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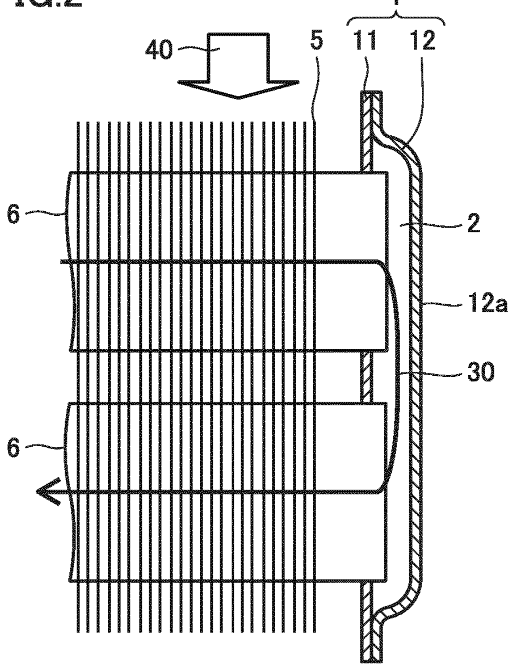
(54) HEAT EXCHANGER AND REFRIGERATION CYCLE APPARATUS

(57) A heat exchanger and a refrigeration cycle apparatus for which a manufacturing cost can be reduced are provided. A heat exchanger (10) includes a first flat tube (6), a second flat tube (6) and a header (1). The header (1) is configured to connect one end of the first flat tube (6) and one end of the second flat tube (6). The header (1) is formed of a first member included in a first plate-shaped body (11) and a second member included in a second plate-shaped body (12). One end of the first flat tube (6) and one end of the second flat tube (6) are fixed to the first member. The second member is connected so as to overlap with the first member. The second member is provided with a recessed portion extending from a position that one end of the first flat tube (6) faces to a position that one end of the second flat tube (6) faces.

FIG.2



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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] Conventionally, there has been a known heat exchanger employing a flat tube through which refrigerant is caused to flow (for example, see Japanese Patent Laying-Open No. 2013-29243 (hereinafter referred to as PTL 1)). In PTL 1, the ends of the flat tubes disposed in different rows are connected to each other with a return head, thereby increasing the effective length of the heat exchanger configured to perform heat exchange between refrigerant and outdoor air, and also thereby reducing the size of the heat exchanger.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: Japanese Patent Laying-Open No. 2013-29243

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] In the heat exchanger disclosed in PTL 1, the return head is formed of four members including a pipe bonding member, a pipe fixing member, a spacer member, and a back plate. When the return head is formed of a large number of components in this way, the cost of components of the return head and the number of manufacturing steps thereof are increased, which leads to an increase in cost of manufacturing a heat exchanger and an air conditioning apparatus to which the heat exchanger is applied.

[0005] The present invention has been made to solve the above-described problems. An object of the present invention is to provide a heat exchanger and a refrigeration cycle apparatus, for which the manufacturing cost can be reduced.

SOLUTION TO PROBLEM

[0006] A heat exchanger according to the present disclosure includes a first flat tube, a second flat tube, and a header. The first flat tube and the second flat tube extend in a direction crossing a flowing direction of a fluid and are arranged side by side in the flowing direction. Refrigerant flows through the first flat tube and the second flat tube. The header is configured to connect one end of the first flat tube and one end of the second flat tube. The header is formed of a first member and a second member. The one end of the first flat tube and the one end of the second flat tube are fixed to the first member. The second member is connected so as to overlap with the first member. The second member is provided with a recessed portion extending from a position that the one end of the first flat tube faces to a position that the one end of the second flat tube faces.

[0007] A refrigeration cycle apparatus according to the present disclosure includes a refrigerant circuit through which refrigerant circulates, the refrigerant circuit including a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger. At least one of the first heat exchanger and the second heat exchanger is the above-described heat exchanger.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] According to the above description, a header can be formed mainly of two members including the first member and the second member. Thus, the structure of the header can be simplified as compared with the conventional case while the number of components can be reduced, so that the manufacturing cost of the header can be reduced. Furthermore, when the recessed portion is formed to have a minimum necessary volume in consideration of the amount of refrigerant flowing through the first flat tube and the second flat tube, the amount of refrigerant held in the heat exchanger can be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 is a schematic diagram showing a heat exchanger according to the first embodiment of the present invention.
Fig. 2 is a partial schematic cross-sectional view including a header of the heat exchanger shown in Fig. 1.
Fig. 3 is an exploded schematic diagram of the header of the heat exchanger shown in Fig. 1.
Fig. 4 is a schematic diagram of the external appearance of the header of the heat exchanger shown in Fig. 1.
Fig. 5 is a schematic diagram of the external appearance of the header of the heat exchanger shown in Fig. 1.
Fig. 6 is a partial schematic cross-sectional view taken along a line VI-VI in Fig. 4.
Fig. 7 is a schematic cross-sectional view taken along a line VII-VII in Fig. 1.
Fig. 8 is a schematic diagram of the external appearance of a header in the first modification of the heat exchanger according to the first embodiment of the present invention.
Fig. 9 is a partial schematic cross-sectional view taken along a line IX-IX in Fig. 8.
Fig. 10 is a partial schematic cross-sectional view of a header in the second modification of the heat exchanger.
Fig. 11 is a partial schematic cross-sectional view of a header in the third modification of the heat exchanger.
Fig. 12 is a partial schematic cross-sectional view of a header in the fourth modification of the heat exchanger.
Fig. 13 is a partial schematic cross-sectional view of a header in the fifth modification of the heat exchanger.
Fig. 14 is a schematic diagram of the external appearance of a header in the sixth modification of the heat exchanger.
Fig. 15 is a schematic diagram of the external appearance of a header in the sixth modification of the heat exchanger.
Fig. 16 is a schematic cross-sectional view in the sixth modification of the heat exchanger.
Fig. 17 is a schematic diagram showing a refrigerant circuit of an air conditioning apparatus according to the second embodiment of the present invention.
Fig. 18 is a schematic diagram for illustrating the size of a header of a heat exchanger according to an example of the present invention.

DESCRIPTION OF EMBODIMENTS

[0010] The embodiments of the present invention will be hereinafter described with reference to the accompanying drawings, in which the same or corresponding components are designated by the same reference characters, and the description thereof will not be repeated. In the following drawings including Fig. 1, the relation in size among the components may be different from the actual relation. Further, the embodiments of the components described in the whole text of the specification are given merely by way of example, and the present invention is not limited thereto.

First Embodiment

<Configuration of Heat Exchanger>

[0011] Fig. 1 is a schematic diagram showing a heat exchanger according to the first embodiment of the present invention. Fig. 2 is a partial schematic cross-sectional view including a header of the heat exchanger shown in Fig. 1. Fig. 3 is an exploded schematic diagram of the header of the heat exchanger shown in Fig. 1. Figs. 4 and 5 each are a schematic diagram of the external appearance of the header of the heat exchanger shown in Fig. 1. Fig. 6 is a partial schematic cross-sectional view taken along a line VI-VI in Fig. 4. Fig. 7 is a schematic cross-sectional view taken along a line VII-VII in Fig. 1.

[0012] A heat exchanger shown in Figs. 1 to 7 includes: at least two flat tubes 6; a plurality of fins 5 each extending in the direction crossing the extending direction of flat tube 6 and each having an opening through which at least two flat tubes 6 pass; and a header 1 connecting one ends of flat tubes 6. The plurality of fins 5 are fixedly connected to each flat tube 6 disposed to pass through the opening. Each flat tube 6 has one end to which header 1 as a liquid guiding header is connected and the other end on the opposite side thereof. To the other end of flat tube 6 on the upwind side, a liquid header 7 as a distribution header is connected. To the other end of flat tube 6 on the downwind side, a gas header 8 is connected. A plurality of flat tubes 6 are disposed to be spaced apart from each other in the direction perpendicular to the surface of the sheet of paper showing Fig. 1. The collection of the plurality of flat tubes 6 and the plurality of fins 5 is also referred to as a heat exchanger core. As shown in Fig. 1, the plurality of flat tubes 6 constituting a heat exchanger core are disposed in rows on the upwind side and in rows on the downwind side such that their one ends are aligned with each other. Thus, when the one ends of flat tubes 6 are inserted into the corresponding openings of header 1, header 1 can be readily positioned relative to flat tubes 6.

