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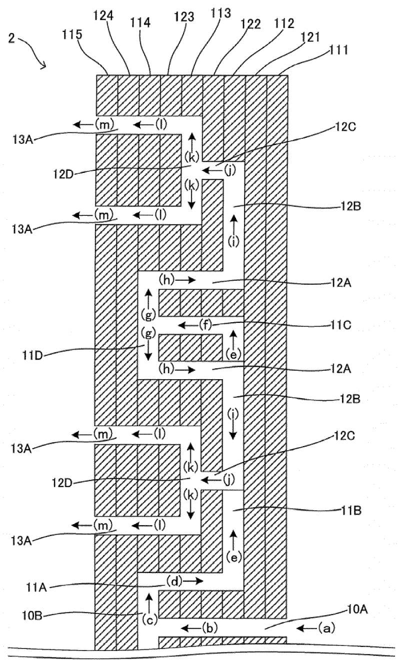
(54) **LAMINATED HEADER, HEAT EXCHANGER AND REFRIGERATION CYCLE DEVICE**

(57) In a laminated header, second flow passages and fourth flow passages are configured in such a manner that refrigerant flowing through each of the second flow passages and the fourth flow passages flows in a direction opposite to a direction in which the refrigerant flows through each of a first flow passage, third flow passages, fifth flow passages, and sixth flow passages.

FIG. 5



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Description

Technical Field

[0001] The present invention relates to a laminated header that distributes and supplies refrigerant, a heat exchanger provided with this laminated header, and a refrigeration cycle apparatus provided with this heat exchanger.

Background Art

[0002] For reducing a pressure loss of refrigerant flowing in a heat transfer tube, a typical heat exchanger includes flow passages formed by arranging a plurality of heat transfer tubes in parallel. A header that distributes and supplies the refrigerant to each heat transfer tube is disposed at a refrigerant inlet of each heat transfer tube. As the header, a laminated header has been known. This laminated header is formed by laminating a plurality of plates in which a distribution flow passage is formed, the distribution flow passage branching into a plurality of outlet flow passages for one inlet flow passage, to distribute and supply refrigerant to each heat transfer tube of a heat exchanger (e.g., see Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: WO 2016/071946

Summary of Invention

Technical Problem

[0004] In the laminated header, a distribution ratio of the refrigerant for each heat transfer tube of the heat exchanger is desirably kept uniform to uniformly supply the refrigerant to each heat transfer. Especially when the heat exchanger is to act as an evaporator, for ensuring the performance of the heat exchanger that acts as the evaporator, it is important to keep uniform a ratio of a flow rate of liquid refrigerant that flows out of each of the plurality of outlet flow passages, that is, the distribution ratio of the refrigerant.

[0005] In the laminated header of Patent Literature 1, the liquid refrigerant may come into an uneven state in the distribution flow passage as the refrigerant repeatedly branches in the branching flow passage, and the liquid refrigerant may nonuniformly flows out of each of the plurality of refrigerant outlets. Then, the refrigerant is nonuniformly supplied to each heat transfer tube of the heat exchanger, leading to deterioration in heat exchange performance.

[0006] The present invention has been made in view of the problem as described above, and it is an object of the present invention to provide a laminated header, a heat exchanger, and a refrigeration cycle apparatus, the laminated header being configured to uniformly distribute refrigerant to each heat transfer tube of the heat exchanger.

Solution to Problem

[0007] A laminated header according to an embodiment of the present invention includes one first opening, a plurality of second openings, and a distribution flow passage communicating between the first opening and each of the plurality of second openings, the laminated header including a plurality of plates that are laminated, the distribution flow passage includes a first flow passage communicating with the first opening and having a linear shape extending in a direction in which the plurality of plates are laminated, a first branching flow passage communicating with the first flow passage and branching the first flow passage into a plurality of flow passages, a plurality of second flow passages communicating with the first branching flow passage and each having a linear shape extending in the direction in which the plurality of plates are laminated, a first return flow passage communicating with each of the plurality of second flow passages and extending in a longitudinal direction of a same plate of the plurality of plates, a plurality of third flow passages each communicating with a corresponding one of the first return flow passages and each having a linear shape extending in the direction in which the plurality of plates are laminated, a second branching flow passage communicating with each of the plurality of third flow passages and branching each of the plurality of third flow passages into a plurality of flow passages, a plurality of fourth flow passages communicating with the second branching flow passage and each having a linear shape extending in the direction in which the plurality of plates are laminated, a second return flow passage communicating with each of the plurality of fourth flow passages and extending in a longitudinal direction of a same plate of the plurality of plates, a plurality of fifth flow passages each communicating with a corresponding one of the second return flow passages and each having a linear shape extending in the direction in which the plurality of plates are laminated, a third branching flow passage communicating with each of the plurality of fifth flow passages and branching each of the plurality of fifth flow passages into a plurality of flow passages, and a plurality of sixth flow passages communicating with the third branching flow passage and each having a linear shape extending in the direction in which the plurality of plates are laminated, and the plurality of second flow passages and the plurality of fourth flow passages are configured in such a manner that refrigerant flowing through each of the plurality of second flow passages and the plurality of fourth flow passages flows in a direction opposite to a flow direction of the refrigerant flowing through each of the first flow passage, the plurality of third flow passages, the plurality of fifth flow passages, and the plurality of sixth flow passages.

Advantageous Effects of Invention

[0008] In the laminated header according to an embodiment of the present invention, each of the first flow passage, the second flow passages, the third flow passages, the fourth flow passages, the fifth flow passages, and the sixth flow passages that are linear portions is formed to have a certain length, so that it is possible to prevent the uneven state of the refrigerant and make a distribution ratio uniform.

Brief Description of Drawings

[0009]

Fig. 1 is a front view schematically illustrating a configuration of a heat exchanger according to Embodiment 1 of the present invention.
Fig. 2 is an explanatory view for describing first plates constituting the laminated header according to Embodiment 1 of the present invention.
Fig. 3 is an explanatory view for describing second plates constituting the laminated header according to Embodiment 1 of the present invention.
Fig. 4 is an exploded perspective view for schematically illustrating a state in which the laminated header according to Embodiment 1 of the present invention has been disassembled.
Fig. 5 is a longitudinal sectional view for describing a flow of refrigerant in the laminated header according to Embodiment 1 of the present invention.
Fig. 6 is a circuit configuration diagram schematically illustrating an example of a refrigerant circuit configuration of an air-conditioning apparatus that is an example of a refrigeration cycle apparatus according to Embodiment 2 of the present invention.

Description of Embodiments

[0010] Hereinafter, a laminated header, a heat exchanger, and a refrigeration cycle apparatus according to the present invention will be described with reference to the drawings.

[0011] Note that configurations, operations, and other features described below are merely examples, and the laminated header, the heat exchanger, and the refrigeration cycle apparatus according to the present invention are not limited to those having such configurations, operations, and other features. In the drawings, the same or similar components are provided with the same reference sign, or provision of the reference sign is omitted. Illustration of a detailed structure is simplified or omitted as appropriate. Overlapping description or similar description is simplified or omitted as appropriate.

[0012] In the following, a case will be described where the laminated header according to the present invention distributes refrigerant flowing into a heat exchanger, but the laminated header is not limited to such a case and may be a laminated header that distributes refrigerant flowing into other device. Further, a case will be described where the heat exchanger according to the present invention is applied to an air-conditioning apparatus, which is an example of the refrigeration cycle apparatus, but the heat exchanger is not limited to such a case and may be applied to another refrigeration cycle apparatus having a refrigerant cycle circuit, for example. Moreover, a case will be described where the refrigeration cycle apparatus switches between a heating operation (heating-up operation) and a cooling operation (cooling-down operation), but the refrigeration cycle apparatus is not limited to such a case and may be a refrigeration cycle apparatus that performs only the heating operation or the cooling operation.

Embodiment 1

[0013] A laminated header 2 and a heat exchanger 1 according to Embodiment 1 of the present invention will be described.

<Configuration of heat exchanger 1>

[0014] Hereinafter, a schematic configuration of the heat exchanger 1 according to Embodiment 1 will be described.

[0015] Fig. 1 is a front view schematically illustrating a configuration of the heat exchanger 1 according to Embodiment 1. In Fig. 1, a flow direction of refrigerant is indicated by an arrow.

[0016] As illustrated in Fig. 1, the heat exchanger 1 includes the laminated header 2, a cylindrical header 3, a plurality of heat transfer tubes 4, a retainer 5, and a plurality of fins 6.

[0017] Instead of the cylindrical header 3, a header of the same type as the laminated header 2 may be used.

[0018] The laminated header 2 includes one refrigerant inflow port 2A and a plurality of refrigerant outflow ports 2B. Inside the laminated header 2, at least one distribution flow passage communicating between the one refrigerant inflow port 2A and the plurality of refrigerant outflow ports 2B is formed. A refrigerant pipe 20A of a refrigeration cycle apparatus is connected to the refrigerant inflow port 2A. One end portion 4A of a heat transfer tube 4 is connected to each refrigerant outflow port 2B.

[0019] Note that the refrigerant inflow port 2A corresponds to the "first opening" of the present invention. The refrigerant outflow port 2B corresponds to the "second opening" of the present invention.

[0020] The cylindrical header 3 includes a plurality of refrigerant inflow ports 3A and one refrigerant outflow port 3B. Inside the cylindrical header 3, a merging flow passage communicating between the plurality of refrigerant inflow ports 3A and the one refrigerant outflow port 3B is formed. The other end portion 4B of the heat transfer tube 4 is connected to each refrigerant inflow port 3A. A refrigerant pipe 20B of the refrigeration cycle apparatus is connected to the refrigerant outflow port 3B.

