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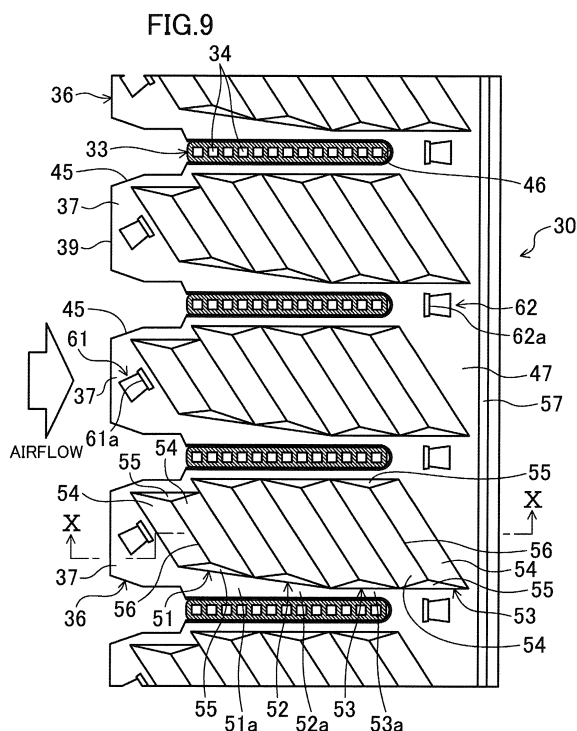
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(54) **HEAT EXCHANGER AND AIR CONDITIONER**

(57) Each of a plurality of heat-transfer portions (37) has a plurality of protrusions (51, 52, 53) which are pro-

truded toward an air passage (38) and extend in a direction intersecting with an airflow direction. The protrusions (51, 52, 53) are arranged in the airflow direction.



Description

TECHNICAL FIELD

[0001] The present invention relates to heat exchangers having a flat tube and a plurality of fins and configured to exchange heat between a fluid flowing in the flat tube and air, and air conditioners having the heat exchangers.

BACKGROUND ART

[0002] Heat exchangers having a flat tube and fins have been known. For example, Patent Document 1 shows a heat exchanger in which a plurality of flat tubes, each extending in a horizontal direction, are arranged one above another with a predetermined space between the flat tubes, and plate-like fins are arranged in a direction along which the flat tubes extend, with a predetermined space between the fins. Further, Patent Document 2 and Patent Document 3 show heat exchangers in which a plurality of flat tubes, each extending in a horizontal direction, are arranged one above another with a predetermined space between the flat tubes, and a corrugated fin is provided between adjacent flat tubes. In these heat exchangers, air flowing in contact with the fins exchanges heat with a fluid flowing in the flat tubes.

[0003] In general, fins of the heat exchanger of this type include louvers which promote heat transfer. The louvers are formed by cutting and bending part of the fins. It is advantageous to make the length of each louver as long as possible so that the heat transfer properties of the fins are increased. Thus, as shown in FIG. 2 of Patent Document 2 and FIG. 4 of Patent Document 3, fins of the conventional heat exchangers include louvers each having a width almost equal to the width of the fin and arranged in a direction in which air passes.

CITATION LIST

PATENT DOCUMENT

[0004]

Patent Document 1: Japanese Patent Publication No. 2003-262485

Patent Document 2: Japanese Patent Publication No. 2010-002138

Patent Document 3: Japanese Patent Publication No. H11-294984

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0005] A refrigerant circuit of an air conditioner is provided with an outdoor heat exchanger in which a refrigerant is heat exchanged with outdoor air. The outdoor heat exchanger functions as an evaporator in a heating

operation of the air conditioner. When the evaporation temperature of the refrigerant in the outdoor heat exchanger is below 0°C, moisture in the air turns into frost (i.e., ice) and adheres to the outdoor heat exchanger.

Therefore, during a heating operation under low outdoor air temperature conditions, defrosting is performed at predetermined time interval, for example, to melt the frost adhering to the outdoor heat exchanger. During defrosting, a high temperature refrigerant is supplied to the outdoor heat exchanger, and the frost adhering to the outdoor heat exchanger is melted by the refrigerant. As a result, the frost on the outdoor heat exchanger melts into drain water, and is discharged from the outdoor heat exchanger.

Heat exchangers having flat tubes arranged one above another can be used as an outdoor heat exchanger of an air conditioner. However, in this heat exchanger, the flat surfaces of the flat tubes face upward, and therefore, drain water can be easily accumulated on the flat tubes. In particular, if a fin includes a plurality of louvers on its surface, the drain water enters through the slits of the cut and bent louvers, and accumulates at the slits. The drain water accumulated around the fins may block heat transfer from the refrigerant to the frost, and it may take a long time to melt the frost completely.

The present invention is thus intended to promote discharge of drain water, and reduce a time necessary for defrosting, in a heat exchanger having flat tubes arranged one above another.

SOLUTION TO THE PROBLEM

The first aspect of the present invention is directed to a heat exchanger, including: a plurality of flat tubes (33) arranged one above another such that flat surfaces thereof face each other and each having therein a passage (34) of a fluid; and a plurality of fins (35, 36) configured to divide a space between adjacent ones of the flat tubes (33) into a plurality of air passages (38) through which air flows, each of the plurality of fins (35, 36) including a plurality of plate-like heat-transfer portions (37) each of which extends from one to the other of the adjacent flat tubes (33) and comprises a side wall of each of the air passages (38), and a downwind side plate (42, 47) connected to a downwind side edge of each of the heat-transfer portions (37) and serving as a discharge path. In the heat exchanger, each of the plurality of heat-transfer portions (37) has a plurality of protrusions (51, 52, 53) which are protruded toward the air passage (38) and extend in a direction intersecting with an airflow direction, and the plurality of protrusions (51, 52, 53) are arranged in the airflow direction.

According to the first aspect of the present invention, the heat exchanger (30) includes a plurality of flat tubes (33) and a plurality of fins (35, 36). The heat-transfer portions (37) of the fins (35, 36) are disposed in the space between vertically adjacent ones of the flat tubes (33). Thus, the air passages (38) are formed in the

space between the flat tubes (33). The heat exchanger (30) exchanges heat between the air flowing in the air passages (38) and a fluid flowing in the passage (34) inside each flat tube (33).

[0010] The heat-transfer portion (37) of the present invention has a plurality of protrusions (51, 52, 53) which are protruded toward the air passage (38), and the protrusions (51, 52, 53) are arranged in the airflow direction in the air passage (38). The plurality of protrusions (51, 52, 53) increase the heat transfer properties of the heat-transfer portion (37).

[0011] When the temperature of the fluid flowing in the flat tube (33) is below 0°C, the moisture in the air turns into frost and adheres to the surface of the heat-transfer portion (37). During defrosting operation for melting the frost, water (i.e., drain water) melted from the frost on the surface of the heat-transfer portion (37) is generated. Unlike conventional louvers, the protrusions (51, 52, 53) of the heat-transfer portion (37) of the present invention are not formed by cutting and bending part of the heat-transfer portion (37). This means that the protrusions (51, 52, 53) of the present invention have no cut in which the drain water accumulates, and therefore, the drain water around the protrusions (51, 52, 53) smoothly flows to the downwind side. The drain water is discharged downward along the wall surface of the downwind side plate (42, 47).

[0012] The second aspect of the present invention is that in the first aspect of the present invention, the plurality of protrusions (51, 52, 53) include an upwind protrusion (51) provided at an upwind side of the air passage (38), and a downwind protrusion (53) provided at a downwind side of the air passage (38), and in the heat-transfer portion (37), a height of a flat portion (51a) provided in an area between the upwind protrusion (51) and the flat tube (33) located below is greater than a height of a flat portion (53a) provided in an area between the downwind protrusion (53) and the flat tube (33) located below.

[0013] The heat-transfer portion (37) of the second aspect of the present invention has an upwind protrusion (51) closer to the upwind side, and a downwind protrusion (53) closer to the downwind side. In the case where the temperature of the fluid flowing in the flat tube (33) is below 0°C, and frost adheres to the surface of the heat-transfer portion (37), the amount of frost adhering to the upwind protrusion (51) is greater than the amount of frost adhering to the downwind protrusion (53). Thus, during defrosting, the amount of drain water generated at the upwind protrusion (51) is greater than the amount of drain water generated at the downwind protrusion (53). In the present invention, the height of the flat portion (51a) on the lower side of the upwind protrusion (51) is greater than the height of the flat portion (53a) on the lower side of the downwind protrusion (53). Thus, during defrosting, a considerable amount of drain water generated around the upwind protrusion (51) flows down smoothly along the flat portion (51a) on the lower side of the upwind protrusion (51).

[0014] The third aspect of the present invention is that

in the first or second aspect of the present invention, a height including the heights of the flat portions (51a, 52a, 53a) provided in the area between the plurality of protrusions (51, 52, 53) and the flat tube (33) located below is reduced in a direction from the upwind side to the downwind side.

[0015] According to the third aspect of the present invention, a height including the heights of the flat portions (51a, 52a, 53a) on the lower side of the plurality of protrusions (51, 52, 53) is reduced in a direction from the upwind side to the downwind side. In other words, in the adjacent heat-transfer portions (37), the height of the gap along the flat portions (51a, 52a, 53a) is reduced with decreasing distance to the downwind side. Thus, during defrosting, the drain water generated around the upwind protrusion (51) is drawn to the downwind side of the heat-transfer portion (37) by capillary action.

[0016] The fourth aspect of the present invention is that in any one of the first to third aspects of the present invention, the protrusion (51, 52, 53) is tilted with a vertical direction such that a lower end of the protrusion (51, 52, 53) is located downwind of an upper end of the protrusion (51, 52, 53).

[0017] According to the fourth aspect of the present invention, the protrusion (51, 52, 53) is tilted with respect to a vertical direction such that the lower end of the protrusion (51, 52, 53) is located downwind of the upper end of the protrusion (51, 52, 53). Thus, the drain water generated around the protrusions (51, 52, 53) during defrosting is guided by the protrusions (51, 52, 53) and flows down to the downwind side.