[0013] Header 1 shown in Figs. 1 to 6 is placed in the heat exchanger shown in Fig. 1 and serves to connect flat tubes 6 in rows on the upwind side and flat tubes 6 in rows on the downwind side that are arranged in the fluid flowing direction.

Header 1 is formed of two plates made of aluminum. Specifically, header 1 is formed by stacking and fixing: an aluminum plate as a first plate-shaped body 11 having a flat-shaped opening 4 provided on one side; and an aluminum plate as a second plate-shaped body 12 provided with a recessed portion having a semicircular arc-shaped cross section on one side so as to have a flow path. The ends of flat tubes 6 are fixedly inserted into the corresponding openings 4. Header 1 forms a refrigerant path connecting flat tube 6 in each row on the upwind side and flat tube 6 in each row on the downwind side, as shown in Fig. 2. Two aluminum plates are fixed by a crimping portion 3. Furthermore, a brazing material is cladded to the mating surface between these two aluminum plates. Thus, after applying a flux onto the brazing material, the aluminum plates stacked on one another are heated, with the result that these aluminum plates are blazed.

[0014] As shown in Fig. 2, for example, the refrigerant flowing from first flat tube 6 on the upwind side into header 1 flows through opening 4 formed to extend along the cross-sectional shape of flat tube 6 (see Fig. 3) as indicated by an arrow 30. Then, the refrigerant reaches the space inside header 1. This space is provided as refrigerant path 2 having a semicircular cross-sectional shape and surrounded by the recessed portion of second plate-shaped body 12 and first plate-shaped body 11. The refrigerant having flown into refrigerant path 2 flows through the refrigerant path as indicated by arrow 30 in Fig. 2, and thereafter flows through opening 4 along the cross-sectional shape of flat tube 6 located on the downwind side into second flat tube 6 on the downwind side. In this case, refrigerant path 2 is configured to have a necessary minimum depth and a necessary minimum formation region area, so that the internal volume can be reduced as compared with conventional headers. Accordingly, the amount of refrigerant stored in header 1 can be reduced, so that the amount of refrigerant introduced into heat exchanger 10 can be reduced.

[0015] As shown in Figs. 3 to 6, flat-shaped opening 4 in header 1 is disposed to extend in the horizontal direction (in the direction perpendicular to the gravity direction). Furthermore, in header 1 shown in the figures, opening 4 on the upwind side and opening 4 on the downwind side are arranged side by side in the horizontal direction. Furthermore, the plurality of openings 4 on the upwind side are arranged side by side at a distance from each other in the gravity direction. The plurality of openings 4 on the downwind side are also arranged side by side at a distance from each other in the gravity direction. The central axis along each flat-shaped opening 4 in the gravity direction (the row direction) linearly extends along two adjacent openings on the upwind side and the downwind side in the air flowing direction, as shown in Fig. 5. In this way, flat-shaped opening 4 on the upwind side and flat-shaped opening 4 on the downwind side are disposed such that their central axes extend in parallel or linearly. Thereby, the area of the plane shape of refrigerant path 2 can be reduced as compared with the case where openings 4 in each row are formed such that their central axes are displaced or extend in directions crossing each other. As a result, the volume of the refrigerant path in header 1 can be reduced. In Fig. 5, each of the above-mentioned central axes is shown by an alternate long and short dash line. Also, each of the above-mentioned central axes corresponds to the central axis along one end of flat tube 6 when this one end of flat tube 6 is inserted into opening 4,. In other words, the central axis shown by an alternate long and short dash line in Fig. 5 corresponds to the central axis along one end of flat tube 6.

[0016] As shown in Fig. 6, in header 1, first plate-shaped body 11 includes a plate-shaped first member 11a and a brazing material 11b. Brazing material 11b serves to join first member 11a and second plate-shaped body 12. Furthermore, brazing material 11b can be utilized also as a joining material for joining first member 11a and flat tube 6 that is not shown.

[0017] Thus, flat tubes 6 are disposed to extend from the upwind side toward the downwind side, as described above. Thereby, in the heat exchanger core, flat tubes 6 disposed so as to penetrate through fins 5 are disposed to overlap with each other in a view seen from the upwind side, as shown in Fig. 7. In a different point of view, the central axes of flat tubes 6 arranged side by side on the upwind side and on the downwind side are positioned to extend along the air flowing direction.

<Configuration of Modification of Heat Exchanger>

[0018] Fig. 8 is a schematic diagram of the external appearance of a header in the first modification of the heat exchanger according to the first embodiment of the present invention. Fig. 9 is a partial schematic cross-sectional view taken along a line IX-IX in Fig. 8. The heat exchanger shown in Figs. 8 and 9 is basically identical in configuration to the heat exchanger shown in Figs. 1 to 7, but is different therefrom in configuration of the connection portion between header 1 and flat tube 6. In other words, in the heat exchanger shown in Figs. 8 and 9, first opening 4 is located at the leading end of a first side wall portion 11c in first member 11a protruding from second member 12a toward first flat tube 6. The leading end of first side wall portion 11c is connected via brazing material 11b to a position 6a that is distant from the end face of one end of first flat tube 6. Second opening 4 is formed to have a central axis extending along the same straight line as the central axis of first opening 4 and is identical in configuration to first opening 4. In other words, the second opening is located at the leading end of second side wall portion 11c in first member 11a protruding from second member 12a toward second flat tube 6. The leading end of second side wall portion 11c is connected via brazing material 11b to position 6a that is distant from the end face of one end of second flat tube 6. In addition, the ends of first flat tube 6 and second flat tube 6 are processed to be narrower in width than the center portions of first flat tube 6 and second flat tube 6 in their extending directions. The end with narrowed width is located inside first opening 4 or second opening 4.

[0019] Fig. 10 is a partial schematic cross-sectional view of a header in the second modification of the heat exchanger. The heat exchanger shown in Fig. 10 is basically identical in configuration to the heat exchanger shown in Figs. 8 and 9, but is different therefrom in configuration of the connection portion between header 1 and flat tube 6. In other words, in the heat exchanger shown in Fig. 10, first opening 4 is located at the leading end of first side wall portion 11c in first member 11a protruding from first flat tube 6 toward second member 12a. The leading end of first side wall portion 11c is connected via a brazing material to position 6a that is distant from the end face of one end of first flat tube 6. Second opening 4 is located at the leading end of second side wall portion 11c in first member 11a protruding from second flat tube 6 toward second member 12a. The leading end of second side wall portion 11c is connected via a brazing material to position 6a that is distant from the end face of one end of second flat tube 6.

[0020] Fig. 11 is a partial schematic cross-sectional view of a header in the third modification of the heat exchanger. The heat exchanger shown in Fig. 11 is basically identical in configuration to the heat exchanger shown in Figs. 1 to 7, but is different therefrom in configuration of the connection portion between header 1 and flat tube 6. In other words, in the heat exchanger shown in Fig. 11, the recessed portion formed in second plate-shaped body 12 as the second member that forms header 1 includes: a stepped portion 22 and a bottom portion 23 that is located farther away from first member 11a than stepped portion 22 is. First flat tube 6 and second flat tube 6 are located such that their ends are inserted into first opening 4 and second opening 4, respectively. The end of flat tube 6 protrudes into refrigerant path 2. A part of the end face of the end of each of first flat tube 6 and second flat tube 6 is in contact with stepped portion 22. Furthermore, brazing material 11b is formed on the surface of first member 11a that faces second plate-shaped body 12. Brazing material 11b also has a function as a joining material for joining first member 11a to first flat tube 6 and second flat tube 6.

[0021] Fig. 12 is a partial schematic cross-sectional view of a header in the fourth modification of the heat exchanger. The heat exchanger shown in Fig. 12 is basically identical in configuration to the heat exchanger shown in Figs. 1 to 7, but the cross-sectional shape of the recessed portion formed in second member 12a is different from the cross-sectional shape of the recessed portion shown in Fig. 6. In other words, in the heat exchanger shown in Fig. 12, the recessed portion has a triangular cross-sectional shape having corner portions each formed in a curved shape.