[0021] The one end portion 4A of the heat transfer tubes 4 is connected to each refrigerant outflow port 2B of the laminated header 2, and the other end portion 4B of the heat transfer tube 4 is connected to each refrigerant inflow port 3A of the cylindrical header 3. That is, the plurality of heat transfer tubes 4 are connected between the laminated header 2 and the cylindrical header 3 to connect between the laminated header 2 and the cylindrical header 3. The one end portion 4A, which is the end portion of the heat transfer tube 4 close to the laminated header 2 is connected to the refrigerant outflow port 2B of the laminated header 2 in such a manner that the heat transfer tube 4 is retained by the retainer 5. The heat transfer tube 4 is a flat tube having a plurality of flow passages formed in the heat transfer tube 4, or a circular tube. The heat transfer tube 4 is made of copper or aluminum, for example. The plurality of fins 6 are joined to the circumference of the heat transfer tube 4.

[0022] Although Fig. 1 illustrates a case where eight heat transfer tubes 4 are provided, the number of heat transfer tubes 4 is not limited to the illustrated number and is only required to be two or more.

[0023] The retainer 5 is made up of a plate and has a hole portion through which the one end portion 4A of each heat transfer tube 4 is inserted. That is, by insertion of the heat transfer tube 4 through the hole portion of the retainer 5, the retainer 5 retains a part of the periphery of the heat transfer tube 4. The retainer 5 is made of aluminum, for example.

[0024] The fin 6 is made of aluminum, for example. The heat transfer tube 4 and the fin 6 are joined by brazing, for example.

[0025] Note that the number of fins 6 is not limited.

<Flow of refrigerant in heat exchanger 1>

[0026] In the following, the flow of the refrigerant in the heat exchanger 1 will be described. The flow of the refrigerant in the case of the heat exchanger 1 acting as an evaporator will be described.

[0027] The refrigerant flowing through the refrigerant pipe 20A of the refrigeration cycle apparatus flows into the laminated header 2 via the refrigerant inflow port 2A. The refrigerant having flown into the laminated header 2 is distributed in the distribution flow passage formed inside the laminated header 2 and flows into the plurality of heat transfer tubes 4 via the plurality of refrigerant outflow ports 2B. In the plurality of heat transfer tubes 4, the refrigerant exchanges heat with, for example, air supplied by a fan. The refrigerant flowing through each of the plurality of heat transfer tubes 4 flows into the cylindrical header 3 via each of the plurality of refrigerant inflow ports 3A. The refrigerant having flown into the cylindrical header 3 merges in the merging flow passage formed inside the cylindrical header 3 and flows out toward the refrigerant pipe 20B via the refrigerant outflow port 3B.

[0028] In the heat exchanger 1, the refrigerant can flow reversely, namely, flow from the cylindrical header 3 toward the laminated header 2. That is, when the heat exchanger 1 acts as a condenser, the refrigerant flows from the cylindrical header 3 toward the laminated header 2.

<Configuration of laminated header 2>

[0029] In the following, the configuration of the laminated header 2 will be described. Fig. 2 is an explanatory view for describing first plates constituting the laminated header 2. Fig. 3 is an explanatory view for describing second plates constituting the laminated header 2. Fig. 4 is an exploded perspective view for schematically illustrating a state in which the laminated header 2 has been disassembled. Note that Fig. 2 schematically illustrates a state in which each first plate is seen from the flow direction of the refrigerant. Similarly, Fig. 3 schematically illustrates a state in which each second plate is seen from the flow direction of the refrigerant. In Fig. 4, the flow of the refrigerant is indicated by a broken line arrow. The state of being seen from the flow direction of the refrigerant refers to the state of being seen from the refrigerant inflow port 2A of the laminated header 2.

[0030] As illustrated in Figs. 2 and 4, the laminated header 2 includes a first plate 111, a first plate 112, a first plate 113, a first plate 114, and a first plate 115. The first plate 111, the first plate 112, the first plate 113, the first plate 114, and the first plate 115 are each made up of a plate-like material in a rectangular shape having a thickness of about 1 to 10 mm, for example. Alternatively, the first plate 111, the first plate 112, the first plate 113, the first plate 114, and the first plate 115 are each made of aluminum, for example.

[0031] When it is not particularly necessary to describe the first plates separately in the following description, the first plate 111, the first plate 112, the first plate 113, the first plate 114, and the first plate 115 are collectively called a first plate.

[0032] Further, as illustrated in Figs. 3 and 4, the laminated header 2 includes a second plate 121, a second plate 122, a second plate 123, and a second plate 124. The second plate 121, the second plate 122, the second plate 123, and the second plate 124 are each made up of a plate-like material in a rectangular shape having a thickness of about 1 to 10 mm, for example. The second plate 121, the second plate 122, the second plate 123, and the second plate 124 are each made of aluminum, for example.

[0033] When it is not particularly necessary to describe the second plates separately in the following description, the second plate 121, the second plate 122, the second plate 123, and the second plate 124 are collectively called a second plate.

(First plate 111)

[0034] The first plate 111 has one circular through hole 10a-1 opened in the first plate 111 in the state of being seen from the flow direction of the refrigerant. The through hole 10a-1 serves as the refrigerant inflow port 2A. The through hole 10a-1 is opened at a center portion of the first plate 111.

(First plate 112)

[0035] The first plate 112 has one circular through hole 10a-3 opened in the first plate 112 in the state of being seen from the flow direction of the refrigerant. The through hole 10a-3 is opened at a center portion of the first plate 112.

[0036] The first plate 112 has four linear through holes 12b opened in the first plate 112 in the state of being seen from the flow direction of the refrigerant. The four through holes 12b are opened to be linearly arrayed in a vertical direction on the drawing.

[0037] The first plate 112 has two curved through holes 11b opened in the first plate 112 in the state of being seen from the flow direction of the refrigerant. The through hole 11b on the upper portion of the drawing is opened to bypass the through hole 12b that is second from the top of the drawing. The through hole 11b on the lower portion of the drawing is opened to bypass the through hole 12b that is second from the bottom of the drawing. The two through holes 11b are opened to be point symmetric to each other about the through hole 10a-3. Note that the shape of the through hole 11b is not limited to the illustrated shape and may be any shape as long as the through hole 11b bypasses the through hole 12b.

(First plate 113)

[0038] The first plate 113 has one circular through hole 10a-5 opened in the first plate 113 in the state of being seen from the flow direction of the refrigerant.

[0039] Further, the first plate 113 has two circular through holes 11a-2 opened in the first plate 113 in the state of being seen from the flow direction of the refrigerant. The through holes 11a-2 are opened adjacently to the through hole 10a-5, to be located symmetrically about the through hole 10a-5.

[0040] Moreover, the first plate 113 has four substantially S-shaped through holes 12d opened in the first plate 113 in the state of being seen from the flow direction of the refrigerant. The four through holes 12d are opened to be arrayed in the vertical direction on the drawing.

[0041] Furthermore, the first plate 113 has two circular through holes 11c-2 opened in the first plate 113 in the state of being seen from the flow direction of the refrigerant. The through hole 11 c-2 on the upper portion of the drawing is opened at a center portion between the two through holes 12d on the upper portion of the drawing. The through hole 11c-2 on the lower portion of the drawing is opened at a center portion between the two through holes 12d on the lower portion of the drawing.

[0042] Additionally, the first plate 113 has four circular through holes 12a-2 opened in the first plate 113 in the state of being seen from the flow direction of the refrigerant. The two through holes 12a-2 on the upper portion of the drawing are opened adjacently to the through hole 11c-2 on the upper portion of the drawing, to be arrayed in the vertical direction on the drawing. The two through holes 12a-2 on the lower portion of the drawing are opened adjacently to the through hole 11 c-2 on the lower portion of the drawing, to be arrayed in the vertical direction on the drawing.

(First plate 114)

[0043] The first plate 114 has eight circular through holes 13a-2 opened in the first plate 114 in the state of being seen from the flow direction of the refrigerant. The eight through holes 13a-2 are opened to be arrayed in the vertical direction on the drawing. Further, the eight through holes 13a-2 are arranged in such a manner that two vertically arrayed through holes 13a-2 are defined as one group. That is, the eight through holes 13a-2 are arranged to be vertically arrayed, with two through holes 13a-2 that communicate with the same one third branching flow passage 12D defined as one group.

[0044] The through hole 13a-2 that is first from the top of the drawing and the through hole 13a-2 that is second from the top of the drawing are defined as one group. The through hole 13a-2 that is third from the top of the drawing and the through hole 13a-2 that is fourth from the top of the drawing are defined as one group. The through hole 13a-2 that is fifth from the top of the drawing and the through hole 13a-2 that is sixth from the top of the drawing are defined as one group. The through hole 13a-2 that is seventh from the top of the drawing and the through hole 13a-2 that is eighth from the top of the drawing are defined as one group.

[0045] Moreover, the first plate 114 has two substantially S-shaped through holes 11d and one substantially S-shaped through hole 10b opened in the first plate 114 in the state of being seen from the flow direction of the refrigerant. The one through hole 10b and the two through holes 11d are opened to be arrayed in the vertical direction on the drawing. The through hole 11d on the upper portion of the drawing is opened between the through holes 13a-2 that are second and third from the top of the drawing. The through hole 11b between the through holes 11d is opened between the through holes 13a-2 that are fourth and fifth from the top of the drawing. The through hole 11d on the lower portion of the drawing is opened between the through holes 13a-2 that are sixth and seventh from the top of the drawing.

(First plate 115)

[0046] The first plate 115 has eight circular through holes 13a-4 opened in the first plate 115 in the state of being seen from the flow direction of the refrigerant. The eight through holes 13a-4 are opened to be arrayed in the vertical direction on the drawing. The eight through holes 13a-4 are arranged in such a manner that two vertically arrayed through holes 13a-4 are defined as one group. That is, the eight through holes 13a-4 are arranged to be vertically arrayed, with two through holes 13a-4 that communicate with the same one third branching flow passage 12D defined as one group. The through hole 13a-4 serves as the refrigerant outflow port 2B.

(Second plate 121)

[0047] The second plate 121 has one circular through hole 10a-2 opened in the second plate 121 in the state of being seen from the flow direction of the refrigerant. The through hole 10a-2 is opened at a center portion of the second plate 121.

(Second plate 122)

[0048] The second plate 122 has one circular through hole 10a-4 opened in the second plate 122 in the state of being seen from the flow direction of the refrigerant. The through hole 10a-4 is opened at a center portion of the second plate 122.

