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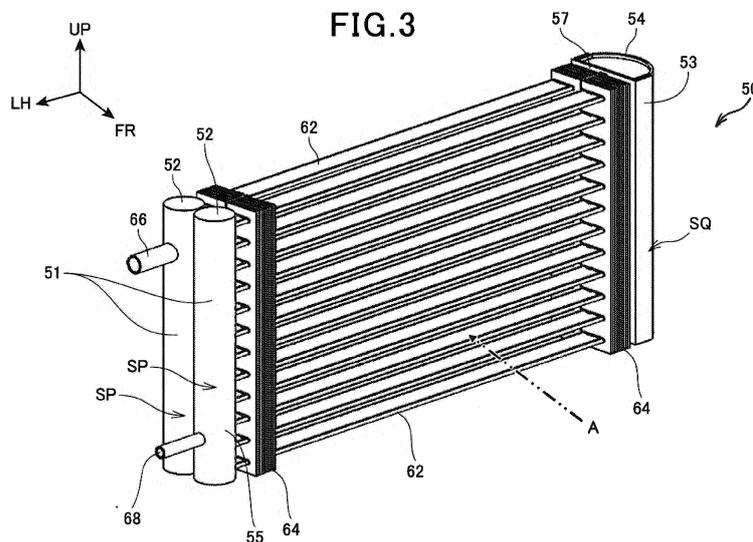
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(54) **HEAT EXCHANGER AND OUTDOOR UNIT**

(57) Provided is a heat exchanger and an outdoor unit that prevent uneven distribution of a refrigerant to a plurality of flat pipes. In a heat exchanger including: a plurality of header pipes 52; and a plurality of flat pipes connected to each of the header pipes 52 in such a manner that the flat pipes are aligned in a longitudinal direction of the header pipes 52, at least one of the header pipes 52 serves as a coupling header pipe 54 to which a plurality of the flat pipes 62 are connected in such a manner that the flat pipes 62 are placed side by side in

a direction intersecting the longitudinal direction of the header pipe 52, a side face of the coupling header pipe 54 has a connection side face 57 to which a plurality of the flat pipes 62 are connected and an opposite-side side face 59 located opposite to the connection side face 57, and the opposite-side side face 59 projects away from the connection side face toward substantially a center in the direction intersecting the longitudinal direction of the coupling header pipe 54.



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a heat exchanger and an outdoor unit.

Description of the Related Art

[0002] International Publication No. WO 2016/121125 discloses a heat exchanger and a refrigeration cycle apparatus that can improve heat exchange performance.

[0003] The heat exchanger of International Publication No. WO 2016/121125 includes a first heat exchange unit, and a second heat exchange unit through which an air current that has passed through the first heat exchange unit passes. The first heat exchange unit includes a first flat pipe having, thereinside, a first channel through which a refrigerant is passed. The second heat exchange unit includes a second flat pipe having, thereinside, a second channel through which the refrigerant is passed. A pressure loss in the second channel is larger than a pressure loss in the first channel.

[0004] The present disclosure provides a heat exchanger and an outdoor unit that prevent uneven distribution of a refrigerant to a plurality of flat pipes.

SUMMARY OF THE INVENTION

[0005] The present disclosure provides a heat exchanger including: a plurality of header pipes; and a plurality of flat pipes connected to each of the header pipes in such a manner that the flat pipes are aligned in a longitudinal direction of the header pipes, in which at least one of the header pipes serves as a coupling header pipe to which a plurality of the flat pipes are connected in such a manner that the flat pipes are placed side by side in a direction intersecting the longitudinal direction of the header pipe, a side face of the coupling header pipe has a connection side face to which a plurality of the flat pipes are connected and an opposite-side side face located opposite to the connection side face, and the opposite-side side face projects away from the connection side face toward substantially a center in the direction intersecting the longitudinal direction of the coupling header pipe.

Advantageous Effect of the Invention

[0006] According to the present disclosure, it is possible to prevent uneven distribution of a refrigerant to a plurality of flat pipes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a perspective view of an outdoor unit according to an embodiment of the present disclosure; FIG. 2 is a plan view of the outdoor unit; FIG. 3 is a perspective view of an outdoor heat exchanger;

FIG. 4 is a perspective view of a coupling header pipe;

FIG. 5 is a plan view showing a section of the coupling header pipe taken on a plane V of FIG. 4;

FIG. 6 is a perspective view showing a section of the coupling header pipe taken on a plane VI of FIG. 4; FIG. 7 is a plan view showing a section of a coupling header pipe according to a modification of the present disclosure; and

FIG. 8 is a plan view showing a section of a coupling header pipe according to a modification of the present disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Knowledge and the like Underlying Present Disclosure)

[0008] At the time when the inventors conceived the present disclosure, there was a technique of a heat exchanger and a refrigeration cycle apparatus. This technique includes a first heat exchange unit, and a second heat exchange unit through which an air current that has passed through the first heat exchange unit passes. The first heat exchange unit includes a first flat pipe having, thereinside, a first channel through which a refrigerant is passed, the second heat exchange unit includes a second flat pipe having, thereinside, a second channel through which the refrigerant is passed, and a pressure loss in the second channel is larger than a pressure loss in the first channel.

[0009] This improves the heat exchange performance in the heat exchanger and the refrigeration cycle apparatus.

[0010] However, in the conventional configuration, when a heat exchanger including header pipes and flat pipes is used as an evaporator, a gas-liquid two-phase refrigerant flowing into one of the header pipes from a refrigerant inflow pipe in each heat exchanger, flowing through a plurality of flat pipes, and flowing into the other of the header pipes from the flat pipes collides with a wall of the other header pipe. Then, in this heat exchanger, the refrigerant moves up or down through a communication pipe connected to the other header pipe and flows out in the direction opposite to the flowing direction of the refrigerant flowing therein from the flat pipes. Thus, the inventors have found a problem that, in this heat exchanger, after the refrigerant collides with the wall, the refrigerant tends to separate up and down into a liquid refrigerant and a gas refrigerant due to the influence of gravity, the gas-liquid state of the refrigerant flowing out to a plurality of flat pipes from the other header pipe after flowing through the communication pipe becomes non-

uniform, and the heat exchange performance is reduced, and has come to constitute the subject matter of the present disclosure to solve this problem.

[0011] Thus, the present disclosure provides a heat exchanger and an outdoor unit that prevent uneven distribution of a refrigerant to a plurality of flat pipes.

[0012] Hereinbelow, embodiments will be described in detail with reference to the drawings. Note that more details than necessary may be omitted. For example, detailed description of already well-known matters or repetitive description for substantially identical configurations may be omitted. This is to avoid making the following description unnecessary redundant and facilitate the understanding of those skilled in the art.

[0013] Note that the accompanying drawings and the following description are provided to enable those skilled in the art to fully understand the present disclosure and are not intended to limit the subject matter described in the claims.

(First Embodiment)

[0014] Hereinbelow, a first embodiment will be described with reference to FIGS. 1 to 6. In each of the drawings, reference character FR denotes the front side of an outdoor unit that is installed on an installation surface and normally used, reference character UP denotes the upper side of the outdoor unit, and reference character LH denotes the left side of the outdoor unit. Directions in the following description are based on these directions of the outdoor unit.

[1-1. Configuration]

[1-1-1. Configuration of Outdoor Unit]

[0015] FIG. 1 is a perspective view of an outdoor unit 1 of an air conditioning apparatus according to the present embodiment.

[0016] The air conditioning apparatus of the present embodiment includes a refrigeration circuit, the refrigeration circuit including an indoor heat exchanger housed in an indoor unit, and a compressor 5, an expansion valve, and an outdoor heat exchanger 50 that are housed in the outdoor unit 1, and the like. The air conditioning apparatus circulates a refrigerant through the refrigeration circuit to perform air conditioning in a space to be air-conditioned in which the indoor unit is provided.

[0017] As shown in FIG. 1, the outdoor unit 1 of the present embodiment is a so-called side-flow type or side-blow type outdoor unit that draws air into the inside thereof through the outdoor heat exchanger 50 disposed on a side face, performs heat exchange between the air and the refrigerant, and blows the air out through another side face.

[0018] FIG. 2 is a plan view schematically showing the internal structure of the outdoor unit 1. In FIG. 2, for convenience of explanation, edges of a bottom plate 12 con-

stituting lower edges of a front intake opening 15 and a side intake opening 17 and a predetermined portion of a back plate 18 constituting an edge of an exhaust opening 19 are indicated by long dashed short dashed lines. In FIG. 2, a flowing direction of air blown by an air-blowing fan 30 is indicated by a long dashed double-dotted line arrow A.

[0019] As shown in FIGS. 1 and 2, the outdoor unit 1 includes a housing 10 having a box shape, the longitudinal direction of the housing 10 extending in the right-left direction. In the present embodiment, each part of the housing 10 is formed of a steel plate.

[0020] The housing 10 includes the bottom plate 12 constituting the bottom face of the housing 10, a top plate 14 constituting the top face, a front plate 16 constituting the front face, the back plate 18 constituting the back face, a left side plate 11 constituting the left side face, and a right side plate 13 constituting the right side face.

[0021] As shown in FIG. 1, the front plate 16 is provided with the front intake opening 15. The front intake opening 15 is a rectangular opening through which air is drawn into the inside of the housing 10 from the outside thereof. In the front plate 16, the front intake opening 15 is provided at a position closer to the left side plate 11 than to the right side plate 13.

[0022] In the front plate 16, a plurality of fastening holes 20, which are through holes, are provided at positions close to an edge of the front intake opening 15, the edge being adjacent to the right side plate 13. These fastening holes 20 are aligned on a line extending in the up-down direction of the housing 10. In the present embodiment, the front plate 16 is provided with three fastening holes 20.

