion 54, the fifth gas-side portion 55, the sixth gas-side portion 56, and the seventh gas-side portion 57 are joined to each other by brazing.

(4-1) First gas-side portion

[0097] The first gas-side portion 51 constitutes a part of the gas header 50 and includes the first gas side plate part 51a, the first gas side plate part 51c, the second gas side plate part 51d, first gas crimping claws 51e, and second gas crimping claws 51f. The first gas-side portion 51 mainly constitutes the periphery of the outer shape of the gas header 50 together with the seventh gas-side portion 57.

[0098] The first gas plate part 51a is stacked so as to face and be in contact with the left-side surface of the second gas plate part 52a of the second gas-side portion 52. The first gas plate part 51a has a plurality of gas-side flat tube connection openings 51b.

[0099] The plurality of gas-side flat tube connection openings 51b are openings aligned in the up-down direction and penetrating the first gas plate part 51a in the plate thickness direction. The contour of the gas-side flat tube connection openings 51b has a shape that follows the contour of the flat tubes 28. Thus, the flat tubes 28 are brazed to the gas-side flat tube connection openings 51b

in a state where the tip-ends of the flat tubes 28 in the insertion direction have passed through the gas-side flat tube connection openings 51b, and where the outer peripheries of the flat tubes 28 are in contact with the inner peripheries of the gas-side flat tube connection openings 51b.

[0100] The first gas side plate part 51c is a plate-shaped part extending rightward from the front-side edge of the first gas plate part 51a. The second gas side plate part 51d is a plate-shaped part extending rightward from the rear-side edge of the first gas side plate part 51a. The first gas side plate part 51c and the second gas side plate part 51d are provided to face each other in the front-rear direction, thereby sandwiching the second gas plate part 52a, the third gas plate part 53a, the fourth gas plate part 54a, the fifth gas plate part 55a, the sixth gas plate part 56a, and the seventh gas plate part 57a from the front-rear directions.

[0101] The first gas crimping claws 51e are a plurality of crimping claws provided at a predetermined interval in the up-down direction at the right-side end part of the first gas side plate part 51c. The second gas crimping claws 51f are a plurality of crimping claws provided at a predetermined interval in the up-down direction at the right-side end part of the second gas side plate part 51d. In a state before crimping, the first gas crimping claws 51e extend rightward on an extension of the first gas side plate part 51c, and the second gas crimping claws 51f extend rightward on an extension of the second gas side plate part 51d. Then, in a state where the first gas plate part 51a, the second gas plate part 52a, the third gas plate part 53a, the fourth gas plate part 54a, the fifth gas plate part 55a, the sixth gas plate part 56a, and the seventh gas plate part 57a are stacked, the first gas crimping claws 51e and the second gas crimping claws 51f are folded so as to approach each other in the front-rear direction, whereby the first gas plate part 51a, the second gas plate part 52a, the third gas plate part 53a, the fourth gas plate part 54a, the fifth gas plate part 55a, the sixth gas plate part 56a, and the seventh gas plate part 57a are crimped and integrated. In this state, brazing is performed in a furnace or the like, whereby the members are joined and completely fixed together by brazing.

(4-2) Second gas-side portion

[0102] The second gas-side portion 52 constitutes a part of the gas header 50 and has the second gas plate part 52a.

[0103] The second gas plate part 52a is stacked so as to face and be in contact with the right-side surface of the first gas plate part 51a, and so as to face and be in contact with the left-side surface of the third gas plate part 53a. The second gas plate part 52a has a plurality of gas insertion openings 52b.

[0104] The plurality of gas insertion openings 52b are openings aligned in the up-down direction and penetrating the second gas plate part 52a in the plate thickness direction. The front and rear edges of the gas insertion openings 52b are positioned outside the front and rear edges of the gas-side flat tube connection openings 51b when viewed in the plate thickness direction of the second gas plate part 52a. Further, the upper and lower edges of the plurality of gas insertion openings 52b are positioned outside the upper and lower edges of the gas-side flat tube connection openings 51b when viewed in the plate thickness direction of the second gas plate part 52a. When viewed in the plate thickness direction of the second gas plate part 52a, the contour of the gas insertion openings 52b 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-ends of the flat tubes 28 in the insertion direction are inserted so as to pass through the gas insertion openings 52b. Further, even if there is excess brazing material at the time of brazing, a clearance is secured between the flat tubes 28 and the gas insertion openings 52b so that the excess brazing material can be guided. Therefore, the flow path of the flat tubes 28 can be prevented from being blocked by the excess brazing material.

(4-3) Third gas-side portion

[0105] The third gas-side portion 53 constitutes a part of the gas header 50 and has the third gas plate part 53a.

[0106] The third gas plate part 53a is stacked so as to face and be in contact with the right-side surface of the second gas plate part 52a, and so as to face and be in contact with the left-side surface of the fourth gas plate part 54a. The third gas plate part 53a has a plurality of gas restriction openings 53b.

[0107] The plurality of gas restriction openings 53b are openings aligned in the up-down direction and penetrating the third gas plate part 53a in the plate thickness direction. The front and rear edges of the gas restriction openings 53b are positioned inside the front and rear edges of the gas insertion openings 52b when viewed in the plate thickness direction of the third gas plate part 53a. The width of the plurality of gas restriction openings 53b 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-ends of the flat tubes 28 in the insertion direction abut the edges of the gas restriction openings 53b, whereby the insertion position is determined. The upper and lower edges of the plurality of gas restriction openings 53b are positioned outside the front and rear edges of the flat tubes 28.

[0108] In the refrigerant flow direction 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 formed by the third gas plate part 53a, the fourth gas plate part 54a, the fifth gas plate part 55a, the sixth gas plate part 56a, and the seventh gas plate part 57a via the gas refrigerant connection pipe 19a is branched and flows to the plurality of gas restriction openings 53b.

(4-4) Fourth gas-side portion

[0109] The fourth gas-side portion 54 constitutes a part of the gas header 50 and has the fourth gas plate part 54a.

[0110] The fourth gas plate part 54a is stacked so as to face and be in contact with the right-side surface of the third gas plate part 53a, and so as to face and be in contact with the left-side surface of the fifth gas plate part 55a. The fourth gas plate part 54a has a fourth gas opening 54b.

[0111] The fourth gas opening part 54b is an opening penetrating the fourth gas plate part 54a in the plate thickness direction, and is an opening whose longitudinal direction is in the up-down direction. When viewed in the plate thickness direction of the fourth gas plate part 54a, the fourth gas opening 54b overlaps the connection area of the plurality of flat tubes 28 in the gas header 50, and, for example, overlaps the connection area of three or more or five or more flat tubes 28. The width of the fourth gas opening 54b in the front-rear direction corresponds to the width of the gas restriction openings 53b of the third member 43 in the front-rear direction.

(4-5) Fifth gas-side portion

[0112] The fifth gas-side portion 55 constitutes a part of the gas header 50 and has the fifth gas plate part 55a.

[0113] The fifth gas plate part 55a is stacked so as to face and be in contact with the right-side surface of the fourth gas plate part 54a, and so as to face and be in contact with the left-side surface of the sixth gas plate part 56a. The fifth gas plate part 55a has a fifth gas opening part 55b.

[0114] The fifth gas opening part 55b is an opening penetrating the fifth gas plate part 55a in the plate thickness direction, and is an opening whose longitudinal direction is in the up-down direction. When viewed in the plate thickness direction of the fifth gas plate part 55a, the fifth gas opening part 55b overlaps the connection area of the plurality of flat tubes 28 in the gas header 50.

(4-6) Sixth gas-side portion

[0115] The sixth gas-side portion 56 constitutes a part of the gas header 50 and has the sixth gas plate part 56a.

[0116] The sixth gas plate part 56a is stacked so as to face and be in contact with the right-side surface of the fifth gas plate part 55a, and so as to face and be in contact with the left-side surface of the seventh gas plate part 57a. The sixth gas plate part 56a has a sixth gas opening part 56b (an example of "second opening part").

[0117] The sixth gas opening part 56b is an opening penetrating the sixth gas plate part 56a in the plate thickness direction, and is an opening whose longitudinal direction is in the up-down direction. When viewed in the plate thickness direction of the sixth gas plate part 56a, the sixth gas opening part 56b overlaps the connection area of the plurality of flat tubes 28 in the gas header 50.

(4-7) Seventh gas-side portion

[0118] The seventh gas-side portion 57 constitutes a part of the gas header 50 and has the seventh gas plate part 57a.

[0119] The seventh gas plate part 57a is stacked so as to face and be in contact with the right-side surface of the sixth gas plate part 56a. The seventh gas plate part 57a has a gas pipe connection opening 57b which is an opening penetrating the seventh gas plate part 57a in the plate thickness direction and to which the gas refrigerant connection pipe 19a is connected.

[0120] The seventh gas plate part 57a is a plate-shaped member which has a surface extending so as to overlap the sixth gas opening part 56b when viewed in the plate thickness direction of the seventh gas plate part 57a, and which constitutes an outer wall portion of the gas header 50 so as to close the gas space 50S from the right side.

[0121] The front-side part of the seventh gas plate part 57a is crimped by the first gas crimping claws 51e of the first member 41. The rear-side part of the seventh gas plate part 57a is crimped by the second gas crimping claws 51f.

(5) Details of liquid header

[0122] Fig. 8 is a schematic exploded perspective view of the liquid header 60 (corresponding to "header"). Fig. 9 is a schematic horizontal cross-sectional configuration diagram of the liquid header 60. Note that Fig. 9 shows a horizontal cross-section obtained when, of the flat tubes 28 connected to the liquid header 60, the flat tube 28 at the same height position as a second blow-up region 64j is cut horizontally at the center position in the thickness direction (up-down direction). In Fig. 9, the first connection pipe 71 and the second connection pipe 72 are not shown. Fig. 10 shows a partially enlarged view of the vicinity of the lower end of the sixth liquid-side portion 66 in the liquid header 60. Fig. 11 is a diagram illustrating how the refrigerant flows in the liquid header 60 when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant.

[0123] The liquid header 60 is configured to include a first liquid-side portion 61 of the first member 41, a second liquid-side portion 62 of the second member 42, a third liquid-side portion 63 of the third member 43, a fourth liquid-side portion 64 of the fourth member 44, a fifth liquid-side portion 65 of the fifth member 45, a sixth liquid-side portion 66 of the sixth member 46, a seventh liquid-side portion 67 of the seventh member 47, the first connection pipe 71, and the second connection pipe 72. Among these, the fourth liquid-side portion 64, the fifth liquid-side portion 65, the sixth liquid-side portion 66, and the seventh liquid-side portion 67 form the liquid space 60S of the liquid header 60.

[0124] The liquid header 60 is formed by joining the first liquid-side portion 61, the second liquid-side portion 62, the third liquid-side portion 63, the fourth liquid-side portion 64, the fifth liquid-side portion 65, the sixth liquid-side portion 66, and the seventh liquid-side portion 67 to each other by brazing.

[0125] The liquid refrigerant connection pipe 20a is connected to the liquid header 60.

[0126] In the liquid header 60, in the refrigerant flow when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the refrigerant flowing in via the liquid refrigerant connection pipe 20a is split inside the liquid header 60, and the split flows of the refrigerant are sent to the plurality of flat tubes 28 included in the first flow path group X among the plurality of flat tubes 28.

(5-1) First liquid-side portion

[0127] The first liquid-side portion 61 constitutes a part of the liquid header 60 and includes the first liquid plate part 61a, the first liquid side plate part 61c, the second liquid side plate part 61d, first liquid crimping claws 61e, and second liquid crimping claws 61f. The first liquid-side portion 61 mainly constitutes the periphery of the outer shape of the liquid header 60 together with the seventh liquid-side portion 67.

[0128] The first liquid plate part 61a is provided so as to be continuous with the first gas plate part 51a on the same plane. The first liquid side plate part 61c is provided so as to be continuous with the first gas side plate part 51c on the same plane. The second liquid side plate part 61d is provided so as to be continuous with the second gas side plate part 51d on the same plane.

[0129] The first liquid plate part 61a is stacked so as to face and be in contact with the left-side surface of a second liquid plate part 62a of the second liquid-side portion 62. The first liquid plate part 61a has a plurality of liquid-side flat tube connection openings 61b.

[0130] The plurality of liquid-side flat tube connection openings 61b are openings aligned in the up-down direction, and penetrating the first liquid plate part 61a in the plate thickness direction. The contour of the liquid-side flat tube connection openings 61b has a shape that follows the contour of the flat tubes 28. As a result, the flat tubes 28 are brazed to each other in a state where the tip-ends thereof in the insertion direction have passed through the liquid-side flat tube connection openings 61b and the outer peripheries of the flat tubes 28 are in contact with the inner peripheries of the liquid-side flat tube connection openings 61b.

[0131] The first liquid side plate part 61c is a plate-shaped part extending rightward from the front-side edge of the first liquid plate part 61a. The second liquid side plate part 61d is a plate-shaped part extending rightward from the rear-side edge of the first liquid plate part 61a. The first liquid side plate part 61c and the second liquid side plate part 61d are provided so as to face each other in the front-rear direction, thereby sandwiching the second liquid plate part 62a, the third liquid plate part 63a, the fourth liquid plate part 64a, the fifth liquid plate part 65a, the sixth liquid plate part 66a, and the seventh liquid plate part 67a from the front-rear directions.

[0132] The first liquid crimping claws 61e are a plurality of crimping claws provided at a predetermined interval in the up-down direction at the right-side end part of the first liquid side plate part 61c. The second liquid crimping claws 61f are a plurality of crimping claws provided at a predetermined interval in the up-down direction at the right-side end part of the second liquid side plate part 61d. In a state before crimping, the first liquid crimping claws 61e extend rightward on an extension of the first liquid side plate part 61c, and the second liquid crimping claws 61f extend rightward on an extension of the second liquid side plate part 61d. Then, in a state where the first liquid plate part 61a, the second liquid plate part 62a, the third liquid plate part 63a, the fourth liquid plate part 64a, the fifth liquid plate part 65a, the sixth liquid plate part 66a, and the seventh liquid plate part 67a are stacked, the first liquid crimping claws 61e and the second liquid crimping claw 61f are folded so as to approach each other in the front-rear direction, whereby the second liquid plate part 62a, the third liquid plate part 63a, the fourth liquid plate part 64a, the fifth liquid plate part 65a, the sixth liquid plate part 66a, and the seventh liquid plate part 67a are crimped and integrated together. **In** this state, brazing is performed in a furnace or the like, whereby the members are joined and completely fixed together by brazing.

(5-2) Second liquid-side portion

[0133] The second liquid-side portion 62 constitutes a part of the liquid header 60 and is provided between the third liquid-side portion 63 and the first liquid-side portion 61. The second liquid-side portion 62 has the second liquid plate part 62a and a plurality of liquid insertion openings 62b.

[0134] The second liquid plate part 62a is stacked so as to face and be in contact with the right-side surface of the first liquid plate part 61a, and so as to face and be in contact with the left-side surface of the third liquid plate part 63a.

[0135] The plurality of liquid insertion openings 62b are openings aligned in the up-down direction and penetrating the second liquid plate part 62a in the plate thickness direction. The front and rear edges of the liquid insertion openings 62b are positioned outside the front and rear edges of the liquid-side flat tube connection openings 61b when viewed in the plate thickness direction of the second liquid plate part 62a. Also, the upper and lower edges of the plurality of liquid insertion openings 62b are positioned outside the upper and lower edges of the liquid-side flat tube connection openings 61b when viewed in the plate thickness direction of the second liquid plate part 62a. When viewed in the plate thickness direction of the second liquid plate part 62a, the contour of the liquid insertion openings 62b 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-ends of the flat tubes 28 in the insertion direction are inserted so as to pass through the liquid insertion openings 62b. Further, even if there is excess brazing material at the time of brazing, a clearance is secured between the flat tubes 28 and the liquid insertion openings 62b so that the excess brazing material can be guided. Therefore, the flow path of the flat tubes 28 is prevented from being blocked by the excess brazing material.

(5-3) Third liquid-side portion

[0136] The third liquid-side portion 63 constitutes a part of the liquid header 60 and is provided between the fourth liquid-side portion 64 and the second liquid-side portion 62. The third liquid-side portion 63 has the third liquid plate part 63a and a plurality of liquid restriction openings 63b.

[0137] The third liquid plate 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. The third liquid plate part 63a is stacked so as to face and be in contact with the left-side surface of the fourth liquid plate part 64a, and so as to face and be in contact with the right-side surface of the second liquid plate part 62a.

[0138] The plurality of liquid restriction openings 63b are openings aligned in the up-down direction and penetrating the third liquid plate part 63a in the plate thickness direction. The front and rear edges of the liquid restriction openings 63b are positioned inside the front and rear edges of the liquid insertion openings 62b when viewed in the plate thickness direction of the third liquid plate part 63a. The width of the plurality of liquid restriction openings 63b 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-ends of the flat tubes 28 in the insertion direction abut the edges of the liquid restriction openings 63b, whereby the insertion position is determined. The upper and lower edges of the plurality of liquid restriction openings 63b are positioned outside the front and rear edges of the flat tubes 28.

[0139] Two of the plurality of liquid restriction openings 63b at the lower end overlap and communicate with an opening 64b of the fourth liquid-side portion 64 when viewed in the plate thickness direction of the third liquid plate part 63a.

[0140] Of the plurality of liquid restriction openings 63b, those positioned above the two at the lower end are such that a plurality of lower liquid restriction openings 63b overlap and communicate with a first blow-up region 64f of a first through part 64c of the fourth liquid-side portion 64, and such that a plurality of upper liquid restriction openings 63b overlap and communicate with the second blow-up region 64j of a second through part 64g of the fourth liquid-side portion 64.

(5-4) Fourth liquid-side portion

[0141] The fourth liquid-side portion 64 constitutes a part of the liquid header 60 and is provided between the fifth liquid-side portion 65 and the third liquid-side portion 63. The fourth liquid-side portion 64 has the fourth liquid plate part 64a, the opening 64b, the first through part 64c, and the second through part 64g.

