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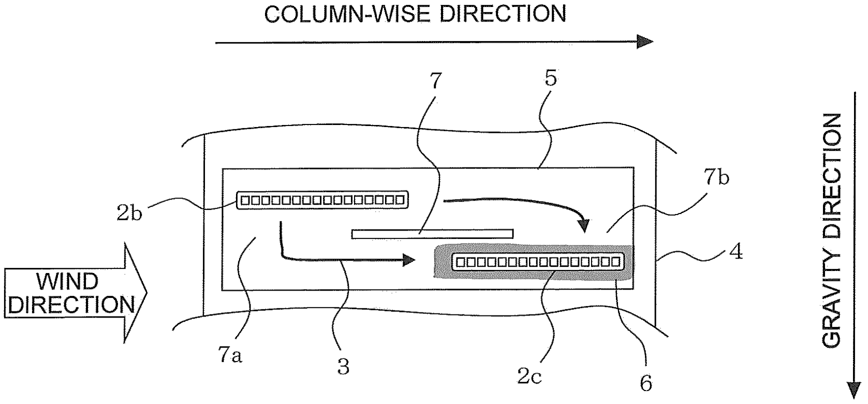
(54) HEAT EXCHANGER AND AIR CONDITIONER USING SAME

(57) A heat exchanger includes a heat transfer tube having an internal flow path through which a heat medium flows, the heat transfer tubes being arranged in a plurality of columns in a column-wise direction in which a heat-exchange medium passes through; a column bridging portion 5 being a heat medium-flow path connecting a pair of the heat transfer tubes arranged adjacent to each other in the column-wise direction; a header 4 to which the heat transfer tubes are connected, the column bridging portion 5 being provided inside the header 4; and a refrigerant partition plate 7 installed in the heat medium-flow path inside the column bridging portion 5.

FIG. 3



EP 3 051 244 A1

Description

Technical Field

[0001] The present invention relates to a heat exchanger having a plurality of columns of heat transfer tubes through which refrigerant flows in the flow direction of a heat-exchange fluid (such as air).

Background Art

[0002] There has been known a heat exchanger having two columns of heat transfer tubes (such as flat tubes) through which refrigerant flows in the flow direction of a heat-exchange fluid (such as air) passing through the heat exchanger, where the refrigerant is allowed to flow between the columns of heat transfer tubes inside a header provided on one end part of the heat transfer tubes. This type of heat exchanger is configured so that, when the heat exchanger is used as an evaporator, the flowing heat-exchange fluid and refrigerant flow parallel to each other, and when the heat exchanger is used as a condenser, the flowing heat-exchange fluid and refrigerant flow in directions opposite to each other, improving efficiency of the heat exchanger (see Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2003-287390 (see Fig. 4 and other related information)

Summary of Invention

Technical Problem

[0004] Fig. 8 shows an internal structure of a header 4 of a conventional heat exchanger as described above, and is a cross-sectional view of a column bridging portion 5 that allows the refrigerant to flow between the columns of heat transfer tubes. Fig. 8 (a) shows a liquid refrigerant flow 3 when the cross-sectional shape of the column bridging portion 5 is a rectangle, and Fig. 8 (b) shows the liquid refrigerant flow 3 when the cross-sectional shape of the column bridging portion 5 is a substantial parallelogram. Inside the column bridging portion 5, two-phase gas-liquid refrigerant having a quality of approximately 0.5 flows out of a porous flat tube 2 on the windward side of air, which is a heat-exchange fluid, and flows into a porous flat tube 2 of the leeward column as indicated by the refrigerant flow 3. In both cases of Figs. 8 (a) and 8 (b), liquid refrigerant 6 in the two-phase gas-liquid refrigerant concentrates in a leeward side part in the vicinity of the porous flat tube 2 of the leeward column by inertia force from the outflow side-heat transfer tube. For this reason, the flow rate of the liquid refrigerant inside the heat transfer tube at and after the column bridging portion 5 becomes uneven, and the liquid refrigerant does not flow through the refrigerant flow path of the porous flat tube 2 on the windward side where heat load is large, leading to a problem of degradation in heat exchange performance.

[0005] The present invention has been made to solve the above problem, and aims to provide a heat exchanger configured so that, when heat transfer tubes arranged in a column-wise direction are connected in a column bridging portion, which is a refrigerant flow path, the flow rate distribution of liquid refrigerant flowing into the heat transfer tube at and after the column bridging portion is even, or the flow rate distribution is appropriate to heat load, achieving excellent performance of the heat exchanger.

Solution to Problem

[0006] A heat exchanger according to the present invention includes a heat transfer tube having an internal flow path through which a heat medium flows, the heat transfer tubes being arranged in a plurality of columns in a column-wise direction in which a heat-exchange medium passes through; a column bridging portion being a heat medium-flow path connecting a pair of the heat transfer tubes arranged adjacent to each other in the column-wise direction; a header to which the heat transfer tubes are connected, the column bridging portion being provided inside the header; and a refrigerant partition plate installed in the heat medium-flow path inside the column bridging portion.

