

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

(43) Date of publication:
12.11.2014 Bulletin 2014/46

(51) Int Cl.: *F28F 1/30* ^(2006.01) *F28F 1/32* ^(2006.01)

(21) Application number: **12856905.0**

(86) International application number:
PCT/JP2012/082140

(22) Date of filing: **12.12.2012**

(87) International publication number:
WO 2013/089116 (20.06.2013 Gazette 2013/25)

(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

(30) Priority: 14.12.2011 JP 2011273439

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(54) **HEAT EXCHANGER**

(57) An object of the present invention is to bring fins and heat transfer pipes into contact without difficulty while maintaining a function for conveying condensed water.

A first fin unit (51) and a second fin unit (52) in fins (50a, 50b) are arranged so that a plate thickness direction intersects an air flow direction (F), and are mutually adjacent. The first fin unit (51) and the second fin unit (52) have heat conducting parts (51a, 52a), upper water conveying parts (51b, 52b) projecting upward from the heat conducting parts (51a, 52a), and lower water conveying parts (51c, 52c) projecting downward from the heat conducting parts (51a, 52a). The amount of projection of the upper water conveying part (51b) of the first fin unit (51) differs from the amount of projection of the upper water conveying part (52b) of the second fin unit (52), but equals the amount of projection of the lower water conveying part (52c) of the second fin unit (52). The amount of projection of the lower water conveying part (51c) of the first fin unit (51) differs from the amount of projection of the lower water conveying part (52c) of the second fin unit (52), but equals the amount of projection of the upper water conveying part (52b) of the second fin unit (52).

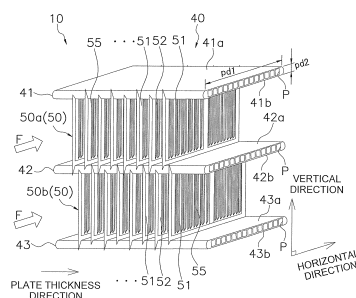


FIG. 3

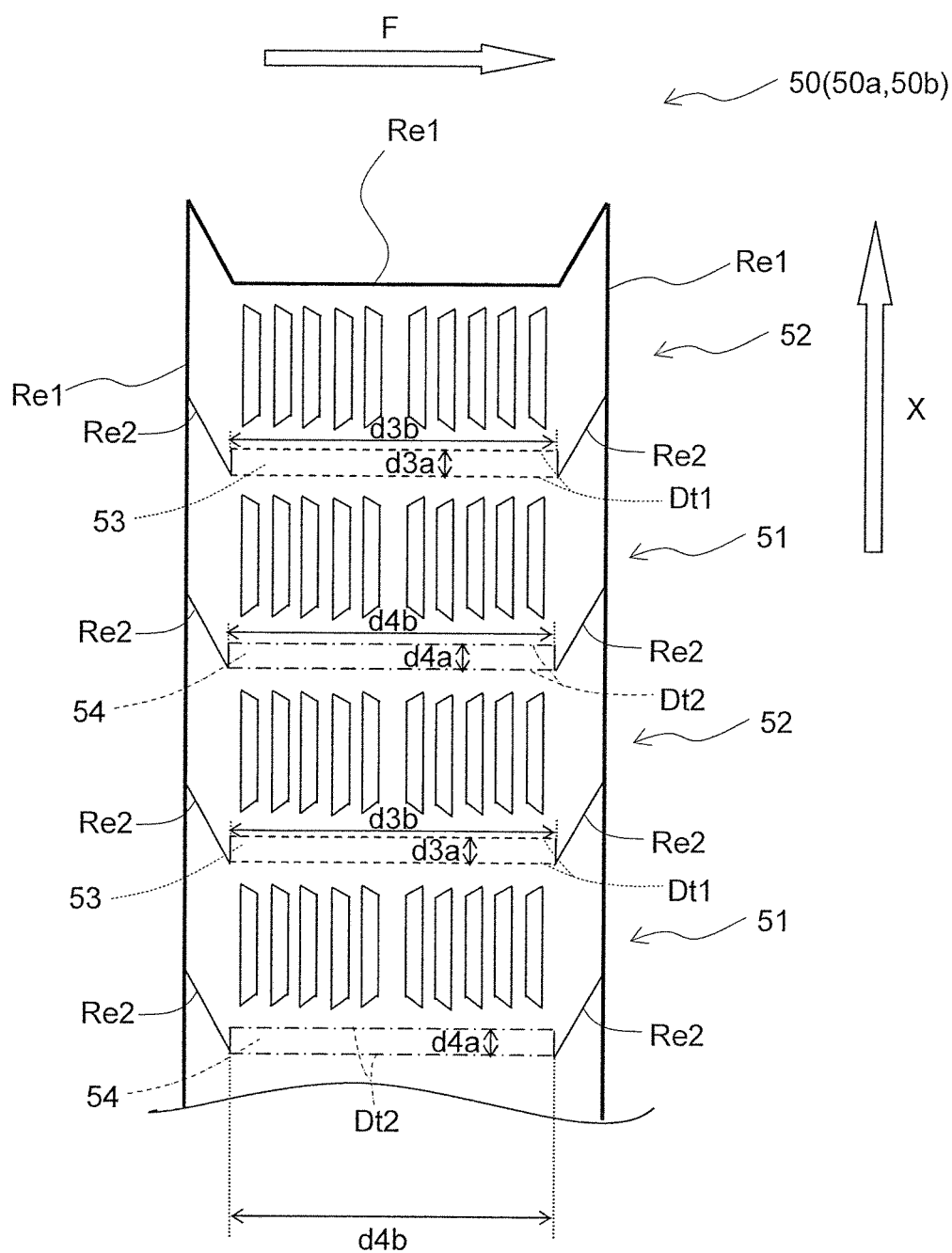


FIG. 5

Description**TECHNICAL FIELD**

5 [0001] The present invention relates to a heat exchanger.

BACKGROUND ART

10 [0002] Heat exchangers for heating or cooling air are used in outdoor units of air conditioning systems and heating units of water heaters, among other applications. Types of heat exchangers are indicated, for example, in Patent Document 1 (Japanese Laid-Open Patent Application 2008-101847).

15 [0003] The heat exchanger of Patent Document 1 has a structure in which flattened heat transfer pipes are arranged so that the flattened parts of the heat transfer pipes are horizontal, and corrugated fins are arranged between mutually separated flattened heat transfer pipes. In particular, the heat exchanger of Patent Document 1 has a structure having protruding parts extending from the heat transfer surface of the corrugated fins and protruding from the flattened part of the flattened heat transfer pipes, wherein the protruding parts function as water conveyance surfaces for conveying condensed water from the corrugated fins. As a result, condensed water flows downward by means of the water conveyance surfaces.

SUMMARY OF THE INVENTION

<Technical Problem>

25 [0004] The corrugated fins according to Patent Document 1 have a waveform folded structure, and thus have a plurality of plate-shaped heat transfer surfaces which are adjacent in the plate thickness direction, the water conveyance surfaces described earlier, and folded parts linking mutually adjacent heat transfer surfaces. A so-called clad material having a brazing material coated on the surface is often used as the material of these corrugated fins, and the corrugated fins are joined to the flattened heat transfer pipes by brazing.

30 [0005] Due to the area of the water conveyance surfaces extending from the mutually adjacent heat transfer surfaces, however, there is a risk of insufficient contact between the corrugated fins and the flattened heat transfer pipes due to differences in the quantity of brazing material, or so-called erosion in which the brazing material has melted in an undesirable manner.

[0006] Therefore, the problem addressed by the present invention is to bring fins and heat transfer pipes into contact without difficulty while maintaining a function for conveying condensed water.

35 <Solution to Problem>

40 [0007] A heat exchanger according to a first aspect of the present invention is provided with fins and a plurality of heat transfer pipes. The fins have a plate-shaped first fin unit and second fin unit. The first fin unit and the second fin unit are arranged so that the plate thickness direction intersects an air flow direction, and are mutually adjacent. The plurality of heat transfer pipes are fitted onto the fins so as to intersect the air flow direction. The first fin unit and the second fin unit have heat conducting parts, upper water conveying parts, and lower water conveying parts. The heat conducting parts exchange heat with air. The upper water conveying parts project upward from the heat conducting parts. The lower water conveying parts project downward from the heat conducting parts. The amount of projection of the upper water conveying part of the first fin unit differs from the amount of projection of the upper water conveying part of the second fin unit, but equals the amount of projection of the lower water conveying part of the second fin unit. The amount of projection of the lower water conveying part of the first fin unit differs from the amount of projection of the lower water conveying part of the second fin unit, but equals the amount of projection of the upper water conveying part of the second fin unit.

50 [0008] In this heat exchanger, the mutually adjacent first fin unit and second fin unit differ in the amount of projection of the upper water conveying parts and in the amount of projection of the lower water conveying parts. The amount of projection of the upper water conveying part of the first fin unit equals the amount of projection of the lower water conveying part of the second fin unit, and the amount of projection of the lower water conveying part of the first fin unit equals the amount of projection of the upper water conveying part of the second fin unit. Therefore, the total area of the upper water conveying part and the lower water conveying part in the first fin unit equals the total area of the upper water conveying part and the lower water conveying part in the second fin unit. This configuration can prevent insufficient contact between the fins and the flattened heat transfer pipes due to differences in the quantity of brazing material, or so-called erosion in which the brazing material has melted in an undesirable manner. Therefore, the fins and the heat

transfer pipes can be brought into contact without difficulty while ensuring a function for conveying condensed water.

