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(54) **HEAT EXCHANGER**

(57) A heat exchanger (10) includes a plurality of flat tubes (20) and one or more fins (30). The flat tubes (20) are arranged in a first direction. The fin (30) is joined to the flat tubes (20). The heat exchanger (10) causes heat exchange between a refrigerant that flows inside the flat tubes (20) and air that flows outside the flat tubes (20) along a second direction that intersects the first direction. The fin (30) includes a first joint portion (32) and a first plate portion (33). The first joint portion (32) is joined to a first flat tube (20a). The first plate portion (33) is positioned between an air flow downstream end (30b) and the first joint portion (32). The first plate portion (33) is formed with a first protruding portion (133) for causing water to flow in the first direction in a vicinity of the first flat tube (20a).

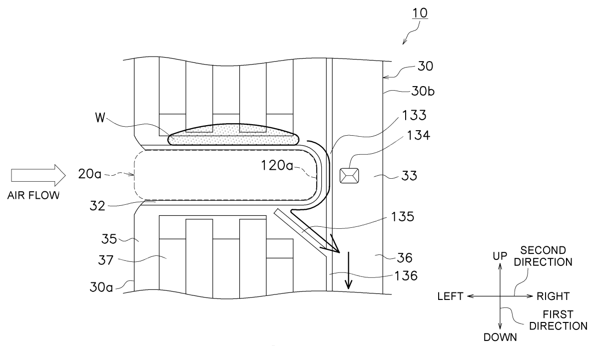

FIG. 5

EP 4 560 246 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a heat exchanger.

BACKGROUND ART

[0002] Conventionally, a heat exchanger including flat tubes and fins has been known. An example of such a heat exchanger is disclosed in International Publication No. 2018/003123 (PTL 1).

[0003] In PTL 1, a fin of a heat exchanger has a water guiding area disposed above and below each of a plurality of flat tubes, and a water drainage area disposed on a portion of one side of each of the plurality of flat tubes. In addition, the water guiding area has water guiding structures that guide water to the water drainage area, and the water drainage area has water drainage structures that guide water in the gravity direction.

SUMMARY OF INVENTION

<Technical Problem>

[0004] In the above-described PTL 1, water generated around the flat tubes is drawn into the water guiding area, and then is transported to the water drainage area. Since the drainage is performed in two stages in this manner, it takes time for the water to be drained.

<Solution to Problem>

[0005] A heat exchanger of a first aspect includes a plurality of flat tubes and a fin. The flat tubes are arranged in a first direction. The fin is joined to the flat tubes. The heat exchanger causes heat exchange between a refrigerant that flows inside the flat tube and air that flows outside the flat tube along a second direction that intersects the first direction. The fin includes a first joint portion and a first plate portion. The first joint portion is joined to a first flat tube. The first plate portion is positioned between an air flow downstream end of the fin and the first joint portion. The first plate portion is formed with a first protruding portion for causing water to flow in the first direction in a vicinity of the first flat tube.

[0006] In the heat exchanger of the first aspect, the first protruding portion can cause water located in the vicinity of the first flat tube to flow in the first direction. This can reduce the time required to drain, in the first direction, the water that is on the fin and is in the vicinity of the flat tube.

[0007] A heat exchanger of a second aspect is the heat exchanger of the first aspect, in which the first protruding portion extends in the first direction.

[0008] In the heat exchanger of the second aspect, since the first protruding portion extends in the first direction, the water can be transported along the first protruding portion. This can further reduce the time required to drain, in the first direction, the water that is on the fin and is in the vicinity of the flat tube.

[0009] A heat exchanger of a third aspect is the heat exchanger of the first or second aspect, in which a distance in the second direction between an air flow downstream end of the first flat tube and the first protruding portion is less than a distance in the second direction between the air flow downstream end of the fin and the first protruding portion.

[0010] In the heat exchanger of the third aspect, the first protruding portion is disposed in the first plate portion, on the upstream side near the flat tube. Therefore, splashing of water from the heat exchanger can be suppressed.

[0011] A heat exchanger of a fourth aspect is the heat exchanger of any one of the first to third aspects, in which the fin further includes a second joint portion and a second plate portion. The second joint portion is joined to a second flat tube that is disposed adjacent to the first flat tube in the first direction. The second plate portion is positioned between the first joint portion and the second joint portion. The second plate portion is formed with a second protruding portion extending in a direction inclined with respect to the first direction and the second direction.

[0012] In the heat exchanger of the fourth aspect, the second protruding portion can drain the water between the first flat tube and the second flat tube.

[0013] A heat exchanger of a fifth aspect is the heat exchanger of the fourth aspect, in which the first protruding portion extends in an up-down direction. The second protruding portion extends obliquely downward from a vicinity of an air flow downstream portion of the first flat tube.

[0014] In the heat exchanger of the fifth aspect, the second protruding portion can cause the water below and on the downstream side of the first flat tube to flow downward.

[0015] A heat exchanger of a sixth aspect is the heat exchanger of the fourth aspect, in which the first protruding portion extends in an up-down direction. The second protruding portion extends obliquely downward from a vicinity of an air flow upstream portion of the first flat tube.

[0016] In the heat exchanger of the sixth aspect, the second protruding portion can cause the water below and on the upstream side of the first flat tube to flow downward.

[0017] A heat exchanger of a seventh aspect is the heat exchanger of any one of the first to sixth aspects, in which the fin further includes a second joint portion, a second plate portion, and a third plate portion. The second joint portion is joined to a second flat tube that is disposed adjacent to the first flat tube in the first direction. The second plate portion is positioned between the first joint portion and the second joint portion. The third plate portion is positioned between the air flow downstream end of the fin and the second plate portion. The third plate portion is formed with a third protruding portion that is continuous with the first protruding portion.

[0018] In the heat exchanger of the seventh aspect, the first protruding portion and the third protruding portion can cause the water located in the vicinity of the first flat tube to flow in the first direction to the second flat tube.

[0019] A heat exchanger of an eighth aspect is the heat exchanger of any one of the first to seventh aspects, in which the fin further includes a second joint portion and a second plate portion. The second joint portion is joined to a second flat tube that is disposed adjacent to the first flat tube in the first direction. The second plate portion is positioned between the first joint portion and the second joint portion. The second plate portion is formed with a notch for enhancing heat transfer.

[0020] In the heat exchanger of the eighth aspect, the notch can enhance heat transfer between air and the fin.

[0021] A heat exchanger of a ninth aspect is the heat exchanger of any one of the first to eighth aspect, in which a plurality of the fins are arranged in an extending direction of the flat tube. A fin pitch of the fins is greater than or equal to 1.2 mm and less than or equal to 1.4 mm. A height of the first protruding portion is greater than or equal to 0.1 mm and less than or equal to 0.6 mm.

[0022] In the heat exchanger of the ninth aspect, in the heat exchanger where the plurality of fins are stacked, the first protruding portion can easily realize a reduction in the time required to drain water in the first direction.

[0023] A heat exchanger of a tenth aspect is the heat exchanger of any one of the first to ninth aspect, in which the heat exchanger is included in an indoor unit of an air-conditioning apparatus.

[0024] The heat exchanger of the tenth aspect can be applied to a heat exchanger of the indoor unit of the air-conditioning apparatus.

BRIEF DESCRIPTION OF DRAWINGS

[0025]

[Fig. 1] Fig. 1 is a schematic configuration diagram of an air-conditioning apparatus including a heat exchanger according to an embodiment of the present disclosure.

[Fig. 2] Fig. 2 is a perspective view of the heat exchanger according to an embodiment of the present disclosure.

