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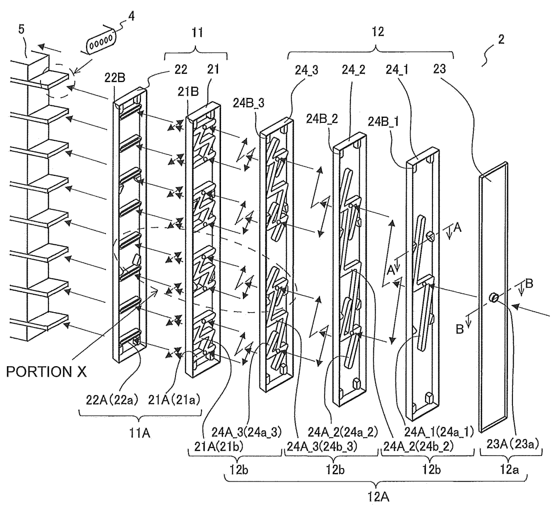
(54) ## STACKED HEADER, HEAT EXCHANGER, AND AIR CONDITIONING DEVICE

(57) A stacking-type header 2 according to the present invention includes a first plate-shaped unit 11 having a plurality of first outlet flow passages 11 A, a second plate-shaped unit 12 stacked on the first plate-shaped unit 11 and having a distribution flow passage 12A, the distribution flow passage 12A causing refrigerant entering from a first inlet flow passage 12a to be distributed and flow out to the first outlet flow passages 11A. The distribution flow passage 12A includes at least one branching flow passage 12b. The second plate-shaped unit 12 has at least one first plate-shaped member that has at least one first projection formed by press working. The branching flow passage 12b is formed as the inside of the first projection is closed in a region other than a region where refrigerant flows in and a region where refrigerant flows out.

F I G. 2



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Description

Technical Field

[0001] The present invention relates to a stacking-type header, a heat exchanger, and an air-conditioning apparatus.

Background Art

[0002] As an example of stacking-type headers according to related art, there is a stacking-type header including a first plate-shaped unit provided with a plurality of outlet flow passages, and a second plate-shaped unit stacked on the first plate-shaped unit and provided with a distribution flow passage that causes refrigerant entering from an inlet flow passage to be distributed and flow out to the outlet flow passages provided in the first plate-shaped unit. The distribution flow passage includes a branching flow passage with a plurality of grooves extending perpendicularly to the inflow direction of refrigerant. Refrigerant entering the branching flow passage from the inlet flow passage is divided into a plurality of branches while passing through the grooves, before flow outing through the outlet flow passages provided in the first plate-shaped unit (see, for example, Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2000-161818 (paragraphs [0012] to [0020], Figs. 1 and 2)

Summary of Invention

Technical Problem

[0004] With this type of stacking-type header, in order to reduce the thickness of plate-shaped members that make up the second plate-shaped unit to achieve reductions in parts cost, weight, and the like, it is necessary to reduce the cross-sectional area of the grooves. In that case, however, pressure loss of refrigerant passing through the grooves increases. That is, stacking-type headers according to related art have a problem in that it is difficult to achieve reductions in parts cost, weight, and the like while minimizing an increase in the pressure loss of refrigerant.

[0005] The present invention has been made in view of the above-mentioned problem. Accordingly, it is an object of the present invention to provide a stacking-type header that makes it possible to achieve reductions in parts cost, weight, and the like while minimizing an increase in the pressure loss of refrigerant. It is another object of the present invention to provide a heat exchanger including the stacking-type header. It is still another object of the present invention to provide an air-conditioning apparatus including the heat exchanger.

Solution to Problem

[0006] A stacking-type header according to the present invention includes a first plate-shaped unit having a plurality of first outlet flow passages, and a second plate-shaped unit stacked on the first plate-shaped unit, the second plate-shaped unit having a distribution flow passage, the distribution flow passage causing refrigerant entering from a first inlet flow passage to be distributed and flow out to the first outlet flow passages. The distribution flow passage includes at least one branching flow passage, the second plate-shaped unit has at least one first plate-shaped member, the first plate-shaped member having at least one first projection formed by press working, and the branching flow passage is formed as an inside of the first projection is closed in a region other than a region where the refrigerant flows in and a region where the refrigerant flows out. Advantageous Effects of Invention

[0007] In the stacking-type header according to the present invention, the distribution flow passage includes at least one branching flow passage, and the second plate-shaped unit has at least one first plate-shaped member having at least one first projection that is formed by press working, and the branching flow passage is formed as the inside of the first projection is closed in a region other than a region where refrigerant flows in and a region where refrigerant flows out. Therefore, even when the first plate-shaped member is reduced in thickness, a sufficient cross-sectional area of the branching flow passage can be secured, thereby making it possible to achieve reductions in parts cost, weight, and the like while minimizing an increase in the pressure loss of refrigerant. Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 illustrates the configuration of a heat exchanger according to Embodiment 1.

[Fig. 2] Fig. 2 is a perspective view, with a stacking-type header in an exploded state, of the heat exchanger according to Embodiment 1.

[Fig. 3] Fig. 3 is a cross-sectional view, with the stacking-type header in a stacked state, of the heat exchanger according to Embodiment 1.

[Fig. 4] Fig. 4 is a cross-sectional view, with the stacking-type header in a stacked state, of the heat exchanger according to Embodiment 1.

[Fig. 5] Fig. 5 is a perspective view and a cross-sectional view of main portions, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 1.

[Fig. 6] Fig. 6 is a perspective view and a cross-sectional view of main portions, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 1.

[Fig. 7] Fig. 7 is a development diagram of the stacking-type header of the heat exchanger according to Embodiment 1.

[Fig. 8] Fig. 8 illustrates the configuration of an air-conditioning apparatus to which the heat exchanger according to Embodiment 1 is applied.

[Fig. 9] Fig. 9 is a perspective view, with the stacking-type header in an exploded state, of Modification-1 of the heat exchanger according to Embodiment 1.

[Fig. 10] Fig. 10 is a cross-sectional view, with the stacking-type header in a stacked state, of Modification-1 of the heat exchanger according to Embodiment 1.

[Fig. 11] Fig. 11 is a development diagram of the stacking-type header of Modification-1 of the heat exchanger according to Embodiment 1.

[Fig. 12] Fig. 12 is a perspective view and a cross-sectional view of main portions, with the stacking-type header in an exploded state, of Modification-2 of the heat exchanger according to Embodiment 1.

[Fig. 13] Fig. 13 is a perspective view, with the stacking-type header in an exploded state, of Modification-3 of the heat exchanger according to Embodiment 1.

[Fig. 14] Fig. 14 is a perspective view, with the stacking-type header in an exploded state, of Modification-4 of the heat exchanger according to Embodiment 1.

[Fig. 15] Fig. 15 illustrates the configuration of a heat exchanger according to Embodiment 2.

[Fig. 16] Fig. 16 is a perspective view, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 2.

[Fig. 17] Fig. 17 is a development diagram of the stacking-type header of the heat exchanger according to Embodiment 2.

[Fig. 18] Fig. 18 illustrates the configuration of an air-conditioning apparatus to which the heat exchanger according to Embodiment 2 is applied.

[Fig. 19] Fig. 19 illustrates the configuration of a heat exchanger according to Embodiment 3.

[Fig. 20] Fig. 20 is a perspective view, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 3.

[Fig. 21] Fig. 21 is a development diagram of the stacking-type header of the heat exchanger according to Embodiment 3.

[Fig. 22] Fig. 22 illustrates the configuration of an air-conditioning apparatus to which the heat exchanger according to Embodiment 3 is applied. Description of Embodiments

[0009] Hereinafter, a stacking-type header according to the present invention will be described with reference to the drawings.

[0010] Although the following description is directed to a case in which the stacking-type header according to the present invention distributes refrigerant entering a heat exchanger, the stacking-type header according to the present invention may distribute refrigerant entering another apparatus. The configuration, operation, and the like described below are illustrative only, and not intended to limit the present invention to the specific configuration, operation, and the like described below. In the drawings, the same reference signs are used to identify the same or similar elements, or reference signs are omitted for those elements. Further, illustration of detailed structures in the drawings will be simplified or omitted as appropriate. Further, description of overlapping or similar features will be simplified or omitted as appropriate.

Embodiment 1

[0011] A heat exchanger according to Embodiment 1 will be described.

<Configuration of Heat Exchanger >

[0012] Hereinafter, the configuration of a heat exchanger according to Embodiment 1 will be described.

[0013] Fig. 1 illustrates the configuration of the heat exchanger according to Embodiment 1.

[0014] As illustrated in Fig. 1, a heat exchanger 1 has a stacking-type header 2, a header 3, a plurality of first heat transfer tubes 4, and a plurality of fins 5.

[0015] The stacking-type header 2 has a refrigerant inflow part 2A, and a plurality of refrigerant outflow parts 2B. The header 3 has a plurality of refrigerant inflow parts 3A, and a refrigerant outflow part 3B. A refrigerant pipe is connected to the refrigerant inflow part 2A of the stacking-type header 2 and the refrigerant outflow part 3B of the header 3. The first heat transfer tubes 4 are connected between the refrigerant outflow parts 2B of the stacking-type header 2 and the refrigerant inflow parts 3A of the header 3.

[0016] The first heat transfer tube 4 is a flat tube provided with a plurality of passages. The first heat transfer tube 4 is made of, for example, aluminum. The end portions at the stacking-type header 2 side of the first heat transfer tubes 4 are connected to the respective refrigerant outflow parts 2B of the stacking-type header 2. The end portions at the stacking-type header 2 side of the first heat transfer tubes 4 may be connected to the respective refrigerant outflow parts 2B of the stacking-type header 2 while being held by a plate-shaped holding member. The fins 5 are joined to the first heat transfer tube 4. The fin 5 is made of, for example, aluminum. The first heat transfer tube 4 and the fin 5 may be joined together by brazing. While Fig. 1 depicts a case in which there are eight first heat transfer tubes 4, the present invention is not limited to this case. Further, the present invention is not limited to a case in which the first heat transfer tube 4 is a flat tube.

<Flow of Refrigerant in Heat Exchanger>

[0017] Hereinafter, flow of refrigerant in the heat exchanger according to Embodiment 1 will be described.

[0018] Refrigerant flowing through the refrigerant pipe flows in the stacking-type header 2 via the refrigerant inflow part 2A, and after being distributed in the stacking-type header 2, the distributed refrigerant flows out to the first heat transfer tubes 4 via the refrigerant outflow parts 2B. In the first heat transfer tubes 4, the refrigerant exchanges heat with air or the like supplied by a fan, for example. The refrigerant flowing through each of the first heat transfer tubes 4 flows in the header 3 via the refrigerant inflow parts 3A, and after merging in the header 3, the merged refrigerant flows out to the refrigerant pipe via the refrigerant outflow part 3B. Refrigerant flow can be reversed.

<Configuration of Stacked Header>

[0019] Hereinafter, the configuration of the stacking-type header of the heat exchanger according to Embodiment 1 will be described.

[0020] Fig. 2 is a perspective view, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 1.

[0021] As illustrated in Fig. 2, the stacking-type header 2 has a first plate-shaped unit 11, and a second plate-shaped unit 12. The first plate-shaped unit 11 and the second plate-shaped unit 12 are stacked together.

[0022] The first plate-shaped unit 11 is stacked on the refrigerant outflow side toward which refrigerant flows out. The first plate-shaped unit 11 has a first plate-shaped member 21, and a second plate-shaped member 22. The first plate-shaped unit 11 is provided with a plurality of first outlet flow passages 11 A. The first outlet flow passages 11A correspond to the refrigerant outflow parts 2B in Fig. 1.

[0023] The second plate-shaped unit 12 is stacked on the refrigerant inflow side from which refrigerant flows in. The second plate-shaped unit 12 has a third plate-shaped member 23, and a plurality of fourth plate-shaped members 24_1 to 24_3. The second plate-shaped unit 12 is provided with a distribution flow passage 12A. The distribution flow passage 12A has a first inlet flow passage 12a, and a plurality of branching flow passages 12b. The first inlet flow passage 12a corresponds to the refrigerant inflow part 2A in Fig. 1.

[0024] The first plate-shaped member 21 has a first projection 21A and a second projection 21 B. The first projection 21 A and the second projection 21 B are formed by press working such as drawing or bending, and project toward the refrigerant inflow side. The first projection 21A has a bottom. In a state in which the first plate-shaped member 21 is stacked, a part of an inner face 21 a of the first projection 21 A serves as a part of the first outlet passage 11 A, and a part of an outer face 21 b of the first projection 21A serves as a part of the branching flow passage 12b. The second projection 21 B has a bottom, and in a state in which the first plate-shaped member 21 is stacked, the second projection 21 B serves as a joint reinforcement. The first plate-shaped member 21 is made of, for example, aluminum.

[0025] The second plate-shaped member 22 has a first projection 22A and a second projection 22B. The first projection 22A and the second projection 22B are formed by press working such as drawing or bending, and project toward the refrigerant inflow side. The first projection 22A has a bottom being void. In a state in which the second plate-shaped member 22 is stacked, an inner face 22a of the first projection 22A serves as a joint with the first heat transfer tube 4. The second projection 22B has a bottom, and in a state in which the second plate-shaped member 22 is stacked, the second projection 22B serves as a joint reinforcement. The second plate-shaped member 22 is made of, for example, aluminum.

[0026] The inner face 21 a of the first projection 21 A of the first plate-shaped member 21, and the inner face 22a of the first projection 22A of the second plate-shaped member 22 each have a shape that conforms to the outer peripheral surface of the first heat transfer tube 4. The outer peripheral surface of the first heat transfer tube 4 is joined to the inner face 22a of the first projection 22A of the second plate-shaped member 22 by, for example, brazing or adhesion. The bottom portion of the first projection 21 A of the first plate-shaped member 21, and an end face of the first heat transfer tube 4 have a gap therebetween when in a joined state.

[0027] The third plate-shaped member 23 has a first projection 23A. The first projection 23A is formed by press working such as drawing or bending, and projects toward the refrigerant inflow side. The first projection 23A has a bottom being void. In a state in which the third plate-shaped member 23 is stacked, an inner face 23a of the first projection 23A serves as the first inlet flow passage 12a. The third plate-shaped member 23 is made of, for example, aluminum.

[0028] The inner face 23a of the first projection 23A of the third plate-shaped member 23 has a shape that conforms to the outer peripheral surface of the refrigerant pipe. The outer peripheral surface of the refrigerant pipe is joined to the inner face 23a of the first projection 23A of the third plate-shaped member 23 by, for example, brazing or adhesion. A metal sleeve or the like may be attached to the outer face of the first projection 23A of the third plate-shaped member 23, and the refrigerant pipe may be connected via the metal sleeve or the like.

[0029] The fourth plate-shaped members 24_1 to 24_3 have first projections 24A_1 to 24A_3 and second projections 24B_1 to 24B_3, respectively. The first projections 24A_1 to 24A_3 and the second projections 24B_1 to 24B_3 are formed by press working such as drawing or bending, and project toward the refrigerant inflow side. The first projection 24A_1 of the fourth plate-shaped member 24_1 has a bottom. In a state in which the fourth plate-shaped member 24_1 is stacked, an inner face 24a_1 of the first projection 24A_1 serves as a part of the branching flow passage 12b. The first projections 24A_2 and 24A_3 of the fourth plate-shaped members

24_2 and 24_3 have a bottom. In a state in which the fourth plate-shaped members 24_2 and 24_3 are stacked, inner faces 24a_2 and 24a_3 and outer faces 24b_2 and 24b_3 of the first projections 24A_2 and 24A_3 serve as a part of the branching flow passage 12b, respectively. The second projections 24B_1 to 24B_3 have a bottom. In a state in which the fourth plate-shaped members 24_1 to 24_3 are stacked, the second projections 24B_1 to 24B_3 serve as a joint reinforcement. The fourth plate-shaped members 24_1 to 24_3 are made of, for example, aluminum.