[0009] The heat exchanger according to the second aspect of the present invention is the heat exchanger according to the first aspect, wherein the first fin unit and the second fin unit have bilateral symmetry with respect to a center line bisecting the width along the air flow direction.

[0010] As a result, the total area of the upper water conveying parts and the lower water conveying parts in the first fin unit better equals the total area of the upper water conveying parts and the lower water conveying parts in the second fin unit. This can better prevent differences in the quantity of brazing material between the first fin unit and the second fin unit.

[0011] The heat exchanger according to the third aspect of the present invention is the heat exchanger according to the first aspect or the second aspect, wherein the upper water conveying parts and the lower water conveying parts have a shape becoming narrower in width toward the tips thereof.

[0012] This configuration ensures the part of the fins contacting the heat transfer pipes, and further facilitates ensuring a function for conveying condensed water.

[0013] The heat exchanger according to the fourth aspect of the present invention is the heat exchanger according to any of the first to third aspects, wherein the fins are formed between adjacent heat transfer pipes by folding a plate-shaped member in a waveform at intervals of approximately 90 degrees.

[0014] This configuration can prevent insufficient contact between the fins and the flattened heat transfer pipes due to differences in the quantity of brazing material, or so-called erosion in which the brazing material has melted in an undesirable manner, even in the case that so-called corrugated fins are employed as the fins.

<Advantageous Effects of Invention>

[0015] The heat exchanger according to the first aspect of the present invention can bring the fins and the heat transfer pipes into contact without difficulty while ensuring a function for conveying condensed water.

[0016] The heat exchanger according to the second aspect of the present invention can better prevent differences in the quantity of brazing material between the first fin unit and the second fin unit.

[0017] The heat exchanger according to the third aspect of the present invention ensures the part of the fins contacting the heat transfer pipes, and further facilitates ensuring a function for conveying condensed water.

[0018] The heat exchanger according to the fourth aspect of the present invention can prevent insufficient contact between the fins and the flattened heat transfer pipes due to differences in the quantity of brazing material, or so-called erosion in which the brazing material has melted in an undesirable manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is an external view of a heat exchanger according to an embodiment.

FIG. 2 is an expanded view of the area indicated by A in FIG. 1.

FIG. 3 is a schematic perspective view of the heat exchanger according to the present embodiment.

FIG. 4 is a cross section taken at the plane indicated by IV-IV in FIG. 2, and is a side elevation view of the heat exchanger of FIG. 3 viewed from the right.

FIG. 5 is a diagram illustrating fins formed from a single plate-shaped member.

FIG. 6 is an exterior view of a first fin unit according to the present embodiment.

FIG. 7 is an exterior view of a second fin unit according to the present embodiment.

FIG. 8 is an exterior view of fins formed by folding the plate-shaped member of FIG. 5 in a waveform.

FIG. 9 is a diagram of mutually contacting fins and flattened heat transfer pipes as viewed from the air flow direction.

FIG. 10 is an exterior view of a certain conventional first fin unit.

FIG. 11 is an exterior view of a certain conventional second fin unit.

FIG. 12 is a cross-sectional view of fins taken at the plane indicated by XII-XII in FIG. 4.

DESCRIPTION OF EMBODIMENTS

[0020] The heat exchanger according to the present invention will be described in detail hereinafter with reference to the accompanying drawings. The following embodiments are specific examples of the present invention, and are not to be taken as limiting the technical scope of the present invention.

(1) Overview

[0021] FIG. 1 is an exterior view of a heat exchanger 10 according to an embodiment of the present invention. The heat exchanger 10 according to the present embodiment is disposed inside the outdoor unit of an air conditioning system, and can function as a coolant evaporator or a coolant radiator.

[0022] Although not shown in the drawings, the present embodiment takes the example of a separated air conditioning system having a configuration in which an outdoor unit installed outdoors is separate from an indoor unit installed indoors. Besides a cooling operation and a heating operation, examples of operational types of an air conditioning system include a defrost operation for removing frost adhering to the heat exchanger 10 in the outdoor equipment.

[0023] The heat exchanger 10 according to the present embodiment is an air-cooled type and ventilating type heat exchanger. Therefore, the air conditioning system is provided with a blower (not shown) for supplying an air flow to the heat exchanger 10. Hereafter, the air flow direction is indicated as "F" in the drawings.

[0024] The blower may be arranged downstream or upstream from the heat exchanger 10 in the air flow direction F created by the blower. The air flow direction F of the air flow formed by the blower can be freely changed by using another member forming a blower flow channel, or the like. The heat exchanger is arranged such that the air, after being freely changed in direction, passes through nearly horizontally when passed through the heat exchanger 10.

[0025] In the case that the heat exchanger 10 is in a state supplied with air from the blower while functioning as a coolant evaporator, the heat exchanger 10 uses the air supplied by the blower to exchange heat. During the heat exchange between the coolant and the air, coolant flowing inside the flattened heat transfer pipes 41, 42, 43, ... as described later is evaporated by the heat of the air supplied by the blower. The air passing through the heat exchanger 10, however, is cooled by the heat of the coolant flowing inside the flattened heat transfer pipes 41, 42, 43, ..., lowering the temperature of the air. During this process, the surface temperature of the heat exchanger 10 reaches a lower state than the temperature of the supplied air. As a result, during cooling by supplied air, moisture in the air may become cooled and adhere to the surface of the heat exchanger 10 as condensed water.

[0026] For this reason, the heat exchanger 10 according to the present embodiment has a structure for conveying condensed water downward.

(2) Configuration of heat exchanger

[0027] Next, the structure of the heat exchanger 10 according to the present embodiment will be described in detail. As shown in FIG. 1, the heat exchanger 10 is mainly provided with a distribution header 20, a merging header 30, a flattened heat transfer pipe group 40, and a fin group 50.

[0028] In the following description, expressions will be used as appropriate to indicate directions such as "upper," "lower," "vertical," or "horizontal," where these expressions indicate the directions in the case that the heat exchanger 10 has been installed as shown in FIG. 1. As shown in FIG. 1, the side from which the heat exchanger 10 is viewed is called the "front," and "top" and "bottom" are ascertained with reference to the front.

(2-1) Distribution header and merging header

[0029] The distribution header 20 and the merging header 30 are arranged vertically in the longitudinal direction as shown in FIG. 1. A flattened heat transfer pipe group 40 is connected to the distribution header 20 and the merging header 30. Specifically, the distribution header 20 and the merging header 30 extend parallel, separated from each other by a predetermined distance, and the flattened heat transfer pipes 41, 42, 43, ... in the flattened heat transfer pipe group 40 are connected to the headers so as to be arranged along the longitudinal direction of the two headers.

[0030] Coolant in a liquid state or a gas-liquid two-phase state is supplied to the distribution header 20 from the direction R1 in FIG. 1. The coolant supplied to the distribution header 20 is divided between a plurality of flow passages of the flattened heat transfer pipes 41, 42, 43, ..., and flows to the merging header 30.

[0031] The merging header 30, which is disposed in a similar position to the distribution header 20 with respect to the component of the air flow direction F, merges the coolant flowing from the plurality of flow passages of the plurality of flattened heat transfer pipes 41, 42, 43, ..., and discharges the coolant in the direction R2 in FIG. 1.

(2-2) Flattened heat transfer pipe group

[0032] As shown in FIGS. 3, 4, and 9, the flattened heat transfer pipe group 40 comprises the plurality of flattened heat transfer pipes (corresponding to heat transfer pipes) 41, 42, 43,

[0033] The flattened heat transfer pipes 41, 42, 43, ... are formed of aluminum or an aluminum alloy, and are fitted onto the fin group 50 so as to intersect (specifically, nearly orthogonally) the air flow direction F produced by ventilation. More specifically, as shown in FIGS. 3 and 4, the flattened heat transfer pipes 41, 42, 43, ... are arranged parallel,

mutually separated by a predetermined distance vertically, and as shown in FIG. 3, have flat surfaces 41a, 41b, 42a, 42b, 43a, 43b... spreading in horizontal planes nearly parallel with respect to the air flow direction F produced horizontally by ventilation. The flat surfaces 41a, 41b, 42a, 42b, 43a, 43b... spread horizontally both vertically above and vertically below. Thus, because the flat surfaces 41a, 41b, 42a, 42b, 43a, 43b... spread horizontally, the flattened heat transfer pipes 41, 42, 43, ... can minimize draft resistance to the air flow flowing horizontally, compared to a case in which the pipes are tilted from horizontal.