[Fig. 3] Fig. 3 is a cross-sectional view of the heat exchanger according to an embodiment of the present disclosure.

[Fig. 4] Fig. 4 is an enlarged view of a fin constituting the heat exchanger.

[Fig. 5] Fig. 5 is a diagram for describing a flow of water.

[Fig. 6] Fig. 6 is an enlarged view of a fin constituting a heat exchanger according to a modification.

[Fig. 7] Fig. 7 is an enlarged view of a fin constituting a heat exchanger according to another modification.

DESCRIPTION OF EMBODIMENTS

(1) Air-conditioning apparatus

[0026] An air-conditioning apparatus including a heat exchanger according to an embodiment of the present disclosure will be described with reference to Fig. 1. As illustrated in Fig. 1, an air-conditioning apparatus 200 is an apparatus used for cooling and heating the inside of a room in a building or the like by performing a vapor compression refrigeration cycle operation.

[0027] The air-conditioning apparatus 200 mainly includes an outdoor unit 220, an indoor unit 230, and a liquid-refrigerant connection pipe 240 and a gas-refrigerant connection pipe 250 that connect the outdoor unit 220 and the indoor unit 230 to each other. In addition, a vapor compression refrigerant circuit 210 of the air-conditioning apparatus 200 is configured by connecting the outdoor unit 220 and the indoor unit 230 via the liquid-refrigerant connection pipe 240 and the gas-refrigerant connection pipe 250.

(1-1) Outdoor unit

[0028] The outdoor unit 220 is installed outdoors. The outdoor unit 220 mainly includes a compressor 221, a flow path switching mechanism 222, an outdoor heat exchanger 223, and an expansion mechanism 224.

[0029] The compressor 221 is a mechanism that compresses a low-pressure refrigerant in the refrigeration cycle until the pressure of the refrigerant becomes high.

[0030] The flow path switching mechanism 222 is a mechanism that switches the flow direction of a refrigerant when switching between a cooling operation and a heating operation. During the cooling operation, the flow path switching mechanism 222 connects a discharge side of the compressor 221 and a gas side of the outdoor heat exchanger 223, and connects a gas side of an indoor heat exchanger 231 (described later) and a suction side of the compressor 221 to each other via the gas-refrigerant connection pipe 250 (see solid lines in the flow path switching mechanism 222 in Fig. 1). On the other hand, during the heating operation, the flow path switching mechanism 222 connects the discharge side of the compressor 221 and the gas side of the indoor heat exchanger 231 to each other via the gas-refrigerant connection pipe 250, and connects the gas side of the outdoor heat exchanger 223 and the suction side of the compressor 221 to each other (see broken lines in the flow path switching mechanism 222 in Fig. 1).

[0031] The outdoor heat exchanger 223 is a heat exchanger that functions as a radiator for a refrigerant during the cooling operation, and functions as an evaporator for the refrigerant during the heating operation. The outdoor heat exchanger 223 has a liquid side connected to the expansion mechanism 224, and has the gas side connected to the flow path switching mechanism 222.

[0032] The expansion mechanism 224 is a mechanism that decompresses a high pressure liquid refrigerant that has radiated heat in the outdoor heat exchanger 223 before the refrigerant is sent to the indoor heat exchanger 231 during the cooling operation, and decompresses a high pressure liquid refrigerant that has radiated heat in the indoor heat exchanger 231 before the refrigerant is sent to the outdoor heat exchanger 223 during the heating operation.

[0033] In addition, the outdoor unit 220 is provided with an outdoor fan 225 for sucking outdoor air into the outdoor unit 220, supplying the outdoor air to the outdoor heat exchanger 223, and then discharging the outdoor air to the outside of the outdoor unit 220.

(1-2) Indoor unit

[0034] The indoor unit 230 is installed indoors. The indoor unit 230 mainly includes the indoor heat exchanger 231 and an indoor fan 232.

[0035] The indoor heat exchanger 231 is a heat exchanger that functions as an evaporator for a refrigerant during the cooling operation, and functions as a radiator for the refrigerant during the heating operation. The indoor heat exchanger 231 has a liquid side connected to the liquid-refrigerant connection pipe 240, and has the gas side connected to the gas-refrigerant connection pipe 250.

[0036] In addition, the indoor unit 230 is provided with the indoor fan 232 for sucking indoor air into the indoor unit 230, supplying the indoor air to the indoor heat exchanger 231, and then discharging the indoor air to the outside of the indoor unit 230.

(1-3) Operation

(1-3-1) Cooling operation

[0037] In a case where the air-conditioning apparatus 200 performs the cooling operation, a low-pressure refrigerant in the refrigeration cycle is sucked into the compressor 221, is compressed until the pressure of the refrigerant becomes high in the refrigeration cycle, and is then discharged. The high-pressure refrigerant discharged from the compressor 221 is sent to the outdoor heat exchanger 223 through the flow path switching mechanism 222. The high-pressure refrigerant sent to the outdoor heat exchanger 223 exchanges heat with outdoor air supplied by the outdoor fan 225 and radiates heat in the outdoor heat exchanger 223. The high-pressure refrigerant that has radiated heat in the outdoor heat exchanger 223 is sent to the expansion mechanism 224, and is decompressed until the pressure of the refrigerant becomes low in the refrigeration cycle. The low-pressure refrigerant decompressed in the expansion mechanism 224 is sent to the indoor heat exchanger 231 through the liquid-refrigerant connection pipe 240. The low-pressure refrigerant sent to the indoor heat exchanger 231 exchanges heat with indoor air supplied by the indoor fan 232 and evaporates in the indoor heat exchanger 231. As a result, the indoor air is cooled and blown into the room. The low-pressure refrigerant that has evaporated in the indoor heat exchanger 231 is sucked again into the compressor 221 through the gas-refrigerant connection pipe 250 and the flow path switching mechanism 222.

(1-3-2) Heating operation

[0038] In a case where the air-conditioning apparatus 200 performs the heating operation, a low-pressure refrigerant in the refrigeration cycle is sucked into the compressor 221, is compressed until the pressure of the refrigerant becomes high in the refrigeration cycle, and is then discharged. The high-pressure refrigerant discharged from the compressor 221 is sent to the indoor heat exchanger 231 through the flow path switching mechanism 222 and the gas-refrigerant connection pipe 250. The high-pressure refrigerant sent to the indoor heat exchanger 231 exchanges heat with indoor air supplied by the indoor fan 232 and radiates heat in the indoor heat exchanger 231. As a result, the indoor air is heated and blown into the room. The high-pressure refrigerant that has radiated heat in the indoor heat exchanger 231 is sent to the expansion mechanism 224 through the liquid-refrigerant connection pipe 240, and is decompressed until the pressure of the refrigerant becomes low in the refrigeration cycle. The low-pressure refrigerant decompressed in the expansion mechanism 224 is sent to the outdoor heat exchanger 223. The low-pressure refrigerant sent to the outdoor heat exchanger 223 exchanges heat with outdoor air supplied by the indoor fan 232 and evaporates in the outdoor heat exchanger 223. The low-pressure refrigerant that has evaporated in the outdoor heat exchanger 223 is sucked again into the compressor 221 through the flow path switching mechanism 222.

(2) Heat exchanger

(2-1) Overall configuration

[0039] A heat exchanger 10 according to an embodiment of the present disclosure will be described with reference to Figs. 1 to 5. The heat exchanger 10 of the present embodiment is included in the indoor unit 230 of the air-conditioning apparatus 200 in Fig. 1. Specifically, the heat exchanger 10 is the indoor heat exchanger 231 illustrated in Fig. 1.