[0018] The fifth aspect of the present invention is that in any one of the first to fourth aspects of the present invention, the height of the flat portion (51a, 51b) provided in the area between at least one protrusion (51, 52) of the plurality of protrusions (51, 52, 53) and the flat tube (33) located below the protrusion (51, 52) is reduced in the direction from the upwind side to the downwind side.

[0019] According to the fifth aspect of the present invention, the height of the flat portion (51a, 52a) on the lower side of at least one protrusion (51, 52) of the plurality of protrusions (51, 52, 53) is reduced in the direction from the upwind side to the downwind side. In other words, in the adjacent heat-transfer portions (37), the height of the gap along the flat portions (51a, 52a, 53a) is reduced with decreasing distance to the downwind side. Thus, during defrosting, the drain water generated around the protrusion (51, 52) is drawn to the downwind side of the heat-transfer portion (37) by capillary action.

[0020] The sixth aspect of the present invention is that in any one of the first to fifth aspects of the present invention, each of the plurality of fins (36) is in a plate-like shape having, in an upwind side thereof, a plurality of cutouts (45) for inserting the flat tubes (33); the fins (36) are arranged in an extension direction of the flat tube (33), with a predetermined space between adjacent ones of the fins (36); and the flat tube (33) is fitted to a periphery of the cutout (45), and in the fin (36), an area between

vertically adjacent ones of the cutouts (45) comprises the heat-transfer portion (37), and a vertically extending portion continuous with the downwind side edge of each of the heat-transfer portions (37) comprises the downwind side plate (47).

[0021] According to the sixth aspect of the present invention, a downwind side plate (47) is formed on the downwind side of the plurality of heat-transfer portions (37), which are arranged one above another, such that the downwind side plate (47) is continuous with the plurality of heat-transfer portions. Thus, an integrally formed, elongated fin (36) is obtained. The flat tube (33) is fitted to the periphery of the cutout (45) formed in each of the fins (36), and therefore, a plurality of air passages (38) are formed by being surrounded by adjacent flat tubes (33) and the heat-transfer portions (37).

[0022] The seventh aspect of the present invention is that in the sixth aspect of the present invention, the downwind side plate (47) is provided with a rib (57) extending along the downwind side edges of the plurality of heat-transfer portions (37).

[0023] According to the seventh aspect of the present invention, the drain water generated at the heat-transfer portions (37) during defrosting flows to the downwind side plate (47), and flows down along the rib (57).

[0024] The eighth aspect of the present invention is that in the sixth or seventh aspect of the present invention, the fin (36) includes a raised portion (61, 62) that is cut and bent toward the air passage (38), and a bent surface (61a, 62a) of the raised portion (61, 62) is tilted with respect to a horizontal plane.

[0025] According to the eighth aspect of the present invention, the fin (36) includes a raised portion (61, 62). The tip of the raised portion (61, 62) is brought into contact with the adjacent fin (36), thereby keeping a predetermined space between two adjacent fins (36). The provision of a raised portion like the raised portion (61, 62) may cause a situation where drain water generated during defrosting is retained on the upper surface of the raised portion (61, 62). However, the raised portion (61, 62) of the present invention is tilted with respect to the horizontal plane, and therefore, the drain water on the upper surface of the raised portion (61, 62) is smoothly flows down.

[0026] The ninth aspect of the present invention is directed to an air conditioner (10), and includes refrigerant circuit (20) in which the heat exchanger (30) of any one of the first to eighth aspects of the present invention is provided, wherein the refrigerant circuit (20) performs a refrigeration cycle by circulating a refrigerant.

[0027] According to the ninth aspect of the present invention, the heat exchanger (30) of any one of the first to eighth aspects of the present invention is connected to a refrigerant circuit (20). In the heat exchanger (30), the refrigerant circulating in the refrigerant circuit (20) flows in the passage (34) of the flat tube (33) and exchanges heat with the air flowing in the air passage (39).

ADVANTAGES OF THE INVENTION

[0028] In the present invention, part of each of the heat-transfer portions (37) of the plurality of fins (35, 36) is protruded toward the air passage (38), thereby forming a plurality of protrusions (51, 52, 53). The protrusions (51, 52, 53) can promote heat transfer between air and a fluid. In addition, the protrusions (51, 52, 53) of the present invention are not in such a shape that is formed by giving a cut in the heat-transfer portion and bending the cut portion, unlike the conventional louvers. Thus, the protrusions (51, 52, 53) do not easily accumulate drain water melted from frost during defrosting, and thus, the drain water can be smoothly discharged to the downwind side. As a result, the time necessary for defrosting can be reduced.

[0029] In the second aspect of the present invention, the height of the flat portion (51a) on the lower side of the upwind protrusion (51) is greater than the height of the flat portion (53a) on the lower side of the downwind protrusion (53). Much frost adheres particularly on the surface of the upwind protrusion (51), and a considerable amount of drain water is accordingly generated on the surface of the upwind protrusion (51) during defrosting. However, a sufficient gap is provided along the flat portion (51a) on the lower side of the upwind protrusion (51), and thus, the considerable amount of drain water generated at the upwind protrusion (51) can be smoothly discharged.

[0030] In the third aspect of the present invention, the height of the downwind flat portion (53a) is reduced, thereby making it possible to draw the drain water accumulated on the upper surface of the flat tube (33) located below to the downwind side by capillary action.

[0031] In the fourth aspect of the present invention, the protrusion (51, 52, 53) is tilted such that the lower end of the protrusion (51, 52, 53) is located downwind of the upper end of the protrusion (51, 52, 53). Thus, water melted from frost on the surface of the protrusion (51, 52, 53) can be smoothly discharged to the downwind side.

[0032] In the fifth aspect of the present invention, the height of the flat portion (51a, 52a) on the lower side of at least one protrusion (51, 52) is gradually reduced with decreasing distance to the downwind side, thereby making it possible to draw drain water accumulated on the upper surface of the flat tube (33) to the downwind side by capillary action.

[0033] In the seventh aspect of the present invention, downwind side edges of the heat-transfer portions (37) arranged one above another are connected by a downwind side plate (47), and a rib (57) is formed on the downwind side plate (47). Thus, the drain water having moved to the downwind side plate (47) from the heat-transfer portion (37) can be collected on the surface of the rib (57), and the drain water can be guided downward along the rib (57).

[0034] In the eighth aspect of the present invention, the fin (36) includes a raised portion (61, 62). The raised

portion (61, 62) can be used as a spacer between adjacent fins (36). Further, the bent surface (61a, 62a) of the raised portion (61, 62) is tilted with respect to a horizontal plane, thereby making it possible to prevent drain water from being accumulated on the upper surface of the horizontal plane.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

FIG. 1 is a refrigerant circuit diagram showing a schematic configuration of an air conditioner having a heat exchanger of the first embodiment.

FIG. 2 is an oblique view schematically showing the heat exchanger of the first embodiment.

FIG. 3 is a partial cross-sectional view of the front side of the heat exchanger of the first embodiment.

FIG. 4 is a cross-sectional view of part of the heat exchanger taken along the line IV-IV of FIG. 3.

FIG. 5 is a cross-sectional view of a fin taken along the line V-V of FIG. 4.

FIG. 6 is an oblique view of the fin of the first embodiment.

FIG. 7 is an oblique view schematically showing a heat exchanger of the second embodiment.

FIG. 8 is a partial cross-sectional view of the front side of the heat exchanger of the second embodiment.

FIG. 9 is a cross-sectional view of part of the heat exchanger taken along the line IX-IX of FIG. 8.

FIG. 10 is a cross-sectional view of a fin taken along the line X-X of FIG. 9.

DESCRIPTION OF EMBODIMENTS

[0036] Embodiments of the present invention will be described in detail below based on the drawings.

«First Embodiment of Invention»

[0037] The first embodiment of the present invention will be described. An exchanger (30) of the first embodiment comprises an outdoor heat exchanger (23) of an air conditioner (10) described later.

-Air Conditioner-

[0038] The air conditioner (10) having the heat exchanger (30) of the present embodiment will be described with reference to FIG. 1.

<Configuration of Air Conditioner>

[0039] The air conditioner (10) has an outdoor unit (11) and an indoor unit (12). The outdoor unit (11) and the indoor unit (12) are connected to each other via a liquid communication pipe (13) and a gas communication pipe

(14). In the air conditioner (10), a refrigerant circuit (20) is formed by the outdoor unit (11), the indoor unit (12), the liquid communication pipe (13), and the gas communication pipe (14).

[0040] The refrigerant circuit (20) includes a compressor (21), a four-way valve (22), an outdoor heat exchanger (23), an expansion valve (24), and an indoor heat exchanger (25). The compressor (21), the four-way valve (22), the outdoor heat exchanger (23), and the expansion valve (24) are accommodated in the outdoor unit (11). The outdoor unit (11) is provided with an outdoor fan (15) configured to supply outdoor air to the outdoor heat exchanger (23). The indoor heat exchanger (25) is accommodated in the indoor unit (12). The indoor unit (12) is provided with an indoor fan (16) configured to supply indoor air to the indoor heat exchanger (25).

[0041] The refrigerant circuit (20) is a closed circuit filled with a refrigerant. In the refrigerant circuit (20), a discharge side of the compressor (21) is connected to a first port of the four-way valve (22), and a suction side of the compressor (21) is connected to a second port of the four-way valve (22). In the refrigerant circuit (20), the outdoor heat exchanger (23), the expansion valve (24), and the indoor heat exchanger (25) are provided sequentially from a third port to a fourth port of the four-way valve (22).

[0042] The compressor (21) is a scroll type or rotary type hermetic compressor (21). The four-way valve (22) switches between a first state (the state shown in solid line in FIG. 1) in which the first port communicates with the third port, and the second port communicates with the fourth port, and a second state (the state shown in broken line in FIG. 1) in which the first port communicates with the fourth port, and the second port communicates with the third port. The expansion valve (24) is a so-called electronic expansion valve (24).

[0043] In the outdoor heat exchanger (23), the outdoor air is heat exchanged with the refrigerant. The outdoor heat exchanger (23) is comprised of the heat exchanger (30) of the present embodiment. In the indoor heat exchanger (25), the indoor air is heat exchanged with the refrigerant. The indoor heat exchanger (25) is comprised of a so-called cross-fin type fin-and-tube heat exchanger having a circular heat-transfer tube.