[0030] Hereinafter, the fourth plate-shaped members 24_1 to 24_3 will be sometimes generically referred to as fourth plate-shaped member 24. Hereinafter, the first projections 24A_1 to 24A_3 of the fourth plate-shaped member 24 will be sometimes generically referred to as first projection 24A. The inner faces 24a_1 to 24a_3 of the first projection 24A of the fourth plate-shaped member 24 will be sometimes generically referred to as inner face 24a. The outer faces 24b_1 to 24b_3 of the first projection 24A of the fourth plate-shaped member 24 will be sometimes generically referred to as outer face 24b. The second projections 24B_1 to 24B_3 of the fourth plate-shaped member 24 will be sometimes generically referred to as second projection 24B. Hereinafter, the first plate-shaped member 21, the second plate-shaped member 22, the third plate-shaped member 23, and the fourth plate-shaped member 24 will be sometimes generically referred to as plate-shaped member. The fourth plate-shaped member 24 corresponds to "first plate-shaped member" according to the present invention.

[0031] Figs. 3 and 4 are each a cross-sectional view, with the stacking-type header in a stacked state, of the heat exchanger according to Embodiment 1. Fig. 3 is a cross-sectional view taken along a line A-A in Fig. 2, and Fig. 4 is a cross-sectional view taken along a line B-B in Fig. 2. In Figs. 3 and 4, the portion where refrigerant flows in is shaded.

[0032] As illustrated in Figs. 3 and 4, the peripheral edge of the plate-shaped member is bent in the stacking direction, and the distal end of the peripheral edge is joined to the side face of the plate-shaped member that is adjacently stacked on the refrigerant inflow side.

[0033] The inner face 24a of the first projection 24A provided in the fourth plate-shaped member 24, and the outer face 24b or 21 b of the first projection 24A or 21A provided in the fourth plate-shaped member 24 or the first plate-shaped member 21 adjacently stacked on the refrigerant outflow side, are joined while being in fitting engagement with each other, thus forming each of the branching flow passages 12b.

[0034] The inner face of the second projection 21 B or 24B provided in the first plate-shaped member 21 or the fourth plate-shaped member 24, and the outer face of the second projection 22B, 21 B, or 24B of the second plate-shaped member 22, the first plate-shaped member 21, or the fourth plate-shaped member 24 adjacently stacked on the refrigerant outflow side, are joined while being in fitting engagement with each other, thus forming a reinforcement. The outer face of the second projection 24B_1 of the fourth plate-shaped member 24_1 is joined to the surface of the third plate-shaped member 23.

[0035] Figs. 5 and 6 are each a perspective view and a cross-sectional view of main portions, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 1. Figs. 5 and 6 are each a perspective view of the portion X in Fig. 2 and a cross-sectional view. Fig. 5(b) is a cross-sectional view taken along a line C-C in Fig. 5(a), and Fig. 6(b) is a cross-sectional view taken along a line D-D in Fig. 6(a). In Figs. 5(b) and 6(b), the portion where refrigerant flows in is shaded. While the following description is directed to the branching flow passage 12b formed by the inner face 24a_3 of the first projection 24A_3 of the fourth plate-shaped member 24_3 and the outer face 21 b of the first projection 21 A of the first plate-shaped member 21, the same applies to the other branching flow passages 12b.

[0036] As illustrated in Fig. 5, the inner face of a Z-shaped region (hereinafter, a Z-shaped region of the plate-shaped member located on the refrigerant inflow side will be generically referred to as inflow-side Z-shaped region 12b_1 a) of the first projection 24A_3 of the fourth plate-shaped member 24_3 (hereinafter, the inner face of the inflow-side Z-shaped region 12b_1 a will be generically referred to as inner face 12b_1 b), and the outer face of a Z-shaped region (hereinafter, a Z-shaped region of the plate-shaped member located on the refrigerant outflow side will be generically referred to as outflow-side Z-shaped region 12b_2a) of the first projection 21 A of the first plate-shaped member 21 (hereinafter, the outer face of the outflow-side Z-shaped region 12b_2a will be generically referred to as outer face 12b_2b), are joined while being in fitting engagement with each other, thus forming the branching flow passage 12b.

[0037] The inflow-side Z-shaped region 12b_1a has such a shape that connects two end portions 12b_1c and 12b_1d via a linear portion 12b_1e that is perpendicular to the direction of gravity. The inflow-side Z-shaped region 12b_1a has a through-hole 12b_1f provided at the center. Respective peripheral portions 12b_1h and 12b_1i of the two end portions 12b_1c and 12b_1d of the inflow-side Z-shaped region 12b_1a on the surface of the fourth plate-shaped member 24_3 project toward the refrigerant outflow side.

[0038] The outflow-side Z-shaped region 12b_2a has such a shape that connects two end portions 12b_2c and 12b_2d via a linear portion 12b_2e that is perpendicular to the direction of gravity. The two end portions 12b_2c and 12b_2d of the outflow-side Z-shaped region 12b_2a are provided with through-holes 12b_2f and 12b_2g, respectively. Respective peripheral portions 12b_2h and 12b_2i of the two end portions 12b_2c and 12b_2d of the outflow-side Z-shaped region 12b_2a on the first projection 21 A of the first plate-shaped member 21 project toward the refrigerant outflow side.

[0039] The peripheral portion 12b_1h or

12b_1projecting toward the refrigerant outflow side, and the peripheral portion 12b_2h or 12b_2i recessed toward the refrigerant outflow side are joined while being in fitting engagement with each other. Consequently, the refrigerant entering through the through-hole 12b_1f and divided into two branches passes between the inner face 12b_1b of the inflow-side Z-shaped region 12b_1a and the outer face 12b_2b of the outflow-side Z-shaped region 12b_2a without leaking, and flows out from the through-hole 12b_2f or 12b_2g.

[0040] A protrusion 12b_2j is provided below the center of the outflow-side Z-shaped region 12b_2a in Figs. 5 and 6. The protrusion 12b_2j is joined while being in fitting engagement with a part of the inner face of the outflow-side Z-shaped region 12b_2a of another branching flow passage 12b adjacently located on the refrigerant outflow side, which communicates with a part located below the center of the inflow-side Z-shaped region 12b_1a in Figs. 5 and 6. The protrusion 12b_2j prevents refrigerant entering through the through-hole 12b_1f from leaking from the branching flow passage 12b by passing through the inner face of the outflow-side Z-shaped region 12b_2a of another branching flow passage 12b adjacently located on the refrigerant outflow side. The inner face of the outflow-side Z-shaped region 12b_2a of another branching flow passage 12b adjacently located on the refrigerant outflow side may be closed by another method.

[0041] As illustrated in Fig. 6, the peripheral portions 12b_1h and 12b_1that project toward the refrigerant outflow side may be recessed toward the refrigerant inflow side, and the peripheral portions 12b_2h and 12b_2i recessed toward the refrigerant outflow side may project toward the refrigerant inflow side. In that case as well, as the peripheral portion 12b_1h or 12b_1 projecting toward the refrigerant inflow side, and the peripheral portion 12b_2h or 12b_2i recessed toward the refrigerant inflow side, are joined while being in fitting engagement with each other, the refrigerant entering through the through-hole 12b_1f and divided into two branches passes between the inner face 12b_1b of the inflow-side Z-shaped region 12b_1a and the outer face 12b_2b of the outflow-side Z-shaped region 12b_2a without leaking, and flows out from the through-holes 12b_2f or 12b_2g.

[0042] That is, the branching flow passage 12b divides entering refrigerant into two branches that flow out the branching flow passage 12b. Accordingly, if there are eight first heat transfer tubes 4 to be connected, a minimum of three fourth plate-shaped members 24 are required. If there are sixteen first heat transfer tubes 4 to be connected, a minimum of four fourth plate-shaped members 24 are required. The number of first heat transfer tubes 4 to be connected is not limited to a power of 2. In such a case, a combination of the branching flow passages 12b and non-branching flow passages may be used. The number of first heat transfer tubes 4 to be connected may be two.

[0043] To divide entering refrigerant into branches flow outing at different heights, the end portion 12b_1c of the inflow-side Z-shaped region 12b_1a and the end portion 12b_2c of the outflow-side Z-shaped region 12b_2a are located at different heights from the end portion 12b_1d of the inflow-side Z-shaped region 12b_1a and the end portion 12b_2d of the outflow-side Z-shaped region 12b_2a, respectively. In particular, if one of the two end portions is located on the upper side in comparison to the linear portion 12b_1e of the inflow-side Z-shaped region 12b_1a and the linear portion 12b_2e of the outflow-side Z-shaped region 12b_2a, and the other is located on the lower side in comparison to the linear portion 12b_1e of the inflow-side Z-shaped region 12b_1a and the linear portion 12b_2e of the outflow-side Z-shaped region 12b_2a, imbalance of the distances along the branching flow passage 12b from the through-hole 12b_1f to the through-hole 12b_2f and to the through-hole 12b_2g can be reduced without increasing geometric complflow outy. The straight line connecting the through-hole 12b_2f and the through-hole 12b_2g extends in parallel to the longitudinal direction of the plate-shaped member. This makes it possible to reduce the size of the plate-shaped member in the transverse direction, thus reducing parts cost, weight, and the like. Further, the straight line connecting the through-hole 12b_2f and the through-hole 12b_2g extends in parallel to the arrangement direction of the first heat transfer tubes 4, which allows space saving for the heat exchanger 1.

[0044] The stacking-type header 2 is not limited to one in which the first outlet flow passages 11A are arranged along the direction of gravity. For example, the stacking-type header 2 may be also used for applications in which the heat exchanger 1 is disposed in a slanted orientation, as in the case of a heat exchanger in wall-mounted room air-conditioner's indoor units, outdoor units for air-conditioning apparatuses, and chiller outdoor units. In that case, the inflow-side Z-shaped region 12b_1a and the outflow-side Z-shaped region 12b_2a may have such a shape that the linear portion 12b_1e and the linear portion 12b_2e are not perpendicular to the longitudinal direction of the plate-shaped member, respectively.

[0045] Further, the branching flow passage 12b may have another shape. That is, the branching flow passage 12b may not be Z-shaped. For example, the inflow-side Z-shaped region 12b_1a and the outflow-side Z-shaped region 12b_2a may not have the linear portion 12b_1e and the linear portion 12b_2e, respectively. If the linear portion 12b_1e and the linear portion 12b_2e are present, this reduces the influence of gravity when refrigerant flows in from the through-hole 12b_1f and splits into two branches. That is, irrespective of the flow rate and quality of the refrigerant entering in a two-phase gas-liquid state, the influence of gravity is reduced. Consequently, the flow rate and quality of refrigerant entering each of the first heat transfer tubes 4 can be made uniform. Further, for example, the inflow-side Z-shaped region 12b_1a and the outflow-side Z-shaped region 12b_2a may have a shape that branches out. If the inflow-side Z-shaped region 12b_1a and the outflow-side Z-shaped region 12b_2a do not branch out, the uniformity of refrigerant distribution can be improved.

[0046] The plate-shaped members may be stacked together by brazing. Stacking the plate-shaped members together by brazing allows the plate-shaped members to be stacked without any gap therebetween, thus minimizing leakage of refrigerant and also ensuring pressure tightness. If the plate-shaped members are brazed together while applying pressure, brazing failures are further reduced. If a process that promotes fillet formation, such as forming ribs, is applied to areas susceptible to refrigerant leakages, brazing failures are further reduced.

[0047] Further, if all of the members to be brazed together, including the first heat transfer tube 4 and the fin 5, are made of the same material (for example, aluminum), these members can be brazed together at once, thus improving productivity. Brazing of the first heat transfer tube 4 and the fin 5 may be performed after brazing of the stacking-type header 2. Further, first, only the first plate-shaped unit 11 may be joined to the first heat transfer tube 4 by brazing, and then the second plate-shaped unit 12 may be joined to the first heat transfer tube 4 by brazing.

<Flow of Refrigerant in Stacked Header>

[0048] Hereinafter, flow of refrigerant in the stacking-type header of the heat exchanger according to Embodiment 1 will be described.

[0049] Fig. 7 is a development diagram of the stacking-type header of the heat exchanger according to Embodiment 1.

[0050] As indicated by arrows in Figs. 2 and 7, the refrigerant that has passed through the first projection 23A of the third plate-shaped member 23 passes through the through-hole provided in the first projection 24A_1 of the fourth plate-shaped member 24_1, that is, the through-hole 12b_1f of the inflow-side Z-shaped region 12b_1a, and flows in the inside of the first projection 24A_1 of the fourth plate-shaped member 24_1. The refrigerant hits the projection of a member stacked adjacent thereto, and splits into two branches. The branched refrigerant passes between the inner face 12b_1b of the inflow-side Z-shaped region 12b_1a and the outer face 12b_2b of the outflow-side Z-shaped region 12b_2a, and then passes through the through-holes provided in the first projection 24A_2 of the fourth plate-shaped member 24_2, that is, the through-holes 12b_2f and 12b_2b of the outflow-side Z-shaped region 12b_2a.

[0051] The refrigerant that has passed through the through-hole provided in the first projection 24A_2 of the fourth plate-shaped member 24_2, that is, the through-hole 12b_1f of the inflow-side Z-shaped region 12b_1a of the adjacent branching flow passage 12b, flows in the inside of the first projection 24A_2 provided in the fourth plate-shaped member 24_2. The refrigerant hits the projection of a member stacked adjacent thereto, and splits into two branches. The branched refrigerant passes between the inner face 12b_1b of the inflow-side Z-shaped region 12b_1a and the outer face 12b_2b of the outflow-side Z-shaped region 12b_2a, and then passes through the through-holes provided in the first projection 24A_3 of the fourth plate-shaped member 24_3, that is, the through-holes 12b_2f and 12b_2b of the outflow-side Z-shaped region 12b_2a.

[0052] The refrigerant that has passed through the through-hole provided in the first projection 24A_3 of the fourth plate-shaped member 24_3, that is, the through-hole 12b_1f of the inflow-side Z-shaped region 12b_1a of the adjacent branching flow passage 12b, flows in the inside of the first projection 24A_3 provided in the fourth plate-shaped member 24_3. The refrigerant hits the projection of a member stacked adjacent thereto, and splits into two branches. The branched refrigerant passes between the inner face 12b_1b of the inflow-side Z-shaped region 12b_1a and the outer face 12b_2b of the outflow-side Z-shaped region 12b_2a, and then passes through the through-holes provided in the first projection 21 A of the first plate-shaped member 21, that is, the through-holes 12b_2f and 12b_2b of the outflow-side Z-shaped region 12b_2a.

[0053] The refrigerant that has passed through the through-holes provided in the first projection 21A of the first plate-shaped member 21 passes through the first projection 22A of the second plate-shaped member 22, and flows in the first heat transfer tube 4.

<Use of Heat Exchanger>

[0054] Hereinafter, an example of use of the heat exchanger according to Embodiment 1 will be described.