[0040] As illustrated in Figs. 2 to 5, the heat exchanger 10 includes a plurality of flat tubes 20 and a plurality of fins 30. The flat tubes 20 are arranged in a first direction. The fins 30 are joined to the flat tubes 20. The heat exchanger 10 causes heat exchange between a refrigerant that flows inside the flat tubes 20 and air that flows outside the flat tubes 20. The heat exchanger 10 causes heat exchange between air and the refrigerant without mixing the air and the refrigerant with each other.

[0041] Air flows outside the flat tubes 20 along a second direction that intersects the first direction. Here, the first direction is the up-down (vertical) direction. The second direction is orthogonal to the first direction. Specifically, the second direction is the left-right direction. In addition, as illustrated in Figs. 2 to 5, air flows in a direction from the left to the right. In other words, the left side is the upstream side of the air flow, and the right side is the downstream side of the air flow.

(2-2) Detailed configuration

(2-2-1) Flat tube

[0042] As illustrated in Fig. 3, a plurality of the flat tubes 20 are disposed parallel to each other at an interval along the first direction. As illustrated in Fig. 2, the flat tubes 20 extend in a third direction. The third direction intersects the first direction and the second direction. Here, the third direction is orthogonal to the first direction and the second direction. Specifically, the third direction is the front-rear direction.

[0043] As illustrated in Figs. 2 to 5, the cross-sectional shape of the flat tube 20 is a flat oval shape or a rectangular shape with rounded corners. The length (width) of the flat tube 20 in the second direction is greater than the length (thickness) of the flat tube 20 in the first direction. The flat tube 20 is made of, for example, aluminum or an aluminum alloy.

[0044] The flat tube 20 is a heat transfer tube in which a refrigerant flows. The flat tube 20 is formed with a plurality of through holes 21 arranged in the second direction. The refrigerant that exchanges heat with air in the heat exchanger 10 passes through the through holes 21. These plurality of through holes extend through the flat tube 20 along the third direction.

(2-2-2) Fin

[0045] The fins 30 are joined to the plurality of flat tubes 20. Here, the flat tubes 20 and the fins 30 are joined to each other by brazing. The fins 30 increase the heat transfer area between the flat tubes 20 and air, and enhance heat exchange between the refrigerant and the air.

[0046] As illustrated in Fig. 2, the plurality of fins 30 are disposed parallel to each other at intervals along the third direction. The fins 30 extend in the first direction. The fins 30 are disposed so as to intersect (here, orthogonal to) an extending direction of the flat tubes 20. In the present embodiment, the plurality of fins 30 are disposed in parallel and at equal intervals. In other words, the plurality of fins 30 are arranged in the third direction at a predetermined fin pitch P. In the present embodiment, the fin pitch P is greater than or equal to 1.2 mm and less than or equal to 1.4 mm.

[0047] The fin 30 has a flat plate shape. The fin 30 is formed by press working or the like. The fin 30 is made of, for example, aluminum or an aluminum alloy.

[0048] As illustrated in Figs. 3 to 5, the fin 30 is formed with a plurality of insertion portions 31 for inserting the flat tubes 20. The insertion portion 31 is notched in the second direction from an air flow upstream end 30a toward an air flow downstream end 30b side. The plurality of insertion portions 31 are arranged at intervals along the first direction.

[0049] The fin 30 includes a first joint portion 32, a first plate portion 33, a second joint portion 34, a second plate portion 35, and a third plate portion 36. Hereinafter, in Fig. 3, the flat tube 20 positioned on the upper side will be described as a first flat tube 20a, and the flat tube 20 positioned on the lower side will be described as a second flat tube 20b. The first flat tube 20a and the second flat tube 20b are disposed adjacent to each other in the first direction.

[0050] As illustrated in Fig. 3, the first joint portion 32 is joined to the first flat tube 20a. Here, the first joint portion 32 has a U shape as viewed in cross section. In the present embodiment, the first joint portion 32 is a collar portion. Specifically, the first joint portion 32 extends so as to protrude in the third direction from the insertion portion 31 on one surface (front surface) side of the fin 30 toward the other surface (rear surface) of an adjacent fin 30.

[0051] The first plate portion 33 is positioned between an air flow downstream end 30b and the first joint portion 32. The first plate portion 33 is continuous with the first joint portion 32. The first plate portion 33 is formed with a first protruding portion 133 and a rib 134.

[0052] The first protruding portion 133 causes water to flow in the first direction in the vicinity of the first flat tube 20a. In other words, the first protruding portion 133 is a water-guiding rib that causes water located in the vicinity of the first flat tube 20a to flow in the first direction.

[0053] As illustrated in Fig. 4, a distance L1 in the second direction between an air flow downstream end 120a of the first flat tube 20a and the first protruding portion 133 is less than a distance L2 in the second direction between the air flow downstream end 30b of the fin 30 and the first protruding portion 133. The distance L1 is preferably 1/3 or less of the distance L2, and more preferably 1/5 or less of the distance L2.

[0054] The first protruding portion 133 extends in the first direction. In Figs. 3 to 5, the first protruding portion 133 extends in the up-down direction. In the present embodiment, the first protruding portion 133 extends in the gravity (vertical) direction. With such a configuration, in the present embodiment, the first protruding portion 133 causes water to flow downward by the weight of the water in the vicinity of the downstream side of the first joint portion 32 joined to the first flat tube 20a.

[0055] The height of the first protruding portion 133 is not limited, but is greater than or equal to 0.1 mm and less than or equal to 0.6 mm, for example. Note that the height is a protruding distance (distance in the third direction) from one surface of the fin 30 toward the other surface of the adjacent fin 30.

[0056] The rib 134 is a rib for enhancing heat transfer. The rib 134 protrudes from one surface of the fin 30 toward the other surface of the adjacent fin 30. The rib 134 has a rectangular shape as viewed in cross section. In Figs. 3 to 5, the length (width) of the rib 134 in the second direction is greater than the length (width) of the first protruding portion 133 in the second direction.

[0057] The second joint portion 34 is joined to the second flat tube 20b. The second joint portion 34 has the same shape as the first joint portion 32.

[0058] The second plate portion 35 is positioned between the first joint portion 32 and the second joint portion 34. The second plate portion 35 is continuous with the first joint portion 32 and the second joint portion 34. The second plate portion 35 is formed with a second protruding portion 135 and notches 37.

[0059] The second protruding portion 135 extends in a direction inclined with respect to the first direction and the second direction. In Figs. 3 to 5, the second protruding portion 135 extends from an upper end portion of the second plate portion 35 toward the lower right. The second protruding portion 135 is a water-guiding rib that drains water between the first flat tube 20a and the second flat tube 20b.

[0060] In the present embodiment, the second protruding portion 135 extends obliquely downward from the vicinity of an air flow downstream portion of the first flat tube 20a. Specifically, the second protruding portion 135 extends from the vicinity of the downstream end 120a toward the downstream side of the air flow so as to be connected to a third protruding portion 136. With such a configuration, the second protruding portion 135 provided here is a water-guiding rib that drains water located in the vicinity of the air flow downstream portion of the first flat tube 20a between the first flat tube 20a and the second flat tube 20b toward the lower right.

[0061] As illustrated in Fig. 4, a distance L3 in the second direction between the air flow downstream end 120a of the first flat tube 20a and one end (left end in Fig. 4) of the second protruding portion 135 in the second direction is less than a distance L4 in the second direction between the air flow upstream end 30a of the fin 30 and one end (left end in Fig. 4) of the second protruding portion 135 in the second direction. The distance L3 is preferably 1/3 or less of the distance L4, and more preferably 1/5 or less of the distance L4.

