(19) Europäisches Patentamt / European Patent Office / Office européen des brevets

(11) **EP 3 483 544 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
15.05.2019 Bulletin 2019/20

(21) Application number: **16908178.3**

(22) Date of filing: **07.07.2016**

(51) Int Cl.:
F28F 1/30 *(2006.01)* ***F25B 39/02*** *(2006.01)*
F28D 1/053 *(2006.01)*

(86) International application number:
PCT/JP2016/070185

(87) International publication number:
WO 2018/008134 (11.01.2018 Gazette 2018/02)

(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 MD

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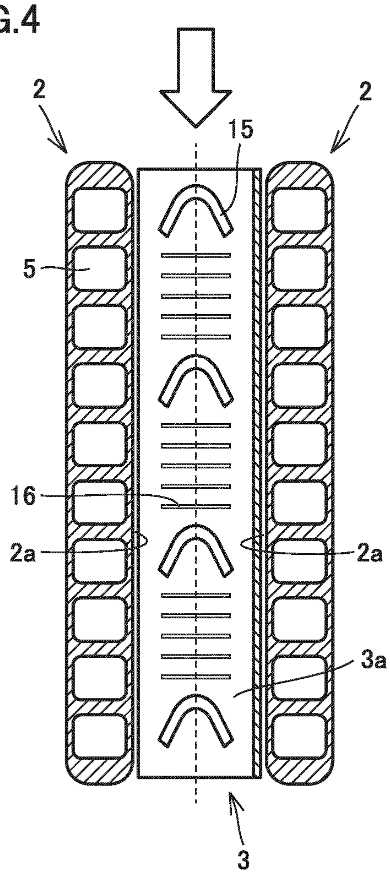
(54) **HEAT EXCHANGER**

(57) Provided is a heat exchanger preventing dew condensation water generated on a fin surface from being scattered downwind. The heat exchanger includes at least one heat transfer tube (2) and a fin (3). The heat transfer tube (2) includes a flow path (5) in which refrigerant flows. The fin (3) is connected to the heat transfer tube (2). The fin (3) has a first end, a flat portion (3a), and a second end (3b). The flat portion (3a) has at least one rib (15) in a line shape protruding from the flat portion (3a). The rib (15) includes a rib central portion (15b) and portion having a straight-line portion (15a). The rib central portion (15b) is located centrally between the first end and the second end. The aforementioned portion continues from the rib central portion (15b) and formed to approach any one of the first end and the second end in a downstream direction of flowing air.

FIG.4



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Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger having a corrugated fin.

BACKGROUND ART

[0002] A heat exchanger having a corrugated fin (hereinafter also referred to as fin) has been known. For example, as shown in Fig. 1, a parallel-flow heat exchanger exchanging heat between refrigerant flowing in a flat tube and air outside the flat tube is well known as an example of the conventional heat exchanger. In the heat exchanger shown in Fig. 1, a plurality of flat tubes oriented in the vertical direction are arranged in parallel in the horizontal direction. The flat tubes have respective upper ends provided with a header and respective lower ends opposite to the upper ends and provided with a header. A corrugated fin is disposed between the flat tubes.

[0003] A conventional heat exchanger to be incorporated in an air conditioner, particularly a heat exchanger to be incorporated in an indoor unit for a split-type air conditioner, is disposed to surround a cross-flow fan in the indoor unit (see for example PTL 1: Japanese Patent Laying-Open No. 2011-47600). The above-described parallel-flow heat exchanger incorporated in the indoor unit is also disposed to surround the cross-flow fan.

[0004] When the above-described heat exchanger is used as an evaporator, the temperature of the surfaces of the flat tube and the fin is lower than the temperature of the air. Therefore, when the air passes through the heat exchanger, moisture in the air condenses into dew condensation water on the surfaces of the flat tube and the fin.

[0005] The gravity, a force imparted by the air passing through the heat exchanger, a surface tension between the flat tube and the dew condensation water, and a surface tension between the fin and the dew condensation water are applied to the dew condensation water generated on the fin surface of the heat exchanger. Depending on the relation among these forces, the dew condensation water is caused to flow down on the flat tube into a lower portion of the heat exchanger, or to drip downwind from the heat exchanger, or to be held to stay between fins.

[0006] For the aforementioned indoor unit or the like, generally a drain pan is disposed below the heat exchanger. The dew condensation water flowing down from the bottom of the heat exchanger is received by the drain pan and discharged outdoors. The dew condensation water dripping downwind from the heat exchanger, however, may not be received by the drain pan and the dew condensation water may be discharged from the inside to the outside of the indoor unit (into a room for example).

[0007] In order to prevent such discharge of the dew condensation water into a room, a configuration has been proposed in which one of the front end face and the rear end face of a flat tube protrudes from an end of a corrugated fin and the protruded portion is used as a drainage channel (see for example PTL 2: Japanese Patent Laying-Open No. 2004-177082). A configuration in which a flat tube is provided with a drain groove has also been proposed (see for example PTL 3: Japanese Patent Laying-Open No. 7-190661). These configurations are considered to enable the heat exchanger to promote drainage of dew condensation water.

CITATION LIST

PATENT LITERATURE

[0008]

PTL 1: Japanese Patent Laying-Open No. 2011-47600
PTL 2: Japanese Patent Laying-Open No. 2004-177082
PTL 2: Japanese Patent Laying-Open No. 7-190661

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0009] The dew condensation water generated on the fin surface of the heat exchanger may be caused to flow on the fin surface in the downwind direction by the gravity and the force imparted by the air passing through the heat exchanger. If the dew condensation water does not flow down on a side surface of the flat tube or a curved portion of the fin but flows down on the fin surface between parallel-arranged flat tubes in the downwind direction, the dew condensation water is scattered downwind without undergoing the advantageous effect given by the drainage channel of the flat tube or the drain groove. As a result of this, the scattered dew condensation water may be discharged from the inside to the outside (into a room) of the indoor unit.

[0010] The present invention has been made to solve the problem as described above. An object of the present invention is to provide a heat exchanger preventing dew condensation water generated on the fin surface from being scattered downwind.

SOLUTION TO PROBLEM

[0011] A heat exchanger according to the present embodiment includes at least one heat transfer tube and a fin. The heat transfer tube is disposed to extend in a single direction, and refrigerant flows in the heat transfer tube. The fin is connected to at least one heat transfer tube. The fin includes a first end, a flat portion, and a second end. The first end is connected to the heat transfer tube. The flat portion continues from the first end. The second end continues from the flat portion and is located opposite to the first end with respect to the flat portion. The flat portion has at least one rib in a line shape protruding from the flat portion. The at least one rib includes a rib central portion located centrally between the first end and the second end. The at least one rib includes a portion continuing from the rib central portion. This portion is formed to approach any one of the first end and the second end in a downstream direction of flowing air.

ADVANTAGEOUS EFFECTS OF INVENTION

[0012] In the heat exchanger according to the present invention, dew condensation water generated on the flat portion of the fin moves in the downstream (downwind) direction of flowing air and, at this time, the dew condensation water is brought into contact with the rib and guided by the rib toward one of the first end and the second end of the fin. As a result of this, the dew condensation water flows through the first end to the surface of the heat transfer tube or flows along the second end of the fin, and then flows on the surface of the heat transfer tube or the second end of the fin to be finally collected by a drain pan or the like. Accordingly, the possibility that the dew condensation water flows as it is on the flat portion of the fin to be scattered downwind can be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

Fig. 1 is a schematic perspective view showing a heat exchanger according to a first embodiment.
Fig. 2 is a schematic side view showing the heat exchanger according to the first embodiment.
Fig. 3 is a schematic perspective view of a relevant portion of the heat exchanger according to the first embodiment.
Fig. 4 is a schematic longitudinal cross-sectional view of a relevant portion of the heat exchanger having U-shaped ribs according to the first embodiment.
Fig. 5 is a schematic enlarged view of a U-shaped rib according to the first embodiment.
Fig. 6 is a schematic cross-sectional view along line VI-VI in Fig. 5.
Fig. 7 is a schematic cross-sectional view of a modification of the U-shaped rib according to the first embodiment.
Fig. 8 is a schematic cross-sectional view of an indoor unit for a split-type air conditioner according to the first embodiment.
Fig. 9 is a schematic vertical cross-sectional view of dew condensation water sticking to the heat exchanger according to the first embodiment.
Fig. 10 is a schematic horizontal cross-sectional view of dew condensation water sticking to the heat exchanger according to the first embodiment.
Fig. 11 is a schematic longitudinal cross-sectional view of a relevant portion of the heat exchanger having V-shaped ribs according to the first embodiment.
Fig. 12 is a schematic enlarged view of a V-shaped rib according to the first embodiment.
Fig. 13 is a schematic longitudinal cross-sectional view of a relevant portion of a heat exchanger having straight line-shaped ribs according to the first embodiment.
Fig. 14 is a schematic enlarged view of a straight line-shaped rib according to the first embodiment.
Fig. 15 is a schematic perspective view of a relevant portion of a heat exchanger according to a second embodiment.
Fig. 16 is a schematic perspective view of a relevant portion of a heat exchanger according to a third embodiment.
Fig. 17 is a schematic perspective view of a relevant portion of a heat exchanger according to a fourth embodiment.
Fig. 18 is a schematic perspective view of a relevant portion of a heat exchanger according to a fifth embodiment.