Advantageous Effects of Invention

[0007] According to the heat exchanger of the present invention, the refrigerant partition plate for guiding the flowing heat medium is provided inside the column bridging portion. Thus, the flow rate distribution of liquid refrigerant flowing into the heat transfer tube at and after the column bridging portion is made even, or the flow rate distribution becomes appropriate to heat load, achieving excellent performance of the heat exchanger.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a partial front view of a heat exchanger according to Embodiment 1.
[Fig. 2] Fig. 2 is a cross-sectional view of porous flat tubes of the heat exchanger according to Embodiment 1.
[Fig. 3] Fig. 3 is a cross-sectional view of a column bridging portion 5 when the heat exchanger according to Embodiment 1 is used as an evaporator.
[Fig. 4] Fig. 4 is a cross-sectional view of the column bridging portion 5 when the heat exchanger according to Embodiment 1 is used as a condenser.
[Fig. 5] Fig. 5 is a cross-sectional view of a column bridging portion 5 when a heat exchanger according to Embodiment 2 is used as an evaporator.
[Fig. 6] Fig. 6 is a cross-sectional view of the column bridging portion 5 when the heat exchanger according to Embodiment 2 is used as a condenser.
[Fig. 7] Fig. 7 is a refrigerant circuit diagram of an air-conditioning apparatus using the heat exchangers according to Embodiments 1 and 2.
[Fig. 8] Figs. 8 are cross-sectional views of a column bridging portion 5 of a conventional heat exchanger.

Description of Embodiments

[0009] Hereinafter, embodiments of the present invention will be described with reference to the drawings. Note that the present invention is not limited to the embodiments described below.

Embodiment 1

[0010] An outline of the structure of a heat exchanger according to Embodiment 1 will be described by use of Figs. 1 and 2.
[0011] Fig. 1 is a partial front view of the heat exchanger according to Embodiment 1.
[0012] Fig. 2 is a cross-sectional view of porous flat tubes of the heat exchanger according to Embodiment 1.
[0013] As shown in Figs. 1 and 2, the heat exchanger according to Embodiment 1 is a finned tube type heat exchanger. Heat transfer tubes of the heat exchanger are arranged in the horizontal direction, while fins 1 are arranged in the vertical direction. A header 4 is connected to one end side of the heat transfer tubes. The header 4 is arranged so that its axial direction is parallel to the gravity direction. The heat transfer tubes are a porous flat tubes 2 each having many refrigerant flow paths arranged in parallel, and are arranged in two columns in the flowing direction of air, which is a heat-exchange fluid. As shown in Fig. 2, the porous flat tubes 2 in the two columns are arranged in a staggered manner in cross-sectional view.
[0014] Refrigerant flows inside the porous flat tubes 2, and the fins 1 are provided perpendicular to the axial directions of the porous flat tubes 2. The porous flat tubes 2 and the fins 1 are formed of a highly conductive metal such as copper and aluminum, and are joined by methods such as brazing, soldering, and welding under a state in which the porous flat tubes 2 are inserted into heat transfer tube insertion parts, which are cut out on the fins 1, to transfer heat to each other.
[0015] The fin 1 is configured of a first fin 1a arranged on the windward side of the flow direction of air, which is a heat-exchange fluid, and a second fin 1 b arranged on the leeward side.
[0016] A single path of the porous flat tubes 2 is formed of four porous flat tubes 2a, 2b, 2c, and 2d as one unit. The porous flat tubes 2a and 2b penetrate the first fins 1 a arranged on the windward side of the flow direction of air, and form a first column. Meanwhile, the porous flat tubes 2c and 2d penetrate the second fins 1 b arranged on the leeward side of the flow direction of air, and form a second column. Also, multiple steps of the porous flat tubes 2a and 2b are arranged layeredly in the axial direction of the header 4 while penetrating the first fins 1a. Additionally, multiple steps of the porous flat tubes 2c and 2d are arranged layeredly in the axial direction of the header 4 while penetrating the second fins 1 b.
[0017] The header 4 has a hollow structure having a substantially rectangular cross section, and includes a refrigerant flow path therein. The refrigerant flow path is formed as a column bridging portion 5, which connects the porous flat tubes 2b and 2c in the column-wise direction.
[0018] When the heat exchanger is used as an evaporator, as indicated by arrows of refrigerant flows 3 in Figs. 1 and 2, liquid refrigerant flows in from one end part of the porous flat tube 2a of the first column on the windward side passes

through a U-bend 9 from the other end part of the porous flat tube 2a to move from step to step, and flows into one end part of the porous flat tube 2b. The other end part of the porous flat tube 2b is connected to the header 4, and the refrigerant having flowed out of the porous flat tube 2b passes through the column bridging portion 5 of the header 4 to move from column to column, and flows into one end part of the porous flat tube 2c of the second column. The refrigerant having flowed into one end part of the porous flat tube 2c passes through the U-bend 9 from the other end part of the porous flat tube 2c to move from step to step, and flows into one end part of the porous flat tube 2d. Then, the refrigerant flows out of the other end part of the porous flat tube 2d.

[0019] Meanwhile, when the heat exchanger is used as a condenser, gas refrigerant flows in from the other end part of the porous flat tube 2d of the second column, follows through a flow path opposite to that of the case in which the heat exchanger is used as the evaporator, and flows out of one end part of the porous flat tube 2a of the first column.

[0020] The heat exchanger is configured by layering multiple steps of the paths of a unit formed in this manner, in the axial direction of the header 4.

[0021] Fig. 3 is a cross-sectional view of the column bridging portion 5 when the heat exchanger according to Embodiment 1 is used as an evaporator.