[0034] As shown in FIG. 4, the flattened heat transfer pipes 41, 42, 43, ... have a plurality of coolant flow passages P through which coolant flows in a nearly orthogonal direction to the air flow direction F, and are heat transfer pipes known as so-called multi-hole pipes. Because the flattened heat transfer pipes 41, 42, 43, ... are formed in a flattened shape, the plurality of coolant flow passages P are disposed arranged along the air flow direction F in the flattened heat transfer pipes 41, 42, 43, The diameter of the coolant flow passages P is very small, with one flow channel measuring about $250\text{ }\mu\text{m} \times \text{about } 250\text{ }\mu\text{m}$ square, and thus form a so-called micro-channel heat exchanger.

(2-3) Fin groups

[0035] As shown in FIGS. 2-4, at least between adjacent flattened heat transfer pipes 41, 42, 43, ..., the fin group 50 comprises fins 50a and 50b, which have been arranged bonded to at least some of the adjacent flattened heat transfer pipes 41, 42, 43, Specifically, the fin group 50 is disposed between adjacent flattened heat transfer pipes 41, 42, 43, ..., and is separated from another fin group such as fins 50a located between adjacent flattened heat transfer pipes 41 and 42, and fins 50b located between adjacent flattened heat transfer pipes 42 and 43.

[0036] The fins 50a and 50b are so-called corrugated fins formed by folding a plate-shaped member in a waveform at intervals of approximately 90 degrees when the heat exchanger 10 in FIG. 1 is viewed from the front. Specifically, as shown in FIG. 5, the fins 50a and 50b are formed in a waveform by cutting a single plate-shaped member made of aluminum or an aluminum alloy along the solid lines Re1 indicated by thick lines, then cutting the member along the solid lines Re2, and alternately forming mountain folds along the dotted lines Dt1 and valley folds along the single-dot broken lines Dt2. When forming these mountain and valley folds in the plate-shaped member, the plate-shaped member is folded at intervals of approximately 90 degrees.

[0037] As shown in FIGS. 3 and 4, the fins 50a formed in this way are arranged so as to lie between the flattened heat transfer pipes 41 and 42, with the folded part 53 folded in mountains contacting the flat surface 41b, i.e., the bottom of the flattened heat transfer pipe 41, and the folded part 54 folded in valleys contacting the flat surface 42a, i.e., the top of the flattened heat transfer pipe 42. Similarly, the fins 50b are arranged so as to lie between the flattened heat transfer pipe 42 and 43, with the folded part 53 folded in mountains contacting the flat surface 42b, i.e., the bottom of the flattened heat transfer pipe 42, and the folded part 54 folded in valleys contacting the flat surface 43a, i.e., the top of the flattened heat transfer pipe 43. The folded parts 53 and 54 are adhered by brazing where the flattened heat transfer pipes 41, 42, 43, ... contact the fins 50a and 50b as described earlier.

[0038] As a result, the heat of the coolant flowing inside the flattened heat transfer pipes 41, 42, 43, ... conducts heat to the surfaces of the fins 50a and 50b as well as the surfaces of the flattened heat transfer pipes 41, 42, 43, This increases the heat transfer surface area of the heat exchanger 10 and improves heat exchange efficiency, allowing the heat exchanger 10 itself to be made more compact.

[0039] The heat exchanger 10 according to the present embodiment is a so-called stacked heat exchanger, in which the flattened heat transfer pipes 41, 42, 43, ... and the fins 50a and 50b are alternately stacked vertically. Consequently, the gap between the flattened heat transfer pipes 41, 42, 43, ... can be easily ensured by the fins 50a and 50b in between, and the assembly operation of the heat exchanger 10 can be improved.

[0040] The plate thickness of the fins 50a and 50b according to the present embodiment is, for example, about 0.1 mm.

(2-4) Detailed configuration of fins

[0041] As shown in FIGS. 5-9, the fins 50a and 50b have a first fin unit 51, a second fin unit 52, which has a shape different from the first unit 51, the folded parts 53 and 54 already described, and a plurality of louvers 55.

(2-4-1) First fin unit and second fin unit

[0042] The first fin unit 51 and the second fin unit 52 are mutually adjacent, and comprise the portions of the plate in the fins 50a and 50b folded in a waveform which do not contact the flattened heat transfer pipes 41, 42, 43, Specifically, as shown in FIGS. 3 and 4, the first fin unit 51 and the second fin unit 52 are arranged so that the plate thickness direction intersects the air flow direction F, and refer to the portion of the fins 50a and 50b spreading evenly from the mountain portions to the valley portions of the fin shape. The first fin unit 51 and the second fin unit 52 are arranged alternately as shown in FIGS. 5, 8, and 9, and have a bilateral symmetric shape with respect to a center line Ln1 bisecting the width

along the air flow direction F, as shown in FIGS. 6 and 7. Such a first fin unit 51 and second fin unit 52 have heat conducting parts 51a and 52a, upper water conveying parts 51b and 52b, and lower water conveying parts 51c and 52c, respectively.

[0043] The heat conducting parts 51a and 52a are the main parts for exchanging heat with the air, and are arranged so that their planes nearly extend in the air flow direction F. Such a configuration of the heat conducting parts 51a and 52a can minimize draft resistance caused by the disposition of the fins 50a and 50b.

[0044] The upper water conveying parts 51b and 52b project upward from the heat conducting parts 51a and 52a, and play a role of guiding condensed water to below the heat exchanger 10. Specifically, the upper water conveying parts 51b and 52b are made to project on the upper side vertically when the fins 50a and 50b have been folded in a waveform, and have a substantially triangular shape becoming narrower in width toward the tip.

[0045] The lower water conveying parts 51c and 52c project downward from the heat conducting parts 51a and 52a, and like the upper water conveying parts 51b and 52b, play a role of guiding condensed water to below the heat exchanger 10. Specifically, the lower water conveying parts 51c and 52c are made to project in the opposite direction to the upper water conveying parts 51b and 52b - that is, on the lower side vertically - when the fins 50a and 50b have been folded in a waveform, and have a substantially triangular shape becoming narrower in width toward the tip.

[0046] In particular, in the present embodiment, the amount of projection d1a of the upper water conveying part 51b of the first fin unit 51 differs from the amount of projection d2a of the upper water conveying part 52b of the second fin unit 52, but equals the amount of projection d2b of the lower water conveying part 52c of the second fin unit 52. The amount of projection d1b of the lower water conveying part 51c of the first fin unit 51 differs from the amount of projection d2b of the lower water conveying part 52c of the second fin unit 52, but equals the amount of projection d2a of the upper water conveying part 52b of the second fin unit 52. For example, the amount that the upper water conveying part 51b of the first fin unit 51 projects from the flat upper edge of the heat conducting part 51a (that is, the amount of projection d1a), and the amount that the lower water conveying part 52c of the second fin unit 52 projects from the flat lower edge of the heat conducting part 52a (that is, the amount of projection d2b) may both be about 2 mm. The amount that the lower water conveying part 51c of the first fin unit 51 projects from the flat lower edge of the heat conducting part 51a (that is, the amount of projection d1b), and the amount that the upper water conveying part 52b of the second fin unit 52 projects from the flat upper edge of the heat conducting part 52a (that is, the amount of projection d2a) may both be about 0.5 mm. In particular, the amounts of projection d1a and d2b of the upper water conveying part 51b of the first fin unit 51 and the lower water conveying part 52c of the second fin unit 52 are greater than the thickness Pd2, which is the vertical width of the flattened heat transfer pipes 41, 42, 43, ..., while the amounts of projection d1b and d2a of the lower water conveying part 51c of the first fin unit 51 and the upper water conveying part 52b of the second fin unit 52 are less than the thickness Pd2 of the flattened heat transfer pipes 41, 42, 43, ... (see FIGS. 3, 4, and 9).

[0047] In the present embodiment, the amounts of projection d1a and d1b of the water conveying parts 51b and 51c in the first fin unit 51 are determined so that the average of the amounts of projection d1a and d1b of these water conveying parts 51b and 51c is greater than the thickness Pd2 of the flattened heat transfer pipes 41, 42, 43, Similarly, the amounts of projection d2a and d2b of the water conveying parts 52b and 52c in the second fin unit 52 are determined so that the average of the amounts of projection d2a and d2b of these water conveying parts 52b and 52c is greater than the thickness Pd2 of the flattened heat transfer pipes 41, 42, 43, This is done to maintain the so-called drainage performance of surely guiding condensed water to below the fins 50a and 50b.

[0048] The angle of the tip portions of the lower water conveying part 51c and the upper water conveying part 52b, which have a lesser amount of projection, may be, for example, about 10-40 degrees. The angle of the tip portions of the upper water conveying part 51b and the lower water conveying part 52c, which have a greater amount of projection, may be, for example, about 30-60 degrees.