[0055] While the following description is directed to a case in which the heat exchanger according to Embodiment 1 is used in an air-conditioning apparatus, the present invention is not limited to such a case. For example, the heat exchanger according to Embodiment 1 may be used in other refrigeration cycle devices having a refrigerant circuit. Further, while the following description is directed to a case in which the air-conditioning apparatus switches between cooling operation and heating operation, the present invention is not limited to such a case. The air-conditioning apparatus may perform only cooling operation or heating operation.

[0056] Fig. 8 illustrates the configuration of an air-conditioning apparatus to which the heat exchanger according to Embodiment 1 is applied. In Fig. 8, flow of refrigerant in cooling operation is indicated by solid arrows, and flow of refrigerant in heating operation is indicated by dotted arrows.

[0057] As illustrated in Fig. 8, an air-conditioning apparatus 51 includes a compressor 52, a four-way valve 53, a heat source-side heat exchanger 54, an expansion device 55, a load-side heat exchanger 56, a heat source-side fan 57, a load-side fan 58, and a controller 59. The compressor 52, the four-way valve 53, the heat source-side heat exchanger 54, the expansion device 55, and the load-side heat exchanger 56 are connected by the refrigerant pipe to form a refrigerant circuit.

[0058] The controller 59 is connected with, for example, the compressor 52, the four-way valve 53, the expansion device 55, the heat source-side fan 57, the load-side fan 58, and various sensors. The controller 59 switches the flow passages of the four-way valve 53 to switch between cooling operation and heating operation. The heat source-side heat exchanger 54 acts as a condenser in cooling operation, and acts as an evaporator in heating operation. The load-side heat exchanger 56 acts as an evaporator in cooling operation, and acts as a condenser in heating operation.

[0059] Flow of refrigerant in cooling operation will be described.

[0060] Refrigerant at high pressure and high temperature in a gaseous state discharged from the compressor 52 flows in the heat source-side heat exchanger 54 via the four-way valve 53, where the refrigerant exchanges heat with the outside air supplied by the heat source-side fan 57, causing the refrigerant to condense into refrigerant at high pressure in a liquid state, which then flows out the heat source-side heat exchanger 54. The refrigerant at high pressure in a liquid state that has flow outed the heat source-side heat exchanger 54 flows in the expansion device 55, where the refrigerant turns into refrigerant at low pressure in a two-phase gas-liquid state. The refrigerant at low pressure in a two-phase gas-liquid state flow outing the expansion device 55 flows in the load-side heat exchanger 56, where the refrigerant exchanges heat with the indoor air supplied by the load-side fan 58, causing the refrigerant to evaporate into refrigerant at low pressure in a gaseous state, which then flows out the load-side heat exchanger 56. The refrigerant at low pressure in a gaseous state flow outing the load-side heat exchanger 56 is sucked by the compressor 52 via the four-way valve 53.

[0061] Flow of refrigerant in heating operation will be described.

[0062] Refrigerant at high pressure and high temperature in a gaseous state discharged from the compressor 52 flows in the load-side heat exchanger 56 via the four-way valve 53, where the refrigerant exchanges heat with the indoor air supplied by the load-side fan 58 which causes the refrigerant to condense into refrigerant at high pressure in a liquid state, which then flows out the load-side heat exchanger 56. The refrigerant at high pressure in a liquid state that has flow outed the load-side heat exchanger 56 flows in the expansion device 55, where the refrigerant turns into refrigerant at low pressure in a two-phase gas-liquid. The refrigerant at low pressure in a two-phase gas-liquid flow outing the expansion device 55 flows in the heat source-side heat exchanger 54 where the refrigerant exchanges heat with the outside air supplied by the heat source-side fan 57, causing the refrigerant to condense into refrigerant at low pressure in a gaseous state, which then flows out the heat source-side heat exchanger 54. The refrigerant at low pressure in a gaseous state flow outing the heat source-side heat exchanger 54 is sucked by the compressor 52 via the four-way valve 53.

[0063] The heat exchanger 1 is used in at least one of the heat source-side heat exchanger 54 and the load-side heat exchanger 56. The heat exchanger 1 is connected in such a way that when the heat exchanger 1 acts as an evaporator, refrigerant flows in from the stacking-type header 2, and refrigerant flows out from the header 3. That is, when the heat exchanger 1 acts as an evaporator, refrigerant in a two-phase gas-liquid state flows in the stacking-type header 2 from the refrigerant pipe, and refrigerant in a gaseous state flows in the header 3 from the first heat transfer tube 4. When the heat exchanger 1 acts as a condenser, refrigerant in a gaseous state flows in the header 3 from the refrigerant pipe, and refrigerant in a liquid state flows in the stacking-type header 2 from the first heat transfer tube 4.

<Operation of Heat Exchanger>

[0064] Hereinafter, operation of the heat exchanger according to Embodiment 1 will be described.

[0065] The branching flow passage 12b of the stacking-type header 2 is formed by the inner face 12b_1b of the inflow-side Z-shaped region 12b_1 a, that is, the inner face of the first projection of the plate-shaped member, and the outer face 12b_2b of the outflow-side Z-shaped region 12b_2a, that is, the outer face of the first projection of another plate-shaped member. This makes it possible to ensure a sufficient cross-sectional area of the branching flow passage 12b even when the plate-shaped member is reduced in thickness, thereby achieving reductions in parts cost, weight, and the like while minimizing an increase in the pressure loss of refrigerant.

[0066] The reduced thickness of the plate-shaped member enables a reduction in thermal capacity, which leads to shorter time required for heating and cooling performed during joining processes such as brazing, thus improving production efficiency.

[0067] Since the projection provided in the plate-shaped member can be formed by press working such as drawing or bending, machining cost is reduced.

[0068] Since a space is created between the plate-shaped members, in comparison to when a passage is formed by applying cutting to a thick plate-shaped member, thermal insulation is improved, thus minimizing heating and cooling of refrigerant passing through the stacking-type header 2. The space between the plate-shaped members may be filled with a heat insulating material.

[0069] The peripheral edge of the plate-shaped member is bent in the stacking direction, and the distal end of the peripheral edge is joined to the side face of an adjacently stacked plate-shaped member. Accordingly, in comparison to when plate-shaped members that are not bent are stacked flat and joined together over a large area, the brazing filler metal is easily allowed to gather tightly at the distal end of the peripheral edge owing to surface tension. This reduces the frequency of joint failures due to uneven application of the brazing filler metal, and the amount of the brazing filler metal used. Further, for example, a process of finishing the joint surface into a flat surface, and a jig for applying uniform pressure over a large area during the brazing process become unnecessary, thus reducing manufacturing cost. That is, if the members to be joined are brazed together in a state in which their spacing is not uniform, the brazing filler metal becomes concentrated in areas where the spacing is narrow, resulting in an uneven joint, a shrinkage cavity, or the like. In the stacking-type header 2, the members to be joined have a tight spacing and a small joint surface, which allows the brazing filler metal to gather tightly when joining these members together, thus reducing an uneven joint, a shrinkage cavity, or the like. In particular, if the peripheral edge of the plate-shaped member is bent obliquely in the stacking direction as illustrated in Figs. 3 and 4, the joint area increases for improved joint strength.

[0070] Further, the plate-shaped member is provided with the second projection, and the inner face of the second projection is joined to the outer face of the second projection provided in the adjacently stacked plate-shaped member. Consequently, these projections are joined to each other in a manner similar to line contact, which allows the brazing filler metal to easily gather tightly owing to surface tension. Therefore, the frequency of joint failures due to uneven application of the brazing filler metal is reduced, thus improving the reliability of reinforcement. Furthermore, the amount of the brazing filler metal used is reduced. Further, for example, a process of finishing the joint surface into a flat surface, and a jig for applying uniform pressure over a large area during brazing become unnecessary, thus reducing manufacturing cost.

[0071] The inner face 12b_1b of the inflow-side Z-shaped region 12b_1 a, that is, the inner face of the first projection of the plate-shaped member, and the outer face 12b_2b of the outflow-side Z-shaped region 12b_2a, that is, the outer face of the first projection of another plate-shaped member, are joined while being in fitting engagement with each other. Consequently, these projections are joined to each other in a manner similar to line contact, which allows the brazing filler metal to easily gather tightly owing to surface tension. Therefore, the frequency of joint failures due to uneven application of the brazing filler metal, and the amount of the brazing filler metals used are reduced. Further, for example, a process of finishing the joint surface into a flat surface, and a jig for applying uniform pressure over a large area during brazing become unnecessary, thus reducing manufacturing cost. Furthermore, it is impossible to join the plate-shaped members together by changing their stacking order, thus reducing the risk of the plate-shaped members being stacked in the wrong order.

<Modification-1>

[0072] Fig. 9 is a perspective view, with the stacking-type header in an exploded state, of Modification-1 of the heat exchanger according to Embodiment 1. Fig. 10 is a cross-sectional view, with the stacking-type header in a stacked state, of Modification-1 of the heat exchanger according to Embodiment 1. Fig. 11 is a development diagram of the stacking-type header in Modification-1 of the heat exchanger according to Embodiment 1. Fig. 10 is a cross-sectional view taken along a line E-E in Fig. 9. In Fig. 10, the portion where refrigerant flows in is shaded. Fig. 11 illustrates a state in which the first plate-shaped member 21, the second plate-shaped member 22, the third plate-shaped member 23, and the fourth plate-shaped member 24, and fifth plate-shaped members 25_1 to 25_5 are joined to each other.

[0073] As illustrated in Figs. 9 to Fig. 11, the fifth plate-shaped members 25_1 to 25_5 may be joined to the first plate-shaped member 21, the second plate-shaped member 22, the third plate-shaped member 23, and the fourth plate-shaped member 24. The plate-shaped member has the first projection 21A, 22A, 23A, or 24A, which is formed by press working such as drawing or bending and projects toward the refrigerant inflow side. The first projection 21 A, 22A, 23A, or 24A has a bottom being void, and in a state in which the plate-shaped member is stacked, its inner face 21 a, 22a, 23a or 24a serves as a part of the branching flow passage 12b. Hereinafter, the fifth plate-shaped members 25_1 to 25_5 will be sometimes generically referred to as fifth plate-shaped member 25. The fifth plate-shaped member 25 corresponds to "second plate-shaped member" according to the present invention.

[0074] The fifth plate-shaped members 25_1 to 25_5 are provided with through-holes 25A_1 to 25A_5, respectively. The outer periphery at the distal end of each of the first projections 21 A, 22A, 23A, and 24A is joined to the corresponding one of the through-holes 25A_1 to 25A_5 while being in fitting engagement with the corresponding through-hole. When the plate-shaped members are stacked together, the inside of the first projection 21A, 22A, 23A, or 24A is closed in a region other than the region where refrigerant flows in and the region where refrigerant flows out, by the surface of the fifth plate-shaped member 25 stacked on the refrigerant outflow side, and the surface of another plate-shaped member stacked on the refrigerant inflow side, thus forming the branching flow passage 12b.

<Modification-2>

[0075] Fig. 12 is a perspective view and a cross-sectional view of main portions, with the stacking-type header in an exploded state, of Modification-2 of the heat exchanger according to Embodiment 1. Fig. 12(a) is a perspective view of main portions with the stacking-type header in an exploded state, and Fig. 12(b) is a cross-sectional view of the first plate-shaped member 21 taken along a line F-F in Fig. 12(a). In Fig. 12(b), the portion where refrigerant flows in is shaded.

[0076] As illustrated in Fig. 12, a region of the inner face 21 a of the first projection 21A of the first plate-shaped member 21 other than the outflow-side Z-shaped region 12b_2a may have such a shape that gradually widens toward the refrigerant outflow side. With this configuration, if the first heat transfer tube 4 is a flat tube, the pressure loss of refrigerant as the refrigerant passes through the first outlet passage 11A is reduced.

<Modification-3>

[0077] Fig. 13 is a perspective view, with the stacking-type header in an exploded state, of Modification-3 of the heat exchanger according to Embodiment 1.

[0078] As illustrated in Fig. 13, the third plate-shaped member 23 may be provided with a plurality of first inlet flow passages 12a to reduce the number of fourth plate-shaped members 24. This configuration allows reductions in parts cost, weight, and the like.

<Modification-4>

[0079] Fig. 14 is a perspective view, with the stacking-type header in an exploded state, of Modification-4 of the heat exchanger according to Embodiment 1.

[0080] As illustrated in Fig. 14, the first inlet flow passage 12a may be provided in a plate-shaped member other than the third plate-shaped member 23. In that case, a through-hole may be provided in another plate-shaped member, and a projection for introducing refrigerant from the through-hole to the inner face 24a_1 of the first projection 24A_1 of the fourth plate-shaped member 24_1 may be provided in another plate-shaped member and a neighboring plate-shaped member. That is, the present invention encompasses configurations in which the first inlet flow passage 12a is provided in the first plate-shaped unit 11, and the "distribution flow passage" according to the present invention encompasses distribution flow passages other than the distribution flow passage 12A that has the first inlet flow passage 12a provided in the second plate-shaped unit 12.

Embodiment 2

[0081] A heat exchanger according to Embodiment 2 will be described.

[0082] In the following, description of features that overlap with or are similar to those of Embodiment 1 will be simplified or omitted as appropriate.

<Configuration of Heat Exchanger>

[0083] Hereinafter, the configuration of a heat exchanger according to Embodiment 2 will be described.

[0084] Fig. 15 illustrates the configuration of a heat exchanger according to Embodiment 2.

[0085] As illustrated in Fig. 15, a heat exchanger 1 has a stacking-type header 2, a plurality of first heat transfer tubes 4, and a plurality of fins 5.

[0086] The stacking-type header 2 has a refrigerant inflow part 2A, a plurality of refrigerant outflow parts 2B, a plurality of refrigerant inflow parts 2C, and a refrigerant outflow part 2D. A refrigerant pipe is connected to the refrigerant inflow part 2A of the stacking-type header 2 and the refrigerant outflow part 2D of the stacking-type header 2. The first heat transfer tube 4 is a flat tube with a hair pin bend. The first heat transfer tubes 4 are connected between the refrigerant outflow parts 2B of the stacking-type header 2 and the refrigerant inflow parts 2C of the stacking-type header 2.

<Flow of Refrigerant in Heat Exchanger>

[0087] Hereinafter, flow of refrigerant in the heat exchanger according to Embodiment 2 will be described.

[0088] Refrigerant flowing through the refrigerant pipe flows in the stacking-type header 2 via the refrigerant inflow part 2A, and after being distributed in the stacking-type header 2, the distributed refrigerant flows out to the first heat transfer tubes 4 via the refrigerant outflow parts 2B. In the first heat transfer tubes 4, the refrigerant exchanges heat with air or the like supplied by a fan, for example. The refrigerant that has passed through each of the first heat transfer tubes 4 flows in the stacking-type header 2 via the refrigerant inflow parts 2C, and after merging in the stacking-type header 2, the merged refrigerant flows out to the refrigerant pipe via the refrigerant outflow part 2D. Refrigerant flow can be reversed.

<Configuration of Stacked Header >

[0089] Hereinafter, the configuration of the stacking-type header of the heat exchanger according to Embodiment 2 will be described.

[0090] Fig. 16 is a perspective view, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 2. Fig. 17 is a development diagram of the stacking-type header of the heat exchanger according to Embodiment 2.

[0091] As illustrated in Figs. 16 and 17, the stacking-type header 2 has a first plate-shaped unit 11, and a second plate-shaped unit 12. The first plate-shaped unit 11 and the second plate-shaped unit 12 are stacked together.