[0022] The column bridging portion 5 is formed as a substantially cuboidal hollow part inside the header 4. The porous flat tube 2b and the porous flat tube 2c are connected to and open to the column bridging portion 5, and two-phase gas-liquid refrigerant having flowed out of the porous flat tube 2b of the first column passes through the column bridging portion 5 to move between columns of the porous flat tubes 2b and 2c, and flows into one end part of the porous flat tube 2c of the second column.

[0023] The positional relation between the porous flat tube 2b and the porous flat tube 2c is shown in Fig. 3, where the porous flat tube 2c of the second column is shifted from the porous flat tube 2b of the first column in the axial direction of the header 4.

[0024] Additionally, a refrigerant partition plate 7 horizontally partitioning the inside of the column bridging portion 5 is installed between the porous flat tube 2b and the porous flat tube 2c in the axial direction of the header 4.

[0025] The refrigerant partition plate 7 is supported by straddling and being attached to two surfaces, which are a side wall of the column bridging portion 5 on which the porous flat tube 2b and the porous flat tube 2c open, and another side wall opposite to this side wall. Moreover, the refrigerant partition plate 7 is provided in the center position of the column-wise direction in which the porous flat tube 2b and the porous flat tube 2c are arranged, thus a first opening 7a is formed below the porous flat tube 2b, and a second opening 7b is formed above the porous flat tube 2c in the configuration.

[0026] The refrigerant partition plate 7 configured in this manner blocks the shortest route for the two-phase gas-liquid refrigerant having flowed out of the porous flat tube 2b of the first column to flow into one end part of the porous flat tube 2c of the second column, and divides the flow path of the refrigerant into two parts.

[0027] Thus, liquid refrigerant 6 in the two-phase gas-liquid refrigerant flows into the porous flat tube 2c through two flow paths, on the windward side and leeward side of the flow direction of heat-exchange fluid inside the column bridging portion 5, supplying the liquid refrigerant 6 evenly to the refrigerant flow paths of the porous flat tube 2c.

[0028] Thus, sufficient liquid refrigerant 6 flows evenly into the refrigerant flow paths of the porous flat tube 2c and evaporates, improving heat exchange performance as an evaporator.

[0029] Note that, although a plate-like refrigerant partition plate 7 has been described in Embodiment 1, the refrigerant partition plate 7 may be any form as long as it can obstruct the flow of the refrigerant, and may be a fine mesh plate or a protrusion formed on a side wall of the column bridging portion 5, for example. Also, the refrigerant partition plate 7 may be formed integrally with the header 4, or may be attached as a separate body. Further, the refrigerant partition plate is preferred to be made of the same material as that of the header 4, and may be made of a copper plate, an aluminum plate, or a resin plate, for example.

[0030] Next, Fig. 4 is a cross-sectional view of the column bridging portion 5 when the heat exchanger according to Embodiment 1 is used as a condenser.

[0031] When the heat exchanger functions as a condenser, the flow direction of refrigerant flowing through the porous flat tube 2 of the heat exchanger is opposite to that of the case in which the heat exchanger is used as the evaporator described above.

[0032] Thus, the refrigerant partition plate 7 blocks the shortest route for the refrigerant having flowed out of the porous flat tube 2c of the second column to flow into one end part of the porous flat tube 2b of the first column, and divides the flow path of the refrigerant into two parts.

[0033] The liquid refrigerant 6 flows into the porous flat tube 2b through two flow paths, on the windward side and leeward side of the flow direction of heat-exchange fluid inside the column bridging portion 5, supplying gas refrigerant and the liquid refrigerant 6 evenly to the refrigerant flow paths of the porous flat tube 2b.

[0034] Thus, gas refrigerant and the liquid refrigerant 6 flow evenly into the refrigerant flow paths of the porous flat tube 2b and the gas refrigerant is condensed, causing the condense effect to occur evenly in the refrigerant flow paths, and improving heat exchange performance as a condenser.

Embodiment 2

[0035] Of a heat exchanger according to Embodiment 2, only parts that are different from that of Embodiment 1 will be described.

[0036] Fig. 5 is a cross-sectional view of a column bridging portion 5 when a heat exchanger according to Embodiment 2 is used as an evaporator.

[0037] The column bridging portion 5 is formed inside a header 4, as a hollow part having a substantially parallelogram-shaped cross section. Similarly to Embodiment 1, in this configuration, a porous flat tube 2b and a porous flat tube 2c are connected to and open to the column bridging portion 5, and two-phase gas-liquid refrigerant having flowed out of the porous flat tube 2b of a first column passes through the column bridging portion 5 to move between columns of the porous flat tubes 2b and 2c, and flows into one end part of the porous flat tube 2c of a second column.

[0038] The positional relation between the porous flat tube 2b and the porous flat tube 2c is shown in Fig. 5, where the porous flat tube 2b of the first column is provided in the vicinity of the upper side of the column bridging portion 5, and the porous flat tube 2c of the second column is provided in the vicinity of the lower side of the column bridging portion 5.

[0039] Additionally, a first refrigerant partition plate 8a and a second refrigerant partition plate 8b horizontally partitioning the inside of the column bridging portion 5 are installed around the porous flat tube 2b and around the porous flat tube 2c.

[0040] The first refrigerant partition plate 8a and the second refrigerant partition plate 8b are supported by straddling and being attached to two surfaces, which are a side wall of the column bridging portion 5 on which the porous flat tube 2b and the porous flat tube 2c open, and another side wall opposite to this side wall.