[0049] Within the first fin unit 51 and the second fin unit 52 configured in this way, the upper water conveying part 51b of the first fin unit 51 projects upward more than the upper water conveying part 52b of the second fin unit 52 when the second fin unit 52 has been arrayed to the side of the first fin unit 51 (see FIG. 8). By contrast, the lower water conveying part 52c of the second fin unit 52 projects downward more than the lower water conveying part 51c of the first fin unit 51. As shown in FIGS. 3 and 9, when the flattened heat transfer pipes 41, 42, and 43 are fitted onto the fins 50a and 50b, the lower water conveying part 51c of the first fin unit 51 and the upper water conveying part 52b of the second fin unit 52 are not greater than the thickness Pd2 of the flattened heat transfer pipes 41, 42, 43, ..., while the upper water conveying part 51b of the first fin unit 51 and the lower water conveying part 52c of the second fin unit 52 are greater than the thickness Pd2 of the flattened heat transfer pipes 41, 42, 43,

[0050] Because the first fin unit 51 and the second fin unit 52 have bilateral symmetry with respect to the center line In1 as already described, the first fin unit 51 and the second fin unit 52 according to the present embodiment may be said to be in a relationship of point symmetry to each other; that is, the shape of the first fin unit 51 is upside down in relation to the second fin unit 52. Therefore, the length of the front edge of the first fin unit 51 is the same as the length of the front edge of the second fin unit 52 in the present embodiment.

[0051] The reason that the first fin unit 51 and the second fin unit 52 are shaped as shown in FIGS. 6 and 7 will be

described simply. FIGS. 10 and 11 show an example of a conventional first fin unit 151 and second fin unit 152.

[0052] First, as shown in FIGS. 10 and 11, the amount of projection of the upper water conveying part 151b and the amount of projection of the lower water conveying part 151c are the same in the first fin unit 151, and the amount of projection of the upper water conveying part 152b and the amount of projection of the lower water conveying part 152c are the same in the second fin unit 152. In this case, the first fin unit 151 and the second fin unit 152 are not in a relationship of point symmetry to each other, and have fin portions of completely different shapes. Furthermore, the first fin unit 151 and the second fin unit 152 have upper and lower symmetry, and bilateral symmetry.

[0053] Like the fins 50a and 50b according to the present embodiment, the fins comprising the first fin unit 151 and the second fin unit 152 are formed by folding a single plate-shaped member. Once folded, the amount of projection of the water conveying parts 151b and 151c in the first fin unit 151 is greater than the spacing of fins between the first fin unit 151 and the second fin unit 152 when the fins have been folded in a waveform, and when the water conveying parts 151b and 151c have been formed, the amount of projection of the water conveying parts 152b and 152c in the second fin unit 152 is less than the amount of projection of the water conveying parts 151b and 152c of the first fin unit 151. That is, the length of the front edge of the second fin unit 152 is much shorter than the length of the front edge of the first fin unit 151.

[0054] In this case, although the first fin unit 151 and the second fin unit 152 are mutually adjacent in the plate thickness direction when the fins have been folded in a waveform, the surface area of the first fin unit 151 is greater than the surface area of the second fin unit 152. As a result, the quantity of brazing material of the first fin unit 151 is greater than the quantity of brazing material of the second fin unit 152. Since the quantity of brazing material required to join the fins to the flattened heat transfer pipes is the same for the first fin unit 151 and the second fin unit 152, such a difference in the quantity of brazing material causes the phenomenon that there is too much brazing material on the first fin unit 151 side and too little brazing material on the second fin unit 152 side. Thereupon, on the first fin unit 151 side having too much quantity of brazing material, the brazing material melts on portions where it should not melt, such as portions where strength is required, and causes erosion (brazing erosion). There is a risk that this melted brazing material will enter openings 155a in the fins, for example, or have the effect of collapsing louvers 155 cut out from the fins, causing the louvers 155 to clog the holes 155a.

[0055] As shown in FIGS. 6 and 7, however, the first fin unit 51 and the second fin unit 52 of the present embodiment do not have upper and lower symmetry comprising bilateral symmetry, and the first fin unit 51 and the second fin unit 52 have shapes which are in a relationship of point symmetry to each other. Consequently, the surface area of the first fin unit 51 equals the surface area of the second fin unit 52. Therefore, the quantities of brazing material for the first fin unit 51 and the second fin unit 52 are uniform, which can prevent problems such as erosion.

[0056] When fitting the flattened heat transfer pipes 41, 42, 43, ... onto the fins 50a and 50b, the fins 50a and the fins 50b are arranged alternately with respect to the flattened pipe 42 located between the fins 50a and 50b, as shown in FIGS. 3 and 9. Consequently, condensed water runs down the flattened heat transfer pipe 42 and the lower water conveying part 51c of the first fin unit 51 in the fins 50a, spreads from the upper water conveying part 52b of the second fin unit 52 in the fins 50b to the heat transfer surface 52a, and ultimately spreads to the flattened heat transfer pipe 43 and the lower water conveying part 51c of the first fin unit 51 in the fins 50b. This can maintain good drainage as well as achieving uniformity of brazing material.

[0057] To facilitate comparison with the first fin unit 51 and the second fin unit 52 according to the present embodiment in FIGS. 10 and 11, the amount of projection of the water conveying parts 151b and 151c in the first fin unit 151 is the same as the amount of projection of the upper water conveying part 51b and the lower water conveying part 52c according to the present embodiment shown in FIGS. 6 and 7. The amount of projection of the water conveying parts 152b and 152c in the second fin unit 152 is also the same as the amount of projection of the lower water conveying part 51c and the upper water conveying part 52b according to the present embodiment shown in FIGS. 6 and 7.

(2-4-2) Folded parts

[0058] The folded parts 53 and 54 are parts for connecting to the mutually adjacent first fin unit 51 and second fin unit 52 when the fins 50a and 50b have been folded in a waveform. The widths d3a and d4a of the folded parts 53 and 54 in direction X intersecting the air flow direction F (see FIGS. 5 and 8) correspond to the distance between the first fin unit 51 and the second fin unit 52. The widths d3b and d4b of the folded parts 53 and 54 along the air flow direction F, on the other hand, are nearly equal to the width Pd1 along the air flow direction F of the flattened heat transfer pipes 41, 42, 43, ... contacting the parts 53 and 54.

[0059] The width d3a of the folded part 53 equals the width d4a of the folded part 54, and may be, for example, about 1.5 mm. The width d3b of the folded part 53 equals the width d4b of the folded part 54, and may be, for example, about 18 mm.

(2-4-3) Louvers

[0060] As shown in FIGS. 3 and 12, a plurality of louvers 55 project in the plate thickness direction from the heat conducting parts 51a and 52a of the first fin unit 51 and the second fin unit 52, and are arranged along the air flow direction F. As shown in FIG. 4, the louvers 55 have a long and narrow rectangular shape in the direction in which the adjacent flattened heat transfer pipes 41, 42, 43, ... are arranged - that is, vertically - and are located at a predetermined spacing, as shown in FIGS. 12 etc.

[0061] Such louvers 55 are formed by cutting out portions of the heat conducting parts 51a and 52a of the first fin unit 51 and the second fin unit 52. Specifically, the louvers 55 are cut out and formed so as to incline upstream in the air flow direction F as shown in FIG. 12. The louvers 55 are also cut out and formed so as to form openings 55a in the heat conducting parts 51a and 52a (see FIGS. 6 and 7).

[0062] In the example taken in the present embodiment, the angle of inclination θ_1 of the louvers 55 to the heat conducting parts 51a and 52a, and the projecting height h_1 of the louvers 55 from the heat conducting parts 51a and 52a are constant. The angle of inclination θ_1 and the projecting height h_1 , however, may differ for each louver 55.

(3) Flow of coolant

[0063] The mode whereby coolant flows to the heat exchanger 10 configured in this way and is discharged from the heat exchanger 10 will be described simply. This mode will be described for the case that an air conditioning system performs a heating operation; that is, the heat exchanger 10 functions as an evaporator.

[0064] First, a coolant in a liquid state or a gas-liquid two-phase state flows into the distribution header 20. The coolant is distributed nearly equally between the coolant flow passages P of the flattened heat transfer pipes 41, 42, 43, ... in the flattened heat transfer pipe group 40.

[0065] While the coolant is flowing in the coolant flow passages P of the flattened heat transfer pipes 41, 42, 43, ..., air supplied by a blower (not shown) warms the fin group 50 and the flattened heat transfer pipe group 40, and also warms the coolant flowing inside the coolant flow passages P. Heating the coolant in this way gradually evaporates the coolant during the process of passing through the coolant flow passages P, and the coolant assumes a gas state. Also during this process, moisture in the air cooled by the heat of the coolant becomes condensed water and adheres to the surface of the heat exchanger 10. The condensed water flows through the upper water conveying parts 51b and 52b and the lower water conveying parts 51c and 52c of the first fin unit 51 and the second fin unit 52, and ultimately flows below the heat exchanger 10.

[0066] Subsequently, the coolant in gas phase passes through the coolant flow passages P of the flattened heat transfer pipe 42, 43, etc., then is merged by the merging header 30 to form a single coolant flow, which is discharged from the heat exchanger 10.

