



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.02.2016 Bulletin 2016/06

(51) Int Cl.:
F28F 9/02 (2006.01) **F28F 1/12** (2006.01)
F28D 1/053 (2006.01)

(21) Application number: **15159508.9**

(22) Date of filing: **17.03.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(71) Applicant: **Sanden Corporation**
Iseaki-shi,
Gunma 372-8502 (JP)

(72) Inventor: **Kaneko, Akira**
Iseaki-shi, Gunma 372-8502 (JP)

(74) Representative: **Prüfer & Partner mbB**
European Patent Attorneys
Sohnckestraße 12
81479 München (DE)

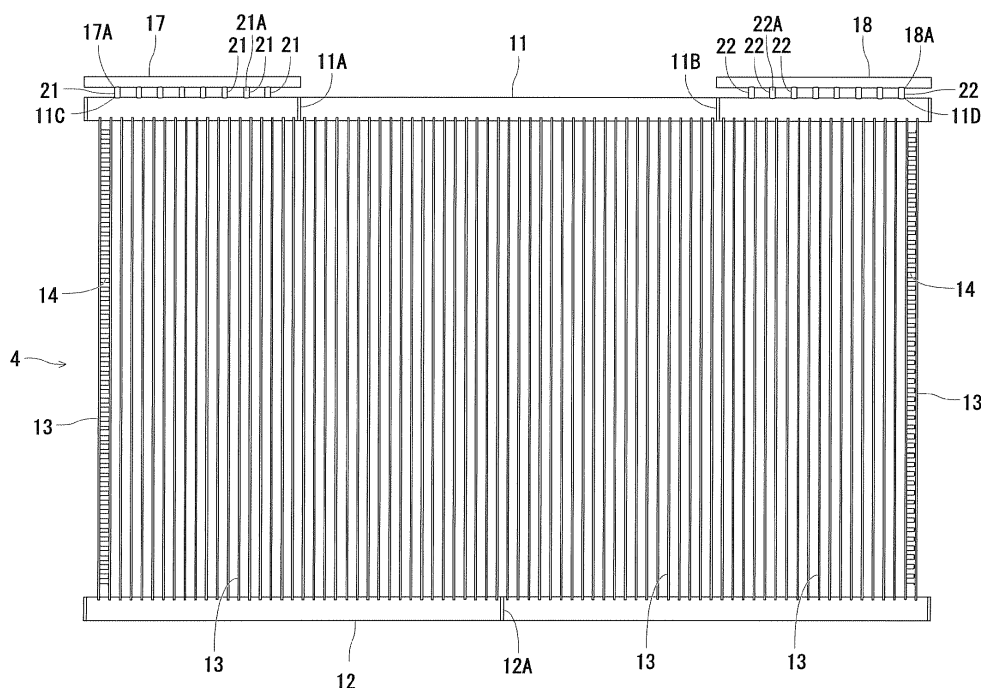
(30) Priority: **05.08.2014 JP 2014159579**

(54) **HEAT EXCHANGER**

(57) There is disclosed a microtube type heat exchanger which can suppress a pressure loss in a refrigerant inlet pipe, suitably distribute a refrigerant and further enlarge a heat exchange area. In an evaporator 4 (the heat exchanger), both ends of a plurality of microtubes 13 are communicated with each other by a pair of

distributors 11 and 12, and carbon dioxide is used as a refrigerant, the heat exchanger comprises a refrigerant inlet pipe 17 connected to the distributor 11, and the distributor 11 is allowed to communicate with the refrigerant inlet pipe 17 by a plurality of passages 21A.

FIG. 2



Description

BACKGROUND OF THE INVENTION

5 Field of the Invention

[0001] The present invention relates to a heat exchanger constituted of a plurality of microtubes.

Background Art

[0002] Heretofore, as this type of heat exchanger constituting a refrigerant circuit of a heat pump apparatus, various types of heat exchangers such as a fin and tube type heat exchanger and a microtube type heat exchanger have been used. The former fin and tube type heat exchanger has a constitution in which fins made of aluminum or the like are pressed or brazed to a pipe made of copper or the like.

[0003] On the other hand, the latter microtube type heat exchanger is a parallel flow type heat exchanger in which a plurality of flat tubes (microtubes) comprising a plurality of micro passages and made of aluminum are disposed in a horizontal direction and fins also made of aluminum are brazed to a portion between the respective microtubes. In recent years, to cope with global environmental problems, it has been suggested that carbon dioxide (CO₂) is used as a refrigerant also in this type of heat pump apparatus. In this case, however, the refrigerant circuit is used in a supercritical state on a high pressure side, and for this reason or the like, an efficiency of the heat pump apparatus deteriorates. Therefore, for the purpose of achieving a high performance of the heat exchanger, this microtube type heat exchanger is used as an evaporator (e.g., see Patent Document 1).

[0004] FIG. 13 shows such a conventional microtube type heat exchanger 100. The heat exchanger 100 is constituted of a pair of distributors 101 and 102 disposed in parallel to vertically face each other, a plurality of microtubes 103 each of which is disposed in a vertical direction between both the distributors 101 and 102 and which are arranged in a right-left direction, and heat exchanging fins 104 attached to each portion between the respective microtubes 103.

[0005] Both the distributors 101 and 102 are connected to upper and lower ends of each of the microtubes 103, whereby refrigerant flow channels having micro diameters and included in the respective microtubes 103 communicate with one another at the upper and lower ends. Additionally, the inside of the upper distributor 101 is partitioned by a partition member 101A attached to a position corresponding to a portion between the microtube 103 of a predetermined number counted from the left and the microtube 103 on the right side, and further, the inside of the distributor 101 is also partitioned by a partition member 101B attached to a position corresponding to a portion between the microtube 103 of a predetermined number counted from the right and the microtube 103 on the left side. Furthermore, the inside of the lower distributor 102 is also partitioned by a partition member 102A attached to a position corresponding to a portion between the two microtubes 103 of a middle of the right-left direction (FIG. 13 perspective shows the respective partition members 101A, 101B, and 102A).

[0006] Furthermore, a refrigerant inlet pipe 107 is connected to an upper surface of a position corresponding to the left side of the partition member 101A of the distributor 101, and the refrigerant inlet pipe 107 is connected to an unshown expansion valve (throttle means). In addition, a refrigerant outlet pipe 108 is connected to an upper surface of a position corresponding to the right side of the partition member 101B of the distributor 101, and the refrigerant outlet pipe 108 is connected to a suction side of an unshown compressor.

[0007] Consequently, a refrigerant allowed to flow into the distributor 101 from the refrigerant inlet pipe 107 of the heat exchanger 100 is distributed to enter the respective microtubes 103 on the left side from the partition member 101A, and passes the refrigerant flow channels in the microtubes 103 to flow into the distributor 102. The refrigerant allowed to flow into the distributor 102 is distributed to enter the microtubes 103 on the right side from the microtubes 103 mentioned above and on the left side from the partition member 102A, and passes the refrigerant flow channels in the microtubes 103 to flow into the distributor 101 on the right side from the partition member 101A.

[0008] The refrigerant allowed to flow into the distributor 101 is distributed to enter the microtubes 103 on the left side from the partition member 101B, and passes the refrigerant flow channels in the microtubes 103 to flow into the distributor 102 on the right side from the partition member 102A. The refrigerant allowed to flow into the distributor 102 is distributed to enter the microtubes 103 further on the right side, and passes the refrigerant flow channels in the microtubes 103 to flow into the distributor 101 on the right side from the partition member 101B. The refrigerant evaporated while flowing through such a route and allowed to flow into the distributor 101 joins the flow in the refrigerant outlet pipe 108 to flow out from the heat exchanger 100.

[Patent Document 1] Jpn. Pat. Appln. Publication No. 2008-292022

SUMMARY OF THE INVENTION

[0009] As described above, in a conventional microtube type heat exchanger 100, a refrigerant inlet pipe 107 and a refrigerant outlet pipe 108 are attached to an upper surface of a distributor 101. On the other hand, as the distributor 101 or a distributor 102, a small-diameter thick pipe is used from a relation of pressure resistance, and hence, it is difficult to increase an inner diameter (a flow channel sectional area) of the refrigerant inlet pipe 107 or the refrigerant outlet pipe 108 connected to the distributor. As a result, there has been the problem that a pressure loss in the refrigerant inlet pipe 107 or the refrigerant outlet pipe 108, especially the pressure loss of the refrigerant inlet pipe enlarges and that a performance deteriorates.

[0010] In addition, upper ends of respective microtubes 103 are inserted and connected into the distributor 101 from a lower surface of the distributor 101. Furthermore, the refrigerant inlet pipe 107 and the refrigerant outlet pipe 108 are also inserted and connected into the distributor 101, and hence when the pipes are not connected to the distributor 101 from an upper surface thereof, the pipes disadvantageously interfere with the microtubes 103.

[0011] However, when the refrigerant inlet pipe 107 and the refrigerant outlet pipe 108 are attached to the upper surface of the distributor 101, a vertical dimension of the heat exchanger 100 enlarges as much as a dimension of the refrigerant inlet pipe 107 or the refrigerant outlet pipe 108. Therefore, a vertical dimension of the microtube 103 in which heat exchange between a refrigerant and air is actually performed has to be accordingly made smaller, and there has been the problem that a heat exchange area disadvantageously reduces.

[0012] Furthermore, when the heat exchanger 100 is used as an outdoor machine of a heat pump apparatus, the heat exchanger becomes a comparatively large type, and hence in the conventional refrigerant inlet pipe 107 and refrigerant outlet pipe 108, there has also been the problem that distribution or joining of the refrigerant in the distributor 101, especially the distribution deteriorates.

[0013] The present invention has been developed to solve such conventional technical problems, and an object thereof is to provide a microtube type heat exchanger which can suppress a pressure loss in a refrigerant inlet pipe, suitably distribute a refrigerant and further enlarge a heat exchange area.

[0014] In the heat exchanger of the present invention, both ends of a plurality of microtubes are communicated with each other by a pair of distributors, and carbon dioxide is used as a refrigerant. The heat exchanger comprises a refrigerant inlet pipe connected to the distributor, and is characterized in that the distributor is allowed to communicate with the refrigerant inlet pipe by a plurality of passages.

[0015] The heat exchanger of the second invention is characterized in that in the above invention, the heat exchanger comprises a refrigerant outlet pipe connected to the distributor, and the distributor is allowed to communicate with the refrigerant outlet pipe by a plurality of passages.

[0016] The heat exchanger of the third invention is characterized in that in the above invention, a total of refrigerant flow channel sectional areas of the respective passages which allow the distributor to communicate with the refrigerant inlet pipe is not less than a flow channel sectional area in the refrigerant inlet pipe, and a total of refrigerant flow channel sectional areas of the respective passages which allow the distributor to communicate with the refrigerant outlet pipe is not less than a flow channel sectional area in the refrigerant outlet pipe.