[0142] The fourth liquid plate 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. The fourth liquid plate part 64a is stacked so as to face and be in contact with the left-side surface of the fifth liquid plate part 65a, and so as to face and be in contact with the right-side surface of the third liquid plate part 63a.

[0143] The first through part 64c is an opening that is provided above the opening 64b in the fourth liquid-side portion 64 and below the second through part 64g, and that penetrates the fourth liquid plate part 64a in the plate thickness direction. The first through part 64c has a first introduction region 64d, a first narrowed region 64e, and the first blow-up region 64f. The first introduction region 64d, the first narrowed region 64e, and the first blow-up region 64f are arranged in this order from bottom to top at the center in the front-rear direction, and are connected to each other. The length of the first narrowing region 64e in the front-rear direction is smaller than the length of the first introduction region 64d in the front-rear direction and smaller than the length of the first blow-up region 64f in the front-rear direction. The first introduction region 64d overlaps and communicates with a first communication opening 65b of the fifth liquid-side portion 65 when viewed in the plate thickness direction of the fourth liquid plate part 64a. The first narrowed region 64e is covered from the right side by the fifth liquid plate part 65a of the fifth liquid-side portion 65. The first blow-up region 64f communicates with a plurality of liquid restriction openings 63b arranged vertically on the left side. The first blow-up region 64f communicates with a first outgoing opening 65d of the fifth liquid-side portion 65 positioned on the right side at the upper end, and communicates with a first return opening 65c of the fifth liquid-side portion 65 positioned on the right side at the lower end. **In** the first blow-up region 64f, the area below the part communicating with the first outgoing opening 65d and above the part communicating with the first return opening 65c is covered by the fifth liquid plate part 65a of the fifth liquid-side portion 65 from the right side.

[0144] The second through part 64g is an opening that is provided above the first through part 64c in the fourth liquid-side portion 64 and that penetrates the fourth liquid plate part 64a in the plate thickness direction. The second through part 64g has a second introduction region 64h, a second narrowed region 64i, and the second blow-up region 64j. The second introduction region 64h, the second narrowed region 64i, and the second blow-up region 64j are arranged from bottom to top in this order at the

center in the front-rear direction, and are connected to each other. The width of the second narrowed region 64i in the front-rear direction is smaller than the width of the second introduction region 64h in the front-rear direction and smaller than the width of the second blow-up region 64j in the front-rear direction. The second introduction region 64h overlaps and communicates with a second communication opening 65e of the fifth liquid-side portion 65 when viewed in the plate thickness direction of the fourth liquid plate part 64a. The second narrowed region 64i is covered from the right side by the fifth liquid plate part 65a of the fifth liquid-side portion 65. The second blow-up region 64j communicates with a plurality of liquid restriction openings 63b arranged vertically on the left side. The second blow-up region 64j communicates with a second outgoing opening 65g of the fifth liquid-side portion 65 positioned on the right side at the upper end, and communicates with a second return opening 65f of the fifth liquid-side portion 65 positioned on the right side at the lower end. **In** the second blow-up region 64j, the area below the part communicating with the second outgoing opening 65g and above the portion communicating with the second return opening 65f is covered by the fifth liquid plate part 65a of the fifth liquid-side portion 65 from the right side.

(5-5) Fifth liquid-side portion

[0145] The fifth liquid-side portion 65 constitutes a part of the liquid header 60 and is provided between the sixth liquid-side portion 66 and the fourth liquid-side portion 64. The fifth liquid-side portion 65 includes the fifth liquid plate part 65a, the first communication opening 65b, the first return opening 65c, the first outgoing opening 65d, the second communication opening 65e, the second return opening 65f, and the second outgoing opening 65g.

[0146] The fifth liquid plate 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. The fifth liquid plate part 65a is stacked so as to face and be in contact with the left-side surface of the sixth liquid plate part 66a, and so as to face and be in contact with the right-side surface of the fourth liquid plate part 64a.

[0147] All of the first communication opening 65b, the first return opening 65c, the first outgoing opening 65d, the second communication opening 65e, the second return opening 65f, and the second outgoing opening 65g are openings penetrating the fifth liquid plate part 65a in the plate thickness direction, and are arranged in this order from the bottom.

[0148] The first communication opening 65b communicates with the first introduction region 64d of the fourth liquid-side portion 64 on the left side, and communicates with the first communication opening 66c of the sixth liquid-side portion 66 on the right side.

[0149] The first return opening 65c communicates with the lower-end part of the first blow-up region 64f of the fourth liquid-side portion 64 on the left side, and communicates with the lower-end part of a first descending opening 66d of the sixth liquid-side portion 66 on the right side.

[0150] The first outgoing opening 65d communicates with the upper-end part of the first blow-up region 64f of the fourth liquid-side portion 64 on the left side, and communicates with the upper-end part of the first descending opening 66d of the sixth liquid-side portion 66 on the right side.

[0151] The second communication opening 65e communicates with the second introduction region 64h of the fourth liquid-side portion 64 on the left side, and communicates with a second communication opening 66e of the sixth liquid-side portion 66 on the right side.

[0152] The second return opening 65f communicates with the lower-end part of the second blow-up region 64j of the fourth liquid-side portion 64 on the left side, and communicates with the lower-end part of a second descending opening 66f of the sixth liquid-side portion 66 on the right side.

[0153] The second outgoing opening 65g communicates with the upper-end part of the second blow-up region 64j of the fourth liquid-side portion 64 on the left side, and communicates with the upper-end part of the second descending opening 66f of the sixth liquid-side portion 66 on the right side.

(5-6) Sixth liquid-side portion

[0154] The sixth liquid-side portion 66 constitutes a part of the liquid header 60 and is provided between the seventh liquid-side portion 67 and the fifth liquid-side portion 65. The sixth liquid-side portion 66 has the sixth liquid plate part 66a, a first opening part 66b, a first communication opening 66c (an example of "second opening part"), the first descending opening 66d (an example of "second opening part"), the second communication opening 66e (an example of "second opening part"), and the second descending opening 66f (an example of "second opening part").

[0155] The sixth liquid plate part 66a 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. The sixth liquid plate part 66a is stacked so as to face and be in contact with the left-side surface of the seventh liquid plate part 67a, and so as to face and be in contact with the right-side surface of the fifth liquid plate part 65a.

[0156] All of the first opening part 66b, the first communication opening 66c, the first descending opening 66d, the second communication opening 66e, and the second descending opening 66f are openings penetrating the sixth liquid plate part 66a in the plate thickness direction, and are arranged in this order from the bottom.

[0157] The first opening part 66b is covered with the fifth liquid plate part 65a of the fifth liquid-side portion 65

on the left side, and communicates with a liquid pipe connection opening 67b, a first distribution opening 67c, and a second distribution opening 67d of the seventh liquid-side portion 67 on the right side. While the details will be described later, when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the first opening part 66b causes the refrigerant flowing in from the liquid pipe connection opening 67b to be divided and flow to the first distribution opening 67c and the second distribution opening 67d.

[0158] The first communication opening 66c communicates with the first communication opening 65b of the fifth liquid-side portion 65 on the left side, and communicates with the first communication opening 67e of the seventh liquid-side portion 67 on the right side.

[0159] The first descending opening 66d communicates with the first return opening 65c of the fifth liquid-side portion 65 at the lower end on the left side, communicates with the first outgoing opening 65d of the fifth liquid-side portion 65 at the upper end on the left side, and is covered by the seventh liquid plate part 67a of the seventh liquid-side portion 67 on the right side.

[0160] The second communication opening 66e communicates with the second communication opening 65e of the fifth liquid-side portion 65 on the left side, and communicates with the second communication opening 67f of the seventh liquid-side portion 67 on the right side.

[0161] The second descending opening 66f communicates with the second return opening 65f of the fifth liquid-side portion 65 at the lower end on the left side, communicates with the second outgoing opening 65g of the fifth liquid-side portion 65 at the upper end on the left side, and is covered by the seventh liquid plate part 67a of the seventh liquid-side portion 67 on the right side.

[0162] When the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the refrigerant introduced into the first introduction region 64d via a flow path (an example of "sixth flow path") configured by the first communication opening 67e, the first communication opening 66c, the first communication opening 65b, and the first introduction region 64d is blown up from the first narrowed region 64e toward the first blow-up region 64f. The refrigerant blown up to the first blow-up region 64f is split to the plurality of liquid restriction openings 63b at the respective height positions while flowing upward in the first blow-up region 64f, and the refrigerant that did not flow toward the plurality of liquid restriction openings 63b reaches the upper end of the first blow-up region 64f. The refrigerant that has reached the upper end of the first blow-up region 64f circulates by passing through the first outgoing opening 65d, descending through the first descending opening 66d, and then returning to the lower-end part of the first blow-up region 64f via the first return opening 65c.

Similarly, when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the refrigerant introduced into the second introduction region 64h via the flow path (an example of "seventh flow path") configured by the second communication opening 67f, the second communication opening 66e, the second communication opening 65e, and the second introduction region 64h is blown up from the second narrowed region 64i toward the second blow-up region 64j. The refrigerant blown up to the second blow-up region 64j is split to the plurality of liquid restriction openings 63b at the respective height positions while flowing upward in the second blow-up region 64j, and the refrigerant that did not flow toward the plurality of liquid restriction openings 63b reaches the upper end of the second blow-up region 64j. The refrigerant that has reached the upper end of the second blow-up region 64j circulates by passing through the second outgoing opening 65g, descending through the second descending opening 66f, and then returning to the lower-end part of the second blow-up region 64j via the second return opening 65f.

[0163] When the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the flow path configured by the first communication opening 67e, the first communication opening 66c, the first communication opening 65b, and the first introduction region 64d, and the flow path configured by the second communication opening 67f, the second communication opening 66e, the second communication opening 65e, and the second introduction region 64h preferably have the same flow path area and the same flow path length.

(5-7) Seventh liquid-side portion

[0164] The seventh liquid-side portion 67 constitutes a part of the liquid header 60 and is provided on the right side of the sixth liquid-side portion 66. The seventh liquid-side portion 67 has the seventh liquid plate part 67a, the liquid pipe connection opening 67b, the first distribution opening 67c, the second distribution opening 67d, the first communication opening 67e, and the second communication opening 67f.

[0165] The seventh liquid plate part 67a is a plate-shaped member constituting an outer wall portion on the right side of the liquid header 60 so as to close the liquid space 60S from the right side, and extends in the up-down and front-rear directions. The seventh liquid plate part 67a covers a part of the first opening part 66b, the first descending opening 66d, and the second descending opening 66f of the sixth liquid-side portion 66 from the right side.

[0166] The liquid pipe connection opening 67b is a cylindrical opening penetrating the seventh liquid plate part 67a in the plate thickness direction at the center in the front-rear direction in the vicinity of the lower end of the seventh liquid-side portion 67. The liquid refrigerant connection pipe 20a is connected to the liquid pipe connection opening 67b.

[0167] The first distribution opening 67c is provided on the lower front side of the liquid pipe connection opening 67b of the seventh liquid-side portion 67, and is a cylindrical opening penetrating the seventh liquid plate part 67a

in the plate thickness direction. The first distribution opening 67c communicates with a fourth region 87 of the first opening part 66b on the left side. A pipe-end part 71a of the first connection pipe 71 is connected to the first distribution opening 67c on the right side.

[0168] The second distribution opening 67d is provided on the lower rear side of the liquid pipe connection opening 67b of the seventh liquid-side portion 67, and is a cylindrical opening penetrating the seventh liquid plate part 67a in the plate thickness direction. The second distribution opening 67d communicates with a fifth region 89 of the first opening part 66b on the left side. A pipe-end part 72a of the second connection pipe 72 is connected to the second distribution opening 67d on the right side.

[0169] The first communication opening 67e is a cylindrical opening penetrating the seventh liquid plate part 67a in the plate thickness direction at the center in the front-rear direction above the liquid pipe connection opening 67b of the seventh liquid-side portion 67. A pipe-end part 71b of the first connection pipe 71 is connected to the first communication opening 67e.

[0170] The second communication opening 67f is a cylindrical opening penetrating the seventh liquid plate part 67a in the plate thickness direction at the center in the front-rear direction above the first communication opening 67e of the seventh liquid-side portion 67. A pipe-end part 72b of the second connection pipe 72 is connected to the second communication opening 67f.

[0171] The front-side part of the seventh liquid plate part 67a is crimped by the first liquid crimping claws 61e. The rear-side part of the seventh liquid plate part 67a is crimped by the second liquid crimping claws 61f.

(5-8) Connection pipe

[0172] The first connection pipe 71 is provided on the right side of the seventh liquid-side portion 67, has the pipe-end part 71a and the pipe-end part 71b, and extends from the pipe-end part 71a to the pipe-end part 71b. The first connection pipe 71 is connected to the first distribution opening 67c of the seventh liquid-side portion 67 at the pipe-end part 71a. The first connection pipe 71 is connected to the first communication opening 67e of the seventh liquid-side portion 67 at the pipe-end part 71b.

[0173] The second connection pipe 72 is provided on the right side of the seventh liquid-side portion 67, has the pipe-end part 72a and the pipe-end part 72b, and extends from the pipe-end part 72a to the pipe-end part 72b. The second connection pipe 72 is connected to the second distribution opening 67d of the seventh liquid-side portion 67 at the pipe-end part 72a. The second connection pipe 72 is connected to the second communication opening 67f of the seventh liquid-side portion 67 at the pipe-end part 72b.

(6) Splitting of refrigerant in first opening part

[0174] The first opening part 66b includes a connecting portion P, a first region 80 (an example of "first portion"), a first narrowed portion 81, a second region 82, a first protrusion 83, a third region 84, a second protrusion 85, a fourth narrowed portion 86, a fourth region 87, a fifth narrowed portion 88, and a fifth region 89.

[0175] The first region 80 is positioned above the center in the front-rear direction of the first opening part 66b, and extends upward and downward such that the longitudinal direction thereof is in the vertical direction. The left side of the first region 80 is covered by the fifth liquid plate part 65a. The first region 80 overlaps and communicates with the liquid pipe connection opening 67b when viewed in the plate thickness direction of the sixth liquid plate part 66a. The first region 80, the liquid pipe connection opening 67b, and the liquid refrigerant connection pipe 20a are aligned in the horizontal direction. Note that the connection part between the first region 80 and the liquid pipe connection opening 67b is preferably located at a position offset above the center of the first region 80 in the up-down direction.

[0176] The first narrowed portion 81 is positioned below the first region 80 and above the connecting portion P, and is connected to the first region 80 and the connecting portion P. The center in the front-rear direction of the first narrowed portion 81, the center in the front-rear direction of the first region 80, and the connecting portion P are aligned in the vertical direction. Preferably, the horizontal cross-sectional area, which is the flow path cross-sectional area, of the first narrowed portion 81 is smaller than the horizontal cross-sectional area, which is the flow path cross-sectional area, of the first region 80, and is equal to or less than half of the horizontal cross-sectional area, which is the flow path cross-sectional area, of the first region 80. The left side of the first narrowed portion 81 is covered by the fifth liquid plate part 65a, and the right side thereof is covered by the seventh liquid plate part 67a.

[0177] The second region 82 is connected to the connecting portion P and extends forward in the horizontal direction on the front side of the connecting portion P. The flow path cross-sectional area of the second region 82 is larger than the horizontal cross-sectional area, which is the flow path cross-sectional area, of the first narrowed portion 81. Accordingly, the flow path of the refrigerant flowing from the first narrowed portion 81 toward the second region 82 rapidly expands, and thus the gas-phase refrigerant and the liquid-phase refrigerant are more easily stirred. Further, the flow path cross-sectional area of the second region 82 is smaller than the horizontal cross-sectional area, which is the flow path cross-sectional area, of the first region 80. Thus, the refrigerant can be made to flow in the second region 82 while the gas-phase refrigerant and the liquid-phase refrigerant are stirred. The flow path cross-sectional area of the second region 82 is the cross-sectional area of a cross section taken along a plane orthogonal to the horizontal direction, which is the refrigerant flow direction, in the second region 82, and may be the cross-sectional area of a cross section at the center in the longitudinal direction of the

second region 82. The left side of the second region 82 is covered by the fifth liquid plate part 65a, and the right side thereof is covered by the seventh liquid plate part 67a.

[0178] The first protrusion 83 is positioned on the front side of the second region 82 and is connected to the second region 82. Specifically, the first protrusion 83 is positioned on the front side with respect to a connection area between the second region 82 and the fourth narrowed portion 86. The upper end and the lower end of the first protrusion 83 are the same as the upper end and the lower end of the second region 82. The length of the first protrusion 83 in the front-rear direction is shorter than the length of the second region 82 in the front-rear direction, and may be, for example, equal to or less than the length of the fourth region 87 in the front-rear direction.

[0179] The third region 84 is connected to the connecting portion P and extends rearward in the horizontal direction on the rear side of the connecting portion P. The flow path cross-sectional area of the third region 84 is larger than the horizontal cross-sectional area, which is the flow path cross-sectional area, of the first narrowed portion 81. Accordingly, the flow path of the refrigerant flowing from the first narrowed portion 81 toward the third region 84 rapidly expand, and thus the gas-phase refrigerant and the liquid-phase refrigerant are more easily stirred. Further, the flow path cross-sectional area of the third region 84 is smaller than the horizontal cross-sectional area, which is the flow path cross-sectional area, of the first region 80. Thus, the refrigerant can be made to flow in the third region 84 while the gas-phase refrigerant and the liquid-phase refrigerant are stirred. The flow path cross-sectional area of the third region 84 is the cross-sectional area of a cross section taken along a plane orthogonal to the horizontal direction, which is the refrigerant flow direction, in the third region 84, and may be the cross-sectional area of a cross section at the center in the longitudinal direction of the third region 84. The flow path cross-sectional area of the third region 84 is equal to the flow path cross-sectional area of the second region 82. The left side of the third region 84 is covered by the fifth liquid plate part 65a, and the right side of the third region 84 is covered by the seventh liquid plate part 67a.