(4) Features

(4-1)

[0067] In this heat exchanger 10, the amounts of projection d1a and d2a of the upper water conveying parts 51b and 52b differ between a mutually adjacent first fin unit 51 and second fin unit 52, and the amounts of projection d1b and d2b of the lower water conveying parts 51c and 52c also differ. The amount of projection d1a of the upper water conveying part 51b of the first fin unit 51 equals the amount of projection d2b of the lower water conveying part 52c of the second fin unit 52, and the amount of projection d1b of the lower water conveying part 51c of the first fin unit 51 equals the amount of projection d2a of the upper water conveying part 52b of the second fin unit 52. Therefore, the total area of the upper water conveying part 51b and the lower water conveying part 51c in the first fin unit 51 is equal to the total area of the upper water conveying part 52b and the lower water conveying part 52c in the second fin unit 52. This can prevent insufficient contact between the fins 50a and 50b and the flattened heat transfer pipes 41, 42, 43, ... due to differences in the quantity of brazing material, or so-called erosion in which the brazing material has melted in an undesirable manner. Therefore, the fins 50a and 50b and the flattened heat transfer pipes 41, 42, 43, ... can be brought into contact without difficulty while ensuring a function for conveying condensed water.

(4-2)

[0068] The first fin unit 51 and the second fin unit 52 in this heat exchanger 10 have a bilateral symmetric shape with respect to the center line ln_1 bisecting the width along the air flow direction F. That is, the first fin unit 51 and the second fin unit 52 may be said to be in a relationship of point symmetry to each other. As a result, the total area of the upper water conveying part 51b and the lower water conveying part 51c in the first fin unit 51 nearly matches the total area of

the upper water conveying part 52b and the lower water conveying part 52c in the second fin unit 52. This can better prevent a difference in the quantity of brazing material between the first fin unit 51 and the second fin unit 52.

(4-3)

[0069] The upper water conveying parts 51b and 52b and the lower water conveying parts 51c and 52c in this heat exchanger 10 have a triangular shape becoming narrower in width toward the tips thereof. This configuration ensures the portion of the fins 50a and 50b contacting the flattened heat transfer pipes 41, 42, 43, ..., and further facilitates ensuring a function for conveying condensed water.

[0070] In particular, in the present embodiment, the upper water conveying parts 51b and 52b and the lower water conveying parts 51c and 52c have a triangular shape, as shown in FIGS. 5-7 etc. This shape can sufficiently ensure the length of the water conveying parts 51b, 52b, 51c, and 52c. Therefore, condensed water can be surely conveyed below the fins 50a and 50b without pooling near the fins 50a and 50b.

(4-4)

[0071] As shown in FIG. 9, the fins 50a and 50b in this heat exchanger 10 are formed between adjacent flattened heat transfer pipes 41, 42, 43, ... by folding a plate-shaped member in a waveform at intervals of approximately 90 degrees. That is, the fins 50a and 50b according to the present embodiment are so-called corrugated fins. This configuration can prevent insufficient contact between the fins 50a and 50b and the flattened heat transfer pipes 41, 42, 43, ... due to differences in the quantity of brazing material, or so-called erosion in which the brazing material has melted in an undesirable manner. Therefore, the fins 50a and 50b and the flattened heat transfer pipes 41, 42, 43, ... can be brought into contact without difficulty while ensuring a function for conveying condensed water.

(5) Modification Examples

(5-1) Modification Example A

[0072] In the present embodiment, a case is described in which the upper water conveying parts 51b and 52b and the lower water conveying parts 51c and 52c have a substantially triangular shape as shown in FIGS. 6 and 7. The shape of the upper water conveying parts 51b and 52b and the lower water conveying parts 51c and 52c, however, is not limited to this shape. Examples of other shapes of the upper water conveying parts 51b and 52b and the lower water conveying parts 51c and 52c are a so-called tapered shape or the like which is not triangular.

(5-2) Modification Example B

[0073] In the present embodiment, a case is described in which the folding angle of the fins 50a and 50b is about 90 degrees. The folding angle of the fins 50a and 50b, however, need not be about 90 degrees. For example, the first fin unit 51 and the second fin unit 52 may extend in directions inclined at predetermined angles with respect to vertical, and facing different directions.

(5-3) Modification Example C

[0074] In the present embodiment, a case is described in which the fins 50a and 50b are corrugated fins formed by folding a single plate-shaped member. The type of the fins 50a and 50b, however, is not limited to corrugated fins. For example, the present invention may be suitably applied to a configuration having no folded parts 53 and 54 and in which the first fin unit and the second fin unit are made of separate plate-shaped members.

REFERENCE SIGNS LIST

[0075]

10	Heat exchanger
20	Distribution header
30	Merging header
40	Flattened heat transfer pipe group
41, 42, 43	Flattened heat transfer pipe
41a, 41b, 42a, 42b, 43a, 43b	Flat surface

50	Fin group
50a, 50b	Fins
51	First fin unit
52	Second fin unit
5 51 a, 52a	Heat conducting part
51b, 52b	Upper water conveying part
51c, 52c	Lower water conveying part
55	Louver
55a	Opening

CITATION LIST

PATENT LITERATURE

- 15 **[0076]** <Patent Literature 1> Japanese Laid-Open Patent Application 2008-101847

Claims

- 20 1. A heat exchanger (10) comprising:
- 25 fins (50a, 50b) arranged so that the plate thickness direction intersects an air flow direction (F) and having a mutually adjacent plate-shaped first fin unit (51) and second fin unit (52); and a plurality of heat transfer pipes (41, 42, 43, ...) inserted into the fins (50a, 50b) so as to intersect the air flow direction,
- 30 the first fin unit (51) and the second fin unit (52) having heat conducting parts (51a, 52a) for exchanging heat with air, upper water conveying parts (51b, 52b) projecting upward from the heat conducting parts, and lower water conveying parts (51c, 52c) projecting downward from the heat conducting parts;
- the amount of projection of the upper water conveying part (51b) of the first fin unit (51) differing from the amount of projection of the upper water conveying part (52b) of the second fin unit (52), and equalling the amount of projection of the lower water conveying part (52c) of the second fin unit (52); and
- 35 the amount of projection of the lower water conveying part (51c) of the first fin unit (51) differing from the amount of projection of the lower water conveying part (52c) of the second fin unit (52), and equalling the amount of projection of the upper water conveying part (52b) of the second fin unit (52).
2. The heat exchanger (10) according to claim 1, wherein the first fin unit (51) and the second fin unit (52) have bilateral symmetry with respect to a center line (ln1) bisecting the width along the air flow direction (F).
- 40 3. The heat exchanger according to claim 1 or 2, wherein the upper water conveying parts (51b, 52b) and the lower water conveying parts (51c, 52c) have a shape becoming narrower in width toward the tips thereof.
- 45 4. The heat exchanger (10) according to any one of claims 1 to 3, wherein the fins (50a, 50b) are formed between adjacent heat transfer pipes (41, 42, 43, ...) by folding a plate-shaped member in a waveform at intervals of approximately 90 degrees.