<Cooling Operation >

[0044] The air conditioner (10) performs a cooling operation. The four-way valve (22) is set to the first state during the cooling operation. The outdoor fan (15) and the indoor fan (16) are driven during the cooling operation.

[0045] The refrigerant circuit (20) performs a refrigeration cycle. Specifically, the refrigerant discharged from the compressor (21) passes through the four-way valve (22), flows into the outdoor heat exchanger (23), and dissipates heat to the outdoor air and condenses. The refrigerant flowing out of the outdoor heat exchanger (23) expands when it passes through the expansion valve

(24), flows into the indoor heat exchanger (25), and takes heat from the indoor air and evaporates. The refrigerant flowing out of the indoor heat exchanger (25) passes through the four-way valve (22) and is then sucked into the compressor (21) and compressed. The indoor unit (12) supplies air which has been cooled in the indoor heat exchanger (25) to an indoor space.

<Heating Operation>

[0046] The air conditioner (10) performs a heating operation. The four-way valve (22) is set to the second state during the heating operation. The outdoor fan (15) and the indoor fan (16) are driven during the heating operation.

[0047] The refrigerant circuit (20) performs a refrigeration cycle. Specifically, the refrigerant discharged from the compressor (21) passes the four-way valve (22), flows into the indoor heat exchanger (25), and dissipates heat to the indoor air and condenses. The refrigerant flowing out of the indoor heat exchanger (25) expands when it passes through the expansion valve (24), flows into the outdoor heat exchanger (23), and takes heat from the outdoor air and evaporates. The refrigerant flowing out of the outdoor heat exchanger (23) passes through the four-way valve (22) and is then sucked into the compressor (21) and compressed. The indoor unit (12) supplies air which has been heated in the indoor heat exchanger (25) to an indoor space.

<Defrosting Operation>

[0048] As described above, the outdoor heat exchanger (23) functions as an evaporator in the heating operation. In the operation under low outdoor air temperature conditions, the evaporation temperature of the refrigerant in the outdoor heat exchanger (23) may sometimes be below 0°C. In this case, the moisture in the outdoor air turns into frost and adheres to the outdoor heat exchanger (23). To avoid this, the air conditioner (10) performs a defrosting operation every time a duration of the heating operation reaches a predetermined value (e.g., several tens of minutes), for example.

[0049] To start the defrosting operation, the four-way valve (22) is switched from the second state to the first state, and the outdoor fan (15) and the indoor fan (16) are stopped. In the refrigerant circuit (20) during the defrosting operation, a high temperature refrigerant discharged from the compressor (21) is supplied to the outdoor heat exchanger (23). The frost adhering to the surface of the outdoor heat exchanger (23) is heated and melted by the refrigerant. The refrigerant which dissipates heat in the outdoor heat exchanger (23) sequentially passes through the expansion valve (24) and the indoor heat exchanger (25), and is then sucked into the compressor (21) and compressed. When the defrosting operation is finished, the heating operation starts again. That is, the four-way valve (22) is switched from the first

state to the second state, and the outdoor fan (15) and the indoor fan (16) are driven again.

-Heat Exchanger of First Embodiment-

[0050] The heat exchanger (30) of the present embodiment which comprises the outdoor heat exchanger (23) of the air conditioner (10) will be described with reference to FIGS. 2 to 6.

<General Configuration of Heat Exchanger>

[0051] As shown in FIG. 2 and FIG. 3, the heat exchanger (30) of the present embodiment includes one first header collecting pipe (31), one second header collecting pipe (32), a plurality of flat tubes (33), and a plurality of fins (35). The first header collecting pipe (31), the second header collecting pipe (32), the flat tubes (33), and the fins (35) are all aluminum alloy members, and are attached to one another with solder.

[0052] Both of the first header collecting pipe (31) and the second header collecting pipe (32) are in an elongated hollow cylindrical shape, with both ends closed. In FIG. 3, the first header collecting pipe (31) is provided upright at the left end of the heat exchanger (30), and the second header collecting pipe (32) is provided upright at the right end of the heat exchanger (30). In other words, the first header collecting pipe (31) and the second header collecting pipe (32) are provided such that their axial directions are vertical.

[0053] As is also shown in FIG. 4, the flat tube (33) is a heat-transfer tube having a flat oblong cross section or a rectangular cross section with rounded corners. In the heat exchanger (30), the plurality of flat tubes (33) extend in a horizontal direction, and are arranged such that the flat surfaces thereof face each other. Further, the plurality of flat tubes (33) are arranged one above another with a predetermined space between the flat tubes (33). One end of each of the flat tubes (33) is inserted in the first header collecting pipe (31), and the other end of the flat tube (33) is inserted in the second header collecting pipe (32).

[0054] As shown in FIG. 4, each flat tube (33) has a plurality of fluid passages (34). Each fluid passage (34) extends in a direction in which the flat tubes (33) extend. In the flat tube (33), the plurality of fluid passages (34) are aligned in a width direction of the flat tube (33) which is orthogonal to the direction in which the flat tube (33) extends. One end of each of the plurality of fluid passages (34) formed in each flat tube (33) communicates with the interior space of the first header collecting pipe (31), and the other end of the fluid passage (34) communicates with the interior space of the second header collecting pipe (32). The refrigerant supplied to the heat exchanger (30) exchanges heat with the air, while flowing in the fluid passages (34) of the flat tubes (33).

[0055] Each of the fins (35) is a corrugated fin which curves up and down and is placed between vertically

adjacent flat tubes (33). As will be described in detail later, the fin (35) includes a plurality of heat-transfer portions (37) and a plurality of intermediate plates (41). The intermediate plates (41) of each fin (35) are attached to the flat tubes (33) with solder.

<Configuration of Fin>

[0056] As shown in FIG. 6, the fin (35) is a corrugated fin obtained by bending a metal plate of a given width, and in a shape which curves up and down. The fin (35) includes the heat-transfer portions (37) and the intermediate plates (41) alternately arranged in the extension direction of the flat tube (33). In other words, the fin (35) includes a plurality of heat-transfer portions (37) arranged in the extension direction of the flat tube (33) and placed between adjacent flat tubes (33). The fin (35) further includes a projecting plate (42) on the downwind side.

[0057] The heat-transfer portion (37) is a plate-like portion which extends from one to the other of vertically adjacent flat tubes (33). The heat-transfer portions (37) are side walls of air passages (38) formed in the space between adjacent flat tubes (33). The upwind side edge of the heat-transfer portion (37) is a leading edge (39). The intermediate plate (41) is a plate-like portion along the flat surface of the flat tube (33), and is continuous with the upper ends or the lower ends of the horizontally adjacent heat-transfer portions (37). The heat-transfer portion (37) and the intermediate plate (41) form an approximately right angle.

[0058] The projecting plate (42) is a plate-like portion continuous with the downwind side edge of each heat-transfer portion (37). The projecting plate (42) is an elongated plate which extends vertically, and projects further to the downwind side than the flat tube (33). The upper end of the projecting plate (42) projects upward from the upper end of the heat-transfer portion (37), and the lower end of the projecting plate (42) projects downward from the lower end of the heat-transfer portion (37). As shown in FIG. 4, in the heat exchanger (30), the projecting plates (42) of vertically adjacent fins (35) which are arranged with a flat tube (33) interposed therebetween are in contact with each other. The vertically continuous projecting plates (42) comprise a downwind side plate which forms a discharge path for drain water.

[0059] As shown in FIG. 4, the heat-transfer portion (37) and the projecting plate (42) of the fin (35) are provided with a plurality of waffle portions (51, 52, 53). The waffle portions (51, 52, 53) comprise a protrusion extending vertically. Each of the waffle portions (51, 52, 53) is protruded toward the air passage (38) into a mountain-like shape such that the ridge of each waffle portion (51, 52, 53) intersects with airflow. The waffle portions (51, 52, 53) are formed by plastically deforming part of the heat-transfer portion (37) by e.g., press work. Each of the waffle portions (51, 52, 53) extends obliquely with respect to the vertical direction such that the lower end

of each waffle portion is positioned downwind of the upper end of the waffle portion.

[0060] Each of the waffle portions (51, 52, 53) includes a pair of trapezoidal surfaces (54, 54) extending vertically, and a pair of flat triangular surfaces (55, 55) at the upper and lower locations. The pair of trapezoidal surfaces (54, 54) are arranged next to each other in the airflow direction, and forms a mountain fold portion (56), i.e., a ridge, in the middle of the pair of trapezoidal surfaces (54, 54). The pair of triangular surfaces (55, 55) are positioned at the upper and lower locations with the mountain fold portion (56) interposed therebetween.

[0061] The heat-transfer portion (37) is provided with the plurality of waffle portions (51, 52, 53) sequentially arranged from the upwind side to the downwind side. The waffle portions (51, 52, 53) include one upwind waffle portion (51) located on the upwind side of the heat-transfer portion (37), two downwind waffle portions (53, 53) located on the downwind side of the heat-transfer portion (37), and one intermediate waffle portion (52) located between the upwind waffle portion (51) and the downwind waffle portion (53). The upwind waffle portion (51) comprises an upwind protrusion located on the most upwind side among the plurality of waffle portions (51, 52, 53). The downwind waffle portions (53, 53) comprise a downwind protrusion located on the most downwind side among the plurality of waffle portions (51, 52, 53).

[0062] The upper end of the upwind waffle portion (51) is located lower than the upper end of the downwind waffle portion (53). The upper end of the intermediate waffle portion (52) and the upper ends of the downwind waffle portions (53) are at approximately the same height. The upper end of the upwind waffle portion (51), the upper end of the intermediate waffle portion (52), and the upper ends of the downwind waffle portions (53) are approximately parallel to the flat surface of the flat tube (33) located above.

[0063] The lower end of the upwind waffle portion (51) is located higher than the lower ends of the downwind waffle portions (53). The lower end of the upwind waffle portion (51) is tilted such that a downwind side of the lower end is located lower than an upwind side of the lower end. The lower end of the intermediate waffle portion (52) is also tilted such that a downwind side of the lower end is located lower than an upwind side of the lower end. The lower ends of the downwind waffle portions (53) are approximately parallel to the flat surface of the flat tube (33).