DESCRIPTION OF EMBODIMENTS

[0014] In the following, embodiments of the present invention are described with reference to the drawings. In the following drawings, the same or corresponding parts are denoted by the same reference numerals, and a description thereof is not repeated. In the following drawings including Fig. 1, the relation in size between the parts may be different from the actual one. Further, embodiments described in the whole text of the specification are given solely by way of example, and the invention is not limited thereto.

First Embodiment

<Configuration of Heat Exchanger>

[0015] Fig. 1 is a schematic perspective view showing a heat exchanger according to the present embodiment. Fig. 2 is a schematic side view showing the heat exchanger according to the present embodiment. Fig. 3 is a schematic perspective view of a relevant portion of the heat exchanger shown in Figs. 1 and 2. Fig. 4 is a schematic longitudinal cross-sectional view of the heat exchanger shown in Figs. 1 and 2. Fig. 5 is a schematic enlarged view of a rib shown in Fig. 4. Fig. 6 is a schematic cross-sectional view along line VI-VI in Fig. 5. Fig. 7 is a schematic cross-sectional view of a modification of the rib shown in Fig. 6. Fig. 8 is a schematic cross-sectional view of an indoor unit for an air conditioner to which a heat exchanger according to the present embodiment is applied. Fig. 9 is a schematic vertical cross-sectional view for illustrating dew condensation water sticking to the heat exchanger. Fig. 10 is a schematic horizontal cross-sectional view illustrating dew condensation water sticking to the heat exchanger. Referring to Figs. 1 to 10, a configuration of the heat exchanger according to the present embodiment is described.

[0016] As shown in Figs. 1 to 3, a heat exchanger 1 according to the present embodiment is disposed to extend in the vertical direction, and includes heat transfer tubes 2 that are a plurality of flat tubes arranged in parallel in the horizontal direction, a fin 3 that is a corrugated fin formed of a plate-like member and disposed between heat transfer tubes 2, and an inlet-side header 4a and an outlet-side header 4b disposed to extend horizontally. Inlet-side header 4a and outlet-side header 4b are disposed to extend horizontally, inlet-side header 4a is connected to respective ends of heat transfer tubes 2, and outlet-side header 4b is connected to respective opposite ends of heat transfer tubes 2.

[0017] In heat transfer tube 2, one or more flow paths 5 in which refrigerant flows are formed. In heat transfer tube 2, flow paths 5 are arranged in parallel. Heat transfer tube 2 is therefore a flat tube of which cross section is rectangular rather than circular. Fin 3 is a corrugated fin formed of a plate-like member folded in such a manner that flat portions 3a alternate with curved portions 3b and flat portions 3a are arranged substantially in parallel at predetermined intervals.

[0018] For example, refrigerant flows into inlet-side header 4a from a refrigerant inlet/outlet port 6. The refrigerant flowing into inlet-side header 4a flows through flow paths 5 in the heat transfer tube and then flows into outlet-side header 4b. The refrigerant flowing into outlet-side header 4b flows out of refrigerant inlet/outlet port 6 of outlet-side header 4b. The direction in which refrigerant flows is not limited to the direction described above, but may be the opposite direction.

[0019] Heat transfer tube 2 and fin 3 are brazed together between a side surface 2a of the outer wall of heat transfer tube 2 and curved portions 3b of fin 3. Air passes through the space between adjacent flat portions 3a of fin 3. In heat exchanger 1 configured in such a manner, heat is exchanged between refrigerant flowing through flow paths 5 in heat transfer tube 2 and air passing between fins 3.

[0020] As shown in Figs. 4 and 5, in heat exchanger (see Fig. 1) according to the present embodiment, at least one line-shaped rib 15 (hereinafter also referred to as rib 15) protruding upward in the vertical direction for example is formed on flat portion 3a of fin 3. Rib 15 is formed to extend across the central line of the space between heat transfer tubes 2 arranged in parallel, namely the central line of flat portion 3a of fin 3. Rib 15 has a rib central portion 15b located to overlap the central line of flat portion 3a, and a straight-line portion 15a in at least a part of the portion(s) continuing from rib central portion 15b. Straight-line portion 15a of rib 15 is formed to incline from the downwind direction indicated by the arrow in Fig. 5 toward side surface 2a. On flat portion 3 a of fin 3, a louver 16 may be formed.

[0021] As shown in Figs. 4 and 5, line-shaped rib 15 may be a U-shaped rib as seen in plan view (also referred to as U-shaped rib) of which at least a part is straight-line portion 15a. In U-shaped rib 15 as shown in Figs. 4 and 5, a central portion (rib central portion 15b) connecting straight-line portions 15a on respective ends opposite to each other is located upwind relative to straight-line portions 15a. Straight-line portion 15a is formed to incline at angle θ from the downwind direction toward side surface 2a (see Fig. 3). From a different perspective, straight-line portion 15a is described as being inclined at angle θ from the central line of flat portion 3a of fin 3.

[0022] Angle θ which is an inclination angle of straight-line portion 15a from the downwind direction or the central line of flat portion 3a may be more than or equal to 10° and less than or equal to 80°, for example. The lower limit of angle θ may be 20° or 30°. The upper limit of angle θ may be 70° or 60°.

[0023] As shown in Fig. 6, the cross-sectional shape of rib 15 may be a triangular shape. As shown in Fig. 7, the cross-sectional shape of rib 15 may be a semicircular shape. The cross-sectional shape of rib 15 is not limited to the shapes shown in Figs. 6 and 7, but may be any shape that can form a projection protruding from the surface of flat portion 3a.

<Configuration of an Air Conditioner to which the Heat Exchanger is Applied>

[0024] Fig. 8 shows a case where heat exchanger 1 of the present embodiment is applied to an indoor unit 7 for a split-type air conditioner used by general households. As shown in Fig. 8, indoor unit 7 includes a casing 8 forming an outer shell, as well as heat exchanger 1 and a cross-flow fan 12 that are arranged in casing 8. Casing 8 is equipped with a suction port 9 and a discharge port 10. While two suction ports 9 are formed in indoor unit 7 shown in Fig. 8, three or more suction ports 9 may be formed. A wind channel 11 is formed from suction ports 9 to discharge port 10. In indoor unit 7, heat of air drawn from suction port 9 is exchanged by heat exchanger 1. Cross-flow fan 12 is driven to discharge the heat-exchanged air from discharge port 10 into a room. For example, when heat exchanger 1 is used as an evaporator for exchange of heat of the air, moisture in the air passing between fins 3 may be condensed into dews sticking to the surface of heat transfer tube 2 and the surface of fin 3. Indoor unit 7 is therefore equipped with a drain pan 13 for receiving dew condensation water generated in heat exchanger 1.