[0049] Further, the second plate 122 has two circular through holes 11a-3 opened in the second plate 122 in the state of being seen from the flow direction of the refrigerant. The through holes 11a-3 are opened adjacently to the through hole 10a-4, to be located symmetrically about the through hole 10a-4.

[0050] Moreover, the second plate 122 has four circular through holes 12c opened in the second plate 122 in the state of being seen from the flow direction of the refrigerant. The four through holes 12c are opened to be arrayed in the vertical direction on the drawing.

[0051] Furthermore, the second plate 122 has two circular through holes 11 c-1 opened in the second plate 122 in the state of being seen from the flow direction of the refrigerant. The through hole 11 c-1 on the upper portion of the drawing is opened at a center portion between the through holes 12c that are first and second from the top of the drawing. The through hole 11 c-1 on the lower portion of the drawing is opened at a center portion between the through holes 12c that are first and second from the bottom of the drawing.

[0052] Additionally, the second plate 122 has four circular through holes 12a-3 opened in the second plate 122 in the state of being seen from the flow direction of the refrigerant. The through holes 12a-3 that are first and second from the top of the drawing are opened adjacently to the through hole 11c-1 on the upper portion of the drawing, to be located symmetrically about the through hole 11c-1 on the upper portion of the drawing. The through holes 12a-3 that are first and second from the bottom of the drawing are opened adjacently to the through hole 11c-1 on the lower portion of the drawing, to be located symmetrically about the through hole 11c-1 on the lower portion of the drawing.

(Second plate 123)

[0053] The second plate 123 has one circular through hole 10a-6 opened in the second plate 123 in the state of being seen from the flow direction of the refrigerant. The through hole 10a-6 is opened at a center portion of the second plate 123.

[0054] Further, the second plate 123 has two circular through holes 11 a-1 opened in the second plate 123 in the state of being seen from the flow direction of the refrigerant. The through holes 11 a-1 are opened adjacently to the through hole 10a-5, to be located symmetrically about the through hole 10a-6.

[0055] Moreover, the second plate 123 has eight circular through holes 13a-1 opened in the second plate 123 in the state of being seen from the flow direction of the refrigerant. The eight through holes 13a-1 are opened to be arrayed in the vertical direction on the drawing. The eight through holes 13a-1 are arranged in such a manner that two vertically arrayed through holes 13a-1 are defined as one group. That is, the eight through holes 13a-1 are arranged to be vertically arrayed, with two through holes 13a-1 that communicate with the same one third branching flow passage 12D defined as one group.

[0056] Furthermore, the second plate 123 has two circular through holes 11 c-3 opened in the second plate 123 in the state of being seen from the flow direction of the refrigerant. The through hole 11c-3 on the upper portion of the drawing is opened at a center portion between the through holes 13a-1 that are second and third from the top of the drawing. The through hole 11c-3 on the lower portion of the drawing is opened at a center portion between the through holes 13a-1 that are second and third from the bottom of the drawing.

[0057] Additionally, the second plate 123 has four circular through holes 12a-1 opened in the second plate 123 in the state of being seen from the flow direction of the refrigerant. The through holes 12a-1 that are first and second from the top of the drawing are opened adjacently to the through hole 11c-3 on the upper portion of the drawing, to be located symmetrically about the through hole 11c-3 on the upper portion of the drawing. The through holes 12a-1 that are first and second from the bottom of the drawing are opened adjacently to the through hole 11c-3 on the lower portion of the drawing, to be located symmetrically about the through hole 11c-3 on the lower portion of the drawing.

(Second plate 124)

[0058] The second plate 124 has eight circular through holes 13a-3 opened in the second plate 124 in the state of being seen from the flow direction of the refrigerant. The eight through holes 13a-3 are opened to be arrayed in the vertical direction on the drawing. The eight through holes 13a-3 are arranged in such a manner that two vertically arrayed through holes 13a-3 are defined as one group. That is, the eight through holes 13a-3 are arranged to be vertically arrayed, with two through holes 13a-3 that communicate with the same one third branching flow passage 12D defined as one group.

(Laminated header 2)

[0059] The laminated header 2 is constituted by alternately laminating the first plates and the second plates made up as above. That is, the laminated header 2 is constituted by placing each of the second plates between corresponding two of the first plates.

[0060] A brazing material is applied to both surfaces or one surface of the second plate.

[0061] The first plates are laminated with the second plate interposed between the first plates and integrally joined together by brazing.

[0062] Specifically, the second plate 121 is placed between the first plate 111 and the first plate 112. The second plate 122 is placed between the first plate 112 and the first plate 113. The second plate 123 is placed between the first plate 113 and the first plate 114. The second plate 124 is placed between the first plate 114 and the first plate 115.

[0063] By laminating the first plates and the second plates, a distribution flow passage that communicates between the refrigerant inflow port 2A and the plurality of refrigerant outflow ports 2B is formed. The distribution flow passage is made up of a first flow passage 10A, a first branching flow passage 10B, second flow passages 11A, first return flow passages 11B, third flow passages 11C, second branching flow passages 11D, fourth flow passages 12A, second return flow passages 12B, fifth flow passages 12C, third branching flow passages 12D, and sixth flow passages 13A. Herein, a case where the refrigerant is branched into eight flows is shown as an example. Specifically, as illustrated in Fig. 4, one first flow passage 10A and one branching flow passage 10B are formed. Two second flow passages 11A, two first return flow passages 11B, two third flow passages 11C, and two second branching flow passages 11D are formed. Four fourth flow passages 12A, four second return flow passages 12B, four fifth flow passages 12C, and four third branching flow passages 12D are formed. Then, eight sixth flow passages 13A are formed.

[0064] By communication among the through hole 10a-1, the through hole 10a-2, the through hole 10a-3, the through hole 10a-4, the through hole 10a-5, and the through hole 10a-6, the first flow passage 10A is formed in a linear shape extending in the direction in which the first plates and the second plates are laminated. That is, in a state where the first plates and the second plates are laminated, the through hole 10a-1, the through hole 10a-2, the through hole 10a-3, the through hole 10a-4, the through hole 10a-5, and the through hole 10a-6 are opened at positions facing each other to communicate with each other.

[0065] Note that the through hole 10b serving as the first branching flow passage 10B is opened at a position across the through hole 10a-6 from the through hole 10a-5. The first flow passage 10A is communicated with the center of the first branching flow passage 10B.

[0066] The first branching flow passage 10B is constituted of the through hole 10b. That is, the first branching flow passage 10B communicates with the first flow passage 10A and branches the first flow passage 10A into a plurality of flow passages. Consequently, the refrigerant having flown through the first flow passage 10A is branched in the first branching flow passage 10B into two flows in the vertical direction on the drawing. The first branching flow passage 10B causes the refrigerant to flow in the reverse direction. The second flow passage 11A is communicated with each of both end portions of the first branching flow passage 10B.

[0067] By communication among the through hole 11a-1, the through hole 11a-2, and the through hole 11a-3, the second flow passage 11A is formed in the linear shape extending in the direction in which the first plates and the second plates are laminated. That is, in the state where the first plates and the second plates are laminated, the through hole 11a-1, the through hole 11a-2, and the through hole 11a-3 are opened at positions facing each other to communicate with each other. In the second flow passage 11A, the refrigerant flows in the direction opposite to the direction in which the refrigerant flows through the first flow passage 10A.

[0068] Note that the through hole 11b serving as the first return flow passage 11 B is opened at a position across the through hole 11a-3 from the through hole 11a-2. Then, the second flow passage 11A is communicated with one end portion of the first return flow passage 11B.

[0069] The first return flow passage 11 B is constituted of the through hole 11b extending in the longitudinal direction of the first plate 112. The refrigerant having flown through the second flow passage 11A flows into the first return flow passage 11 B through the one end portion of the first return flow passage 11B, flows in the longitudinal direction of the first plate 112, and flows out of the first return flow passage 11 B through the other end portion of the first return flow passage 11B. In the first return flow passage 11B, the second flow passage 11A is communicated with the one end portion and the third flow passage 11C is communicated with the other end portion, to cause the refrigerant to flow in the reverse direction. Note that the longitudinal direction of the first plate 112 is the vertical direction of the first plate 112 on the drawing.

[0070] By communication among the through hole 11c-1, the through hole 11c-2, and the through hole 11c-3, the third flow passage 11C is formed in the linear shape extending in the direction in which the first plates and the second plates are laminated. That is, in the state where the first plates and the second plates are laminated, the through hole 11c-1, the through hole 11c-2, and the through hole 11c-3 are opened at positions facing each other to communicate with each other. In the third flow passage 11C, the refrigerant flows in the direction opposite to the direction in which the refrigerant flows through the second flow passage 11A.

[0071] Note that the through hole 11d serving as the second branching flow passage 11 D is opened at a position across the through hole 11c-3 from the through hole 11c-2. The third flow passage 11C is communicated with the center of the second branching flow passage 11D.

[0072] The second branching flow passage 11D is constituted of the through hole 11d. That is, the second branching flow passage 11D communicates with the third flow passage 11C and branches the third flow passage 11C into a plurality of flow passages. Consequently, the refrigerant having flown through the third flow passage 11C is branched in the second branching flow passage 11D into two flows in the vertical direction on the drawing. The second branching flow passage 11D causes the refrigerant to flow in the reverse direction. The fourth flow passage 12A is communicated with each of both end portions of the second branching flow passage 11D.

[0073] By communication among the through hole 12a-1, the through hole 12a-2, and the through hole 12a-3, the fourth flow passage 12A is formed in the linear shape extending in the direction in which the first plates and the second plates are laminated. That is, in the state where the first plates and the second plates are laminated, the through hole 12a-1, the through hole 12a-2, and the through hole 12a-3 are opened at positions facing each other to communicate with each other. In the fourth flow passage 12A, the refrigerant flows in the direction opposite to the direction in which the refrigerant flows through the third flow passage 11C.

[0074] Note that the through hole 12b serving as the second return flow passage 12B is opened at a position across the through hole 12a-3 from the through hole 12a-2. Then, the fourth flow passage 12A is communicated with one end portion of the second return flow passage 12B.