[0064] The fin (35) is provided with a water-conducting rib (57) on the downstream side of the waffle portions (51, 52, 53). Specifically, one water-conducting rib (57) is provided at each projecting plate (42). The water-conducting rib (57) extends vertically along the downwind side edge of the projecting plate (42). As shown in FIG. 5, the water-conducting rib (57) forms a raised line (57a) on one surface of the projecting plate (42), and forms a recessed groove (57b) on the other surface of the projecting plate (42). The raised lines (57a) are formed in

side surfaces on the same side of the vertically adjacent projecting plates (42), and the side surfaces on the same side of the projecting plates (42) adjacent to each other in the extension direction of the flat tube (33). The vertically adjacent water-conducting ribs (57) are approximately aligned in the vertical direction. In the present embodiment, the upper end of the water-conducting rib (57) is located slightly lower than the upper end of the projecting plate (42), and the lower end of the water-conducting rib (57) is located slightly higher than the lower end of the projecting plate (42). Alternatively, each of the water-conducting ribs (57) may extend from the upper end to the lower end of the projecting plate (42).

[0065] Part of the surface of the heat-transfer portion (37) with no waffle portions (51, 52, 53) and no water-conducting rib (57) is flat. Flat portions (51a, 51b, 51c) are formed in the area between the lower ends of the waffle portions (51, 52, 53) and the flat tube (33) located below the waffle portions (51, 52, 53).

[0066] More specifically, in the heat-transfer portion (37), a first flat portion (51a) is provided in the area between the lower end of the upwind waffle portion (51) and the flat tube (33) located below; a second flat portion (52a) is provided in the area between the lower end of the intermediate waffle portion (52) and the flat tube (33) located below; and a third flat portion (53a) is provided in the area between the lower ends of the downwind waffle portions (53) and the flat tube (33) located below. In the heat-transfer portion (37), the height of the first flat portion (51a) is reduced in a direction from the upwind side to the downwind side. In the heat-transfer portion (37), the height of the second flat portion (52a) is reduced as well in the direction from the upwind side to the downwind side. That is, in the present embodiment, the heights of the two flat portions (51a, 52a) located between the lower ends of the two protrusions (51, 52) of the four protrusions (51, 52, 53, 53) and the flat tube (33) located below the protrusions (51, 52) are reduced in the direction from the upwind side to the downwind side. Further, in the heat-transfer portion (37), the height of the first flat portion (51a) is greater than the height of each third flat portion (53a). Here, the height of the flat portion located on the lower side of only one of the four protrusions (51, 52, 53, 53) may be reduced in the direction from the upwind side to the downwind side, or heights of three or more flat portions may be reduced in the direction from the upwind side to the downwind side.

-State of Frost and Drain Water in Defrosting Operation-

[0067] As described above, the heat exchanger (30) of the present embodiment comprises the outdoor heat exchanger (23) of the air conditioner (10). The air conditioner (10) performs a heating operation, but during the operation when the evaporation temperature of the refrigerant in the outdoor heat exchanger (23) is below 0°C, the moisture in the outdoor air turns into frost and adheres to the outdoor heat exchanger (23). Thus, the air condi-

tioner (10) performs a defrosting operation to melt the frost adhering to the outdoor heat exchanger (23). Drain water is generated in the defrosting operation due to melting of the frost.

[0068] The fins have a considerable amount of frost on the heat-transfer portions (37), and the space between adjacent heat-transfer portions (37) is almost clogged with the frost shortly before start of the defrosting operation. The heat-transfer portion (37) of the present embodiment shown in FIG. 4 has much frost particularly on the surface of the upwind waffle portion (51) on the upwind side. However, because a gap is provided along the first flat portion (51a) on the lower side of the upwind waffle portion (51), and air can easily flow through this gap, the moisture in the air can turn into frost and easily adhere to a lower portion of the intermediate waffle portion (52) and a lower portion of the downwind waffle portion (53), as well, in the heat-transfer portion (37).

[0069] As described above, in the heat exchanger (30) of the present embodiment, the height of the first flat portion (51a) on the lower side of the upwind waffle portion (51) is greater than the heights of the second flat portion (52a) and the third flat portions (53a). Thus, it is possible to prevent frost from adhering particularly to the upwind area of the heat-transfer portion (37). This may increase the time until the heat exchanger (30) is degraded in performance due to local frost formation in the heating operation. Since the time from the start of the heating operation until the start of the defrosting operation is extended, the duration of the heating operation is accordingly extended.

[0070] Once the defrosting operation has started, the frost adhering to the heat exchanger (30) is heated by the refrigerant and gradually melted. As mentioned above, the heat-transfer portion (37) has much frost particularly on the surface of the upwind waffle portion (51), and therefore, the amount of water (i.e., drain water) melted from the frost is considerable in this area. Here, the first flat portion (51a) on the lower side of the upwind waffle portion (51) is greater in height than the other flat portions (52a, 53a). This means that the upwind waffle portion (51) has sufficient gap on the lower side thereof, for discharging drain water. Thus, the drain water melted from the frost adhering to the upwind waffle portion (51) runs smoothly along the first flat portion (51a) down to the upper surface of the flat tube (33) located below.

[0071] The drain water discharged smoothly downward as described above allows heat of the heat-transfer portion (37) to be easily transferred to the frost remaining on the surface of the upwind waffle portion (51). Thus, in the present embodiment, the time necessary to melt the frost on the surface of the upwind waffle portion (51) can be reduced, and the duration of the defrosting operation can also be reduced.

[0072] In general, no frost remains, but drain water exists in the heat exchanger (30) shortly after the completion of the defrosting operation. The drain water generated in the defrosting operation flows to the downwind

side. In the present embodiment, the height of the flat portions (51a, 52a, 53a) is reduced with decreasing distance to the downwind side, and in particular, the third flat portion (53a) on the most downwind side has a small height. Thus, the drain water accumulated on the upper surface of the flat tube (33) is drawn to the downwind side by capillary action. In other words, the drain water moves to the downwind side, although the outdoor fan (15) is stopped in the defrosting operation and the upper surface of the flat tube (33) is approximately horizontal.

[0073] Each of the plurality of waffle portions (51) is tilted with respect to the vertical direction such that the lower end of each waffle portion (51) is positioned downwind of the upper end of the waffle portion (51). Thus, the drain water melted from the frost on the surface of the waffle portion (51) moves to the downwind side along the direction of tilt of the waffle portion (51).

[0074] The drain water having moved to the downwind side arrives at the water-conducting rib (57) of the projecting plate (42). The drain water moves on the surface of the raised line (57a) of the water-conducting rib (57), or on the inner side of the recessed groove (57b), and flows down by gravity. The drain water having flowed down from the projecting plate (42) is guided by the water-conducting rib (57) of the projecting plate (42) located below, and flows further down. As a result, the drain water flows to the bottommost fin (35) and is then delivered to a discharge path, such as a drain pan.

-Advantages of First Embodiment-

[0075] In the first embodiment, as shown in FIG. 4, the heat-transfer portion (37) is provided with a plurality of waffle portions (51, 52, 53). The waffle portions (51, 52, 53) are formed by protruding part of the heat-transfer portion (37) toward the air passage (38), and are not formed by giving cuts in the heat-transfer portion (37) as in the conventional louver case. Thus, in the present embodiment, the drain water melted from the frost can be prevented from being accumulated in the cuts of the heat-transfer portion (37), and can be smoothly discharged.

[0076] In particular, as described above, it is possible to prevent frost from adhering particularly to the upwind waffle portion (51) by making the first flat portion (51a) on the lower side of the upwind waffle portion (51) have a greater height than the third flat portion (53a) on the lower side of the downwind waffle portion (53). As a result, the duration of the heating operation can be extended. Also, the drain water generated on the surface of the upwind waffle portion (51) can be smoothly discharged downward along the first flat portion (51a).

[0077] Since the third flat portion (53a) has a smaller height, the drain water accumulated on the upper surface of the flat tube (33) can be smoothly delivered to the downwind side by capillary action. Moreover, since each of the waffle portions (51, 52, 53) is tilted as shown in FIG. 4, the drain water melted from the frost on the surfaces of the waffle portions (51, 52, 53) can be guided

smoothly to the downwind side.

[0078] Since it is possible to reduce time for discharging the drain water in the defrosting operation as described above, it is also possible to reduce time necessary for melting the frost. As a result, the time of the defrosting operation can be reduced, and the heating operation can be accordingly extended.

«Second Embodiment of the Invention»

[0079] Now, the second embodiment of the present invention will be described. Similar to the heat exchanger (30) of the first embodiment, a heat exchanger (30) of the second embodiment comprises an outdoor heat exchanger (23) of an air conditioner (10). The heat exchanger (30) of the present embodiment will be described below with reference to FIGS. 7 to 10.

<General Configuration of Heat Exchanger>

[0080] As shown in FIG. 7 and FIG. 8, the heat exchanger (30) of the present embodiment includes one first header collecting pipe (31), one second header collecting pipe (32), a plurality of flat tubes (33), and a plurality of fins (36). The first header collecting pipe (31), the second header collecting pipe (32), the flat tubes (33), and the fins (36) are all aluminum alloy members, and are attached to one another with solder.

[0081] The configurations and locations of the first header collecting pipe (31), the second header collecting pipe (32), and the flat tubes (33) are the same as those of the heat exchanger (30) of the first embodiment. That is, both of the first header collecting pipe (31) and the second header collecting pipe (32) are in an elongated cylindrical shape. One of the first header collecting pipe (31) and the second header collecting pipe (32) is provided at the left end of the heat exchanger (30), and the other is provided at the right end of the heat exchanger (30). Each of the flat tubes (33) is a heat-transfer tube having a flat cross section, and the flat tubes (33) are arranged one above another such that the flat surfaces thereof face each other. Each flat tube (33) has a plurality of fluid passages (34). One end of each of the flat tubes (33) arranged one above another is inserted in the first header collecting pipe (31), and the other end is inserted in the second header collecting pipe (32).

[0082] Each fin (36) is in a plate-like shape, and the fins (36) are arranged in an extension direction of the flat tube (33) with a predetermined space between the fins (36). In other words, the fins (36) are arranged to be substantially orthogonal to the extension direction of the flat tube (33).