[0062] The height of the second protruding portion 135 may be equal to, less than, or greater than the height of the first protruding portion 133. Here, the height of the second protruding portion 135 is, for example, greater than or equal to 0.1 mm and less than or equal to 0.6 mm.

[0063] The notches 37 are the notches 37 for enhancing heat transfer. A plurality of (three in Fig. 3) notches 37 are arranged in the second direction. In addition, the notch 37 extends in the first direction. Here, the notch 37 is recessed from the other surface of the fin 30 toward one surface of an adjacent fin 30.

[0064] The third plate portion 36 is positioned between the air flow downstream end 30b and the second plate portion 35. The third plate portion 36 is continuous with the first plate portion 33 and the second plate portion 35.

[0065] The third plate portion 36 is formed with the third protruding portion 136 that is continuous with the first protruding portion 133. The third protruding portion 136 is a water-guiding rib that causes water from the first protruding portion 133 to flow in the first direction.

[0066] The third protruding portion 136 extends in the first direction. In Figs. 3 to 5, the third protruding portion 136 extends in the up-down direction. In the present embodiment, the third protruding portion 136 extends in the gravity (vertical) direction. With such a configuration, in the present embodiment, the third protruding portion 136 causes water from the first protruding portion 133 to flow downward.

[0067] The position of the third protruding portion 136 in the second direction is the same as that of the first protruding portion 133. In other words, the first protruding portion 133 and the third protruding portion 136 are linearly continuous in the up-down (vertical) direction.

[0068] The height of the third protruding portion 136 may be equal to, less than, or greater than the height of the first protruding portion 133. Here, the height of the third protruding portion 136 is the same as that of the first protruding portion 133.

[0069] Note that, in the present embodiment, the fin 30 does not have a shape that hinders the guiding of water by the first protruding portion 133, the second protruding portion 135, and the third protruding portion 136.

[0070] In addition, Fig. 3 illustrates an area in which the fin 30 is joined to the first flat tube 20a and the second flat tube 20b, but as illustrated in Fig. 2, in the present embodiment, the fin 30 is joined to three or more flat tubes 20. Furthermore, the linear rib formed by the continuity of the first protruding portion 133 and the third protruding portion 136 extends from the upper end portion to the lower end portion of the fin 30.

(2-3) Operation

[0071] During the operation such as the cooling operation and the heating operation of the air-conditioning apparatus 200 illustrated in Fig. 1, a refrigerant is sent to the flat tubes 20 of the heat exchanger 10 that serves as the indoor heat exchanger 231 in the refrigerant circuit 210. The refrigerant flows through the plurality of through holes 21 of the flat tubes 20. Then, the refrigerant that flows inside the flat tubes 20 exchanges heat with indoor air that flows outside the flat tubes 20. During this operation, condensation water may be generated around the joint portions of the fins 30 joined to the flat tubes 20.

[0072] As illustrated in Fig. 5, water W as condensation water that is accumulated on an upper portion of the first flat tube 20a moves along the first joint portion 32. Specifically, the water W moves in an arc shape along a curved portion of the first protruding portion 133.

[0073] In addition, the water moved along the first protruding portion 133 and water W accumulated on a lower portion of the first flat tube 20a move in a direction inclined with respect to the first direction and the second direction (toward the lower right side in Fig. 5) along the second protruding portion 135.

[0074] Then, the water W moves in the first direction (downward in Fig. 5) along the third protruding portion 136 that is connected to the second protruding portion 135 and is continuous with the first protruding portion 133.

[0075] In this manner, the water W generated around the first flat tube 20a is directly drawn into the first protruding portion 133 and the second protruding portion 135, and is drained downward along the third protruding portion 136. In other words, the water W is drained downward by flowing along the first protruding portion 133, the second protruding portion 135, and the third protruding portion 136. This prevents the water W generated around the first flat tube 20a from getting caught at any point along the way, and increases the drainage rate.

[0076] Note that, in some cases, depending on the amount of the water W, the heights of the first protruding portion 133, the second protruding portion 135, and the third protruding portion 136, and the like, the water W may flow on the left side of the first protruding portion 133 and the third protruding portion 136 in Fig. 5. For example, in a case where the height of the second protruding portion 135 is greater than the heights of the first protruding portion 133 and the third protruding portion 136, the water W mainly flows on the right side of the first protruding portion 133 and the third protruding portion 136. On the other hand, in a case where the height of the second protruding portion 135 is less than or equal to the heights of the first protruding portion 133 and the third protruding portion 136, the water W mainly flows on the left side of the first protruding portion 133 and the third protruding portion 136.

(3) Features

[0077] (3-1)
The heat exchanger 10 according to the present embodiment includes a plurality of flat tubes 20 and one or more fins 30. The flat tubes 20 are arranged in the first direction. The fins 30 are joined to the flat tubes 20. The heat exchanger 10 causes heat exchange between a refrigerant that flows inside the flat tubes 20 and air that flows outside the flat tubes 20 along the second direction that intersects the first direction. The fin 30 includes the first joint portion 32 and the first plate portion 33. The first joint portion 32 is joined to the first flat tube 20a. The first plate portion 33 is positioned between the air flow downstream end 30b and the first joint portion 32. The first plate portion 33 is formed with the first protruding portion 133 for causing water to flow in the first direction in the vicinity of the first flat tube 20a.

[0078] In the heat exchanger 10 of the present embodiment, the first protruding portion 133 can cause the water W located in the vicinity of the first flat tube 20a to flow in the first direction. This can reduce the time required to drain, in the first direction, the water that is on the fin 30 and is in the vicinity of the first flat tube 20a.

[0079] In addition, in the present embodiment, the heat exchanger 10 drains water generated around the first flat tube 20a using the first protruding portion 133 in the vicinity of the first flat tube 20a without transporting the water to the air flow downstream end 30b of the fin 30. Therefore, splashing of water from the fin 30 can be suppressed.

(3-2)
In the heat exchanger 10 of the present embodiment, the first protruding portion 133 extends in the first direction. With such a configuration, the water W can be transported along the first protruding portion 133. This can further reduce the time required to drain, in the first direction, the water W that is on the fin 30 and is in the vicinity of the first flat tube 20a.

(3-3)
In the heat exchanger 10 of the present embodiment, the distance L1 in the second direction between the air flow downstream end 120a of the first flat tube 20a and the first protruding portion 133 is less than the distance L2 in the second direction between the air flow downstream end 30b of the fin 30 and the first protruding portion 133.

[0080] With such a configuration, in the first plate portion 33, the first protruding portion 133 is disposed near the first flat tube 20a and on the upstream side of the air flow. Therefore, splashing of water from the heat exchanger 10 can be further suppressed.

[0081] (3-4)
In the heat exchanger 10 of the present embodiment, the fin 30 further includes the second joint portion 34 and the second plate portion 35. The second joint portion 34 is joined to the second flat tube 20b that is disposed adjacent to the first flat tube 20a in the first direction. The second plate portion 35 is positioned between the first joint portion 32 and the second joint portion 34. The second plate portion 35 is formed with the second protruding portion 135 extending in the direction inclined with respect to the first direction and the second direction.

[0082] Here, the second protruding portion 135 can drain the water W between the first flat tube 20a and the second flat tube 20b.

[0083] (3-5)
In the heat exchanger 10 of the present embodiment, the first protruding portion 133 extends in the up-down direction. The second protruding portion 135 extends obliquely downward from the vicinity of the air flow downstream portion of the first flat tube 20a.

[0084] Here, the second protruding portion 135 can cause the water W below and on the downstream side of the first flat tube 20a to flow downward.