[0180] The second protrusion 85 is positioned on the rear side of the third region 84 and is connected to the third region 84. Specifically, the second protrusion 85 is positioned on the rear side with respect to a connection area between the third region 84 and the fifth narrowed portion 88. The upper end and the lower end of the second protrusion 85 are the same as the upper end and the lower end of the third region 84. The length of the second protrusion 85 in the front-rear direction is shorter than the length of the third region 84 in the front-rear direction, and may be, for example, equal to or less than the length of the fifth region 89 in the front-rear direction.

[0181] The fourth narrowed portion 86 is provided so as to extend upward from the upper end of the front-side end part of the second region 82. The horizontal cross-sectional area, which is the flow path cross-sectional area, of the fourth narrowed portion 86 is smaller than the horizontal cross-sectional area, which is the flow path cross-sectional area, of the fourth region 87, and is smaller than the flow path cross-sectional area of the second region 82. The length of the fourth narrowed portion 86 in the front-rear direction is shorter than the total length of the second region 82 and the first protrusion 83 in the front-rear direction.

[0182] The fourth region 87 is provided so as to extend upward from the upper end of the fourth narrowed portion 86. The center of the fourth narrowed portion 86 in the front-rear direction and the center of the fourth region 87 in the front-rear direction are aligned in the vertical direction. When viewed in the plate thickness direction of the sixth liquid plate part 66a, the area of the fourth region 87 is smaller than the area of the first region 80. The left side of the fourth region 87 is covered by the fifth liquid plate part 65a. The fourth region 87 overlaps and communicates with the first distribution opening 67c when viewed in the plate thickness direction of the sixth liquid plate part 66a. The fourth region 87, the first distribution opening 67c, and the pipe-end part 71a of the first connection pipe 71 are aligned in the horizontal direction. The connection part between the fourth region 87 and the first distribution opening 67c is preferably located at a position offset above the center of the fourth region 87 in the up-down direction.

[0183] The fifth narrowed portion 88 is provided so as to extend upward from the upper end of the rear-side end part of the third region 84. The horizontal cross-sectional area, which is the flow path cross-sectional area, of the fifth narrowed portion 88 is smaller than the horizontal cross-sectional area, which is the flow path cross-sectional area, of the fifth region 89, and is smaller than the flow path cross-sectional area of the third region 84. The horizontal cross-sectional area, which is the flow path cross-sectional area, of the fifth narrowed portion 88 is equal to the horizontal cross-sectional area, which is the flow path cross-sectional area, of the fourth narrowed portion 86. The length of the fifth narrowed portion 88 in the front-rear direction is shorter than the total length of the third region 84 and the second protrusion 85 in the front-rear direction.

[0184] The fifth region 89 is provided so as to extend upward from the upper end of the fifth narrowed portion 88. The center of the fifth narrowed portion 88 in the front-rear direction and the center of the fifth region 89 in the front-rear direction are aligned in the vertical direction. When viewed in the plate thickness direction of the sixth liquid plate part 66a, the area of the fifth region 89 is smaller than the area of the first region 80 and equal to the area of the fourth region 87. The left side of the fifth region 89 is covered by the fifth liquid plate part 65a. The fifth region 89 overlaps and communicates with the second distribution opening 67d when viewed in the plate thickness direction of the sixth liquid plate part 66a. The fifth region 89, the second distribution opening 67d, and the pipe-end part 72a of the second connection pipe 72 are

aligned in the horizontal direction. Note that the connection part between the fifth region 89 and the second distribution opening 67d is preferably located at a position offset above the center of the fifth region 89 in the up-down direction.

[0185] The first opening part 66b described above has a shape that is symmetrical with respect to a virtual plane that includes the connecting portion P and extends in the vertical and horizontal directions. Specifically, the second region 82 and the third region 84 extend in directions having symmetry with respect to the virtual plane, and extend by the same length.

[0186] In the above-described configuration, the liquid header 60 includes a first flow path A, a second flow path B, a third flow path C, a fourth flow path D, and a fifth flow path E which are refrigerant flow paths configured by the fifth liquid-side portion 65, the sixth liquid-side portion 66, and the seventh liquid-side portion 67.

[0187] The first flow path A is a flow path that includes the first region 80 and the first narrowed portion 81 of the sixth liquid-side portion 66 and is configured by being surrounded on the left and right by the fifth liquid-side portion 65 and the seventh liquid-side portion 67, the flow path extending in the vertical direction to the connecting portion P.

[0188] The second flow path B is a flow path which includes the second region 82 and the first protrusion 83 of the sixth liquid-side portion 66 and is configured by being surrounded on the left and right by the fifth liquid-side portion 65 and the seventh liquid-side portion 67, the flow path extending forward from connecting portion P.

[0189] The third flow path C is a flow path which includes the third region 84 and the second protrusion 85 of the sixth liquid-side portion 66 and is configured by being surrounded on the left and right by the fifth liquid-side portion 65 and the seventh liquid-side portion 67, the flow path extending rearward from the connecting portion P.

[0190] The fourth flow path D is a flow path that includes the fourth narrowed portion 86 and the fourth region 87 of the sixth liquid-side portion 66 and is surrounded on the left and right by the fifth liquid-side portion 65 and the seventh liquid-side portion 67, the flow path extending upward from the second flow path B.

[0191] The fifth flow path E is a flow path which includes the fifth narrowed portion 88 and the fifth region 89 of the sixth liquid-side portion 66 and is surrounded on the left and right by the fifth liquid-side portion 65 and the seventh liquid-side portion 67, the flow path extending upward from the third flow path C.

[0192] When the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the refrigerant in a gas-liquid two-phase state that has flowed through the liquid refrigerant connection pipe 20a and has flowed into the first region 80 of the first opening part 66b descends through the first flow path A, has its flow speed increased when passing through the first narrowed portion 81, and is sent to the connecting portion P. The refrigerant sent to the connecting portion P collides with the ends positioned vertically below the first narrowed portion 81 in the second flow path B and the third flow path C, and, with the refrigerant in the gas phase state and the refrigerant in the liquid phase state having been stirred, the refrigerant has its flow direction greatly changed and is then branched and flows to the second flow path B and the third flow path C.

[0193] The refrigerant flowing through the second flow path B is sent to the fourth flow path D. In the fourth flow path D, the refrigerant whose flow speed has been increased in the fourth narrowed portion 86 is blown up to the fourth region 87.

[0194] The refrigerant flowing through the third flow path C is sent to the fifth flow path E. In the fifth flow path E, the refrigerant whose flow speed has been increased in the fifth narrowed portion 88 is blown up to the fifth region 89.

(7) Features of embodiment

[0195] The liquid header 60 of the outdoor heat exchanger 11 has a structure in which, when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the refrigerant that has flowed in via the liquid refrigerant connection pipe 20a is split before being sent to the plurality of flat tubes 28 connected to the liquid header 60. Thus, it is not necessary to provide a conventionally known flow splitter separately from the liquid header 60, and it is possible to make the installation space compact and to reduce the component cost.

[0196] When the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the gas-liquid two-phase refrigerant that has flowed into the first opening part 66b of the liquid header 60 via the liquid refrigerant connection pipe 20a is sent to the connecting portion P with the flow speed increased in the first narrowed portion 81 with the narrowed flow path while descending through the first flow path A, and is then branched to the second flow path B and the third flow path C. Therefore, it is possible to minimize the difference between the ratio of the gas-phase refrigerant and the liquid-phase refrigerant in the refrigerant flowing through the second flow path B and the ratio of the gas-phase refrigerant and the liquid-phase refrigerant in the refrigerant flowing through the third flow path C. In addition, the second flow path B and the third flow path C have the same flow path cross-sectional area and flow path length, and have symmetry with respect to a virtual plane which includes the connecting portion P and extends in the vertical and horizontal directions. Thus, it is also possible to reduce the difference between the amount of the refrigerant flowing from the connecting portion P toward the second flow path B and the amount of the refrigerant flowing from the connecting portion P toward the third flow path C. In addition, the fourth narrowed portion 86 of the fourth flow path D connected to the second flow path B and the fifth narrowed portion 88 of the fifth flow path E connected to the third flow path C have the same flow path cross-

sectional area, and can cause the same degree of pressure loss in the refrigerant. In this respect as well, the difference between the amount of refrigerant in the second flow path B and the amount of refrigerant in the third flow path C is minimized. Thus, the refrigerant passing through the first flow path A can be equally distributed to the second flow path B and the third flow path C.

[0197] Further, the fourth flow path D and the fifth flow path E are also symmetrical with respect to the virtual plane including the connecting portion P and extending in the vertical and horizontal directions, and the connection side of the fourth flow path D to the second flow path B and the connection side of the fifth flow path E to the third flow path C are on the same upper side. Accordingly, it is possible to make the ratios of the gas-phase refrigerant and the liquid-phase refrigerant approximately the same while equalizing the amounts of refrigerant supplied to the fourth flow path D and the fifth flow path E.

[0198] In addition, the second flow path B has the first protrusion 83 protruding toward the opposite side to the connecting portion P side with respect to the branching portion to the fourth flow path D, and the third flow path C has the second protrusion 85 protruding toward the opposite side to the connecting portion P side with respect to the branching portion to the fifth flow path E. As a result, even if there is a difference in the ratio of the liquid-phase refrigerant between the refrigerant flowing through the second flow path B and the refrigerant flowing through the third flow path C, the liquid refrigerant can be held in the protrusion corresponding to the flow path through which a larger amount of the liquid-phase refrigerant has flowed, so that the difference in the ratio of the liquid-phase refrigerant between the refrigerant flowing through the fourth flow path D and the refrigerant flowing through the fifth flow path E can be minimized.

[0199] The first opening part 66b, which achieves the above-described splitting of the refrigerant flowing through the first flow path A into the second flow path B and the third flow path C, and further into the fourth flow path D and the fifth flow path E, is provided in the sixth member 46, which is a single plate-shaped member. Thus, the refrigerant can be split in the liquid header 60 with a small number of members.

[0200] In addition, since the first flow path A, the fourth flow path D, and the fifth flow path E are arranged on the same upper side with respect to the second flow path B and the third flow path C, it is possible to minimize the length of the first opening part 66b in the up-down direction.

(8) Other Embodiments

(8-1) Other embodiment A

[0201] In the above-described embodiment, the example has been described where the outdoor heat exchanger 11 is configured such that, when the outdoor heat exchanger 11 functions as an evaporator of the refrigerant, the refrigerant that has passed through the liquid refrigerant connection pipe 20a flows into the first region 80 of the first opening part 66b of the sixth liquid-side portion 66 via the liquid pipe connection opening 67b of the seventh liquid-side portion 67.

[0202] However, the outdoor heat exchanger 11 is not limited thereto. For example, as shown in Fig. 12, the outdoor heat exchanger 11 may have a fifth liquid-side portion 165 instead of the fifth liquid-side portion 65 of the above-described embodiment, have a seventh liquid-side portion 167 instead of the seventh liquid-side portion 67 of the above-described embodiment, and have the liquid refrigerant connection pipe 20a connected to the lower end of the second header 30. Fig. 13 is an explanatory view of the refrigerant flow when the outdoor heat exchanger 11 according to the other embodiment A is caused to function as an evaporator of the refrigerant. Here, in the second header 30, two flat tubes 28 at the bottom are connected to the region to which the liquid refrigerant connection pipe 20a is connected, and the inside of the second header 30 is partitioned into the region and an upper region (not shown).

[0203] The fifth liquid-side portion 165 is further provided with a connection opening 65h in the fifth liquid-side portion 65 of the above-described embodiment. The connection opening 65h is an opening provided below the first communication opening 65b and penetrating the fifth liquid plate part 65a in the plate thickness direction. The connection opening 65h communicates with the opening 64b of the fourth liquid-side portion 64 on the left side, and communicates with the first region 80 in the first communication opening 66c of the sixth liquid-side portion 66 on the right side.

[0204] The seventh liquid-side portion 167 is obtained by omitting the liquid pipe connection opening 67b in the seventh liquid-side portion 67 of the above-described embodiment. Accordingly, the right side of the first region 80 in the first communication opening 66c of the sixth liquid-side portion 66 is covered by the seventh liquid plate part 67a of the seventh liquid-side portion 167.

[0205] In the above configuration, when the outdoor heat exchanger 11 is caused to function as an evaporator of the refrigerant, the refrigerant introduced into the lower end region of the second header 30 via the liquid refrigerant connection pipe 20a flows through the two flat tubes 28 at the bottom, passes through the two liquid-side flat tube connection openings 61b at the bottom, the two liquid insertion openings 62b at the bottom, and the two liquid restriction openings 63b at the bottom, and the flows merge in the opening 64b of the fourth liquid-side portion 64. At this time, by sending the refrigerant to the two lowermost flat tubes 28 of the outdoor heat exchanger 11, a pressure loss can be generated in the two flat tubes 28, and adhesion of frost and growth of frost in the vicinity of the lower end of the outdoor heat exchanger 11 are suppressed. Then, the refrigerant merged in the opening 64b of the fourth liquid-side portion 64 is introduced into the first region 80 of the first opening

part 66b of the sixth liquid-side portion 66 via the connection opening 65h of the fifth liquid-side portion 165. The refrigerant introduced into the first region 80 collides with the seventh liquid plate part 67a of the seventh liquid-side portion 67, changes its flow direction downward, and flows toward the first narrowed portion 81. Thereafter, the refrigerant flows and is split in the same manner as in the above-described embodiment.

(8-2) Other embodiment B

[0206] In the above-described embodiment, the example has been described where, in the first opening part 66b, the second flow path B is configured to have the same flow path area extending, and the third flow path C is configured to have the same flow path area extending.

[0207] However, the first opening part 66b is not limited thereto. For example, as shown in Fig. 14, in the first opening part 66b, the second flow path B may have a second narrowed portion 98 configured by its flow path area being partially narrowed, and the third flow path C may have a third narrowed portion 99 configured by its flow path area being partially narrowed. The second narrowed portion 98 and the third narrowed portion 99 may have the same flow path cross-sectional area.

[0208] In this case, the refrigerant that has passed through the first narrowed portion 81 is subjected to pressure loss in the second narrowed portion 98 and the third narrowed portion 99, so that the amount of refrigerant passing through the second narrowed portion 98 is limited, and the amount of refrigerant passing through the third narrowed portion 99 is limited, thereby suppressing a concentrated flow of the liquid refrigerant to either the second flow path B or the third flow path C.

(8-3) Other embodiment C

[0209] In the above-described embodiment, the example has been described where, in the first opening part 66b, the first flow path A, the fourth flow path D, and the fifth flow path E are all on the same upper side with respect to the second flow path B and the third flow path C.

[0210] However, the first opening part 66b is not limited thereto. For example, as shown in Fig. 15, the first flow path A may be configured to include a first region 80a and a first narrowed portion 81a, and may be positioned below the second flow path B and the third flow path C.

[0211] Also in this case, the refrigerant blown up from the first region 80a to the connecting portion P via the first narrowed portion 81a is equally distributed to the second flow path B and the third flow path C, and is also equally distributed to the fourth flow path D and the fifth flow path E.

(8-4) Other embodiment D

[0212] In the above-described embodiment, the example has been described where, in the first opening part 66b, the first flow path A, the fourth flow path D, and the fifth flow path E are all on the same upper side with respect to the second flow path B and the third flow path C.

[0213] However, the first opening part 66b is not limited thereto. For example, as shown in Fig. 16, the fourth flow path D may be configured to include a fourth region 87a and a fourth narrowed portion 86a and be positioned below the second flow path B, and the fifth flow path E may be configured to include a fifth region 89a and a fifth narrowed portion 88a and be positioned below the third flow path C.

[0214] Also in this case, the refrigerant blown down from the first region 80 to the connecting portion P via the first narrowed portion 81 is equally distributed to the second flow path B and the third flow path C, and is also equally distributed to the fourth flow path D extending downward from the second flow path B and the fifth flow path E extending downward from the third flow path C.

[0215] In addition to the above, the first opening part 66b may include the fourth flow path D extending downward from the second flow path B and the fifth flow path E extending upward from the third flow path C, or may include the fourth flow path D extending upward from the second flow path B and the fifth flow path E extending downward from the third flow path C.

(8-5) Other embodiment E

[0216] In the above-described embodiment, the example has been described where, in the first opening part 66b, the first flow path A, the fourth flow path D, and the fifth flow path E are all on the same upper side with respect to the second flow path B and the third flow path C.

[0217] However, the first opening part 66b is not limited thereto. For example, as shown in Fig. 17, the first flow path A may be configured to include the first region 80a and the first narrowed portion 81a and be positioned below the second flow path B and the third flow path C, the fourth flow path D may include a fourth region 87a and a fourth narrowed portion 86a and be positioned below the second flow path B, and the fifth flow path E may include a fifth region 89a and a fifth narrowed portion 88a and be positioned below the third flow path C.

[0218] Also in this case, the refrigerant blown up from the first region 80a to the connecting portion P via the first narrowed portion 81a is equally distributed to the second flow path B and the third flow path C, and is also equally distributed to the fourth flow path D extending downward from the second flow path B and the fifth flow path E extending downward from the third flow path C.

[0219] In addition to the above, the first opening part 66b may include the fourth flow path D extending downward from the second flow path B and the fifth flow path E extending upward from the third flow path C, or may include the fourth flow path D extending upward from

the second flow path B and the fifth flow path E extending downward from the third flow path C.

(8-6) Other embodiment F

[0220] In the above-described embodiment, the example has been described where, in the first opening part 66b, the first flow path A is configured to include the first region 80 and the first narrowed portion 81.

[0221] However, the first opening part 66b is not limited thereto. For example, as shown in Fig. 18, in the first opening part 66b, the first flow path A may be configured to include a first region 80b and the first narrowed portion 81. The first region 80b has an upper first region 80x and a lower first region 80y, and the first narrowed portion 81 is interposed between the upper first region 80x and the lower first region 80y in the up-down direction. Note that the position of the first narrowed portion 81 in the first region 80b is preferably provided at a position closer to the connecting portion than the middle point in the up-down direction, which is the refrigerant flow direction of the first flow path A, and is preferably a position closer to the bottom of the first region 80b. The area of the flow path cross-section, which is the horizontal cross-section, of the upper first region 80x and the area of the flow path cross-section, which is the horizontal cross-section, of the lower first region 80y are equal to each other, and are both larger than the area of the flow path cross-section, which is the horizontal cross-section, of the first narrowed portion 81.