[0025] As shown in Fig. 8, heat exchanger 1 may be disposed to incline from the vertical direction toward cross-flow fan 12 so as to extend over cross-flow fan 12. Heat exchanger 1 is placed with inlet-side header 4a on the lower side and outlet-side header 4b on the upper side. Respective positions of inlet-side header 4a and outlet-side header 4b may be reversed. When heat exchanger 1 is inclined toward cross-flow fan 12, a downwind force imparted by air passing through heat exchanger 1 and a force imparted by the gravity are applied to dew condensation water generated in heat exchanger 1. Therefore, the dew condensation water may drip into the cross-flow fan located downwind of heat exchanger 1 to be discharged from discharge port 10 into the room.

<Behavior of Dew Condensation Water in the Heat Exchanger>

[0026] As shown in Figs. 9 and 10, dew condensation water sticking to fin 3 (see Fig. 4) can be classified into three types depending on the location to which the dew condensation water sticks. Specifically, the dew condensation water can be classified into dew condensation water 14a held in contact with side surface 2a of heat transfer tube 2, dew condensation water 14b held in contact with curved portion 3b of fin 3, and dew condensation water 14c held in contact with only flat portion 3a of fin 3 without being in contact with side surface 2a of heat transfer tube 2 and curved portion 3b of fin 3.

[0027] As shown in Fig. 8, it is supposed that heat exchanger 1 is disposed to incline from the vertical direction toward cross-flow fan 12 to extend over cross-flow fan 12. In this case, force Fa imparted by air passing through heat exchanger 1 and force Fg imparted by a gravity component in the direction along flat portion 3a are applied downwind to dew condensation water. Meanwhile, surface tension F1 between the dew condensation water and flat portion 3a of the fin is applied upwind to the dew condensation water. To dew condensation water 14a held in contact with side surface 2a, surface tension F2 between dew condensation water 14a and side surface 2a is applied upwind. To dew condensation water 14b held in contact with curved portion 3b of the fin, surface tension F3 between dew condensation water 14b and curved portion 3b of the fin is applied upwind.

[0028] Regarding dew condensation water 14a to 14c, the total force applied downwind is represented by f1 and the total force applied upwind is represented by f2.

[0029] When f1 > f2 holds (the force applied downwind is larger than the force applied upwind), dew condensation water 14a to 14c flows downwind on the surface of fin 3 for example and may be scattered downwind from heat exchanger 1.

[0030] When $f1 \leq f2$ holds (the force applied upwind is larger than the force applied downwind), dew condensation water 14a to 14c stays on the surface of fin 3, rather than scattering downwind from heat exchanger 1.

[0031] Regarding dew condensation water 14a to 14c, the total forces f1 and f2 are represented by respective formulas as indicated in the following.

[0032] For dew condensation water 14a to 14c, the total force applied downwind is f1 = Fa+Fg.

[0033] For dew condensation water 14a, the total force applied upwind is f2a = F1+F2

[0034] For dew condensation water 14b, the total force applied upwind is f2b = F1+F3.

[0035] For dew condensation water 14c, the total force applied upwind is f2c = F1.

[0036] As clearly seen from the above formulas, the relations f2a > f2c and f2b > f2c hold. Therefore, dew condensation water 14c is more likely to flow downwind and more likely to scatter downwind, as compared with dew condensation water 14a, 14b.

[0037] When f1 > f2c holds for dew condensation water 14c, dew condensation water 14c flows downwind. Dew condensation water 14c then collides with line-shaped rib 15 protruding upward in the vertical direction. Dew condensation water 14c colliding with line-shaped rib 15 then flows on straight-line portion 15a of rib 15 in the direction in which straight-line portion 15a extends. Thus, dew condensation water 14c is brought into contact with side surface 2a of heat transfer tube 2 or curved portion 3b of fin 3 to become condensation water 14a or condensation water 14b. Specifically, dew condensation water 14c is guided by line-shaped rib 15 to become dew condensation water 14a or dew condensation water 14b. Accordingly, total force f2 applied upwind to the dew condensation water increases from f2c (= F1) to f2a (= F1+F2) or f2b (= F1+F3). Because of the increase of the ratio of dew condensation water 14a, 14b for which the total force applied in the upwind direction to the dew condensation water is relatively larger, the ratio of dew condensation water staying between fins 3 increases and dew condensation water becomes less likely to scatter downwind from heat exchanger 1.

[0038] When f1 > f2a holds for dew condensation water 14a, i.e., dew condensation water 14a flows downwind, dew condensation water 14a flows downwind on side surface 2a of heat transfer tube 2. When f1 > f2b holds for dew condensation water 14b, i.e., dew condensation water 14b flows downwind, dew condensation water 14b flows downwind on curved portion 3b of fin 3.

[0039] When dew condensation water 14a flows downwind on side surface 2a of heat transfer tube 2, a front portion 2b of the outer wall of heat transfer tube 2 shown in Fig. 3 can be used as a drainage channel (front portion 2b is also referred to as tube front portion hereinafter). Therefore, dew condensation water 14a flows on front portion 2b (drainage channel) of heat transfer tube 2 into a lower portion of heat exchanger 1. When dew condensation water 14b flows downwind on curved portion 3b of fin 3 as well, dew condensation water 14b flows on front portion 2b (drainage channel) of heat transfer tube 2 adjacent to curved portion 3b into the lower portion of heat exchanger 1.

<Functions and Advantageous Effects of the Heat Exchanger>

[0040] The configuration of above-described heat exchanger 1 is described from a different perspective. Heat exchanger 1 includes at least one heat transfer tube 2 and fin 3. As shown in Figs. 1 and 2, heat transfer tube 2 is disposed to extend in a single direction. The single direction is the direction of gravity, for example. Heat transfer tube 2 includes flow path 5 in which refrigerant flows. Fin 3 is connected to at least one heat transfer tube 2. Fin 3 includes a first end (a part of curved portion 3b of fin 3 with which dew condensation water 14a is held in contact and which is joined to heat transfer tube 2 in Fig. 9), flat portion 3a, and a second end (curved portion 3b of fin 3 with which due condensation water 14b is held in contact). The first end is connected to heat transfer tube 2. Flat portion 3a continues from the first end. The second end (curved portion 3b) is located opposite to the first end with respect to flat portion 3a. Flat portion 3a has at least one line-shaped rib 15 protruding from flat portion 3a. At least one rib 15 includes a rib central portion 15b located centrally between the first end and the second end (curved portion 3b). At least one rib 15 also includes a portion (a portion from rib central portion 15b to an end of rib 15) formed to continue from rib central portion 15b and approach any one of the first end and the second end (curved portion 3b) in the downstream direction of flowing air. This portion includes a straight-line portion 15a.

[0041] The portion of rib 15 formed to approach any one of the first end and the second end may have a shape including no straight-line portion 15a shown in Fig. 5 as seen in plan view. For example, the whole of this portion may have a curved shape as seen in plan view. More specifically, the whole of this portion may be curved to protrude downwind or curved to protrude upwind, or have a shape formed by any combination of the downwind protrusion curve, the upwind protrusion curve, and a straight line. In other words, this portion may have any shape as seen in plan view as long as the shape extends to approach any one of the first end and the second end in the downwind direction from rib central portion 15b.

[0042] From a different perspective, as shown in Fig. 5, a virtual straight line 15c extending from rib central portion 15b toward the end of rib 15 is inclined from the downwind direction toward heat transfer tube 2. From another different perspective, rib 15 is formed in such a manner that virtual straight line 15c approaches any one of the first end and the second end in the downstream direction of flowing air. From still another different perspective, a part (rib central portion 15b) of at least one rib 15 is located at a center of flat portion 3 a in the direction intersecting the direction in which air flows. At least one rib 15 includes straight-line portion 15a. Straight-line portion 15a is inclined by angle θ with respect to the direction in which air flows, so as to approach any one of the first end and the second end (curved portion 3b) in the downstream direction of flowing air.

[0043] At least one heat transfer tube 2 includes a first heat transfer tube (heat transfer tube 2 located on the right side in Fig. 4) and a second heat transfer tube (heat transfer tube 2 located on the left side in Fig. 4). The first heat transfer tube and the second heat transfer tube are arranged with fin 3 interposed therebetween. The first heat transfer tube and the second heat transfer tube are arranged to extend in parallel with each other. The first end of fin 3 is connected to the first heat transfer tube. The outer surface of the second end (curved portion 3b) of fin 3 is connected to the second heat transfer tube.

