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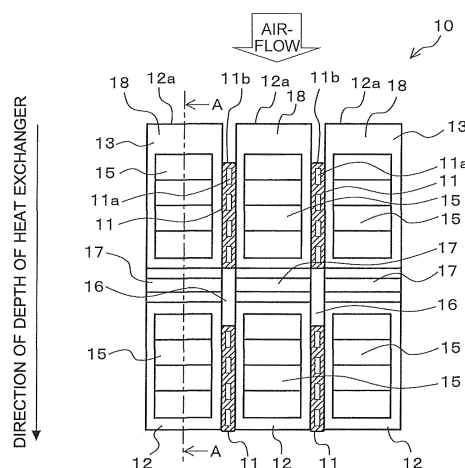
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(54) **HEAT EXCHANGER AND AIR-CONDITIONING AND REFRIGERATING APPARATUS WITH HEAT EXCHANGER**

(57) A heat exchanger includes a heat exchange unit 10 including a plurality of flat pipe groups 11 A and 11 B arranged in rows in a direction of depth of the heat exchanger and corrugated fins 12 each shared between the plurality of flat pipe groups 11 A and 11 B in the rows. The plurality of flat pipe groups 11 A and 11 B have an inter-row gap 16 between the plurality of flat pipe groups 11 A and 11 B and each include a plurality of flat pipes 11 standing in a gravitational direction. The corrugated fins 12 each include a first drainage portion 17 between adjacent ones of the rows of the plurality of flat pipe groups 11 A and 11 B to communicate with the inter-row gap 16.

FIG. 4



Description

Technical Field

5 **[0001]** The present invention relates to a heat exchanger, and an air-conditioning refrigeration apparatus including the heat exchanger.

Background Art

10 **[0002]** In related art, heat exchangers exist that include flat pipes and corrugated fins stacked alternately in a direction orthogonal to the direction of airflow, with the flat pipes being each connected at both ends to a pair of headers (see, for example, Patent Literatures 1 and 2).

15 **[0003]** The corrugated fins have a zigzag configuration formed by an alternating succession of planar and curved portions. Patent Literature 1 discloses a technique to ensure easy drainage of condensed water when a heat exchanger having such corrugated fins is used as an evaporator. Specifically, in Patent Literature 1, the planar portions of the corrugated fins are of a valley configuration having the bottom at the central parts of the corrugated fins in the direction of airflow, a through-hole is bored at the joint of the valley portion and each flat pipe, and condensed water on the surface of each corrugated fin is guided to the valley portion of the planar portion to drain the condensed water from the through-hole.

20 **[0004]** Patent Literature 2 discloses a heat exchanger having a heat exchanger unit in which flat pipe groups each having a plurality of flat pipes aligned with spaces between the plurality of flat pipes are arranged in two rows in the direction of depth of the heat exchanger that is orthogonal to the direction of alignment of the flat pipes, and the flat pipes and the corrugated fins are stacked alternately in the direction of alignment of the flat pipes. Patent Literature 2 discloses a technique with a pair of headers located at the top and the bottom of the heat exchange unit to facilitate drainage of condensed water that builds up on the lower header.

Citation List

Patent Literature

30 **[0005]**

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2005-245187 (Fig. 1)

Patent Literature 2: Japanese Patent No. 4786234 (Fig. 1)

Summary of Invention

Technical Problem

40 **[0006]** Although the technique disclosed in Patent Literature 1 mentioned above allows for improved drainage of condensed water, the technique is directed to a configuration with a single row of flat pipe group.

45 **[0007]** To meet the recent demands for reduced size and weight and increased performance of heat exchangers, flat pipe groups arranged in multiple rows as in Patent Literature 2 have been increasingly common. In Patent Literature 2, corrugated fins are shared between flat pipe groups that are arranged in two rows. Thus, the corrugated fins have an increased length in the direction of depth of the heat exchanger in comparison to corrugated fins adapted to single-row configuration. Although the increased length of the corrugated fins in the direction of depth of the heat exchanger necessitates an improvement in the drainage of condensed water, Patent Literature 2 contains no discussion on the drainage of condensed water from the corrugated fins.

50 **[0008]** The present invention has been made to address the above-mentioned problem, and an object of the invention is accordingly to provide a heat exchanger of a multi-row configuration that allows for improved drainage of condensed water, and an air-conditioning refrigeration apparatus including the heat exchanger. Solution to Problem

55 **[0009]** A heat exchanger according to an embodiment of the present invention includes a heat exchange unit including a plurality of flat pipe groups arranged in rows in a direction of depth of the heat exchanger and corrugated fins each shared between the plurality of flat pipe groups in the rows. The plurality of flat pipe groups have an inter-row gap between the plurality of flat pipe groups and each include a plurality of flat pipes standing in a gravitational direction. The corrugated fins each include a first drainage portion between adjacent ones of the rows of the plurality of flat pipe groups to communicate with the inter-row gap.

[0010] An air-conditioning refrigeration apparatus according to an embodiment of the present invention includes the

heat exchanger mentioned above. Advantageous Effects of Invention

[0011] According to an embodiment of the present invention, drainage of condensed water can be improved for heat exchangers of a multi-row configuration. Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 is a representation of both front and side views of a heat exchanger according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a schematic perspective view of a flat pipe of the heat exchanger according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is an enlarged schematic front view of the heat exchanger according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a cross-sectional view of the heat exchanger according to Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a sectional view taken along A-A in Fig. 4.

[Fig. 6] Fig. 6 is a cross-sectional view of a heat exchanger according to Embodiment 2 of the present invention.