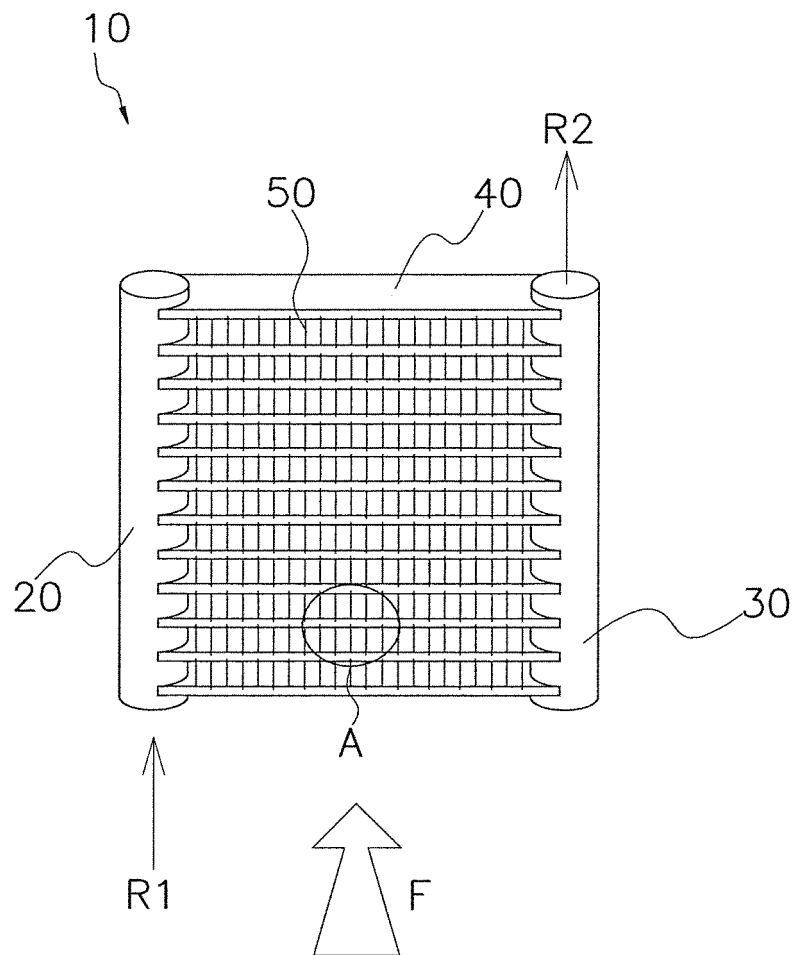


FIG. 1

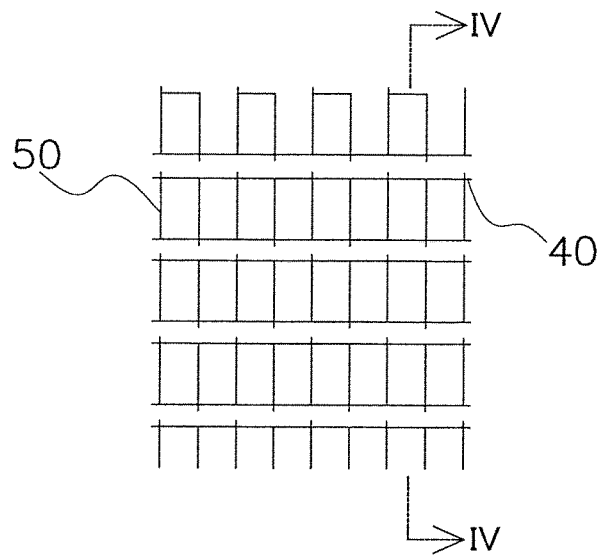


FIG. 2

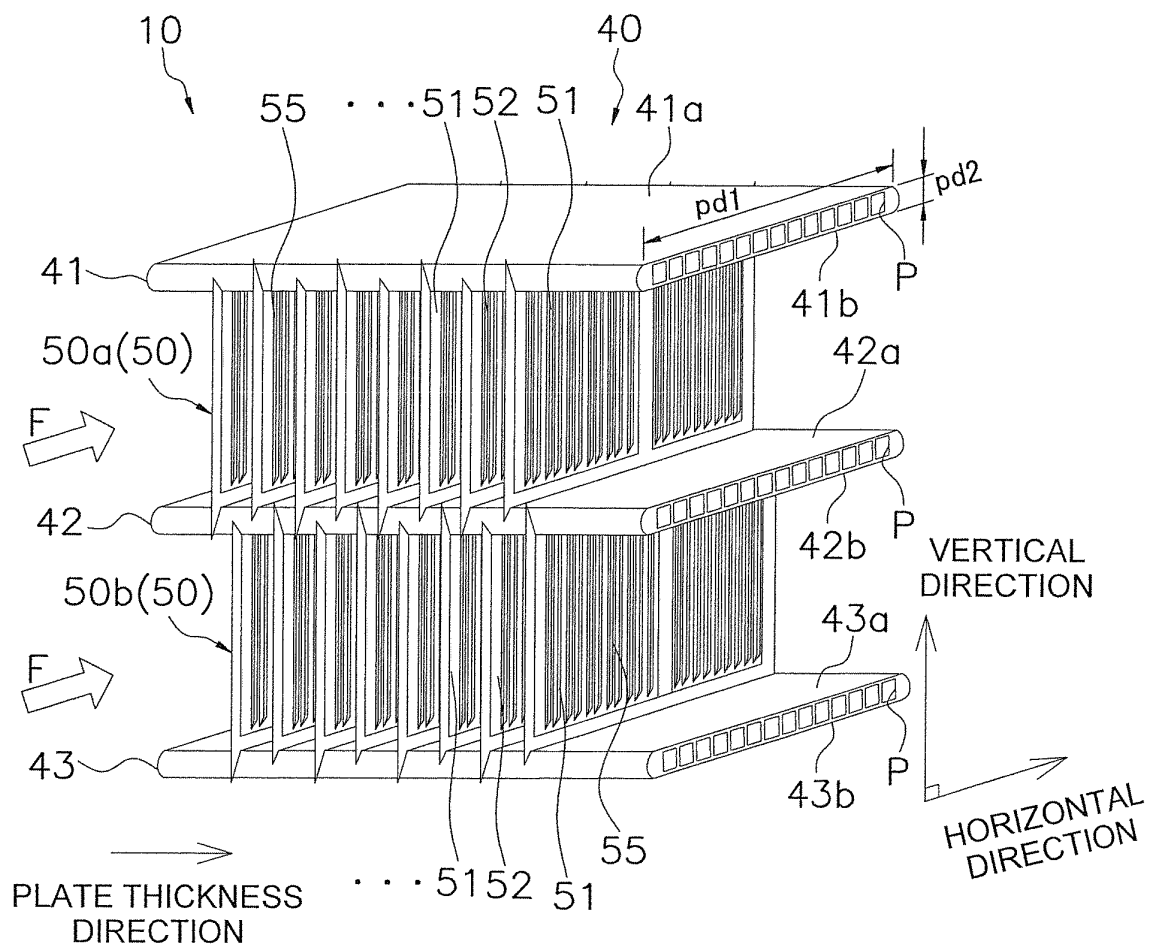


FIG. 3