[0092] The first plate-shaped unit 11 is provided with a plurality of first outlet flow passages 11 A, and a plurality of second inlet flow passages 11 B. The first plate-shaped unit 11 has a first plate-shaped member 21, a sixth plate-shaped member 26, and a second plate-shaped member 22. The second inlet flow passages 11 B correspond to the refrigerant inflow parts 2C in Fig. 15. Hereinafter, the first plate-shaped member 21, the second plate-shaped member 22, a third plate-shaped member 23, a fourth plate-shaped member 24, and the sixth plate-shaped member 26 will be sometimes generically referred to as plate-shaped member.

[0093] The second plate-shaped unit 12 is provided with a distribution flow passage 12A, and a joining flow passage 12B. The joining flow passage 12B has a mixing passage 12c, and a second outlet flow passage 12d. The second outlet flow passage 12d corresponds to the refrigerant outflow part 2D in Fig. 15.

[0094] The second plate-shaped member 22 has a third projection 22C, which is formed by, for example, press working such as drawing or bending and projects toward the refrigerant outflow side. The third projection 22C has a bottom being void only in a region connected to the refrigerant outflow-side end portion of the first heat transfer tube 4. In a state in which the second plate-shaped member 22 is stacked, an outer face 22d of the third projection 22C serves as a part of the second inlet flow passage 11 B.

[0095] The sixth plate-shaped member 26 has a first projection 26A, a second projection 26B, and a third projection 26C, which are formed by, for example, press working such as drawing or bending and project toward the refrigerant outflow side. The third projection 26C has a bottom being void in a region that is not opposed to the refrigerant outflow-side end portion of the first heat transfer tube 4. In a state in which the sixth plate-shaped member 26 is stacked, an inner face 26c of the third projection 26C serves as a part of the second inlet flow passage 11 B.

[0096] The first plate-shaped member 21 has, for example, a through portion 21C, which is formed by press working and does not project to neither the refrigerant outflow side nor the refrigerant inflow side. In a state in which the first plate-shaped member 21 is stacked, the through portion 21C serves as a part of the second inlet flow passage 11 B.

[0097] The fourth plate-shaped member 24 has, for example, third projections 24C_1 to 24C_3, which are formed by press working such as drawing or bending and project toward the refrigerant inflow side. Hereinafter, the third projections 24C_1 to 24C_3 of the fourth plate-shaped member 24 will be sometimes generically referred to as third projection 24C. The third projection 24C has a bottom being void, and in a state in which the fourth plate-shaped member 24 is stacked, inner faces 24c_1 to 24c_3 of the third projection 24C serve as a part of the mixing passage 12c. Hereinafter, the inner faces 24c_1 to 24c_3 of the third projection 24C of the fourth plate-shaped member 24 will be sometimes generically referred to as inner face 24c.

[0098] The third plate-shaped member 23 has, for example, a third projection 23C and a fourth projection 23D. The third projection 23C is formed by press working such as drawing or bending, and projects toward the refrigerant inflow side. The fourth projection 23D, which is provided in the third projection 23C, projects toward the refrigerant outflow side. The third projection 23C has a bottom. In a state in which the third plate-shaped member 23 is stacked, an outer face 23d of the third projection 23C serves as a part of the mixing passage 12c. The fourth projection 23D has a bottom being void. In a state in which the third plate-shaped member 23 is stacked, an inner face 23e of the fourth projection 23D serves as the second outlet flow passage 12d.

[0099] The second outlet flow passage 12d may be provided in a plate-shaped member other than the third plate-shaped member 23. In that case, a through-hole may be provided in another plate-shaped member, and a projection for introducing refrigerant to the through-hole may be provided in another plate-shaped member and a neighboring plate-shaped member. That is, the present invention encompasses configurations in which the second outlet flow passage 12d is provided in the first plate-shaped unit 11, and the "joining flow passage" according to the present invention encompasses joining flow passages other than the joining flow passage 12B that has the second outlet flow passage 12d provided in the second plate-shaped unit 12.

<Flow of Refrigerant in Stacked Header>

[0100] Hereinafter, flow of refrigerant in the stacking-type header of the heat exchanger according to Embodiment 2 will be described.

[0101] As indicated by arrows in Figs. 16 and 17, after passing through the first heat transfer tube 4, refrigerant passes through the third projection 22C of the second plate-shaped member 22, and flows in the inside of the third projection 26C of the sixth plate-shaped member 26. After entering the inside of the third projection 26C of the sixth plate-shaped member 26, the refrigerant passes through the through portion 21C of the first plate-shaped member 21, and flows in the inside of the third projection 24C of the fourth plate-shaped member 24 where the refrigerant is mixed with another flow. The mixed refrigerant passes through the fourth projection 23D of the third plate-shaped member 23, and flows out to the refrigerant pipe.

<Use of Heat Exchanger>

[0102] Hereinafter, an example of use of the heat exchanger according to Embodiment 2 will be described.

[0103] Fig. 18 illustrates the configuration of an air-conditioning apparatus to which the heat exchanger according to Embodiment 2 is applied.

[0104] As illustrated in Fig. 18, the heat exchanger 1 is used for at least one of a heat source-side heat exchanger 54 and a load-side heat exchanger 56. The heat exchanger 1 is connected in such a way that when the heat exchanger 1 acts as an evaporator, refrigerant flows in the first heat transfer tube 4 from the distribution flow passage 12A of the stacking-type header 2, and refrigerant flows in the joining flow passage 12B of the stacking-type header 2 from the first heat transfer tube 4. That is, when the heat exchanger 1 acts as an evaporator, refrigerant in a two-phase gas-liquid state flows in the distribution flow passage 12A of the stacking-type header 2 from the refrigerant pipe, and refrigerant in a gaseous state flows in the joining flow passage 12B of the stacking-type header 2 from the first heat transfer tube 4. When the heat exchanger 1 acts as a condenser, refrigerant in a gaseous state flows in the joining flow passage 12B of the stacking-type header 2 from the refrigerant pipe, and refrigerant in a liquid state flows in the distribution flow passage 12A of the stacking-type header 2 from the first heat transfer tube 4.

<Operation of Heat Exchanger>

[0105] Hereinafter, operation of the heat exchanger according to Embodiment 2 will be described.

[0106] In the stacking-type header 2, the first plate-shaped unit 11 is provided with the second inlet flow passages 11 B, and the second plate-shaped unit 12 is provided with the joining flow passage 12B. Consequently, a header 3 becomes unnecessary, thus reducing, for example, parts cost of the heat exchanger 1. Since the header 3 is not required, it is possible to extend the first heat transfer tube 4 to increase the number of fins 5, that is, increase the mounting volume of the heat exchange unit of the heat exchanger 1.

Embodiment 3

[0107] Hereinafter, a heat exchanger according to Embodiment 3 will be described.

[0108] A description of features that overlap with or are similar to those of Embodiment 1 and Embodiment 2 will be simplified or omitted as appropriate.

<Configuration of Heat Exchanger>

[0109] Hereinafter, the configuration of the heat exchanger according to Embodiment 3 will be described.

[0110] Fig. 19 illustrates the configuration of the heat exchanger according to Embodiment 3.

[0111] As illustrated in Fig. 19, a heat exchanger 1 has a stacking-type header 2, a plurality of first heat transfer tubes 4, a plurality of second heat transfer tubes 6, and a plurality of fins 5.

[0112] The stacking-type header 2 has a plurality of refrigerant turn-around parts 2E. Like the first heat transfer tube 4, the second heat transfer tube 6 is a flat tube with a hair pin bend. The first heat transfer tubes 4 are connected between a plurality of refrigerant outflow parts 2B and the refrigerant turn-around parts 2E of the stacking-type header 2, and the second heat transfer tubes 6 are connected between the refrigerant turn-around parts 2E and a plurality of refrigerant inflow parts 2C of the stacking-type header 2.

<Flow of Refrigerant in Heat Exchanger>

[0113] Hereinafter, flow of refrigerant in the heat exchanger according to Embodiment 3 will be described.

[0114] Refrigerant flowing through the refrigerant pipe flows in the stacking-type header 2 via a refrigerant inflow part 2A, and after being distributed in the stacking-type header 2, the distributed refrigerant flows out to the first heat transfer tubes 4 via the refrigerant outflow parts 2B. In the first heat transfer tubes 4, the refrigerant exchanges heat with air or the like supplied by a fan, for example. The refrigerant that has passed through the first heat transfer tubes 4 flows in the refrigerant turn-around parts 2E of the stacking-type header 2 where the refrigerant is turned around before flow outing to the second heat transfer tubes 6. In the second heat transfer tubes 6, the refrigerant exchanges heat with air or the like supplied by a fan, for example. The refrigerant that has passed through each of the second heat transfer tubes 6 flows in the stacking-type header 2 via the refrigerant inflow parts 2C, and after merging in the stacking-type header 2, the merged refrigerant flows out to the refrigerant pipe via a refrigerant outflow part 2D. Refrigerant flow can be reversed.

<Configuration of Stacked Header>

[0115] Hereinafter, the configuration of the stacking-type header of the heat exchanger according to Embodiment 3 will be described.

[0116] Fig. 20 is a perspective view, with the stacking-type header in an exploded state, of the heat exchanger according to Embodiment 3. Fig. 21 is a development diagram of the stacking-type header of the heat exchanger according to Embodiment 3.

[0117] As illustrated in Figs. 20 and 21, the stacking-type header 2 has a first plate-shaped unit 11, and a second plate-shaped unit 12. The first plate-shaped unit 11 and the second plate-shaped unit 12 are stacked together.

[0118] The first plate-shaped unit 11 is provided with a plurality of first outlet flow passages 11 A, a plurality of second inlet flow passages 11B, and a plurality of turn-back flow passages 11C. The turn-back flow passages 11C correspond to the refrigerant turn-around parts 2E in Fig. 19.

[0119] A second plate-shaped member 22 has a third projection 22C and a fourth projection 22D. The third projection 22C is formed by, for example, press working such as drawing or bending, and projects toward the side opposite to the side from which the refrigerant from the first heat transfer tube 4 flows in. The fourth projection 22D is formed by, for example, press working such as drawing or bending, and projects toward the side to which the refrigerant from the second heat transfer tube 6 flows out. The fourth projection 22D has a bottom being void only in regions that are connected to the refrigerant outflow-side end portion of the first heat transfer tube 4 and the refrigerant inflow-side end portion of the second heat transfer tube 6. In a state in which the second plate-shaped member 22 is stacked, an outer face 22f of the fourth projection 22D serves as a part of the turn-back flow passage 11C.

[0120] A sixth plate-shaped member 26 has a third projection 26C and a fourth projection 26D. The third projection 26C is formed by, for example, press working such as drawing or bending, and projects toward the side opposite to the side from which refrigerant from the first heat transfer tube 4 flows in. The fourth projection 26D is formed by, for example, press working such as drawing or bending, and projects toward the side to which refrigerant from the second heat transfer tube 6 flows out. The fourth projection 26D has a bottom. In a state in which the sixth plate-shaped member 26 is stacked, an inner face 26e of the fourth projection 26D serves as a part of the turn-back flow passage 11C.

<Flow of Refrigerant in Stacked Header>

[0121] Hereinafter, flow of refrigerant in the stacking-type header of the heat exchanger according to Embodiment 3 will be described.

[0122] As indicated by arrows in Figs. 20 and 21, after passing through the first heat transfer tube 4, refrigerant passes through the fourth projection 22D of the second plate-shaped member 22, and flows in the inside of the fourth projection 26D of the sixth plate-shaped member 26. After entering the inside of the fourth projection 26D of the sixth plate-shaped member 26, the refrigerant passes through the fourth projection 22D of the second plate-shaped member 22 again, and flows in the second heat transfer tube 6. The refrigerant that has passed through the second heat transfer tube 6 passes through the third projection 22C of the second plate-shaped member 22 and the third projection 26C of the sixth plate-shaped member 26, and flows in the inside of a third projection 24C of a fourth plate-shaped member 24 where the refrigerant is mixed with another flow. The mixed refrigerant passes through the fourth projection 23D of the third plate-shaped member 23, and flows out to the refrigerant pipe.

<Use of Heat Exchanger>

[0123] Hereinafter, an example of use of the heat exchanger according to Embodiment 3 will be described.

[0124] Fig. 22 illustrates the configuration of an air-conditioning apparatus to which the heat exchanger according to Embodiment 2 is applied.

[0125] As illustrated in Fig. 22, the heat exchanger 1 is used for at least one of a heat source-side heat exchanger 54 and a load-side heat exchanger 56. The heat exchanger 1 is connected in such a way that when the heat exchanger 1 acts as an evaporator, refrigerant flows in the first heat transfer tube 4 from a distribution flow passage 12A of the stacking-type header 2, and refrigerant flows in a joining flow passage 12B of the stacking-type header 2 from the second heat transfer tube 6. That is, when the heat exchanger 1 acts as an evaporator, refrigerant in a two-phase gas-liquid state flows in the distribution flow passage 12A of the stacking-type header 2 from the refrigerant pipe, and refrigerant in a gaseous state flows in the joining flow passage 12B of the stacking-type header 2 from the second heat transfer tube 6. When the heat exchanger 1 acts as a condenser, refrigerant in a gaseous state flows in the joining flow passage 12B of the stacking-type header 2 from the refrigerant pipe, and refrigerant in a liquid state flows in the distribution flow passage 12A of the stacking-type header 2 from the first heat transfer tube 4.

[0126] Further, the heat exchanger 1 is disposed so that when the heat exchanger 1 acts as a condenser, the first heat transfer tube 4 is located on the upstream side of airflow produced by the heat source-side fan 57 or the load-side fan 58 (upstream side of airflow), in comparison to the second heat transfer tube 6. That is, the flow of refrigerant from the second heat transfer tube 6 to the first heat transfer tube 4 and the airflow are opposed to each other. The temperature of refrigerant in the first heat transfer tube 4 is lower than that of refrigerant in the second heat transfer tube 6. The temperature of the airflow produced by the heat source-side fan 57 or the load-side fan 58 is lower on the upstream side of the heat exchanger 1 than on the downstream side of the heat exchanger 1. As a result, in particular, refrigerant can be subcooled (so-called subcooling) by the low-temperature airflow flowing on the upstream side of the heat exchanger 1, thereby improving condenser performance. The heat source-side fan 57 and the load-side fan 58 may be provided on either of the upstream side of airflow and the downstream side of airflow.

<Operation of Heat Exchanger>

[0127] Hereinafter, the configuration of the heat exchanger according to Embodiment 3 will be described.

[0128] In the heat exchanger 1, the first plate-shaped unit 11 is provided with the turn-back flow passages 11C, and the second heat transfer tubes 6 are connected in addition to the first heat transfer tubes 4. For example, the amount of heat exchange can be increased by increasing the area of the heat exchanger 1 as seen in front view. However, in that case, the size of the housing that contains the heat exchanger 1 increases. Further, the amount of heat exchange can be increased by increasing the number of fins 5 by reducing the spacing of the fins 5. However, in that case, it is difficult to make the spacing of the fins 5 less than about 1 mm from the viewpoints of drainage performance, frosting performance, and dust-proofness. Consequently, a sufficient increase in the amount of heat exchange may not be attained in some cases. In contrast, increasing the number of rows of heat transfer tubes as in the case of the heat exchanger 1 makes it possible to increase the amount of heat exchange without changing the area of the heat exchanger 1 as seen in front view, the spacing of the fins 5, or the like. Increasing the number of rows of heat transfer tubes to two increases the amount of heat exchange by more than about 1.5 times. The number of rows of heat transfer tubes may be increased to three or more. Further, the area of the heat exchanger 1 as seen in front view, the spacing of the fins 5, or the like may be changed.