[Fig. 7] Fig. 7 is a cross-sectional view of a heat exchanger according to Embodiment 3 of the present invention.

[Fig. 8] Fig. 8 is a cross-sectional view of a heat exchanger according to Embodiment 4 of the present invention.

[Fig. 9] Fig. 9 is a refrigerant circuit diagram of an air-conditioning refrigeration apparatus according to Embodiment 5 of the present invention. Description of Embodiments

Embodiment 1

[0013] Fig. 1 is a representation of both front and side views of a heat exchanger according to Embodiment 1 of the present invention. Fig. 1 (a) is a front view, and Fig. 1 (b) is a side view. Fig. 2 is a schematic perspective view of a flat pipe of the heat exchanger according to Embodiment 1 of the present invention. In Figs. 1 and 2 and other figures described later, the same reference signs are used to designate the same or equivalent elements, and the same reference signs are used throughout this specification. Further, the implementations of various components given throughout this specification are merely for illustrative purposes and are not intended to limit the invention to the particular implementations disclosed.

[0014] A heat exchanger 1 is used in, for example, an outdoor unit of an air-conditioning apparatus. The heat exchanger 1 includes a heat exchange unit 10, a header 20, and a header 30 as its main components. In Fig. 1, the arrows shown at the location of the header 20 indicate the direction of flow of refrigerant, and the empty arrow indicates the direction of airflow in Fig. 1 (b).

[0015] The heat exchange unit 10 includes flat pipe groups 11 A and 11 B each including a plurality of flat pipes 11 that are aligned with spaces between the plurality of flat pipes 11. The flat pipe groups 11 A and 11 B are arranged in a plurality of rows (two rows in this example) with gaps between the flat pipe groups 11A and 11 B in the direction of depth of the heat exchanger that is perpendicular to the alignment direction in which the flat pipes 11 are aligned. The flat pipes 11 and corrugated fins 12 are stacked alternately in the direction of alignment of the flat pipes 11. The corrugated fins 12 are fins shared between two rows, that is, shared between the upwind flat pipe group 11 A and the downwind flat pipe group 11 B. The heat exchange unit 10 as a whole is made up of two rows that are integrated together.

[0016] As illustrated in Fig. 2, each of the flat pipes 11 has a plurality of (four in this example) through-holes 11 a serving as refrigerant passages. The flat pipes 11 stand in the gravitational direction. The flat pipes 11 are connected at each end of the gravitational direction to the corresponding one of the pair of headers 20 and 30. Specifically, the lower end of each of the flat pipes 11 is connected to and communicates with the header 20 (20a or 20b) serving as an inlet-outlet header, and the upper end of each of the flat pipes 11 is connected to and communicates with the header 30 serving as a return header. The flat pipes 11, the corrugated fins 12, and the headers 20 and 30 are made of, for example, aluminum or aluminum alloy.

[0017] In this example, the header 20 is made up of two headers 20a and 20b provided independently for the upwind flat pipe group 11 A and the downwind flat pipe group 11 B. Alternatively, the header 20 may be a single header that is divided in the inside by a partition plate. Although rectangular headers are used as the headers 20 and 30 in this example, cylindrical headers may be used.

[0018] When the heat exchanger 1 configured as described above is used as an evaporator, the refrigerant flows into the header 20a, which is located in a lower portion in the gravitational direction and at the upwind side of the heat exchanger 1. In the header 20a, the refrigerant is split into a number of passages equal to the number of the upwind flat pipe groups 11A, and moves upward in each of the flat pipes 11 of the upwind flat pipe group 11 A. Then, the streams of refrigerant flowing out of the upper end of each of the flat pipes 11 of the upwind flat pipe group 11 A merge at the header 30. The merged refrigerant is then turned around in the header 30 to flow into each of the flat pipes 11 of the downwind flat pipe group 11 B from the upper end of the flat pipe 11. The streams of refrigerant flowing in from the upper end of each of the flat pipes 11 of the downwind flat pipe group 11 B pass through the interior of the flat pipes 11 to flow

out of the lower end of the flat pipe 11. The streams of refrigerant flowing out of the lower end of the flat pipe 11 merge at the header 20b, and then the merged refrigerant flows out of the heat exchanger 1.

[0019] Fig. 3 is an enlarged schematic front view of the heat exchanger according to Embodiment 1 of the present invention. Fig. 4 is a cross-sectional view of the heat exchanger according to Embodiment 1 of the present invention. Fig. 5 is a sectional view taken along A-A in Fig. 4.

[0020] As illustrated in Fig. 3, the corrugated fins 12 have a zigzag configuration with an alternating succession of planar portions 13 and curved portions 14. Each of the planar portions 13 is provided with a plurality of louvers 15. The louvers 15 are cut and raised to be inclined to the planar portions 13 of the corrugated fins 12. A plurality of (eight in this example) louvers 15 are aligned in each of the planar portions 13 in the direction of depth of the heat exchanger (the same as the direction of airflow). As illustrated in Fig. 5, each of the louvers 15 is inclined downward toward the central part in the direction of depth of the heat exchanger.

[0021] The corrugated fins 12 according to Embodiment 1 are shared between two rows, that is, between the upwind flat pipe group 11 A and the downwind flat pipe group 11 B. Consequently, the corrugated fins 12 have an increased length in the direction of depth of the heat exchanger in comparison to corrugated fins adapted to single-row configuration. This configuration necessitates an improvement in the drainage of condensed water generated on the surface of the corrugated fins 12. Consequently, in Embodiment 1, the corrugated fins 12 include first drainage portions 17 located between the rows of the upwind flat pipe group 11 A and the downwind flat pipe group 11 B to guide condensed water generated on the corrugated fins 12 to gaps (to be referred to as "inter-row gaps" hereinafter) 16 between the adjacent rows of the flat pipes 11.