[0022] Fig. 13 is a partial schematic cross-sectional view of a header in the fifth modification of the heat exchanger. The heat exchanger shown in Fig. 13 is basically identical in configuration to the heat exchanger shown in Figs. 1 to 7, but the cross-sectional shape of the recessed portion formed in second member 12a is different from the cross-sectional shape of the recessed portion shown in Fig. 6. In other words, in the heat exchanger shown in Fig. 13, the recessed portion has a quadrangular cross-sectional shape having corner portions each formed in a curved shape. In a different point of view, in the heat exchanger shown in Fig. 13, the recessed portion has a trapezoidal cross-sectional shape having corner portions each formed in a curved shape.

[0023] Figs. 14 and 15 each are a schematic diagram of the external appearance of a header in the sixth modification of the heat exchanger. Fig. 16 is a schematic cross-sectional view in the sixth modification of the heat exchanger. Figs. 14 and 15 correspond to Figs. 4 and 5, respectively. Fig. 16 also corresponds to Fig. 7. The heat exchanger shown in Figs. 14 to 16 is basically identical in configuration to the heat exchanger shown in Figs. 1 to 7, but is different in configuration of header 1 and arrangement of flat tube 6 from the heat exchanger shown in of Figs. 1 to 7. In other words, in the heat exchanger shown in Figs. 14 to 16, opening 4 having a flat shape is disposed to be inclined at an angle θ to the horizontal direction (to the direction perpendicular to the gravity direction). Furthermore, first opening 4 on the upwind side and second opening 4 on the downwind side that are adjacent to each other are arranged such that the central axes of these openings 4 in the row direction are linearly aligned.

<Method of Manufacturing Heat Exchanger>

[0024] The method of manufacturing a heat exchanger according to the present embodiment can be performed by the following steps. First, a step (S10) of preparing components constituting a heat exchanger is performed. In this step (S10), flat tube 6, fin 5, first plate-shaped body 11 and second plate-shaped body 12 that form header 1, liquid header 7, gas header 8, and the like are prepared. In addition, a brazing material is disposed on the surface of at least one of first plate-shaped body 11 and the second plate-shaped body.

[0025] Then, an assembly step (S20) is performed. In this step (S20), a header assembly step is first performed, in which first plate-shaped body 11 and second plate-shaped body 12 are overlaid on one another, and crimping portion 3 is bent to fix first plate-shaped body 11 and second plate-shaped body 12. Furthermore, a core assembly step is performed, in which a plurality of flat tubes 6 are inserted into openings of fins 5 that are arranging in parallel, thereby fabricating a heat exchanger core. Then, a step of inserting one end of the flat tube of the heat exchanger core into opening 4 of header 1 (see Fig. 3) is performed. In this case, liquid header 7 and gas header 8 may be connected to the other end of flat tube 6. This results in formation of a combined component in which header 1 is connected to the heat exchanger core. Then, a flux is applied onto a prescribed portion of the combined component. The combined component is then placed in a heating furnace and heated therein. By this heating, the brazing material disposed on first plate-shaped body 11 or second plate-shaped body 12 is melted. Then, first plate-shaped body 11 and the second plate-shaped body are joined to thereby form header 1. Further, by disposing a brazing material in advance also between first plate-shaped body 11 and the plurality of flat tubes 6 and between flat tube 6 and fin 5, these members can be fixed to each other. In this way, the heat exchanger according to the present embodiment can be manufactured.

<Characteristic Configuration, Functions and Effects of Heat Exchanger>

[0026] As a summary of the characteristic configuration of the heat exchanger according to the above-described present disclosure, heat exchanger 10 includes first flat tube 6, second flat tube 6 and header 1. First flat tube 6 and second flat tube 6 are disposed to extend in the direction crossing the flowing direction of fluid such as air indicated by an arrow 40 in Fig. 2, and to be arranged side by side in the flowing direction of fluid. Refrigerant flows through first flat tube 6 and second flat tube 6. Header 1 connects one end of first flat tube 6 and one end of second flat tube 6. Header 1 is formed of first member 11a included in first plate-shaped body 11 and second member 12a included in second plate-shaped body 12. Header 1 may include brazing materials 11b and 12b as joining layers for joining first member 11a and second member 12a. To first member 11a, one end of first flat tube 6 and one end of second flat tube 6 are fixed. Second member 12a is connected so as to overlap with first member 11a. Second member 12a is provided with a recessed portion that extends from the position that one end of first flat tube 6 faces to the position that one end of second flat tube 6 faces.

[0027] In this way, header 1 can be formed mainly by two members including first member 11a and second member 12a. Thus, as compared with the conventional case, the structure of the header can be simplified while the number of components can be reduced, so that the cost of manufacturing header 1 can be reduced. Furthermore, when first member 11a and second member 12a each are formed by a plate-shaped member, the recessed portion in second member 12a can be readily formed by press working and the like. Furthermore, when the refrigerant path formed by the recessed portion is configured to have a necessary minimum volume in consideration of the amount of refrigerant flowing through first flat tube 6 and second flat tube 6, the amount of refrigerant held in heat exchanger 10 can be reduced.

[0028] In the above-described heat exchanger 10, the inner circumferential surface of the recessed portion includes a curved line portion as shown in Fig. 6 in the cross section in the lateral direction crossing the direction extending from the position that one end of first flat tube 6 faces to the position that one end of second flat tube 6 faces, as shown in Figs. 2 to 4. The inner circumferential surface of the recessed portion in this cross section may have an arc shape.

[0029] In this case, even when the pressure of the refrigerant is increased, excessive concentration of the stress received by the pressure of the refrigerant on one place can be avoided in the recessed portion where the cross section is curved, that is, formed to have a curved surface. Thus, occurrence of the problem of damage of header 1 by the pressure can be suppressed.

[0030] In the above-described heat exchanger 10, in a view seem from first member 11a, the outer circumferential shape of end 2a in the extending direction of the recessed portion includes a curved portion, as shown in Figs. 3 and 4. In this case, excessive concentration of the stress received from the pressure of the refrigerant on one place can be avoided also in the curved portion in end 2a of the recessed portion.

[0031] In the above-described heat exchanger 10, in a view seen from first member 11a, the central axis along one end of first flat tube 6 and the central axis along one end of second flat tube 6 extend in parallel, as shown in Figs. 2, 3, 5, 15, and the like. Furthermore, first flat tube 6 and second flat tube 6 each may include a plurality of refrigerant paths arranged side by side in the direction along the above-described central axes. In this case, the size of the flat plane of the recessed portion formed at the position facing each of the ends of first flat tube 6 and second flat tube 6 can be reduced as compared with the case where the above-described central axes in first flat tube 6 and second flat tube 6 extend in different directions. Accordingly, the amount of refrigerant stored inside the recessed portion of header 1 can be reduced.

[0032] In the above-described heat exchanger 10, first flat tube 6 and second flat tube 6 are disposed to extend in the direction crossing the gravity direction, as shown in Figs. 1, 15, 16, and the like. In a view seen from first member 11a, the central axis along one end of first flat tube 6 and the central axis along one end of second flat tube 6 are inclined at angle θ to the horizontal direction perpendicular to the gravity direction, as shown in Fig. 15. As shown in Fig. 16, first flat tube 6 and second flat tube 6 are disposed to be inclined downward in the gravity direction toward the downstream in the flowing direction of fluid such as air indicated by arrow 40.

[0033] In this case, when dew condensation water adheres to the surfaces of first flat tube 6 and second flat tube 6, this dew condensation water can readily flow on the surfaces of first flat tube 6 and second flat tube 6. As a result, the drainage performance of heat exchanger 10 can be improved. In other words, the heat exchanger core having stacked fins 5 achieves an improvement in drainage performance for dew condensation water (condensed water) in the case where heat exchanger 10 is used as an evaporator, so that the performance of heat exchanger 10 is improved.