[0017] The heat exchanger of the fourth invention is characterized in that in the second or third invention, the refrigerant inlet pipe and the refrigerant outlet pipe are constituted of pipes having smaller outer diameters than the distributor.

[0018] The heat exchanger of the fifth invention is characterized in that in the second to fourth inventions, each of the passages is disposed to correspond to a space between the adjacent microtubes.

[0019] The heat exchanger of the sixth invention is characterized in that in the second to fifth inventions, a plurality of holes are made in the distributor, the refrigerant inlet pipe and the refrigerant outlet pipe, respectively, the respective holes communicate with a plurality of pipes, and the passages are disposed in the respective pipes.

[0020] The heat exchanger of the seventh invention is characterized in that in the second to fifth inventions, a plurality of holes are made in the distributor, the refrigerant inlet pipe and the refrigerant outlet pipe, respectively, and connecting members in which a plurality of passages that allow communication of the respective holes are formed are interposed between the distributor and the refrigerant inlet pipe and between the distributor and the refrigerant outlet pipe.

[0021] The heat exchanger of the eighth invention is characterized in that in the second to seventh inventions, on the side of a surface of the distributor which is perpendicular to a surface of the distributor which is connected to the microtubes, the refrigerant inlet pipe and the refrigerant outlet pipe are disposed, and are allowed to communicate with the distributor by a plurality of passages.

[0022] The heat exchanger of the ninth invention is characterized in that in the above respective inventions, heat exchanging fins are attached along the respective microtubes.

[0023] According to the present invention, in a heat exchanger, both ends of each of a plurality of microtubes are allowed to communicate with each other by a pair of distributors, and carbon dioxide is used as a refrigerant, the heat exchanger comprises a refrigerant inlet pipe connected to the distributor, and the distributor is allowed to communicate with the refrigerant inlet pipe by a plurality of passages, so that when the refrigerant flows into the distributor from the

refrigerant inlet pipe, the refrigerant is distributed by the plurality of passages.

[0024] In consequence, it is possible to suppress a pressure loss in the refrigerant inlet pipe, and the refrigerant is smoothly and suitably distributed to the microtubes in the distributor, so that a performance of the heat exchanger can remarkably improve.

[0025] According to the second invention, in addition to the above invention, the heat exchanger comprises a refrigerant outlet pipe connected to the distributor, and the distributor is allowed to communicate with the refrigerant outlet pipe by a plurality of passages, so that also when the refrigerant flows into the refrigerant outlet pipe from the distributor, the refrigerant passes through the plurality of passages to flow into the refrigerant outlet pipe, thereby joining the flow.

[0026] In consequence, the refrigerant from the distributor smoothly and suitably joins the flow in the refrigerant outlet pipe, the pressure loss in the refrigerant outlet pipe is suppressed, and the performance of the heat exchanger can further improve.

[0027] In this case, as in the third invention, a total of refrigerant flow channel sectional areas of the respective passages which allow the distributor to communicate with the refrigerant inlet pipe is not less than a flow channel sectional area in the refrigerant inlet pipe, and a total of refrigerant flow channel sectional areas of the respective passages which allow the distributor to communicate with the refrigerant outlet pipe is not less than a flow channel sectional area in the refrigerant outlet pipe. In this case, for example, also when the refrigerant inlet pipe and the refrigerant outlet pipe are constituted of pipes having smaller outer diameters than the distributor as in the fourth invention, it is possible to effectively suppress a pressure loss in the refrigerant inlet pipe and the refrigerant outlet pipe, and it is also possible to further smoothen the distribution of the refrigerant.

[0028] Furthermore, as in the fifth invention, each of the passages is disposed to correspond to a space between the adjacent microtubes. In this case, for example, also when a plurality of holes are made in the distributor, the refrigerant inlet pipe and the refrigerant outlet pipe, respectively, the respective holes communicate with a plurality of pipes and passages are disposed in the respective pipes as in the sixth invention, interference of the pipes constituting the passages with the microtubes does not occur.

[0029] In consequence, a degree of freedom increases in setting of positions of the refrigerant inlet pipe and the refrigerant outlet pipe to the distributor. For example, when on the side of a surface of the distributor which is perpendicular to a surface of the distributor which is connected to the microtubes, the refrigerant inlet pipe and the refrigerant outlet pipe are disposed, and are allowed to communicate with the distributors by a plurality of passages as in the eighth invention, the refrigerant inlet pipe and the refrigerant outlet pipe are not positioned in a longitudinal direction of each microtube, and thus, a length dimension of the microtube is increased. Consequently, it is possible to enlarge a heat exchange area of the heat exchanger corresponding to the microtubes to which fins are attached as in the ninth invention. In consequence, the performance of the heat exchanger can further improve.

[0030] In addition, as in the seventh invention, a plurality of holes are made in the distributor, the refrigerant inlet pipe and the refrigerant outlet pipe, respectively, and connecting members in which a plurality of passages that allow communication of the respective holes are formed are interposed between the distributor and the refrigerant inlet pipe and between the distributor and the refrigerant outlet pipe. In this case, assembling properties can improve as compared with a case where the holes of the distributors, the refrigerant inlet pipe and the refrigerant outlet pipe are allowed to communicate by a plurality of pipes as in the fourth invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

FIG. 1 is a refrigerant circuit diagram of a heat pump apparatus of one embodiment to which a heat exchanger of the present invention is applied;

FIG. 2 is a front view of an evaporator of FIG. 1 of one embodiment of the heat exchanger of the present invention (Embodiment 1);

FIG. 3 is a side view of the evaporator of FIG. 2;

FIG. 4 is an enlarged longitudinal front view of a main part of the evaporator of FIG. 2;

FIG. 5 is a front view of the evaporator of FIG. 1 of another embodiment of the heat exchanger of the present invention (Embodiment 2);

FIG. 6 is a side view of the evaporator of FIG. 5;

FIG. 7 is a plan view of the evaporator of FIG. 5;

FIG. 8 is an enlarged sectional plan view of a main part of the evaporator of FIG. 5;

FIG. 9 is a front view of the evaporator of FIG. 1 of still another embodiment of the heat exchanger of the present invention (Embodiment 3);

FIG. 10 is a side view of the evaporator of FIG. 9;

FIG. 11 is a plan view of the evaporator of FIG. 9;

FIG. 12 is an enlarged sectional plan view of a main part of the evaporator of FIG. 9; and
FIG. 13 is a front view of a conventional microtube type heat exchanger.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings.

[Embodiment 1]

[0033] FIG. 1 is a refrigerant circuit diagram of a heat pump apparatus illustrated to explain the present invention. In this drawing, reference numeral 1 is a compressor, and a discharge side of the compressor 1 is connected to a gas cooler 2. An outlet side of the gas cooler 2 is connected to an expansion valve 3 (may be a capillary tube) as a pressure reducing device, and an outlet side of the expansion valve 3 is connected to an evaporator 4 which is a heat exchanger of an embodiment of the present invention. A structure of the evaporator 4 will be described later in detail, but the evaporator is made of aluminum and disposed in an unshown outdoor machine. Furthermore, an outlet side of the evaporator 4 is connected to a suction side of the compressor 1 to constitute a refrigerant circuit 7 of the heat pump apparatus.

[0034] Furthermore, a predetermined amount of carbon dioxide (CO₂) is enclosed as a refrigerant in the refrigerant circuit 7. When the compressor 1 is operated, the refrigerant (carbon dioxide) is compressed to obtain a high-temperature high-pressure gas state, and the refrigerant is discharged from the discharge side to flow into the gas cooler 2. In the gas cooler 2, an unshown circulation circuit of warm water-generating water or brine is disposed in a heat exchange relation, and the gas refrigerant allowed to flow into the gas cooler 2 performs heat exchange with the water or brine in the circulation circuit to radiate heat, followed by heating for use in warm water generation or the like.

[0035] The refrigerant does not condense in the gas cooler 2 but remains in a supercritical state, and has a temperature lowered, and the refrigerant flows out from the gas cooler 2 to flow into the expansion valve 3. In the expansion valve 3, a pressure of the refrigerant is reduced to transit to a liquid phase, and the refrigerant flows into the evaporator 4 to evaporate. Outside air is passed through the evaporator 4 by an air blower 8, and the refrigerant evaporates to pump up the heat from the outside air (a heat pump). Furthermore, the gas refrigerant evaporated in the evaporator 4 is sucked into the compressor 1 again to repeat this circulation.

[0036] Next, a constitution of the evaporator 4 which is the heat exchanger of this embodiment (Embodiment 1) will be described with reference to FIG. 2 to FIG. 4. The evaporator (heat exchanger) 4 is constituted of a pair of distributors 11 and 12 disposed in parallel to vertically face each other and each including a pipe having a predetermined inner space volume, a plurality of microtubes 13 each of which is disposed in a vertical direction along a space between both the distributors 11 and 12 and which are arranged in a right-left direction, and heat exchanging fins 14 attached to each portion between the microtubes 13.

[0037] The respective microtubes 13 are disposed via a predetermined space, an upper end of each microtube enters the distributor 11 to be connected thereto, and the microtubes communicate with one another in a space of the distributor 11. In addition, a lower end of each microtube 13 enters the distributor 12 to be connected thereto, and the microtubes communicate with one another in a space of the distributor 12.

[0038] As the distributors 11 and 12, thick pipes each having a small diameter are used from a relation of pressure proof. Furthermore, both the distributors 11 and 12 are connected to the upper and lower ends of each microtube 13. In consequence, refrigerant flow channels each having a micro diameter in the respective microtubes 13 communicate with one another at their upper and lower ends.

[0039] In addition, the inside of the upper distributor 11 is partitioned by a partition member 11A attached to a position corresponding to a portion above a space between the microtube 13 of a predetermined number counted from the left (one side) and the microtube 13 on the right side (the other side), and further, the inside of the distributor 11 is also partitioned by a partition member 11B attached to a position corresponding to a portion above a space between the microtube 13 of a predetermined number counted from the right and the microtube 13 on the left side. Additionally, the inside of the lower distributor 12 is also partitioned by a partition member 12A attached to a position corresponding to a portion under a space between the two microtubes 13 of a middle of the right-left direction (FIG. 2 perspectively shows the respective partition members 11A, 11B, and 12A).

[0040] Furthermore, a refrigerant inlet pipe 17 communicates to be connected to an upper surface of a position corresponding to the left side (one side) of the partition member 11A of the distributor 11. The refrigerant inlet pipe 17 is constituted of a pipe having smaller outer and inner diameters than the distributor 11, a right end (the other end) of the refrigerant inlet pipe is closed, and a left end of the refrigerant inlet pipe 17 is opened to connect this left end opening (one end opening) to the expansion valve 3 of FIG. 1. In addition, a refrigerant outlet pipe 18 communicates to be connected to an upper surface of a position corresponding to the right side (the other side) of the partition member 11B of the distributor 11. The refrigerant outlet pipe 18 is also constituted of a pipe having smaller outer and inner diameters

than the distributor 11, a left end (one end) of the refrigerant outlet pipe is closed, and a right end thereof is opened to connect this right end opening (the other end opening) to the suction side of the compressor 1 of FIG. 1.