[0222] Also in this case, the refrigerant blown down from the upper first region 80x of the first region 80b to the lower first region 80y and the connecting portion P further below via the first narrowed portion 81 is equally distributed to the second flow path B and the third flow path C, and is also equally distributed to the fourth flow path D and the fifth flow path E.

(8-7) Other embodiment G

[0223] In the above-described embodiment, the example has been described where, in the first opening part 66b, the second flow path B and the third flow path C extend away from each other horizontally from the connecting portion P.

[0224] However, the first opening part 66b is not limited thereto. For example, as shown in Fig. 19, the second flow path B and the third flow path C may extend obliquely with respect to the horizontal direction away from each other from the connecting portion P. For example, as shown in Fig. 19, the second flow path B may be configured to include a second region 82a and a first protrusion 83a, and the third flow path C may be configured to include a third region 84a and a second protrusion 85a, and the flow paths may extend so as to be positioned higher as they extend away from each other from the connecting portion P. Further, the second flow path B and the third flow path C may extend so as to be positioned lower as they extend away from each other from the connecting portion P (not shown).

[0225] In these cases, the refrigerant flowing through the first flow path A is equally split into the second flow path B and the third flow path C, and is also equally distributed to the fourth flow path D and the fifth flow path E, as in the above-described embodiment.

(8-8) Other embodiment H

[0226] In the above-described embodiment, the example has been described where the outdoor heat exchanger 11 is used in a posture in which the longitudinal direction of the liquid header 60 is in the up-down direction.

[0227] However, the longitudinal direction of the liquid header 60 in the outdoor heat exchanger 11 is not limited thereto. For example, as shown in Fig. 20, the outdoor heat exchanger 11 may be used in a state in which the longitudinal direction of the liquid header 60 is inclined such that the longitudinal direction of a sixth liquid-side portion 166 of the liquid header 60 is inclined with respect to the up-down direction. In this case, even though the longitudinal direction of the sixth liquid-side portion 166 is inclined with respect to the up-down direction, the shape and orientation of a first opening part 166b of the sixth liquid-side portion 166 are the same as in the above-described embodiment. Specifically, the first flow path A extends in the vertical direction, and the second flow path B and the third flow path C are provided so as to have symmetry, and the fourth flow path D and the fifth flow path E are provided so as to have symmetry, with respect to a virtual plane including a line extending in the vertical direction from the connecting portion P and a line along which the flat tube 28 extends from the connecting portion P. Also in this case, similarly to the above-described embodiment, the refrigerant flowing through the first flow path A is equally split into the second flow path B and the third flow path C, and is also equally distributed to the fourth flow path D and the fifth flow path E.

(8-9) Other embodiment I

[0228] In the above-described embodiment, the example has been described where the outdoor heat exchanger 11 has a plurality of flat tubes 28 connected to the liquid header 60.

[0229] However, the heat transfer tubes connected to the liquid header 60 are not limited to the flat tubes, and may include a heat transfer tube having a cylindrical flow path cross-section.

(8-10) Other embodiment J

[0230] In the above-described embodiment, the example has been described where the first flow path A, the second flow path B, and the third flow path C are configured by covering the first opening part 66b of the sixth

liquid-side portion 66 of the sixth member 46, which is a single plate member, with the seventh liquid plate part 67a of the seventh liquid-side portion 67 of the seventh member 47 and the fifth liquid plate part 65a of the fifth liquid-side portion 65 of the fifth member 45.

[0231] However, the first flow path A, the second flow path B, and the third flow path C are not limited thereto. For example, the liquid header 60 may include a plurality of plate members each having an opening with a shape corresponding to the first opening part 66b, and the first flow path A, the second flow path B, and the third flow path C may be configured by covering a stacked body of the plurality of plate members from both sides in the plate thickness direction.

(Appendix)

[0232] 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

1	Air-conditioning apparatus
2	Outdoor unit
3	Control unit
11	Outdoor heat exchanger (heat exchanger)
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 (heat transfer tube)
30	Second header
40	First header (header)
41	First member (plate member)
42	Second member (plate member)
43	Third member (plate member)
44	Fourth member (plate member)
45	Fifth member (plate member)
46	Sixth member (plate member, first plate member, plate-shaped member)
47	Seventh member (plate member)
50	Gas header
50s	Gas space
56b	Sixth gas opening part (second opening part)
60	Liquid header (header)
60s	Liquid space
64d	First introduction region (sixth flow path)
64h	Second introduction region (seventh flow path)
65b	First communication opening (sixth flow path)
65e	Second communication opening (seventh flow path)
66b	First opening part
66c	First communication opening (sixth flow path, second opening part)
66d	First descending opening (second opening part)
66e	Second communication opening (seventh flow path, second opening part)
66f	Second descending opening (second opening part)
67e	First communication opening (sixth flow path)
67f	Second communication opening (seventh flow path)
71	First connection pipe
72	Second connection pipe
80	First region (first portion)
81	First narrowed portion
82	Second region
83	First protrusion
84	Third region
85	Second protrusion
86	Fourth narrowed portion
87	Fourth region
88	Fifth narrowed portion
89	Fifth region
98	Second narrowed portion
99	Third narrowed portion
166	First opening part
166a	First opening part
A	First flow path
B	Second flow path
C	Third flow path
D	Fourth flow path
E	Fifth flow path
P	Connecting portion

Citation List

Patent Literature

[0233] PTL 1: International Publication No. 2015/049727

Claims

1. A heat exchanger (11) comprising:

a header (60); and
a plurality of heat transfer tubes (28) connected to the header,
wherein:
the header includes a first flow path (A), a second flow path (B), and a third flow path (C), the first flow path (A), the second flow path (B), and the third flow path (C) being connected at a connecting portion (P);
the first flow path extends in a first direction which is a vertical direction;
the second flow path extends in a second direction;
the third flow path extends in a third direction;
the second direction and the third direction have

symmetry with respect to a virtual plane including a line extending in the vertical direction from the connecting portion and a line extending in a direction in which the heat transfer tubes extend from the connecting portion; and
the first flow path includes a first narrowed portion (81).

2. The heat exchanger according to claim 1, wherein the second direction and the third direction are horizontal directions.

3. The heat exchanger according to claim 1 or 2, wherein the first narrowed portion is connected to the connecting portion.

4. The heat exchanger according to claim 3, wherein the first narrowed portion is positioned above the connecting portion.

5. The heat exchanger according to any one of claims 1 to 4, wherein the header is a stacked header in which a plurality of plate members (41, 42, 43, 44, 45, 46, 47) including a first plate member (46) are stacked, and
the first plate member forms the first flow path, the second flow path, and the third flow path.

6. The heat exchanger according to any one of claims 1 to 5, wherein:

the second flow path includes a second narrowed portion (98); and
the third flow path includes a third narrowed portion (99).

7. The heat exchanger according to any one of claims 1 to 6, wherein:

a flow path area of the second flow path and a flow path area of the third flow path are the same; and
a flow path length of the second flow path and a flow path length of the third flow path are the same.

8. The heat exchanger according to any one of claims 1 to 7, further comprising:

a fourth flow path (D) connected to the second flow path and extending in a direction different from the direction in which the second flow path extends; and
a fifth flow path (E) connected to the third flow path and extending in a direction different from the direction in which the third flow path extends.

9. The heat exchanger according to claim 8, wherein:

both the fourth flow path and the fifth flow path extend upward; or
both the fourth flow path and the fifth flow path extend downward.

10. The heat exchanger according to claim 8 or 9, wherein:

the second flow path includes a first protrusion (83) that protrudes toward an opposite side to the connecting portion side with respect to a connection area between the second flow path and the fourth flow path in the direction in which the second flow path extends; and
the third flow path includes a second protrusion (85) that protrudes toward an opposite side to the connecting portion side with respect to a connection area between the third flow path and the fifth flow path in the direction in which the third flow path extends.

11. The heat exchanger according to any one of claims 8 to 10, wherein:

the fourth flow path includes a fourth narrowed portion (86); and
the fifth flow path includes a fifth narrowed portion (88).

12. The heat exchanger according to any one of claims 8 to 11, further comprising:

a first connection pipe (71) having both ends connected to the header; and
a second connection pipe (72) having both ends connected to the header,
wherein:
the first connection pipe constitutes at least a part of a flow path connecting the fourth flow path and a sixth flow path (67e, 66c, 65b, 64d) which is a flow path inside the header; and
the second connection pipe constitutes at least a part of a flow path connecting the fifth flow path and a seventh flow path (67f, 66e, 65e, 64h) which is a flow path inside the header.

13. The heat exchanger according to any one of claims 1 to 12, wherein:

the first flow path includes a first portion (80) having a flow path cross-sectional area larger than that of the first narrowed portion; and
a flow path cross-sectional area of the second flow path and a flow path cross-sectional area of the third flow path are smaller than a flow path cross-sectional area of the first portion.

14. The heat exchanger according to any one of claims 1

to 13, wherein the header includes a plate-shaped member (46) in which a first opening part (66b) that forms at least a part of the connecting portion, the first flow path, the second flow path, and the third flow path, and a second opening part (66c, 66d, 66e, 66f, 56b) that is isolated from the first opening part and forms an eighth flow path that is a flow path other than the first flow path, the second flow path, and the third flow path are formed.

15. The heat exchanger according to any one of claims 1 to 14, wherein the refrigerant flows from the first flow path toward the connecting portion when the heat exchanger functions as an evaporator of the refrigerant.

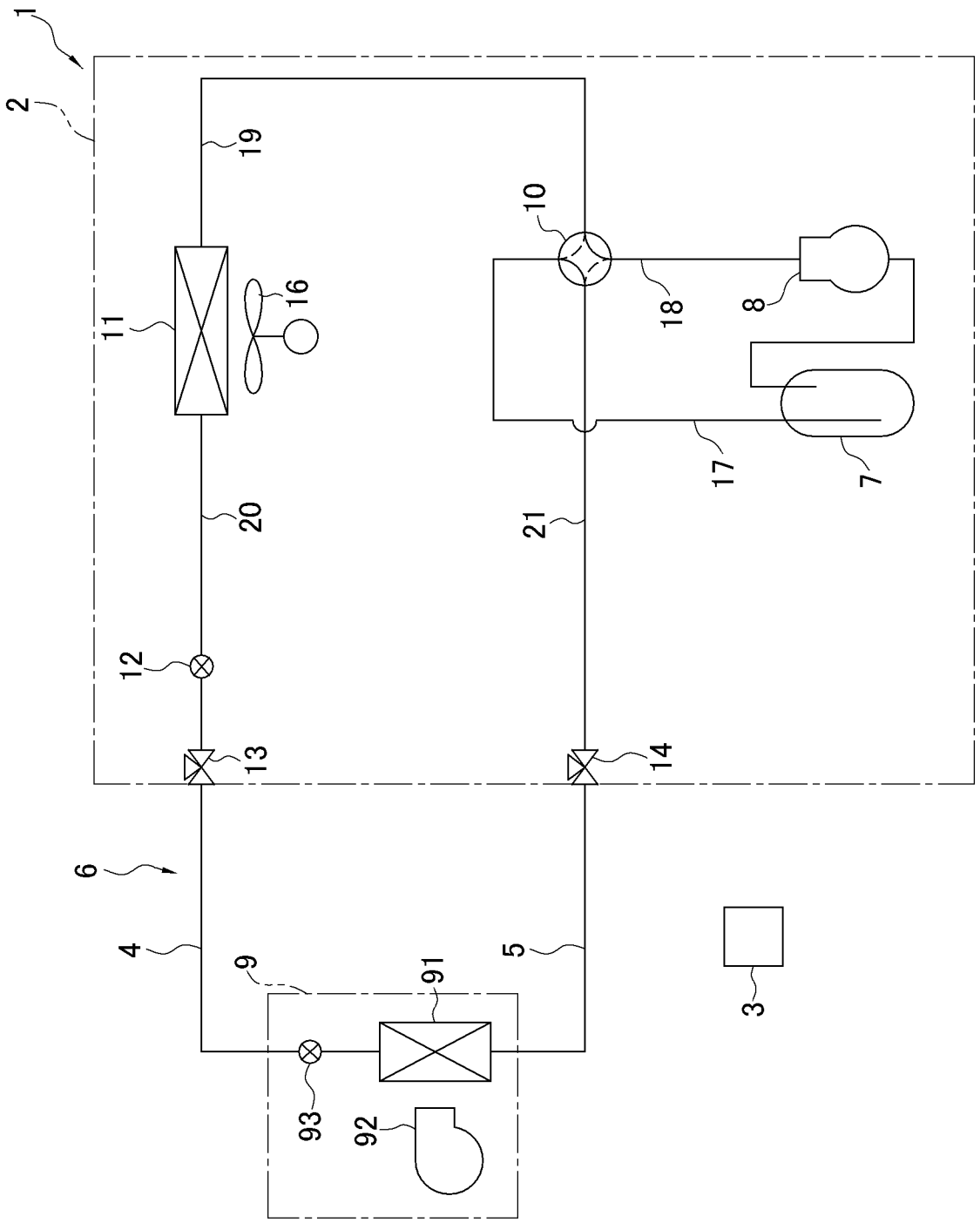
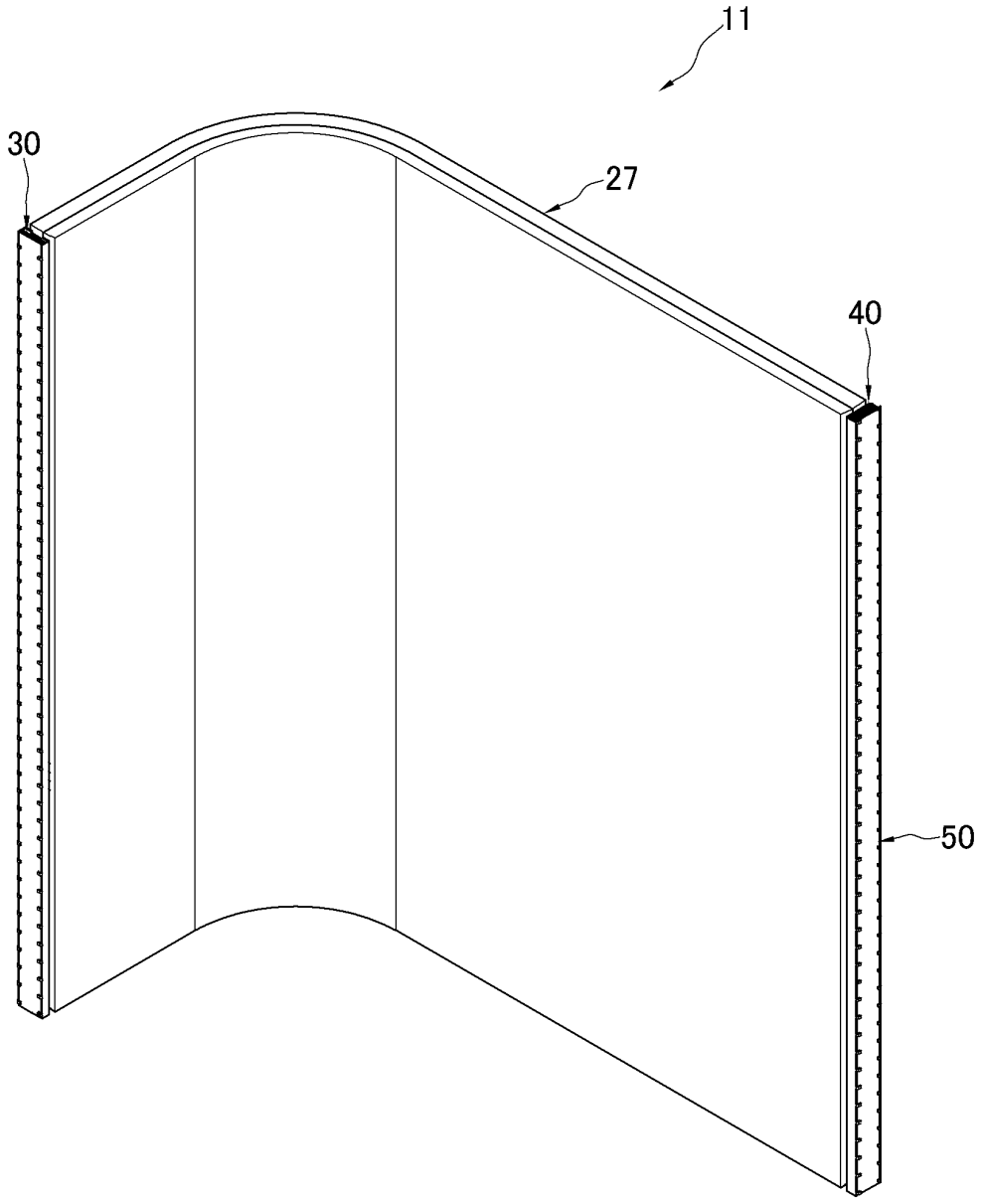