[0044] Accordingly, when dew condensation water 14c sticking to flat portion 3 a of fin 3 flows downwind, dew condensation water 14c collides with rib 15 so that the direction in which dew condensation water 14c flows is changed. Dew condensation water 14c then flows toward side surface 2a of heat transfer tube 2 or curved portion 3b of fin 3. As a result of this, dew condensation water 14c is brought into contact with side surface 2a of heat transfer tube 2 or curved portion 3b of fin 3 to become dew condensation water 14a or dew condensation water 14b shown in Fig. 9. Consequently, the ratio of dew condensation water 14a, 14b staying inside heat exchanger 1 can be increased, and the possibility that the dew condensation water scatters downstream from heat exchanger 1 can be reduced.

<Modification of the Heat Exchanger>

[0045] Fig. 11 is a schematic cross-sectional view of a relevant portion illustrating a first modification of the heat exchanger shown in Figs. 1 to 10, and Fig. 12 is a schematic enlarged view of a rib of the heat exchanger shown in Fig. 11. The heat exchanger shown in Figs. 11 and 12 basically has a configuration similar to that of the heat exchanger shown in Figs. 1 to 10, except that the shape of rib 15 as seen in plan view differs from that of the heat exchanger shown in Figs. 1 to 10. Specifically, as shown in Fig. 12, line-shaped rib 15 is a V-shaped rib 15 of which at least a part is a straight-line portion 15a as seen in plan view. V-shaped rib 15 shown in Figs. 11 and 12 has a central portion connecting straight-line portion 15a of one end and straight-line portion 15a of the opposite end and this central portion is located upwind relative to straight-line portions 15a. Straight-line portion 15a included in V-shaped rib 15 is shaped to incline by angle θ from the downwind direction toward side surface 2a of heat transfer tube 2. The heat exchanger configured in this way can also produce advantageous effects similar to those of the heat exchanger shown in Figs. 1 to 10.

[0046] Fig. 13 is a schematic cross-sectional view of a relevant portion illustrating a second modification of the heat exchanger shown in Figs. 1 to 10, and Fig. 14 is a schematic enlarged view of a rib of the heat exchanger shown in Fig. 13. The heat exchanger shown in Figs. 13 and 14 basically has a configuration similar to that of the heat exchanger shown in Figs. 1 to 10, except that the shape of rib 15 as seen in plan view differs from that of the heat exchanger shown in Figs. 1 to 10. Specifically, as shown in Fig. 14, line-shaped rib 15 is a straight line-shaped rib 15 as seen in plan view. Straight line-shaped rib 15 is formed to incline by angle θ from the downwind direction toward side surface 2a of heat transfer tube 2. A plurality of straight line-shaped ribs 15 are formed to be inclined in different directions with respect to the central line of flat portion 3a. As shown in Fig. 13, as to the direction of inclination with respect to the central line of flat portion 3a, straight line-shaped ribs 15 arranged from the upwind side toward the downwind side may be formed in such a manner that the ribs are inclined alternately in opposite directions. The heat exchanger configured in this way can also produce advantageous effects similar to those of the heat exchanger shown in Figs. 1 to 10.

Second Embodiment

<Configuration of Heat Exchanger>

[0047] Fig. 15 is a schematic perspective view of a relevant portion of a heat exchanger 1 according to the present embodiment. The heat exchanger shown in Fig. 15 basically has a similar configuration to that of the heat exchanger shown in Figs. 1 to 10, but differs from the heat exchanger shown in Figs. 1 to 10 in that a downwind-side front portion 2b of a heat transfer tube 2 is located downwind relative to the downwind-side end of a fin 3. From a different perspective, at least one heat transfer tube 2 includes a downstream-side end located downstream relative to fin 3 in the direction in which air flows (downstream-side end: a portion of heat transfer tube 2 located downstream relative to fin 3).

<Functions and Advantageous Effects of the Heat Exchanger>

[0048] As shown in Fig. 15, front portion 2b of heat transfer tube 2 protruding downwind relative to the downwind-side end face of fin 3 as well as a part of a side surface 2a of heat transfer tube 2 located between this front portion 2b and the downstream-side end of fin 3 are available as a drainage channel 17. Therefore, relative to the heat exchanger shown in Figs. 1 to 10, the area available as drainage channel 17 is increased. Accordingly, even when a large amount of dew condensation water 14a to 14c is generated in heat exchanger 1, dew condensation water flowing on the surface of heat transfer tube 2 and/or curved portion 3b of fin 3 into drainage channel 17 is allowed to flow into a lower portion of heat exchanger 1. In this way, the amount of dew condensation water scattering downwind from heat exchanger 1 can be reduced.

Third Embodiment

<Configuration of Heat Exchanger>

[0049] Fig. 16 is a schematic perspective view of a relevant portion of a heat exchanger 1 according to the present embodiment. The heat exchanger shown in Fig. 16 basically has a similar configuration to that of the heat exchanger shown in Fig. 15, but differs from the heat exchanger shown in Fig. 15 in that a portion of side surface 2a of heat transfer tube 2 located downwind of fin 3 (region serving as drainage channel 17) has a depressed portion 2c formed therein. Depressed portion 2c is formed to extend in the direction in which heat transfer tube 2 extends.

<Functions and Advantageous Effects of the Heat Exchanger>

[0050] Regarding the heat exchanger shown in Fig. 16, side surface 2a in which depressed portion 2c is formed in the end of heat transfer tube 2 protruding downwind relative to the downwind-side end face of fin 3 as well as front portion 2b of heat transfer tube 2 are available as a drainage channel 17. Thus, relative to the heat exchanger shown in Fig. 15, the area of the portion available as drainage channel 17 is increased by forming depressed portion 2c. Therefore, relative to the case where the heat exchanger shown in Fig. 15 is used, even when a large amount of dew condensation water 14a to 14c is generated in heat exchanger 1, dew condensation water flowing on the surface of heat transfer tube 2 and/or curved portion 3b of fin 3 into drainage channel 17 is allowed to flow into a lower portion of heat exchanger 1. In this way, the amount of dew condensation water scattering downwind from heat exchanger 1 can be reduced.

Fourth Embodiment

<Configuration of Heat Exchanger>

[0051] Fig. 17 is a schematic perspective view of a relevant portion of a heat exchanger 1 according to the present embodiment. The heat exchanger shown in Fig. 17 basically has a similar configuration to that of the heat exchanger shown in Fig. 16, but differs from the heat exchanger shown in Fig. 16 in that a portion of side surface 2a of heat transfer tube 2 located downwind of fin 3 (region serving as drainage channel 17) additionally has a protruded portion 2d formed downstream of depressed portion 2c. Protruded portion 2d is formed to extend in the direction in which heat transfer tube 2 extends.

<Functions and Advantageous Effects of the Heat Exchanger>

[0052] Regarding the heat exchanger shown in Fig. 17, side surface 2a in which depressed portion 2c and protruded portion 2d are formed in the end of heat transfer tube 2 protruding downwind relative to the downwind-side end face of fin 3 as well as front portion 2b of heat transfer tube are available as a drainage channel 17. Thus, relative to the heat exchanger shown in Fig. 16, the area of the portion available as drainage channel 17 is further increased by forming protruded portion 2d. Therefore, relative to the case where the heat exchanger shown in Fig. 16 is used, even when a larger amount of dew condensation water 14a to 14c is generated in heat exchanger 1, dew condensation water flowing on the surface of heat transfer tube 2 and/or curved portion 3b of fin 3 into drainage channel 17 is allowed to flow into a lower portion of heat exchanger 1. In this way, the amount of dew condensation water scattering downwind from heat exchanger 1 can be reduced.

Fifth Embodiment

<Configuration of Heat Exchanger>

[0053] Fig. 18 is a schematic perspective view of a relevant portion of a heat exchanger 1 according to the present embodiment. The heat exchanger shown in Fig. 18 basically has a similar configuration to that of the heat exchanger shown in Fig. 15, but differs from the heat exchanger shown in Fig. 15 in that a water absorbing member 18 is disposed on a portion of side surface 2a of heat transfer tube 2 located downwind of fin 3 (region serving as drainage channel 17). Water absorbing member 18 is fixed to side surface 2a of heat transfer tube 2. Water absorbing member 18 is formed to extend in the direction in which heat transfer tube 2 extends.