[0075] The second return flow passage 12B is constituted of the through hole 12b extending in the longitudinal direction of the first plate 112. The refrigerant having flown through the fourth flow passage 12A flows into the second return flow passage 12B through the one end portion of the second return flow passage 12B, flows in the flow direction of the refrigerant in the first plate 112, and flows out of the second return flow passage 12B through the other end portion of the second return flow passage 12B. In the second return flow passage 12B, the fourth flow passage 12A is communicated with the one end portion and the fifth flow passage 12C is communicated with the other end portion, to cause the refrigerant to flow in the reverse direction. Note that the longitudinal direction of the first plate 112 is the vertical direction of the first plate 112 on the drawing.

[0076] By the through hole 12c, the fifth flow passage 12C is formed in the linear shape extending in the direction in which the first plates and the second plates are laminated. That is, in the state where the first plates and the second plates are laminated, the through hole 12c is opened at a position where the other end portion of the second return flow passage 12B and the center of the third branching flow passage 12D face each other to communicate with each other. In the fifth flow passage 12C, the refrigerant flows in the direction opposite to the direction in which the refrigerant flows through the fourth flow passage 12A.

[0077] The third branching flow passage 12D is constituted of the through hole 12d. That is, the third branching flow passage 12D communicates with the fifth flow passage 12C and branches the fifth flow passage 12C into a plurality of flow passages. Consequently, the refrigerant having flown through the fifth flow passage 12C is branched in the third branching flow passage 12D into two flows in the vertical direction on the drawing. The sixth flow passage 13A is communicated with each of both end portions of the third branching flow passage 12D.

[0078] Note that the refrigerant in the third branching flow passage 12D is not caused to flow in the reverse direction.

[0079] By communication among the through hole 13a-1, the through hole 13a-2, the through hole 13a-3, and the through hole 13a-4, the sixth flow passage 13A is formed in the linear shape extending in the direction in which the first plates and the second plates are laminated. That is, in the state where the first plates and the second plates are laminated, the through hole 13a-1, the through hole 13a-2, the through hole 13a-3, and the through hole 13a-4 are opened at positions facing each other to communicate with each other. In the sixth flow passage 13A, the refrigerant flows in the same direction as the direction in which the refrigerant flows through the fifth flow passage 12C.

[0080] Note that the through hole 13a-1 is opened at a position opposite to each of both end portions of the through hole 12d.

[0081] The first plate and the second plate are processed by pressing or cutting. In the case of processing the first plate and the second plate by pressing, plates each having a thickness equal to or smaller than 5 mm and being processable with the pressing may be used. In the case of processing the first plate and the second plate by cutting, plates each having a thickness equal to or larger than 5 mm may be used.

[0082] The refrigerant pipe 20A is connected to the first flow passage 10A of the laminated header 2 via the refrigerant inflow port 2A. The through hole 10a-1 constituting the first flow passage 10A corresponds to the refrigerant inflow port 2A in Fig. 1.

[0083] The heat transfer tube 4 is connected to each of the sixth flow passages 13A of the laminated header 2 via a corresponding one of the refrigerant outflow ports 2B. The through holes 13a-4 each constituting the sixth flow passage 13A correspond to the refrigerant outflow ports 2B in Fig. 1.

[0084] Herein, when the first plates and the second plates are laminated and the distribution flow passage is formed, the first flow passage 10A is communicated with the center of the first branching flow passage 10B formed in the first plate 114.

[0085] Further, when the first plates and the second plates are laminated and the distribution flow passage is formed, the second flow passage 11A is communicated with each of both end portions of the first branching flow passage 10B.

[0086] As thus described, in the laminated header 2, the first plates and the second plates are laminated and brazed to communicate among through holes and form the distribution flow passage.

<Flow of refrigerant in laminated header 2>

[0087] Next, the distribution flow passage and the flow of the refrigerant in the laminated header 2 will be described.

[0088] Fig. 5 is a longitudinal sectional view for describing the flow of the refrigerant in the laminated header 2. In Fig. 5, the flows of the refrigerant are indicated by solid line arrows a to m. Further, in Fig. 5, the upper half of the drawing of the laminated header 2 is enlarged and schematically illustrated.

[0089] When the heat exchanger 1 acts as the evaporator, refrigerant that is in a two-phase gas-liquid state and flows through the refrigerant pipe 20A flows into the laminated header 2 from the through hole 10a-1 of the first plate 111 that serves as the refrigerant inflow port 2A (arrow a). The refrigerant having flown inside the laminated header 2 travels straight in the first flow passage 10A (arrow b) and collides with the surface of the second plate 124 in the first branching flow passage 10B of the first plate 114 to vertically branch in the gravity direction (arrow c). The refrigerant having branched in the first branching flow passage 10B travels to each of both end portions of the first branching flow passage 10B and flows into the pair of second flow passages 11A.

[0090] The refrigerant having flown into the second flow passages 11A travels straight (arrow d) in the second flow passages 11A in a direction opposite to the direction in which the refrigerant travels in the first flow passage 10A. This refrigerant is caused by the first return flow passage 11 B of the first plate 112 to flow in the reverse direction. That is, the refrigerant collides with the surface of the second plate 121 in the first return flow passages 11 B to change its flow direction (arrow e). The refrigerant having flown into the first return flow passage 11 B travels to the end portion of the first return flow passage 11B and flows into the third flow passage 11C.

[0091] The refrigerant having flown into the third flow passage 11C travels straight (arrow f) in the same direction as the direction in which the refrigerant travels in the first flow passage 10A. This refrigerant collides with the surface of the second plate 124 in the second branching flow passage 11D of the first plate 114 to vertically branch in the gravity direction (arrow g). The refrigerant having branched in the second branching flow passage 11D travels to each of both end portions of the second branching flow passage 11 D, and flows into the pair of fourth flow passages 12A formed to communicate with the one second branching flow passage 11 D.

[0092] The refrigerant having flown into the fourth flow passage 12A travels straight (arrow h) in the fourth flow passage 12A in the same direction as the direction in which the refrigerant travels in the second flow passage 11A. This refrigerant collides with the surface of the second plate 121 in the second return flow passage 12B of the first plate 112 to change its flow direction (arrow i). The refrigerant having flown into the second return flow passage 12B travels to the end portion of the second return flow passage 12B and flows into the fifth flow passage 12C. The refrigerant having flown into the fifth flow passage 12C travels straight (arrow j) in the fifth flow passage 12C in the same direction as the direction in which the refrigerant travels in the first flow passage 10A. This refrigerant collides with the surface of the second plate 123 in the third branching flow passage 12D of the first plate 113 to vertically branch in the gravity direction (arrow k). The refrigerant having branched in the third branching flow passage 12D travels to each of both end portions of the third branching flow passage 12D and flows into the pair of sixth flow passages 13A formed to communicate with the one third branching flow passage 12D.

[0093] The refrigerant having flown into the sixth flow passage 13A travels straight (arrow l) in the sixth flow passage 13A in a direction opposite to the direction in which the refrigerant travels in the fourth flow passage 12A. Then, the refrigerant flowing through the sixth flow passage 13A flows out of the sixth flow passage 13A (arrow m) and is uniformly distributed to each of the plurality of heat transfer tubes 4 via the flow passages of the retainer 5.

[0094] In Embodiment 1, the description has been given, as an example, to the case where the refrigerant passes in a branching flow passage three times and is branched into eight flows, but the number of times the refrigerant branches is not particularly limited.

<Regarding state of liquid film in distribution flow passage in laminated header>

[0095] Herein, a state of a liquid film in the laminated header 2 will be described.

[0096] The distribution flow passage of the laminated header 2 repeatedly bends at a right angle and branches at a plurality of positions to reach the plurality of refrigerant outflow ports 2B. When the refrigerant flows through the distribution flow passage, a large amount of liquid film of the refrigerant unevenly exists at portions in the inner circumference of the flow passages in the bending portions and the branching portions of the flow passages due to the centrifugal force. When the refrigerant flows into the next branching flow passage in this state, a large amount of the liquid refrigerant unevenly flows into portions of the branching flow passages, and the two-phase gas-liquid refrigerant cannot be uniformly distributed to the plurality of heat transfer tubes 4.

[0097] To solve the problem, in the laminated header 2, a linear portion ensured to have a certain length is formed between the bending portion or the branching portion of the flow passage and a position at which the refrigerant flows into the next branching flow passage. Specifically, the first flow passage 10A, the second flow passages 11A, the third flow passages 11C, the fourth flow passages 12A, and the fifth flow passages 12C are each configured to have a length larger than the thickness of one plate. This configuration can ensure the straight-traveling portion for the refrigerant and during the passage in this portion, the liquid film in the uneven state is made uniform. Consequently, the refrigerant can be prevented from unevenly flowing in the next branching flow passage, and the two-phase gas-liquid refrigerant is uniformly distributed in all of the branching flow passages. Additionally, as the laminated header 2 includes the first return flow passages 11 B and the second return flow passages 12B, it is possible to equally distribute the two-phase gas-liquid refrigerant while achieving the size reduction.

[0098] Further, the laminated header 2 has no other branching flow passage formed in the second flow passages 11A, the first return flow passages 11B, and the third flow passages 11C through which the first branching flow passage 10B communicates with the second branching flow passages 11D. That is, in the laminated header 2, the refrigerant branched in the first branching flow passage 10B is caused by the first return flow passage 11 B to flow in the reverse direction and reach the second branching flow passage 11D.

[0099] Similarly, the laminated header 2 has no other branching flow passage formed in the fourth flow passages 12A, the second return flow passages 12B, and the fifth flow passages 12C through which the second branching flow passages 11 D communicate with the third branching flow passages 12D. That is, in the laminated header 2, the refrigerant branched in the second branching flow passages 11D is caused by the second return flow passages 12B to flow in the reverse direction and reach the third branching flow passages 12D.