FIG. 1



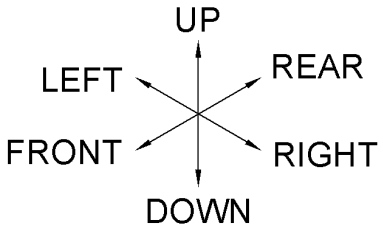


FIG. 2

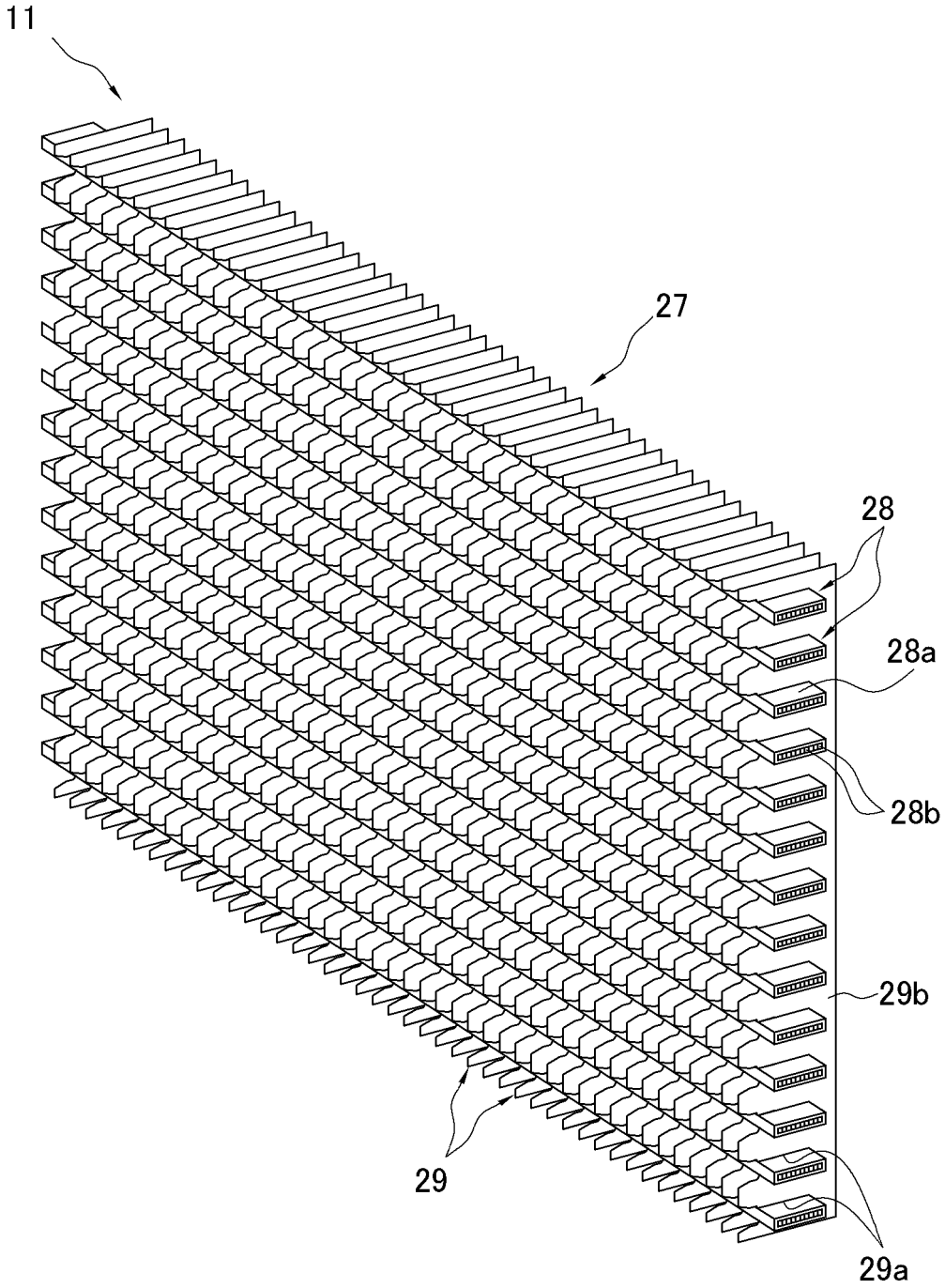


FIG. 3

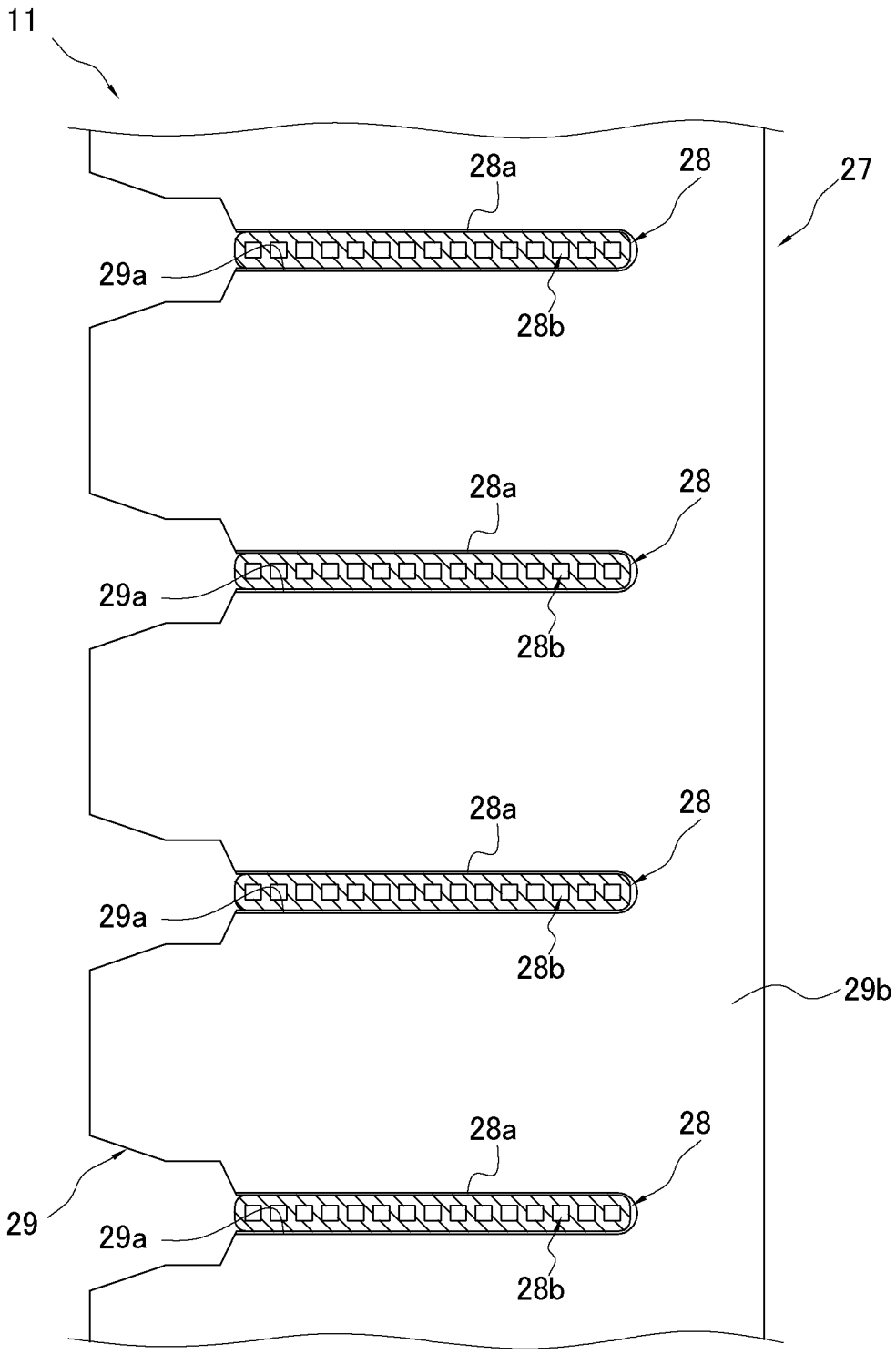

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FIG. 4

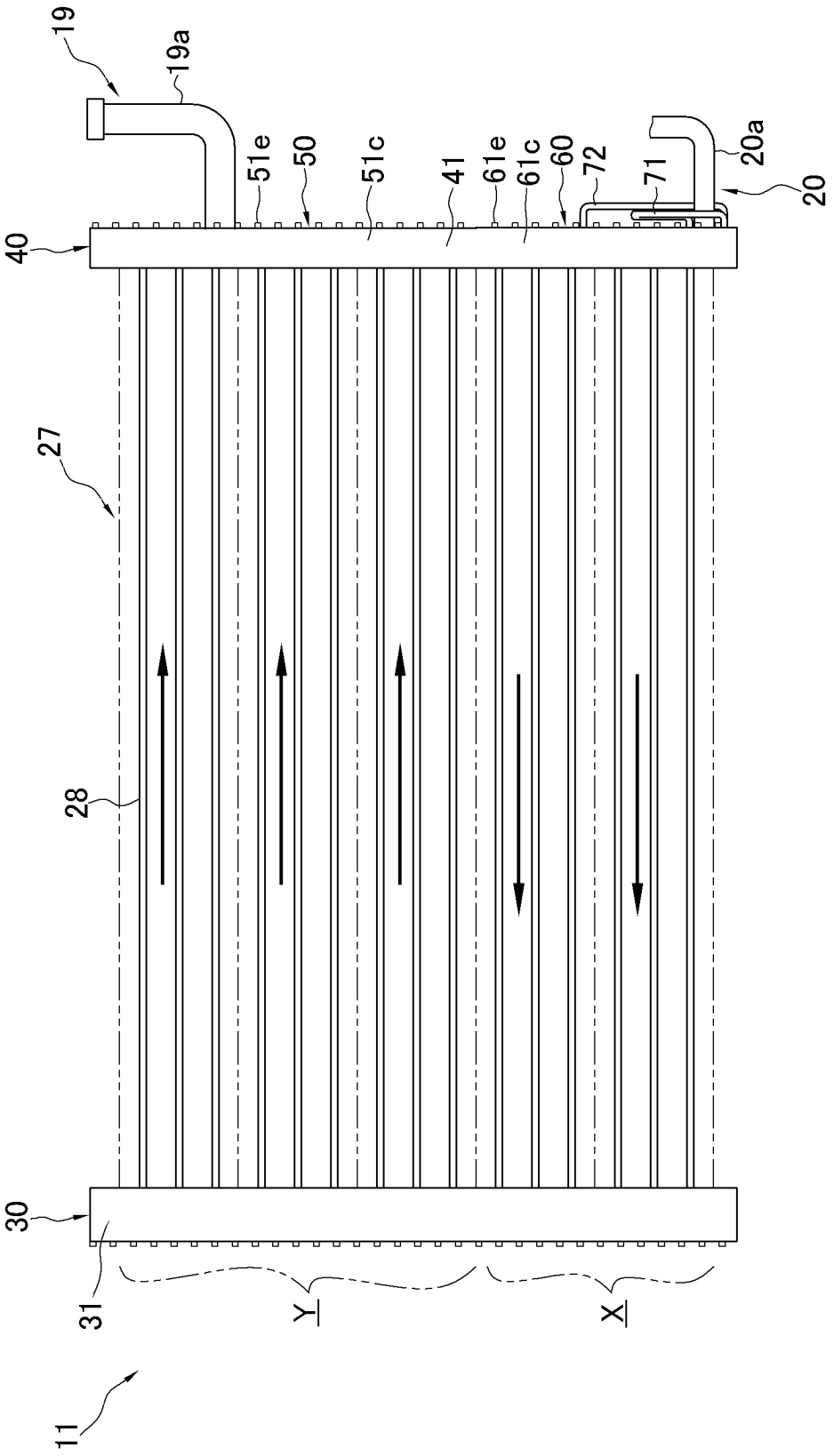


FIG. 5

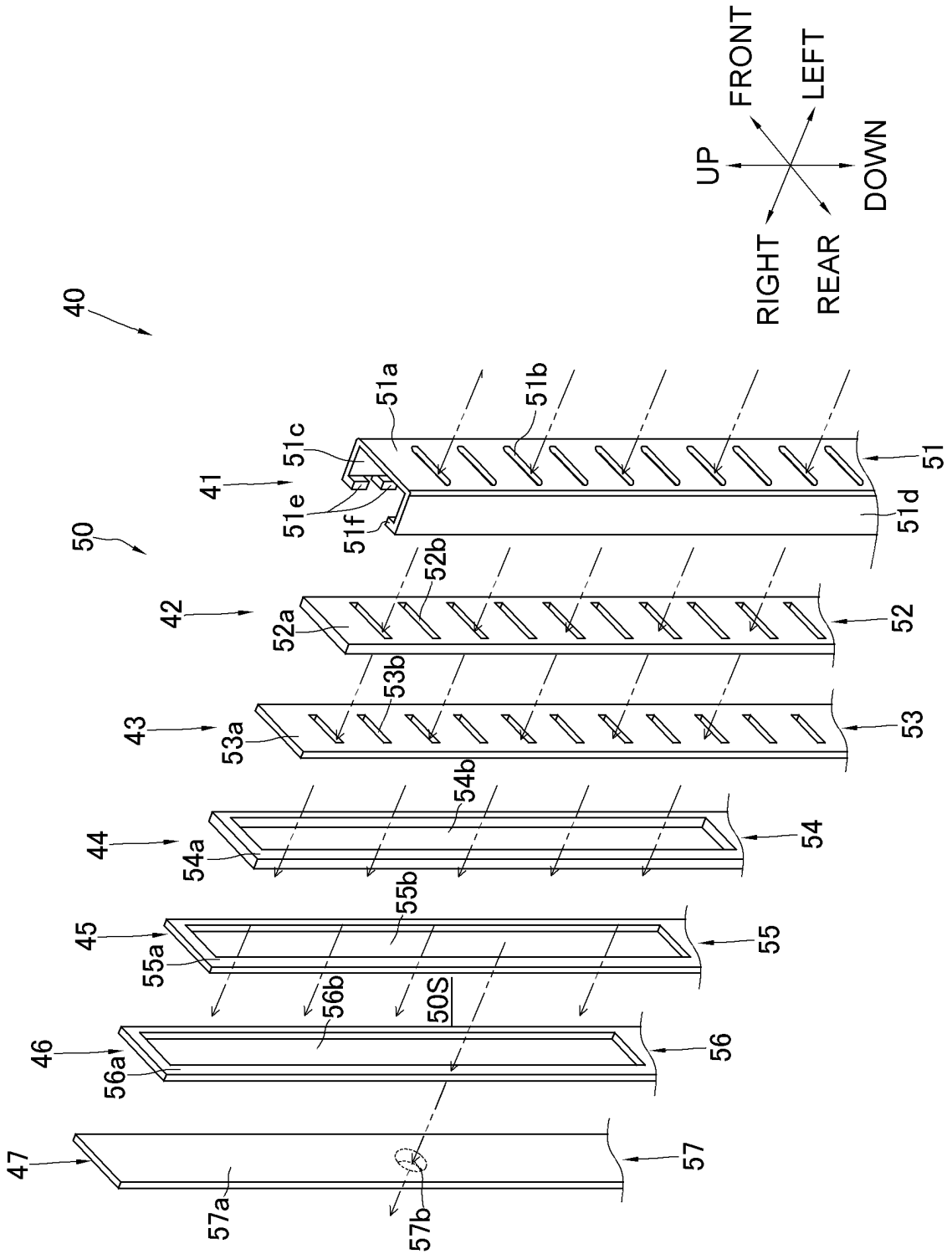

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FIG. 6

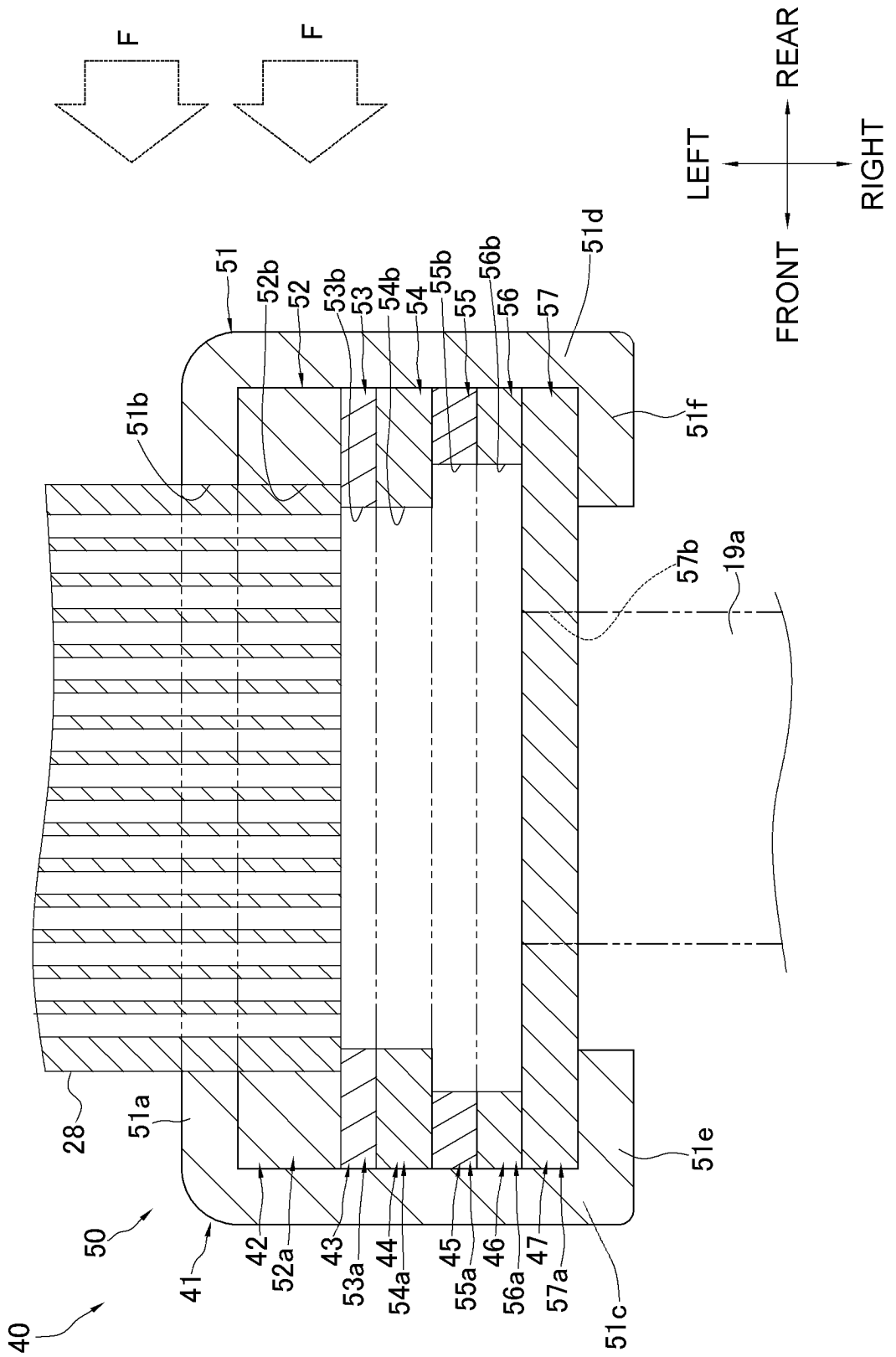

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FIG. 7

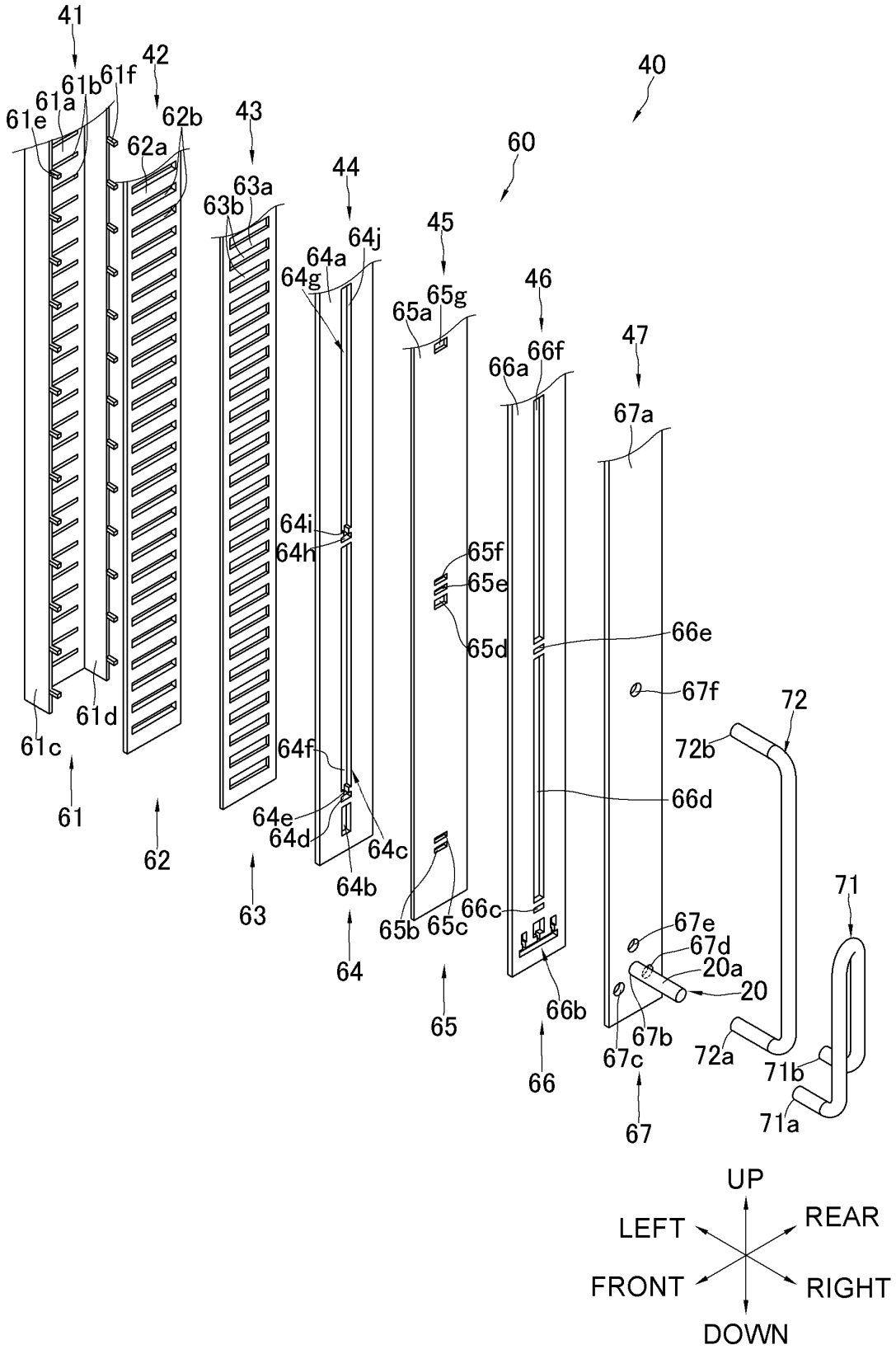