[0041] The first refrigerant partition plate 8a surrounds the porous flat tube 2b, and has a first opening 8c opened downward on the windward side of the flow direction of heat-exchange fluid inside the column bridging portion 5. Meanwhile, the second refrigerant partition plate 8b surrounds the porous flat tube 2c, and has a second opening 8d opened upward on the leeward side of the flow direction of heat-exchange fluid inside the column bridging portion 5.

[0042] The first refrigerant partition plate 8a and the second refrigerant partition plate 8b configured in this manner block the shortest route for two-phase gas-liquid refrigerant having flowed out of the porous flat tube 2b of the first column to flow into one end part of the porous flat tube 2c of the second column, and form the flow path for a refrigerant flow 3 inside the column bridging portion 5 into an S shape.

[0043] Thus, liquid refrigerant 6 in the two-phase gas-liquid refrigerant having flowed out of the porous flat tube 2b flows into the periphery of the porous flat tube 2c through the second opening 8d of the second refrigerant partition plate 8b, concentrates on the windward side of the flow direction of heat-exchange fluid, which is the deepest part of the second refrigerant partition plate 8b, and forms a pool of liquid. In an evaporator, heat load is high on the windward side of the porous flat tube 2c, and thus supplying more liquid refrigerant thereto improves performance of the heat exchanger. Thus, the configuration of the above-mentioned heat exchanger allows the amount of liquid refrigerant on the windward side of the porous flat tube 2c to become relatively larger than that on the leeward side, improving performance of the heat exchanger.

[0044] Next, Fig. 6 is a cross-sectional view of the column bridging portion 5 when the heat exchanger according to Embodiment 2 is used as a condenser.

[0045] When the heat exchanger functions as a condenser, the flow direction of refrigerant flowing through the porous flat tube 2 of the heat exchanger is opposite to that of the case in which the heat exchanger is used as the evaporator described above.

[0046] Thus, the first refrigerant partition plate 8a and the second refrigerant partition plate 8b block the shortest route for the two-phase gas-liquid refrigerant having flowed out of the porous flat tube 2c of the second column to flow into one end part of the porous flat tube 2b of the first column, and form the refrigerant flow 3 inside the column bridging portion 5 into an S shape.

[0047] The liquid refrigerant 6 in the two-phase gas-liquid refrigerant having flowed out of the porous flat tube 2c flows into the periphery of the porous flat tube 2b through the first opening 8c of the first refrigerant partition plate 8a, concentrates on the leeward side of the flow direction of heat-exchange fluid, which is the deepest part of the first refrigerant partition plate 8a, and flows into the porous flat tube 2b. In a condenser, heat load is high on the windward side of the porous flat tube 2b, and thus supplying more gas refrigerant thereto improves performance of the heat exchanger. Thus, the configuration of the above-mentioned heat exchanger allows the amount of gas refrigerant on the windward side of the porous flat tube 2b to become relatively larger than that on the leeward side, improving performance of the heat exchanger.

[0048] Fig. 7 is a refrigerant circuit diagram of an air-conditioning and refrigerating apparatus using the heat exchangers according to Embodiments 1 and 2. A refrigerant circuit shown in Fig. 7 includes a compressor 33, a condensing heat exchanger 34, an expansion device 35, an evaporative heat exchanger 36, and fans 37 driven by fan motors 38. A highly energy efficient air-conditioning and refrigerating apparatus can be implemented, by using the aforementioned heat exchanger according to Embodiments 1 and 2 as the condensing heat exchanger 34, the evaporative heat exchanger 36, or both.

[0049] At this time, the energy efficiency is shown in the following expressions.

Heating energy efficiency = capacity of indoor heat exchanger (condenser) / all input

Cooling energy efficiency = capacity of indoor heat exchanger (evaporator) / all input

[0050] Note that effects of the heat exchangers described in the above Embodiments 1 and 2, and of the air-conditioning and refrigerating apparatus using the heat exchanger can be obtained, by using refrigerants such as R410A, R32, and HFO1234yf.

[0051] Also, although air and refrigerant have been used as examples of working fluids, other gases, liquids, or gas-liquid mixture fluids may be adopted as working fluids.

[0052] Note that any refrigerating machine oils can be used regardless of whether they are miscible or immiscible, such as those based on mineral oil, alkylbenzene oil, ester oil, ether oil, and fluorinated oil, in the heat exchangers described in the above Embodiments 1 and 2, and in the air-conditioning and refrigerating apparatus using the heat exchanger.

[0053] Additionally, although the header 4 of the heat exchanger arranged so that its axial direction is parallel to the gravity direction has been used as an example, the axial direction may be arranged parallel to the horizontal direction.

[0054] By arranging the axial direction of the header 4 parallel to the horizontal direction, liquid refrigerant is freed from influence of gravity, and is less likely to pool inside the header 4. Thus, when the heat exchanger functions as an evaporator, adopting the structure of the header 4 according to Embodiment 1 or 2 amplifies the effect for causing sufficient liquid refrigerant 6 to flow evenly into the refrigerant flow paths of the porous flat tube 2c. Hence, heat exchange performance as an evaporator is improved.