<Configuration of Fin>

[0083] As shown in FIG. 9, each fin (36) is in an elongated plate-like shape formed by pressing a metal plate. The fin (36) is provided with a plurality of elongated cut-

outs (45) each extending in a width direction of the fin (36) from a leading edge (39) of the fin (36). The plurality of cutouts (45) are formed in the fin (36) at predetermined intervals in a longitudinal direction of the fin (36). A downwind portion of the cutout (45) comprises a tube insertion portion (46). A width of the tube insertion portion (46) in a vertical direction is substantially equal to the thickness of the flat tube (33), and a length of the tube insertion portion (46) is substantially equal to the width of the flat tube (33). The flat tube (33) is inserted in the tube insertion portion (46) of the fin (36) and is attached to the periphery of the tube insertion portion (46) with solder.

[0084] In the fin (36), an area between adjacent cutouts (45) comprises a heat-transfer portion (37), and an area on the downwind side of the tube insertion portion (46) comprises a downwind side plate (47). That is, the fin (36) includes a plurality of heat-transfer portions (37) arranged one above another, with the flat tube (33) interposed between adjacent heat-transfer portions (37), and one continuous downwind side plate (47) on the downwind side edges of the heat-transfer portions (37). In the heat exchanger (30) of the present embodiment, the heat-transfer portion (37) of the fin (36) is located between the vertically adjacent flat tubes (33), and the downwind side plate (47) protrudes further to the downwind side than the flat tube (33).

[0085] As shown in FIG. 9, the heat-transfer portion (37) and the downwind side plate (47) of the fin (35) are provided with a plurality of waffle portions (51, 52, 53), similar to the first embodiment. That is, the waffle portions (51, 52, 53) are protruded toward the air passage (38), and comprises a protrusion extending vertically. The waffle portions (51, 52, 53) are formed by plastically deforming part of the heat-transfer portion (37) by e.g., press work. Each of the waffle portions (51, 52, 53) extends obliquely with respect to the vertical direction such that the lower end of each waffle portion is positioned downwind of the upper end of the waffle portion. Similar to the first embodiment, each of the waffle portions (51, 52, 53) includes a pair of +trapezoidal surfaces (54, 54), a pair of triangular surfaces (55, 55), and a mountain fold portion (56).

[0086] The heat-transfer portion (37) is provided with one upwind waffle portion (51), one intermediate waffle portion (52), and two downwind waffle portions (53, 53) sequentially arranged from the upwind side to the downwind side. One of the two downwind waffle portions (53, 53) which is closer to the downwind side is astride the heat-transfer portion (37) and the downwind side plate (47).

[0087] In the second embodiment, as well, flat portions (51a, 51b, 51c) are formed in the area between the lower ends of the waffle portions (51, 52, 53) and the flat tube (33) located below the waffle portions (51, 52, 53). Specifically, in the heat-transfer portion (37), a first flat portion (51a) is provided in the area between the lower end of the upwind waffle portion (51) and the flat tube (33) located below; a second flat portion (52a) is provided in

the area between the lower end of the intermediate waffle portion (52) and the flat tube (33) located below; and a third flat portion (53a) is provided in the area between the lower ends of the downwind waffle portions (53) and the flat tube (33) located below. In the heat-transfer portion (37), the height of the first flat portion (51a) is reduced in the direction from the upwind side to the downwind side. In the heat-transfer portion (37), the height of the second flat portion (52a) is reduced as well in the direction from the upwind side to the downwind side. That is, in the present embodiment, the heights of the two flat portions (51a, 52a) located between the lower ends of the two protrusions (51, 52) of the four protrusions (51, 52, 53, 53) and the flat tube (33) located below the protrusions (51, 52) are reduced in the direction from the upwind side to the downwind side. Further, in the heat-transfer portion (37), the height of the first flat portion (51a) is greater than the height of each third flat portion (53a). Here, the height of the flat portion located on the lower side of only one of the four protrusions (51, 52, 53, 53) may be reduced in the direction from the upwind side to the downwind side, or heights of three or more flat portions may be reduced in the direction from the upwind side to the downwind side.

[0088] The downwind side plate (47) of the fin (36) extends vertically and forms a discharge path of drain water. The downwind side plate (47) is provided with one water-conducting rib (57). The water-conducting rib (57) is an elongated recessed groove extending vertically along the downwind side edge of the downwind side plate (47), and extends from the upper end to the lower end of the downwind side plate (47). As shown in FIG. 10, the water-conducting rib (57) forms a raised line (57a) on one surface of the downwind side plate (47), and forms a recessed groove (57b) on the other surface of the downwind side plate (47). The raised lines (57a) are formed in the side surfaces on the same side of the downwind side plates (47) adjacent to each other in the extension direction of the flat tube (33).

[0089] The fin (36) is provided with tabs (61, 62) configured to keep a space between adjacent fins (36). Each of the tabs (61, 62) is a small rectangular piece formed by cutting and bending part of the fin (36).

[0090] As shown in FIG. 9, an upwind tab (61) is provided at an upwind side edge of each heat-transfer portion (37). The upwind tab (61) is formed by cutting part of the heat-transfer portion (37) and bending the cut portion obliquely upward. That is, a bent surface (61a) of the upwind tab (61) is tilted with respect to a horizontal plane. A downwind tab (62) is provided on the downwind side plate (47) at a downwind side of each flat tube (33). The downwind tab (62) is formed by cutting part of the downwind side plate (47) and bending the cut portion to the upwind side. That is, a bent surface (62a) of the downwind tab (62) is orthogonal to the horizontal plane.

[0091] The bent surface of each of the tabs (61, 62) has a height that allows the tabs (61, 62) to be in contact with the adjacent fin (36). That is, the tabs (61, 62) serve

as spacers which keep a predetermined space between adjacent fins (36). The tabs (61, 62) may be unfolded to the original state of the fin (36) after the fins (36) are soldered to the flat tubes (33).

-Advantages of Second Embodiment-

[0092] The heat exchanger (30) of the second embodiment can have similar advantages as those in the first embodiment. Specifically, the heat transfer properties can be improved in the second embodiment, as well, because a plurality of waffle portions (51, 52, 53) are provided on the heat-transfer portion (37). Unlike the conventional louvers, the waffle portions (51, 52, 53) do not require cuts, and thus, no drain water accumulates around the waffle portions (51, 52, 53). In addition, the first flat portion (51a) on the lower side of the upwind waffle portion (51) allows drain water generated on the surface of the upwind waffle portion (51) to be smoothly discharged downward. The drain water accumulated on the upper surface of the flat tube (33) can be drawn to the downwind side from the gap at the third flat portion (53a) by capillary action. Further, the drain water generated on the surface of each waffle portion (51, 52, 53) can be guided to the downwind side along the direction of tilt of each waffle portion (51, 52, 53).

[0093] The drain water having moved to the downwind side plate (47) after traveling as described above is collected on the surface of the raised line (57a) of the water-conducting rib (57), or on the inner side of the recessed groove (57b), and flows down along the water-conducting rib (57). As a result, the drain water accumulated in the downwind area of the fin (36) can be smoothly discharged to e.g., a drain pan.

[0094] The bent surfaces (61 a, 62a) of the tabs (61, 62) of the second embodiment are tilted with respect to a horizontal plane. It is thus possible to prevent the drain water generated on the surface of the fin (36) from being accumulated on upper portions of the bent surfaces (61a, 62a) of the tabs (61, 62). Thus, airflow in the air passage (38) is not blocked by refrozen drain water on the surface of the tabs (61, 62).

[0095] The foregoing embodiments are merely preferred examples in nature, and are not intended to limit the scope, applications, and use of the invention.

INDUSTRIAL APPLICABILITY

[0096] As described above, the present invention is useful for a heat exchanger which has a flat tube and a plurality of fins and exchanges heat between a fluid flowing in the flat tube and air, and an air conditioner having the heat exchanger.

DESCRIPTION OF REFERENCE CHARACTERS

[0097]

10	air conditioner
30	heat exchanger
5 33	flat tube
34	fluid passage (passage of fluid)
35	fin (corrugated fin)
10 36	fin
37	heat-transfer portion
15 38	air passage
42	projecting plate (downwind side plate)
45	cutout
20 47	downwind side plate
51	upwind waffle portion (upwind protrusion, protrusion)
25 51a	first flat portion (flat portion)
52	intermediate waffle portion (protrusion)
30 52a	second flat portion (flat portion)
53	downwind waffle portion (downwind protrusion, protrusion)
35 53a	third flat portion (flat portion)
57	water-conducting rib (rib)
61	upwind tab (raised portion)
40 61a	bent surface
62	downwind tab (raised portion)
45 62a	bent surface

Claims

- 50 1. A heat exchanger, comprising:
- a plurality of flat tubes (33) arranged one above another such that flat surfaces thereof face each other and each having therein a passage (34) of a fluid; and
- a plurality of fins (35, 36) configured to divide a space between adjacent ones of the flat tubes (33) into a plurality of air passages (38) through