[0129] The header (the stacking-type header 2) is provided only on one side of the heat exchanger 1. If the heat exchanger 1 is disposed in such a way that, in order to increase the mounting volume of its heat exchange unit, for example, the heat exchanger 1 is bent along a plurality of side faces of the housing that contains the heat exchanger 1, each row of heat transfer tubes differs in the radius of curvature of its bent portion, which causes the end portions of individual rows of heat transfer tubes to become misaligned. When a header (the stacking-type header 2) is provided only on one side of the heat exchanger 1 as in the case of the stacking-type header 2, even if the end portions of individual rows of heat transfer tubes become out of alignment, only the end portions on one side needs to be aligned, thus enabling improvements in terms of the freedom of design, production efficiency, and the like in comparison to when headers (the stacking-type header 2 and the header 3) are provided on both sides of the heat exchanger 1 as in the case of the heat exchanger according to Embodiment 1. In particular, it also becomes possible to bend the heat exchanger 1 after joining each member of the heat exchanger 1, thus enabling a further improvement in production efficiency.

[0130] Further, when the heat exchanger 1 acts as a condenser, the first heat transfer tube 4 is located on the upstream side of airflow in comparison to the second heat transfer tube 6. When headers (the stacking-type header 2 and a header 3) are provided on both sides of the heat exchanger 1 as in the case of the heat exchanger according to Embodiment 1, it is difficult to improve the condenser performance of the heat exchanger by providing a difference in the temperature of refrigerant between each row of heat transfer tubes. In particular, if each of the first heat transfer tube 4 and the second heat transfer tube 6 is a flat tube, unlike a circular tube, the limited freedom of bending means that it is difficult to provide a refrigerant temperature difference between each row of heat transfer tubes by deforming refrigerant passages. In contrast, if the first heat transfer tube 4 and the second heat transfer tube 6 are connected to the stacking-type header 2 as in the case of the heat exchanger 1, a difference in refrigerant temperature is naturally created between each row of heat transfer tubes. Consequently, the refrigerant flow and the airflow can be opposed to each other easily without deforming refrigerant passages.

[0131] While Embodiments 1 to 3 have been described above, the present invention is not limited to the embodiments described above. For example, the whole or part of each of the embodiments, modifications, and the like may be combined.

Reference Signs List

[0132] 1 heat exchanger 2 stacking-type header 2A refrigerant inflow part 2B refrigerant outflow part 2C refrigerant inflow part 2D refrigerant outflow part 2E refrigerant turn-around part 3 header 3A refrigerant inflow part 3B refrigerant outflow part 4 first heat transfer tube 5 fin 6 second heat transfer tube 11 first plate-shaped unit 11 A first outlet passage 11 B second inlet flow passage 11C turn-back flow passage 12 second plate-shaped unit 12A distribution flow passage 12B joining flow passage 12a first inlet flow passage 12b branching flow passage 12b_1a inflow-side Z-shaped region 12b_2a outflow-side Z-shaped region 12b_1b inner face of inflow-side Z-shaped region 12b_2b outer face of outflow-side Z-shaped region 12b_1 c, 12b_2c, 12b_1 d, 12b_2d end portion of Z-shaped region 12b_1e, 12b_2e linear portion of Z-shaped region 12b_1f, 12b_2f, 12b_2g through-hole12b_1h, 12b_2h, 12b_1i, 12b_2i peripheral portion 12b_2j protrusion 12c mixing passage 12d second outlet flow passage 21 first plate-shaped member 21A first projection 21 B second projection 21C through portion 21 a inner face of first projection 21 b outer face of first projection 22 second plate-shaped member 22A first projection 22B second projection 22C third projection 22D fourth projection 22a inner face of first projection 22c inner face of third projection 22d outer face of third projection 22f outer face of fourth projection 23 third plate-shaped member 23A first projection 23C third projection 23D fourth projection 23a inner face of first projection 23d outer face of third projection 23e inner face of fourth projection 24,24_1 to 24_3 fourth plate-shaped member 24A, 24A_1 to 24A_3 first projection 24B, 24B_1 to 24B_3 second projection 24C, 24C_1 to 24C_3 third projection 24a, 24a_1 to 24a_3 inner face of first projection 24b, 24b_1 to 24b_3 outer face of first projection 24c, 24c_1 to 24c_3 inner face of third projection 25,25_1 to 25_5 fifth plate-shaped member 25A_1 to 25A_5 through-hole26 sixth plate-shaped member 26A first projection 26B second projection 26C third projection 26D fourth projection 26c inner face of third projection 26e inner face of fourth projection 51 air-conditioning apparatus 52 compressor 53 four-way valve 54 heat source-side heat exchanger 55 expansion device 56 load-side heat exchanger57 heat source-side fan 58 load-side fan 59 controller

Claims

1. A stacking-type header comprising:

a first plate-shaped unit having a plurality of first outlet flow passages formed therein; and
a second plate-shaped unit stacked on the first

plate-shaped unit and having a distribution flow passage formed therein, the distribution flow passage being configured to distribute refrigerant, which passes through a first inlet flow passage to flow into the second plate-shaped unit, to the plurality of first outlet flow passages to cause the refrigerant to flow out from the second plate-shaped unit,
wherein the distribution flow passage includes at least one branching flow passage,
wherein the second plate-shaped unit has at least one first plate-shaped member, the first plate-shaped member having at least one first projection formed by press working, and
wherein the branching flow passage is formed by closing an inside of the first projection in a region other than a region where the refrigerant flows in and a region where the refrigerant flows out.

2. The stacking-type header of claim 1, wherein:

a peripheral edge of the first plate-shaped member is bent in a stacking direction; and
a distal end of the peripheral edge is joined to a side face of a member stacked adjacent thereto.

3. The stacking-type header of claim 1 or 2, wherein:

the first plate-shaped member has at least one second projection provided in a region different from a region provided with the first projection; and
an inner face of the second projection is joined to an outer face of a projection provided in a member stacked adjacent thereto.

4. The stacking-type header of any one of claims 1 to 3, wherein:

the first projection has a bottom; and
the inside of the first projection is closed as an inner face of the first projection is fit with an outer face of a projection provided in a member stacked adjacent thereto.

5. The stacking-type header of any one of claims 1 to 3, wherein:

the second plate-shaped unit has at least one second plate-shaped member, the second plate-shaped member having at least one through portion;
a bottom of the first projection is void;
the second plate-shaped member is joined to the first plate-shaped member so that the through portion is fit with an outer face of a distal end of the first projection; and
the inside of the first projection is closed by a surface of a member stacked on a side of the first plate-shaped member different from a side to which the first projection projects, and a surface of a member stacked on a side of the second plate-shaped member opposite to a side where the first plate-shaped member is present.

6. The stacking-type header of any one of claims 1 to 5, wherein:

the first plate-shaped unit has a plurality of second inlet flow passages; and
the second plate-shaped unit has a joining flow passage, the joining flow passage causing refrigerant entering from each of the second inlet flow passages to join and enter a second outlet flow passage.

7. The stacking-type header of any one of claims 1 to 6, wherein the first plate-shaped unit has a plurality of turn-back flow passages formed therein, the plurality of turn-back flow passages being configured to turn back the refrigerant flowing into the first plate-shaped unit to cause the refrigerant to flow out from the first plate-shaped unit.

8. A heat exchanger comprising:

the stacking-type header of any one of claims 1 to 5; and
a plurality of first heat transfer tubes connected to the plurality of first outlet flow passages, respectively.

9. The heat exchanger of claim 8,
wherein the first plate-shaped unit has a plurality of second inlet flow passages formed therein, into which the refrigerant passing through the plurality of first heat transfer tubes flows, and
wherein the second plate-shaped unit has a joining flow passage formed therein, the joining flow passage being configured to join together flows of the refrigerant, which pass through the plurality of second inlet flow passages to flow into the second plate-shaped unit, to cause the refrigerant to flow into a second outlet flow passage.

10. The heat exchanger of claim 9, wherein:

the first plate-shaped unit has a plurality of turn-back flow passages each connected at an inlet side thereof with a corresponding one of the first heat transfer tubes, the turn-back flow passages causing the refrigerant entering from the first heat transfer tubes to turn around and flow out the turn-back flow passages; and
the heat exchanger includes a plurality of sec-

ond heat transfer tubes, the second heat transfer tubes being each connected to an outlet side of a corresponding one of the turn-back flow passages and a corresponding one of the second inlet flow passages.

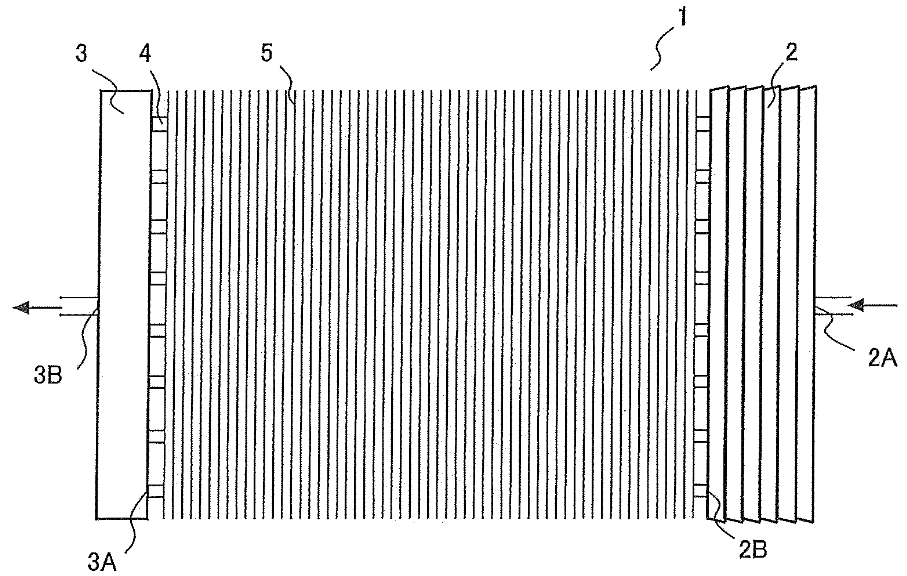
11. The heat exchanger of any one of claims 8 to 10, wherein the plurality of heat transfer tubes each comprise a flat tube.

12. The heat exchanger of claim 11, wherein each of the first outlet flow passages has an inner peripheral surface gradually expanding toward an outer peripheral surface of each of the first heat transfer tubes.

13. An air-conditioning apparatus comprising the heat exchanger of any one of claims 8 to 12,
wherein the distribution flow passage is configured to cause the refrigerant to flow out from the distribution flow passage toward the plurality of first outlet flow passages when the heat exchanger acts as an evaporator.

14. An air-conditioning apparatus comprising the heat exchanger of claim 10,
wherein the distribution flow passage is configured to cause the refrigerant to flow out from the distribution flow passage toward the plurality of first outlet flow passages when the heat exchanger acts as an evaporator, and
wherein the plurality of first heat transfer tubes are positioned on a windward side with respect to the plurality of second heat transfer tubes when the heat exchanger acts as a condenser.

F I G. 1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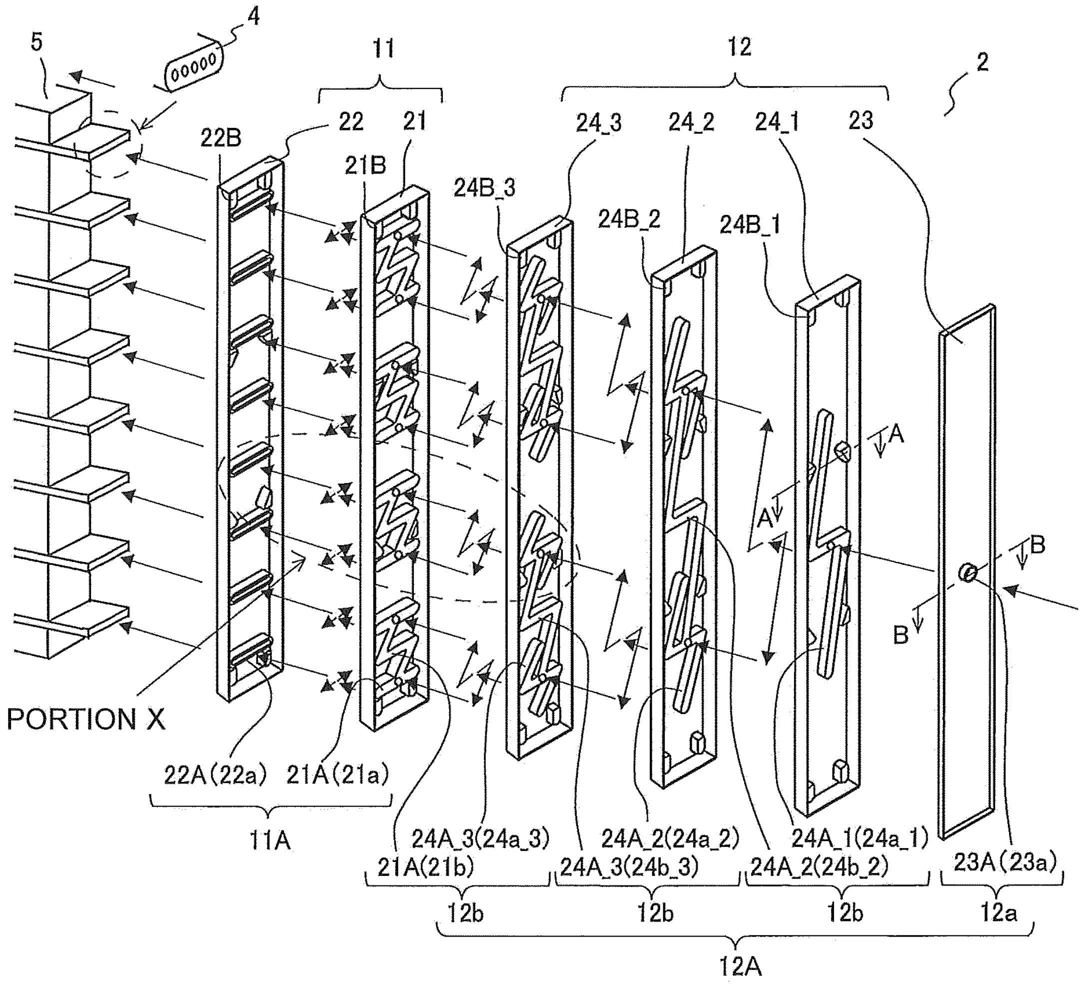
3A
2B