[0023] The left side plate 11 is provided with the side intake opening 17. The side intake opening 17 is a rectangular opening through which air is drawn into the inside of the housing 10. In the left side plate 11, the side intake opening 17 is provided at a position closer to the front plate 16 than to the back plate 18.

[0024] In the left side plate 11, three fastening holes 20 are provided at positions close to an edge of the side intake opening 17, the edge being adjacent to the back plate 18, the fastening holes 20 being aligned on a line extending in the up-down direction of the housing 10.

[0025] As shown in FIG. 2, the back plate 18 is provided with the exhaust opening 19. The exhaust opening 19 is an opening through which air drawn into the inside of the housing 10 is blown out to the outside of the housing 10.

[0026] Note that the front intake opening 15, the side intake opening 17, and the exhaust opening 19 may be provided with a filter or a lattice-shaped protection member.

[0027] An internal space S of the housing 10 is partitioned by a partition plate 21 into two spaces. The partition plate 21 is a plate-like member that extends in the up-down direction of the housing 10 at a predetermined height dimension and extends in the front-back direction of the housing 10. The partition plate 21 is fixed to the

housing 10 with its lower end coupled to the bottom plate 12. The partition plate 21 has an end that is located on the front side of the housing 10 and coupled to the front plate 16 and an end that is located on the back side of the housing 10 and coupled to the back plate 18.

[0028] Accordingly, inside the housing 10, two spaces are formed with the partition plate 21 therebetween, the two spaces including a machine chamber S1 located on the right side of the housing 10 and a fan chamber S2 located on the left side of the housing 10.

[0029] Members constituting the refrigeration circuit, such as the compressor 5, the expansion valve, a header pipe 52 included in the outdoor heat exchanger 50, and a refrigerant pipe, various electrical components, and the like are housed in the machine chamber S1.

[0030] The air-blowing fan 30 and the outdoor heat exchanger 50 excluding the header pipe 52 are housed in the fan chamber S2.

[0031] The air-blowing fan 30 is an axial fan that is driven to rotate to introduce air into the fan chamber S2 from the outside of the housing 10, cause the air to exchange heat with the refrigerant flowing through the outdoor heat exchanger 50, and then release the air again to the outside of the housing 10. The air-blowing fan 30 includes a fan motor 32 and an impeller 34.

[0032] The fan motor 32 is a driver that rotates the impeller 34 and includes a driving shaft 36 to which the impeller 34 is attached.

[0033] The impeller 34 is a rotating component that is rotated by the fan motor 32 to feed air out in the axial flow direction.

[0034] The air-blowing fan 30 is positioned with the impeller 34 facing the exhaust opening 19 and the tip of the driving shaft 36 facing the exhaust opening 19.

[0035] In the present embodiment, when the air-blowing fan 30 is driven to rotate, the air-blowing fan 30 causes air to flow into the inside of the housing 10, that is, the fan chamber S2 from the outside of the outdoor unit 1. Specifically, as indicated by the arrows A in FIG. 2, air flows into the fan chamber S2 mainly through the front intake opening 15 and the side intake opening 17.

[1-1-2. Configuration of Outdoor Heat Exchanger]

[0036] FIG. 3 is a perspective view showing the outdoor heat exchanger 50. For convenience of explanation, FIG. 3 shows the outdoor heat exchanger 50 linearly formed in plan view. In FIG. 3, the flowing direction of air blown by the air-blowing fan 30 is indicated by a long dashed double-dotted line arrow A.

[0037] The outdoor heat exchanger 50 is a heat exchanger having a channel through which a refrigerant flows, the heat exchanger functioning as an evaporator that evaporates the refrigerant fed thereto from the indoor unit or a condenser that condenses the refrigerant.

[0038] As shown in FIG. 3, the outdoor heat exchanger 50 includes a pair of header pipes 52, a coupling header pipe 54, a first refrigerant pipe 66, a second refrigerant

pipe 68, a plurality of flat pipes 62, and a plurality of fins 64.

[0039] In the present embodiment, these members included in the outdoor heat exchanger 50 are all formed of aluminum or a so-called aluminum material made of an aluminum alloy.

[0040] Each of the header pipes 52 is a hollow columnar member whose longitudinal direction extends in the up-down direction of the housing 10. In the present embodiment, each of the header pipes 52 is formed in a cylindrical shape. These header pipes 52 are both provided on one end of the outdoor heat exchanger 50 in the longitudinal direction.

[0041] An internal space SP of the header pipe 52 is provided inside the header pipe 52.

[0042] The first refrigerant pipe 66 is connected to one of the header pipes 52, and the second refrigerant pipe 68 is connected to the other of the header pipes 52. The first refrigerant pipe 66 and the second refrigerant pipe 68 function as an inflow port or an outflow port for the refrigerant in the outdoor heat exchanger 50.

[0043] The first refrigerant pipe 66 is connected to an upper part of a side face 51 of the one header pipe 52. The second refrigerant pipe 68 is connected to a lower part of a side face 51 of the other header pipe 52.

[0044] The coupling header pipe 54 is a hollow columnar member whose longitudinal direction extends in the up-down direction of the housing 10.

[0045] The coupling header pipe 54 has an internal space SQ thereinside. The coupling header pipe 54 is provided on the other end of the outdoor heat exchanger 50 in the longitudinal direction.

[0046] The flat pipes 62 are long and flat tubular members each having, thereinside, a channel through which the refrigerant flows.

[0047] In a state in which the flat pipes 62 are aligned in the longitudinal direction of each of the header pipes 52 and the coupling header pipe 54 with the longitudinal directions of the flat pipes 62 parallel to each other, the opposite ends of each of the flat pipes 62 are connected to the side face 51 of the header pipe 52 and a side face 53 of the header pipe 54.

[0048] That is, the ends of the flat pipes 62 on one side are in a line with a predetermined space therebetween in the longitudinal direction of the header pipe 52 and connected to a predetermined part of the side face 51 of the header pipe 52. Similarly, the ends of the flat pipes 62 on the other side are in a line with a predetermined space therebetween in the longitudinal direction of the coupling header pipe 54 and connected to a predetermined part of the side face 53 of the coupling header pipe 54.

[0049] Thus, the longitudinal direction of each of the flat pipes 62 coincides with the longitudinal direction of the outdoor heat exchanger 50.

[0050] The flat pipes 62 are connected to the header pipes 52 and the coupling header pipe 54 with their width directions parallel to each other. Note that the width di-

rection is perpendicular to the longitudinal direction and the thickness direction of each of the flat pipes 62.

[0051] Hereinbelow, the predetermined part of the side face 51 of each of the header pipes 52 to which each of the flat pipes 62 is connected is referred to as a connection side face 55, and the predetermined part of the side face 53 of the coupling header pipe 54 to which each of the flat pipes 62 is connected is referred to as a connection side face 57.

[0052] The flat pipes 62 extending from the respective header pipes 52 are connected to the connection side face 57 in such a manner that the ends on the other side of the flat pipes 62 are placed side by side in a direction intersecting the longitudinal direction of the coupling header pipe 54.

[0053] In the present embodiment, the flat pipes 62 extending from the respective header pipes 52 are connected to the connection side face 57 in such a manner that the ends on the other side of the flat pipes 62 are placed side by side in a direction perpendicular to the longitudinal direction of the coupling header pipe 54. That is, the flat pipes 62 placed side by side in the direction perpendicular to the longitudinal direction of the coupling header pipe 54 are located at substantially the same height in the up-down direction of the housing 10.

[0054] In this manner, the header pipes 52 are each coupled to the coupling header pipe 54 through the flat pipes 62.

[0055] Both ends of each of the flat pipes 62 have openings. One end of each of the flat pipes 62 is open in the internal space SP, and the other end thereof is open in the internal space SQ.

[0056] The fins 64 are flat-plate members each having, on a flat surface, a plurality of insertion holes in each of which the flat pipe 62 can be inserted. Each of the flat pipes 62 is connected to each of the header pipes 52 and 54 in a state in which the flat pipe 62 is inserted in each of the fins 64. That is, each of the fins 64 is disposed with its longitudinal direction and width direction perpendicular to each of the flat pipes 62. The longitudinal direction of each of the fins 64 disposed in this manner coincides with the longitudinal direction of each of the header pipes 52 and 54.

[0057] In the present embodiment, the pair of header pipes 52, the coupling header pipe 54, the first refrigerant pipe 66, the second refrigerant pipe 68, the plurality of flat pipes 62, and the plurality of fins 64 are fixed to each other by so-called brazing using a brazing material.

[0058] In the fan chamber S2, the outdoor heat exchanger 50 is disposed, in its longitudinal direction, along the front plate 16 and the left side plate 11. Specifically, the header pipes 52 are disposed at a position close to the edge of the front intake opening 15, the edge being adjacent to the right side plate 13, and the header pipe 54 is disposed at a position close to the edge of the side intake opening 17, the edge being adjacent to the back plate 18. The outdoor heat exchanger 50 is bent so as to be close to a corner 23 of the housing 10, the corner

23 being defined by the front plate 16 and the left side plate 11.

[0059] The outdoor unit 1 includes a fixing member 70 that fixes the outdoor heat exchanger 50 to the housing 10.

[0060] Specifically, each of the header pipes 52 included in the outdoor heat exchanger 50 is fixed to the front plate 16 with a plurality of fixing members 70. In the present embodiment, each of the header pipes 52 is fixed with three fixing members 70.

[0061] In the outdoor heat exchanger 50 fixed to the housing 10 in this manner, each of the header pipes 52 and the coupling header pipe 54 are disposed with their longitudinal directions aligned with the up-down direction of the housing 10.

[0062] In the outdoor heat exchanger 50 fixed to the housing 10, one header pipe 52 and the flat pipes 62 connected to the one header pipe 52 are disposed more distant from the side face of the housing 10, that is, disposed closer to the air-blowing fan 30 than the other header pipe 52 and the flat pipes 62 connected to the other header pipe 52 are.