[0055] Further, when the heat exchanger functions as a condenser, similarly, adopting the structure of the header 4 according to Embodiment 1 or 2 allows gas refrigerant and the liquid refrigerant 6 to flow evenly into the refrigerant flow paths of the porous flat tube 2b, improving heat exchange performance as a condenser. Reference Signs List

[0056] 1 fin, 1 a first fin, 1 b second fin, 2 porous flat tube, 2a porous flat tube, 2b porous flat tube, 2c porous flat tube, 2d porous flat tube, 3 refrigerant flow, 4 header, 5 column bridging portion, 6 liquid refrigerant, 7 refrigerant partition plate, 7a first opening, 7b second opening, 8a first refrigerant partition plate, 8b second refrigerant partition plate, 8c first opening, 8d second opening, 9 U-bend, 33 compressor, 34 condensing heat exchanger, 35 expansion device, 36 evaporative heat exchanger, 37 fan, 38 fan motor

Claims

1. A heat exchanger comprising:

a heat transfer tube having an internal flow path through which a heat medium flows, the heat transfer tubes being arranged in a plurality of columns in a column-wise direction in which a heat-exchange medium passes through;
a column bridging portion being a heat medium-flow path connecting a pair of the heat transfer tubes arranged adjacent to each other in the column-wise direction;
a header to which the heat transfer tubes are connected, the column bridging portion being provided inside the header; and
a refrigerant partition plate installed in the heat medium-flow path inside the column bridging portion.

2. The heat exchanger of claim 1,
wherein the pair of the heat transfer tubes are arranged apart from each other in a direction perpendicular to the column-wise direction, and
wherein the refrigerant partition plate is installed between the pair of the heat transfer tubes, in the direction perpendicular to the column-wise direction.

3. The heat exchanger of claim 1 or 2,
wherein the refrigerant partition plate is provided parallel to the column-wise direction, and
wherein an opening through which the heat medium flows is provided on each end part of the refrigerant partition

plate in the column-wise direction.

4. The heat exchanger of any one of claims 1 to 3, wherein the refrigerant partition plate is a flat plate.

5. The heat exchanger of any one of claims 1 to 4, wherein the column bridging portion is cuboidal.

6. The heat exchanger of claim 1, wherein the refrigerant partition plate is provided around each of the pair of the heat transfer tubes, and an opening through which the heat medium flows is provided on each end side in the column-wise direction.

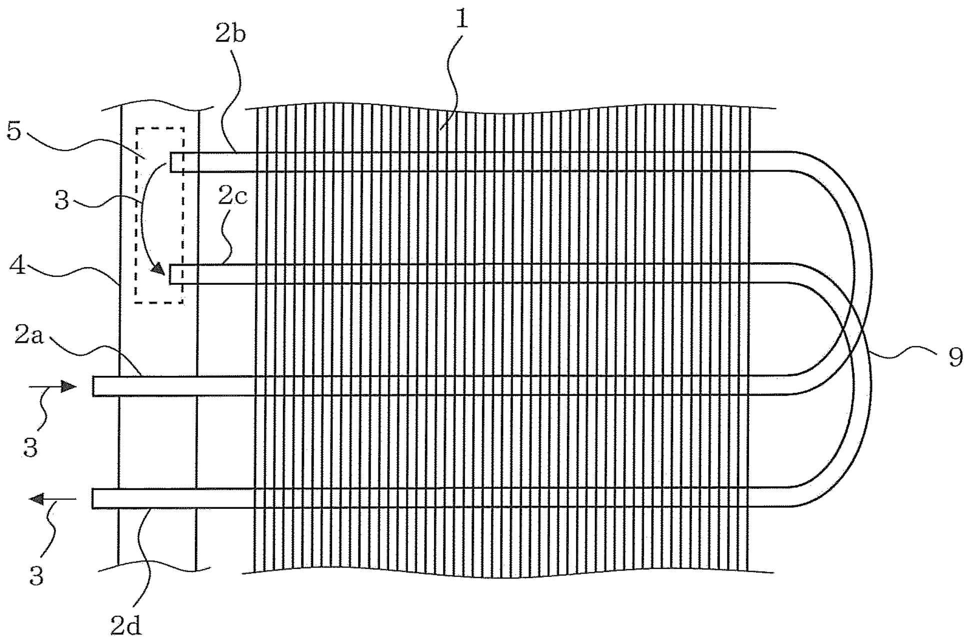
7. The heat exchanger of any one of claims 1 to 4 and 6, wherein a cross-sectional shape of the column bridging portion includes a parallelogram shape.

8. The heat exchanger of any one of claims 1 to 7, wherein the heat exchanger is a finned tube type, in which fins are installed in a direction perpendicular to an axial direction of the heat transfer tube.

9. The heat exchanger of any one of claims 1 to 8, wherein the heat transfer tube is a porous flat tube including a plurality of the flow paths through which the heat medium flows.