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FIG. 8

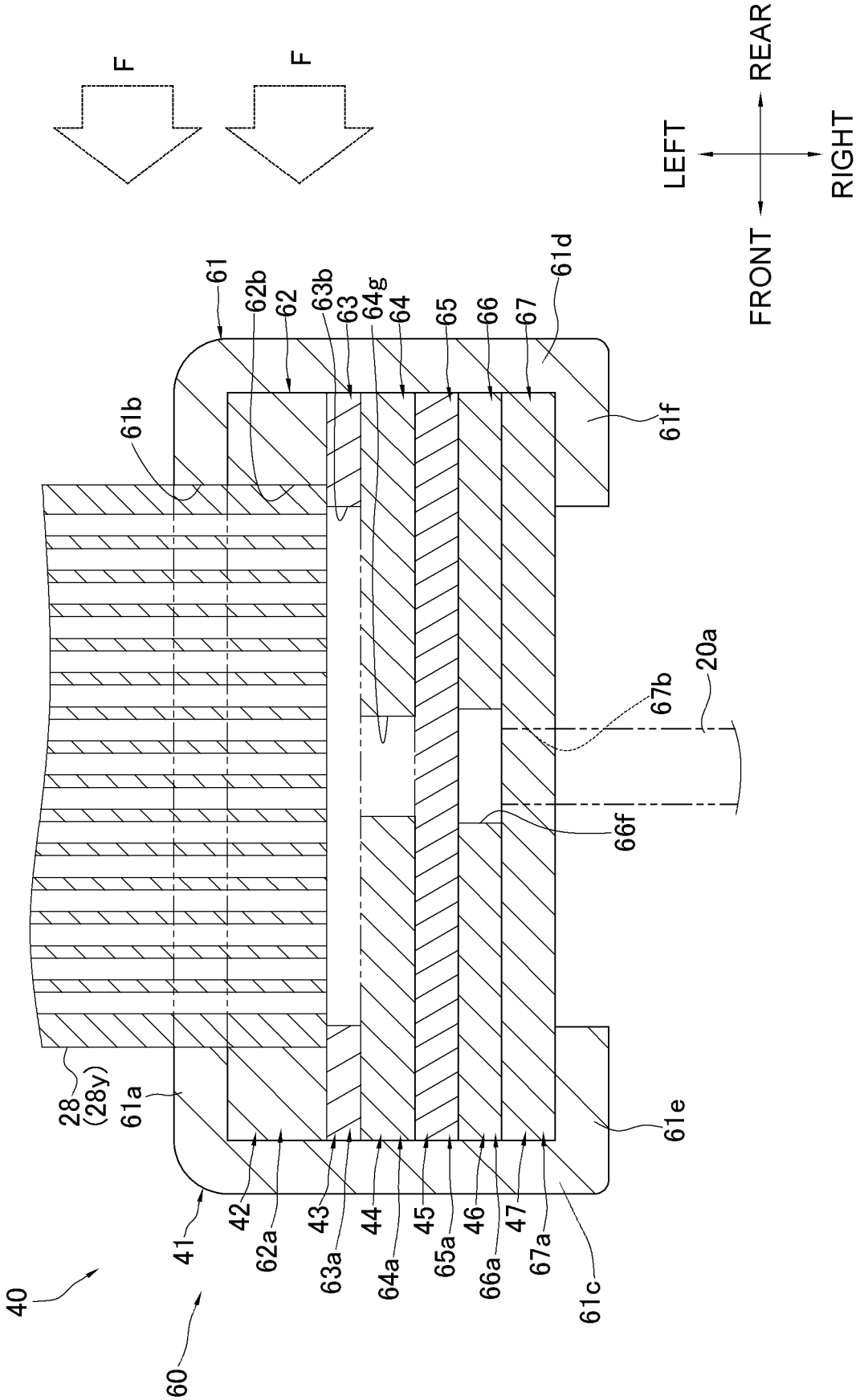

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FIG. 9

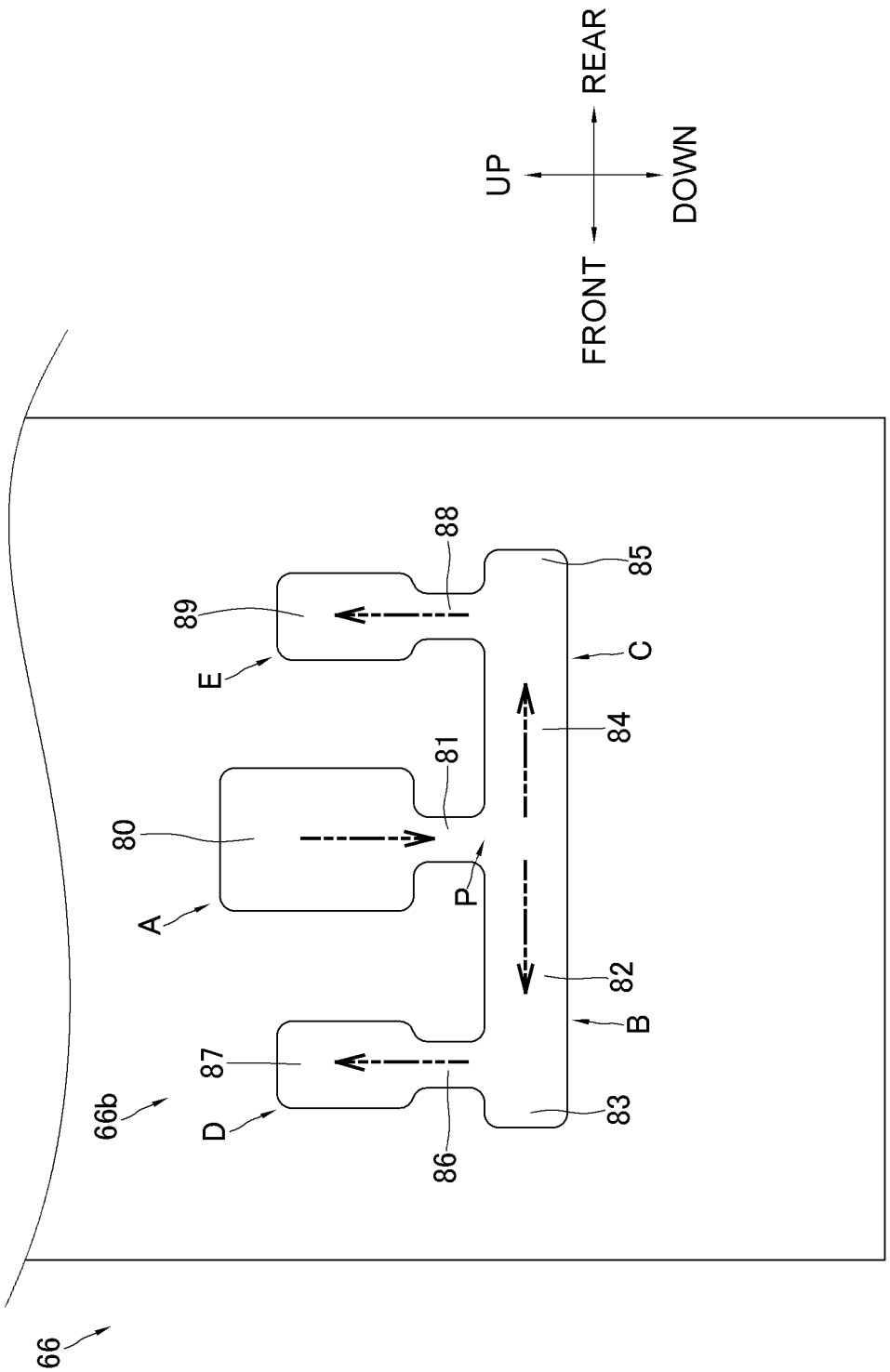


FIG. 10

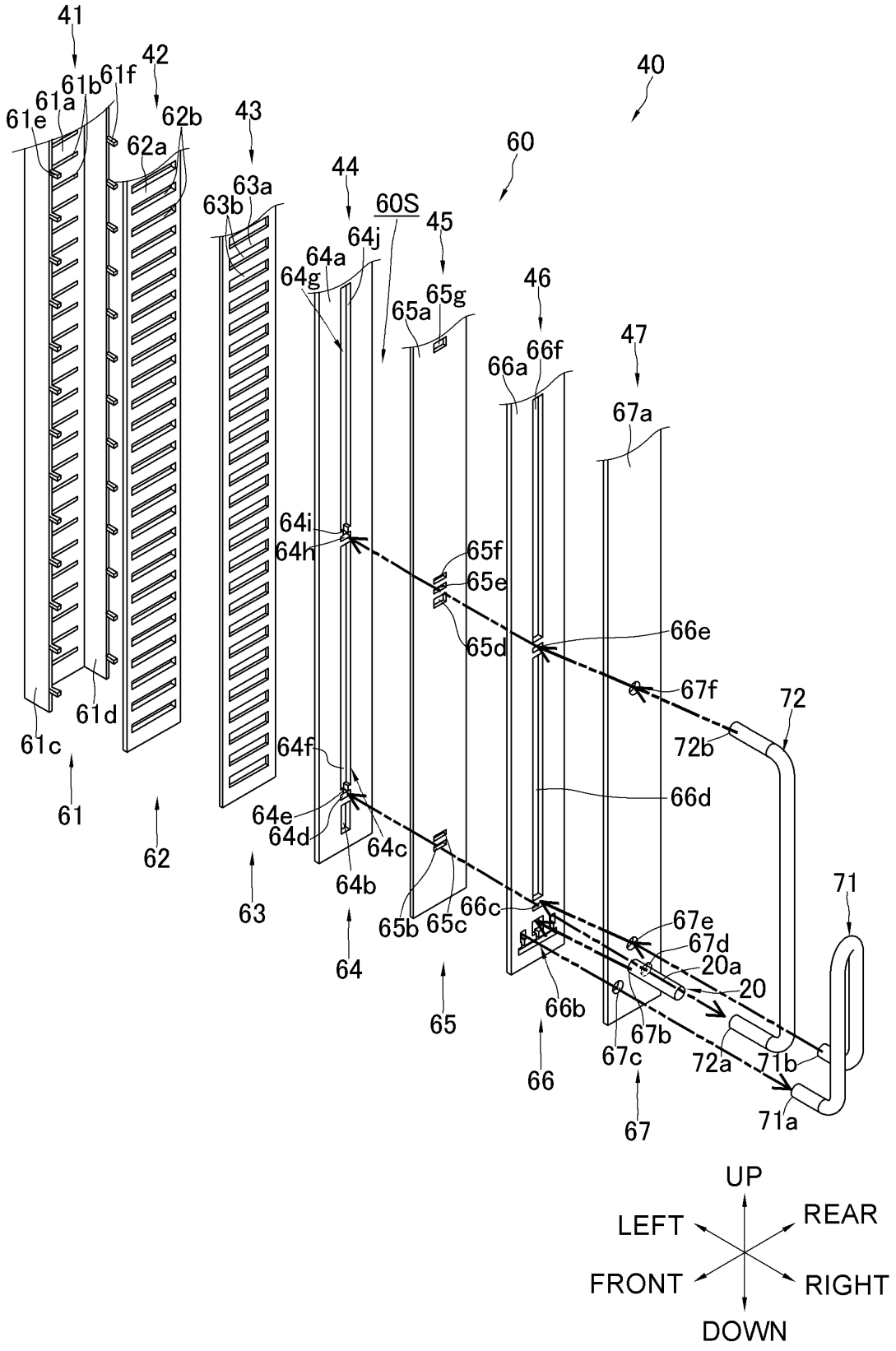

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FIG. 11

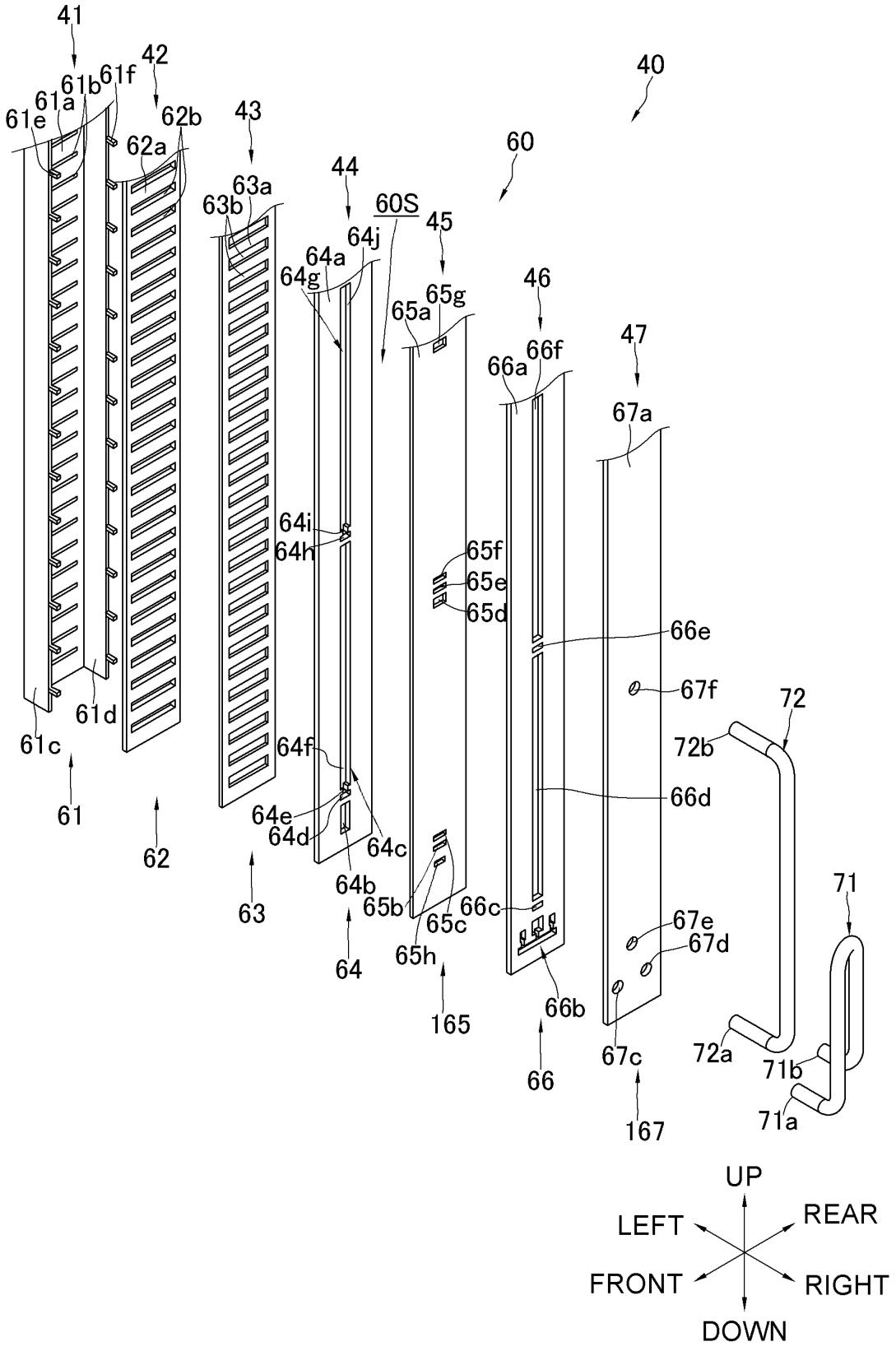

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65h
165
66b
72a
71b
66
67c
167
71a
UP
LEFT
REAR
FRONT
RIGHT
DOWN