[0063] Thus, in the flowing direction of air blown by the air-blowing fan 30, the flat pipes 62 connected to the one header pipe 52 are located upstream of the flat pipes 62 connected to the other header pipe 52. That is, the flat pipes 62 extending from the pair of header pipes 52 are placed side by side in the flowing direction of air blown by the air-blowing fan 30, the flowing direction being perpendicular to the longitudinal direction of the coupling header pipe 54.

[0064] As shown in FIG. 1, in the outdoor heat exchanger 50 fixed to the housing 10, the flat pipes 62 and the fins 64 are largely exposed from the housing 10 through the front intake opening 15 and the side intake opening 17. On the other hand, the header pipes 52 are shielded by the front plate 16, and the coupling header pipe 54 is shielded by the left side plate 11.

[0065] Note that the partition plate 21 is provided extending between the header pipes 52 and the fins 64. Accordingly, header pipes 52 are disposed in the machine chamber S1, and the flat pipes 62, the fins 64, and the coupling header pipe 54 are disposed in the fan chamber S2.

[1-1-3. Configuration of Coupling Header Pipe]

[0066] FIG. 4 is a perspective view of the coupling header pipe 54. In FIG. 4, for convenience of explanation, a second side face portion 90 is indicated by a long dashed double-dotted line, which is a virtual line, so that the internal space SQ can be visually recognized.

[0067] FIG. 5 is a plan view showing a section of the coupling header pipe 54 taken on a plane V of FIG. 4. The plane V extends between the pair of flat pipes 62 and a division plate 88 in the longitudinal direction of the coupling header pipe 54 and is parallel to the direction perpendicular to the longitudinal direction of the coupling

header pipe 54.

[0068] As shown in FIG. 4, the coupling header pipe 54 includes a first side face portion 80 constituting the connection side face 57. As shown in FIG. 5, the first side face portion 80 is formed by bending a plate-like member into a U shape in plan view.

[0069] The first side face portion 80 includes a connection side face portion 82. The connection side face portion 82 has the connection side face 57 that is flat in the flowing direction of air blown by the air-blowing fan 30 and the longitudinal direction of the coupling header pipe 54.

[0070] The connection side face portion 82 has, on its opposite ends in the direction along the flowing direction of air blown by the air-blowing fan 30, coupling end portions 84 extending by a predetermined length dimension toward the side opposite to the flat pipes 62 extending to the header pipes 52. The length dimension of each of the coupling end portions 84 in plan view is smaller than the length dimension of the connection side face 57 in the direction along the flowing direction of air blown by the air-blowing fan 30.

[0071] As shown in FIG. 4, the coupling header pipe 54 includes the second side face portion 90. As shown in FIG. 5, the second side face portion 90 is formed by bending a plate-like member into a U shape in plan view.

[0072] The second side face portion 90 includes an opposite-side side face portion 92. The opposite-side side face portion 92 has an opposite-side side face 59 having an arc shape convex opposite to the connection side face portion 82. The opposite-side side face 59 is formed as a curved face convex opposite to the connection side face portion 82 toward the coupling header pipe 54. The opposite-side side face 59 constitutes a part of the side face 53.

[0073] The opposite-side side face portion 92 has an opposite-side inner side face 93. The opposite-side inner side face 93 is a curved face facing the internal space SQ and a section space SR in the opposite-side side face portion 92. The opposite-side inner side face 93 is a curved face formed in substantially the same shape as the opposite-side side face 59 in plan view in the opposite-side side face portion 92.

[0074] The opposite-side side face portion 92 has, on its opposite ends in the direction along the flowing direction of air blown by the air-blowing fan 30, coupling end portions 94 extending by a predetermined length dimension in substantially the same direction as the flat pipes 62 extending to the header pipes 52. The length dimension of each of the coupling end portions 94 in plan view is smaller than the length dimension of the opposite-side side face portion 92 in the direction along the flowing direction of air blown by the air-blowing fan 30.

[0075] The first side face portion 80 and the second side face portion 90 are coupled to each other in a state in which each of the coupling end portions 94 is located inside the corresponding one of the coupling end portions 84 and the tip of each of the coupling end portions 94 is in contact with the connection side face portion 82 in the

direction along the flowing direction of air blown by the air-blowing fan 30.

[0076] The first side face portion 80 and the second side face portion 90 are fixed to each other by so-called brazing using a brazing material. Thus, side faces of the first side face portion 80 and the second side face portion 90, the side faces facing each other, are coated with the brazing material.

[0077] The coupling header pipe 54 including the first side face portion 80 and the second side face portion 90 coupled to each other in this manner is formed in a partial circle shape in plan view.

[0078] FIG. 6 is a perspective view showing a section of the coupling header pipe 54 taken on a plane VI of FIG. 4. The plane VI intersects the other end of each of the flat pipes 62 housed in the internal space SQ and is parallel to the longitudinal direction of the coupling header pipe 54.

[0079] A plurality of division plates 88 are provided inside the coupling header pipe 54. As shown in FIG. 6, each of the division plates 88 is disposed between the flat pipes 62 adjacent to each other in the longitudinal direction of the coupling header pipe 54. Thus, the division plates 88 are plate-like members that divide the internal space SQ into a plurality of section spaces SR.

[0080] As shown in FIG. 5, the division plate 88 is formed in substantially the same shape as the outer shape of the coupling header pipe 54 in plan view. Edges of the division plate 88 are in contact with the inner side face of the first side face portion 80 and the inner side face of the second side face portion 90 throughout the entire circumference of the division plate 88.

[0081] As described above, the side faces of the first side face portion 80 and the second side face portion 90, the side faces facing each other, are coated with the brazing material. The division plate 88 is brazed to the first side face portion 80 and the second side face portion 90 with the brazing material. The division plate 88 is not coated with the brazing material.

[0082] Accordingly, the amount of the brazing material used in the outdoor heat exchanger 50 can be reduced. This prevents, in the coupling header pipe 54, an excessive brazing material from melting out onto the inner side face, the internal space SQ, and the section spaces SR of the coupling header pipe 54 during brazing and remaining in a projecting manner into the internal space SQ and the section space SR from the opposite-side inner side face 93, thereby obstructing the flow of the refrigerant. Further, it is possible to prevent, in the outdoor heat exchanger 50, the remaining brazing material from changing the direction of the flow of the refrigerant flowing inside the coupling header pipe 54, and causing a collision and separation of the refrigerant into liquid and gas. Thus, the gas-liquid state of the refrigerant flowing out to the flat pipes 62 becomes uniform, and the heat exchange performance can be improved.

[0083] The other end of each of the pair of flat pipes 62 adjacent to each other in the air flowing direction is

disposed inside each of the section spaces SR.

[1-2. Operation]

[0084] The operation of the outdoor unit 1 configured as described above will be described below.

[0085] First, the flow of the refrigerant in the air conditioning apparatus will be described.

[0086] In the case of a heating operation of the air conditioning apparatus, when the outdoor unit 1 starts operating, the compressor 5 is driven. The compressor 5 compresses the refrigerant sealed in the refrigeration circuit and feeds the gas refrigerant out through each refrigerant pipe.

[0087] The gas refrigerant is condensed in the indoor heat exchanger by dissipating heat, then flows into the expansion valve through the pipe, is decompressed by the expansion valve, and flows into the internal space SP of the other header pipe 52 through the second refrigerant pipe 68. The refrigerant flowing into the internal space SP flows into each of the section spaces SR of the coupling header pipe 54 through each flat pipe 62. Then, the refrigerant flows toward the one header pipe 52 through each flat pipe 62 connected to the one header pipe 52. The refrigerant flowing through the outdoor heat exchanger 50 absorbs heat and evaporates by exchanging heat with air fed by the air-blowing fan 30 in the flat pipes 62. The refrigerant flows into the internal space SP of the one header pipe 52 and then returns to the compressor 5 through the first refrigerant pipe 66.

[0088] When the outdoor unit 1 starts operating, the air-blowing fan 30 starts rotating prior to the compressor 5. The rotating air-blowing fan 30 causes air to flow into the inside of the housing 10, that is, the fan chamber S2 from the outside of the outdoor unit 1. Specifically, the air flows into the fan chamber S2 mainly through the front intake opening 15 and the side intake opening 17. The air flowing into the fan chamber S2 passes between the flat pipes 62 and the fins 64 in the direction perpendicular to the longitudinal direction and the up-down direction of the outdoor heat exchanger 50, in other words, the width direction of the flat pipes 62.

[0089] This facilitates heat exchange between the refrigerant flowing inside the flat pipes 62 and the air flowing between the fins 64.

[0090] The air-blowing fan 30 discharges the air that has exchanged heat with the refrigerant to the outside of the housing 10 through the exhaust opening 19.

[0091] The outdoor unit 1 absorbs heat from the outdoor air into the refrigeration circuit and feeds the air to the inside of the room by repeating the operation described above.

[0092] When the air conditioning apparatus performs a cooling operation, the refrigerant circulation direction in the refrigeration circuit is opposite to that in a heating operation, and the outdoor heat exchanger 50 functions as a condenser.

[0093] As described above, in the coupling header pipe

54, the internal space SQ is divided by the division plates 88 into the section spaces SR.

[0094] This prevents, in the longitudinal direction of the coupling header pipe 54, the refrigerant flowing to the coupling header pipe 54 from one of the flat pipes 62 adjacent to each other in the air flowing direction from merging and splitting in the internal space SQ inside the coupling header pipe 54. In the section space SR, the refrigerant flows out through the other of the flat pipes 62 adjacent to each other in the air flowing direction.