[0100] With such a configuration formed, in the laminated header 2, an entrance distance from a branching point toward another branching point can be ensured to be long and each amount of the refrigerant after the branching can be made equal. That is, in the laminated header 2, the flow passage from the first branching flow passage 10B serving as the first branching point to the second branching flow passage 11D serving as the next branching point can be made longer than twice the thickness of the four plates, so that the straight-traveling portion for the refrigerant can be ensured and, in the straight-traveling portion, the liquid film in the uneven state can be made uniform.

[0101] In the laminated header 2, the first branching flow passage 10B and the second branching flow passages 11D are formed in the first plate 114 having the eight through holes 13a-2 opened in the first plate 114.

[0102] With such a configuration formed, in the laminated header 2, the distance of the flow passage from the first branching flow passage 10B serving as the first branching point to the second branching flow passage 11 D serving as the next branching point can be made the same as a reciprocating distance. That is, in the laminated header 2, the distance of the flow passage between the branching points can be ensured to be long and each amount of the refrigerant after the branching can be made equal.

[0103] In the laminated header 2, the opening positions of the eight through holes 13a-2 opened in the first plate 114 are not equally spaced but arranged in such a manner that two through holes are defined as one group. In the laminated header 2, a space between the groups is made wider than a space between two through holes 13a-2 defined as one group. Then, in the laminated header 2, at least one of the through hole 10b serving as the first branching flow passage 10B and the through hole 11d serving as the second branching flow passage 11D is opened in the wider space between the through holes 13a-2, namely the space between the groups.

[0104] With such a configuration formed, in the laminated header 2, each of the first branching flow passage 10B and the second branching flow passages 11D can be disposed between corresponding two of the sixth flow passages 13A and other corresponding two of the sixth flow passages 13A, and the linear distance of the flow passage from the first branching flow passage 10B serving as the first branching point to the second branching flow passages 11D each serving as the next branching point can be made long. That is, in the laminated header 2, the entrance distance from a branching point toward another branching point can be ensured to be long and the rectifying effect of the liquid film can be further improved.

[0105] Although the case where both the through hole 10b and the through holes 11d are opened in the first plate 114 has been shown as an example in Embodiment 1, either through hole may be opened in another plate.

[0106] In the laminated header 2, the second branching flow passages 11D are each formed at a position that is closer to corresponding ones of the through holes 13a-2 than is the position of a corresponding one of the third branching flow passages 12D.

[0107] With such a configuration formed, in the laminated header 2, the entrance distance from each of the second branching flow passages 11D to a corresponding one of the third branching flow passages 12D can be ensured to be long and the rectifying effect of the liquid film can be further improved.

Embodiment 2

[0108] Hereinafter, an example of a usage mode of the heat exchanger 1 according to Embodiment 1 will be described as Embodiment 2 of the present invention. In Embodiment 2, an air-conditioning apparatus 100 provided with the heat exchanger 1 according to Embodiment 1 will be described as an example of the refrigeration cycle apparatus. However, the present invention is not limited to the case where the heat exchanger 1 is provided in the air-conditioning apparatus 100, and for example, the heat exchanger 1 may be provided in another refrigeration cycle apparatus including a refrigerant cycle circuit. Further, a case will be described where the air-conditioning apparatus 100 switches between a cooling operation and a heating operation, but the air-conditioning apparatus 100 is not limited to such a case and may perform only the cooling operation or the heating operation. In this case, it is not necessary to provide a four-way valve 22.

<Configuration of air-conditioning apparatus 100>

[0109] Fig. 6 is a circuit configuration diagram schematically illustrating an example of the refrigerant circuit configuration of the air-conditioning apparatus 100, which is an example of the refrigeration cycle apparatus according to Embodiment 2 of the present invention. In Embodiment 2, a difference from Embodiment 1 will be mainly described, and the same portion as in Embodiment 1 is provided with the same reference sign and the description of the same portion will be omitted. In Fig. 6, the flow of the refrigerant during the cooling operation is indicated by a broken line arrow, and the flow of the refrigerant during the heating operation is indicated by a solid line arrow.

[0110] As illustrated in Fig. 6, the air-conditioning apparatus 100 includes a compressor 21, the four-way valve 22, an outdoor heat exchanger 23, an expansion device 24, an indoor heat exchanger 25, an outdoor fan 26, an indoor fan 27, and a controller 28.

[0111] The compressor 21, the four-way valve 22, the outdoor heat exchanger 23, the expansion device 24, the outdoor fan 26, and the controller 28 are mounted in a heat-source-side unit. The indoor heat exchanger 25 and the indoor fan 27 are mounted in a load-side unit.

[0112] Note that the expansion device 24 may be mounted in the load-side unit. The controller may be mounted in the load-side unit. Further, the controller may be provided in each of both the heat-source-side unit and the load-side unit and may be communicable.

[0113] The compressor 21, the outdoor heat exchanger 23, the expansion device 24, and the indoor heat exchanger 25 are connected by a refrigerant pipe 20, to form a refrigerant cycle circuit. The refrigerant pipe 20 includes the refrigerant pipe 20A and the refrigerant pipe 20B described in Embodiment 1.

[0114] The compressor 21 compresses refrigerant. The refrigerant compressed by the compressor 21 is discharged and sent to the outdoor heat exchanger 23 or the indoor heat exchanger 25. The compressor 21 is, for example, a rotary compressor, a scroll compressor, a screw compressor, or a reciprocating compressor.

[0115] The four-way valve 22 switches the flows of the refrigerant between the heating operation and the cooling operation. That is, the four-way valve 22 is switched to connect between the compressor 21 and the indoor heat exchanger 25 during the heating operation, and switched to connect between the compressor 21 and the outdoor heat exchanger 23 during the cooling operation. Note that a combination of two-way valves or three-way valves may be adopted in place of the four-way valve 22.

[0116] The outdoor heat exchanger 23 is used as a heat-source-side heat exchanger, acts as the evaporator during the heating operation, and acts as the condenser during the cooling operation. That is, when the outdoor heat exchanger 23 acts as the evaporator, in the outdoor heat exchanger 23, low-temperature low-pressure refrigerant having flown out of the expansion device 24 exchanges heat with air supplied by the outdoor fan 26, and low-temperature low-pressure liquid refrigerant or two-phase refrigerant is evaporated. Meanwhile, when the outdoor heat exchanger 23 acts as the condenser, in the outdoor heat exchanger 23, high-temperature high-pressure refrigerant having discharged from the compressor 21 exchanges heat with air supplied by the outdoor fan 26, and high-temperature high-pressure gas refrigerant is condensed.

[0117] The outdoor fan 26 is used as a heat-source-side fan and supplies air to the outdoor heat exchanger 23.

[0118] The expansion device 24 expands and depressurizes the refrigerant having flown out of the outdoor heat exchanger 23 or the indoor heat exchanger 25. The expansion device 24 may be, for example, an electric expansion valve capable of adjusting the flow rate of refrigerant. As the expansion device 24, it is possible to apply not only the electric expansion valve but also a mechanical expansion valve with a diaphragm adopted in its pressure receptor, a capillary tube, or other devices.

[0119] The indoor heat exchanger 25 is used as a load-side heat exchanger, acts as the condenser during the heating operation, and acts as the evaporator during the cooling operation. That is, when the indoor heat exchanger 25 acts as the condenser, in the indoor heat exchanger 25, high-temperature high-pressure refrigerant having discharged from the compressor 21 exchanges heat with air supplied by the indoor fan 27, and high-temperature high-pressure gas refrigerant is condensed. Meanwhile, when the indoor heat exchanger 25 acts as the evaporator, in the indoor heat exchanger 25, low-temperature low-pressure refrigerant having flown out of the expansion device 24 exchanges heat with air supplied by the indoor fan 27, and low-temperature low-pressure liquid refrigerant or two-phase refrigerant is evaporated.

[0120] The indoor fan 27 is used as a load-side fan and supplies air to the indoor heat exchanger 25.

[0121] The controller 28 integrally controls the entire operation of the air-conditioning apparatus 100. Specifically, in accordance with the content of the user's operation, the controller 28 controls the operation of each unit of the air-conditioning apparatus 100, namely, the compressor 21, the four-way valve 22, the expansion device 24, the outdoor fan 26, and the indoor fan 27, each of which is an actuator. Specifically, the actuators, a variety of unillustrated sensors, and other devices are connected to the controller 28, and the controller 28 controls the operation of the actuators while acquiring temperature information and pressure information, to perform an operation in accordance with the content of the user's operation. For example, the flow passages of the four-way valve 22 are switched by the controller 28, to switch between the cooling operation and the heating operation.

[0122] The controller 28 can be hardware such as a circuit device that achieves its function or can be an arithmetic unit such as a microcomputer and software executed on the arithmetic unit.

<Operation of air-conditioning apparatus 100>

[0123] Next, the operation of the air-conditioning apparatus 100 will be described together with the flow of the refrigerant.

[0124] Firstly, the cooling operation performed by the air-conditioning apparatus 100 will be described. Note that the flow of the refrigerant during the cooling operation is indicated by the broken line arrow in Fig. 6.

[0125] By driving the compressor 21, the refrigerant in the high-temperature high-pressure gas state is discharged from the compressor 21. Hereinafter, the refrigerant flows to follow the broken line arrow. The high-temperature high-pressure gas refrigerant discharged from the compressor 21 flows into the outdoor heat exchanger 23 that acts as the condenser via the four-way valve 22. In the outdoor heat exchanger 23, the high-temperature high-pressure gas refrigerant having flown in exchanges heat with air supplied by the outdoor fan 26, and the high-temperature high-pressure gas refrigerant is condensed to become high-pressure liquid refrigerant.

[0126] The high-pressure liquid refrigerant having flown out of the outdoor heat exchanger 23 is brought into low-pressure two-phase gas-liquid refrigerant by the expansion device 24. The low-pressure two-phase gas-liquid refrigerant flows into the indoor heat exchanger 25 that acts as the evaporator. In the indoor heat exchanger 25, the two-phase gas-liquid refrigerant having flown in exchanges heat with air supplied by the indoor fan 27, and the liquid refrigerant out of the refrigerant in the two-phase state is evaporated to become low-pressure gas refrigerant. At this time, the air with its heat exchanged is supplied to an air-conditioned space by the indoor fan 27 to cool the air-conditioned space.