[0022] The first drainage portions 17 are grooves that are located in the central part of the planar portions 13 in the direction of depth of the heat exchanger to extend in the direction of alignment of the flat pipes 11 (the left-right direction in Fig. 4), and are recessed downward in the gravitational direction. The first drainage portion 17 is provided in each of the planar portions 13. The first drainage portions 17 are located at the same position as the inter-row gaps 16 in the direction of depth of the heat exchanger. The first drainage portions 17, and the inter-row gaps 16 serving as drainage paths are alternately arranged side by side in the alignment direction of the flat pipes 11 (the left-right direction in Fig. 4) to communicate with each other.

[0023] Fin upwind ends 12a of the corrugated fins 12 are extended so that the fin upwind ends 12a are located upwind of upwind ends 11 b of the flat pipes 11. These extended portions form second drainage portions 18.

[0024] When the heat exchanger 1 configured as described above is used as an evaporator, condensed water is generated on the surface of the corrugated fins 12. The condensed water is collected to the first drainage portions 17 via areas on the corrugated fins 12 and via the louvers 15 to move toward the flat pipes 11, and drained downward in the gravitational direction from the inter-row gaps 16. At this time, because the planar portions 13 are inclined to the gravitational direction, the condensed water readily flows from the first drainage portions 17 to the inter-row gaps 16.

[0025] In an evaporator, condensation tends to occur in its upwind portion against which air collides first. The inclination of the planar portions 13 allows the condensed water generated at the upwind side of the corrugated fins 12 to flow through the second drainage portions 18 to be drained downward in the gravitational direction.

[0026] As described above, in Embodiment 1, the first drainage portions 17 for draining condensed water to the inter-row gaps 16 are provided to the heat exchange unit 10 and located between the rows of the upwind flat pipe group 11 A and the downwind flat pipe group 11 B in the direction of depth of the heat exchanger. This configuration has the following effect. That is, even when the corrugated fins 12 are elongated in the direction of depth of the heat exchanger, the condensed water on the entire surface of the fins can be collected to the first drainage portions 17 for drainage through the inter-row gaps 16, thus allowing for improved drainage.

[0027] Further, the corrugated fins 12 are configured as fins shared between two rows, that is, between two adjacent rows of the flat pipes 11. In comparison to use of fins divided for two rows, this configuration requires only a single fin insertion process during manufacture, thus improving the ease of manufacture.

[0028] When the heat exchanger 1 is used as an evaporator under low outside air temperature conditions, the condensed water depositing on the surface of the corrugated fins 12 may freeze to form frost in some cases. The upwind portion of the corrugated fins 12 against which air collides first is particularly prone to such frost formation. In Embodiment 1, the second drainage portions 18 are provided to improve drainage in the upwind portion of the corrugated fins 12. Consequently, concentration of frost in the vicinity of the fin upwind ends 12a of the corrugated fins 12 can be prevented even under operating conditions that cause frost to form.

[0029] Although the louvers 15 provided in the planar portions 13 of the corrugated fins 12 are inclined downward toward the central part in the direction of depth of the heat exchanger, the louvers 15 may not necessarily be inclined in this direction but may be all inclined in the same direction.

Embodiment 2

[0030] In Embodiment 2, a drainage facilitating member is provided in each of the inter-row gaps 16. Items or features

not mentioned in Embodiment 2 are the same as those in Embodiment 1. The following description will mainly focus on differences of Embodiment 2 from Embodiment 1.

[0031] Fig. 6 is a cross-sectional view of a heat exchanger according to Embodiment 2 of the present invention.

[0032] When condensed water is to be drained downward in the gravitational direction, the smaller the inter-row gaps 16, that is, the smaller the drainage path, the greater the surface tension of the condensed water, leading to greater amount of condensed water flowing into the inter-row gaps 16 from the first drainage portions 17, thus allowing for improved drainage. In Embodiment 2, two rods 40 serving as a drainage facilitating member are disposed in each of the inter-row gaps 16 to divide the interior of the inter-row gap 16 into a portion communicating with the first drainage portions 17 and another portion. The portion communicating with the first drainage portions 17 serves as a drainage path 41.

[0033] Each of the rods 40 is a rod with a circular sectional shape with a brazing filler material clad onto its outer periphery in advance. Each of the rods 40 is made of, for example, aluminum or aluminum alloy, and secured to at least one of the corresponding corrugated fin 12 and the flat pipe 11.

[0034] As described above, Embodiment 2 provides an effect similar to that of Embodiment 1. Further, in Embodiment 2, the rods 40 are disposed in each of the inter-row gaps 16 to divide the interior of the inter-row gap 16 to define the drainage path 41 that is smaller than the inter-row gap 16. This configuration provides the following effect. That is, in Embodiment 1 mentioned above, the entirety of each of the inter-row gaps 16 acts as a drainage path, whereas in Embodiment 2, the rods 40 are placed to reduce the size of the drainage path, thus allowing the condensed water to be more readily guided to the drainage path 41 than when the rods 40 are not provided. Further, the rods 40 extend in the gravitational direction to facilitate guiding of condensed water in the gravitational direction. Drainage can be further improved accordingly.