10. An air-conditioning apparatus comprising the heat exchanger of any one of claims 1 to 9.

FIG. 1


1
2b
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3
2c
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2a
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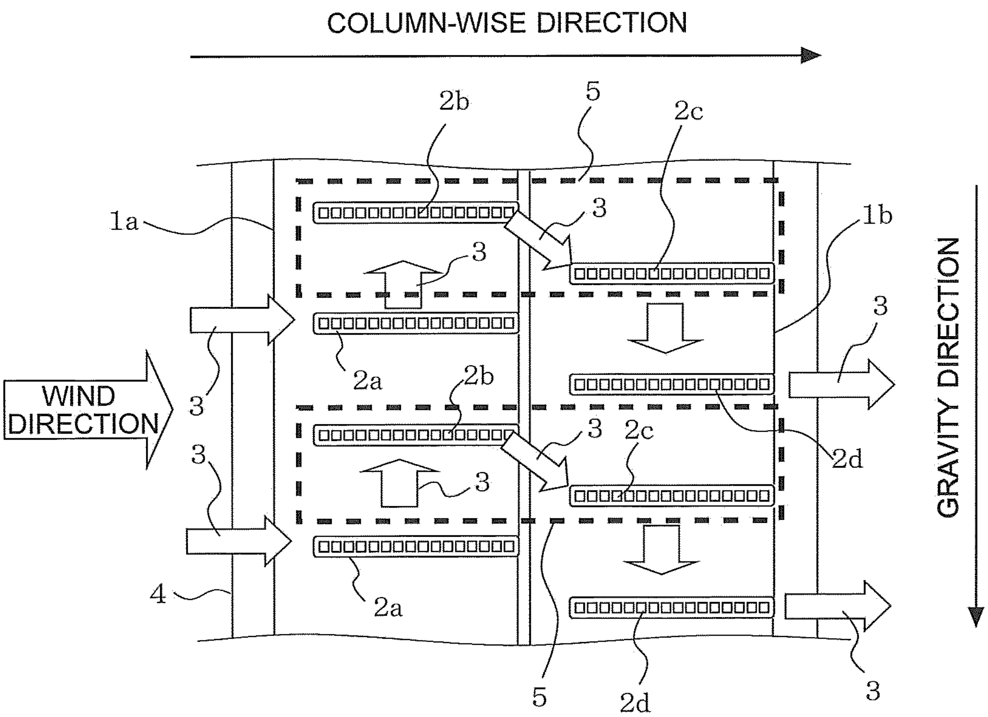
3
2d
9

FIG. 2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WIND DIRECTION
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3
3
4
2a
5
2d
3
GRAVITY DIRECTION