[0127] The low-pressure gas refrigerant having flown out of the indoor heat exchanger 25 flows into the compressor 21 via the four-way valve 22 and is compressed to become high-temperature high-pressure gas refrigerant, which is discharged again from the compressor 21. Hereinafter, this cycle is repeated.

[0128] Next, the heating operation performed by the air-conditioning apparatus 100 will be described. Note that the flow of the refrigerant during the heating operation is indicated by the solid line arrow in Fig. 6.

[0129] By driving the compressor 21, the refrigerant in the high-temperature high-pressure gas state is discharged from the compressor 21. Hereinafter, the refrigerant flows to follow the solid line arrow. The high-temperature high-pressure gas refrigerant discharged from the compressor 21 flows into the indoor heat exchanger 25 that acts as the condenser via the four-way valve 22. In the indoor heat exchanger 25, the high-temperature high-pressure gas refrigerant having flown in exchanges heat with air supplied by the indoor fan 27, and the high-temperature high-pressure gas refrigerant is condensed to become high-pressure liquid refrigerant. At this time, the air with its heat exchanged is supplied to an air-conditioned space by the indoor fan 27 to heat the air-conditioned space.

[0130] The high-pressure liquid refrigerant sent out from the indoor heat exchanger 25 is brought into low-pressure two-phase gas-liquid refrigerant by the expansion device 24. The low-pressure two-phase gas-liquid refrigerant flows into the outdoor heat exchanger 23 that acts as the evaporator. In the outdoor heat exchanger 23, the two-phase gas-liquid refrigerant having flown in exchanges heat with air supplied by the outdoor fan 26, and the liquid refrigerant out of the refrigerant in the two-phase state is evaporated to become low-pressure gas refrigerant.

[0131] The low-pressure gas refrigerant having flown out of the outdoor heat exchanger 23 flows into the compressor 21 via the four-way valve 22 and is compressed to become high-temperature high-pressure gas refrigerant, which is discharged again from the compressor 21. Hereinafter, this cycle is repeated.

[0132] In the air-conditioning apparatus 100, the heat exchanger 1 according to Embodiment 1 is only required to be used for at least one of the outdoor heat exchanger 23 and the indoor heat exchanger 25, but as illustrated in Fig. 6, the heat exchanger 1 according to Embodiment 1 may be used for both the outdoor heat exchanger 23 and the indoor heat exchanger 25.

[0133] When the heat exchanger 1 according to Embodiment 1 acts as the evaporator, the heat exchanger 1 is connected in such a manner that the refrigerant flows in from the laminated header 2 and flows out to the cylindrical header 3. That is, when the heat exchanger 1 acts as the evaporator, the refrigerant in the two-phase gas-liquid state flows into the laminated header 2 from the refrigerant pipe 20, branches, and flows into each heat transfer tube 4 of the heat exchanger 1. When the heat exchanger 1 acts as the condenser, the liquid refrigerant flows from each heat transfer tube 4, merges in the laminated header 2, and flows out to the refrigerant pipe 20.

[0134] Consequently, in the air-conditioning apparatus 100, as the heat exchanger 1 according to Embodiment 1 is used for at least one of the outdoor heat exchanger 23 and the indoor heat exchanger 25, the two-phase gas-liquid refrigerant is distributed to the laminated header 2 more uniformly to improve the heat exchange efficiency.

[0135] Note the refrigerant used for the air-conditioning apparatus 100 is not particularly limited, and the effect can be exerted even when refrigerant such as R410A, R32, and HFO1234yf is used.

[0136] As a working fluid, the examples of the air and the refrigerant have been shown, but the working fluid is not limited to the examples, and the same effect can be exerted even when other gases, liquids, or gas-liquid mixed fluids are used. That is, the working fluid varies and the effect can be exerted in any case.

[0137] Moreover, the other examples of the refrigeration cycle apparatus include a water heater, a refrigerator, and an air-conditioning water-heater compound machine, and the heat exchange efficiency improves in any case.

Reference Signs List

[0138]

1 heat exchanger2 laminated header 2A refrigerant inflow port
2B refrigerant outflow port 3 cylindrical header 3A refrigerant inflow port 3B refrigerant outflow port 4 heat transfer tube 4A one end portion
4B other end portion 5 retainer 6 fin 10A first flow passage 10a-1 through hole 10a-2 through hole 10a-3 through hole 10a-4 through hole
10a-5 through hole 10a-6 through hole 10B first branching flow passage 10b through hole 11A second flow passage 11a-1 through hole
11a-2 through hole 11a-3 through hole 11 B first return flow passage 11b through hole 11C third flow passage 11 c-1 through hole
11c-2 through hole 11c-3 through hole 11D second branching flow passage 11d through hole 12A fourth flow passage 12a-1 through hole 12a-2 through hole 12a-3 through hole 12B second return flow passage 12b through hole 12C fifth flow passage 12c through hole
12D third branching flow passage 12d through hole 13A sixth flow passage 13a-1 through hole 13a-2 through hole 13a-3 through hole
13a-4 through hole 20 refrigerant pipe 20A refrigerant pipe
20B refrigerant pipe 21 compressor 22 four-way valve 23 outdoor heat exchanger 24 expansion device 25 indoor heat exchanger 26 outdoor fan 27 indoor fan 28 controller 100 air-conditioning apparatus
111 first plate 112 first plate 113 first plate 114 first plate
115 first plate 121 second plate 122 second plate 123 second plate
124 second plate

Claims

1. A laminated header, comprising:

one first opening;
a plurality of second openings; and
a distribution flow passage communicating between the first opening and each of the plurality of second openings,
the laminated header including a plurality of plates that are laminated,
the distribution flow passage including
a first flow passage communicating with the first opening and having a linear shape extending in a direction in which the plurality of plates are laminated,
a first branching flow passage communicating with the first flow passage and branching the first flow passage into a plurality of flow passages,
a plurality of second flow passages communicating with the first branching flow passage and each having a linear shape extending in the direction in which the plurality of plates are laminated,
a first return flow passage communicating with each of the plurality of second flow passages and extending in a longitudinal direction of a same plate of the plurality of plates,
a plurality of third flow passages each communicating with a corresponding one of the first return flow passages and each having a linear shape extending in the direction in which the plurality of plates are laminated,
a second branching flow passage communicating with each of the plurality of third flow passages and branching each of the plurality of third flow passages into a plurality of flow passages,
a plurality of fourth flow passages communicating with the second branching flow passage and each having a linear shape extending in the direction in which the plurality of plates are laminated,
a second return flow passage communicating with each of the plurality of fourth flow passages and extending in a longitudinal direction of a

same plate of the plurality of plates,
a plurality of fifth flow passages each communicating with a corresponding one of the second return flow passages and each having a linear shape extending in the direction in which the plurality of plates are laminated,
a third branching flow passage communicating with each of the plurality of fifth flow passages and branching each of the plurality of fifth flow passages into a plurality of flow passages, and
a plurality of sixth flow passages communicating with the third branching flow passage and each having a linear shape extending in the direction in which the plurality of plates are laminated,
the plurality of second flow passages and the plurality of fourth flow passages being configured in such a manner that refrigerant flowing through each of the plurality of second flow passages and the plurality of fourth flow passages flows in a direction opposite to a flow direction of the refrigerant flowing through each of the first flow passage, the plurality of third flow passages, the plurality of fifth flow passages, and the plurality of sixth flow passages.

2. The laminated header of claim 1, wherein each of the first flow passage, the plurality of second flow passages, the plurality of third flow passages, the plurality of fourth flow passages, and the plurality of fifth flow passages is configured to have a length larger than a thickness of one plate of the plurality of plates.

3. The laminated header of claim 1 or 2, wherein the distribution flow passage is configured in such a manner that the refrigerant branched in the first branching flow passage reaches the second branching flow passages without being branched in the plurality of second flow passages, the first return flow passages, and the plurality of third flow passages.

4. The laminated header of any one of claims 1 to 3, wherein the distribution flow passage is configured in such a manner that the refrigerant branched in the second branching flow passage reaches the third branching flow passages without being branched in the plurality of fourth flow passages, the second return flow passages, and the plurality of fifth flow passages.

5. The laminated header of any one of claims 1 to 4, wherein a through hole forming the first branching flow passage and through holes each forming a corresponding one of the second branching flow passages are formed in a same plate of the plurality of plates in which at least one of through holes each forming a corresponding one of the plurality of sixth flow passages is formed.

6. The laminated header of claim 5, wherein
among the through holes each forming a corresponding one of the plurality of sixth flow passages, two through holes communicating with a same one of the third branching flow passages are defined as one group,
a space between the groups is made wider than a space between the two through holes defined as the one group, and
at least one of the through hole forming the first branching flow passage and the through holes each forming a corresponding one of the second branching flow passages are formed between the groups.

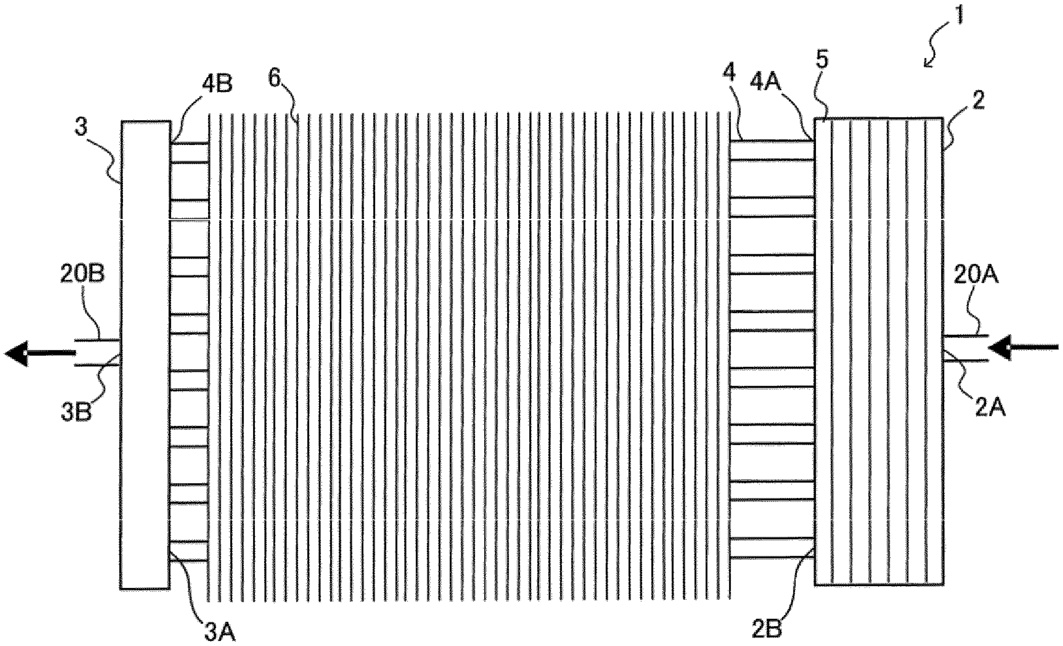
7. The laminated header of any one of claims 1 to 6, wherein the second branching flow passages are formed at positions that are closer to the plurality of second openings than are positions of the third branching flow passages.