[0035] The use of the rods 40 with the brazing filler material clad onto the outer peripheries allows for easier joining of the corrugated fins 12 and the flat pipes 11, thus also improving the ease of manufacture.

[0036] Although each of the rods 40 has a circular sectional shape in Embodiment 2, each of the rods 40 is not limited to a circular sectional shape. Each of the rods 40 may have, for example, a rectangular or elliptical sectional shape.

[0037] Although the number of rods 40 is two in this example, the number of rods 40 is not limited to two. The number of rods 40 may be one, or may be three or more. In short, any number of rods 40 may be placed as long as placing the rods 40 divides the interior of each of the inter-row gaps 16 to separately define a drainage path in the inter-row gap 16 to communicate with the first drainage portions 17.

Embodiment 3

[0038] Embodiment 3 differs from Embodiment 2 in the configuration of the drainage facilitating member. Items or features not mentioned in Embodiment 3 are similar to those in Embodiments 1 and 2. The following description will mainly focus on differences of Embodiment 3 from Embodiments 1 and 2.

[0039] Fig. 7 is a cross-sectional view of a heat exchanger according to Embodiment 3 of the present invention.

[0040] In Embodiment 3, plates 50 each curved in an arc in the lateral direction and having a rectangular shape are inserted in the inter-row gaps 16 between the flat pipes 11. Two plates 50 are disposed in each of the inter-row gaps 16, and secured to the corrugated fins 12 by use of a brazing filler material clad onto the side face at each end of the arc. In the gap between the plate 50 and the corrugated fin 12, drainage paths 51 are separately defined in each of the inter-row gaps 16 to communicate with the first drainage portions 17.

[0041] Embodiment 3 provides the same effect as that of Embodiment 2.

[0042] Although the number of plates 50 is two in this example, the number of plates 50 is not limited to two. In short, any number of plates 50 may be placed as long as placing the plates 50 divides the interior of each of the inter-row gaps 16 to separately define a drainage path in the inter-row gap 16 to communicate with the first drainage portions 17.

Embodiment 4

[0043] Embodiment 4 relates to improved drainage at the downwind end of the corrugated fins 12. Items or features not mentioned in Embodiment 4 are the same as those in Embodiment 1. The following description will mainly focus on differences of Embodiment 4 from Embodiment 1.

[0044] Fig. 8 is a cross-sectional view of a heat exchanger according to Embodiment 4 of the present invention.

[0045] The corrugated fins 12 of the heat exchanger 1 according to Embodiment 4 are configured so that fin downwind ends 12b are extended to be located downwind of flat-pipe downwind ends 11c of the downwind flat pipe group 11B. Such extended portions form third drainage portions 19. The extended distance a of the third drainage portions 19 is set shorter than the extended distance b of the second drainage portions 18.

[0046] Embodiment 4 provides the same effect as that of Embodiment 1. Further, when the heat exchanger is used as an evaporator, the condensed water moving downwind along with the airflow can be drained via the third drainage

portions 19 in the gravitational direction from inter-row gaps 16a.

[0047] In extending both the fin upwind ends 12a and the fin downwind ends 12b of the corrugated fins 12 from the flat-pipe upwind ends 11 b and the flat-pipe downwind ends 11 c to form the second drainage portions 18 and the third drainage portions 19, the distribution of the extended distances of these portions is set so that the extended distance a of the third drainage portions 19 is shorter than the extended distance b of the second drainage portions 18. Sufficient drainage and frost resistance can therefore be ensured for the second drainage portions 18 on the upwind side of the fins while easy drainage can be ensured for the third drainage portions 19 on the downwind side of the fins.

Embodiment 5

[0048] Fig. 9 is a refrigerant circuit diagram of an air-conditioning refrigeration apparatus according to Embodiment 5 of the present invention.

[0049] An air-conditioning refrigeration apparatus includes a compressor 61, a condenser 62, an expansion device 63, an evaporator 64, a refrigerant circuit through which refrigerant circulates, and fans 65. In the condenser 62 and the evaporator 64, heat is exchanged between the air blown by the fans 65 driven to rotate by fan motors 66, and the refrigerant. Using the heat exchanger according to any one of Embodiments 1 to 4 mentioned above for one or both of the condenser 62 and the evaporator 64 can construct an air-conditioning refrigeration apparatus with high energy efficiency.

[0050] The energy efficiency is represented by the following equations.

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

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

[0051] The heat exchanger according to each of Embodiments 1 to 5 mentioned above, and the air-conditioning refrigeration apparatus including the heat exchanger are able to exhibit their effects when refrigerant such as R410A, R32, and HF01234yf is used.

[0052] Although air and refrigerant are used as an example of working fluid, the same effect as mentioned above is achieved when other gases, liquids, or gas-liquid mixture fluids are used.

[0053] The same effect as mentioned above can be achieved also when the heat exchanger according to each of Embodiments 1 to 5 mentioned above is used for an indoor unit.

[0054] The heat exchanger according to each of Embodiments 1 to 5 mentioned above and the air-conditioning refrigeration apparatus including the heat exchanger are able to exhibit their effects for any type of refrigerating machine oil, such as those based on mineral oil, alkylbenzene oil, ester oil, ether oil, and fluorine oil, irrespective of whether the refrigerant and the oil are soluble or insoluble in each other.