FIG. 12

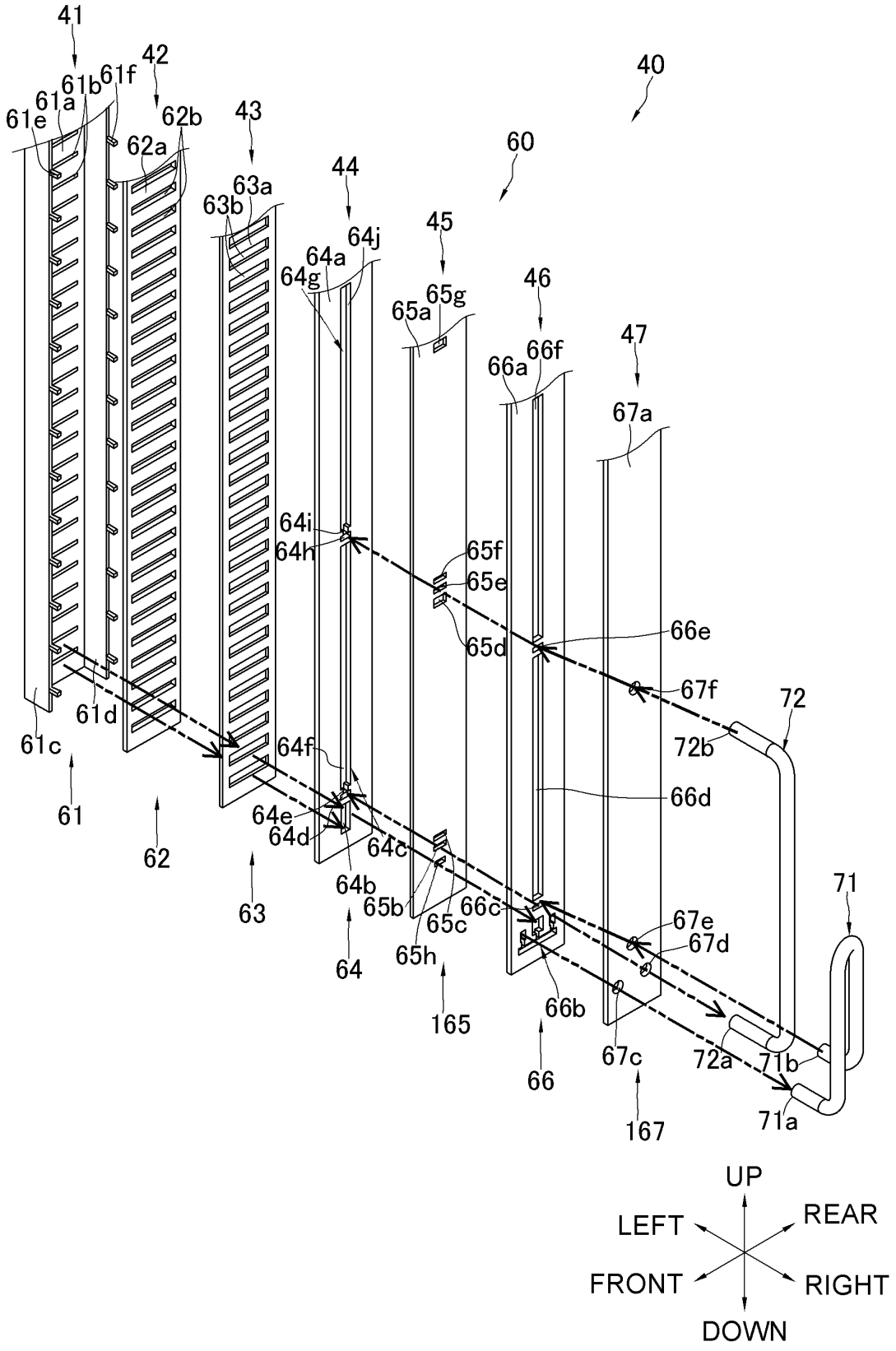

41
42
61b
61f
61a
61e
62b
62a
43
63a
63b
44
64j
64a
64g
45
65g
65a
46
66f
66a
47
67a
60
40
64i
64h
65f
65e
65d
66e
67f
72
72b
61d
61c
64f
66d
61
62
64e
64d
64c
64b
63
65b
65c
66c
71
67e
67d
64
65h
165
66b
66
67c
72a
71b
71a
167
UP
LEFT
REAR
FRONT
RIGHT
DOWN