[0085] (3-6)
In the heat exchanger 10 of the present embodiment, the fin 30 further includes the second joint portion 34, the second plate portion 35, and the third plate portion 36. The second joint portion 34 is joined to the second flat tube 20b that is disposed adjacent to the first flat tube 20a in the first direction. The second plate portion 35 is positioned between the first joint portion 32 and the second joint portion 34. The third plate portion 36 is positioned between the air flow downstream end 30b and the second plate portion 35. The third plate portion 36 is formed with the third protruding portion 136 that is continuous with the first protruding portion 133.

[0086] Here, the first protruding portion 133 and the third protruding portion 136 can cause the water W located in the vicinity of the first flat tube 20a to flow in the first direction to the second flat tube 20b.

[0087] In addition, the second protruding portion 135 can guide the water W below and on the downstream side of the first flat tube 20a to the third protruding portion 136, and the third protruding portion 136 can cause the water W to flow further downward.

[0088] (3-7)
In the heat exchanger 10 of the present embodiment, the fin 30 further includes the second joint portion 34 and the second plate portion 35. The second joint portion 34 is joined to the second flat tube 20b that is disposed adjacent to the first flat tube 20a in the first direction. The second plate portion 35 is positioned between the first joint portion 32 and the second joint portion 34. The second plate portion 35 is formed with the notches 37 for enhancing heat transfer.

[0089] Here, the notches 37 can enhance heat transfer between air and the fin 30. This can enhance heat exchange between the refrigerant that flows inside the flat tubes 20 and air that flows outside the fins 30.

[0090] (3-8)
In the heat exchanger 10 of the present embodiment, the plurality of fins 30 are arranged in the extending direction of the flat tubes 20. The fin pitch P of the fins 30 is greater than or equal to 1.2 mm and less than or equal to 1.4 mm. The height of the first protruding portion 133 is greater than or equal to 0.1 mm and less than or equal to 0.6 mm.

[0091] With such a configuration, in the heat exchanger 10 where the plurality of fins 30 are stacked, the first protruding portion 133 can easily realize a reduction in the time required to drain water in the first direction.

[0092] (3-9)
The heat exchanger 10 of the present embodiment is included in the indoor unit 230 of the air-conditioning apparatus 200. In other words, the heat exchanger 10 of the present embodiment can be applied to the indoor unit 230 of the air-conditioning apparatus 200. The heat exchanger 10 of the present embodiment can reduce the time required to drain water and can suppress the splashing of the water from the fin 30. Therefore, the heat exchanger 10 is suitably used for the indoor heat exchanger 231 disposed indoors.

(4) Modifications

(4-1) Modification 1

[0093] In the above-described embodiment, the second protruding portion 135 extends obliquely downward from the vicinity of the air flow downstream portion of the first flat tube 20a, but the present invention is not limited thereto. In a heat exchanger 11 of the present modification, as illustrated in Fig. 6, the second protruding portion 135 extends obliquely downward from the vicinity of an air flow upstream portion 120b of the first flat tube 20a. Here, the second protruding portion 135 extends from the vicinity of an air flow upstream end of the first joint portion 32 toward the lower right.

[0094] As illustrated in Fig. 6, a distance in the second direction between the air flow downstream end 120a of the first flat tube 20a and one end (left end in Fig. 6) of the second protruding portion 135 in the second direction is greater than a distance in the second direction between the air flow upstream end 30a of the fin 30 and one end (left end in Fig. 6) of the second protruding portion 135 in the second direction.

[0095] In the present modification, the water W accumulated on the lower portion of the first flat tube 20a moves from the upstream side of the air flow in the direction inclined with respect to the first direction and the second direction (toward the lower right side in Fig. 6) along the second protruding portion 135. Then, the water W moves in the first direction (downward in Fig. 6) along the third protruding portion 136 that is connected to the second protruding portion 135.

[0096] As described above, in the heat exchanger 11 of the present modification, the first protruding portion 133 extends in the up-down (vertical) direction. The second protruding portion 135 extends obliquely downward from the vicinity of the air flow upstream portion 120b of the first flat tube 20a.

[0097] Here, the second protruding portion 135 can cause the water W below and on the upstream side of the first flat tube 20a to flow downward.

(4-2) Modification 2

[0098] In the above-described embodiment, the first protruding portion 133 and the third protruding portion 136 are formed as water-guiding ribs for causing water to flow in the first direction, but another water-guiding rib may be further formed. As illustrated in Fig. 7, a heat exchanger 12 of the present modification is further formed with a fourth protruding portion 138 for causing water to flow in the first direction. The fourth protruding portion 138 is formed on the downstream side of the first protruding portion 133 and the third protruding portion 136 in the air flow.

[0099] Specifically, the fourth protruding portion 138 is formed in the vicinity of the air flow downstream end 30b of the fin 30 so as to extend in the first direction. The fourth protruding portion 138 continuously extends from the upper end portion to the lower end portion of the fin 30. The fourth protruding portion 138 is parallel and liner to the first protruding portion 133 and the third protruding portion 136.

(4-3) Modification 3

[0100] In the above-described embodiment, the fin 30 is formed with the notches 37, ribs 134, and the like for enhancing heat transfer, but the present invention is not limited thereto. Notches, ribs, and the like for enhancing heat transfer are formed as appropriate. In the present modification, ribs for enhancing heat transfer are further formed on both sides of the third protruding portion 136. The ribs formed on both sides are, for example, L-shaped as viewed in cross section.

(4-4) Modification 4

[0101] In the above-described embodiment, the heat exchanger 10 is applied to the indoor heat exchanger 231, but the present invention is not limited thereto. In the present modification, the heat exchanger 10 is applied to the outdoor heat exchanger 223.

(4-5) Modification 5

[0102] In the above-described embodiment, the heat exchanger 10 is applied to the air-conditioning apparatus 200, but the present invention is not limited thereto. The heat exchanger 10 may be applied to a hot water supply apparatus, a floor heating apparatus, and a refrigeration apparatus such as a refrigerating device.

[0103] The embodiment of the present disclosure has been described heretofore, and it will be understood that a variety of modifications in mode and detail may be made without departing from the gist and scope of the present disclosure as set forth in claims.

REFERENCE SIGNS LIST

[0104]

1 AIR-CONDITIONING APPARATUS
10, 11, 12 HEAT EXCHANGER
20, 20a, 20b FLAT TUBE
30 FIN
30b, 120a DOWNSTREAM END
32 FIRST JOINT PORTION
33 FIRST PLATE PORTION
34 SECOND JOINT PORTION
35 SECOND PLATE PORTION
36 THIRD PLATE PORTION
37 NOTCH
133 FIRST PROTRUDING PORTION
135 SECOND PROTRUDING PORTION
136 THIRD PROTRUDING PORTION
200 AIR-CONDITIONING APPARATUS
210 REFRIGERANT CIRCUIT
230 INDOOR UNIT

CITATION LIST

PATENT LITERATURE

[0105] PTL 1: International Publication No. 2018/003123

Claims

1. A heat exchanger (10), comprising:

    a plurality of flat tubes (20) arranged in a first direction; and
    a fin (30) joined to the flat tubes, and
    the heat exchanger causing heat exchange between a refrigerant that flows inside the flat tube and air that flows outside the flat tube along a second direction that intersects the first direction, wherein
    the fin includes:

        a first joint portion (32) joined to a first flat tube included in the flat tubes; and
        a first plate portion (33) positioned between an air flow downstream end and the first joint portion, and
        the first plate portion is formed with a first protruding portion (133) for causing water to flow in the first direction in a vicinity of the first flat tube.