F I G. 2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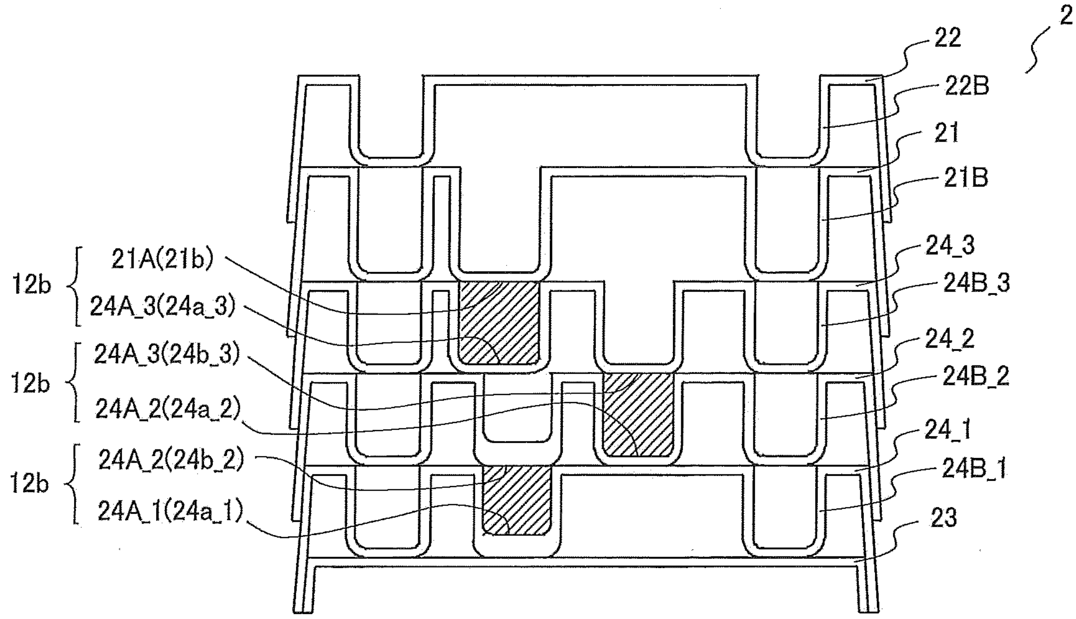
12A

FIG. 3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24A_3(24a_3)
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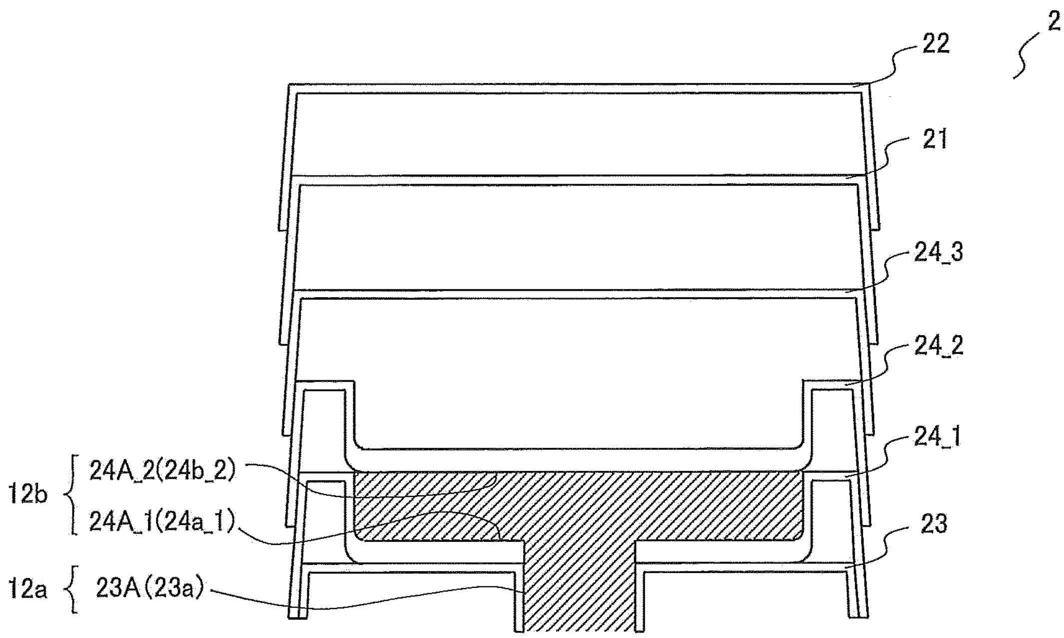
FIG. 4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22
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24_3
24_2
24_1
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12b
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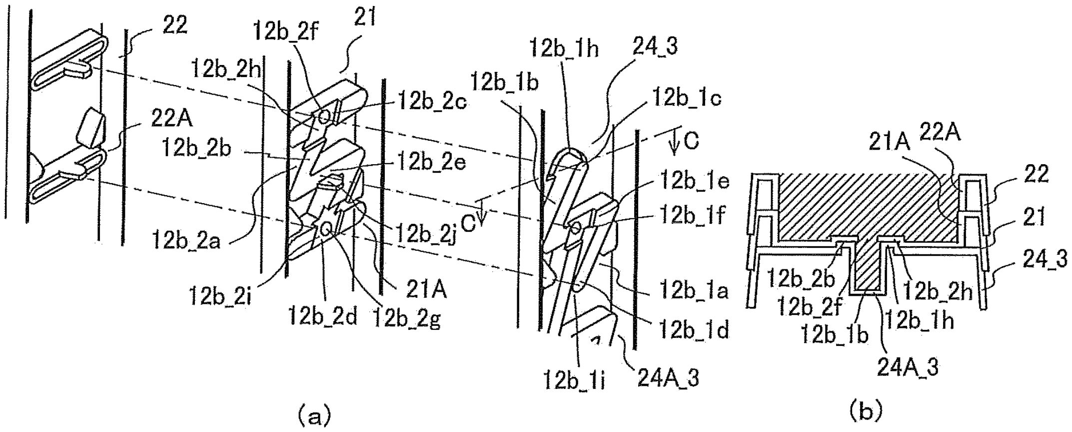
12a
23A(23a)

F I G. 5



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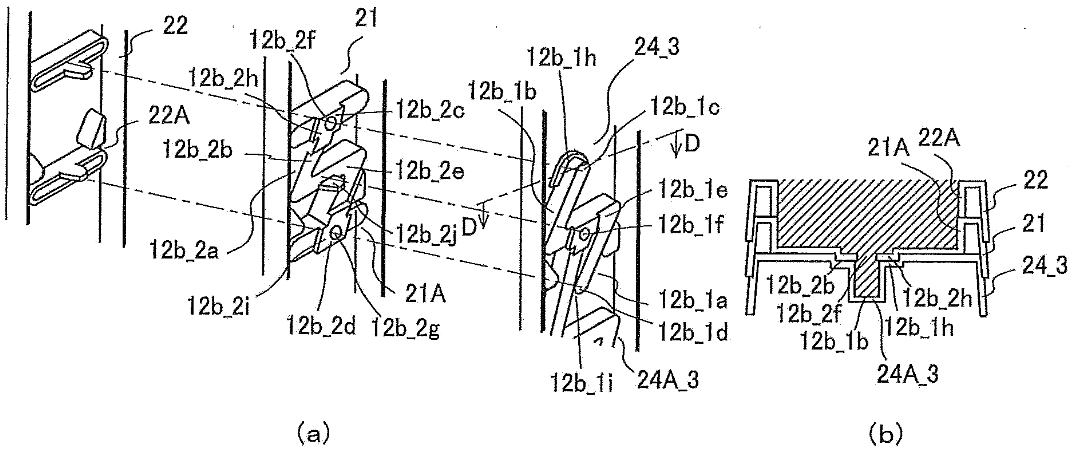


F I G. 7

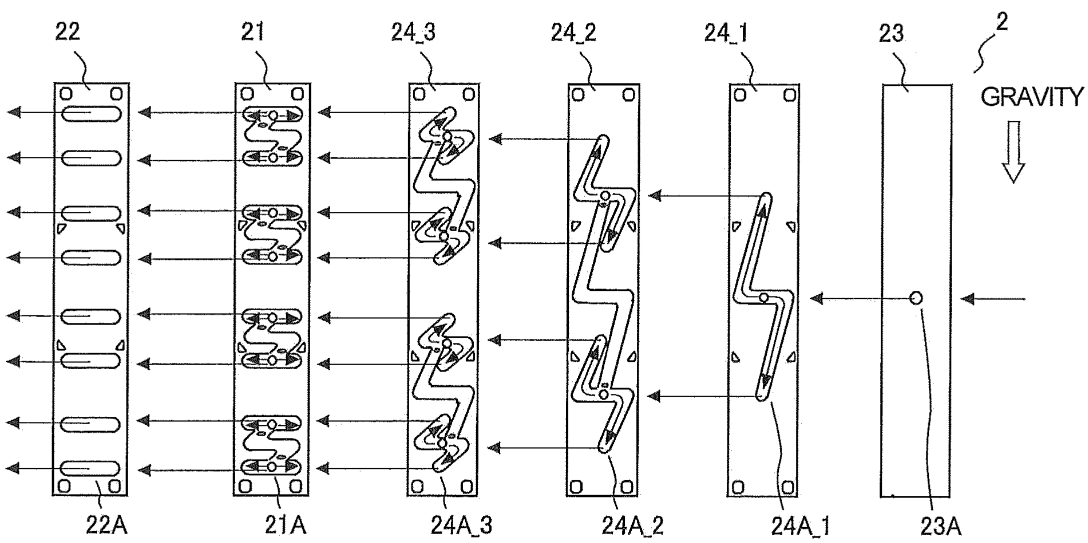
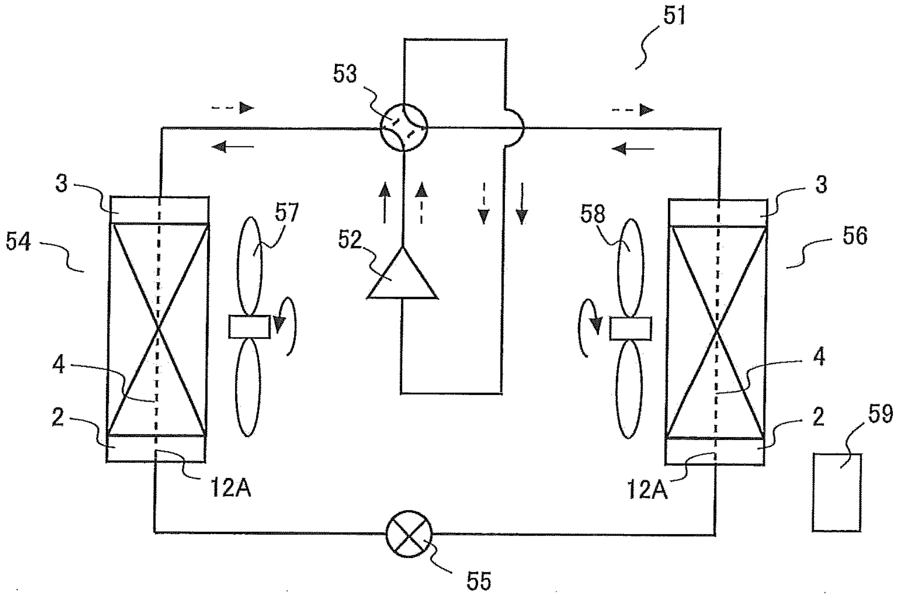


FIG. 8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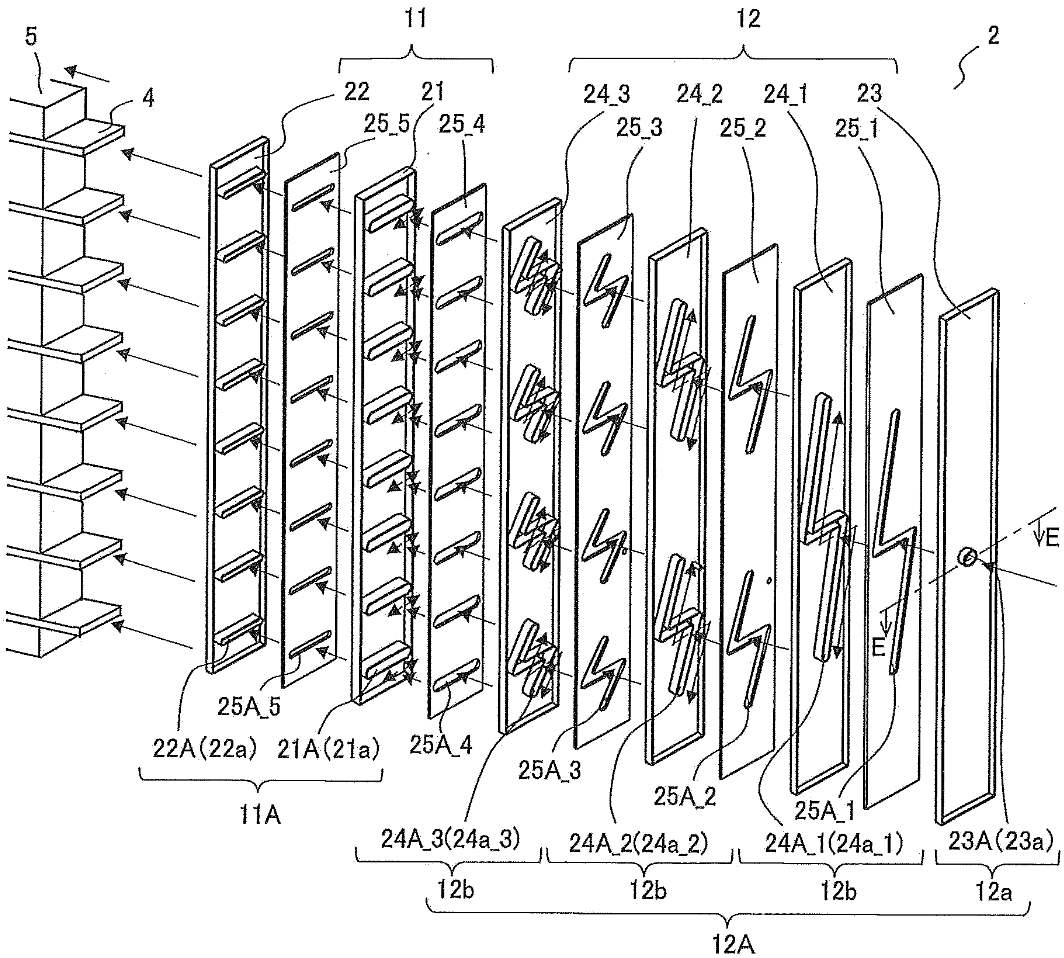
4
2
2
59
12A
12A
55

FIG. 9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24_2
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E
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11A
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12b
12a
12A