[0034] In the above-described heat exchanger 10, in a view seen from first member 11a, the central axis along one end of first flat tube 6 and the central axis along one end of second flat tube 6 are positioned to extend along the same straight line, as shown in Figs. 5, 8, 15, and the like. In this case, it becomes possible to minimize the occupancy area of first flat tube 6 and second flat tube 6 in a view seen from the upwind side in the fluid flowing direction as indicated by arrow 40. Accordingly, the resistance against the fluid in heat exchanger 10 can be reduced.

[0035] In the above-described heat exchanger 10, liquid header 7 and gas header 8 as other headers each including an inlet and an outlet for refrigerant are connected to the other ends of first flat tube 6 and second flat tube 6, respectively, on the opposite side of one ends thereof to which header 1 is connected, as shown in Fig. 1. In this case, for example, liquid header 7 including an inlet for refrigerant is connected to the other end of first flat tube 6 while gas header 8 including an outlet for refrigerant is connected to the other end of second flat tube 6, thereby allowing formation of a refrigerant path through which refrigerant flows from first flat tube 6 through header 1 to second flat tube 6.

[0036] Furthermore, for example, in a configuration in which a plurality of first flat tubes 6 are disposed in the direction perpendicular to the fluid flowing direction, that is, in the direction crossing the extending direction of each first flat tube 6, and for example, in the direction perpendicular to the surface of the sheet of paper showing Fig. 1, and in which a plurality of second flat tubes are disposed in the direction perpendicular to the fluid flowing direction, that is, in the direction crossing the extending direction of each second flat tube 6, and for example, in the direction perpendicular to the surface of the sheet of paper showing Fig. 1, a plurality of first flat tubes 6 and a plurality of second flat tubes 6 can be connected to liquid header 7 and gas header 8, respectively, as other headers. For the plurality of first flat tubes 6 and the plurality of second flat tubes 6, header 1 is configured so as to connect first flat tube 6 and second flat tube 6 arranged side by side in the fluid flowing direction indicated by arrow 40, as shown in Figs. 1, 2 and the like. For example, first member 11a is provided with a plurality of openings 4 for fixing the plurality of first flat tubes 6 and the plurality of second flat tubes 6. Furthermore, second member 12a is provided with a plurality of recessed portions extending in the fluid flowing direction. A plurality of recessed portions are provided at the positions facing the above-mentioned openings 4.

[0037] In the above-described heat exchanger 10, header 1 includes a crimping portion 3 configured to crimp first member 11a and second member 12a so as to be fixed. First member 11a is provided with first opening 4 and second opening 4. One end of first flat tube 6 is inserted into first opening 4. One end of second flat tube 6 is inserted into second opening 4. Header 1 further includes a brazing material 11b for connecting one ends of first flat tube 6 and second flat tube 6 to the surface of first member 11a.

[0038] In this case, first member 11a and second member 12a can be fixed by crimping portion 3. Thus, the configuration of header 1 can be simplified as compared with the case where separate members such as an adhesive and a fixing bolt are used. Also, the manufacturing cost can be reduced. Furthermore, when first member 11a of header 1 is joined by brazing material 11b to one ends of first flat tube 6 and second flat tube 6, leakage of the refrigerant through a connection portion between header 1 and each of first flat tube 6 and second flat tube 6 can be suppressed.

[0039] In the heat exchanger shown in Figs. 8 and 9, first member 11a is connected by brazing material 11b to each of first flat tube 6 and second flat tube 6 at position 6a that is distant from the end face of one end of each of first flat tube 6 and second flat tube 6. This can suppress entry of brazing material 11b into the flow path of flat tube 6 through the end face of one end of flat tube 6. Accordingly, it becomes possible to suppress occurrence of the problem that the refrigerant path inside each of first flat tube 6 and second flat tube 6 is clogged by brazing material 11b.

[0040] Furthermore, in the heat exchanger shown in Fig. 10, first member 11a is connected by the brazing material to each of first flat tube 6 and second flat tube 6 at position 6a that is distant from the end face of one end of each of first flat tube 6 and second flat tube 6. Thus, the same effect as that achieved by the heat exchanger shown in Figs. 8 and 9 described above can be achieved. Furthermore, first flat tube 6 and second flat tube 6 can be inserted into first opening 4 and second opening 4 along first side wall portion 11c and second side wall portion 11c, respectively, during assembly of header 1. Thus, the assembility of the header can be improved.

[0041] Furthermore, in the heat exchanger shown in Fig. 11, a part of the end face of one end of each of first flat tube 6 and second flat tube 6 is in contact with stepped portion 22 of second plate-shaped body 12. As a result, by inserting this one end of flat tube 6 into opening 4 until the one end comes into contact with stepped portion 22, first flat tube 6 and second flat tube 6 can be readily positioned relative to first opening 4 and second opening 4.

[0042] Furthermore, in the heat exchanger shown in Figs. 14 to 16, two openings 4 among flat-shaped openings 4 that are adjacent to each other on the upwind side and the downwind side are disposed such that their central axes extend in parallel or extend along the straight line. Thereby, the volume of refrigerant path 2 can be reduced.

Second Embodiment

<Configuration of Air Conditioning Apparatus>

[0043] Fig. 17 is a schematic diagram showing a refrigerant circuit of an air conditioning apparatus as an example of a refrigeration cycle apparatus according to the second embodiment of the present invention. The refrigerant circuit shown in Fig. 17 includes: a compressor 33; a first heat exchanger 34 acting as a condenser; a throttle device 35 acting as an expansion valve; a second heat exchanger 36 acting as an evaporator; and two blowers 37. Two blowers are driven by their respective blower motors 38. Two blowers 37 each blow gas (for example, air) against a corresponding one of first heat exchanger 34 and second heat exchanger 36. In the refrigerant circuit, refrigerant flows through compressor 33, first heat exchanger 34, throttle device 35, and second heat exchanger 36 sequentially in this order. In a different point of view, the air conditioning apparatus shown in Fig. 17 includes a refrigerant circuit through which refrigerant flow. The refrigerant circuit includes compressor 33, first heat exchanger 34, throttle device 35 as an expansion valve, and second heat exchanger 36.

[0044] At least one of first heat exchanger 34 and second heat exchangers 36 shown in Fig. 17 serves as heat exchanger 10 having been described in the first embodiment. The above-described blowers 37 blow gas on their respective heat exchangers, for example, along the direction indicated by arrow 40 in Fig. 2. In addition, by disposing a four-way valve and the like in the refrigerant circuit, the refrigerant flowing direction through first heat exchanger 34 and second heat exchanger 36 in the refrigerant circuit is reversed from the direction shown in Fig. 14, so that the first heat exchanger may act as an evaporator while the second heat exchanger may act as a condenser.

<Functions and Effects of Air Conditioning Apparatus>

[0045] Since the air conditioning apparatus according to the present disclosure is a heat exchanger according to the above-described first embodiment as a heat exchanger, the manufacturing cost is reduced. Furthermore, by applying the heat exchanger according to the above-described first embodiment, an air conditioning apparatus with enhanced energy efficiency can be implemented. In this case, the energy efficiency is represented by the following equations.

$$\text{Heating energy efficiency} = \text{indoor heat exchanger (condenser) performance} / \text{total input}$$

$$\text{Cooling energy efficiency} = \text{indoor heat exchanger (evaporator) performance} / \text{total input}$$

[0046] For the heat exchanger according to the above-described embodiment and the air conditioning apparatus employing this heat exchanger, refrigerant such as R410A, R32 and HFO1234yf may be used. The above-described effects can be achieved also in this case.

[0047] Furthermore, the example of air and refrigerant have been exemplified as a working fluid. However, the same effect is achieved also when other gas, liquid or gas-liquid mixed fluid is used as a working fluid. Furthermore, in the heat exchanger having been described in the above embodiments and the air conditioning apparatus employing this heat exchanger, the effect can be achieved also in the case where any type of refrigeration oil such as mineral oil base, alkylbenzene oil base, ester oil base, ether oil base, and fluorine oil base is used irrespective of whether refrigerant and oil are dissolved or not.