2. The heat exchanger according to claim 1, wherein the first protruding portion extends in the first direction.

3. The heat exchanger according to claim 1 or 2, wherein a distance (L1) in the second direction between an air flow downstream end (120a) of the first flat tube and the first protruding portion is less than a distance (L2) in the second direction between the air flow downstream end (30b) of the fin and the first protruding portion.

4. The heat exchanger according to any one of claims 1 to 3, wherein
    the fin further includes:

        a second joint portion (34) joined to a second flat tube that is included in the flat tubes and is disposed adjacent to the first flat tube in the first direction; and
        a second plate portion (35) positioned between the first joint portion and the second joint portion,

and
the second plate portion is formed with a second protruding portion (135) extending in a direction inclined with respect to the first direction and the second direction.

5. The heat exchanger according to claim 4, wherein

the first protruding portion extends in an up-down direction, and
the second protruding portion extends obliquely downward from a vicinity of an air flow downstream portion of the first flat tube.

6. The heat exchanger according to claim 4, wherein

the first protruding portion extends in an up-down direction, and
the second protruding portion extends obliquely downward from a vicinity of an air flow upstream portion of the first flat tube.

7. The heat exchanger according to any one of claims 1 to 6, wherein
the fin further includes:

a second joint portion (34) joined to a second flat tube that is included in the flat tubes and is disposed adjacent to the first flat tube in the first direction;
a second plate portion (35) positioned between the first joint portion and the second joint portion; and
a third plate portion (36) positioned between the air flow downstream end and the second plate portion, and
the third plate portion is formed with a third protruding portion (136) that is continuous with the first protruding portion.

8. The heat exchanger according to any one of claims 1 to 7, wherein
the fin further includes:

a second joint portion (34) joined to a second flat tube that is included in the flat tubes and is disposed adjacent to the first flat tube in the first direction; and
a second plate portion (35) positioned between the first joint portion and the second joint portion, and
the second plate portion is formed with a notch (37) for enhancing heat transfer.

9. The heat exchanger according to any one of claims 1 to 8, wherein

a plurality of the fins are arranged in an extending direction of the flat tube, and
a fin pitch (P) of the fins is greater than or equal to 1.2 mm and less than or equal to 1.4 mm, and
a height of the first protruding portion is greater than or equal to 0.1 mm and less than or equal to 0.6 mm.

10. The heat exchanger according to any one of claims 1 to 9, wherein the heat exchanger is included in an indoor unit (230) of an air-conditioning apparatus (200).