[0055] Although the flat pipe groups are arranged in two rows, that is, the upwind flat pipe group 11 A and the downwind flat pipe group 11 B in Embodiments 1 to 5 mentioned above, the flat pipe groups may be arranged in three or more rows. In this case as well, the same first drainage portions 17 as the ones mentioned above are provided in the portions of the corrugated fins 12 corresponding to the areas between adjacent rows to ensure easy drainage. Further, the second drainage portions 18 and the third drainage portions 19 can also be used for the configurations having three or more rows.

[0056] Although Embodiments 1 to 5 mentioned above have been described above as separate embodiments, features characteristic of the individual embodiments may be combined as appropriate to construct a heat exchanger and an air-conditioning refrigeration apparatus including the heat exchanger. For example, Embodiment 2 illustrated in Fig. 6 and Embodiment 8 illustrated in Fig. 8 may be combined to further provide the third drainage portions 19 to the configuration illustrated in Fig. 6.

[0057] Modifications applicable to components in each of Embodiments 1 to 5 are similarly applicable to the same components in embodiments other than the particular embodiment in which such modifications are described.

Industrial Applicability

[0058] Example applications of the present invention include heat pump devices requiring to be easily manufactured and have improved heat exchange performance and improved energy saving performance.

Reference Signs List

[0059] 1 heat exchanger 10 heat exchange unit 11 flat pipe 11 A upwind flat pipe group 11B downwind flat pipe group 11 a through-hole 11 b flat-pipe upwind end 11c flat-pipe downwind end 12 corrugated fin 12a fin upwind end 12b fin downwind end 13 planar portion 14 curved portion 15 louver 16 inter-row gap 16a inter-row gap 17 first drainage portion 18 second drainage portion 19 third drainage portion 20 (20a, 20b) header 30 header 40 rod 41 drainage path 50 plate 51 drainage path 61 compressor 62 condenser 63 expansion device 64 evaporator 65 fan 66 fan motor

Claims

1. A heat exchanger comprising a heat exchange unit including a plurality of flat pipe groups arranged in rows in a direction of depth of the heat exchanger and corrugated fins each shared between the plurality of flat pipe groups in the rows,
the plurality of flat pipe groups having an inter-row gap between the plurality of flat pipe groups, the plurality of flat pipe groups each including a plurality of flat pipes standing in a gravitational direction, the corrugated fins each including a first drainage portion between adjacent ones of the rows of the plurality of flat pipe groups to communicate with the inter-row gap.
2. The heat exchanger of claim 1, wherein the first drainage portion comprises a groove recessed downward in the gravitational direction.
3. The heat exchanger of claim 1 or 2, wherein the corrugated fins each have a shape with an alternating succession of planar portions and curved portions, and wherein the first drainage portion is formed in the planar portions.
4. The heat exchanger of claim 3, wherein the planar portions are inclined to the gravitational direction.
5. The heat exchanger of any one of claims 1 to 4, wherein a drainage facilitating member is disposed in the inter-row gap, the drainage facilitating member extending in the gravitational direction to divide an interior of the inter-row gap into a portion communicating with the first drainage portion and an other portion.
6. The heat exchanger of claim 5, wherein the drainage facilitating member comprises a rod.
7. The heat exchanger of claim 6, wherein the rod is secured to at least one of each of the corrugated fins and each of the plurality of flat pipes by use of a brazing filler material clad onto an outer periphery of the rod in advance.
8. The heat exchanger of claim 5, wherein the drainage facilitating member comprises a plate curved in an arc in a lateral direction and having a rectangular shape.
9. The heat exchanger of claim 8, wherein the plate is secured to each of the corrugated fins by use of a brazing filler material clad onto a side face at each end of the arc of the plate.
10. The heat exchanger of any one of claims 1 to 9, further comprising second drainage portions formed by extending upwind ends of the corrugated fins so that the upwind ends of the corrugated fins are located upwind of upwind ends of the plurality of flat pipes.
11. The heat exchanger of any one of claims 1 to 10, further comprising third drainage portions formed by extending downwind ends of the corrugated fins so that the downwind ends of the corrugated fins are located downwind of downwind ends of the plurality of flat pipes.
12. The heat exchanger of claim 11 as dependent on claim 10, wherein an extended distance of the third drainage

portions is shorter than an extended distance of the second drainage portions.

13. The heat exchanger of any one of claims 1 to 12, wherein the corrugated fins each include a plurality of louvers cut and raised to be inclined to a surface of each of the corrugated fins, each of the plurality of louvers being inclined downward toward a central part in the direction of depth of the heat exchanger.