(Example of Specific Configuration of Heat Exchanger)

[0048] Fig. 18 is a schematic diagram for illustrating the size of a header of a heat exchanger according to an example of the present invention. In Fig. 18, for example, first member 11a has a thickness of 3.0 mm and second member 12a has a thickness of 2.0 mm. First member 11a and second member 12a each are made of an aluminum alloy. For example, A3003 defined in JIS (Japanese Industrial Standards) H4000 : 2006 can be used as an aluminum alloy. Furthermore, a brazing material formed of aluminum containing silicon can be used as a brazing material that is to be cladded to first member 11a or second member 12a. The content of silicon can be set at 8%, for example.

[0049] The inner circumferential surface of the recessed portion in the cross section in the lateral direction perpendicular to the extending direction of the recessed portion shown on the right side in Fig. 18 can be formed to have a radius of curvature of 3.5 mm. Furthermore, the width of the inner circumferential surface in the extending direction of the recessed portion can be set at 40 mm, for example. Also, the unit region joining first member 11a and second member 12a for forming one recessed portion can be sized to have a length of 52 mm and a width of 13.6 mm, for example.

[0050] Although the embodiments of the present invention have been described as above, the above-described embodiments can also be variously modified. Furthermore, the scope of the present invention is not limited to above-described embodiments. The scope of the present invention is defined by the terms of the claims, and is intended to include any modifications within the meaning and scope equivalent to the terms of the claims.

INDUSTRIAL APPLICABILITY

[0051] The present invention is applicable to a refrigeration cycle apparatus, a heat pump apparatus and the like such as an air conditioning apparatus, a refrigerating apparatus and a cooling apparatus.

REFERENCE SIGNS LIST

[0052] 1 header, 2 refrigerant path, 2a end, 3 crimping portion, 4 opening, 5 fin, 6 flat tube, 6a position, 7 liquid header, 8 gas header, 10 heat exchanger, 11 first plate-shaped body, 11a first member, 11b brazing material, 11c side wall portion, 12 second plate-shaped body, 12a second member, 22 stepped portion, 23 bottom portion, 30, 40 arrow, 33 compressor, 34 first heat exchanger, 35 throttle device, 36 second heat exchanger, 37 blower, 38 blower motor.

Claims

1. A heat exchanger comprising:

    a first flat tube and a second flat tube that extend in a direction crossing a flowing direction of a fluid, and that are arranged side by side in the flowing direction, refrigerant flowing through the first flat tube and the second flat tube; and
    a header configured to connect one end of the first flat tube and one end of the second flat tube,
    the header being formed of

        a first member to which the one end of the first flat tube and the one end of the second flat tube are fixed, and
        a second member connected so as to overlap with the first member, the second member being provided with a recessed portion extending from a position that the one end of the first flat tube faces to a position that the one end of the second flat tube faces.

2. The heat exchanger according to claim 1, wherein the recessed portion has an inner circumferential surface having a curved line portion in a cross section in a lateral direction crossing a direction extending from a position that the one end of the first flat tube faces to a position that the one end of the second flat tube faces.

3. The heat exchanger according to claim 1 or 2, wherein, in a view seen from the first member, an outer circumferential shape of an end of the recessed portion in an extending direction of the recessed portion has a curved portion.

4. The heat exchanger according to any one of claims 1 to 3, wherein a central axis along one end of the first flat tube and a central axis along one end of the second flat tube are in parallel with each other in a view seen from the first member.

5. The heat exchanger according to claim 4, wherein
the first flat tube and the second flat tube are disposed to extend in a direction crossing a gravity direction, and
the central axis along one end of the first flat tube and the central axis along one end of the second flat tube are inclined to a horizontal direction perpendicular to the gravity direction, in a view seen from the first member.

6. The heat exchanger according to claim 4 or 5, wherein the central axis along one end of the first flat tube and the central axis along one end of the second flat tube extend along a same straight line, in a view seen from the first member.

7. The heat exchanger according to any one of claims 1 to 6, wherein other headers each are connected to a corresponding one of the other ends opposite to the one end of the first flat tube and the one end of the second flat tube, and each of the other headers has an inlet and an outlet for refrigerant.

8. The heat exchanger according to any one of claims 1 to 7, wherein
the header comprises a crimping portion configured to crimp the first member and the second member so as to be fixed,
the first member is provided with a first opening and a second opening,
the one end of the first flat tube is inserted into the first opening,
the one end of the second flat tube is inserted into the second opening, and

the header further comprises a brazing material for connecting the one end of the first flat tube and the one end of the second flat tube to a surface of the first member.

9. The heat exchanger according to claim 8, wherein
the first opening is located at a leading end of a first side wall portion in the first member protruding from the second member toward the first flat tube,
the leading end of the first side wall portion is connected via the brazing material to a position that is distant from an end face of the one end of the first flat tube,
the second opening is located at a leading end of a second side wall portion in the first member protruding from the second member toward the second flat tube, and
the leading end of the second side wall portion is connected via the brazing material to a position that is distant from an end face of the one end of the second flat tube.

10. The heat exchanger according to claim 8, wherein
the first opening is located at a leading end of a first side wall portion in the first member protruding from the first flat tube toward the second member,
the leading end of the first side wall portion is connected via the brazing material to a position that is distant from an end face of the one end of the first flat tube,
the second opening is located at a leading end of a second side wall portion in the first member protruding from the second flat tube toward the second member, and
the leading end of the second side wall portion is connected via the brazing material to a position that is distant from an end face of the one end of the second flat tube.

11. A refrigeration cycle apparatus comprising a refrigerant circuit through which refrigerant circulates, the refrigerant circuit comprising a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger, wherein at least one of the first heat exchanger and the second heat exchanger is the heat exchanger according to any one of claims 1 to 10.