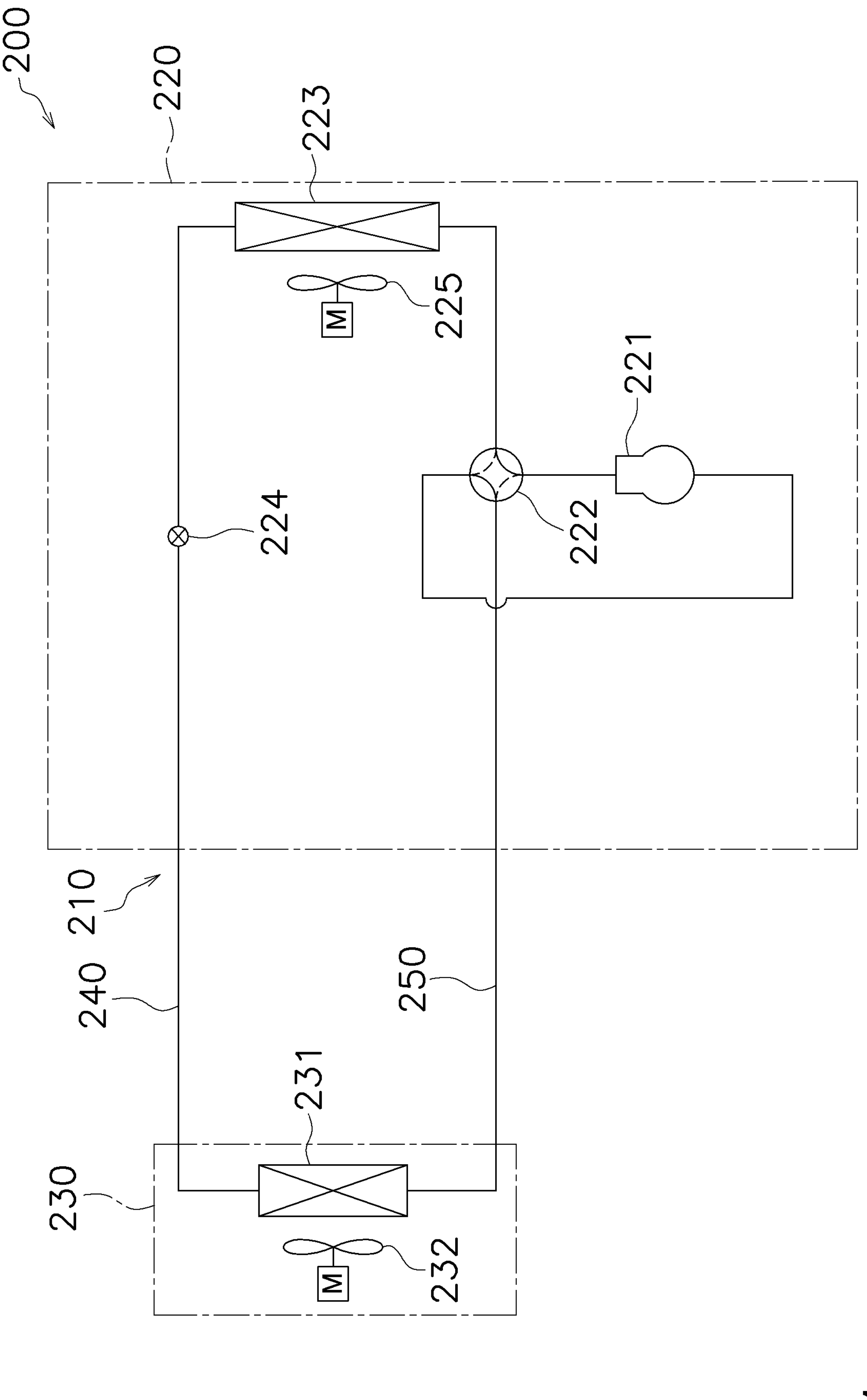

FIG. 1

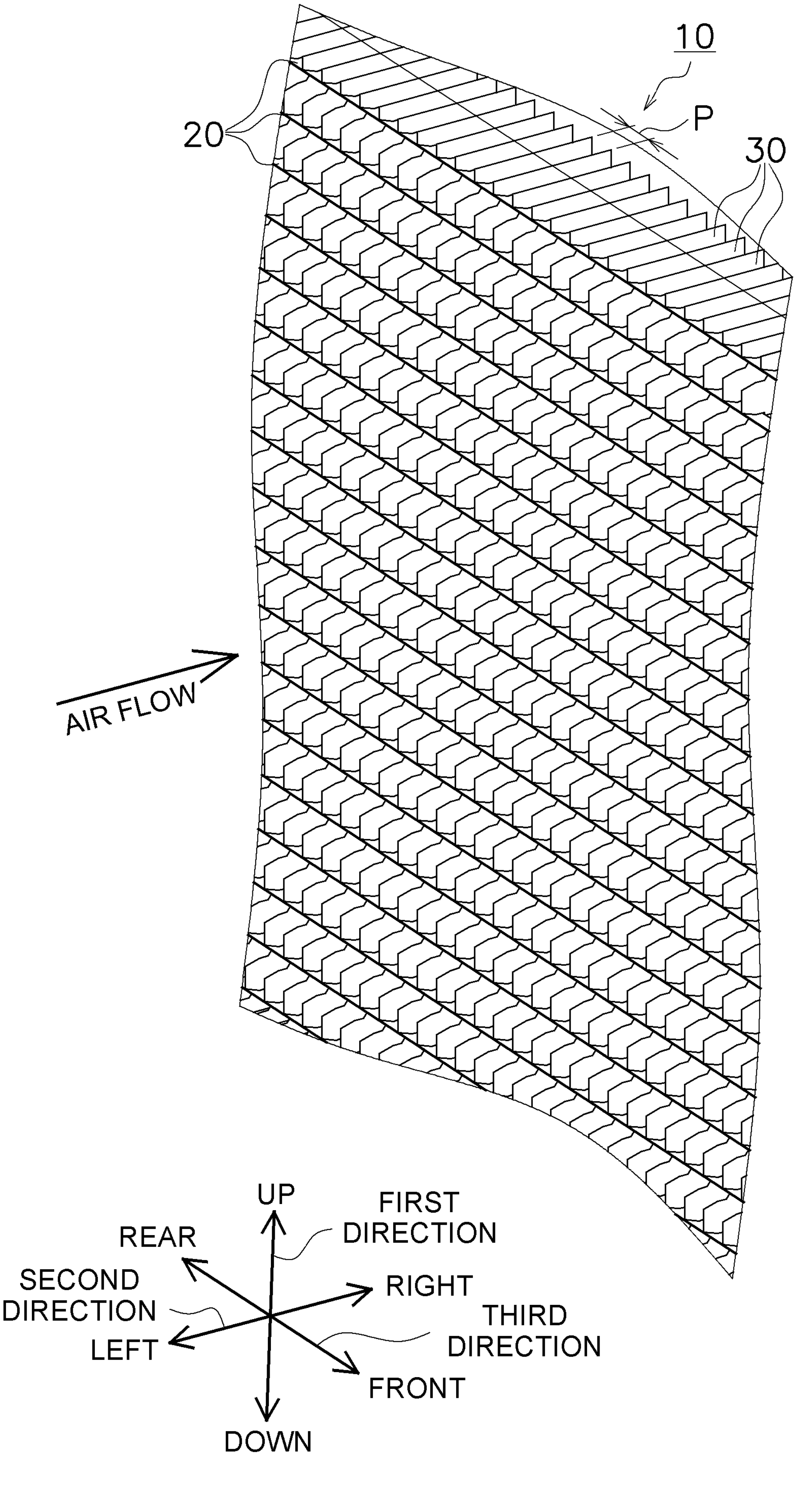
10
P
20
30
AIR FLOW
UP
FIRST
DIRECTION
REAR
SECOND
DIRECTION
RIGHT
THIRD
DIRECTION
LEFT
FRONT
DOWN

FIG. 2

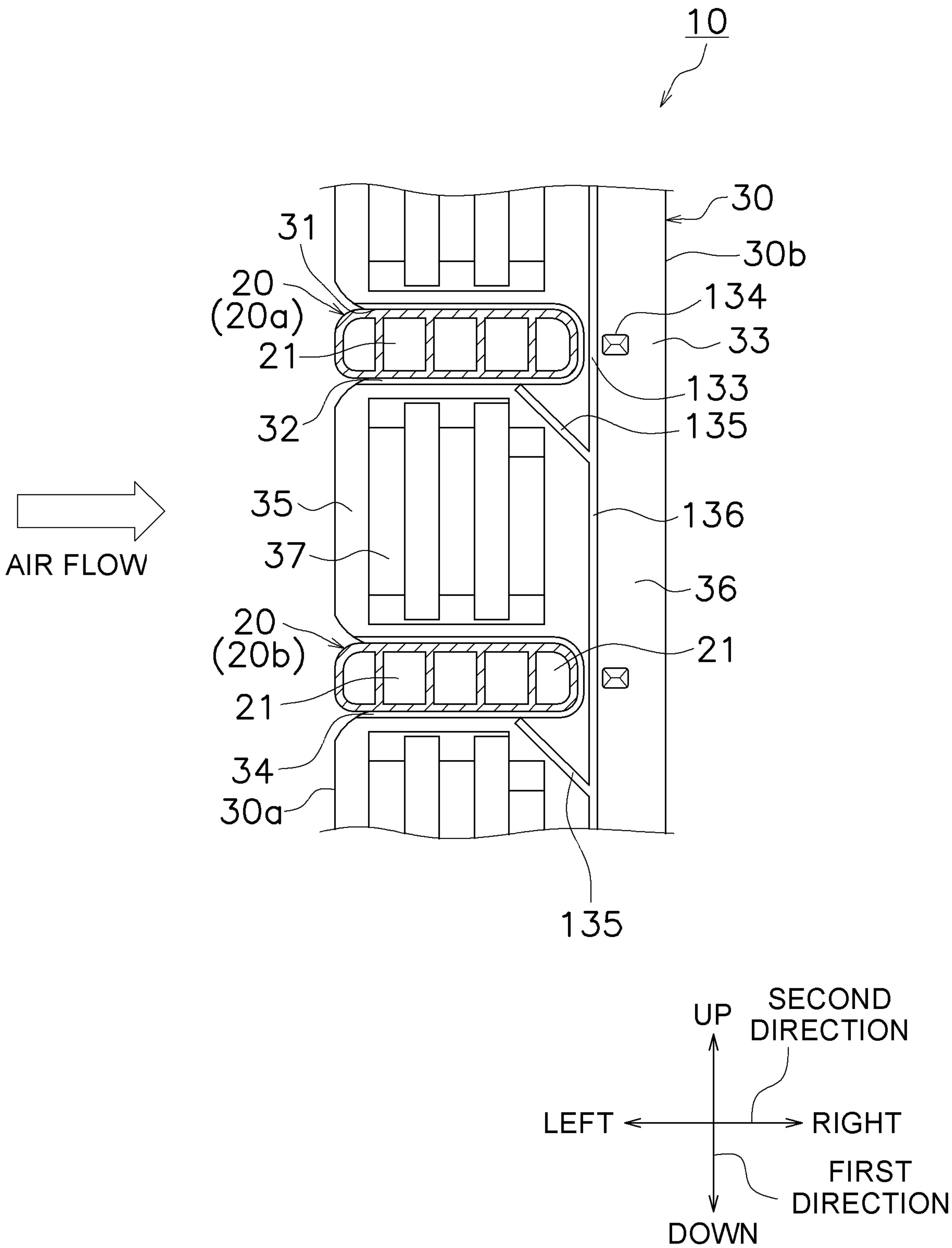
10
30
31
30b
20
(20a)
134
33
21
133
32
135
35
136
AIR FLOW
37
36
20
(20b)
21
21
34
30a
135
UP
SECOND
DIRECTION
LEFT
RIGHT
FIRST
DIRECTION
DOWN