[0095] Thus, the refrigerant flowing to the coupling header pipe 54 from one of the flat pipes 62 adjacent to each other in the air flowing direction is prevented from interfering or mixing with the flow of the refrigerant flowing to the coupling header pipe 54 from another flat pipe 62 adjacent to this flat pipe 62 in the up-down direction and obstructing a flow along the opposite-side inner side face 93. In the coupling header pipe 54, it is possible to prevent the gas-liquid state in the internal space SQ from becoming non-uniform, the gas-liquid state of the refrigerant flowing out of the internal space SQ to the flat pipes 62 becomes uniform, and the heat exchange performance can be improved.

[0096] This flow of the refrigerant in the coupling header pipe 54 can be achieved even during a high-load operation in which, in particular, the refrigerant circulation amount is large and the refrigerant flow velocity is high. Thus, in the outdoor unit 1, this flow of the refrigerant can prevent the refrigerant from suddenly changing its direction and colliding with the wall surface, and separating into liquid and gas in the coupling header pipe 54, the gas-liquid state of the refrigerant flowing out to the flat pipes 62 becomes uniform, and the heat exchange performance can be improved.

[0097] The refrigerant flows through one of the flat pipes 62 adjacent to each other in the air flowing direction and then flows into the section space SR from the other end of this flat pipe 62 in the coupling header pipe 54. The refrigerant flows toward substantially the center of the coupling header pipe 54 in the air flowing direction along the opposite-side inner side face 93. Then, the refrigerant flows closer to the other of the flat pipes 62 adjacent to each other in the air flowing direction. Then, the refrigerant enters the other of the flat pipes 62 adjacent to each other in the air flowing direction and flows out of the coupling header pipe 54.

[0098] Accordingly, in the coupling header pipe 54, the flowing direction of the refrigerant flowing from one of the flat pipes 62 adjacent to each other in the air flowing direction is changed toward the flat pipe 62 connected to one of the header pipes 52 along the opposite-side inner side face 93. Thus, in the coupling header pipe 54, it is possible to reduce the influence of a collision with the opposite-side inner side face 93 and prevent separation of liquid and gas. In the coupling header pipe 54, the gas-liquid state of the refrigerant flowing to the other of the flat pipes 62 adjacent to each other in the air flowing direction becomes uniform, and the heat exchange per-

formance can be improved.

[0099] In addition, in the section space SR, half or more of the refrigerant flowing from one of the flat pipes 62 adjacent to each other in the air flowing direction, the half of more of the refrigerant flowing close to the opposite-side inner side face 93, changes its direction along the opposite-side inner side face 93. Accordingly, in the section space SR, half or less of the refrigerant flowing from one of the flat pipes 62 adjacent to each other in the air flowing direction, the half or less of the refrigerant flowing close to the connection side face 57, is affected by the flow of the refrigerant flowing close to the opposite-side inner side face 93. Then, the refrigerant flows to the other of the flat pipes 62 adjacent to each other in the air flowing direction and flows out.

[0100] Accordingly, in the section space SR, even during a low-load operation in which, in particular, the refrigerant circulation amount is small and an inertial force is small, by causing half or more of the refrigerant to flow along the opposite-side inner side face 93, the remaining refrigerant can be caused to follow the same flow. In the section space SR, the flow can be changed to the direction opposite to the flowing direction of the refrigerant flowing into the section space SR.

[0101] Thus, in the section space SR, it is possible to reduce the influence of a collision with the opposite-side inner side face 93 and prevent separation of liquid and gas, the gas-liquid state of the refrigerant flowing out to the flat pipes 62 becomes uniform, and the heat exchange performance can be improved.

[1-3. Effects and the like]

[0102] As above, in the present embodiment, the outdoor heat exchanger 50 includes the coupling header pipe 54 to which the flat pipes 62 are connected in such a manner that the flat pipes 62 are placed side by side in the air flowing direction. The side face 53 of the coupling header pipe 54 has the connection side face 57 to which the flat pipes 62 are connected and the opposite-side side face 59 located opposite to the connection side face 57. The opposite-side side face 59 projects away from the connection side face toward substantially the center of the coupling header pipe 54 in the air flowing direction.

[0103] Accordingly, in the coupling header pipe 54, the flowing direction of the refrigerant flowing from one of the flat pipes 62 adjacent to each other in the air flowing direction is gently changed toward the flat pipe 62 connected to one of the header pipes 52 along the opposite-side inner side face 93. Thus, in the coupling header pipe 54, it is possible to reduce the influence of a collision with the opposite-side inner side face 93 and prevent separation of liquid and gas. Thus, the outdoor heat exchanger 50 can improve the heat exchange performance.

[0104] As described in the present embodiment, in the coupling header pipe 54, the internal space SQ may be divided by the division plates 88 into the section spaces

SR.

[0105] This prevents, in the longitudinal direction of the coupling header pipe 54, the refrigerant flowing to the coupling header pipe 54 from one of the flat pipes 62 adjacent to each other in the air flowing direction from merging and splitting in the internal space SQ inside the coupling header pipe.

[0106] Thus, the refrigerant flowing to the coupling header pipe 54 from one of the flat pipes 62 adjacent to each other in the air flowing direction is prevented from interfering or mixing with the flow of the refrigerant flowing to the coupling header pipe 54 from another flat pipe 62 adjacent to this flat pipe 62 in the up-down direction and obstructing a flow along the opposite-side inner side face 93. In the coupling header pipe 54, it is possible to prevent the gas-liquid state in the internal space SQ from becoming non-uniform, the gas-liquid state of the refrigerant flowing out of the internal space SQ to the flat pipes 62 becomes uniform, and the outdoor heat exchanger 50 can improve the heat exchange performance.

[0107] As described in the present embodiment, the division plate 88 may not be coated with the brazing material.

[0108] Accordingly, the amount of the brazing material used in the outdoor heat exchanger 50 can be reduced. This prevents an excessive brazing material from melting out onto the inner side face of the coupling header pipe 54 during brazing and an unnecessary brazing material remaining on the opposite-side inner side face 93 from obstructing the flow of the refrigerant. Thus, in the outdoor heat exchanger 50, it is possible to prevent the refrigerant flowing inside the coupling header pipe 54 from changing its flowing direction, causing a collision, and separating into liquid and gas. Thus, the gas-liquid state of the refrigerant flowing out to the flat pipes 62 becomes uniform, and the heat exchange performance can be improved.

(Other Embodiments)

[0109] As above, the first embodiment has been described as an example of the techniques disclosed in the present application. However, the techniques in the present disclosure are not limited thereto and also applicable to embodiments with changes, replacements, additions, omissions, and the like. Also, the constituent elements described above in the first embodiment may be combined to constitute a new embodiment.

[0110] Thus, hereinbelow, other embodiments will be described as examples.

[0111] FIG. 7 is a plan view showing a section of a coupling header pipe 154 according to a first modification of the present disclosure. FIG. 7 shows the section taken on a plane that extends between the pair of flat pipes 62 and the division plate 88 in the longitudinal direction of the coupling header pipe 154 and is parallel to a direction perpendicular to the longitudinal direction of the coupling header pipe 154 as with the plane V of FIG. 4.

[0112] In the first embodiment, the coupling header

pipe 54 having the opposite-side side face 59 formed in a circular arc shape in plan view has been described. However, this is not a limitation. For example, as shown in FIG. 7, the outdoor heat exchanger 50 may include the coupling header pipe 154, the coupling header pipe 154 including an opposite-side side face portion 192 having a flat face 100 parallel to the connection side face 57 on substantially the center in the air flowing direction.

[0113] The opposite-side side face portion 192 has an opposite-side side face 159 constituting the outer side face of the coupling header pipe 154, and an opposite-side inner side face 193 constituting the inner side face of the coupling header pipe 154, the opposite-side inner side face 193 facing the internal space SQ and the section space SR.

[0114] The opposite-side side face portion 192 has, on both sides of the flat face 100, curved faces 110 each having an arc shape and projecting outward of the coupling header pipe 154. The opposite-side side face 159 and the opposite-side inner side face 193 extend throughout an area where the flat face 100 and the pair of curved faces 110 are provided on the opposite-side side face portion 192.

[0115] In the coupling header pipe 154, in the section space SR, the refrigerant flowing to the coupling header pipe 154 from one of the flat pipes 62 adjacent to each other in the air flowing direction flows along one of the curved faces 110, then flows along the flat face 100, and then flows along the other of the curved faces 110. Accordingly, in the coupling header pipe 154, the flowing direction of the refrigerant flowing thereto is changed without a sudden change, and the refrigerant is then caused to flow out to the other of the flat pipes 62 adjacent to each other in the air flowing direction.

[0116] Accordingly, in the coupling header pipe 154, even during a high-load operation in which, in particular, the refrigerant circulation amount is large and the refrigerant flow velocity is high, it is possible to prevent the refrigerant from suddenly changing its direction and colliding with the wall surface, and separating into liquid and gas. Thus, in the coupling header pipe 154, the gas-liquid state of the refrigerant flowing out to the flat pipes 62 becomes uniform, and the heat exchange performance of the outdoor heat exchanger 50 can be improved.

[0117] FIG. 8 is a plan view showing a section of a coupling header pipe 254 according to a second modification of the present disclosure. FIG. 8 shows the section taken on a plane that extends between the pair of flat pipes 62 and the division plate 88 in the longitudinal direction of the coupling header pipe 254 and is parallel to a direction perpendicular to the longitudinal direction of the coupling header pipe 254 as with the plane V of FIG. 4.

[0118] As shown in FIG. 8, the outdoor heat exchanger 50 may include the coupling header pipe 254, the coupling header pipe 254 having coupling faces 120 on both sides of the flat face 100 instead of the curved faces 110 on the opposite-side side face 159. The coupling faces 120 are flat faces inclined outward of the coupling header

pipe 254 from the flat face 100 toward the connection side face 57 in plan view of the coupling header pipe 254.