<Functions and Advantageous Effects of the Heat Exchanger>

[0054] Regarding the heat exchanger shown in Fig. 18, side surface 2a to which water absorbing member 18 is fixed as well as front portion 2b of heat transfer tube 2 are available as a drainage channel 17. The aforementioned side surface 2a is located at the end of heat transfer tube 2 protruding downwind relative to the downwind-side end face of fin 3 and is further provided with water absorbing member 18 connected to the downstream end of heat transfer tube 2 (the portion of heat transfer tube 2 located downstream relative to fin 3). Thus, relative to the heat exchanger shown in Fig. 15, the portion which is made available as the drainage channel by being equipped with water absorbing member 18 has a higher ability to hold dew condensation water. Therefore, relative to the case where the heat exchanger shown in Fig. 15 is used, even when a large amount of dew condensation water 14a to 14c is generated in heat exchanger 1, dew condensation water flowing on the surface of heat transfer tube 2 and/or curved portion 3b of fin 3 to water absorbing member 18 is allowed to flow into a lower portion of heat exchanger 1. In this way, the amount of dew condensation water scattering downwind from heat exchanger 1 can be reduced.

[0055] As a material for water absorbing member 18, any material having a water absorbing property can be used. For example, sponge-like resin or porous material may be used. While water absorbing member 18 is disposed on side surface 2a of heat transfer tube 2, water absorbing member 18 may be disposed in a groove formed in side surface 2a. In this case, the height to which water absorbing member 18 protrudes into the air flow path can be reduced and therefore, increase of the air flow resistance due to water absorbing member 18 can be suppressed. Moreover, the thickness of water absorbing member 18 may be identical to the depth of the groove so that the surface of water absorbing member 18 is coplanar with the portion of side surface 2a where the groove is not formed.

[0056] While the foregoing is a description of the embodiments of the present invention, the embodiments may be modified in various ways. The scope of the present invention is not limited to the above-described embodiments. It is intended that the scope of the present invention is defined by claims, and encompasses all variations equivalent in meaning and scope to the claims.

INDUSTRIAL APPLICABILITY

[0057] The present invention is effectively used for a parallel-flow heat exchanger as well as an air conditioner equipped with a parallel-flow heat exchanger.

REFERENCE SIGNS LIST

[0058] 1 heat exchanger; 2 heat transfer tube; 2a side surface; 2b front portion; 2c depressed portion; 2d protruded portion; 3 fin; 3a flat portion; 3b curved portion; 4a inlet-side header; 4b outlet-side header; 5 flow path; 6 refrigerant inlet/outlet port; 7 indoor unit; 8 casing; 9 suction port; 10 discharge port; 11 wind channel; 12 cross-flow fan; 13 drain pan; 14a, 14b, 14c dew condensation water; 15 rib; 15a straight-line portion; 15b rib central portion; 16 louver; 17 drainage channel; 18 water absorbing member

Claims

1. A heat exchanger comprising:

at least one heat transfer tube in which refrigerant flows; and
a fin connected to the at least one heat transfer tube,
the fin comprising:

a first end connected to the heat transfer tube;
a flat portion continuing from the first end; and
a second end continuing from the flat portion and located opposite to the first end with respect to the flat portion,
the flat portion having at least one rib in a line shape protruding from the flat portion,
the at least one rib comprising:

a rib central portion located centrally between the first end and the second end; and
a portion continuing from the rib central portion and formed to approach any

one of the first end and the second end in a downstream direction of flowing air.

2. The heat exchanger according to claim 1, wherein the portion of the at least one rib includes a straight-line portion.

3. The heat exchanger according to claim 1 or 2, wherein the at least one heat transfer tube includes a downstream end located downstream relative to the fin.

4. The heat exchanger according to claim 3, wherein a surface of the downstream end comprises a depressed portion.

5. The heat exchanger according to claim 4, wherein the surface of the downstream end comprises a protruded portion located downstream relative to the depressed portion.

6. The heat exchanger according to claim 3, further comprising a water absorbing member connected to the downstream end.

7. The heat exchanger according to any one of claims 1 to 6, wherein
the at least one heat transfer tube includes a first heat transfer tube and a second heat transfer tube,
the first heat transfer tube and the second heat transfer tube are arranged with the fin interposed between the first heat transfer tube and the second heat transfer tube,
the first end of the fin is connected to the first heat transfer tube, and
the second end of the fin is connected to the second heat transfer tube.