FIG. 13

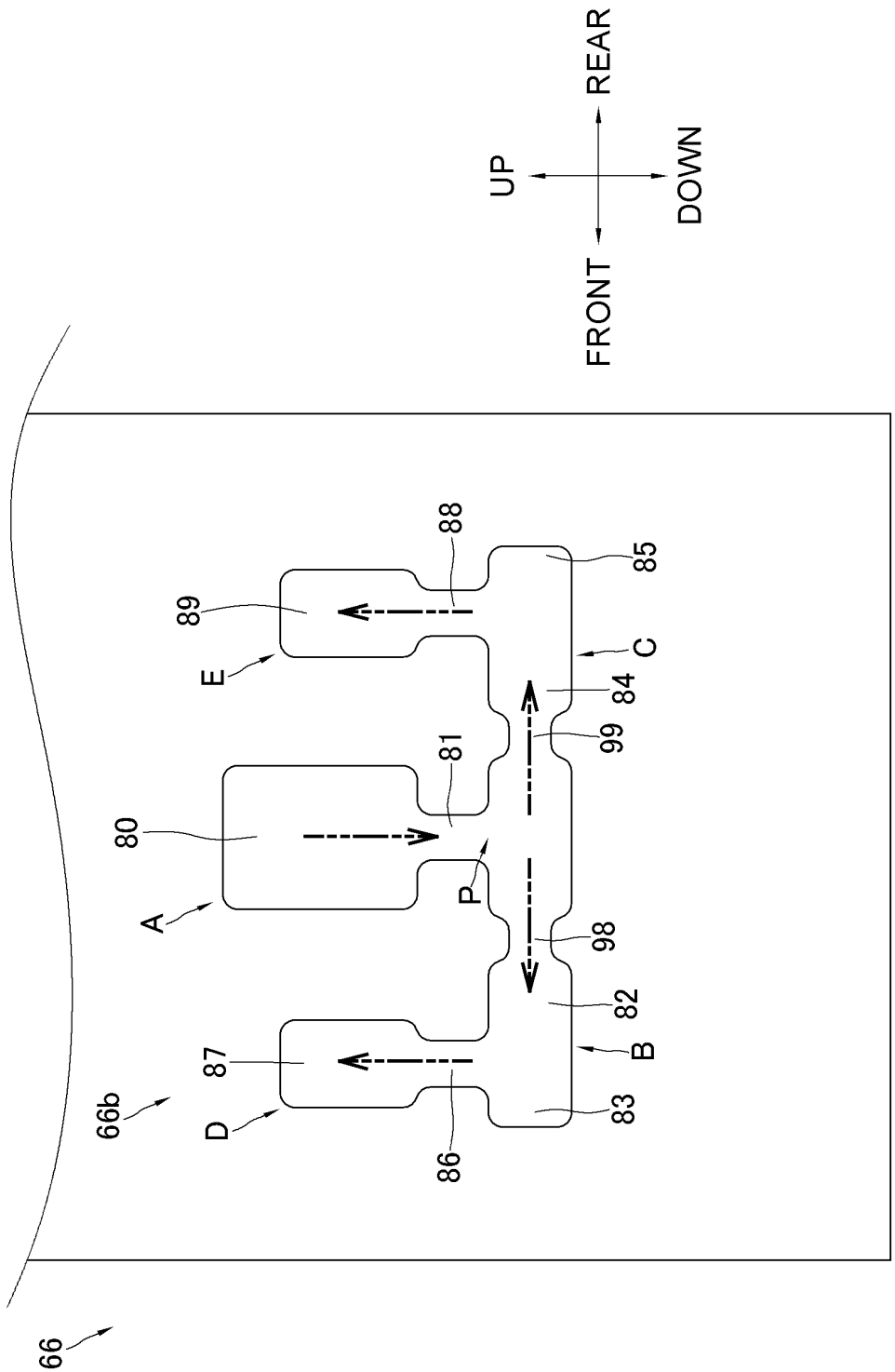

UP
REAR
DOWN
FRONT
66
66b
80
81
88
85
89
C
E
84
99
A
P
98
82
87
B
D
83
86

FIG. 14

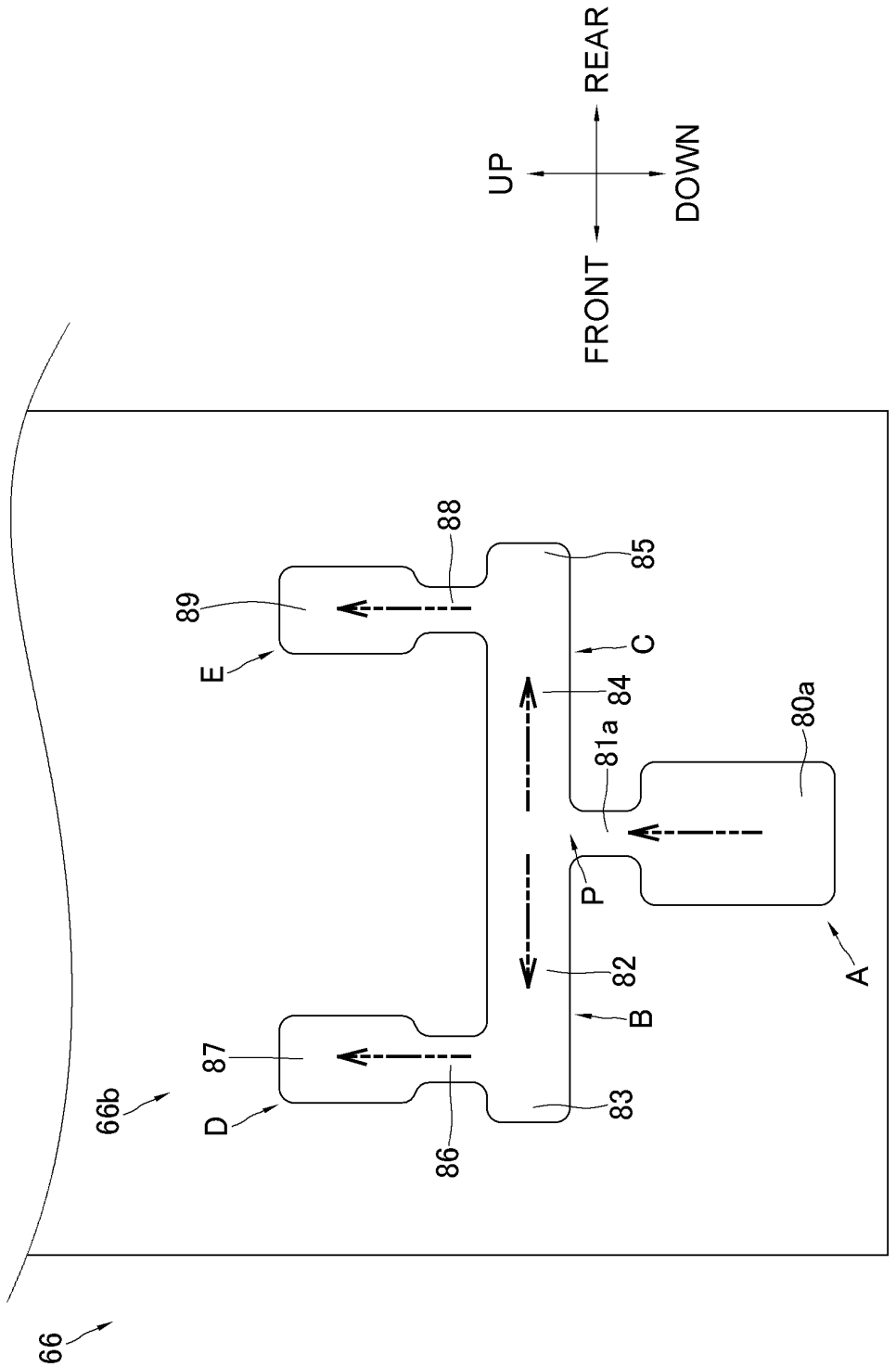


FIG. 15

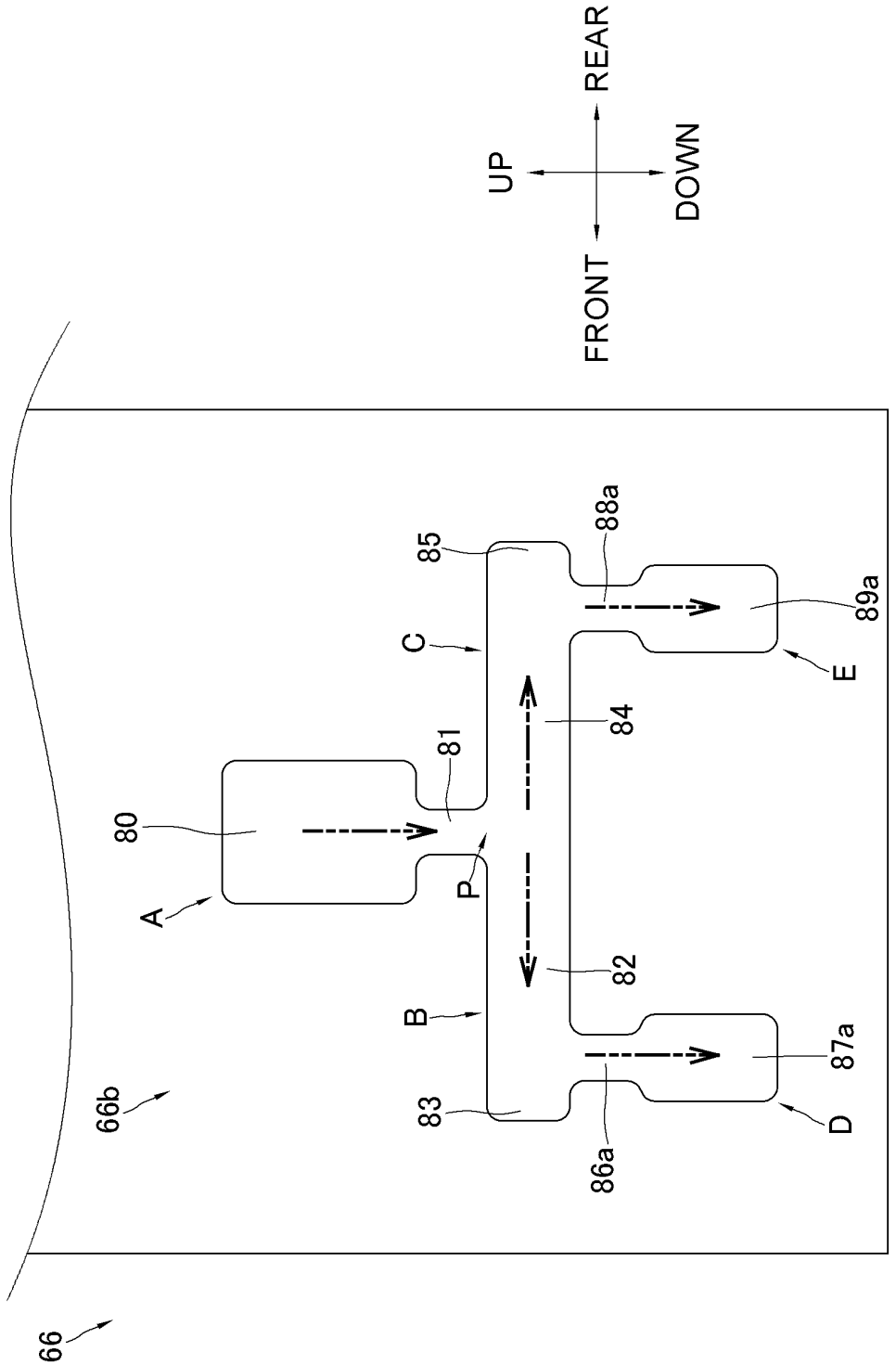

REAR
UP
DOWN
FRONT
66
66b
80
81
85
88a
89a
84
82
83
86a
87a
A
B
C
D
E
P

FIG. 16

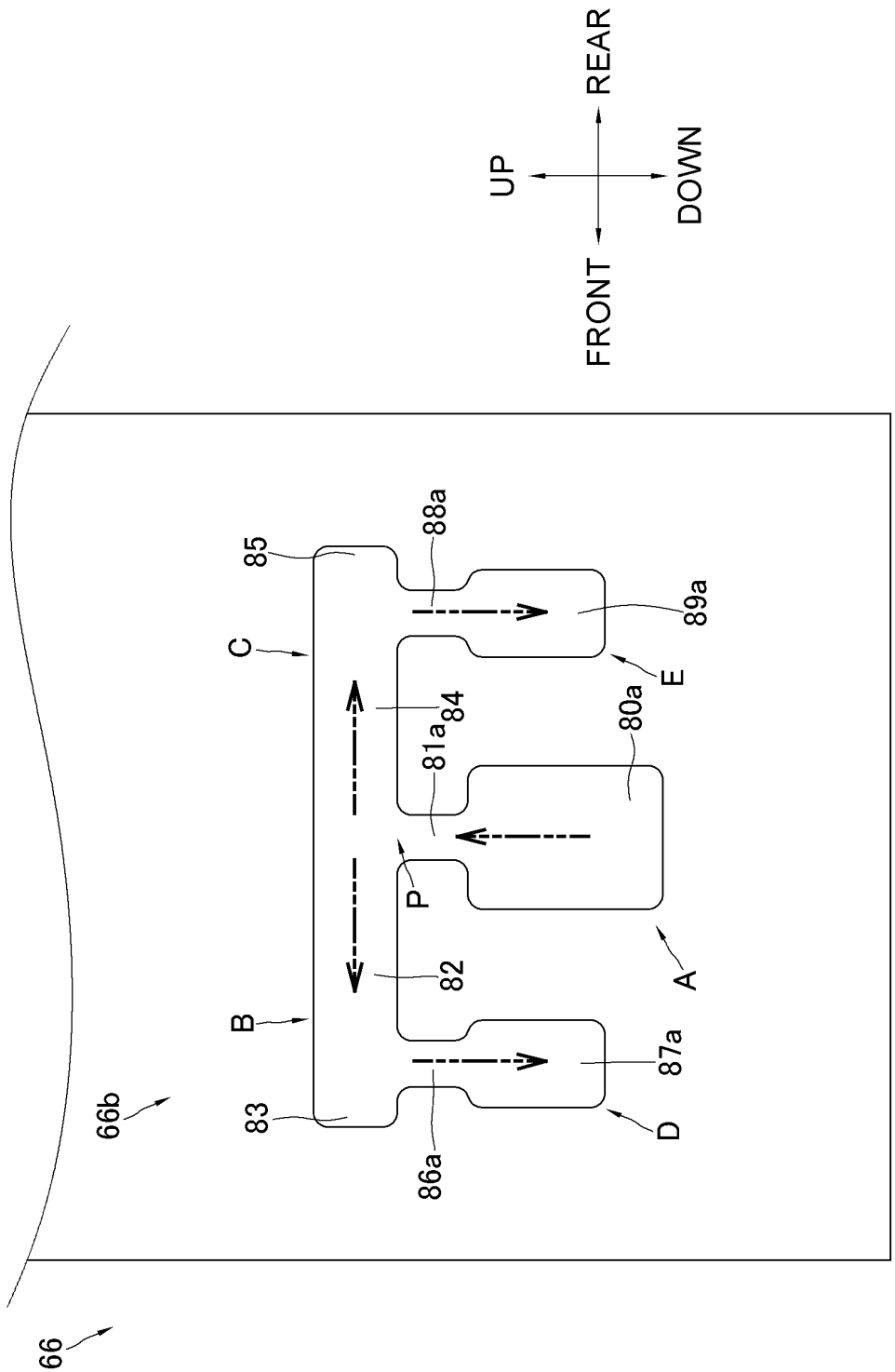

UP
REAR
DOWN
FRONT
66
66b
85
88a
89a
C
E
84
81a
80a
P
82
A
B
83
87a
D
86a

FIG. 17

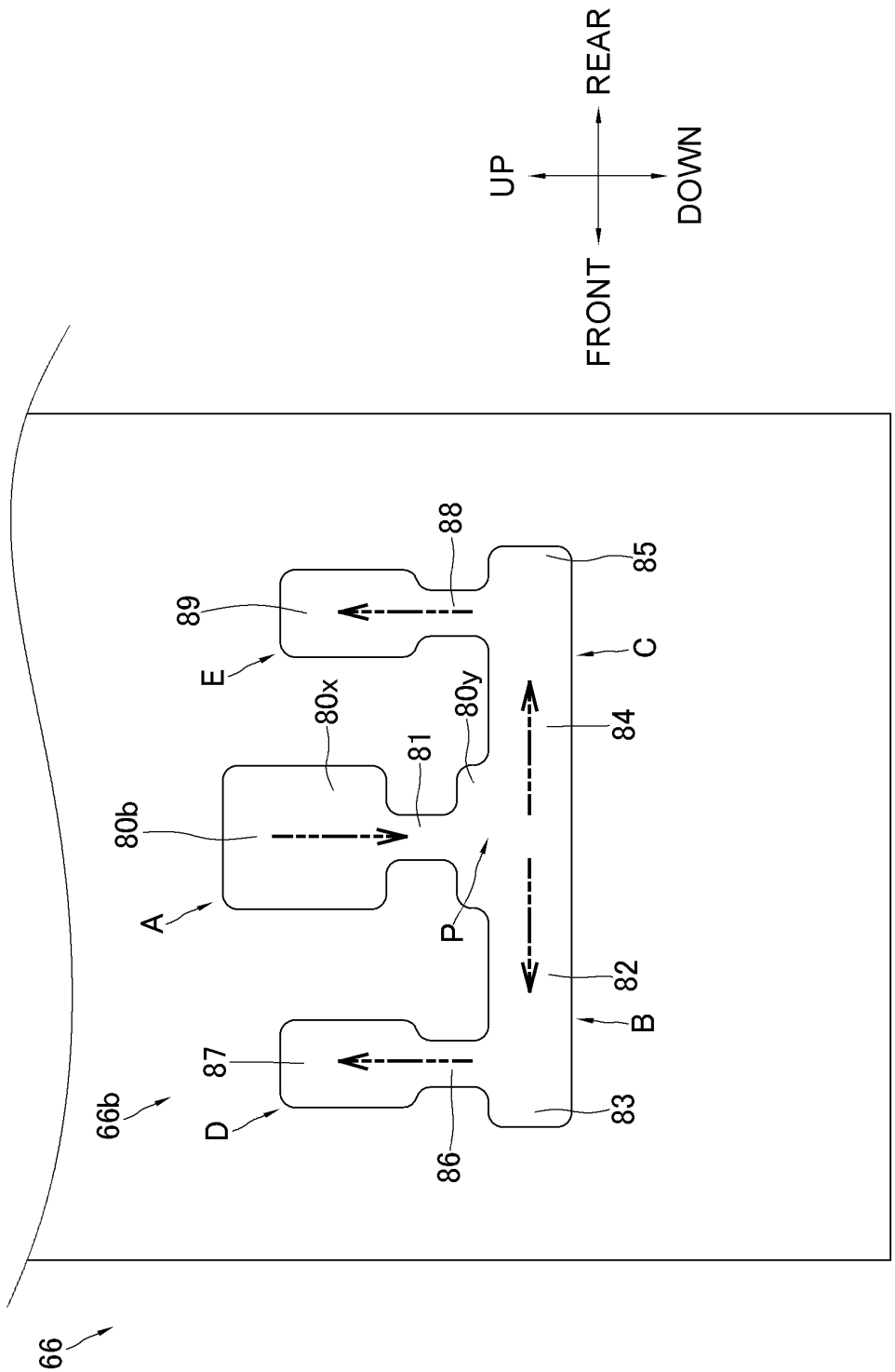

UP
REAR
DOWN
FRONT
66
66b
88
85
89
C
E
80x
80y
81
84
80b
A
P
82
B
87
D
86
83

FIG. 18

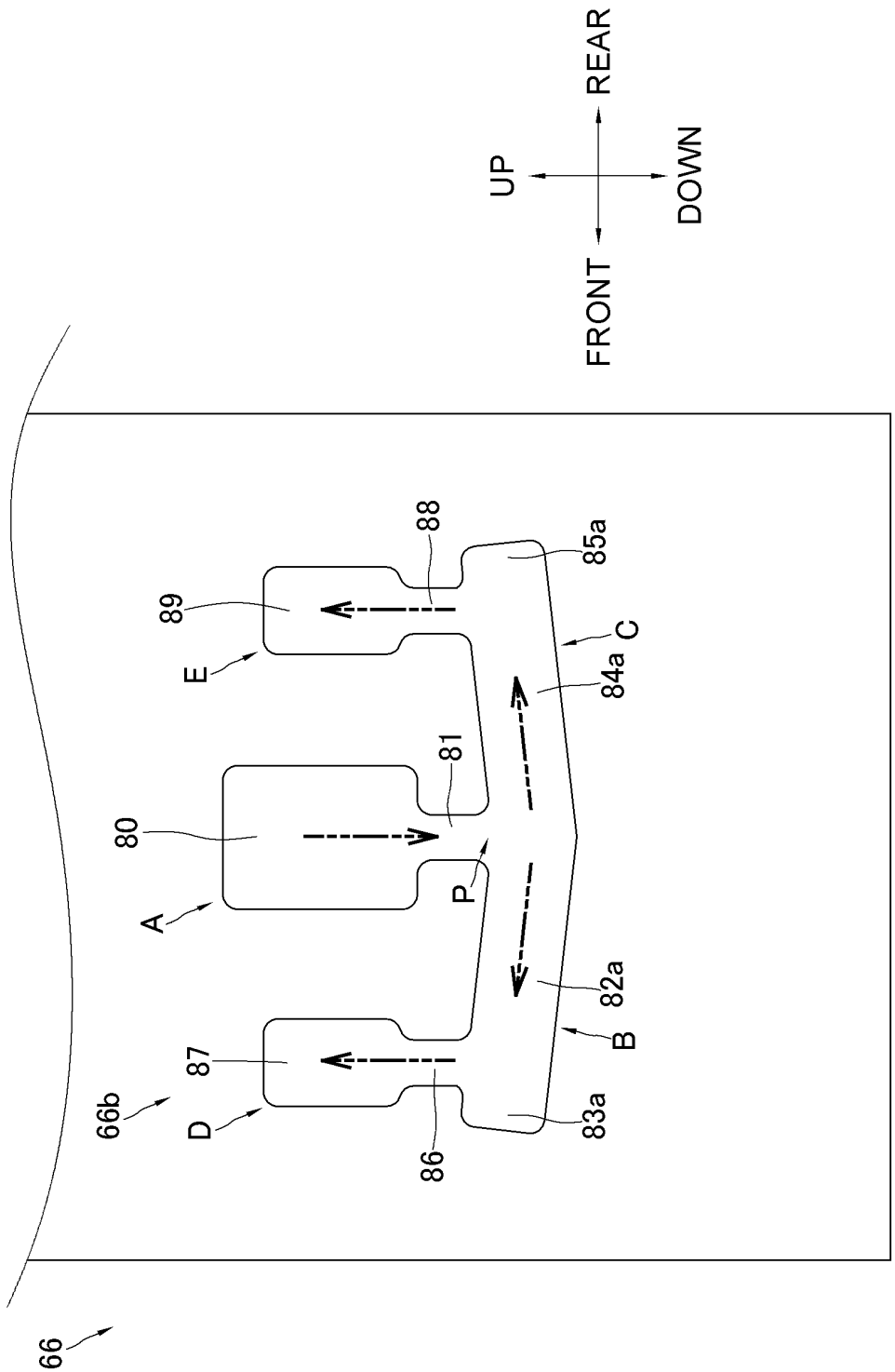

UP
REAR
DOWN
FRONT
66
66b
88
85a
89
E
C
84a
81
80
A
P
82a
B
87
D
86
83a

FIG. 19

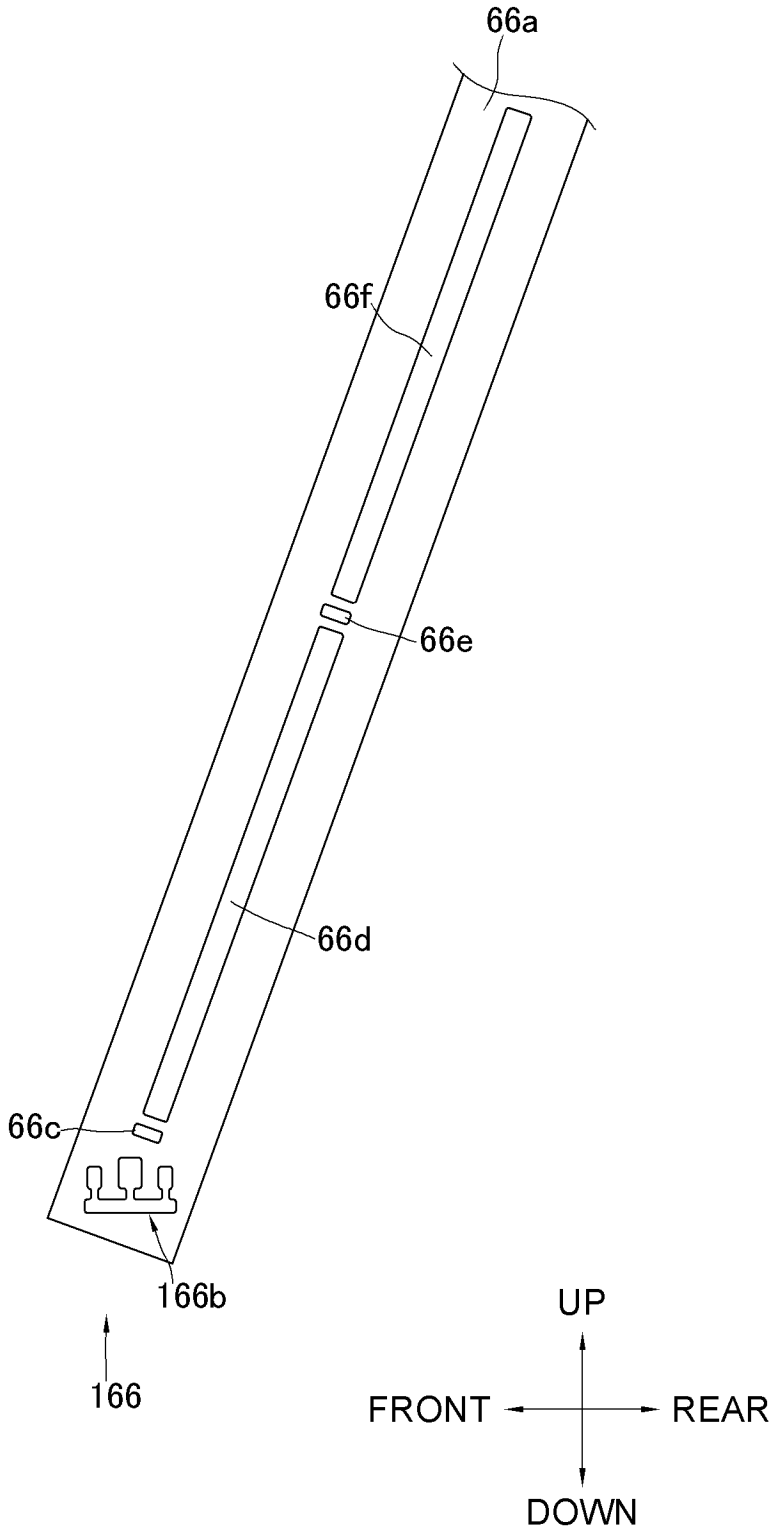


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2024/034842

A. CLASSIFICATION OF SUBJECT MATTER

F28F 9/02(2006.01)i; ***F25B 49/02***(2006.01)i; ***F28D 1/053***(2006.01)i
FI: F28F9/02 301J; F25B49/02 510B; F28D1/053 A

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

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.
X	WO 2018/181828 A1 (DAIKIN INDUSTRIES, LTD.) 04 October 2018 (2018-10-04) paragraphs [0072]-[0089], fig. 4-8	1-3, 6, 13, 15
A		4-5, 7-12, 14
X	WO 2017/042866 A1 (MITSUBISHI ELECTRIC CORPORATION) 16 March 2017 (2017-03-16) paragraphs [0011]-[0031], [0065]-[0087], fig. 1-6, 17-18	1-5, 7-8, 11, 13, 15
A		6, 9-10, 12, 14
A	JP 2010-038330 A (KABUSHIKI KAISHA KOBE SEIKO SHO) 18 February 2010 (2010-02-18) paragraphs [0028]-[0032], fig. 3-4	1-15
A	WO 2019/234836 A1 (MITSUBISHI ELECTRIC CORPORATION) 12 December 2019 (2019-12-12) paragraphs [0010]-[0022], [0054]-[0058], fig. 1-2, 10	1-15

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2024	**03 December 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.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/034842

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2018/181828 A1	04 October 2018	US 2020/0025428 A1 paragraphs [0092]-[0109], fig. 4-8 JP 2019-56544 A EP 3605001 A1 CN 110476035 A	
WO 2017/042866 A1	16 March 2017	US 2018/0216858 A1 paragraphs [0032]-[0063], [0135]-[0179], fig. 1-6, 17-18 US 2020/0309427 A1 EP 3348945 A1 CN 107949762 A	
JP 2010-038330 A	18 February 2010	(Family: none)	
WO 2019/234836 A1	12 December 2019	US 2021/0140692 A1 paragraphs [0020]-[0032], [0066]-[0070], fig. 1-2, 10 EP 3805670 A1 CN 112204321 A	

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Patent documents cited in the description

- WO 2015049727 A **[0003]**