8. A heat exchanger, comprising:

the laminated header of any one of claims 1 to 7; and
a plurality of heat transfer tubes each connected to a corresponding one of the plurality of second openings.

9. A refrigeration cycle apparatus, comprising the heat exchanger of claim 8 as at least one of an evaporator and a condenser.

FIG. 1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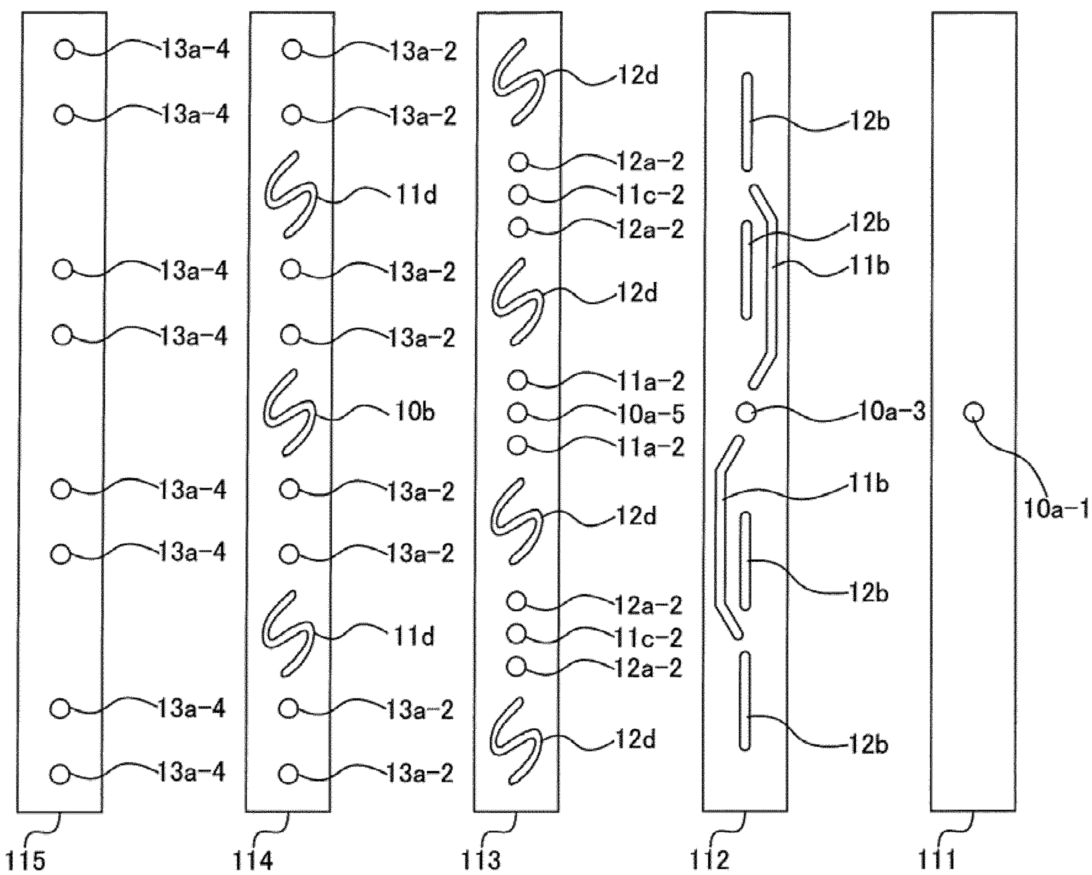
2
3
4
4A
4B
5
6
20A
20B
2A
2B
3A
3B

FIG. 2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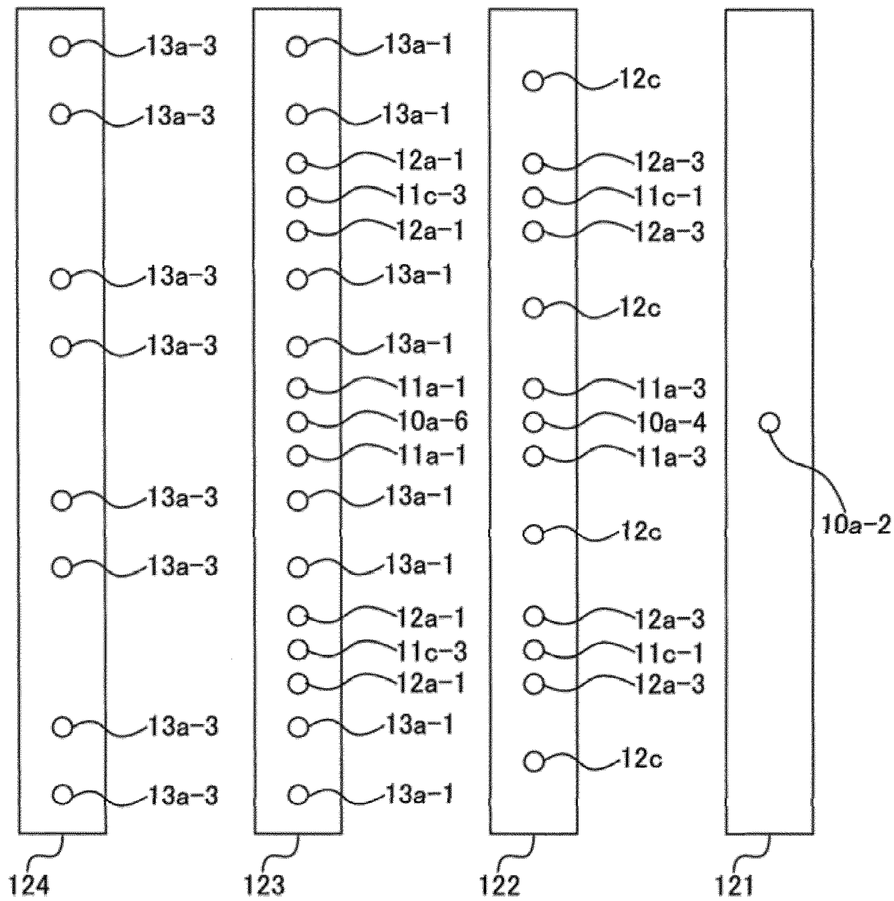
11d
10b
12d
12a-2
11c-2
11a-2
10a-5
12b
11b
10a-3
10a-1
115
114
113
112
111

FIG. 3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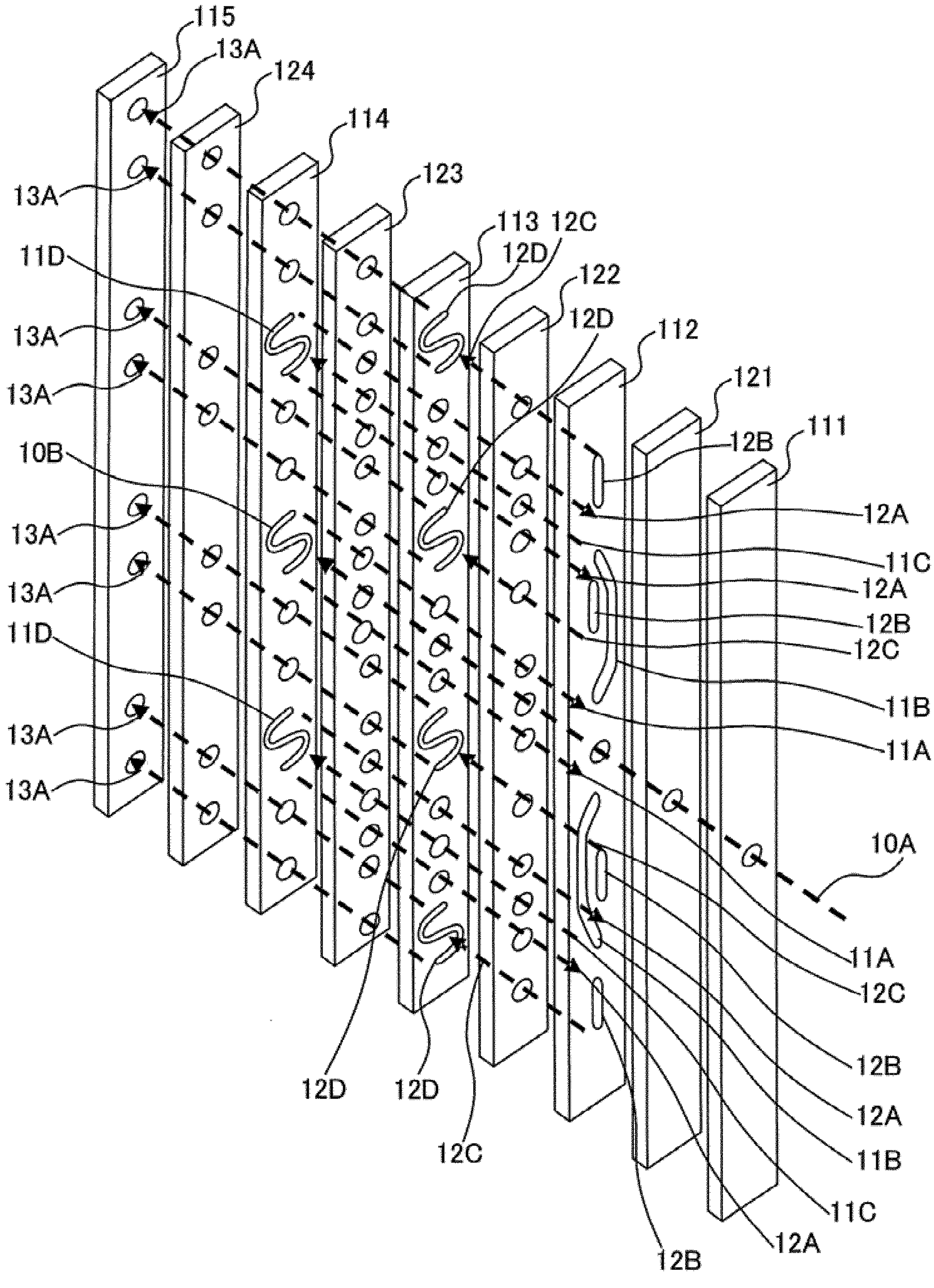
11c-3
12a-1
13a-1
13a-1
11a-1
10a-6
11a-1
13a-1
13a-1
12a-1
11c-3
12a-1
13a-1
13a-1
12c
12a-3
11c-1
12a-3
12c
11a-3
10a-4
11a-3
12c
12a-3
11c-1
12a-3
12c
10a-2
124
123
122
121