FIG.1

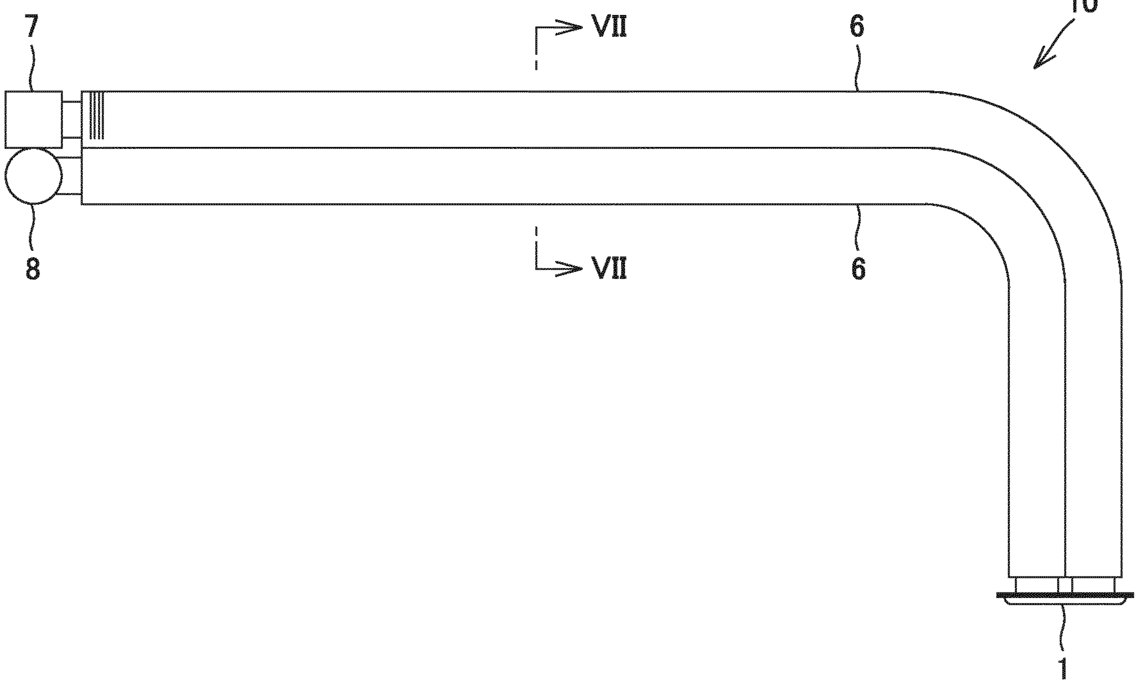


FIG.2

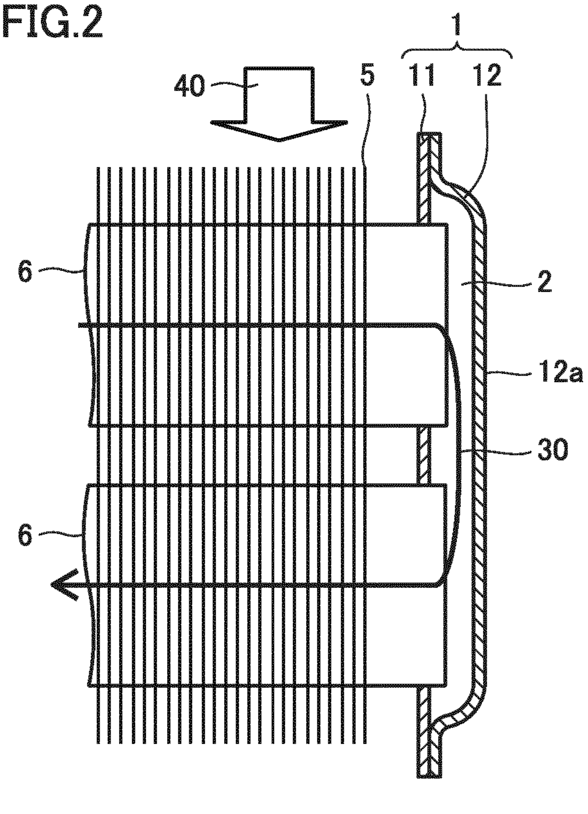


FIG.3

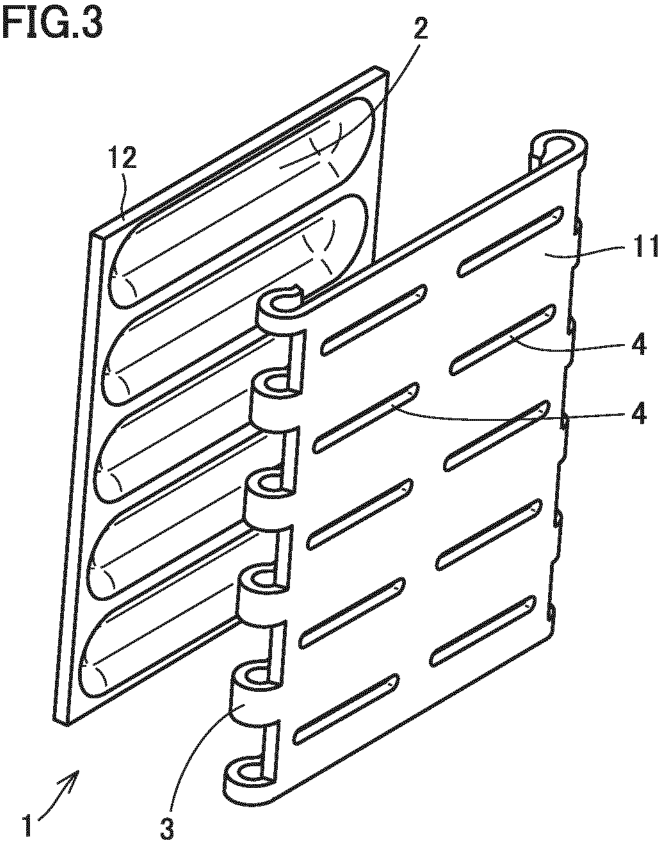


FIG.4

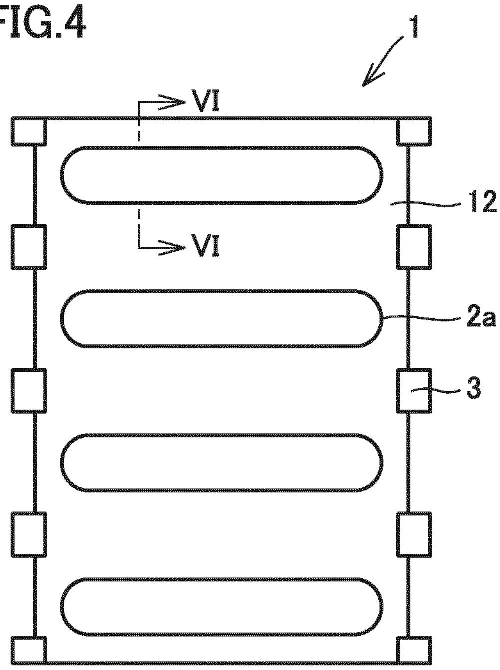


FIG.5

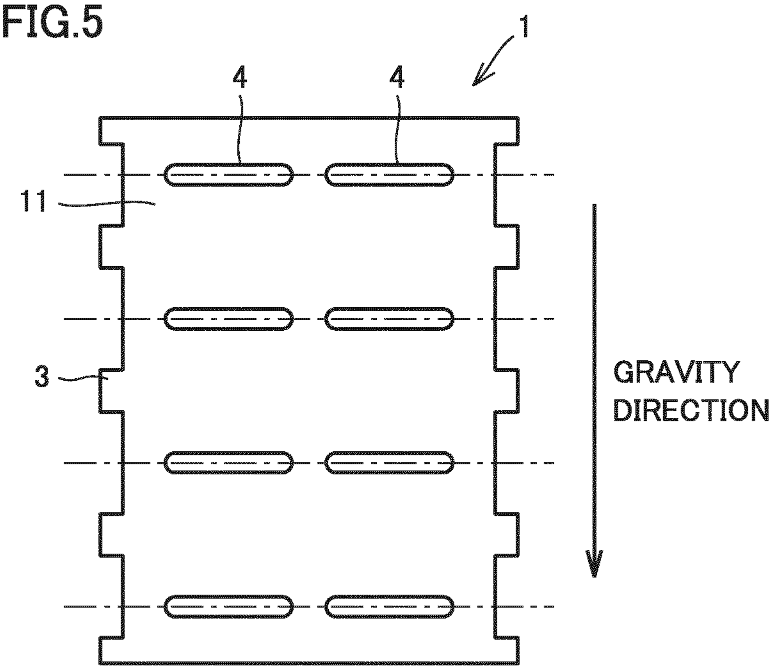


FIG.6

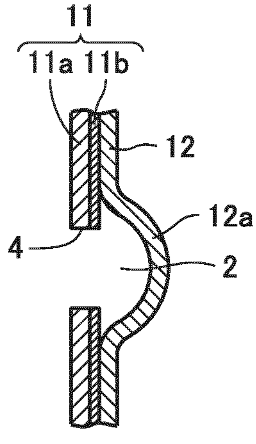


FIG.7

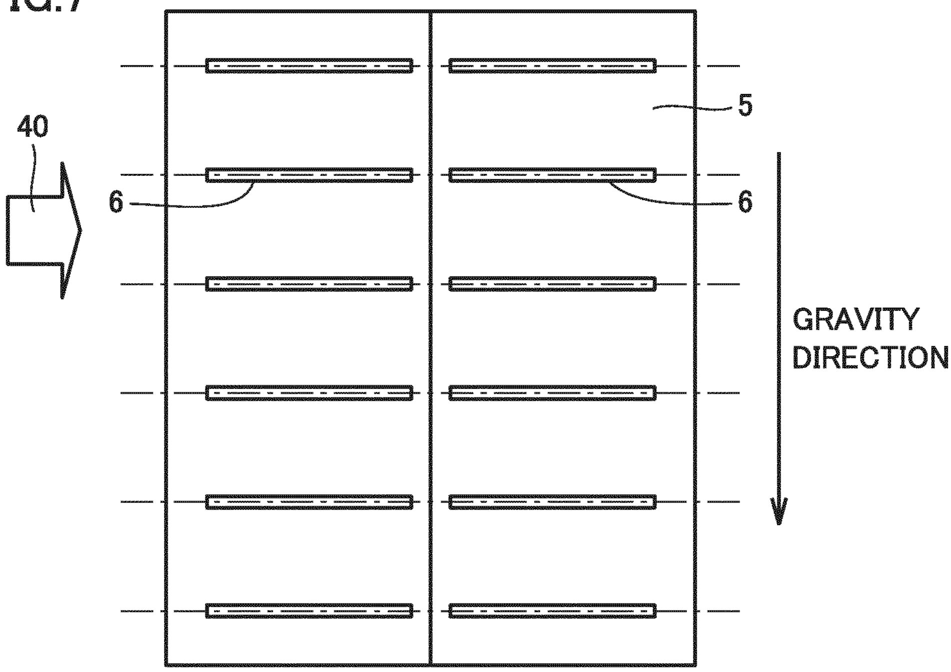


FIG.8

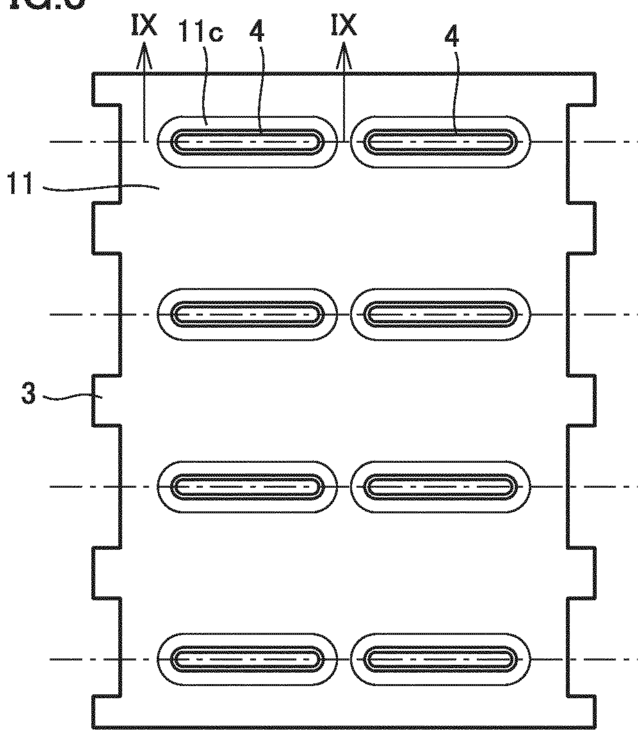


FIG.9

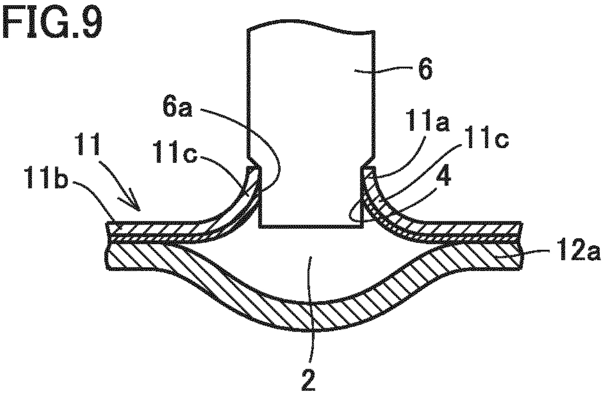


FIG.10

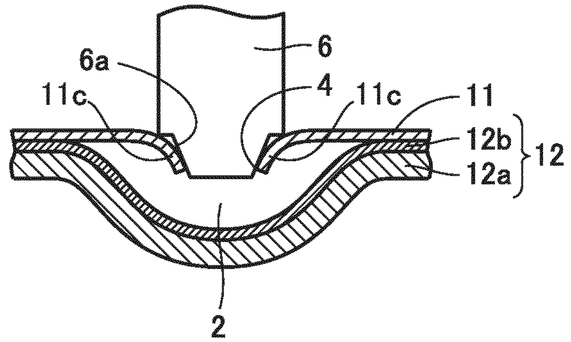


FIG.11

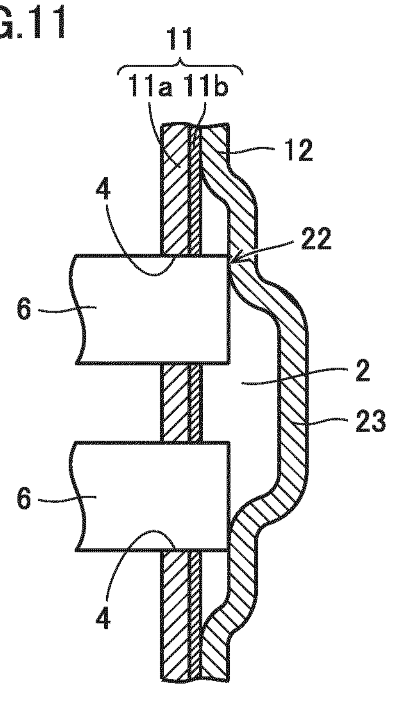


FIG.12

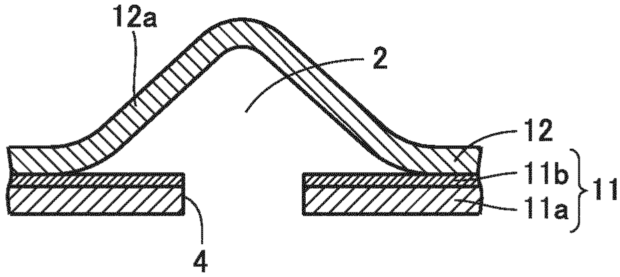


FIG.13

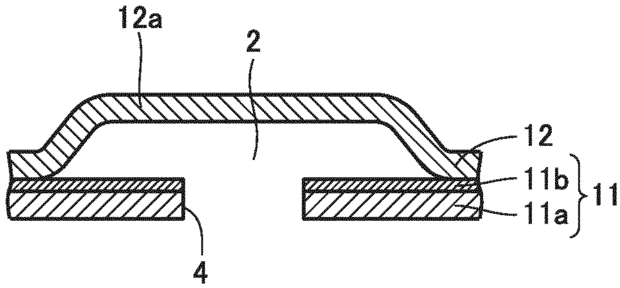


FIG.14

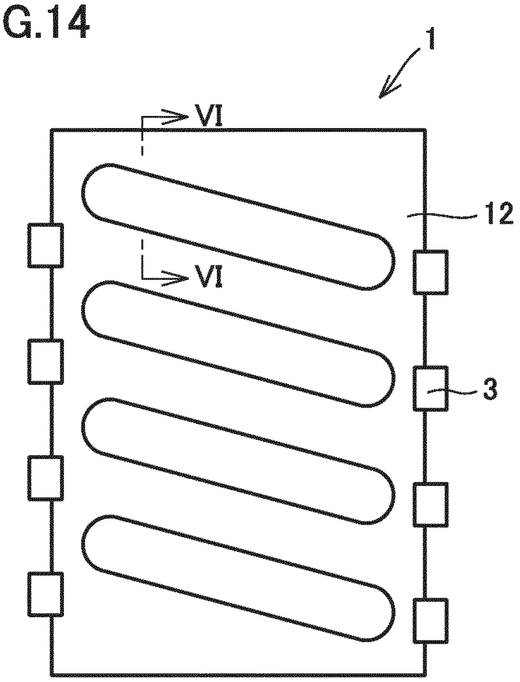


FIG.15

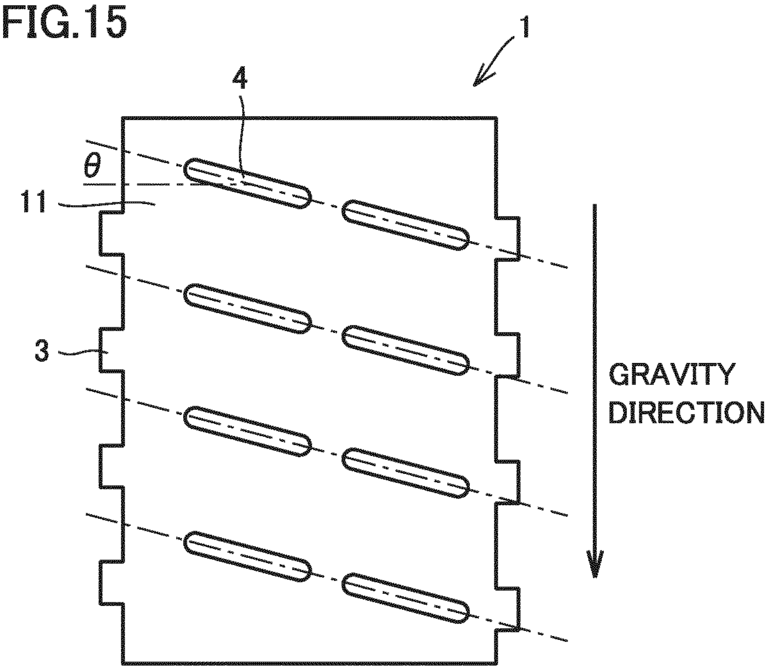


FIG.16

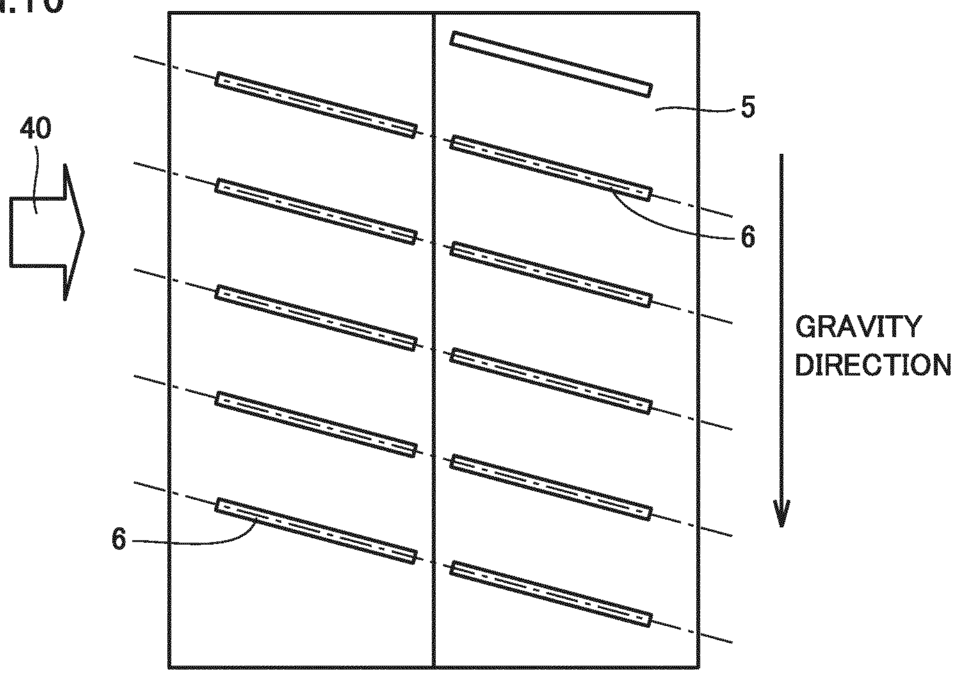


FIG.17

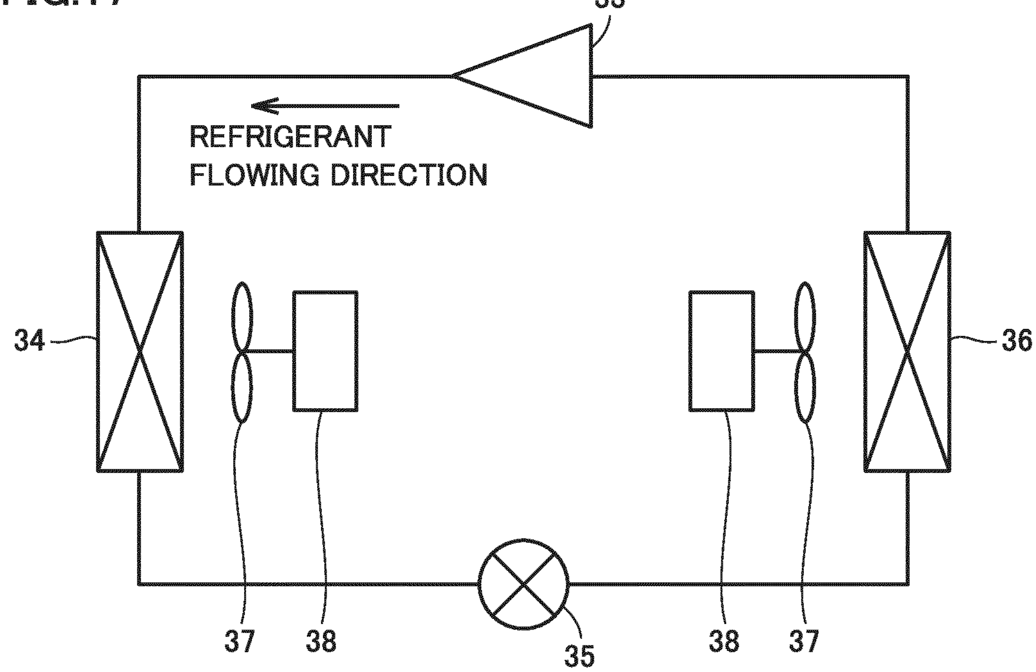
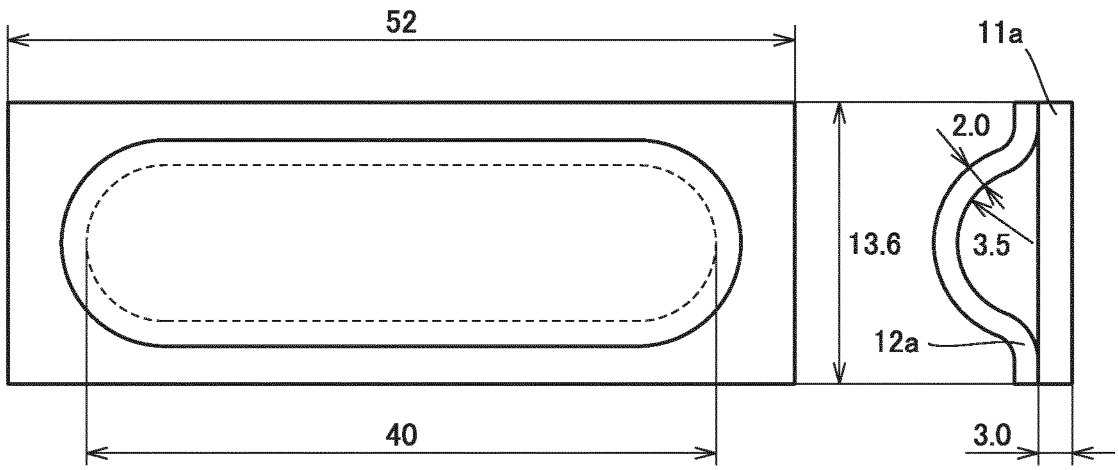