[0041] Additionally, in this embodiment, the distributor 11 and the refrigerant inlet pipe 17, and the distributor 11 and the refrigerant outlet pipe 18 communicated to be connected by a plurality of thin pipes 21 and 22, respectively.

[0042] In this case, as enlarged and shown in FIG. 4, in a lower surface of the refrigerant inlet pipe 17, a plurality of (eight in the embodiment) small-diameter holes 17A are made via a predetermined space in a longitudinal direction of the pipe, and also in an upper surface of the distributor 11 on the left side from the partition member 11A, a plurality of (similarly eight) small-diameter holes 11C are made via a predetermined space in the longitudinal direction. At this time, in the upper surface of the distributor 11 on the left side from the partition member 11A, the respective holes 11C are formed via a predetermined space along approximately the whole region of the longitudinal direction of the distributor.

[0043] Additionally, similarly to the case of the refrigerant inlet pipe 17 shown in FIG. 4, also in a lower surface of the refrigerant outlet pipe 18, a plurality of (eight in the embodiment) small-diameter holes 18A are made via a predetermined space in a longitudinal direction of the pipe, and also in an upper surface of the distributor 11 on the right side from the partition member 11B, a plurality of (similarly eight) small-diameter holes 11D are made via a predetermined space in the longitudinal direction of the distributor. At this time, in the upper surface of the distributor 11 on the right side from the partition member 11B, the respective holes 11D are formed via a predetermined space along approximately the whole region of the longitudinal direction of the distributor.

[0044] Furthermore, both ends (upper and lower ends) of each of the pipes 21 enter each hole 17A of the refrigerant inlet pipe 17 and each hole 11C of the distributor 11 to be connected (brazed) thereto, respectively, and the respective pipes 21 are attached along a space between the refrigerant inlet pipe 17 and the distributor 11. In the plurality of pipes 21, passages 21A are constituted, respectively, and the plurality of passages 21A allow the inside of the distributor 11 on the left side from the partition member 11A to communicate with the inside of the refrigerant inlet pipe 17. In addition, both ends (upper and lower ends) of each of the pipes 22 enter each hole 18A of the refrigerant outlet pipe 18 and each hole 11D of the distributor 11 to be connected (brazed) thereto, respectively, and the respective pipes 22 are attached along a space between the refrigerant outlet pipe 18 and the distributor 11. In the plurality of pipes 22, passages 22A are constituted, respectively, and the plurality of passages 22A allow the inside of the distributor 11 on the right side from the partition member 11B to communicate with the inside of the refrigerant outlet pipe 18.

[0045] In this case, as shown in FIG. 4, each of the pipes 21 which allow the refrigerant inlet pipe 17 to communicate with the distributor 11 corresponds to a portion above a space between the microtube 13 under the pipe and the adjacent microtube 13. In addition, each of the pipes 22 which allow the refrigerant outlet pipe 18 to communicate with the distributor 11 corresponds to a portion above a space between the microtube 13 under the pipe and the adjacent microtube 13.

[0046] In addition, dimensions of the respective pipes 21 and 22 are set so that a total of refrigerant flow channel sectional areas of the passages 21A in the respective pipes 21 (the total of those of the eight passages) is not less than a flow channel sectional area in the refrigerant inlet pipe 17, and a total of refrigerant flow channel sectional areas of the passages 22A in the respective pipes 22 (the total of those of the eight passages) is not less than a flow channel sectional area in the refrigerant outlet pipe 18.

[0047] Next, a flow of the refrigerant in the evaporator 4 according to the abovementioned constitution will be described. The refrigerant passed through the expansion valve 3 flows into the refrigerant inlet pipe 17 of the evaporator 4 (the heat exchanger) from the left end thereof. The refrigerant allowed to flow into the refrigerant inlet pipe 17 is distributed to enter the plurality of pipes 21, and passes the passages 21A in the respective pipes 21 to flow from the upside into the distributor 11 on the left side from the partition member 11A. At this time, the respective pipes 21 are disposed along approximately the whole region of the longitudinal direction of the distributor 11 on the left side from the partition member 11A, and hence the refrigerant substantially equally flows into the whole region of the longitudinal direction of the distributor 11 on the left side from the partition member 11A.

[0048] The refrigerant allowed to flow into the distributor 11 on the left side from the partition member 11A in this manner is distributed to flow into the respective microtubes 13 connected to the left side from the partition member 11A, flows down through the refrigerant flow channels of the respective microtubes 13, and flows into the distributor 12. The refrigerant allowed to flow into the distributor 12 is distributed to flow into the microtubes 13 on the right side from the above microtubes 13 (the microtubes 13 in which the refrigerant flows down) and on the left side from the partition member 12A, and rises through the refrigerant flow channels of the microtubes 13 to flow into the distributor 11 on the right side from the partition member 11A.

[0049] The refrigerant allowed to flow into the distributor 11 is distributed to enter the microtubes 13 on the right side from the above microtubes 13 (the microtubes 13 through which the refrigerant has risen) and on the left side from the partition member 11B, and flows down through the refrigerant flow channels of the microtubes 13 to flow into the distributor 12 on the right side from the partition member 12A. The refrigerant allowed to flow into the distributor 12 is distributed to enter the microtubes 13 further on the right side from the above microtubes (the microtubes 13 in which the refrigerant has flowed down), and rises through the refrigerant flow channels of the microtubes 13 to flow into the distributor 11 on

the right side from the partition member 11B.

[0050] As described above, the refrigerant flows while meandering up and down to evaporate. The outside air is passed through the evaporator 4 from a direction (a forward direction in the embodiment on a front side of FIG. 2) perpendicular to the longitudinal direction of the microtube 13 by the air blower 8, and the refrigerant evaporates to absorb the heat from the outside air (the heat pump). Furthermore, the refrigerant allowed to flow into the distributor 11 on the right side from the partition member 11B passes the passages 22A in the respective pipes 22 to flow into the refrigerant outlet pipe 18 from the downside. At this time, the respective pipes 22 are disposed along approximately the whole region of the longitudinal direction of the distributor 11 on the right side from the partition member 11B, and hence the refrigerant is substantially equally distributed to enter the passages 22A of the respective pipes 22, and enters the refrigerant outlet pipe 18 to join the flow. The refrigerant joined in the refrigerant outlet pipe 18 flows out from the right end of the pipe to be sucked into the compressor 1.

[0051] As described above in detail, according to the evaporator 4 constituted of the heat exchanger of this embodiment of the present invention, when the upper and lower ends of the plurality of microtubes 13 are communicated with each other by the pair of distributors 11 and 12 and carbon dioxide is used as the refrigerant, the evaporator comprises the refrigerant inlet pipe 17 connected to the distributor 11, and the distributor 11 is allowed to communicate with the refrigerant inlet pipe 17 by the plurality of passages 21A. Therefore, when the refrigerant flows from the refrigerant inlet pipe 17 into the distributor 11, the refrigerant is distributed by the plurality of passages 21A.

[0052] In consequence, it is possible to suppress a pressure loss in the refrigerant inlet pipe 17, and the refrigerant is smoothly and suitably distributed to the microtubes 13 in the distributor 11, so that a performance of the evaporator 4 (the heat exchanger) can remarkably improve.

[0053] Additionally, in the embodiment, the evaporator comprises the refrigerant outlet pipe 18 connected to the distributor 11, and the distributor 11 is allowed to communicate with the refrigerant outlet pipe 18 by the plurality of passages 22A, so that when the refrigerant flows into the refrigerant outlet pipe 18 from the distributor 11, the refrigerant passes through the plurality of passages 22A to flow into the refrigerant outlet pipe 18, thereby joining the flow.

[0054] In consequence, the joining of the refrigerant from the distributor 11 in the refrigerant outlet pipe 18 is smoothly and suitably performed, and the pressure loss in the refrigerant outlet pipe 18 is suppressed, so that the performance of the evaporator 4 (the heat exchanger) can further improve.

[0055] In this case, the total of the refrigerant flow channel sectional areas of the respective passages 21A which allow the distributor 11 to communicate with the refrigerant inlet pipe 17 is not less than the flow channel sectional area in the refrigerant inlet pipe 17, and the total of the refrigerant flow channel sectional areas of the respective passages 22A which allow the distributor 11 to communicate with the refrigerant outlet pipe 18 is not less than the flow channel sectional area in the refrigerant outlet pipe 18. Therefore, also when the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are constituted of the pipes having smaller outer and inner diameters than the distributor 11 as in the embodiment, it is possible to effectively suppress the pressure loss in the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 and it is also possible to further smoothen the distribution and joining of the refrigerant.

[0056] Furthermore, each of the passages 21A and 22A is disposed to correspond to the space between the adjacent microtubes 13. Therefore, as in the embodiment, when the plurality of holes 11C and 11D are made in the distributor 11, the plurality of holes 17A are made in the refrigerant inlet pipe 17 and the plurality of holes 18A are also made in the refrigerant outlet pipe 18 and when the plurality of pipes 21 allow the respective holes 11C and 17A to communicate with one another and the plurality of pipes 22 allow the respective holes 11D and 18A to communicate with one another to constitute the passages 21A and 22A in the pipes 21 and 22, respectively, interference of the pipes 21 and 22 constituting the passages 21A and 22A with the microtubes 13 does not occur. In consequence, a degree of freedom increases in setting of positions of the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 to the distributor 11.

[Embodiment 2]

[0057] Next, another embodiment of the heat exchanger of the present invention will be described with reference to FIG. 5 to FIG. 8. It is to be noted that in the respective drawings, components denoted with the same reference signs as in FIG. 1 to FIG. 4 perform the same or similar functions. In addition, a heat exchanger of this embodiment is also used as the evaporator 4 in FIG. 1.

[0058] In this embodiment, a refrigerant inlet pipe 17 communicates to be connected to a front surface (one surface on an inflow side of air by an air blower 8) of a position corresponding to a left side (one side) of a partition member 11A of a distributor 11. A right end (the other end) of the refrigerant inlet pipe 17 is also closed, and a left end of the refrigerant inlet pipe 17 is opened to connect this left end opening (one end opening) to the expansion valve 3 of FIG. 1. Additionally, in this embodiment, a refrigerant outlet pipe 18 communicates to be connected to a front surface of a position corresponding to a right side (the other side) of a partition member 11B of the distributor 11. A left end (one end) of the refrigerant outlet pipe 18 is also closed, and a right end thereof is opened to connect this right end opening (the other end opening) to a suction side of the compressor 1 of FIG. 1.

[0059] Additionally, also in this embodiment, the distributor 11 and the refrigerant inlet pipe 17, and the distributor 11 and the refrigerant outlet pipe 18 communicate to be connected by a plurality of thin pipes 21 and 22, respectively.