FIG. 10

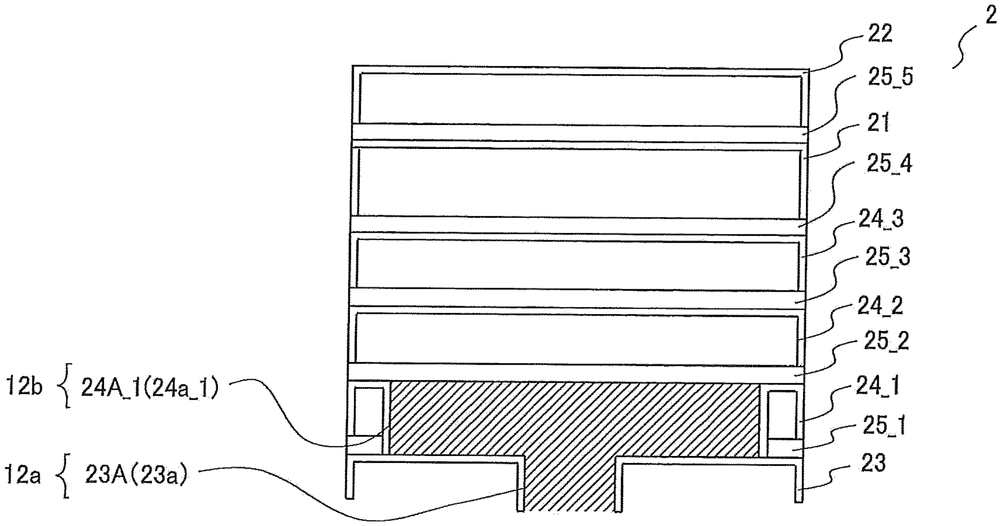


FIG. 11

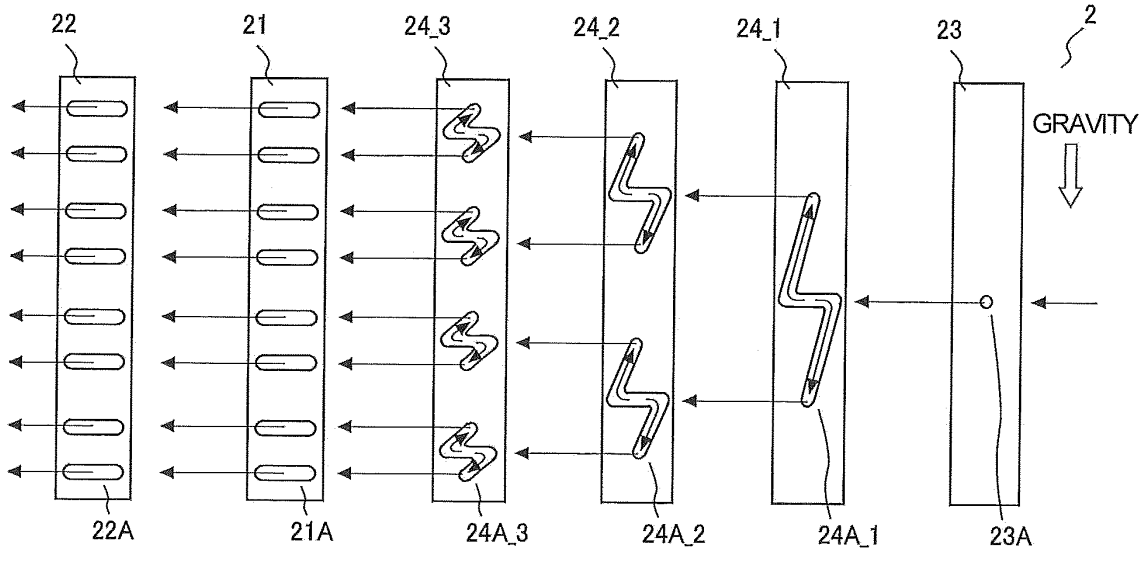
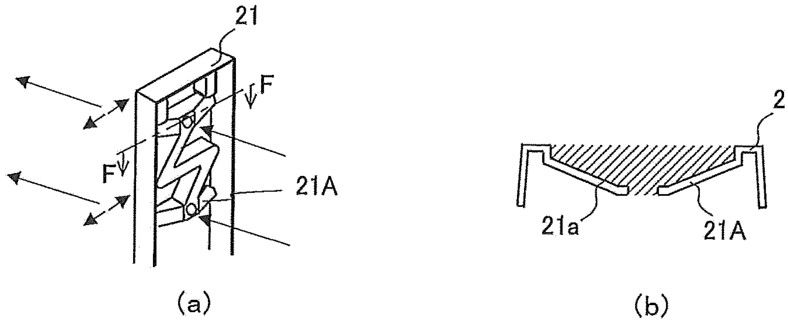


FIG. 12



F I G. 1 3

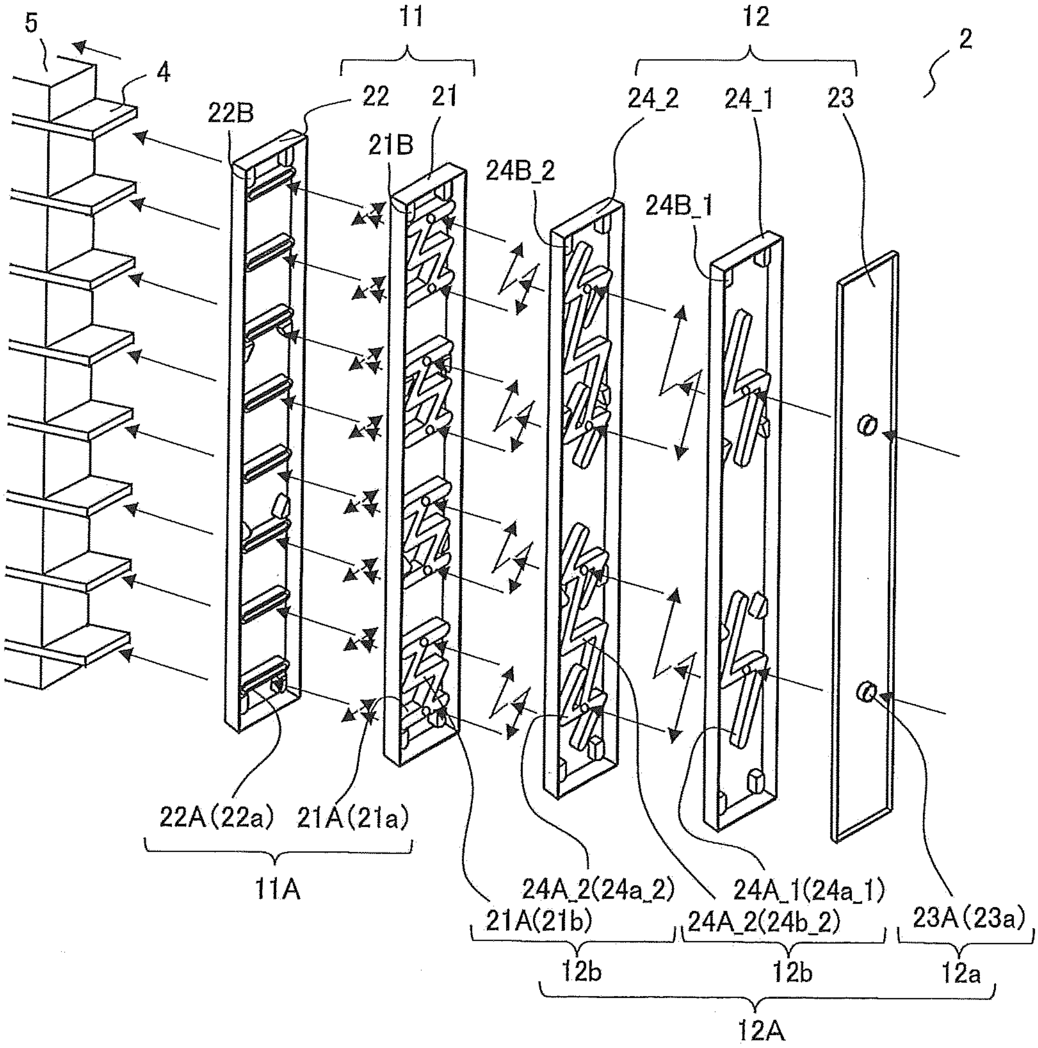

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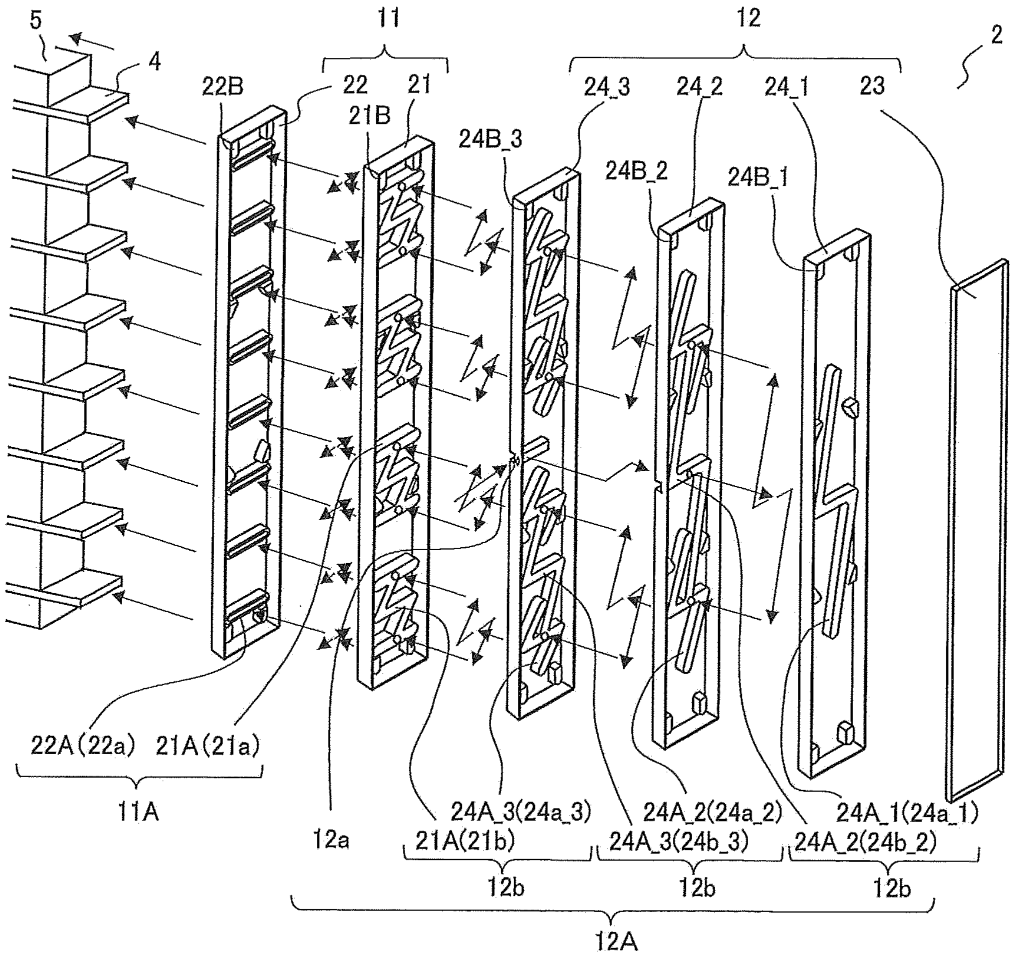
FIG. 14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22B
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21
21B
24_3
24_2
24_1
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24B_3
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24B_1
22A(22a) 21A(21a)
11A
12a
24A_3(24a_3)
21A(21b)
24A_2(24a_2)
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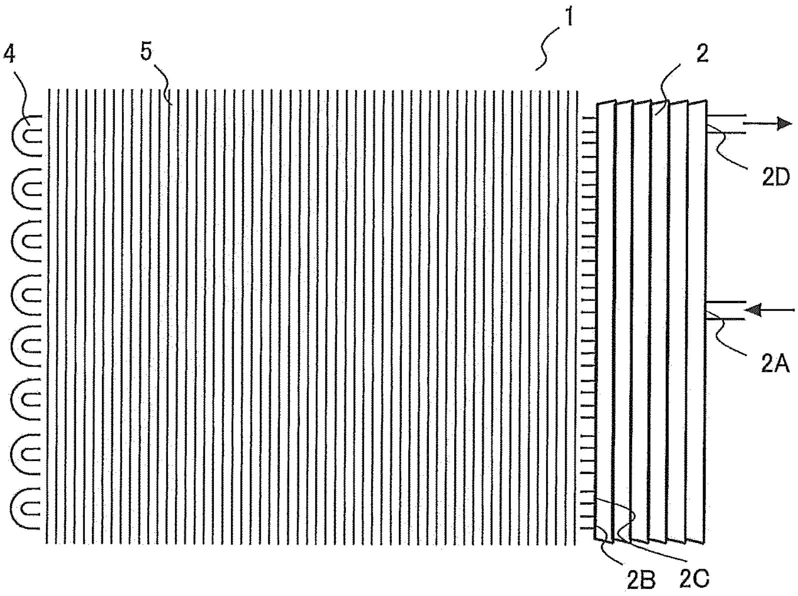
12b
12A

FIG. 15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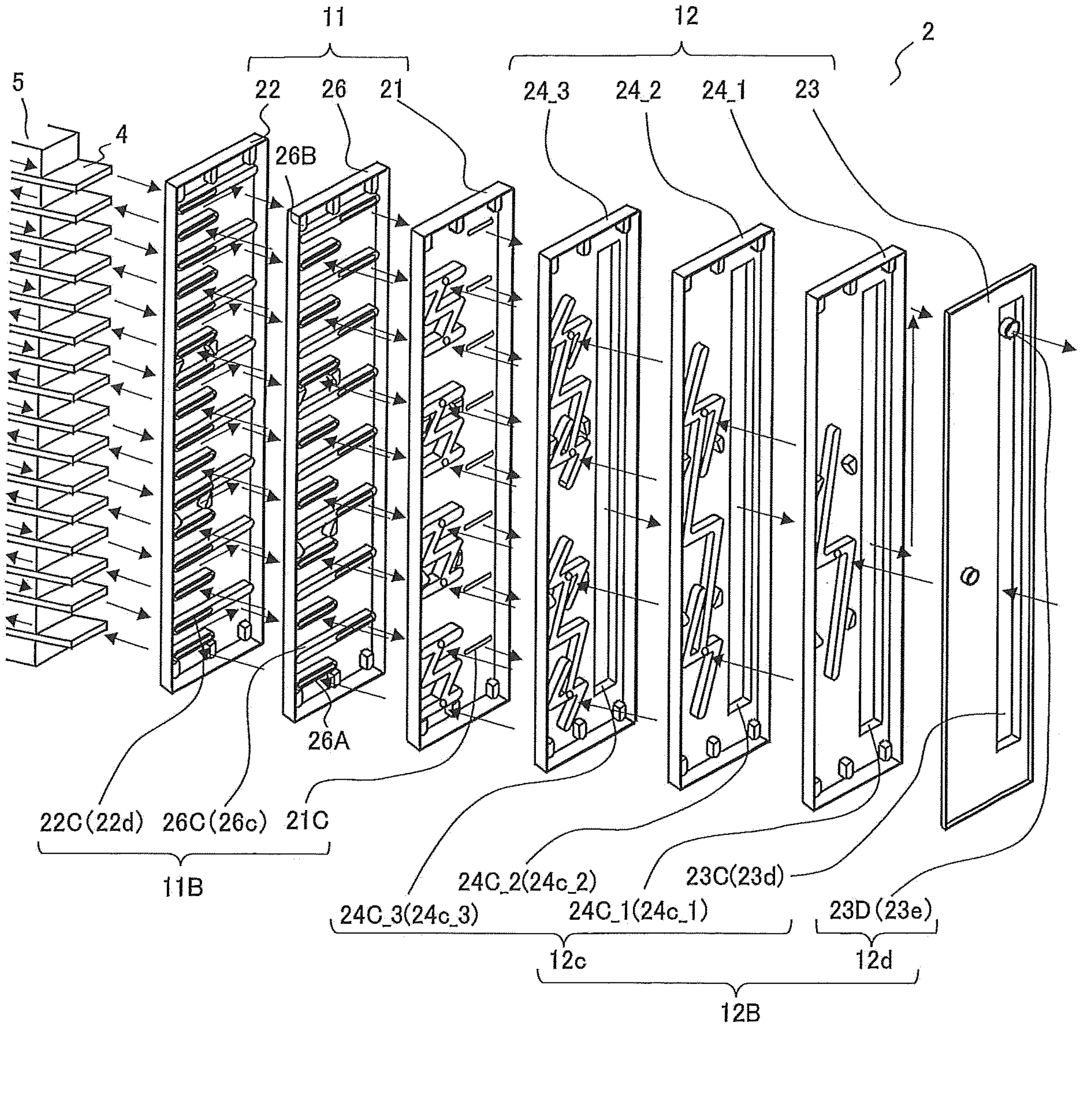
4
5
2
2D
2A
2B
2C