[0119] The coupling header pipe 254 includes an opposite-side side face portion 292. The opposite-side side face portion 292 has an opposite-side side face 259 constituting the outer side face of the coupling header pipe 254, and an opposite-side inner side face 293 constituting the inner side face of the coupling header pipe 254, the opposite-side inner side face 293 facing the internal space SQ and the section space SR. The opposite-side side face 259 and the opposite-side inner side face 293 extend throughout an area where the flat face 100 and the pair of coupling faces 120 are provided on the opposite-side side face portion 292.

[0120] In the coupling header pipe 254, in the section space SR, the refrigerant flowing to the coupling header pipe 254 from one of the flat pipes 62 adjacent to each other in the air flowing direction flows along one of the coupling faces 120, then flows along the flat face 100, and then flows along the other of the coupling faces 120. Accordingly, in the coupling header pipe 254, the flowing direction of the refrigerant flowing thereto is changed without a sudden change, and the refrigerant is then caused to flow out to the other of the flat pipes 62 adjacent to each other in the air flowing direction.

[0121] Since the embodiments described above are intended to exemplify the techniques in the present disclosure, various changes, replacements, additions, omissions, and the like can be made within the scope of the claims or a scope equivalent thereto.

(Supplement)

[0122] (Technique 1) A heat exchanger including: a plurality of header pipes; and a plurality of flat pipes connected to each of the header pipes in such a manner that the flat pipes are aligned in a longitudinal direction of the header pipes, in which at least one of the header pipes serves as a coupling header pipe to which a plurality of the flat pipes are connected in such a manner that the flat pipes are placed side by side in a direction intersecting the longitudinal direction of the header pipe, a side face of the coupling header pipe has a connection side face to which a plurality of the flat pipes are connected and an opposite-side side face located opposite to the connection side face, and the opposite-side side face projects away from the connection side face toward substantially a center in the direction intersecting the longitudinal direction of the coupling header pipe.

[0123] According to this technique, in the coupling header pipe, the flowing direction of the refrigerant flowing from one of the flat pipes adjacent to each other in the air flowing direction is gently changed toward the flat pipe connected to one of the header pipes along the opposite-side side face. Thus, in the coupling header pipe, it is possible to reduce the influence of a collision with the opposite-side side face and prevent separation of liquid and gas.

[0124] (Technique 2) The heat exchanger according to technique 1, in which the opposite-side side face has opposite ends located in the direction intersecting the longitudinal direction of the coupling header pipe, the opposite ends being located on an outer side relative to a plurality of the flat pipes placed side by side in the direction intersecting the longitudinal direction of the coupling header pipe.

[0125] According to this technique, inside the coupling header pipe, even during a low-load operation in which, in particular, the refrigerant circulation amount is small and an inertial force is small, by causing half or more of the refrigerant to flow along the opposite-side side face, the remaining refrigerant can be caused to follow the same flow. Thus, inside the coupling header pipe, it is possible to reduce the influence of a collision with the opposite-side side face and prevent separation of liquid and gas, the gas-liquid state of the refrigerant flowing out to the flat pipes becomes uniform, and the heat exchange performance can be improved.

[0126] (Technique 3) The heat exchanger according to technique 1 or 2, in which the opposite-side side face has a flat face on substantially the center in the direction intersecting the longitudinal direction of the coupling header pipe, the flat face being flat in the direction intersecting the longitudinal direction of the coupling header pipe.

[0127] According to this technique, in the coupling header pipe, even during a high-load operation in which, in particular, the refrigerant circulation amount is large and the refrigerant flow velocity is high, it is possible to prevent the refrigerant from suddenly changing its direction and colliding with the wall surface, and separating into liquid and gas. Thus, in the coupling header pipe, the gas-liquid state of the refrigerant flowing out to the flat pipes becomes uniform, and the heat exchange performance of the outdoor heat exchanger can be improved.

[0128] (Technique 4) The heat exchanger according to any one of techniques 1 to 3, in which the opposite-side side face has projecting shapes on both sides of substantially the center in the direction intersecting the longitudinal direction of the coupling header pipe, the projecting shapes projecting from inside of the coupling header pipe toward outside of the coupling header pipe.

[0129] According to this technique, the refrigerant flowing to the coupling header pipe from one of the flat pipes adjacent to each other in the air flowing direction gently changes its direction along the projecting shapes of the opposite-side side face to the direction opposite to the flowing direction of the refrigerant flowing thereto and flows out through the other of the flat pipes adjacent to each other in the air flowing direction. Thus, even during a maximum-load operation in which, in particular, the refrigerant circulation amount is maximum and the refrigerant flow velocity is highest, change in the direction of the flow of the refrigerant can be reduced.

[0130] (Technique 5) The heat exchanger according

to any one of techniques 1 to 4, in which the coupling header pipe is provided with a division plate that separates the flat pipes adjacent to each other in the longitudinal direction of the coupling header pipe.

[0131] This technique prevents, in the longitudinal direction of the coupling header pipe, the refrigerant flowing to the coupling header pipe from one of the flat pipes adjacent to each other in the air flowing direction from merging and splitting in the internal space inside the coupling header pipe. Thus, the refrigerant flowing to the coupling header pipe from one of the flat pipes adjacent to each other in the air flowing direction is prevented from interfering or mixing with the flow of the refrigerant flowing to the coupling header pipe from another flat pipe adjacent to this flat pipe in the up-down direction and obstructing a flow along the opposite-side side face.

[0132] (Technique 6) The heat exchanger according to technique 5, in which the coupling header pipe is coated with a brazing material on a face with which a refrigerant comes into contact, and the division plate is not coated with the brazing material.

[0133] According to this technique, the amount of the brazing material used in the outdoor heat exchanger can be reduced. This prevents an excessive brazing material from melting out onto the side face of the coupling header pipe during brazing and an unnecessary brazing material remaining on the opposite-side side face from obstructing the flow of the refrigerant. Thus, in the outdoor heat exchanger, it is possible to prevent the refrigerant flowing inside the coupling header pipe from changing its flowing direction, causing a collision, and separating into liquid and gas.

[0134] (Technique 7) An outdoor unit including the heat exchanger according to any one of techniques 1 to 6.

[0135] According to this technique, the outdoor unit achieves the same effects as those achieved by the heat exchanger described above.

Industrial Applicability

[0136] The present disclosure is applicable to a heat exchanger including a flat pipe and a header pipe. Specifically, the present disclosure is applicable to, for example, a heat exchanger mounted on an outdoor unit.

Reference Signs List

- [0137]**
- 1 outdoor unit
 - 50 outdoor heat exchanger
 - 51, 53 side face
 - 54, 154, 254 coupling header pipe
 - 55, 57 connection side face
 - 59, 159 opposite-side side face
 - 62 flat pipe

Claims

1. A heat exchanger (50) comprising: a plurality of header pipes (52); and a plurality of flat pipes (62) connected to each of the header pipes in such a manner that the flat pipes are aligned in a longitudinal direction of the header pipes, **characterized in that**

at least one of the header pipes serves as a coupling header pipe (54, 154, 254) to which a plurality of the flat pipes are connected in such a manner that the flat pipes are placed side by side in a direction intersecting the longitudinal direction of the header pipe, a side face of the coupling header pipe has a connection side face (55, 57) to which a plurality of the flat pipes are connected and an opposite-side side face (59, 159) located opposite to the connection side face, and the opposite-side side face projects away from the connection side face toward substantially a center in the direction intersecting the longitudinal direction of the coupling header pipe.

2. The heat exchanger according to claim 1, wherein the opposite-side side face has opposite ends located in the direction intersecting the longitudinal direction of the coupling header pipe, the opposite ends being located on an outer side relative to a plurality of the flat pipes placed side by side in the direction intersecting the longitudinal direction of the coupling header pipe.

3. The heat exchanger according to claim 1 or 2, wherein the opposite-side side face has a flat face (100) on substantially the center in the direction intersecting the longitudinal direction of the coupling header pipe, the flat face being flat in the direction intersecting the longitudinal direction of the coupling header pipe.

4. The heat exchanger according to claim 1 or 2, wherein the opposite-side side face has projecting shapes on both sides of substantially the center in the direction intersecting the longitudinal direction of the coupling header pipe, the projecting shapes projecting from inside of the coupling header pipe toward outside of the coupling header pipe.

5. The heat exchanger according to claim 1 or 2, wherein the coupling header pipe is provided with a division plate (88) that separates the flat pipes adjacent to each other in the longitudinal direction of the coupling header pipe.

6. The heat exchanger according to claim 5, wherein

the coupling header pipe is coated with a brazing

material on a face with which a refrigerant comes into contact, and the division plate is not coated with the brazing material.