14. An air-conditioning refrigeration apparatus comprising the heat exchanger of any one of claims 1 to 13.

FIG. 1

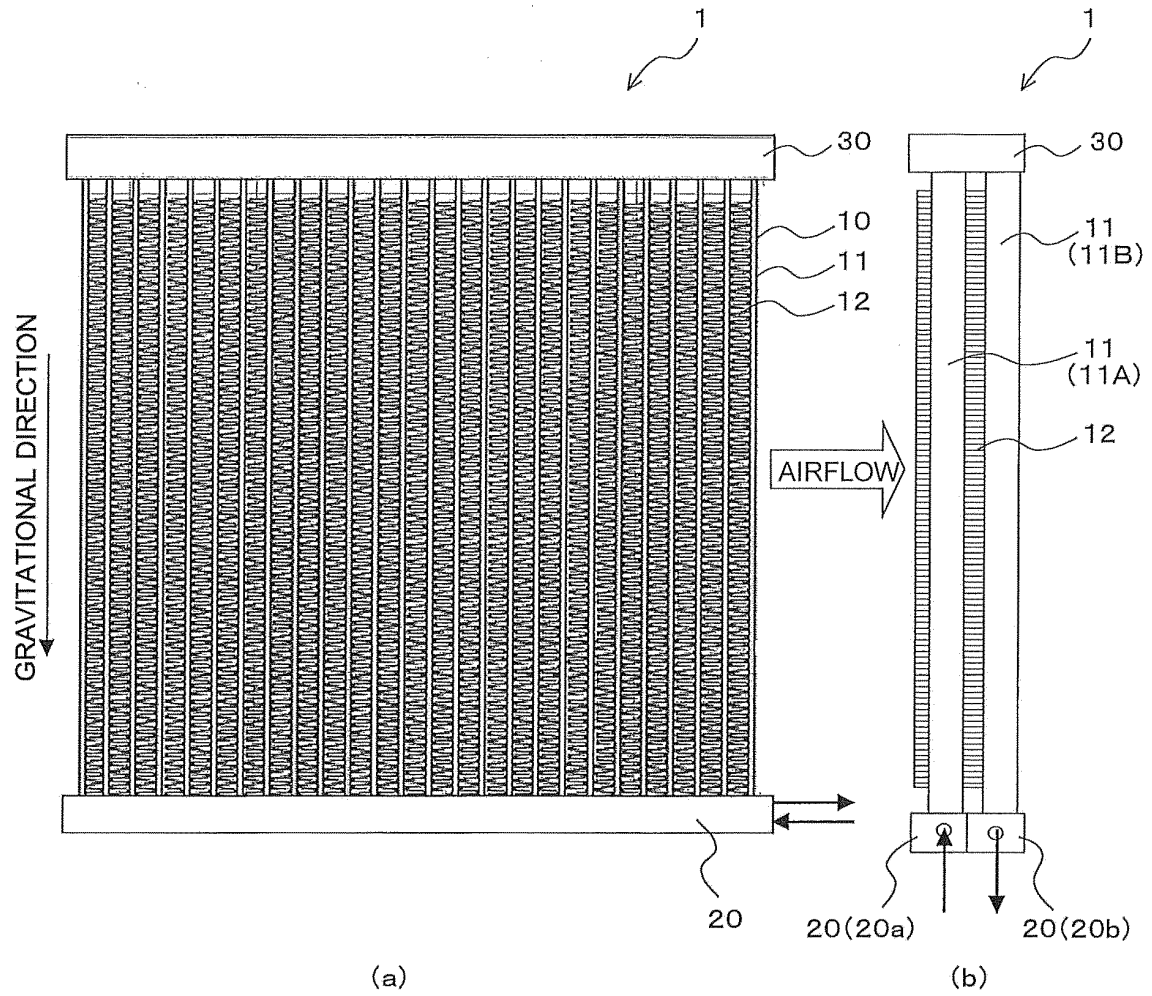


FIG. 2

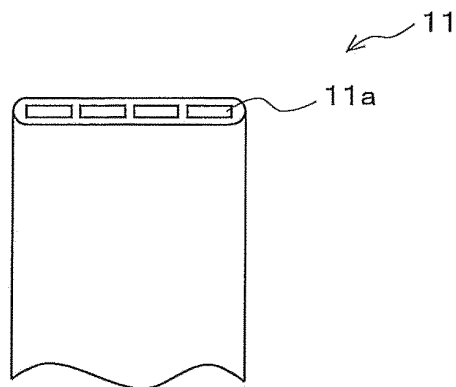


FIG. 3

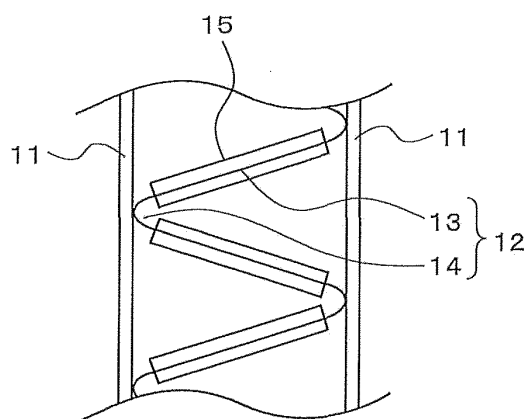


FIG. 4

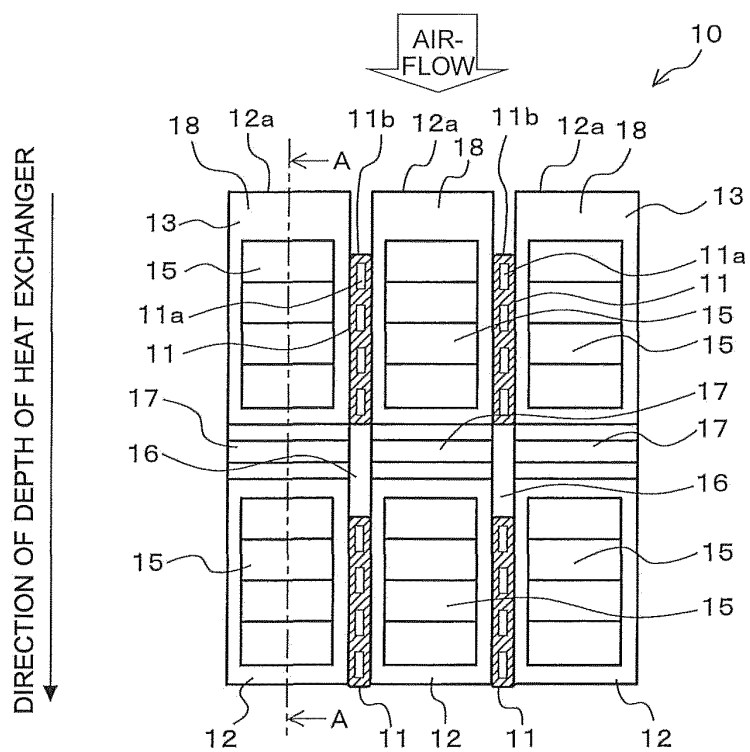


FIG. 5

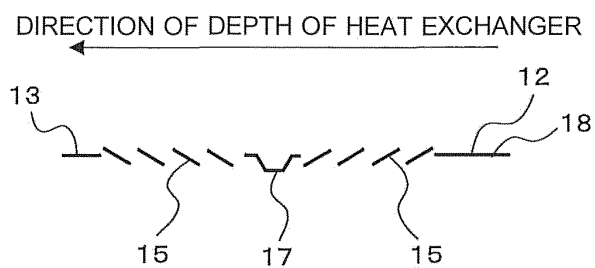


FIG. 6

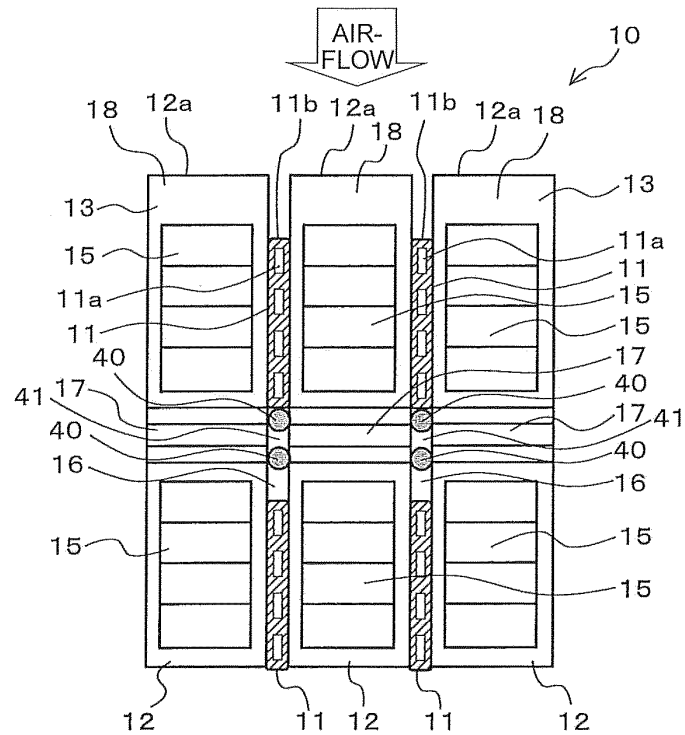


FIG. 7

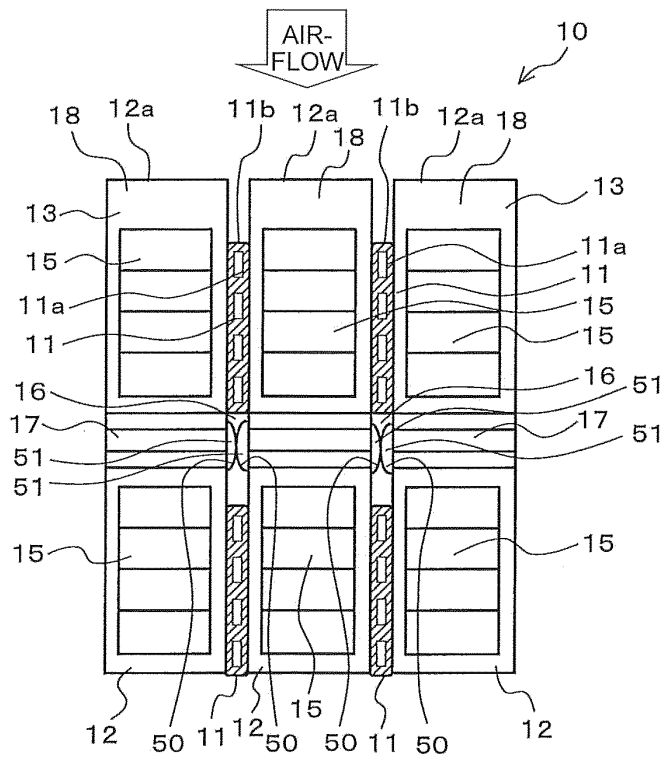


FIG. 8

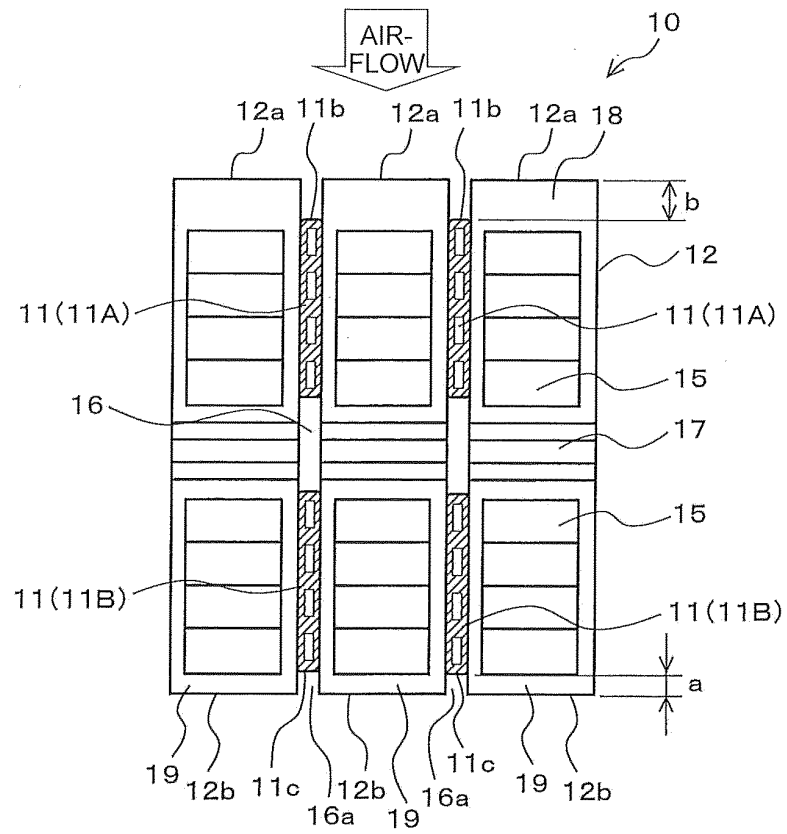
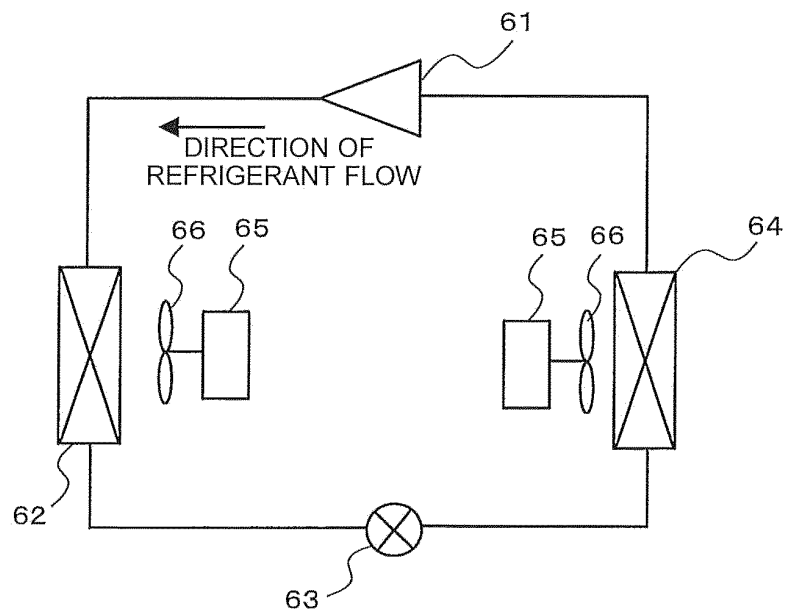


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/069642

A. CLASSIFICATION OF SUBJECT MATTER

F28F17/00(2006.01)i, F25B39/02(2006.01)i, F28F1/30(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)

F28F1/30-1/32, F28F17/00, F25B39/02, B60H1/32

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.