F I G. 1 6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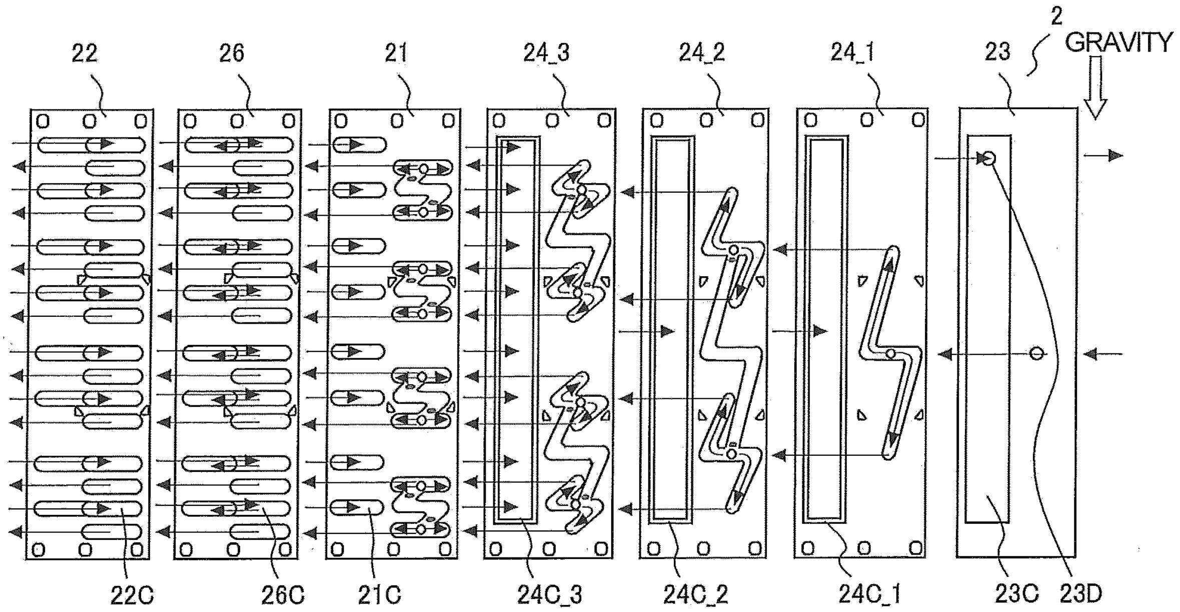
12B

F I G. 1 7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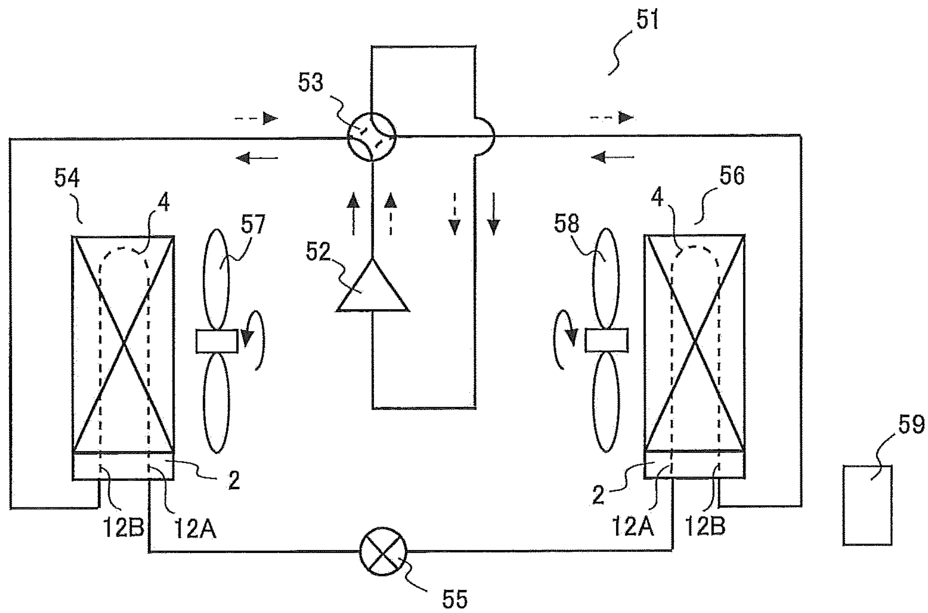
F I G. 1 8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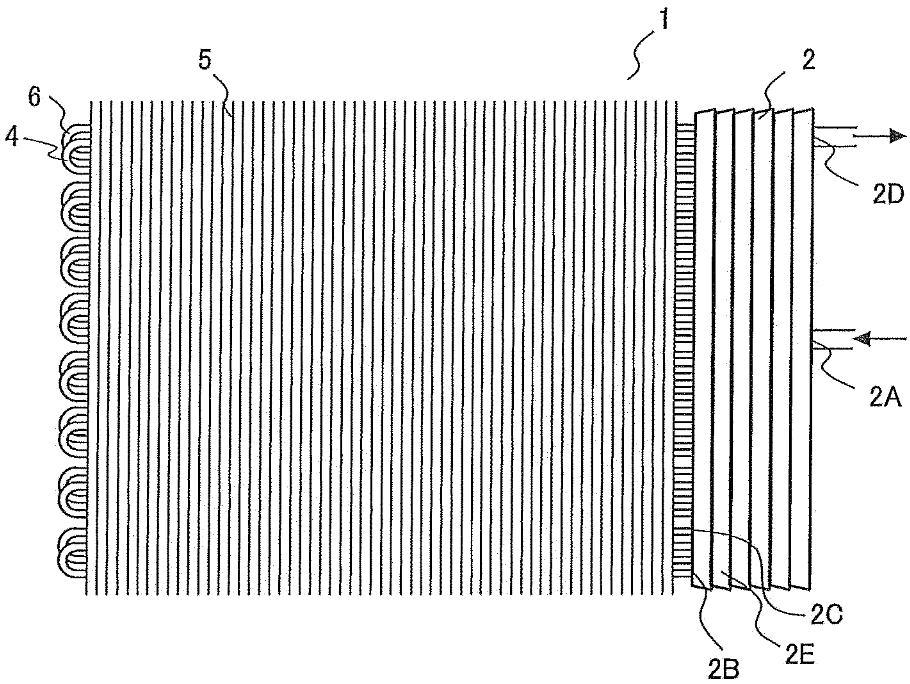
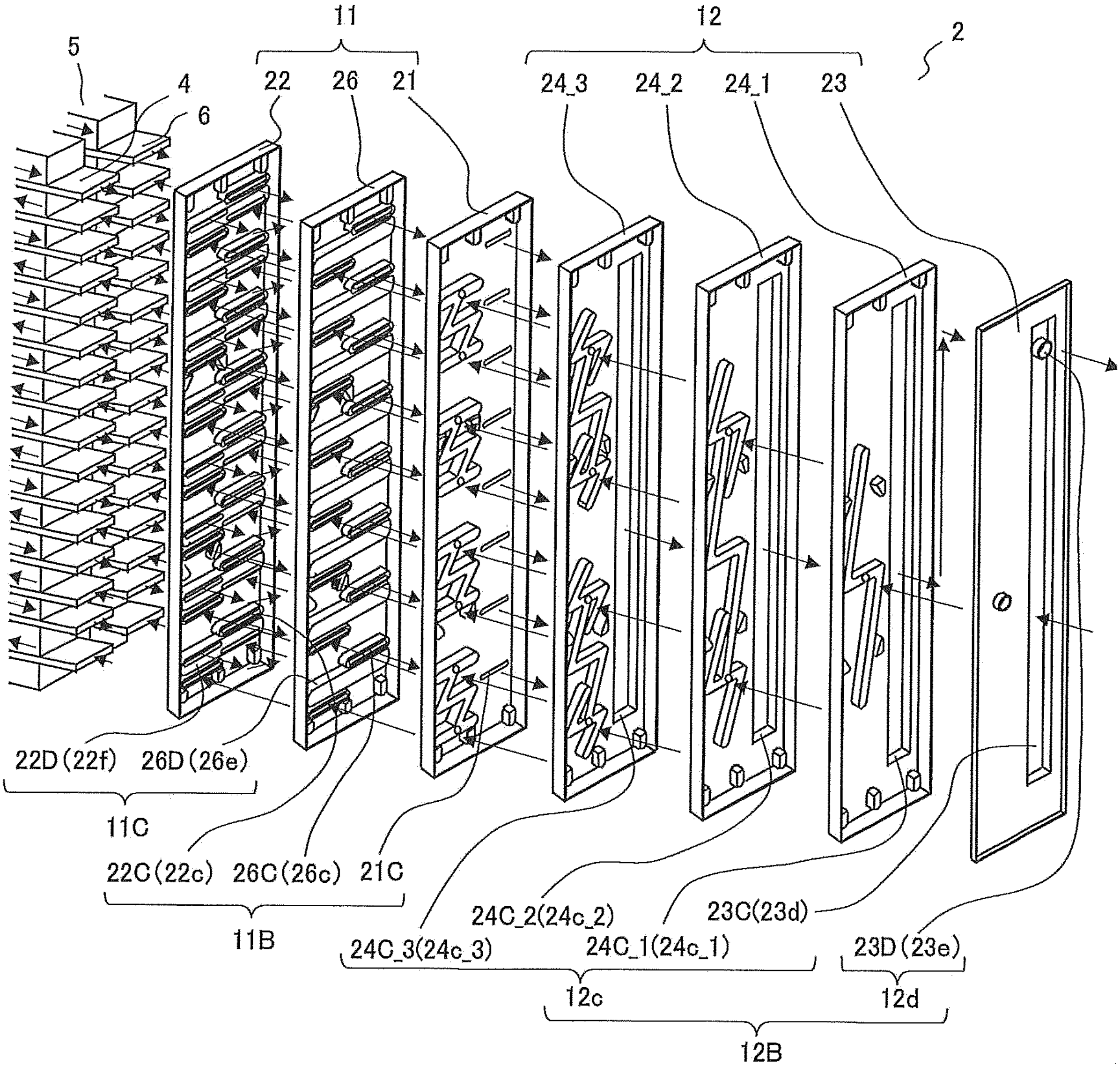
F I G. 1 9



F I G. 2 0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22C (22c)
26C (26c)
21C
11B
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12d
12B

FIG. 21

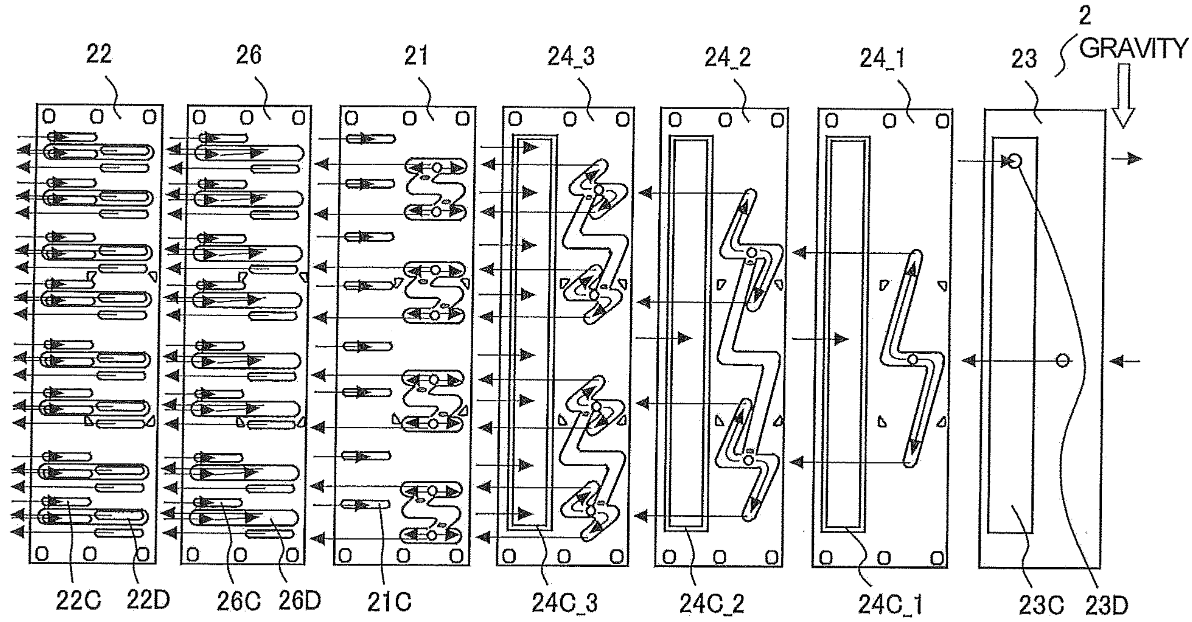
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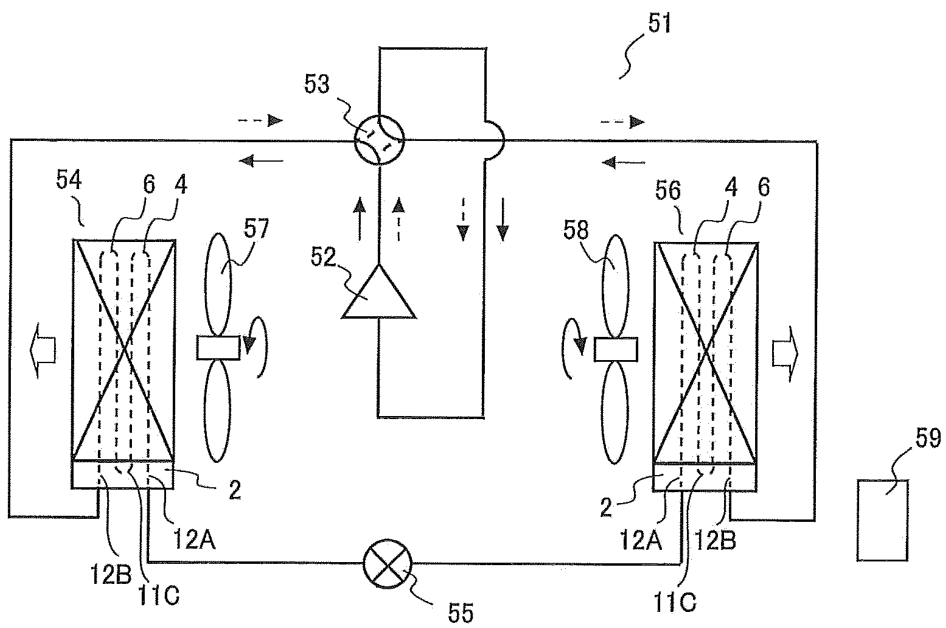
FIG. 22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59

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/063602

A. CLASSIFICATION OF SUBJECT MATTER
F28F9/02(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

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	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 6-11291 A (Nartron Corp.), 21 January 1994 (21.01.1994), fig. 1 to 9 & US 5242016 A	1-14
A	JP 2007-298197 A (Showa Denko Kabushiki Kaisha), 15 November 2007 (15.11.2007), fig. 1 to 7 & US 2007/0251682 A1	1-14

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

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"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 July, 2013 (12.07.13)	23 July, 2013 (23.07.13)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2000161818 A **[0003]**