[0060] In this case, as enlarged and shown in FIG. 8, in a rear surface of the refrigerant inlet pipe 17, a plurality of (eight in the embodiment) small-diameter holes 17A are made via a predetermined space in a longitudinal direction of the pipe, and also in an front surface of the distributor 11 on the left side from the partition member 11A, a plurality of (similarly eight) small-diameter holes 11C are made via a predetermined space in the longitudinal direction. At this time, in the front surface of the distributor 11 on the left side from the partition member 11A, the respective holes 11C are formed via a predetermined space along approximately the whole region of the longitudinal direction of the distributor.

[0061] Additionally, similarly to the case of the refrigerant inlet pipe 17 shown in FIG. 8, also in a rear surface of the refrigerant outlet pipe 18, a plurality of (eight in the embodiment) small-diameter holes 18A are made via a predetermined space in a longitudinal direction of the pipe, and also in a front surface of the distributor 11 on the right side from the partition member 11B, a plurality of (similarly eight) small-diameter holes 11D are made via a predetermined space in the longitudinal direction. At this time, in the front surface of the distributor 11 on the right side from the partition member 11B, the respective holes 11D are formed via a predetermined space along approximately the whole region of the longitudinal direction of the distributor.

[0062] Furthermore, both ends (front and rear ends) of each of the pipes 21 enter each hole 17A of the refrigerant inlet pipe 17 and each hole 11C of the distributor 11 to be connected (brazed) thereto, respectively, and the respective pipes 21 are attached along a space between the refrigerant inlet pipe 17 and the distributor 11. In the plurality of pipes 21, passages 21A are constituted, respectively, and the plurality of passages 21A allow the inside of the distributor 11 on the left side from the partition member 11A to communicate with the inside of the refrigerant inlet pipe 17. In addition, both ends (front and rear ends) of each of the pipes 22 enter each hole 18A of the refrigerant outlet pipe 18 and each hole 11D of the distributor 11 to be connected (brazed) thereto, respectively, and the respective pipes 22 are attached along a space between the refrigerant outlet pipe 18 and the distributor 11. In the plurality of pipes 22, passages 22A are constituted, respectively, and the plurality of passages 22A allow the inside of the distributor 11 on the right side from the partition member 11B to communicate with the inside of the refrigerant outlet pipe 18. The other constitution is similar to the constitution shown in FIG. 2 to FIG. 4.

[0063] As described above, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are connected to the distributor 11, and hence the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are disposed on the side of a surface (the front surface of the distributor 11) perpendicular to a surface (the lower surface) of the distributor 11 which is connected to the microtubes 13 (see FIG. 5 to FIG. 7). In consequence, the refrigerant inlet pipe 17, the refrigerant outlet pipe 18 and the distributor 11 are arranged upstream and downstream in an air passing direction (from the front to the rear mentioned above) of the outside air by the air blower 8 mentioned above as shown in FIG. 6. In particular, an outer diameter of each of the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 is smaller than that of the distributor 11 as described above, and hence as shown in FIG. 5, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 fall (hide) in a projected area of the distributor 11 in the air passing direction (from the front to the rear) of the outside air by the air blower 8.

[0064] It is to be noted that also in this embodiment, each of the pipes 21 which allow the refrigerant inlet pipe 17 to communicate with the distributor 11 corresponds to a position before a space between a microtube 13 positioned on a lower rear side of the pipe and a microtube 13 adjacent to the microtube as shown in FIG. 8. In addition, each of the pipes 22 which allow the refrigerant outlet pipe 18 to communicate with the distributor 11 corresponds to a position before a space between a microtube 13 positioned on a lower rear side of the pipe and a microtube 13 adjacent to the microtube.

[0065] Additionally, also in this case, dimensions of the respective pipes 21 and 22 are set so that a total of refrigerant flow channel sectional areas of the passages 21A in the respective pipes 21 (the total of those of the eight passages) is not less than a flow channel sectional area in the refrigerant inlet pipe 17, and a total of refrigerant flow channel sectional areas of the passages 22A in the respective pipes 22 (the total of those of the eight passages) is not less than a flow channel sectional area in the refrigerant outlet pipe 18.

[0066] A flow of the refrigerant in the evaporator 4 of this embodiment according to the abovementioned constitution will be described. The refrigerant passed through the expansion valve 3 flows into the refrigerant inlet pipe 17 of the evaporator 4 (the heat exchanger) from the left end thereof. The refrigerant allowed to flow into the refrigerant inlet pipe 17 is distributed to enter the plurality of pipes 21, and passes the passages 21A in the respective pipes 21 to flow from the front side into the distributor 11 on the left side from the partition member 11A. At this time, the respective pipes 21 are disposed along approximately the whole region of the longitudinal direction of the distributor 11 on the left side from the partition member 11A, and hence the refrigerant substantially equally flows into the whole region of the longitudinal direction of the distributor 11 on the left side from the partition member 11A.

[0067] Subsequently, similar to the abovementioned embodiment, the refrigerant flows while meandering up and down to evaporate. Furthermore, the refrigerant allowed to flow into the distributor 11 on the right side from the partition member 11B passes the passages 22A in the respective pipes 22 to flow into the refrigerant outlet pipe 18 from the rear side. At

this time, the respective pipes 22 are disposed along approximately the whole region of the longitudinal direction of the distributor 11 on the right side from the partition member 11B, and hence the refrigerant is substantially equally distributed to enter the passages 22A of the respective pipes 22, and enters the refrigerant outlet pipe 18 to join the flow. The refrigerant joined in the refrigerant outlet pipe 18 flows out from the right end thereof to be sucked into the compressor 1.

[0068] As described above, in this embodiment, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are disposed on the side of the surface (the front surface) of the distributor 11 which is perpendicular to the surface (the lower surface) of the evaporator which is connected to the microtubes 13, and are allowed to communicate with the distributor 11 by the plurality of passages 21A and 22A, so that unlike Embodiment 1 and the conventional example mentioned above, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are not positioned in a longitudinal direction of the microtubes 13.

[0069] In consequence, a length dimension of the microtube 13 can be increased as much as a dimension of a range where the refrigerant inlet pipe 17, the refrigerant outlet pipe 18 and the pipes 21 and 22 are present as shown in FIG. 2, and hence a heat exchange area of the evaporator 4 (the heat exchanger) corresponding to the microtubes 13 to which fins 14 are attached can be enlarged as much as the dimension, so that a performance of the evaporator 4 (the heat exchanger) can further improve.

[0070] Additionally, when the pipes 21 and 22 are connected to the front surface of the distributor 11 as in this embodiment, the pipes 21 and 22 come close to the microtubes 13 connected to the lower surface of the distributor, which further increases the risk that the microtubes and the pipes interfere with one another. Also in this embodiment, however, each of the pipes 21 and 22 constituting the passages 21A and 22A is disposed in the space between the microtube 13 and the microtube 13 adjacent to the microtube, and hence such a problem does not occur (i.e., a degree of freedom increases in setting of positions of the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 to the distributor 11).

[Embodiment 3]

[0071] Next, still another embodiment of the heat exchanger of the present invention will be described with reference to FIG. 9 to FIG. 12. It is to be noted that in the respective drawings, components denoted with the same reference signs as in FIG. 1 and FIG. 5 to FIG. 8 perform the same or similar functions. In addition, a heat exchanger of this embodiment is also used as the evaporator 4 in FIG. 1.

[0072] Also in this embodiment, similarly to Embodiment 2 mentioned above, a refrigerant inlet pipe 17 communicates to be connected to a front surface (one surface on an inflow side of air by an air blower 8) of a position corresponding to a left side (one side) of a partition member 11A of a distributor 11. A right end (the other end) of the refrigerant inlet pipe 17 is also closed, and a left end of the refrigerant inlet pipe 17 is opened to connect this left end opening (one end opening) to the expansion valve 3 of FIG. 1. Additionally, in this embodiment, a refrigerant outlet pipe 18 communicates to be connected to a front surface of a position corresponding to a right side (the other side) of a partition member 11B of the distributor 11. A left end (one end) of the refrigerant outlet pipe 18 is also closed, and a right end thereof is opened to connect this right end opening (the other end opening) to a suction side of the compressor 1 of FIG. 1.

[0073] However, in this embodiment, the distributor 11 and the refrigerant inlet pipe 17, and the distributor 11 and the refrigerant outlet pipe 18 communicate to be connected via connecting members 23 each having a strip plate-like shape (a width is about the same as an outer diameter of the refrigerant inlet pipe 17 or the refrigerant outlet pipe 18). In the connecting member 23, a plurality of (eight in the embodiment) passages 23A each extending through the connecting member are formed via a predetermined space along a longitudinal direction of the connecting member, and collar-like flanges (denoted with 23B and 23C in FIG. 12) are projected around front and rear opening edges of the respective passages 23A (front and rear surfaces of the connecting member 23).

[0074] Also in this case, in a rear surface of the refrigerant inlet pipe 17, as enlarged and shown in FIG. 12, a plurality of (eight in the embodiment) of small-diameter holes 17A are made via a predetermined space in a longitudinal direction of the pipe, and also in a front surface of the distributor 11 on the left side from the partition member 11A, a plurality of (similarly eight) small-diameter holes 11C are made via a predetermined space in the longitudinal direction of the distributor. At this time, in the front surface of the distributor 11 on the left side from the partition member 11A, the respective holes 11C are formed via a predetermined space along approximately the whole region of the longitudinal direction of the distributor.

[0075] Additionally, similarly to the case of the refrigerant inlet pipe 17 shown in FIG. 12, also in a rear surface of the refrigerant outlet pipe 18, a plurality of (eight in the embodiment) small-diameter holes 18A are made via a predetermined space in a longitudinal direction of the pipe, and also in a front surface of the distributor 11 on the right side from the partition member 11B, a plurality of (similarly eight) small-diameter holes 11D are made via a predetermined space in the longitudinal direction of the distributor. At this time, in the front surface of the distributor 11 on the right side from the partition member 11B, the respective holes 11D are formed via a predetermined space along approximately the whole region of the longitudinal direction of the distributor.

[0076] Furthermore, the connecting member 23 is sandwiched between the distributor 11 and the refrigerant inlet pipe 17, the flanges 23B on front surface sides of the respective passages 23A of the connecting member 23 are allowed to enter the respective holes 17A of the refrigerant inlet pipe 17, and the flanges 23C on rear surface sides of the respective passages 23A of the connecting member 23 are allowed to enter the respective holes 11C of the distributor 11. In this state, three components, i.e., the distributor 11, the connecting member 23 and the refrigerant inlet pipe 17 are integrally connected (brazed). The plurality of passages 23A of the connecting member 23 allow the inside of the distributor 11 on the left side from the partition member 11A to communicate with the inside of the refrigerant inlet pipe 17.