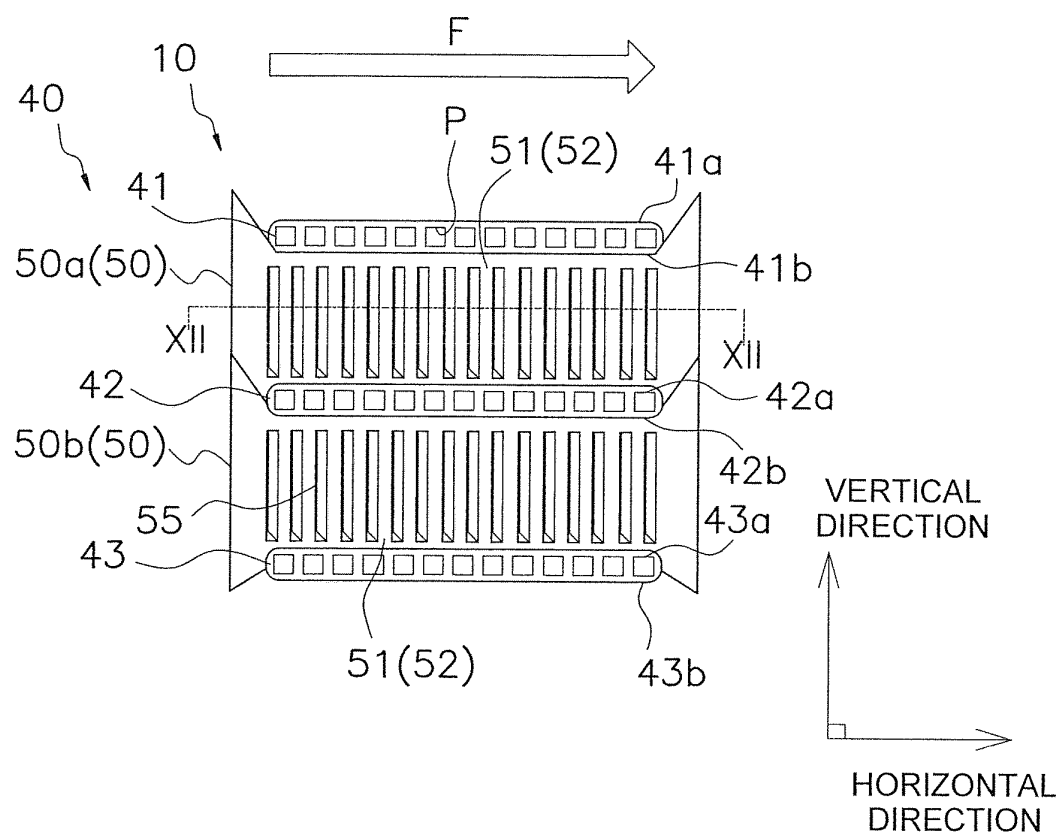


FIG. 4

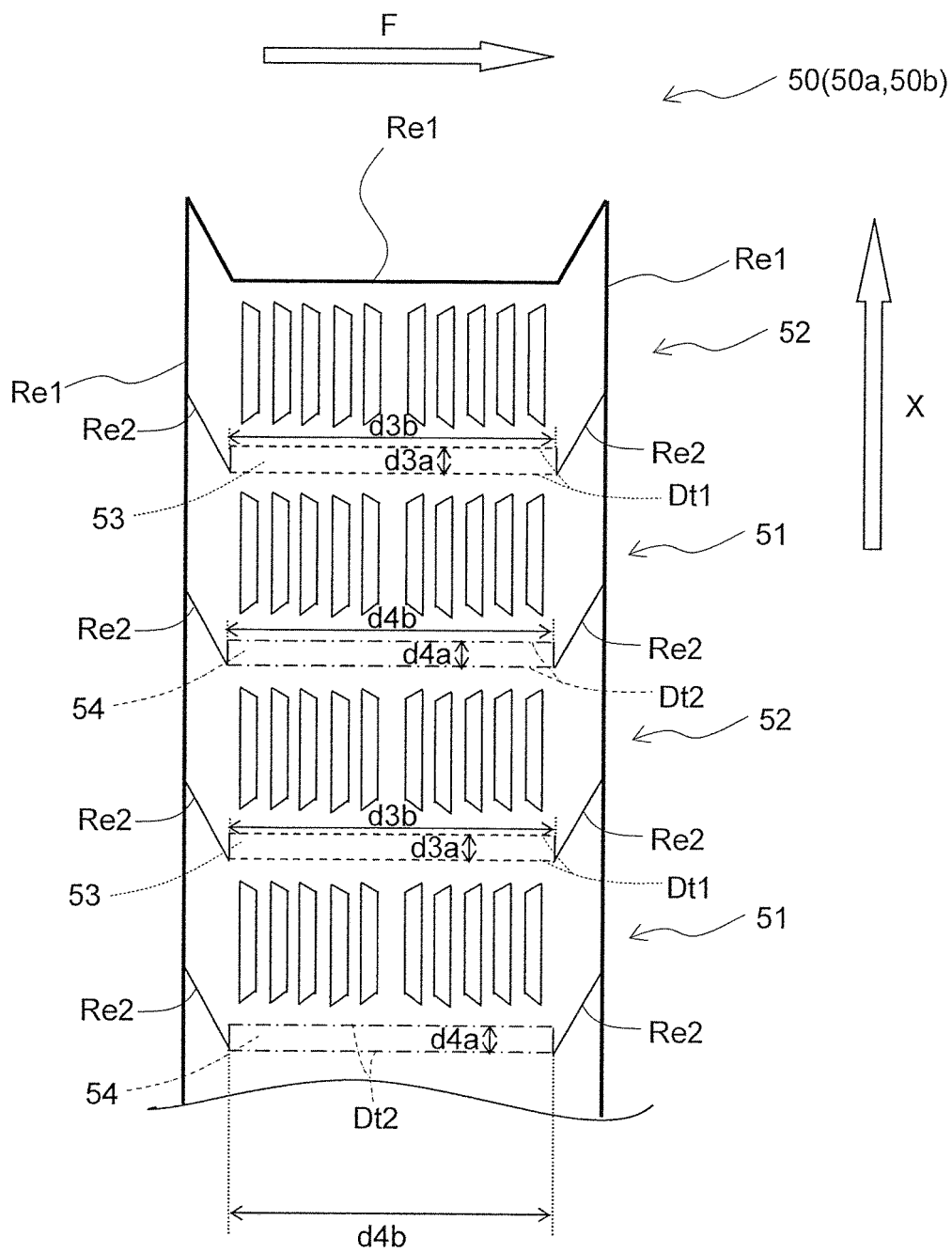


FIG. 5

FIG. 6

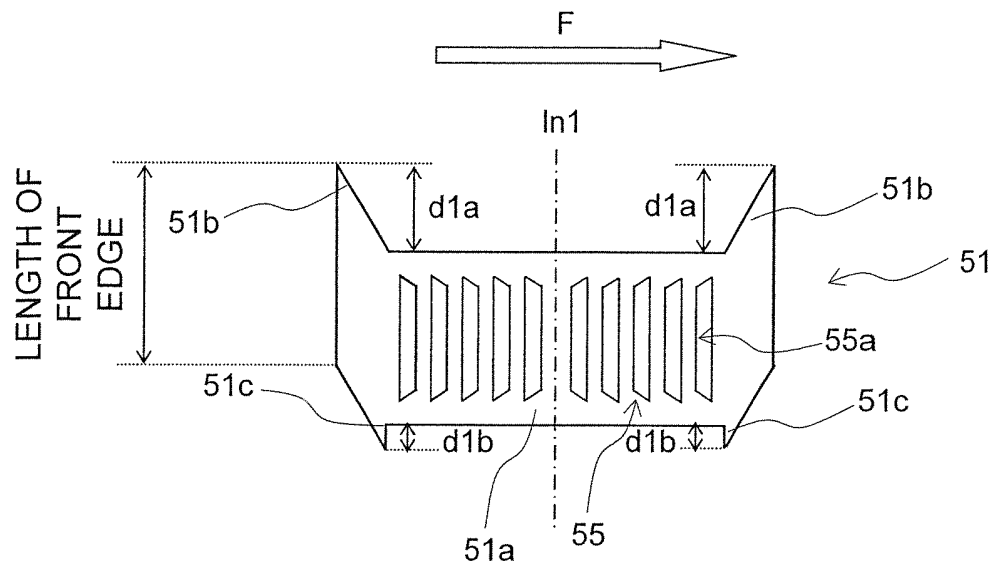
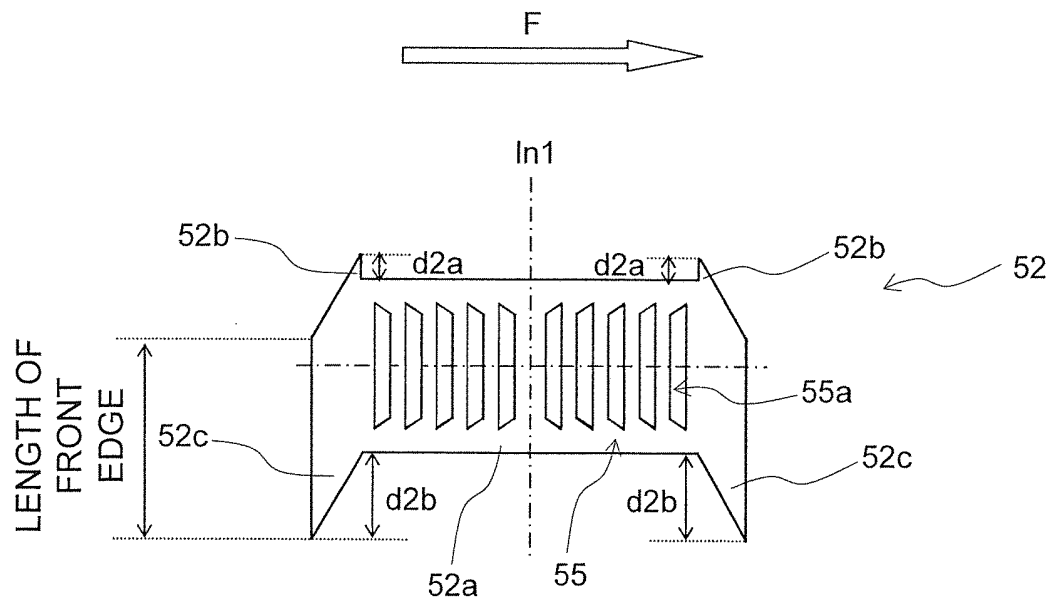