FIG.18



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/003401

A. CLASSIFICATION OF SUBJECT MATTER
F28F9/02(2006.01)i, *F25B39/00*(2006.01)i

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, F25B39/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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.
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Y	JP 2014-35122 A (Toshiba Corp.), 24 February 2014 (24.02.2014), paragraphs [0007] to [0013]; fig. 1 to 4 (Family: none)	5,8-11

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

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Date of the actual completion of the international search	Date of mailing of the international search report
10 April 2017 (10.04.17)	18 April 2017 (18.04.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/003401

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	JP 2010-96369 A (Denso Corp.), 30 April 2010 (30.04.2010), paragraphs [0023], [0037], [0041], [0045]; fig. 3 (Family: none)	8-11
Y	JP 2008-224057 A (Calsonic Kansei Corp.), 25 September 2008 (25.09.2008), paragraphs [0028] to [0029], [0034]; fig. 1 to 5, 8 (Family: none)	8-11
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 091323/1989(Laid-open No. 031068/1991) (Tokyo Radiator Mfg. Co., Ltd.), 26 March 1991 (26.03.1991), specification, page 4, line 7 to page 7, line 18; fig. 1 to 4 (Family: none)	10-11
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/003401

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2950092 A (CARRIER CORP.), 23 August 1960 (23.08.1960), entire text; all drawings (Family: none)	1-11

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REFERENCES CITED IN THE DESCRIPTION

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