FIG. 3

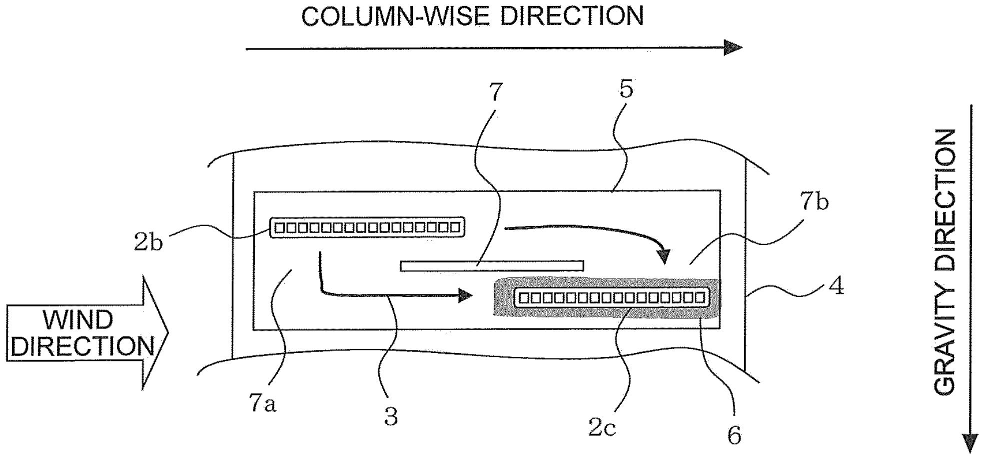


FIG. 4

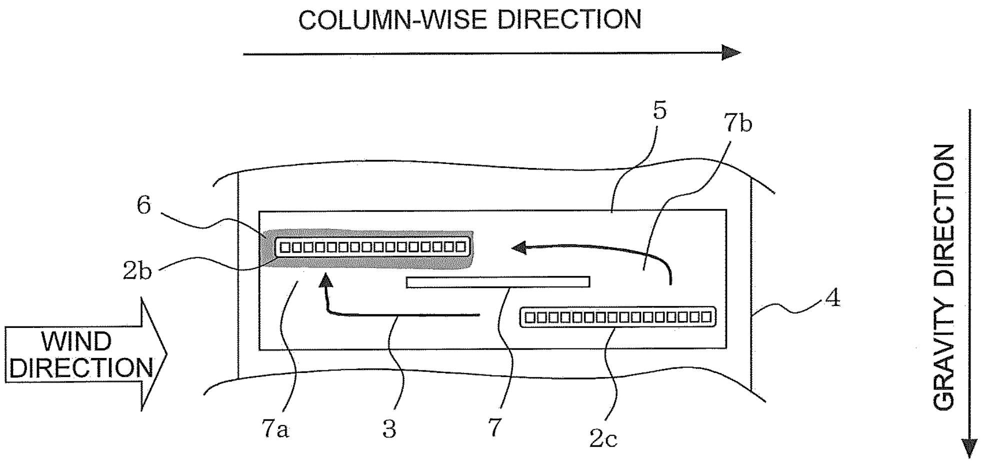


FIG. 5

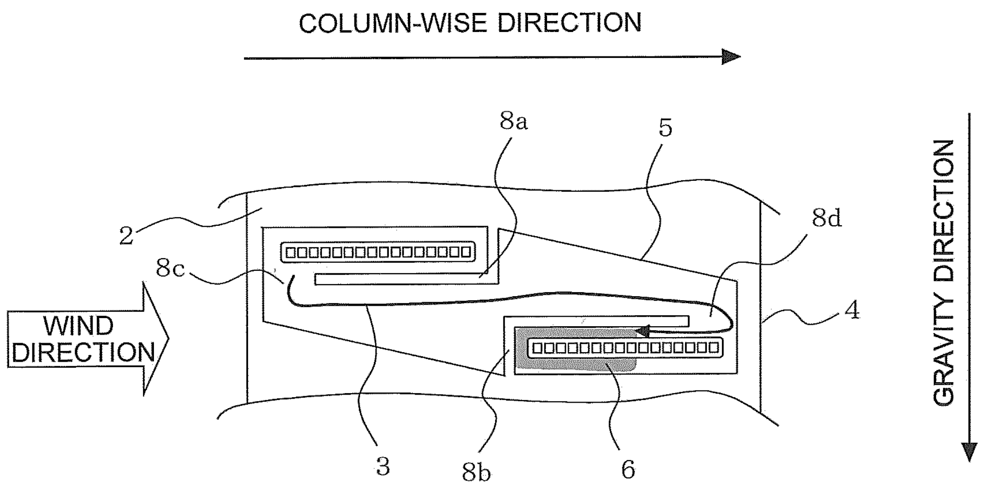
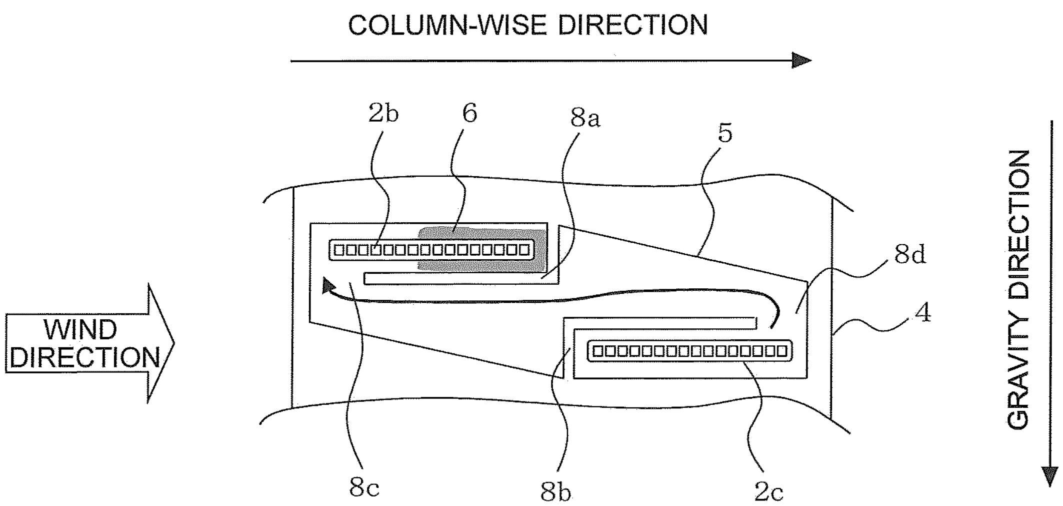


FIG. 6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8a
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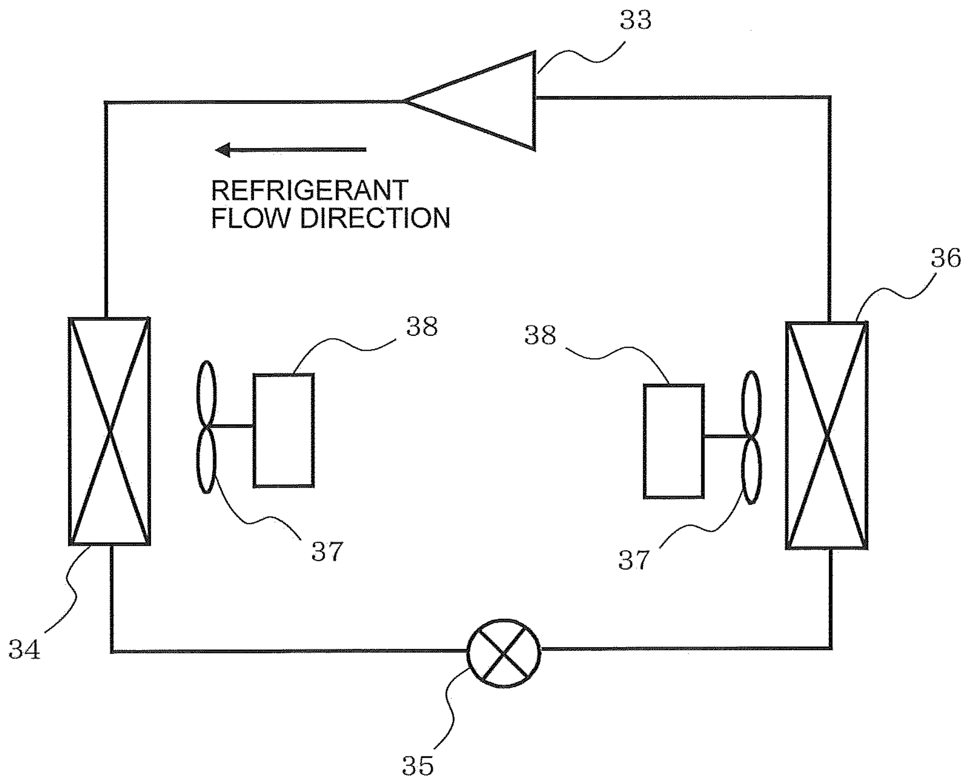
WIND DIRECTION
GRAVITY DIRECTION
8c
8b
2c