7. An outdoor unit (1) comprising the heat exchanger according to claim 1 or 2.

FIG. 1

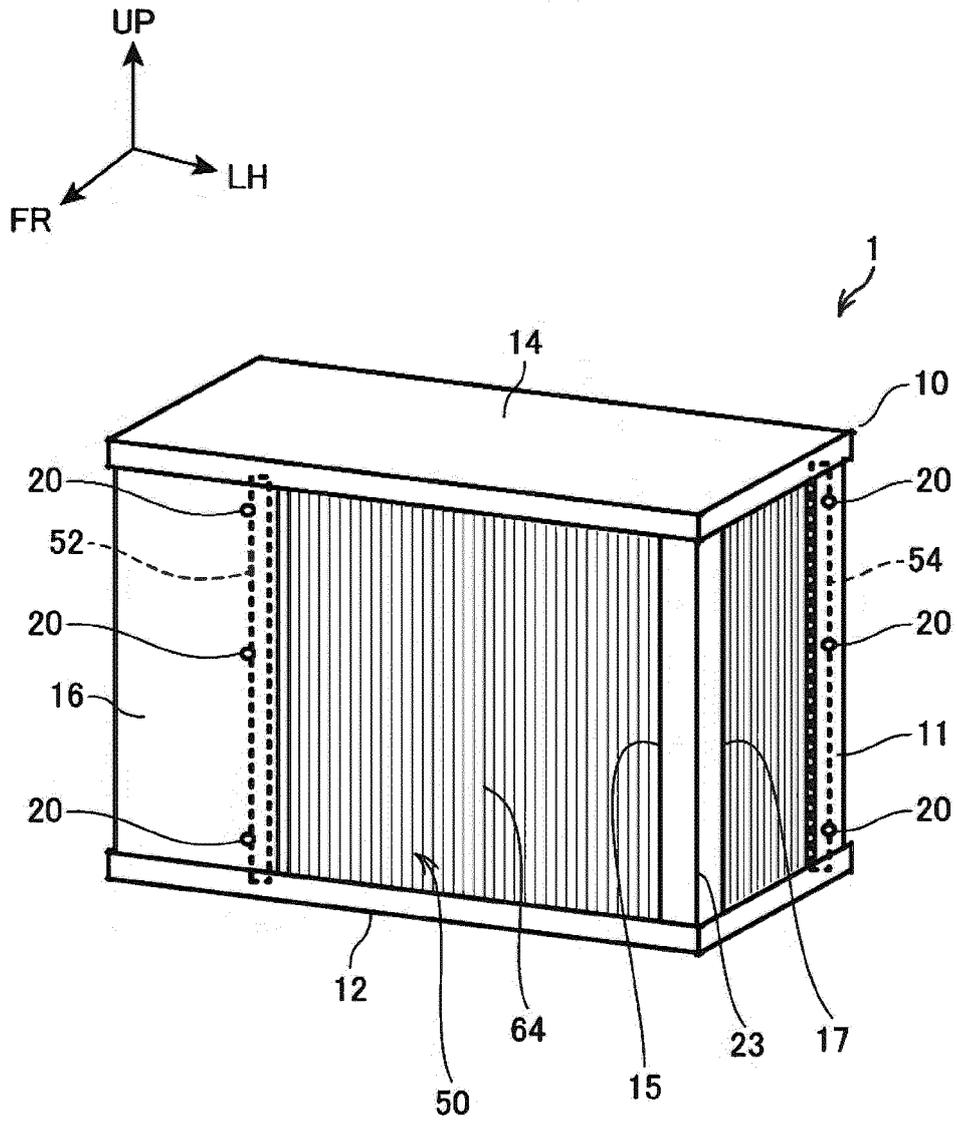
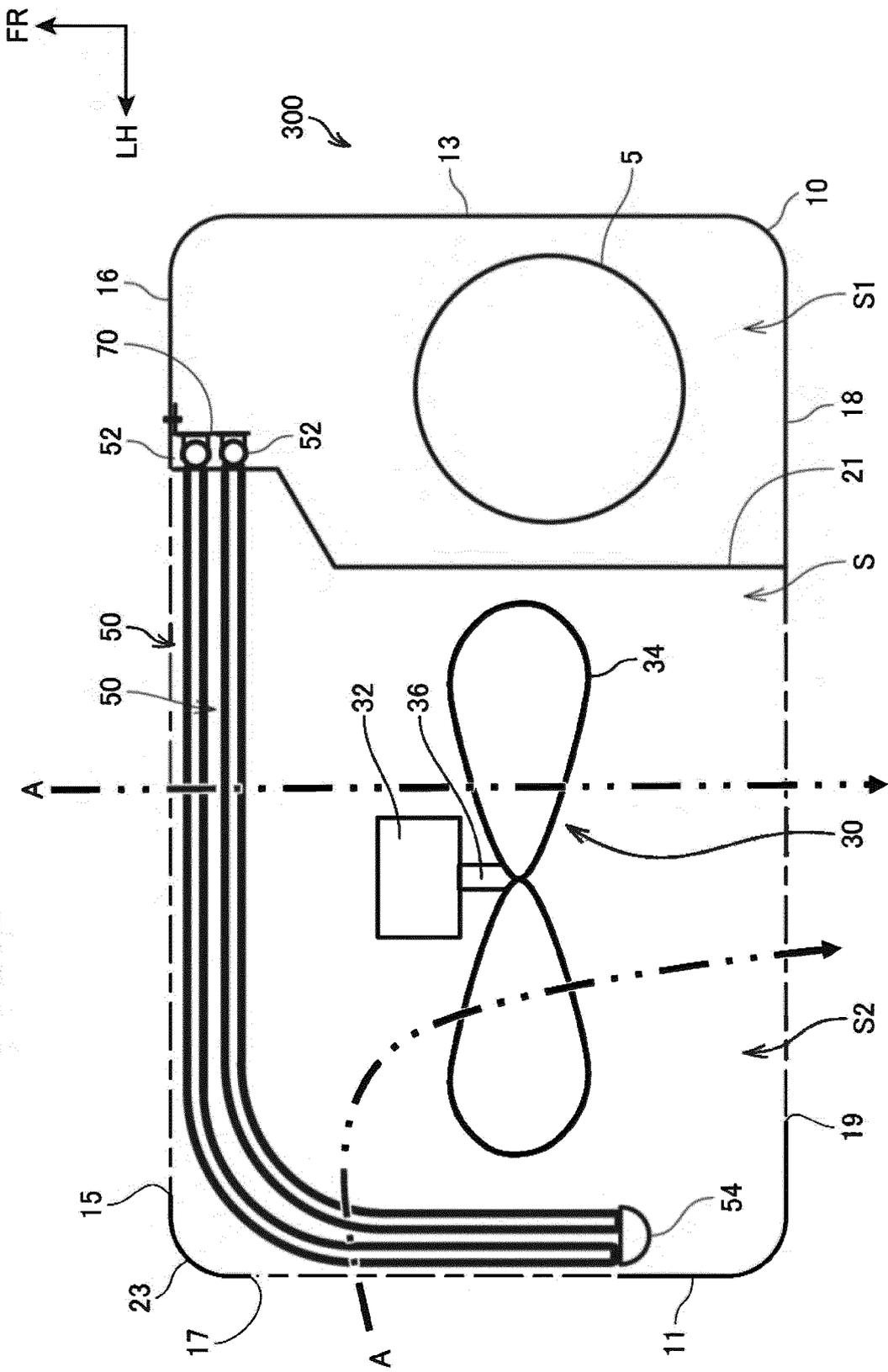