- which air flows,
each of the plurality of fins (35, 36) including
a plurality of plate-like heat-transfer portions
(37) each of which extends from one to the other
of the adjacent flat tubes (33) and comprises a
side wall of each of the air passages (38), and
a downwind side plate (42, 47) connected to a
downwind side edge of each of the heat-transfer
portions (37) and serving as a discharge path,
wherein
each of the plurality of heat-transfer portions (37)
has a plurality of protrusions (51, 52, 53) which
are protruded toward the air passage (38) and
extend in a direction intersecting with an airflow
direction, and the plurality of protrusions (51, 52,
53) are arranged in the airflow direction.
2. The heat exchanger of claim 1, wherein
the plurality of protrusions (51, 52, 53) include an
upwind protrusion (51) provided at an upwind side
of the air passage (38), and a downwind protrusion
(53) provided at a downwind side of the air passage
(38), and
in the heat-transfer portion (37), a height of a flat
portion (51a) provided in an area between the up-
wind protrusion (51) and the flat tube (33) located
below is greater than a height of a flat portion (53a)
provided in an area between the downwind protrusion
(53) and the flat tube (33) located below.
 3. The heat exchanger of claim 1 or 2, wherein
a height including the heights of the flat portions (51a,
52a, 53a) provided in the area between the plurality
of protrusions (51, 52, 53) and the flat tube (33) lo-
cated below is reduced in a direction from the upwind
side to the downwind side.
 4. The heat exchanger of any one of claims 1-3, where-
in
the protrusion (51, 52, 53) is tilted with respect to a
vertical direction such that a lower end of the protru-
sion (51, 52, 53) is located downwind of an upper
end of the protrusion (51, 52, 53).
 5. The heat exchanger of any one of claim 1-4, wherein
the height of the flat portion (51a, 51b) provided in
the area between at least one protrusion (51, 52) of
the plurality of protrusions (51, 52, 53) and the flat
tube (33) located below the protrusion (51, 52) is
reduced in the direction from the upwind side to the
downwind side.
 6. The heat exchanger of any one of claims 1-5, where-
in
each of the plurality of fins (36) is in a plate-like shape
having, in an upwind side thereof, a plurality of cut-
outs (45) for inserting the flat tubes (33); the fins (36)
are arranged in an extension direction of the flat tube
(33), with a predetermined space between adjacent
ones of the fins (36); and the flat tube (33) is fitted
to a periphery of the cutout (45), and
in the fin (36), an area between vertically adjacent
ones of the cutouts (45) comprises the heat-transfer
portion (37), and a vertically extending portion con-
tinuous with the downwind side edge of each of the
heat-transfer portions (37) comprises the downwind
side plate (47).
 7. The heat exchanger of claim 6, wherein
the downwind side plate (47) is provided with a rib
(57) extending along the downwind side edges of
the plurality of heat-transfer portions (37).
 8. The heat exchanger of claim 6 or 7, wherein
the fin (36) includes a raised portion (61, 62) that is
cut and bent toward the air passage (38), and
a bent surface (61a, 62a) of the raised portion (61,
62) is tilted with respect to a horizontal plane.
 9. An air conditioner, comprising a refrigerant circuit
(20) in which the heat exchanger (30) of any one of
claims 1-8 is provided, wherein
the refrigerant circuit (20) performs a refrigeration
cycle by circulating a refrigerant.