FIG. 7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38
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37
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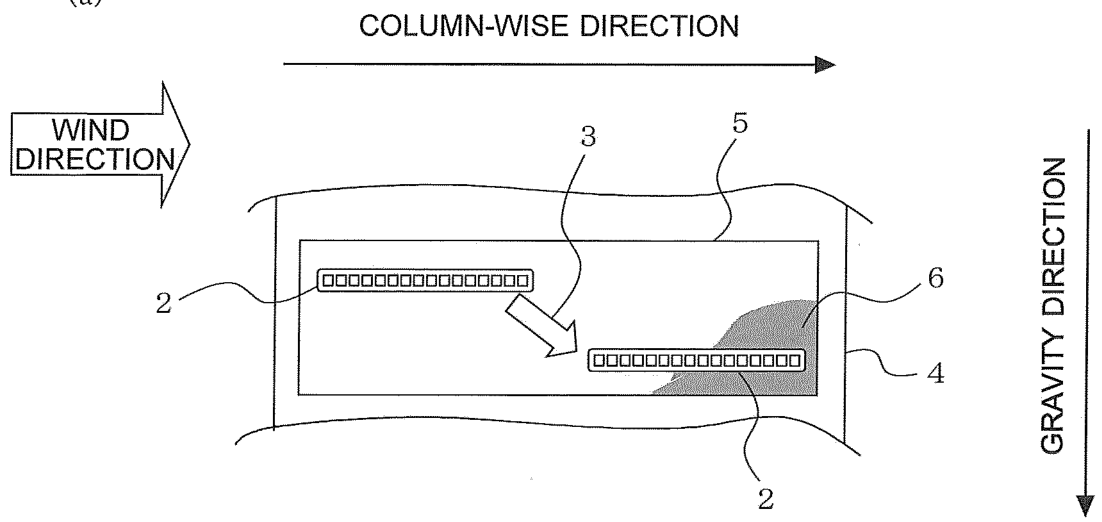
34
35

FIG. 8

(a)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WIND DIRECTION
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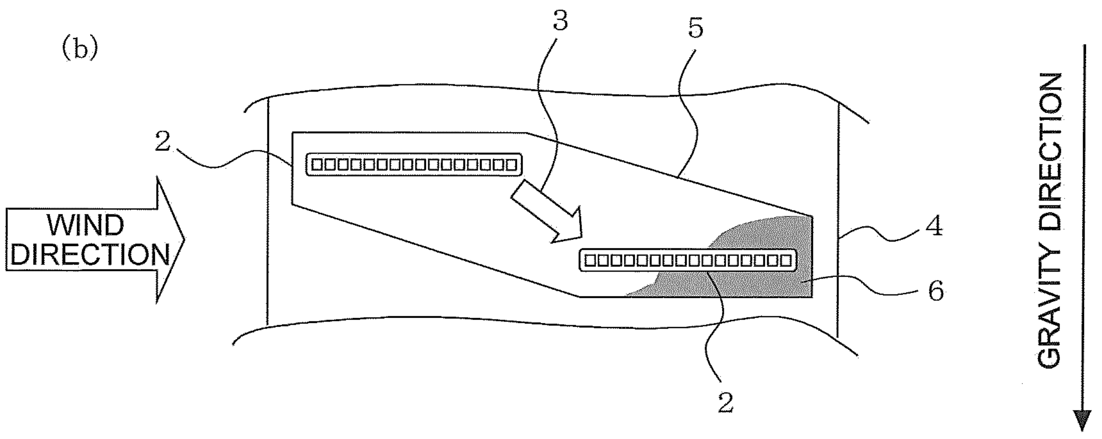
2
6
4
2
GRAVITY DIRECTION

(b)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WIND DIRECTION
4
6
2
GRAVITY DIRECTION

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/075328

A. CLASSIFICATION OF SUBJECT MATTER
F28F9/02(2006.01)i, *F25B39/00*(2006.01)i, *F28D1/047*(2006.01)i, *F28D1/053*(2006.01)i, *F28F9/22*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F28F9/02, F25B39/00, F28D1/047, F28D1/053, F28F9/22

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 145924/1988(Laid-open No. 069289/1990) (Mitsubishi Heavy Industries, Ltd.), 25 May 1990 (25.05.1990), specification, page 2, line 1 to page 8, line 16; fig. 1 (Family: none)	1,3-5,7-10 2,6
Y A	JP 6-213532 A (Showa Aluminum Corp.), 02 August 1994 (02.08.1994), paragraphs [0016], [0042] to [0047]; fig. 2 to 3, 11 (Family: none)	1,3-5,7-10 2

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

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Date of the actual completion of the international search	Date of mailing of the international search report
11 December, 2014 (11.12.14)	22 December, 2014 (22.12.14)

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-166797 A (Toyo Radiator Co., Ltd.), 13 June 2003 (13.06.2003), paragraphs [0009], [0012]; fig. 1 to 4 (Family: none)	8-9
A	JP 2007-32993 A (Showa Denko Kabushiki Kaisha), 08 February 2007 (08.02.2007), paragraphs [0023] to [0026]; fig. 1 to 3 (Family: none)	1-10
A	JP 6-117783 A (Showa Aluminum Corp.), 28 April 1994 (28.04.1994), paragraph [0011]; fig. 2, 3 (Family: none)	7
A	JP 2006-29653 A (Calsonic Kansei Corp.), 02 February 2006 (02.02.2006), paragraphs [0032], [0055]; fig. 2 (Family: none)	7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003287390 A **[0003]**