FIG. 4



115
13A
124
114
123
113
12C
12D
122
12D
112
121
12B
111
13A
11D
13A
13A
10B
13A
13A
11D
13A
13A
12A
11C
12A
12B
12C
11B
11A
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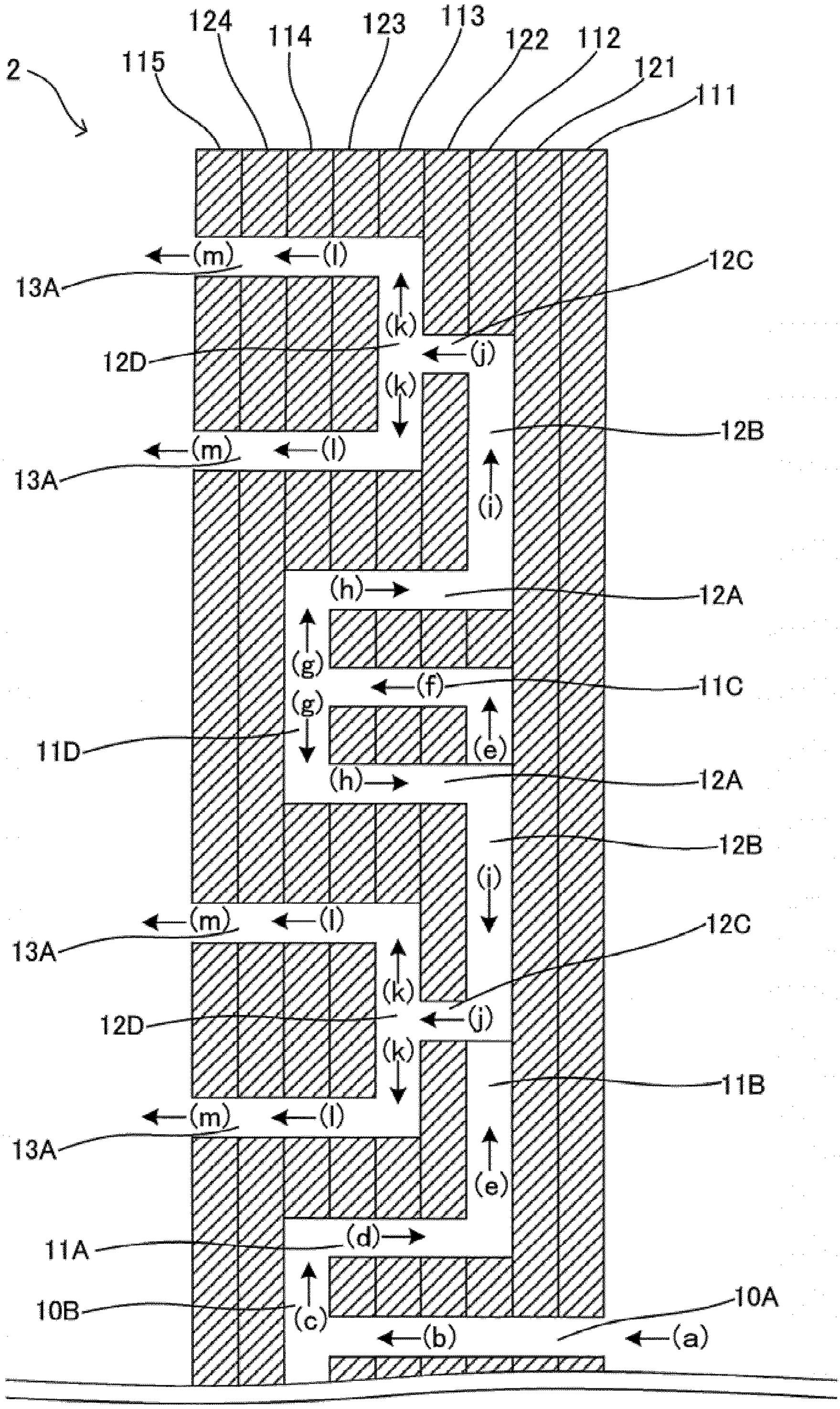
11A
12C
12B
12A
11B
11C
12A
12B
12D
12D
12C

FIG. 5


2
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124
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(f)
11C
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(e)
11D
(h)
12A
12B
(j)
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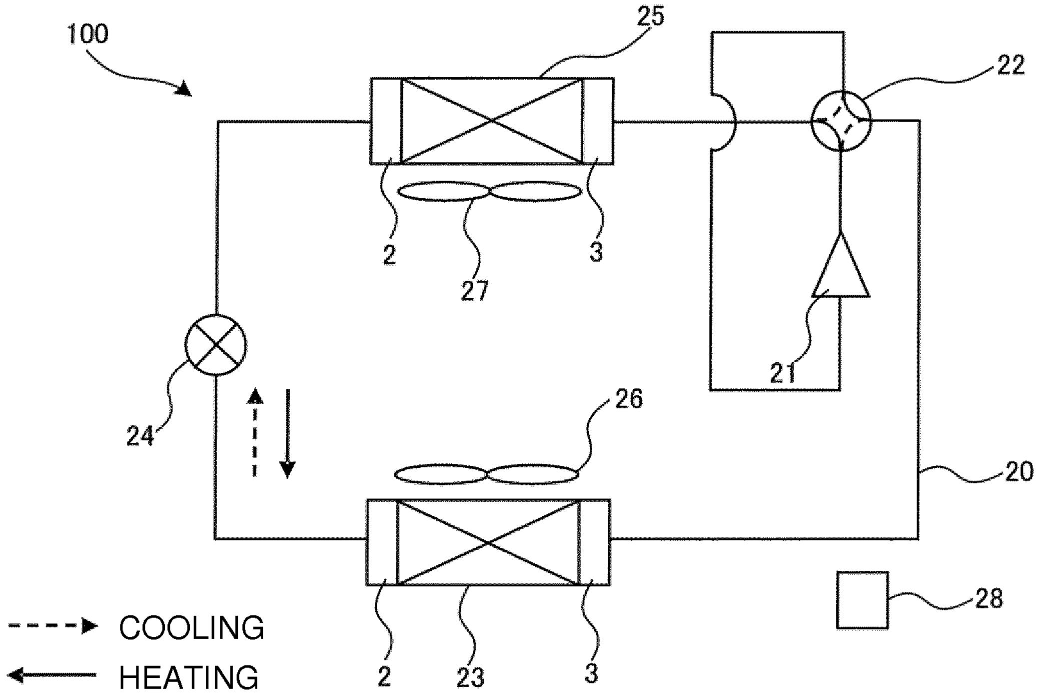
(l)
13A
12C
(k)
12D
(j)
(k)
11B
(m)
(l)
13A
(e)
(d)
11A
10B
(c)
10A
(b)
(a)

FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/037256

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F28F9/02(2006.01)i, F25B39/00(2006.01)i, F25B41/00(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)
Int. Cl. F28F9/02, F25B39/00-39/04, F25B41/00-41/06, F28D1/053

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2017
Registered utility model specifications of Japan	1996-2017
Published registered utility model applications of Japan	1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI (Derwent Innovation), Japio-GPG/FX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2016/071946 A1 (MITSUBISHI ELECTRIC CORP.) 12 May 2016, paragraphs [0003], [0011], [0012], [0026], [0027], [0036], fig. 1-3 & EP 3217135 A1, paragraphs [0003], [0016], [0017], [0044]-[0049], [0061], fig. 1-3 & AU 2014410872 A & KR 10-2017-0074991 A & CN 107003085 A	1-5, 8-9 6-7
Y	JP 9-189463 A (MITSUBISHI ELECTRIC CORP.) 22 July 1997, fig. 4, 5 (Family: none)	1-5, 8-9
Y	WO 2014/184917 A1 (MITSUBISHI ELECTRIC CORP.) 20 November 2014, paragraphs [0057], [0058], fig. 13 & US 2016/0076824 A1, paragraphs [0103]-[0105], fig. 13 & EP 2998682 A1 & CN 105229404 A	3-4

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18.12.2017	26.12.2017

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/JP2017/037256

C (Continuation). 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 CORPORATION) 21 January 1994, abstract, fig. 2 & US 5242016 A, abstract, fig. 2	1-9
A	US 5992453 A (ZIMMER, Johannes) 30 November 1999, abstract, fig. 1 & WO 1997/014511 A1 & CN 1200057 A	1-9
A	US 5241839 A (MODINE MANUFACTURING COMPANY) 07 September 1993, abstract, fig. 1 & EP 634615 A1 & CA 2100648 A & AU 4199493 A	1-9

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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