FIG.2



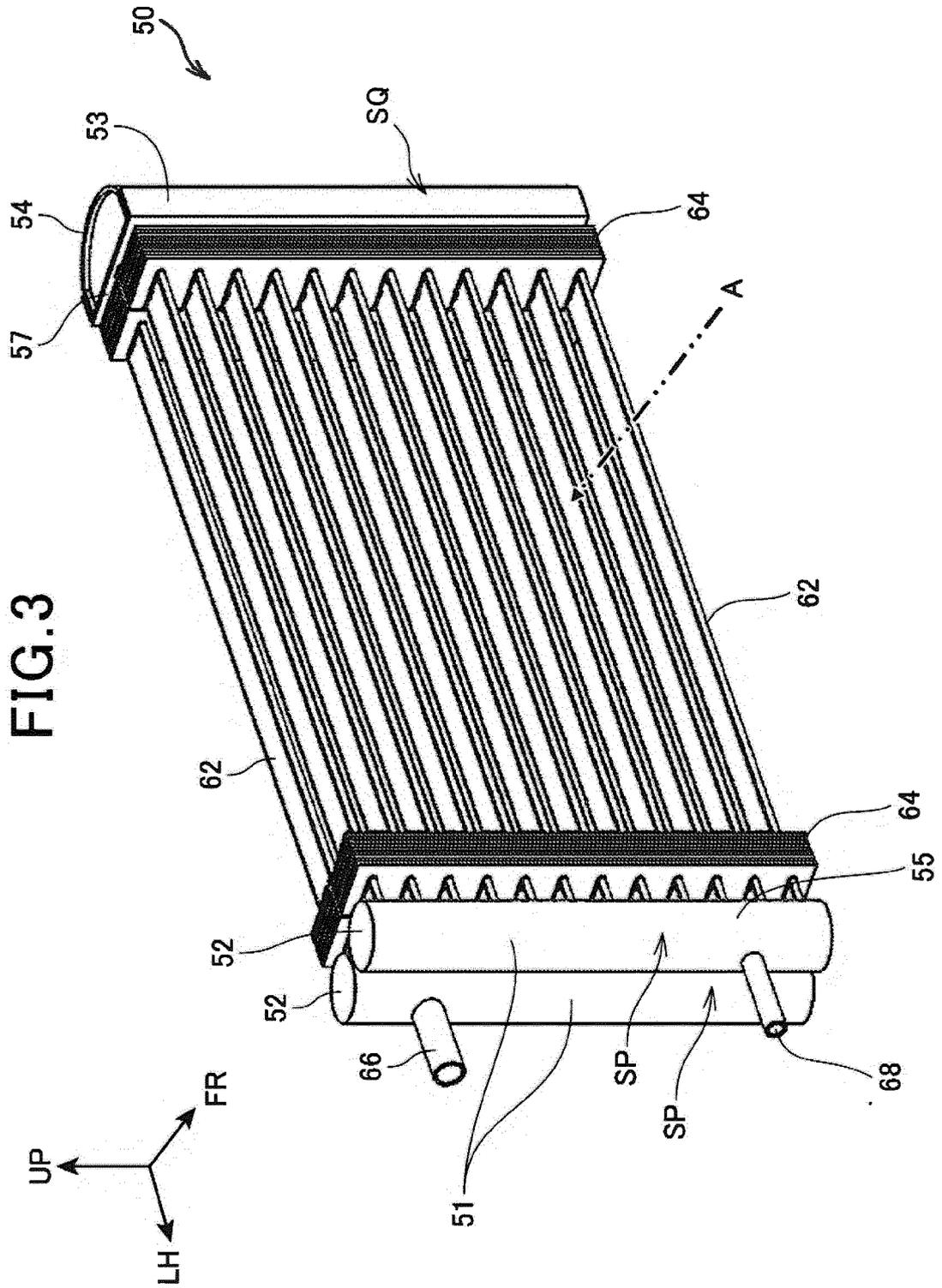


FIG. 4

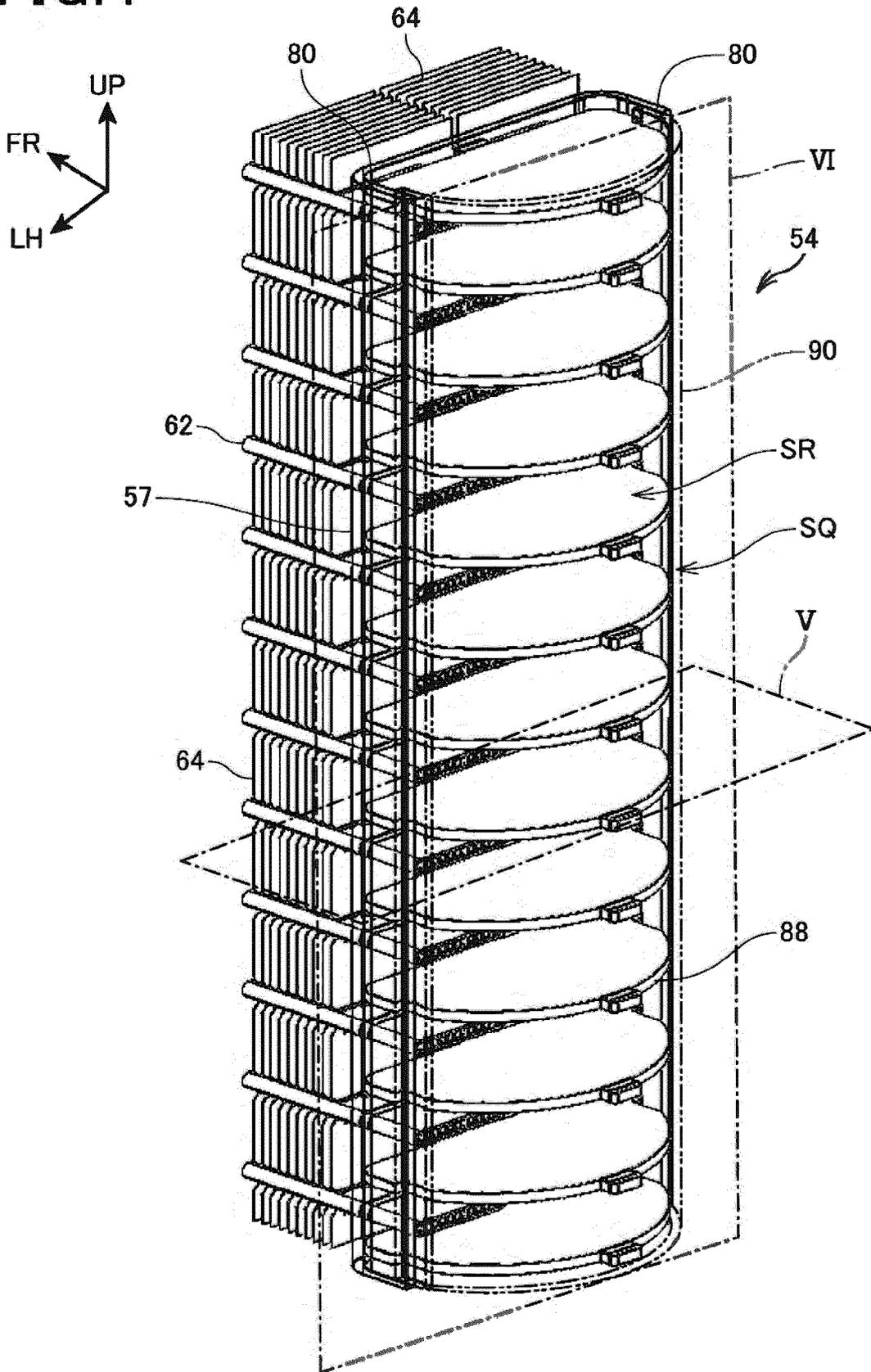


FIG. 5

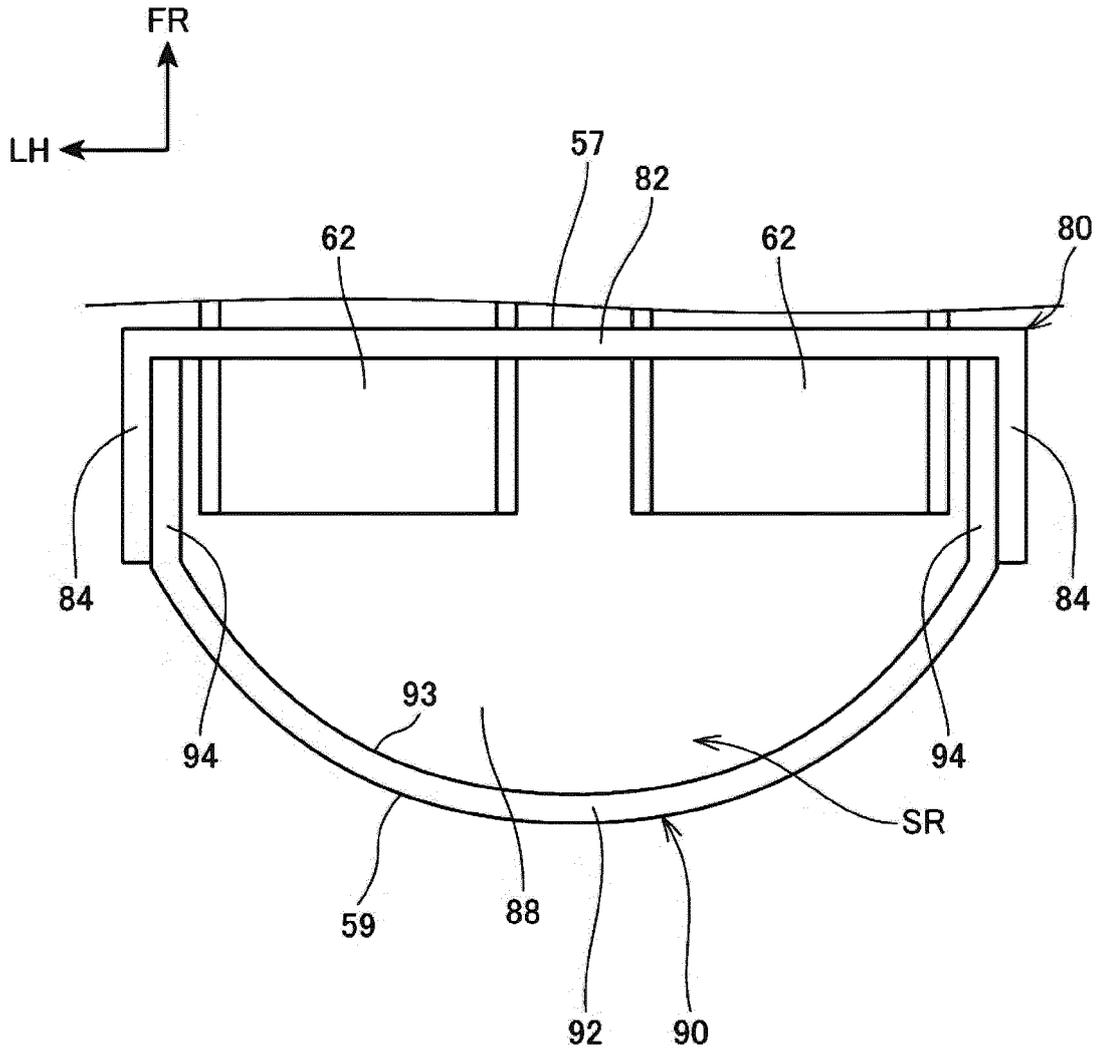


FIG. 6

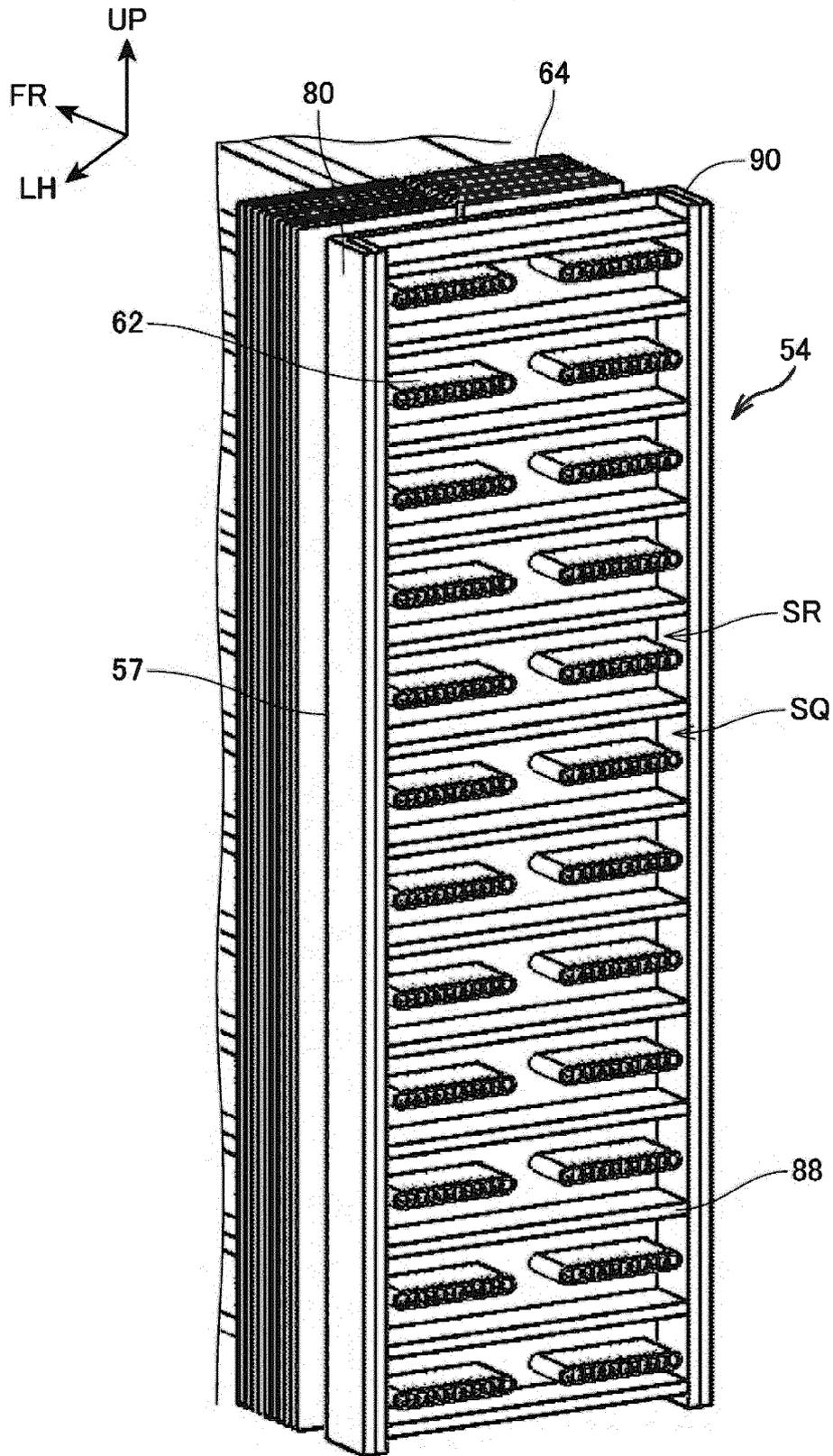


FIG. 7

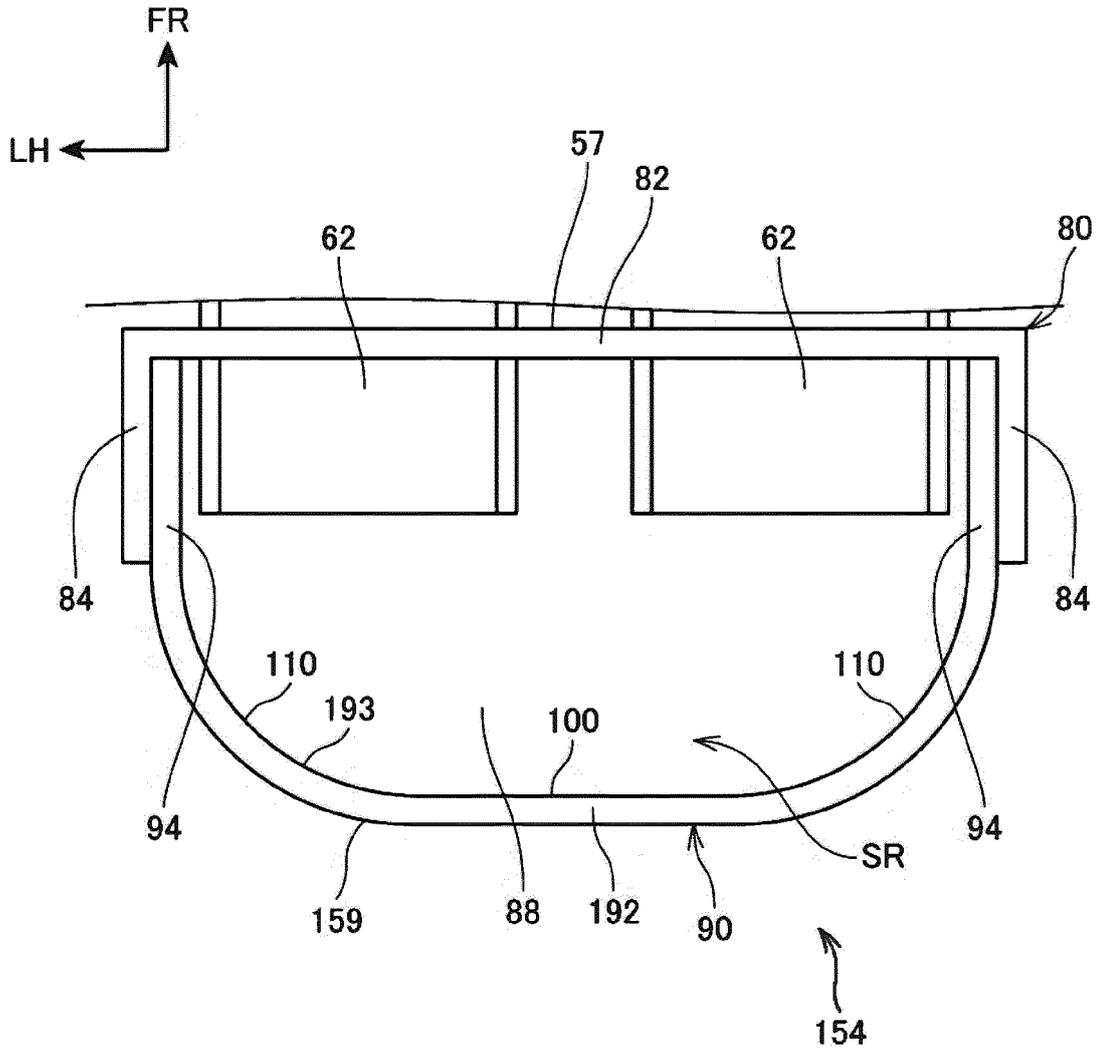
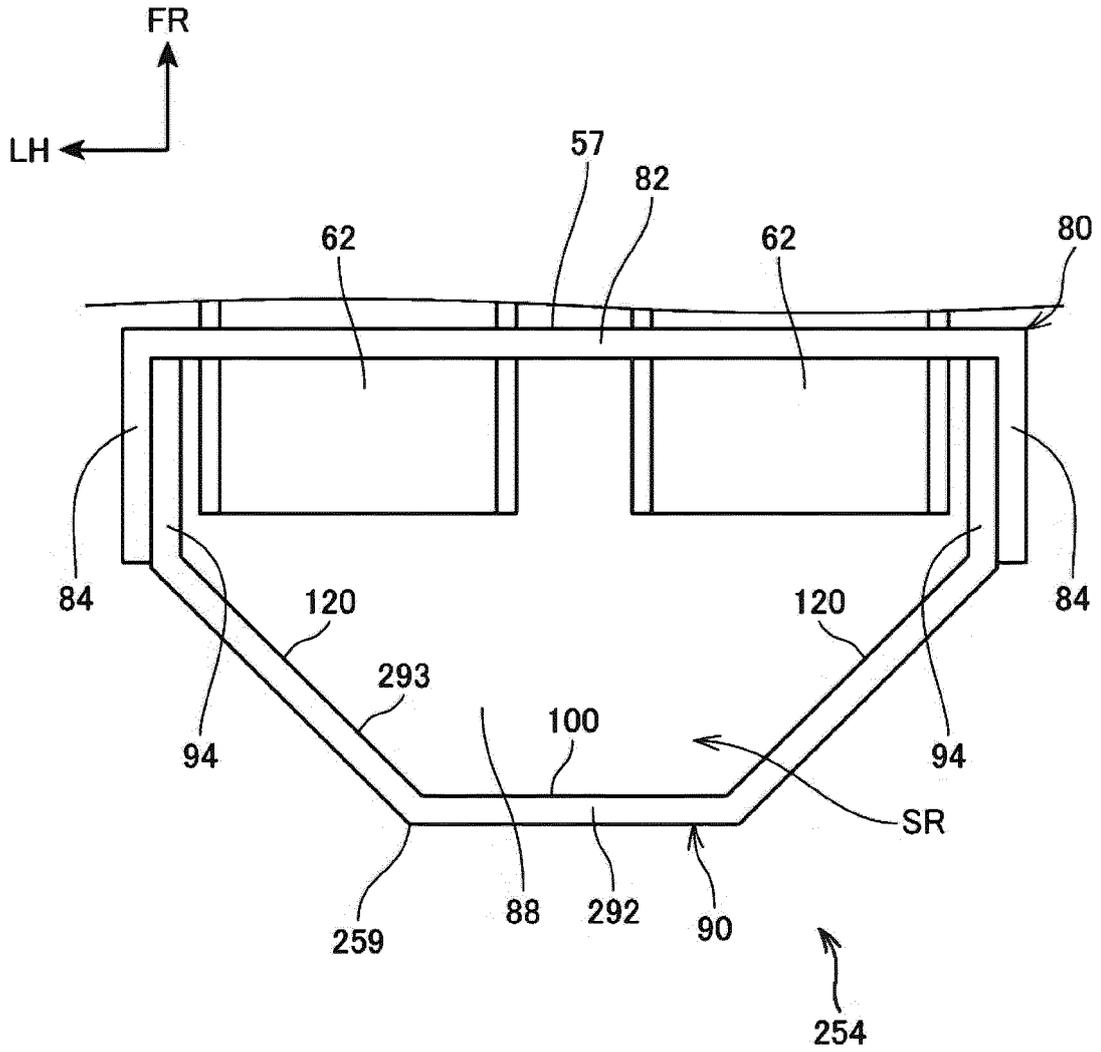


FIG. 8





EUROPEAN SEARCH REPORT

Application Number

EP 23 19 7429

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The present search report has been drawn up for all claims

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Place of search Munich	Date of completion of the search 6 February 2024	Examiner Jessen, Flemming
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