FIG.1

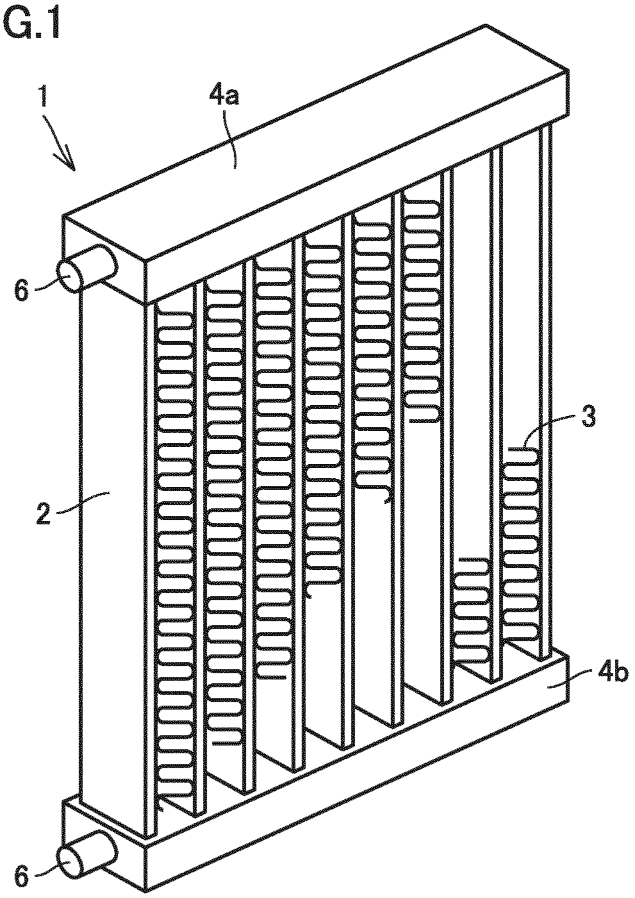


FIG.2

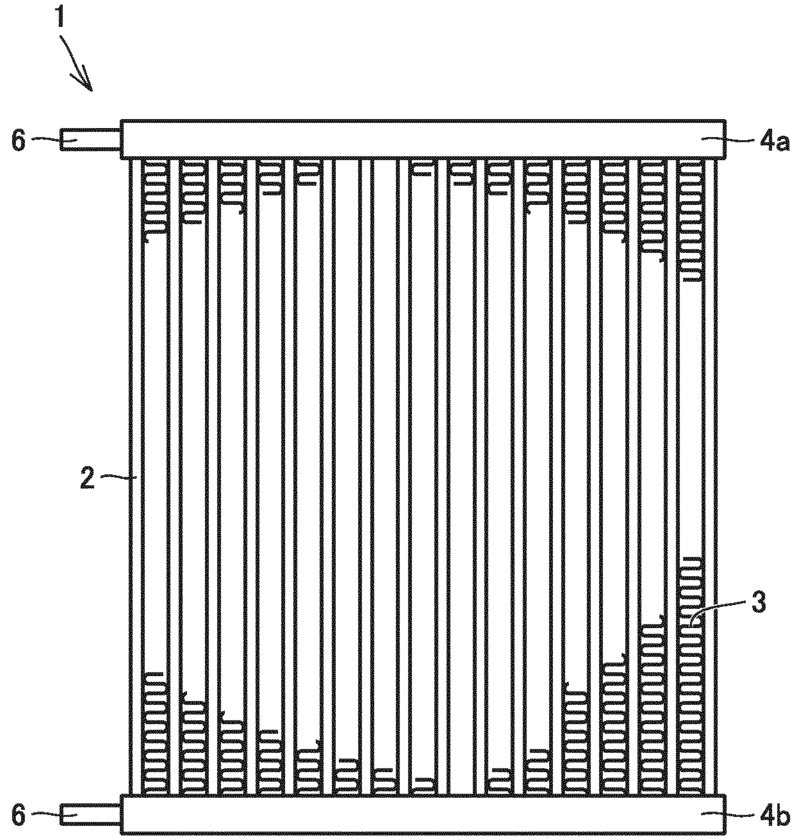


FIG.3

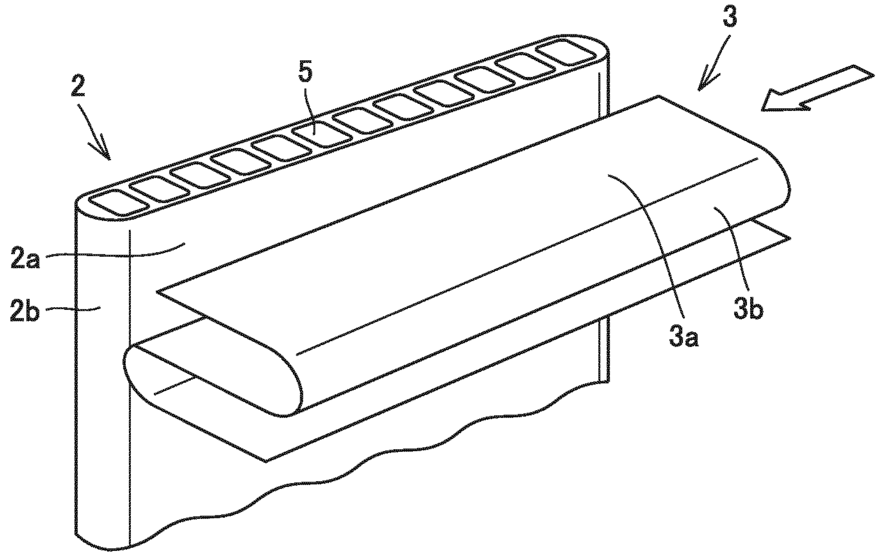


FIG.4

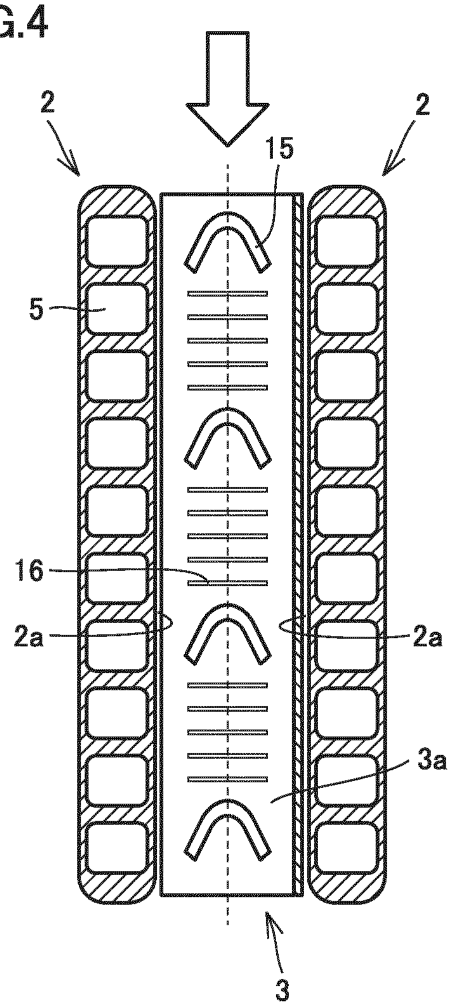


FIG.5

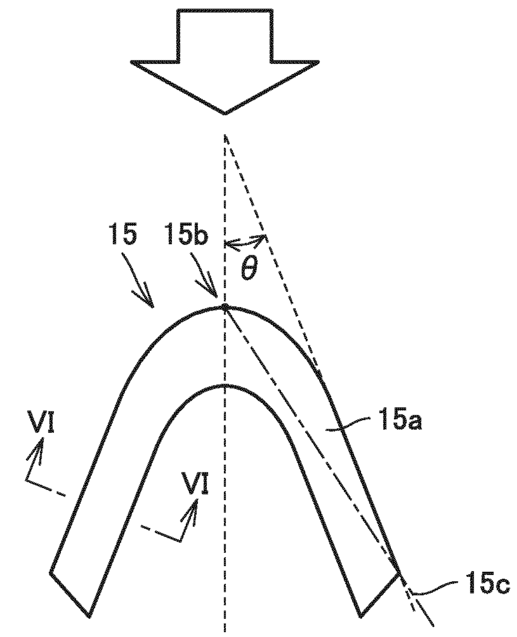


FIG.6

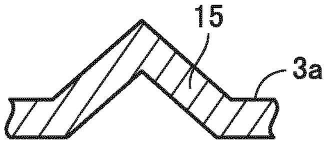


FIG.7

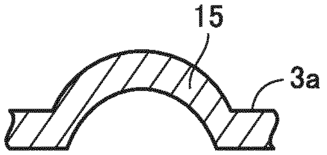


FIG.8

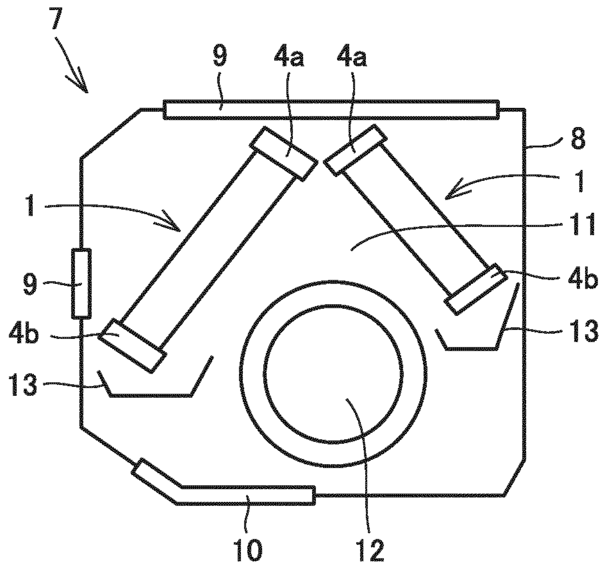


FIG.9

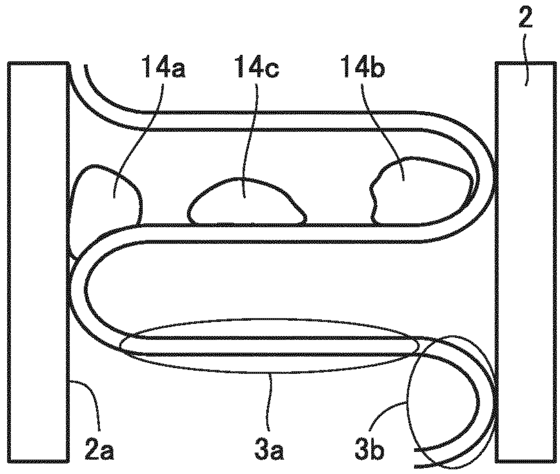


FIG.10

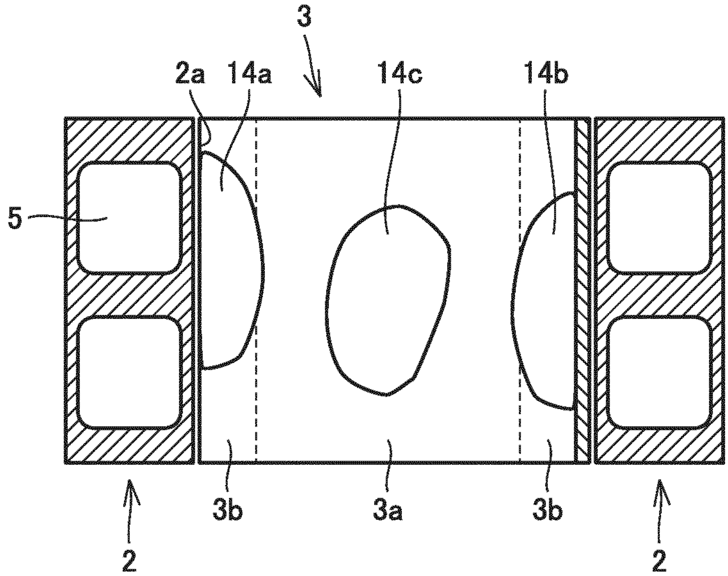


FIG.11

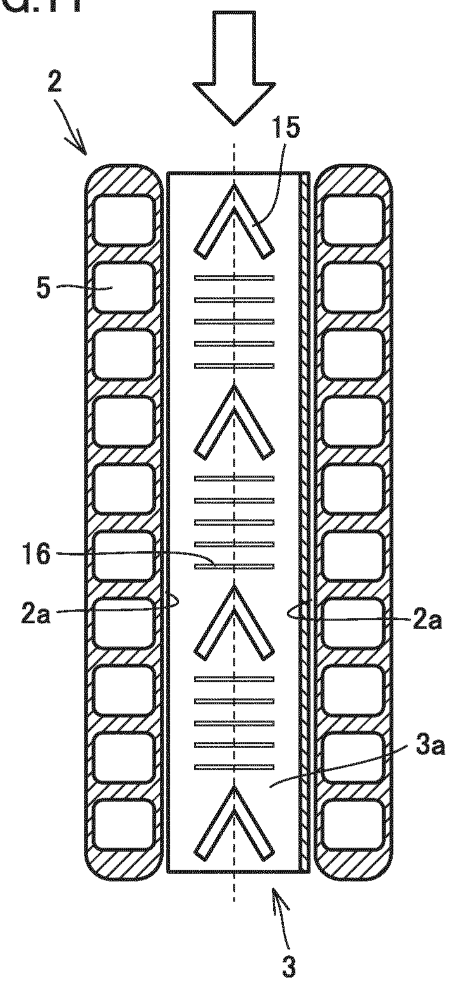


FIG.12

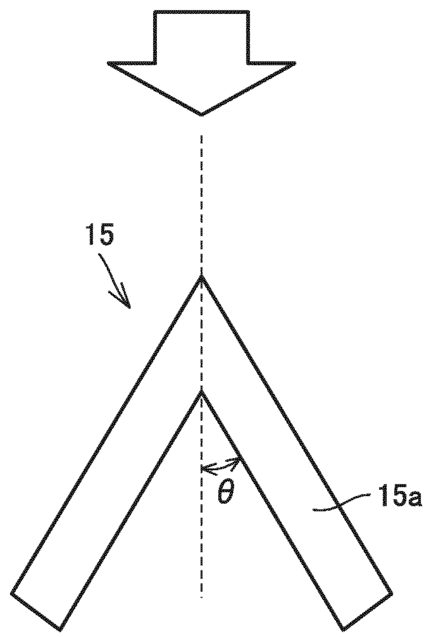


FIG.13

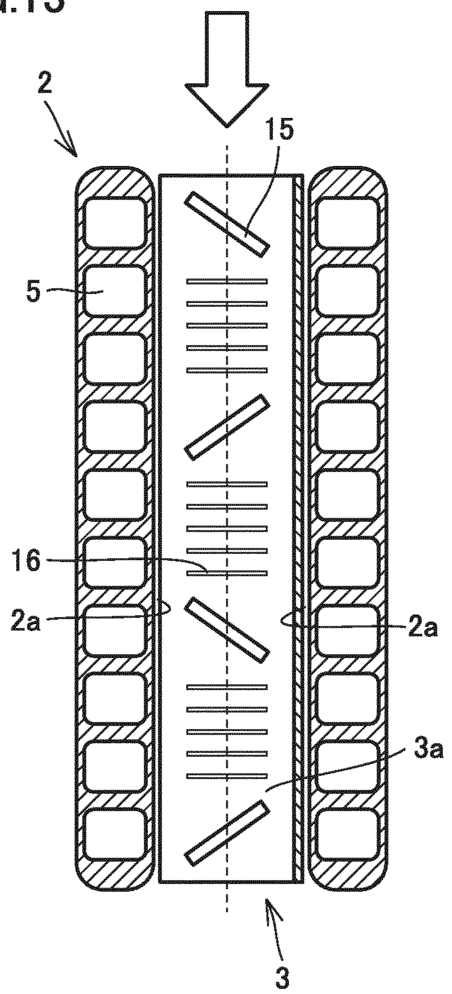


FIG.14

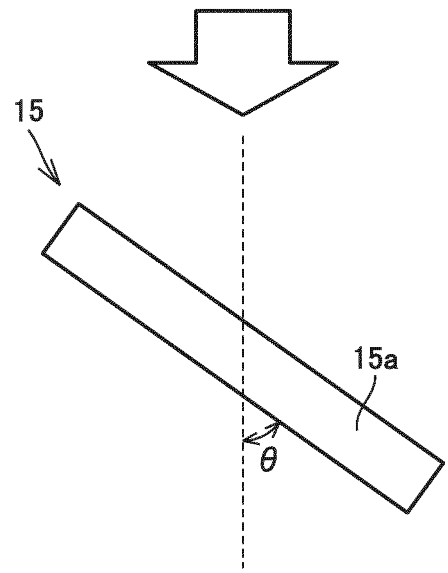


FIG.15

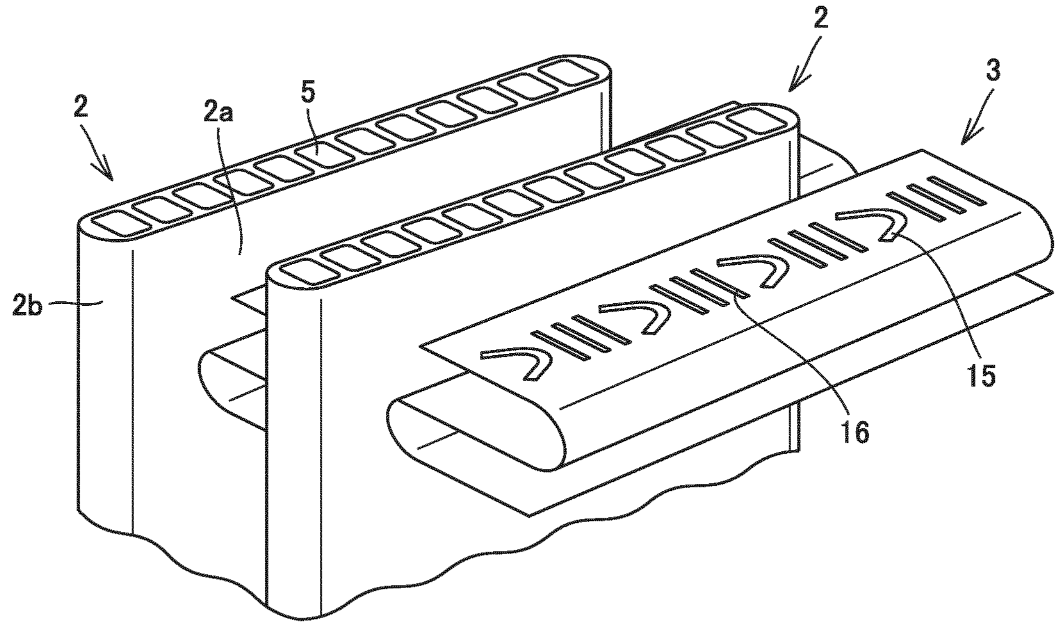


FIG.16

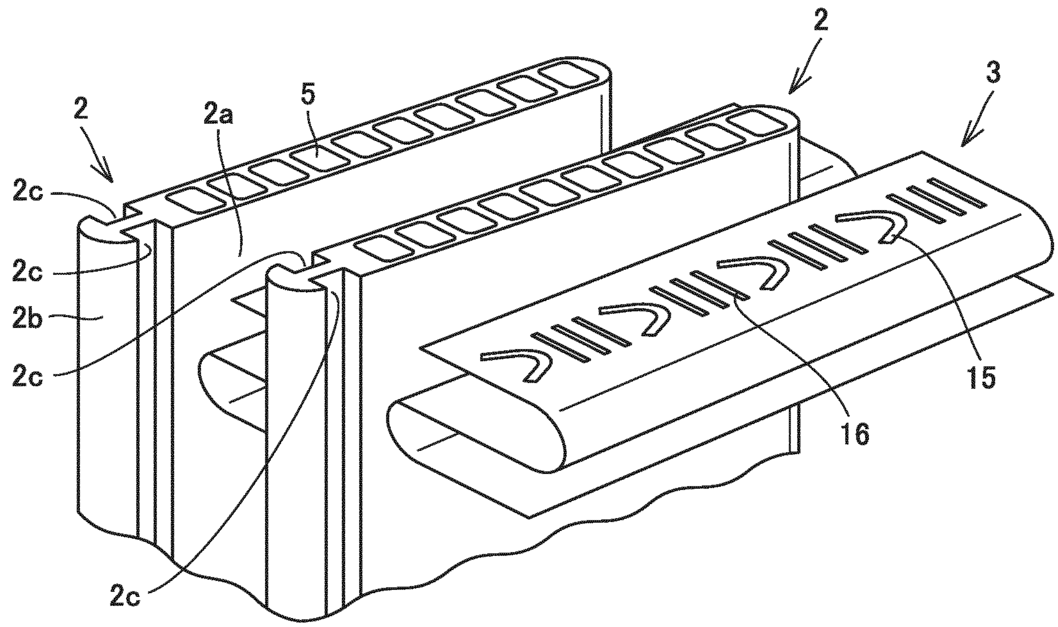


FIG.17

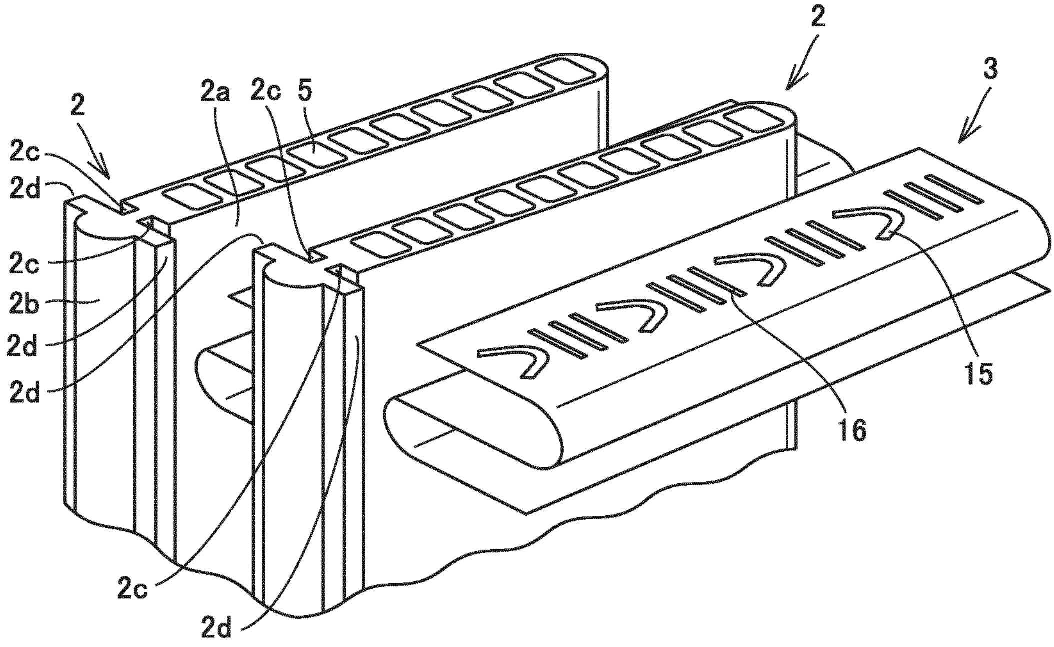
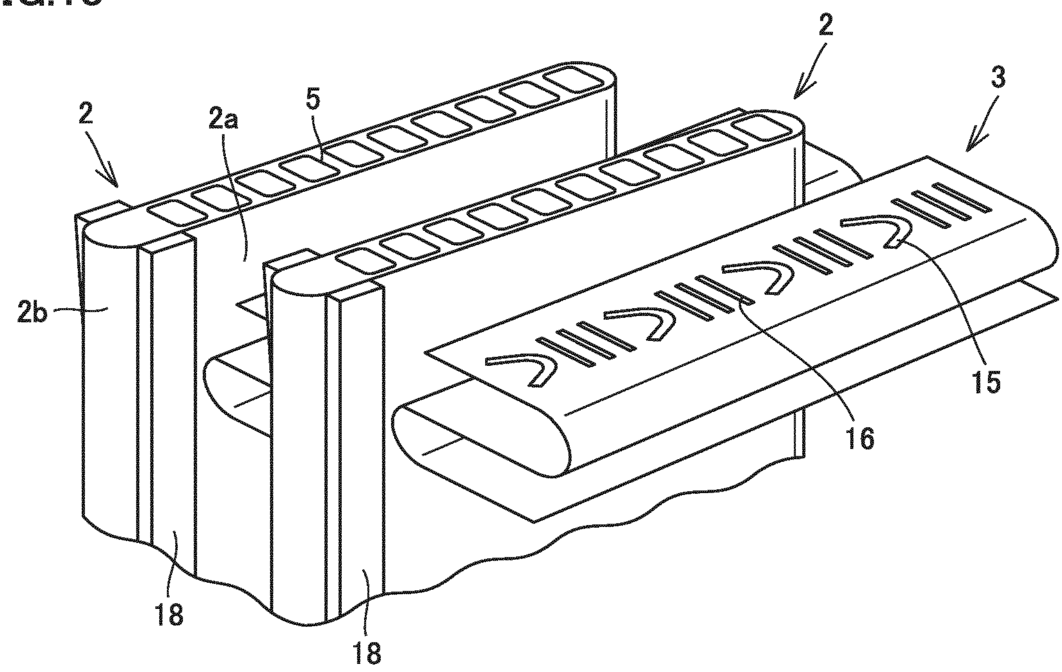


FIG.18



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/070185