FIG.1

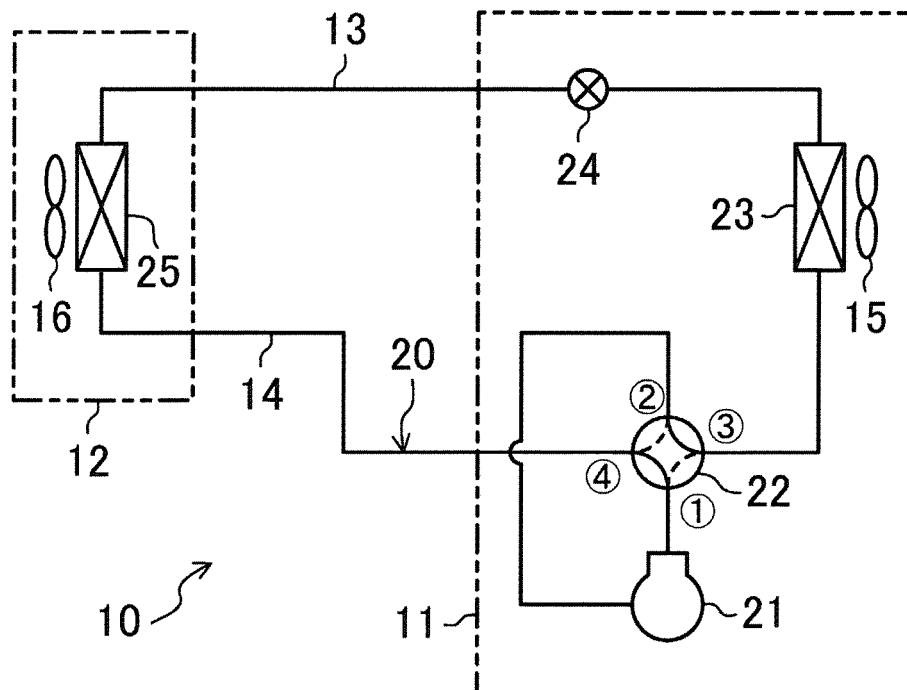


FIG.2

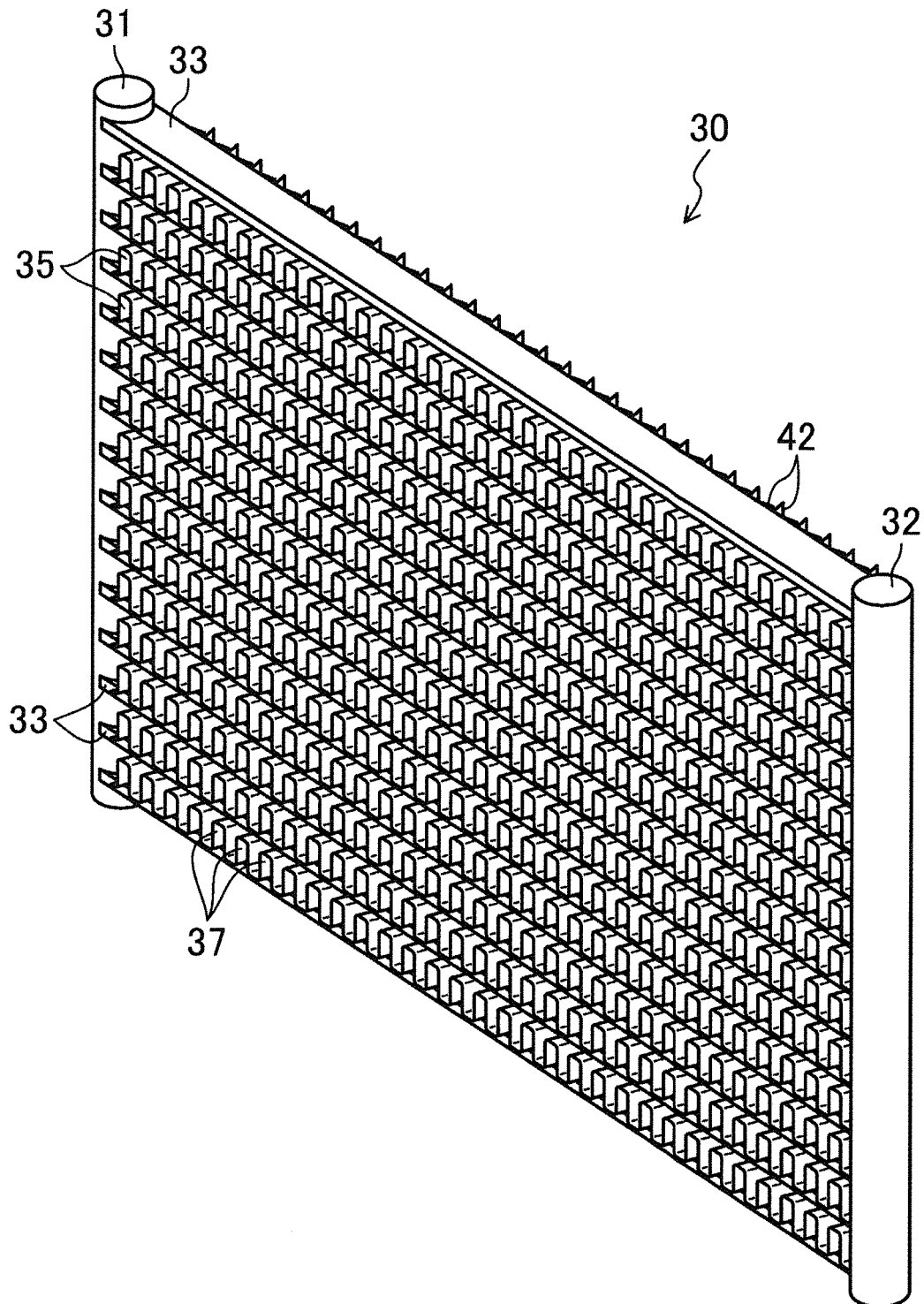


FIG.3

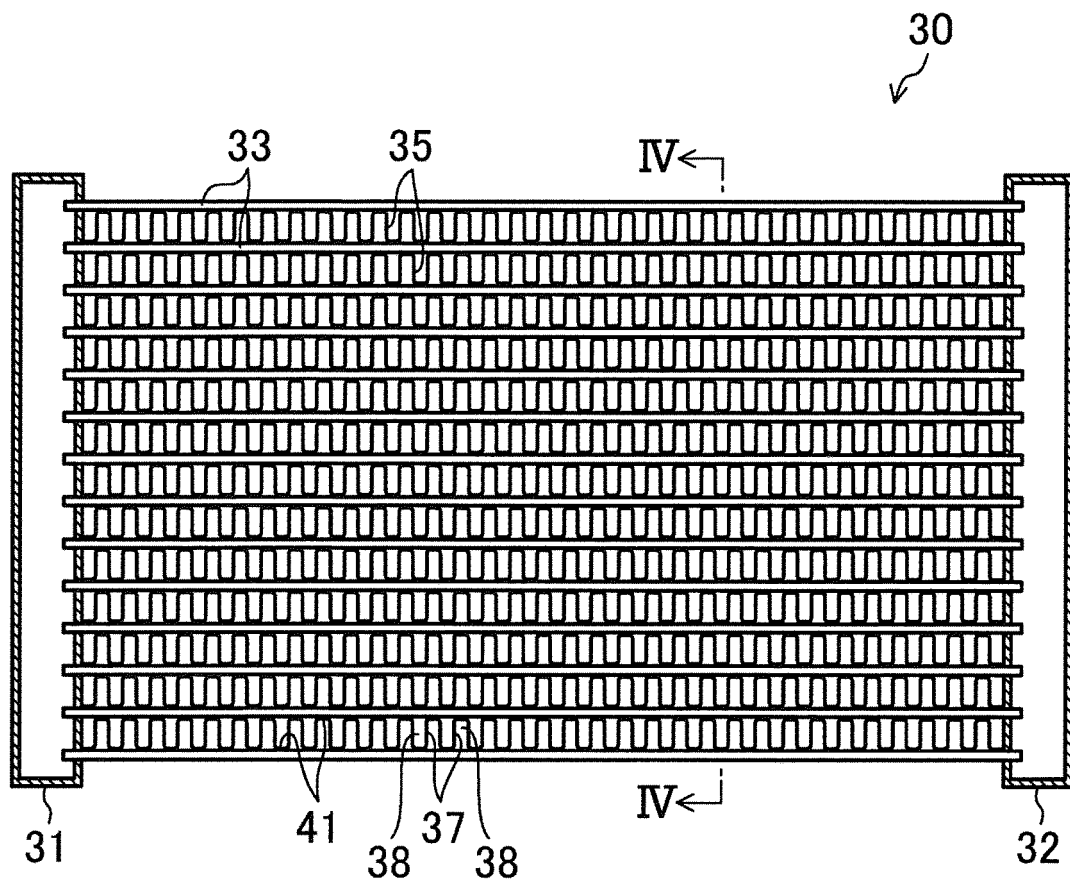


FIG.4

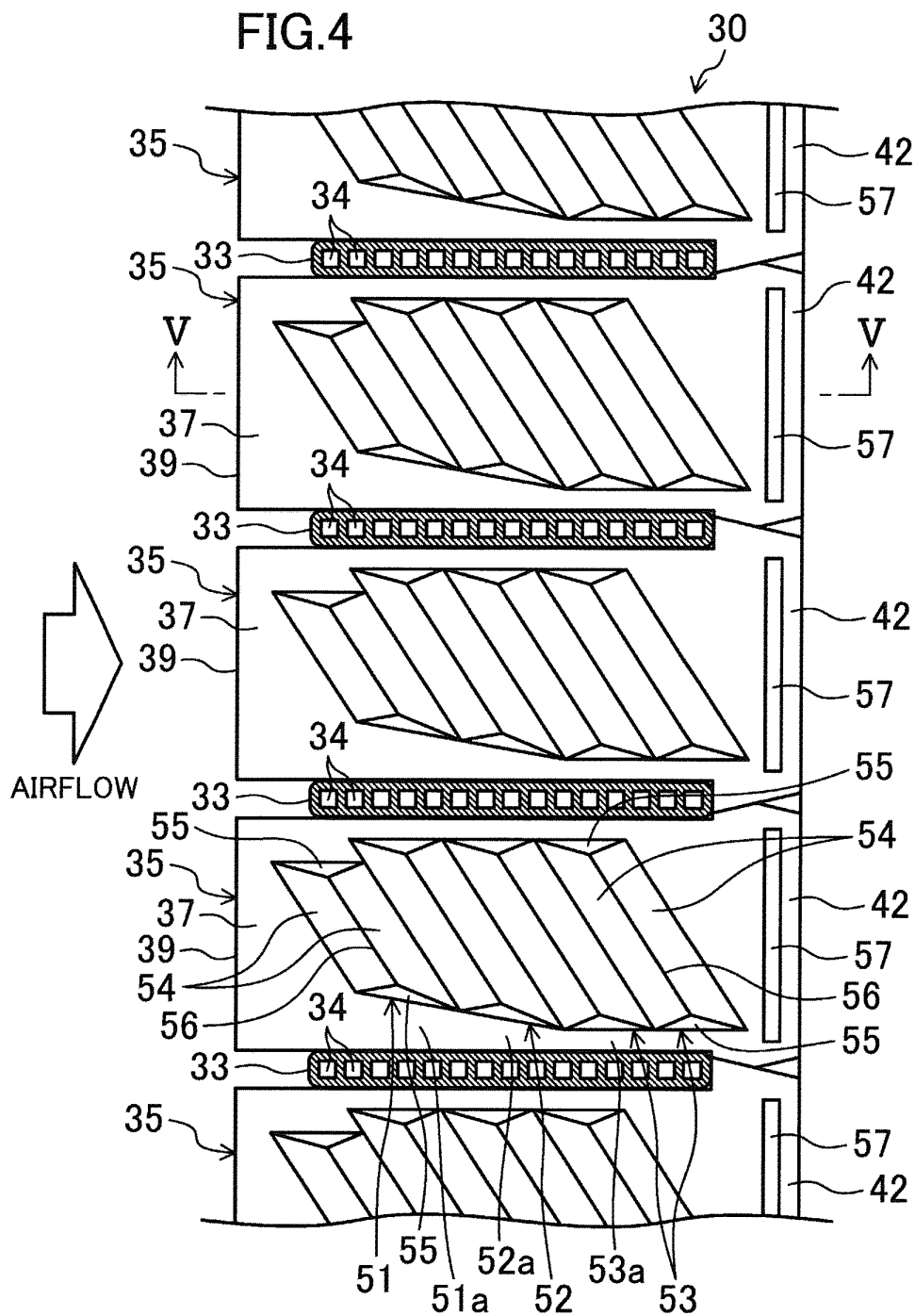


FIG.5

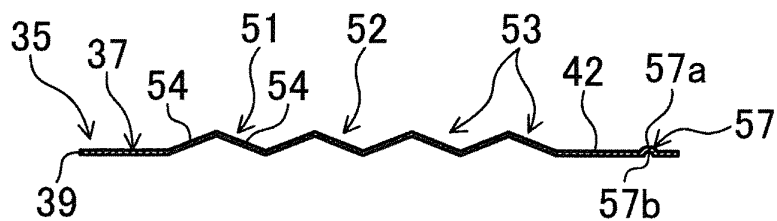


FIG.6

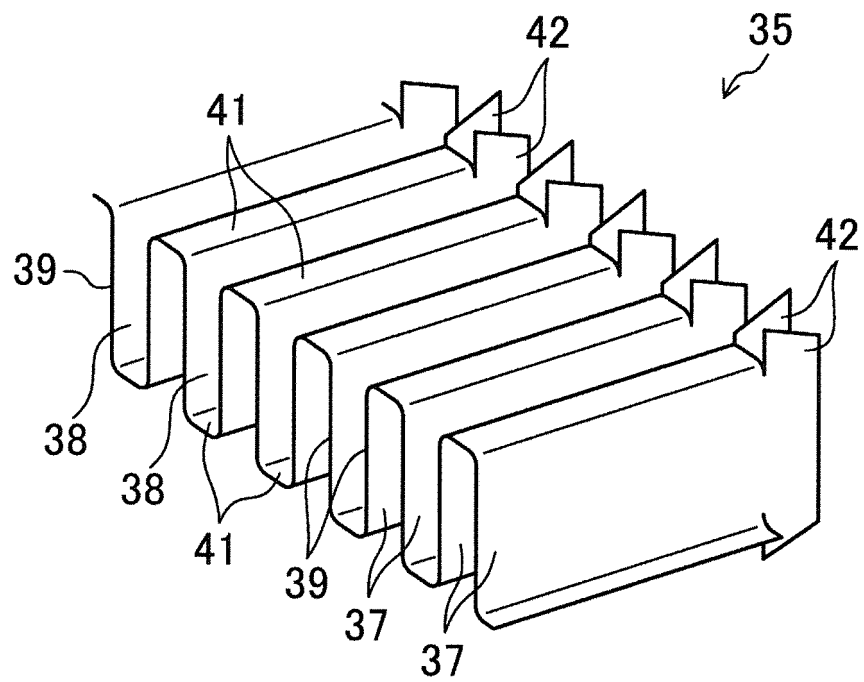


FIG. 7

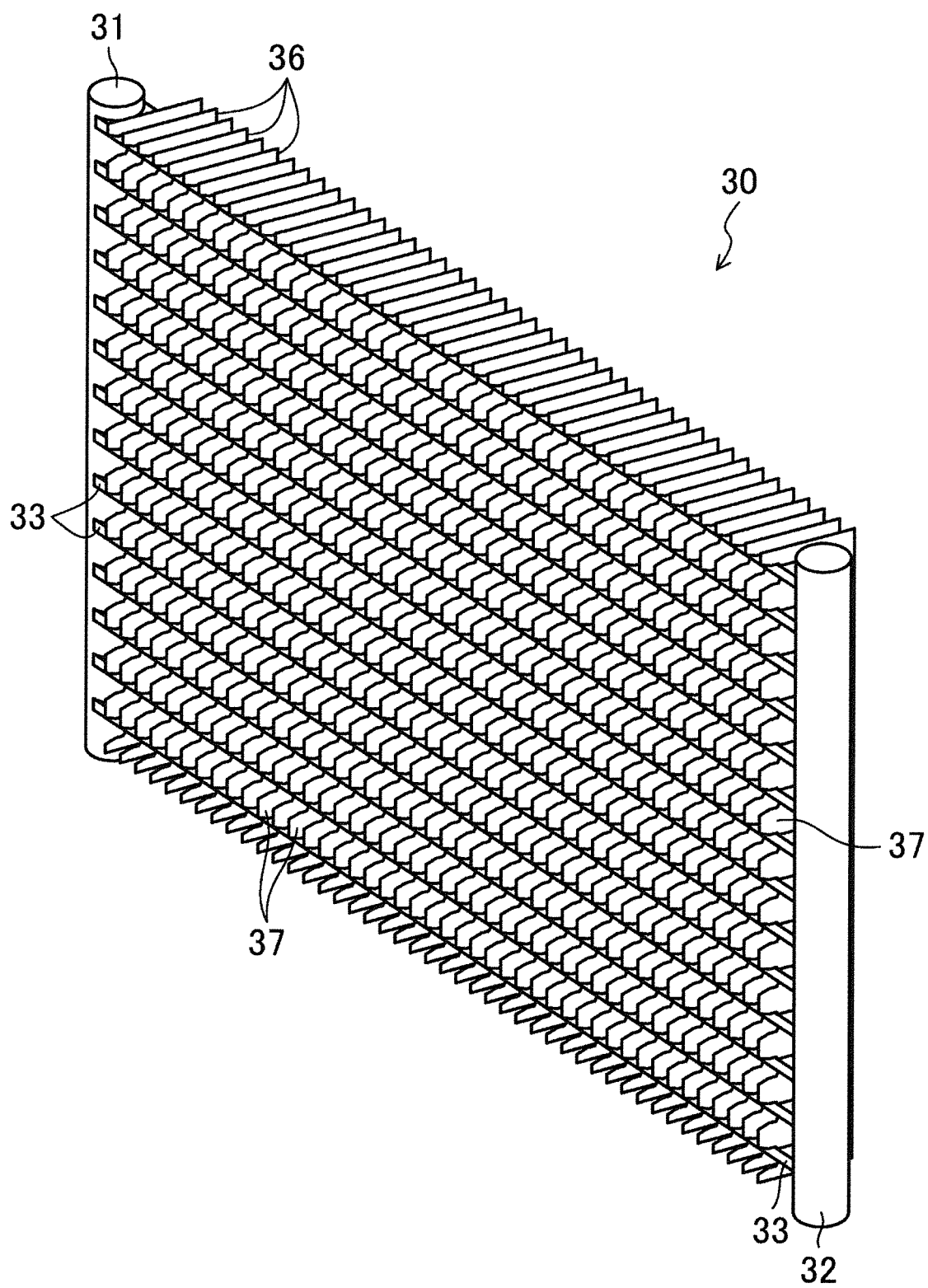


FIG.8

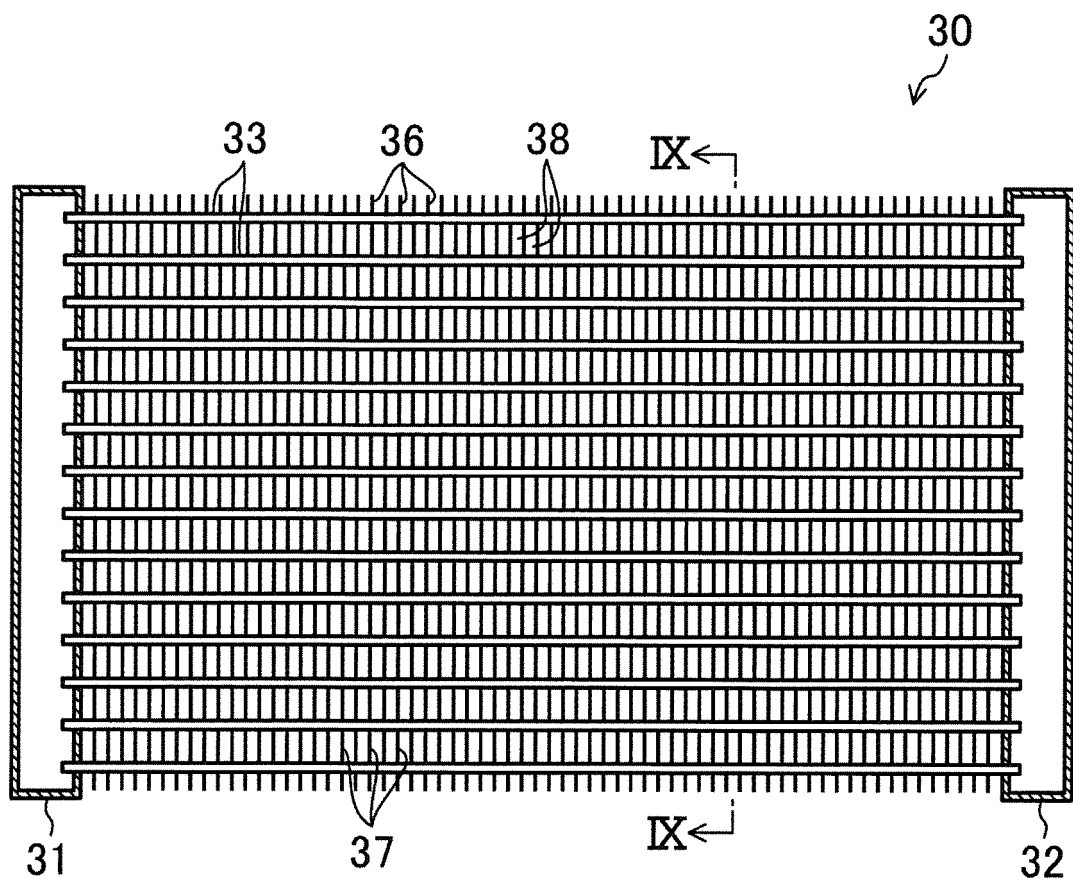


FIG.9

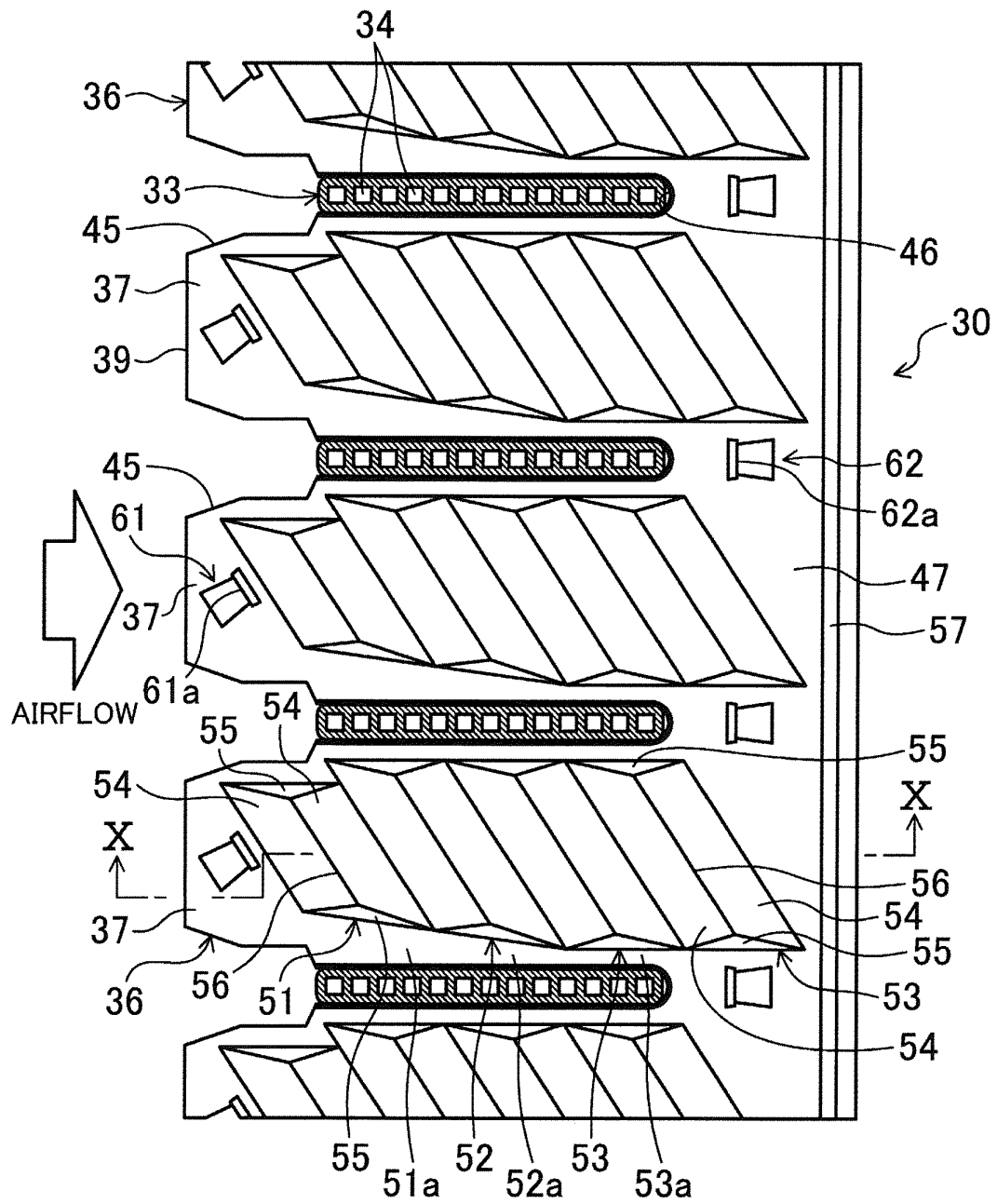
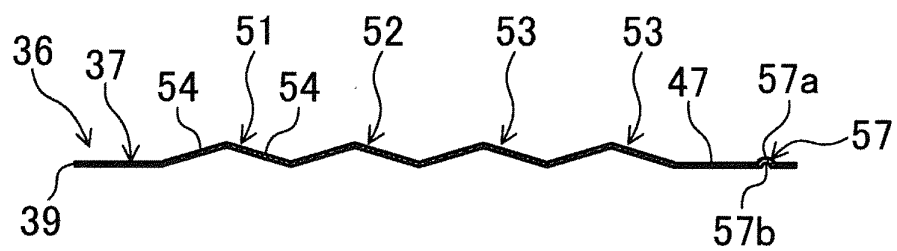


FIG.10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/000370

A. CLASSIFICATION OF SUBJECT MATTER 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) F28F1/32		
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 1996-2012 Kokai Jitsuyo Shinan Koho 1971-2012 Toroku Jitsuyo Shinan Koho 1994-2012		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 5-60482 A (Showa Aluminum Corp.), 09 March 1993 (09.03.1993), entire text; all drawings (particularly, paragraphs [0001], [0011] to [0017]; fig. 1) (Family: none)	1, 4-9 2, 3
Y A	JP 2005-201467 A (Matsushita Electric Industrial Co., Ltd.), 28 July 2005 (28.07.2005), entire text; all drawings (particularly, fig. 1) (Family: none)	1, 4-9 2, 3
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 13 April, 2012 (13.04.12)		Date of mailing of the international search report 24 April, 2012 (24.04.12)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/000370

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2007-17042 A (Matsushita Electric Industrial Co., Ltd.), 25 January 2007 (25.01.2007), entire text; all drawings (particularly, paragraphs [0029] to [0042]; fig. 4) (Family: none)	1, 4-9 2, 3
Y A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 33123/1992 (Laid-open No. 90173/1993) (Sumitomo Light Metal Industries, Ltd.), 07 December 1993 (07.12.1993), entire text; all drawings (particularly, fig. 2 to 9) (Family: none)	7 2, 3
Y A	JP 9-324995 A (Toshiba Corp.), 16 December 1997 (16.12.1997), entire text; all drawings (particularly, claim 1; paragraphs [0036] to [0082]; fig. 1 to 11) (Family: none)	8 2, 3

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003262485 A [0004]
- JP 2010002138 A [0004]
- JP H11294984 B [0004]