[0077] In addition, the connecting member 23 is also sandwiched between the distributor 11 and the refrigerant outlet pipe 18, the flanges 23B on the front surface sides of the respective passages 23A of the connecting member 23 are allowed to enter the respective holes 18A of the refrigerant outlet pipe 18, and the flanges 23C on the rear surface sides of the respective passages 23A of the connecting member 23 are allowed to enter the respective holes 11D of the distributor 11, respectively. In this state, three components, i.e., the distributor 11, the connecting member 23 and the refrigerant outlet pipe 18 are integrally connected (brazed). The plurality of passages 23A of the connecting member 23 allow the inside of the distributor 11 on the right side from the partition member 11B to communicate with the inside of the refrigerant outlet pipe 18. The other constitution is similar to the constitution of FIG. 2 to FIG. 8.

[0078] The refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are connected to the distributor 11 in this manner, and hence also in this embodiment, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are disposed on the side of a surface (the front surface of the distributor 11) which is perpendicular to a surface (the lower surface) of the distributor 11 which is connected to the microtubes 13 (see FIG. 9 and FIG. 10). In consequence, the refrigerant inlet pipe 17, the refrigerant outlet pipe 18 and the distributor 11 are arranged upstream and downstream as shown in FIG. 10 in an air passing direction (from the front to the rear mentioned above) of the outside air by the air blower 8 mentioned above.

[0079] In particular, an outer diameter of the refrigerant inlet pipe 17 or the refrigerant outlet pipe 18 is smaller than that of the distributor 11 as described above. Additionally, in the embodiment, the width of the connecting member 23 is also about the same as the outer diameter of each of the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18, and hence as shown in FIG. 9, the refrigerant inlet pipe 17, the refrigerant outlet pipe 18 and the respective connecting members 23 fall (hide) in a projected area of the distributor 11 in the air passing direction (from the front to the rear) of the outside air by the air blower 8.

[0080] It is to be noted that also in this embodiment, each of the passages 23A and the flanges 23C which allow the refrigerant inlet pipe 17 to communicate with the distributor 11 corresponds to a position before a space between a microtube 13 positioned on a lower rear side of the passage and flange and a microtube 13 adjacent to the microtube as shown in FIG. 12. In addition, each of the passages 23A and the flanges 23C which allow the refrigerant outlet pipe 18 to communicate with the distributor 11 corresponds to a position before a space between a microtube 13 positioned on the lower rear side and a microtube 13 adjacent to the microtube.

[0081] Additionally, also in this case, a dimension of each passage 23A is set so that a total of refrigerant flow channel sectional areas of the passages 23A (the total of those of the eight passages) is not less than a flow channel sectional area in the refrigerant inlet pipe 17, and the total of the refrigerant flow channel sectional areas of the passages is not less than a flow channel sectional area in the refrigerant outlet pipe 18.

[0082] A flow of the refrigerant in the evaporator 4 of this embodiment according to the abovementioned constitution will be described. The refrigerant passed through the expansion valve 3 flows into the refrigerant inlet pipe 17 of the evaporator 4 (the heat exchanger) from the left end thereof. The refrigerant allowed to flow into the refrigerant inlet pipe 17 is distributed to enter the respective passages 23A of the connecting member 23 on the left side, and passes the passages to flow from the front side into the distributor 11 on the left side from the partition member 11A. At this time, the respective passages 23A are disposed along approximately the whole region of the longitudinal direction of the distributor 11 on the left side from the partition member 11A, and hence the refrigerant substantially equally flows into the whole region of the longitudinal direction of the distributor 11 on the left side from the partition member 11A.

[0083] Subsequently, similar to the abovementioned embodiment, the refrigerant flows while meandering up and down to evaporate. Furthermore, the refrigerant allowed to flow into the distributor 11 on the right side from the partition member 11B passes the respective passages 23A of the connecting member 23 on the right side to flow into the refrigerant outlet pipe 18 from the rear side. At this time, the respective passages 23A are disposed along approximately the whole region of the longitudinal direction of the distributor 11 on the right side from the partition member 11B, and hence the refrigerant is substantially equally distributed to enter the respective passages 23A, and enters the refrigerant outlet pipe 18 to join the flow. The refrigerant joined in the refrigerant outlet pipe 18 flows out from the right end thereof to be sucked into the compressor 1.

[0084] As described above, also in this embodiment, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are disposed on the side of the surface (the front surface) of the distributor 11 which is perpendicular to the surface (the lower surface) of the distributor which is connected to the microtubes 13, and are allowed to communicate with the distributor 11 by the plurality of passages 23A of the connecting members 23, so that unlike Embodiment 1 and the

conventional example mentioned above, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are not positioned in a longitudinal direction of the microtubes 13.

[0085] In consequence, a length dimension of the microtube 13 can be increased similarly to Embodiment 2 mentioned above, and hence a heat exchange area of the evaporator 4 (the heat exchanger) corresponding to the microtubes 13 to which fins 14 are attached can be enlarged, so that a performance of the evaporator 4 (the heat exchanger) can further improve.

[0086] Additionally, also in this embodiment, when the flanges 23C of the respective passages 23A of the connecting members 23 are connected to the front surface of the distributor 11, the respective flanges 23C come close to the microtubes 13 connected to the lower surface of the distributor, which further increases the risk that the microtubes and flanges interfere with one another. Also in this embodiment, the passage 23A is disposed in the space between the microtube 13 and the adjacent microtube 13, and hence such a problem does not occur (i.e., also in this case, a degree of freedom increases in setting of positions of the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 to the distributor 11).

[0087] Particularly, in this embodiment, the plurality of holes 11C, 11D, 17A and 18A are made in the distributor 11, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18, respectively, and the connecting members 23 in which the plurality of passages 23A communicating with the respective holes are formed are interposed between the distributor 11 and the refrigerant inlet pipe 17 and between the distributor and the refrigerant outlet pipe 18, respectively, and hence as compared with a case where the plurality of pipes 21 and 22 allow the communication of the holes of the distributor 11, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 as in Embodiment 1 and Embodiment 2 mentioned above, assembling properties can remarkably improve.

[0088] It is to be noted that in this embodiment, two right and left connecting members 23 are used to attach the refrigerant outlet pipe 18 and the refrigerant inlet pipe 17 to the distributor 11, but a series of connecting member may be interposed between the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 to be connected to the distributor 11.

[0089] Additionally, in the abovementioned respective embodiments, the refrigerant inlet pipe 17 and the refrigerant outlet pipe 18 are allowed to communicate with the distributor 11 by the plurality of passages 21A, 22A and 23A, respectively, but the first invention is not limited to the embodiments, and is effective even when the refrigerant inlet pipe 17 is only allowed to communicate with the distributor 11 by the plurality of passages 21A or 23A.

[0090] Furthermore, in the abovementioned respective embodiments, the distributors 11 and 12 are disposed at the upper and lower ends of the evaporator 4 (the heat exchanger), each microtube 13 is extended in the upward-downward direction, and the plurality of microtubes are disposed in the right-left direction, but the present invention is not limited to the embodiments, and is also effective for a heat exchanger in which the distributors 12 and 11 are positioned on right and left sides and each microtube 13 is extended in the right-left direction.

[0091] Additionally, in the respective embodiments, the heat exchanger of the present invention is used as the evaporator of the refrigerant circuit, but the heat exchanger may be used in a gas cooler, and in any case, the present invention is especially effective in a heat pump apparatus in which carbon dioxide is used as the refrigerant, or the like.

Description of Reference Signs

[0092]

1	compressor
2	gas cooler
3	expansion valve
4	evaporator (heat exchanger)
7	refrigerant circuit
11 and 12	distributor
11A, 11B and 12A	partition member
11C, 11D, 17A and 18A	hole
13	microtube
14	fin
17	refrigerant inlet pipe
18	refrigerant outlet pipe
21 and 22	pipe
21A, 22A and 23A	passage
23	connecting member

Claims

1. A heat exchanger in which both ends of a plurality of microtubes are communicated with each other by a pair of distributors, and carbon dioxide is used as a refrigerant, the heat exchanger comprising:

a refrigerant inlet pipe connected to the distributor,
wherein the distributor is allowed to communicate with the refrigerant inlet pipe by a plurality of passages.
2. The heat exchanger according to claim 1,
which comprises a refrigerant outlet pipe connected to the distributor,
wherein the distributor is allowed to communicate with the refrigerant outlet pipe by a plurality of passages.
3. The heat exchanger according to claim 2,
wherein a total of refrigerant flow channel sectional areas of the respective passages which allow the distributor to communicate with the refrigerant inlet pipe is not less than a flow channel sectional area in the refrigerant inlet pipe, and
a total of refrigerant flow channel sectional areas of the respective passages which allow the distributor to communicate with the refrigerant outlet pipe is not less than a flow channel sectional area in the refrigerant outlet pipe.
4. The heat exchanger according to claim 2 or 3,
wherein the refrigerant inlet pipe and the refrigerant outlet pipe are constituted of pipes having smaller outer diameters than the distributor.
5. The heat exchanger according to any one of claims 2 to 4,
wherein each of the passages is disposed to correspond to a space between the adjacent microtubes.
6. The heat exchanger according to any one of claims 2 to 5,
wherein a plurality of holes are made in the distributor, the refrigerant inlet pipe and the refrigerant outlet pipe, respectively, the respective holes communicate with a plurality of pipes, and the passages are disposed in the respective pipes.
7. The heat exchanger according to any one of claims 2 to 5,
wherein a plurality of holes are made in the distributor, the refrigerant inlet pipe and the refrigerant outlet pipe, respectively, and connecting members in which a plurality of passages that allow communication of the respective holes are formed are interposed between the distributor and the refrigerant inlet pipe and between the distributor and the refrigerant outlet pipe.
8. The heat exchanger according to any one of claims 2 to 7,
wherein on the side of a surface of the distributor which is perpendicular to a surface of the distributor which is connected to the microtubes, the refrigerant inlet pipe and the refrigerant outlet pipe are disposed, and are allowed to communicate with the distributor by a plurality of passages.
9. The heat exchanger according to any one of claims 1 to 8,
wherein heat exchanging fins are attached along the respective microtubes.