FIG. 7



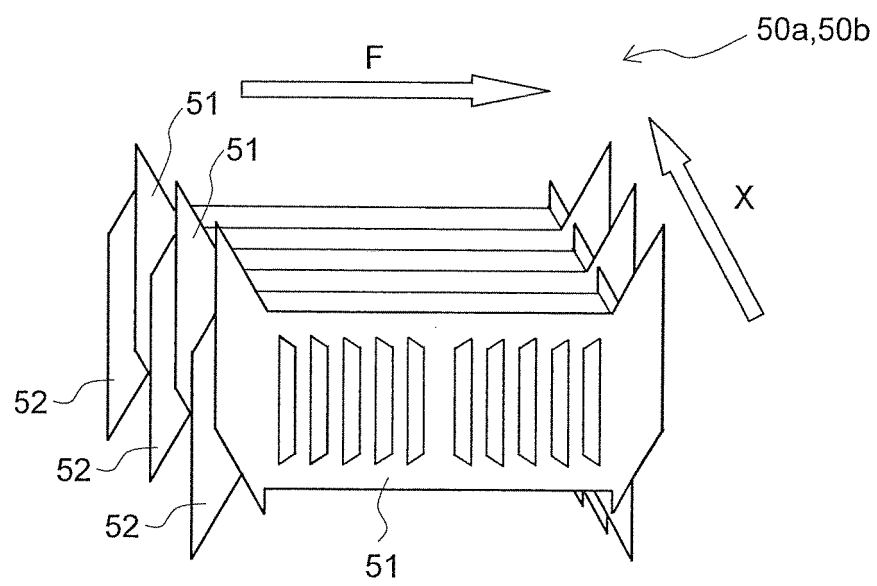


FIG. 8

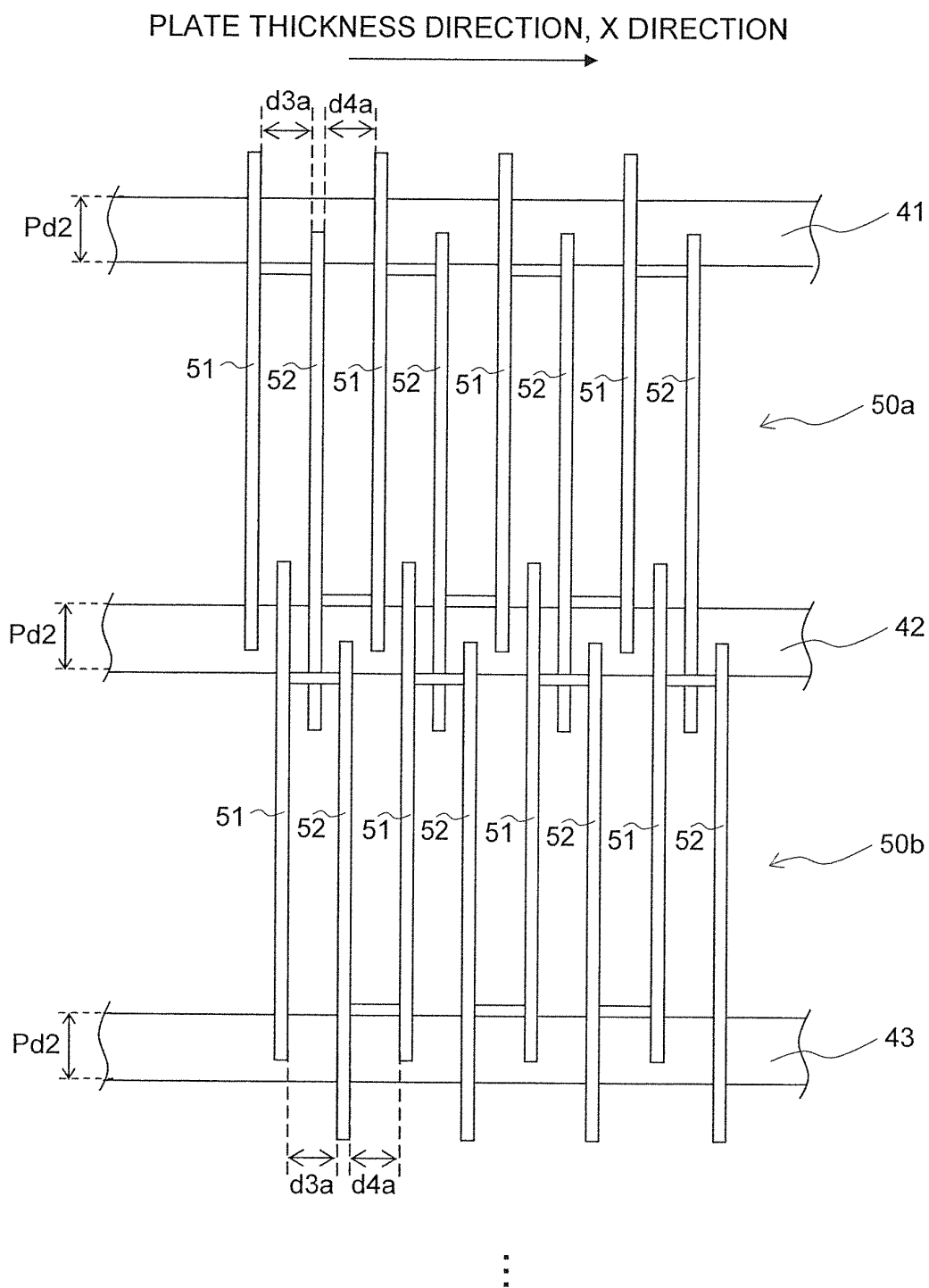


FIG. 9

FIG. 10

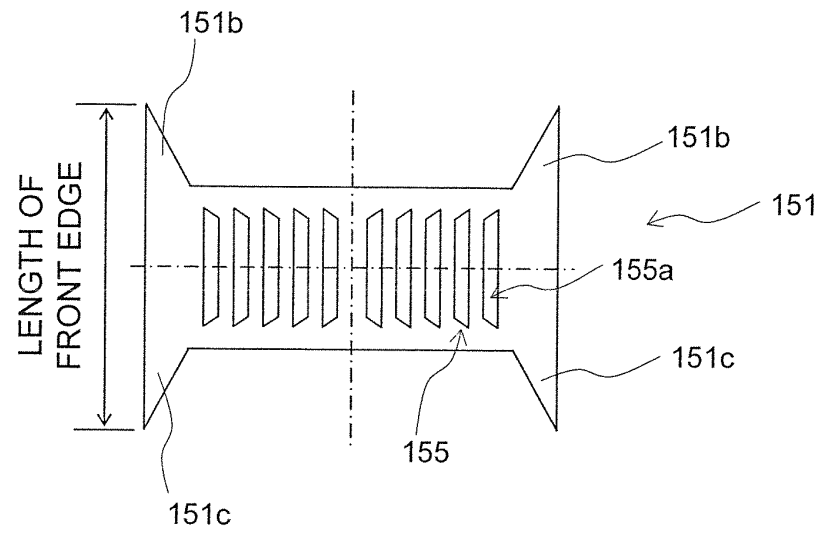
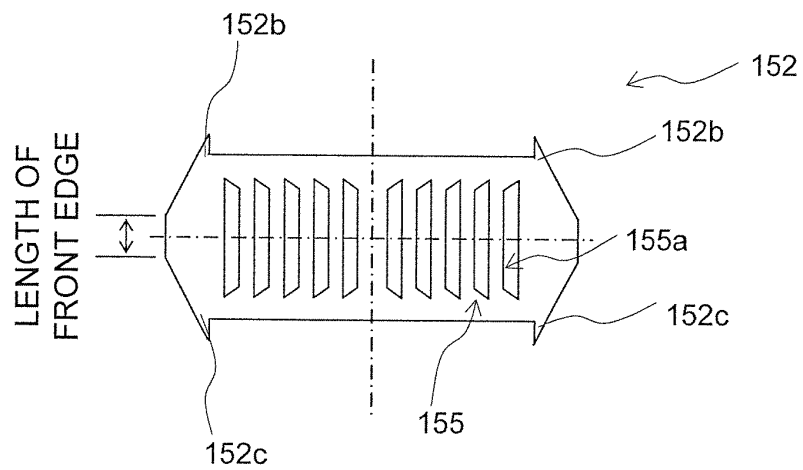


FIG. 11



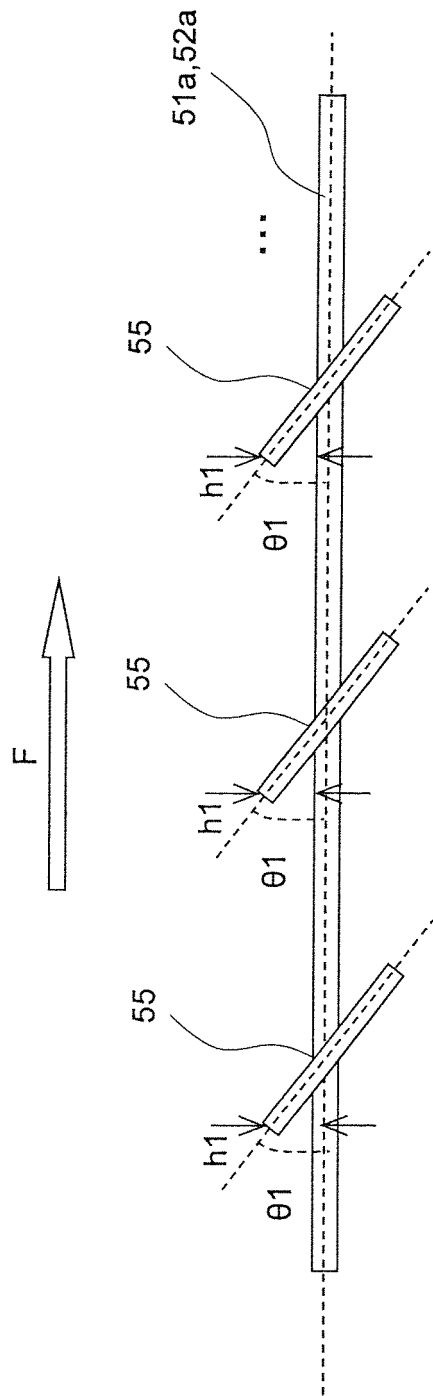


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/082140

A. CLASSIFICATION OF SUBJECT MATTER

F28F1/30(2006.01) i, F28F1/32(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, F28F1/32

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 1996-2013

Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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.
A	JP 2010-2138 A (Daikin Industries, Ltd.), 07 January 2010 (07.01.2010), entire text; all drawings & US 2011/0139428 A1 & EP 2314972 A1 & WO 2009/153985 A1 & AU 2009261466 A & KR 10-2011-0017458 A & CN 102047064 A	1-4
A	JP 9-101092 A (Calsonic Corp.), 15 April 1997 (15.04.1997), entire text; all drawings (particularly, paragraphs [0015] to [0018]; fig. 1) (Family: none)	1-4

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

* Special categories of cited documents:

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Date of the actual completion of the international search

01 March, 2013 (01.03.13)

Date of mailing of the international search report

12 March, 2013 (12.03.13)

Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/082140

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	A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 153223/1989 (Laid-open No. 96582/1991) (Toyo Radiator Co., Ltd.), 02 October 1991 (02.10.1991), entire text; all drawings (Family: none)	1-4
15	A	JP 2010-236745 A (Daikin Industries, Ltd.), 21 October 2010 (21.10.2010), entire text; all drawings (Family: none)	1-4
20	A	JP 5-60482 A (Showa Aluminum Corp.), 09 March 1993 (09.03.1993), entire text; all drawings (Family: none)	1-4
25	A	JP 7-55380 A (Nippondenso Co., Ltd.), 03 March 1995 (03.03.1995), entire text; all drawings (Family: none)	1-4
30	A	JP 2010-14330 A (Daikin Industries, Ltd.), 21 January 2010 (21.01.2010), entire text; all drawings (Family: none)	1-4
35	A	JP 2008-101847 A (Daikin Industries, Ltd.), 01 May 2008 (01.05.2008), entire text; all drawings (Family: none)	1-4
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Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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