A. CLASSIFICATION OF SUBJECT MATTER
F28F1/30(2006.01)i, *F25B39/02*(2006.01)i, *F28D1/053*(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, F25B39/02, F28D1/053

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	1996-2016
Kokai Jitsuyo Shinan Koho	1971-2016	Toroku Jitsuyo Shinan Koho	1994-2016

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 2004-271113 A (Matsushita Electric Industrial Co., Ltd.), 30 September 2004 (30.09.2004), paragraphs [0003], [0015] to [0024]; fig. 3 to 6 (Family: none)	1-2,7 3-7
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 020074/1980(Laid-open No. 122066/1981) (Diesel Kiki Co., Ltd.), 17 September 1981 (17.09.1981), specification, page 4, line 15 to page 5, line 1; fig. 4 (Family: none)	3-7

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 September 2016 (08.09.16)	20 September 2016 (20.09.16)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/070185

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 178707/1980(Laid-open No. 101873/1982) (Nissan Motor Co., Ltd.), 23 June 1982 (23.06.1982), specification, page 3, line 6 to page 4, line 5; fig. 5 (Family: none)	3-7
Y	JP 2013-19596 A (Mitsubishi Electric Corp.), 31 January 2013 (31.01.2013), paragraphs [0018], [0022] to [0023]; fig. 1 to 3 (Family: none)	3-4,6-7
Y	JP 2012-37092 A (Sharp Corp.), 23 February 2012 (23.02.2012), paragraphs [0024] to [0025]; fig. 2 (Family: none)	6-7
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 176322/1981(Laid-open No. 081473/1983) (Howa Machinery, Ltd.), 02 June 1983 (02.06.1983), specification, page 1, line 17 to page 11, line 19; fig. 1 to 6 (Family: none)	1-2,7 3-7
A	WO 2013/183136 A1 (Hitachi, Ltd.), 12 December 2013 (12.12.2013), entire text; all drawings & US 2015/0211781 A1	1-7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011047600 A **[0003] [0008]**
- JP 2004177082 A **[0007] [0008]**
- JP 7190661 A **[0007] [0008]**