FIG. 1

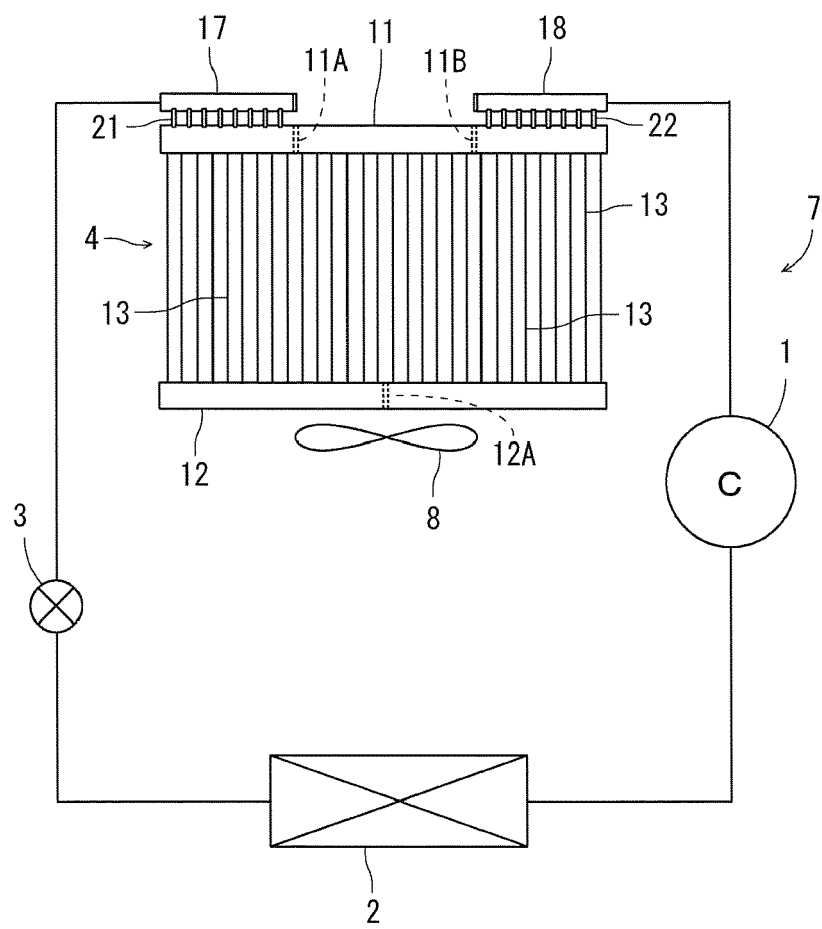


FIG. 2

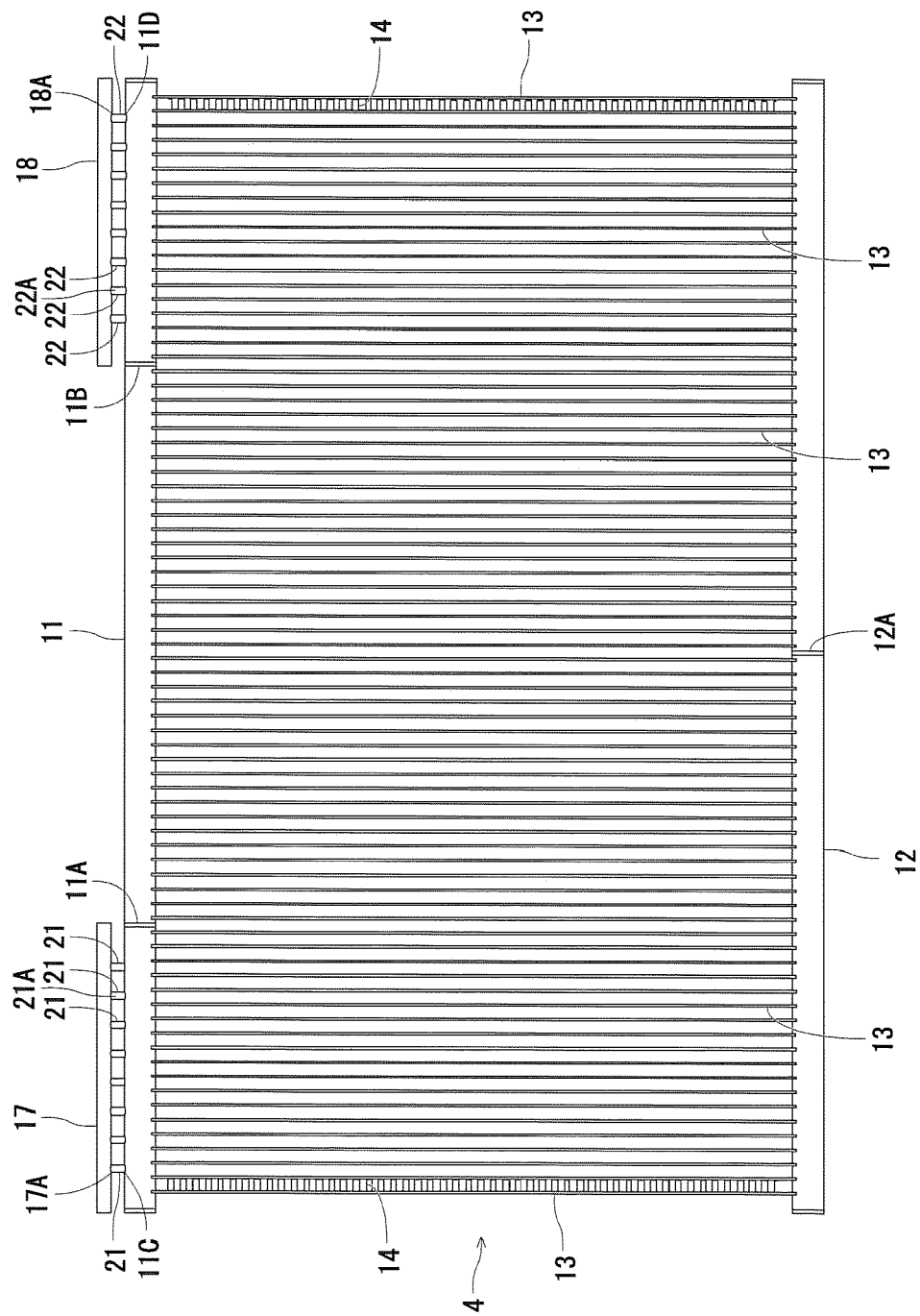


FIG. 3

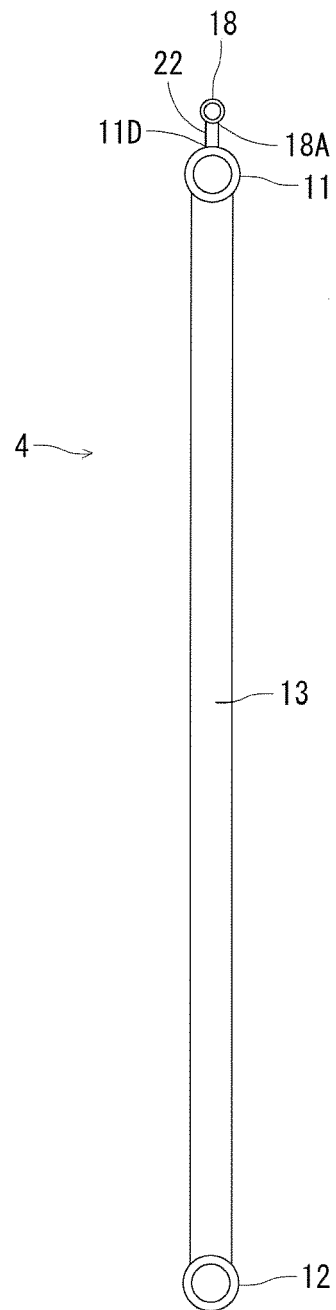


FIG. 4

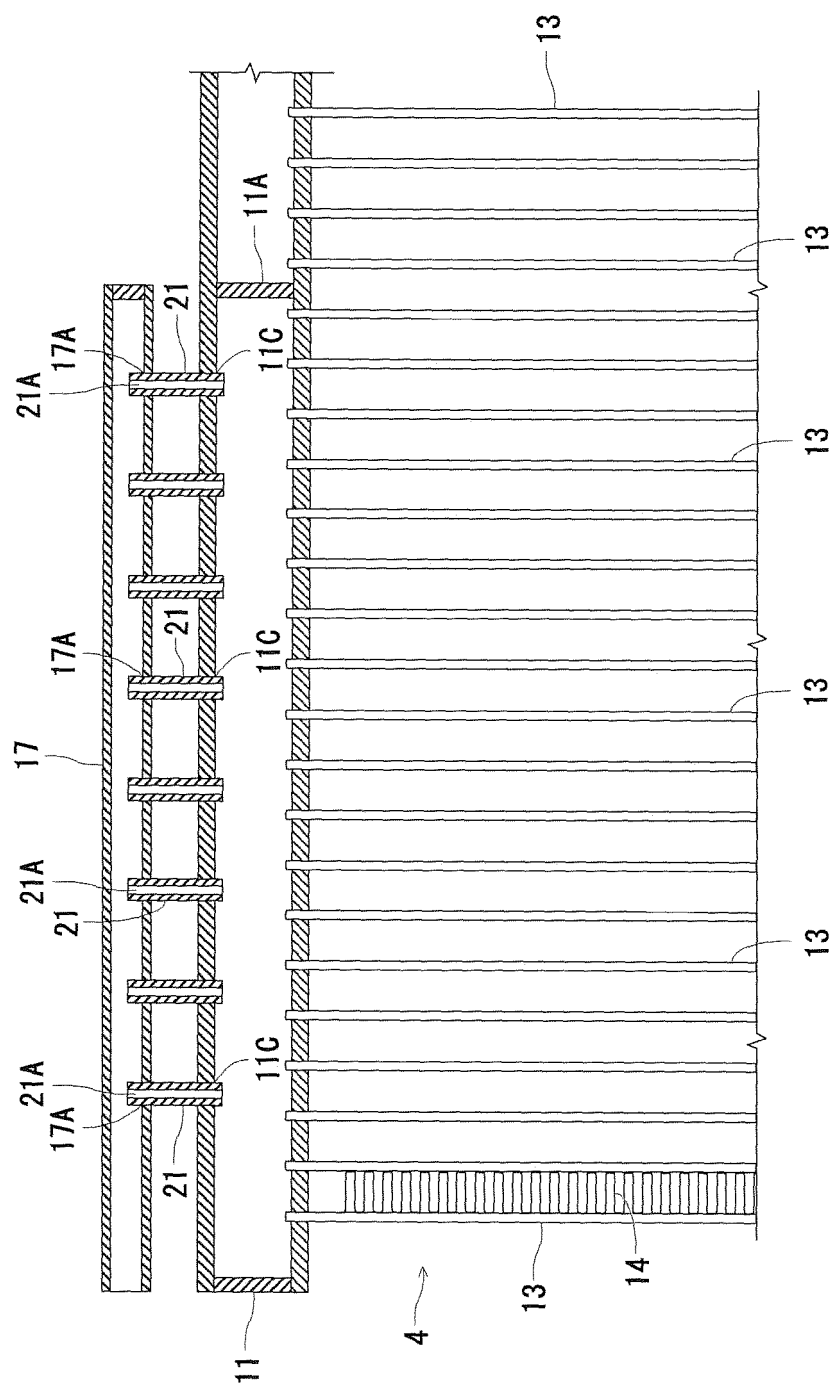


FIG. 5

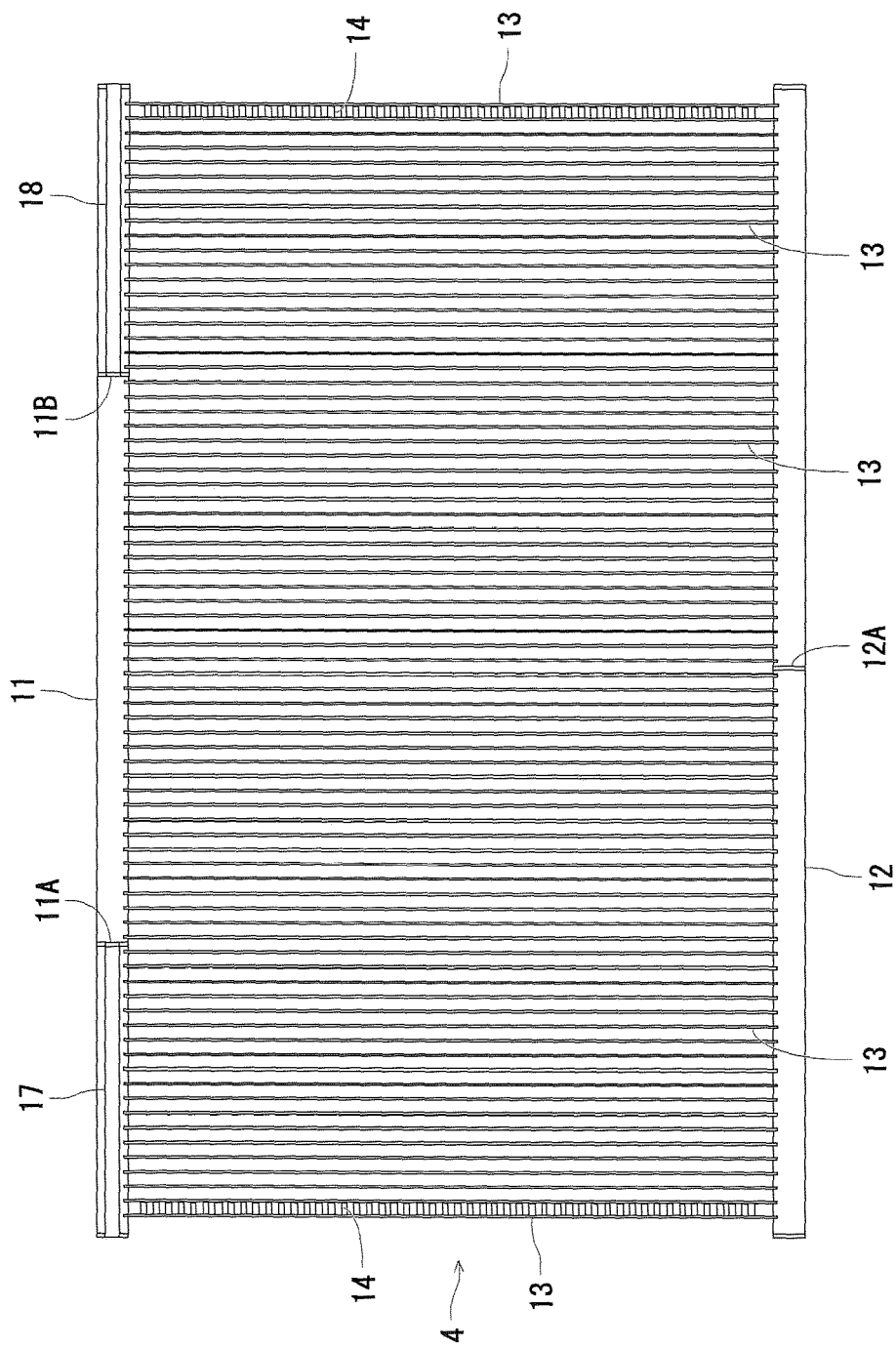


FIG. 6

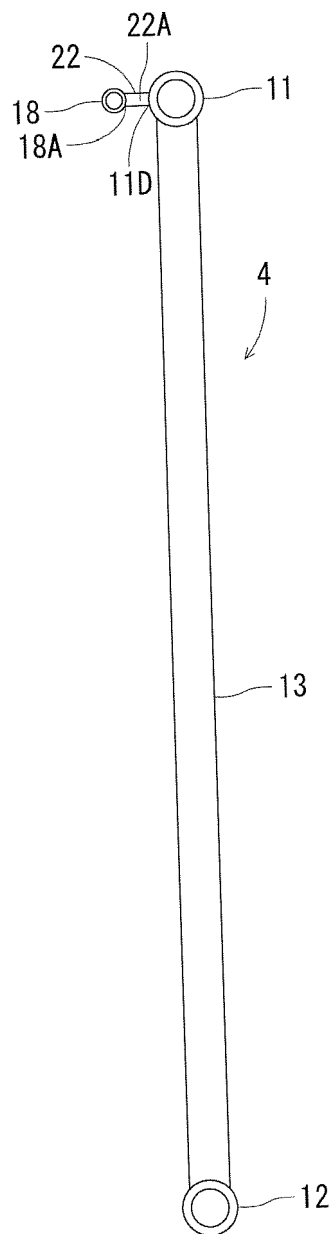


FIG. 7

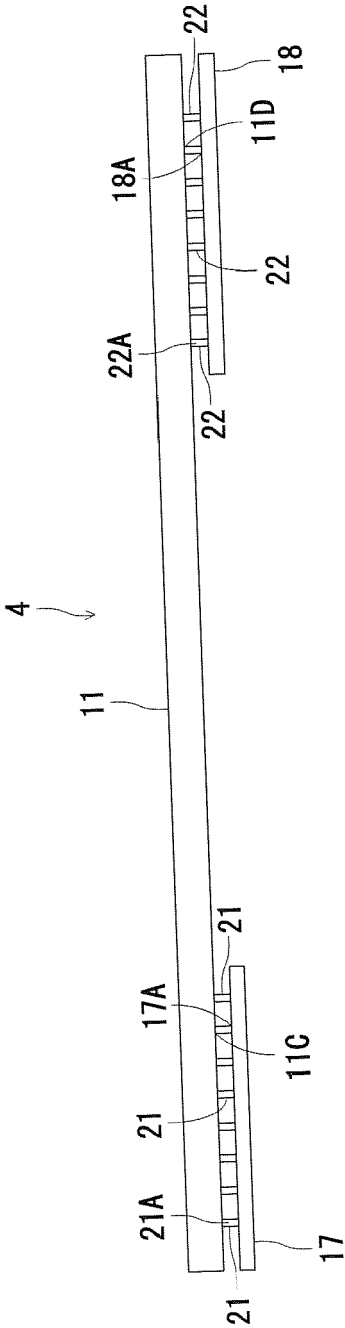


FIG. 8

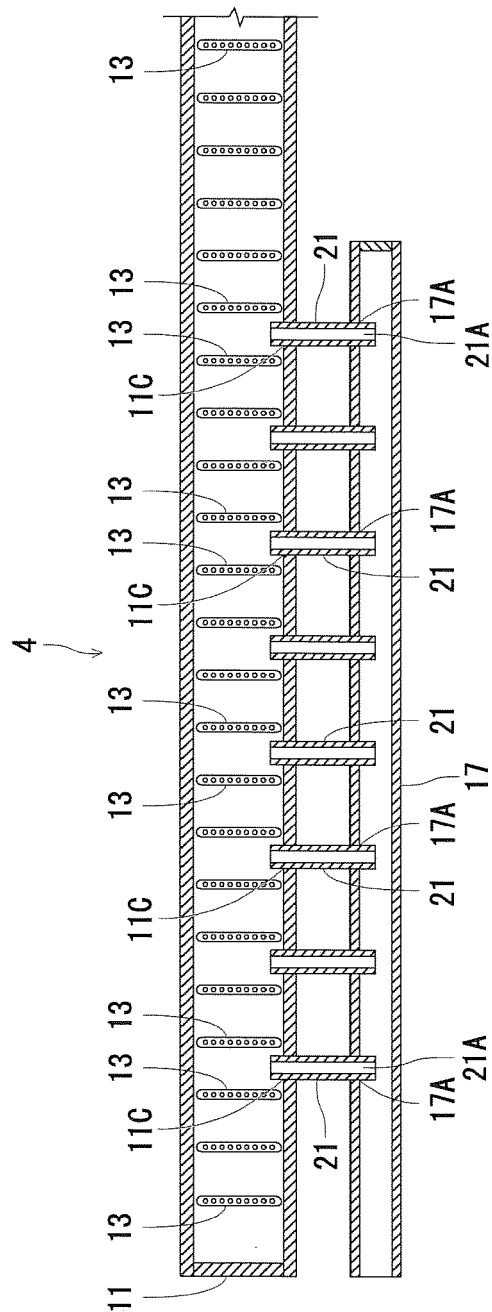


FIG. 9

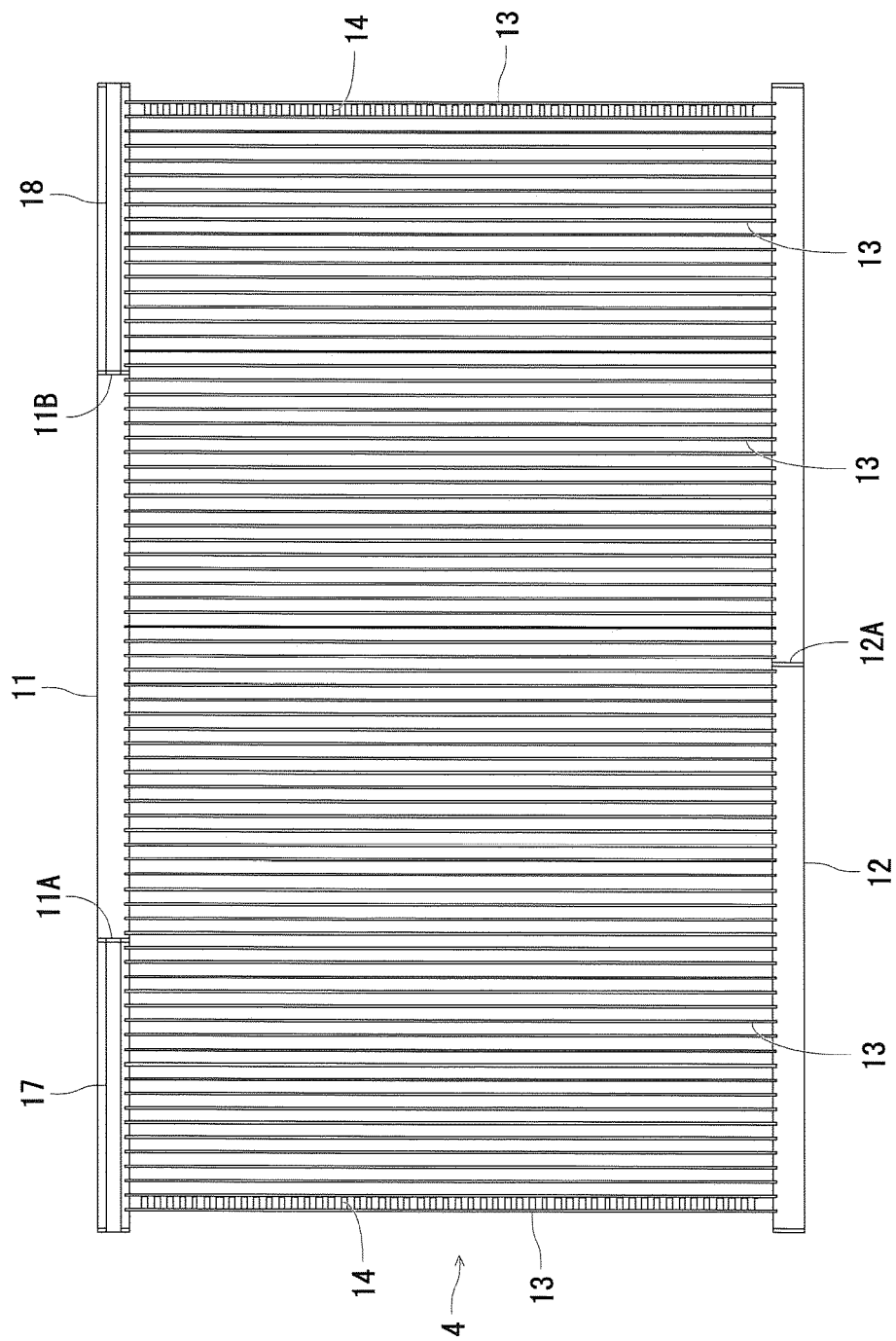


FIG. 10

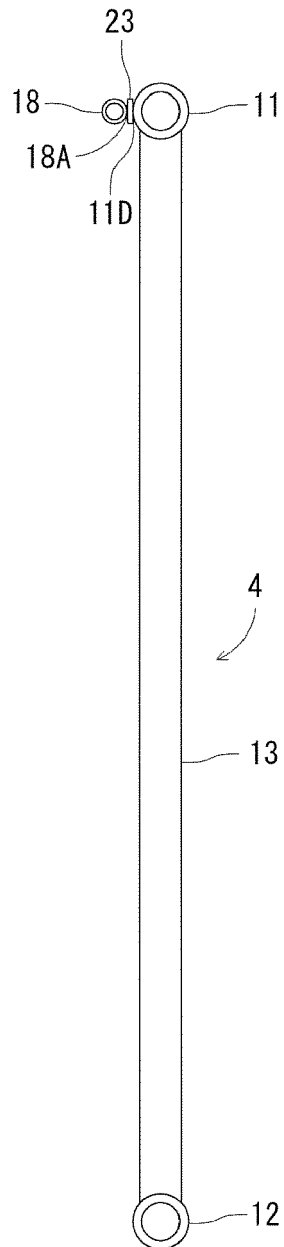


FIG. 11

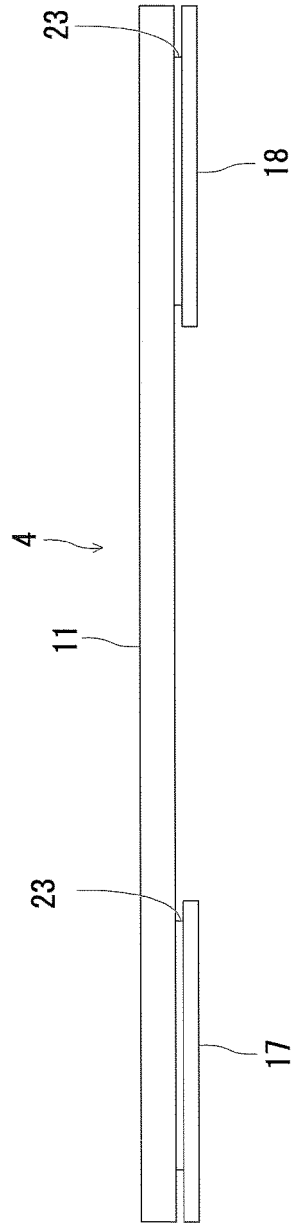


FIG. 12

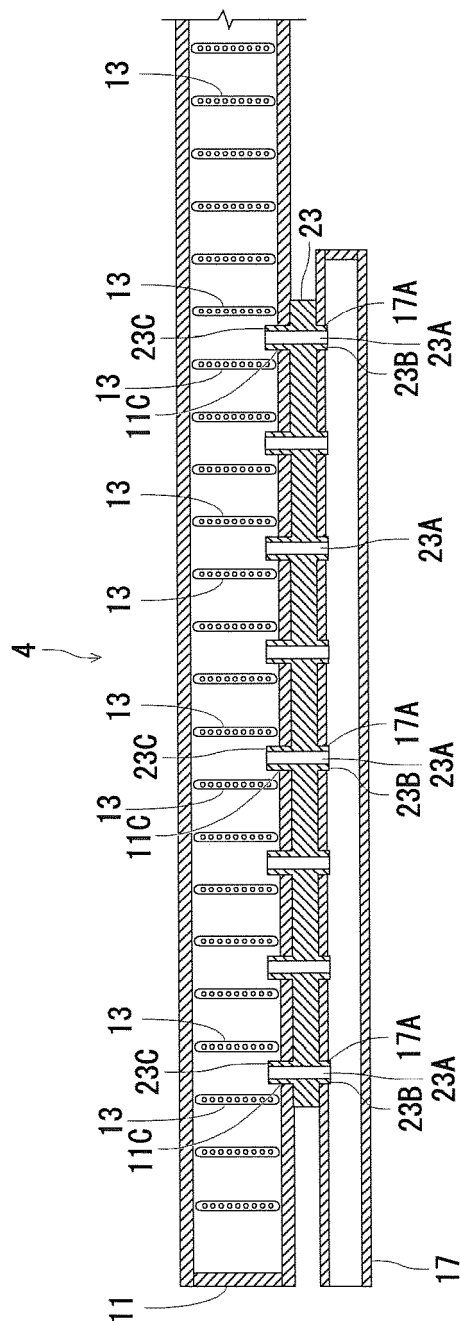