X Y	JP 2008-298391 A (Denso Corp.), 11 December 2008 (11.12.2008), paragraphs [0003], [0006], [0012] to [0016], [0043]; fig. 1 to 4, 13 & US 2008/0296002 A1 & DE 102008026120 A & CN 101315231 A	1 2-14
Y	JP 2004-85170 A (LG Electronics Inc.), 18 March 2004 (18.03.2004), paragraphs [0014] to [0025]; fig. 1 to 2 & US 2004/0035559 A1 & KR 10-2004-0017920 A & CN 1477364 A	2-14
Y	JP 6-241678 A (Hitachi, Ltd.), 02 September 1994 (02.09.1994), fig. 1, 7 (Family: none)	4-14

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

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21 October, 2014 (21.10.14)Name and mailing address of the ISA/
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International application No.

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5	C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
10	Y	WO 2010/122684 A1 (Sharp Corp.), 28 October 2010 (28.10.2010), paragraphs [0030] to [0031], [0040] to [0041], [0050]; fig. 3 to 4 & JP 4503682 B & US 2012/0024509 A1 & EP 2423632 A1 & AU 2009344987 A & CN 102395854 A & KR 10-2012-0010239 A & TW 201038904 A	5-14
15	Y	JP 11-83371 A (Denso Corp.), 26 March 1999 (26.03.1999), paragraph [0004]; fig. 9 (Family: none)	10-14
20	Y	JP 2007-113802 A (Denso Corp.), 10 May 2007 (10.05.2007), paragraph [0046]; fig. 3 & US 2007/0084589 A1	12-14
25	A	JP 58-217195 A (Mitsubishi Electric Corp.), 17 December 1983 (17.12.1983), page 2, lower left column, line 15 to lower right column, line 20; fig. 9 to 11 (Family: none)	1-14
30	A	JP 55-110892 A (Nihon Radiator Co., Ltd.), 26 August 1980 (26.08.1980), fig. 5 to 8 (Family: none)	1-14
35	A	JP 2005-24187 A (Matsushita Electric Industrial Co., Ltd.), 27 January 2005 (27.01.2005), fig. 1 (Family: none)	1-14
40	A	JP 4786234 B2 (Showa Denko Kabushiki Kaisha), 05 October 2011 (05.10.2011), paragraph [0049]; fig. 1 & US 2007/0209386 A1 & WO 2006/004071 A1 & CN 1981176 A	1-14
45			
50			
55			

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005245187 A [0005]
- JP 4786234 B [0005]