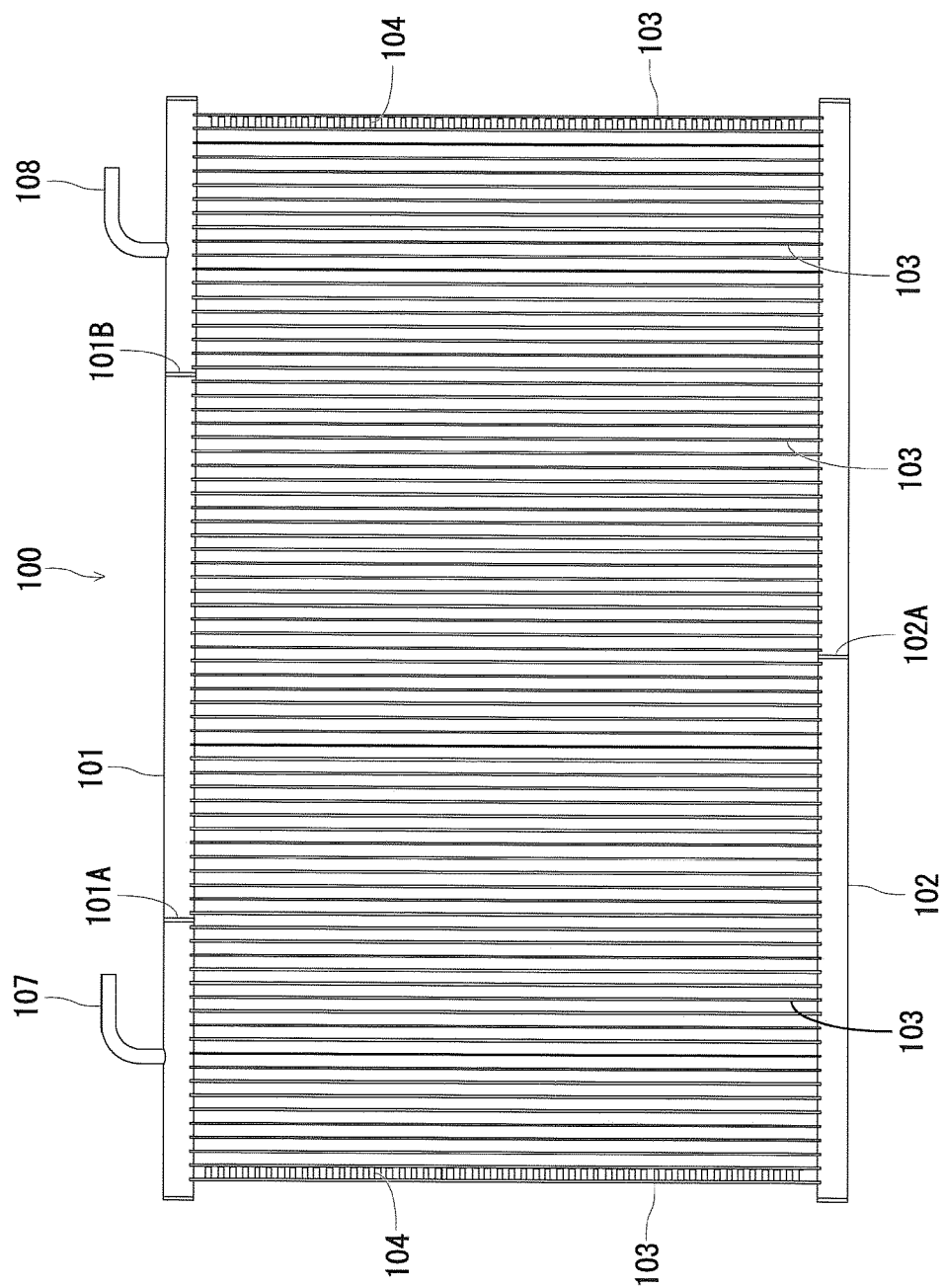


FIG. 13





EUROPEAN SEARCH REPORT

Application Number
EP 15 15 9508

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 640 682 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 29 March 2006 (2006-03-29) * figure 3 *	1-9	INV. F28F9/02 F28F1/12 F28D1/053
X	DE 195 15 527 A1 (THERMAL WERKE BETEILIGUNGEN GM [DE]) 31 October 1996 (1996-10-31) * figure 1 *	1,4-9	
X	US 2008/190134 A1 (KHATIB NAZIH M [US] ET AL) 14 August 2008 (2008-08-14) * figures 6-8 *	1,3-9	
X	KR 2012 0016519 A (LEE IL JAE [KR]) 24 February 2012 (2012-02-24) * figure 2 *	1-3,5, 7-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28F F28D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 July 2015	Examiner Vassoille, Bruno
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 15 9508

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-07-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1640682 A1	29-03-2006	CN 1749680 A	22-03-2006
		EP 1640682 A1	29-03-2006
		KR 20060025082 A	20-03-2006
		US 2006054310 A1	16-03-2006
DE 19515527 A1	31-10-1996	NONE	
US 2008190134 A1	14-08-2008	NONE	
KR 20120016519 A	24-02-2012	NONE	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008292022 A [0008]