FIG. 3

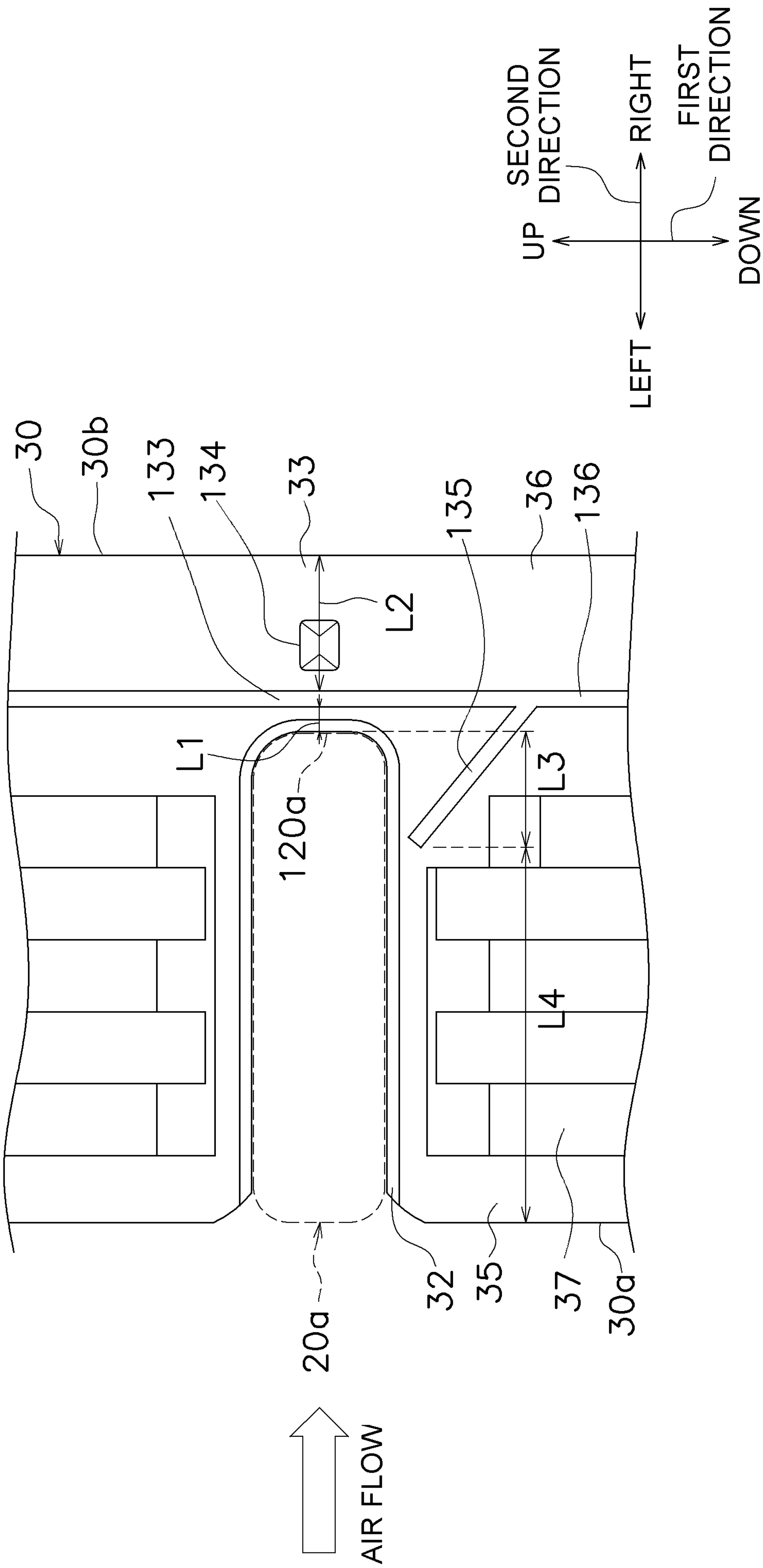
10
30
30b
133
134
33
L2
135
36
136
L1
120a
L3
L4
20a
32
35
37
30a
AIR FLOW
SECOND DIRECTION
RIGHT
FIRST DIRECTION
UP
DOWN
LEFT

FIG. 4

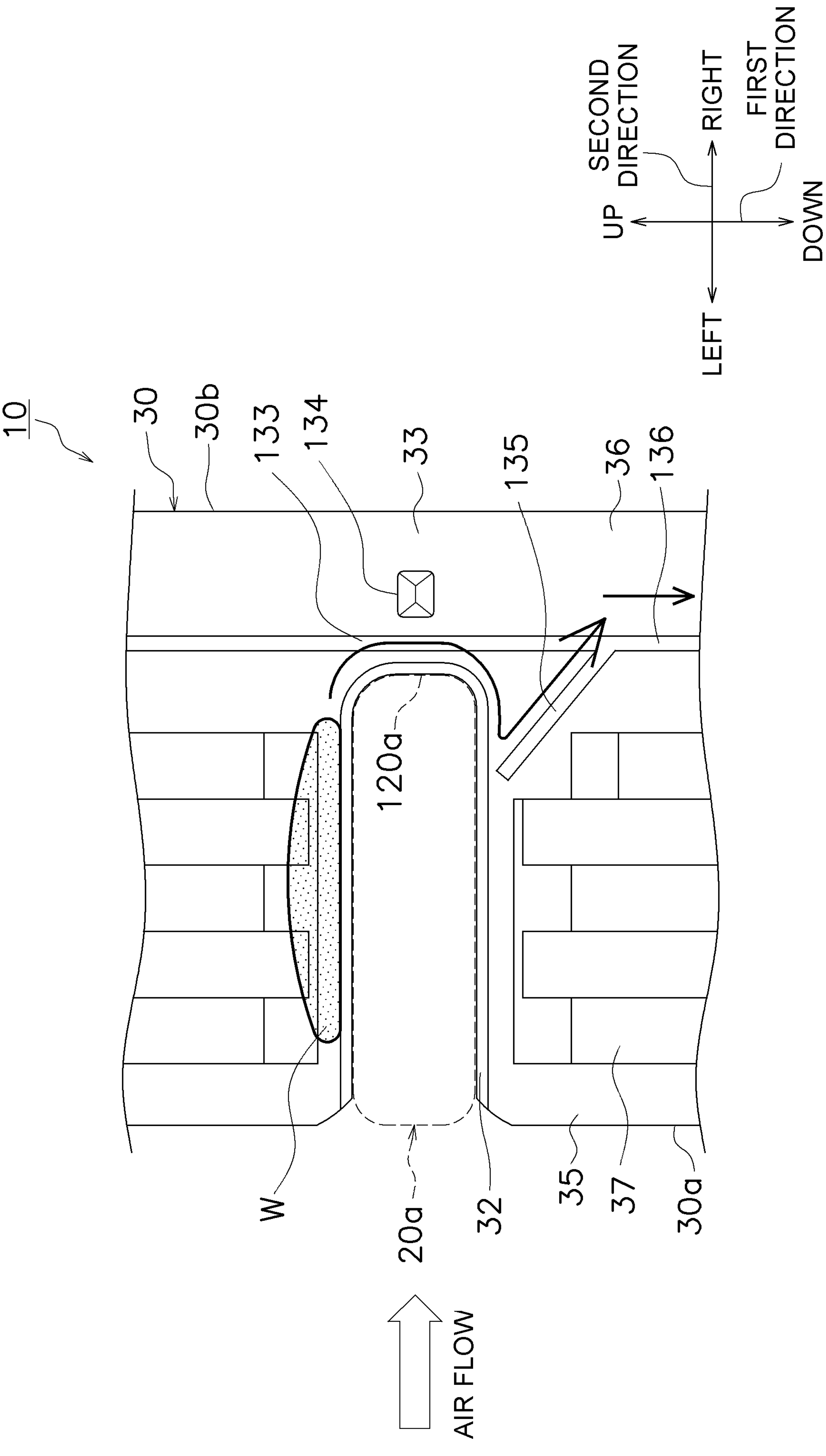
10
30
30b
133
134
33
135
36
136
120a
W
20a
32
35
37
30a
AIR FLOW
SECOND
DIRECTION
RIGHT
FIRST
DIRECTION
UP
DOWN
LEFT

FIG. 5

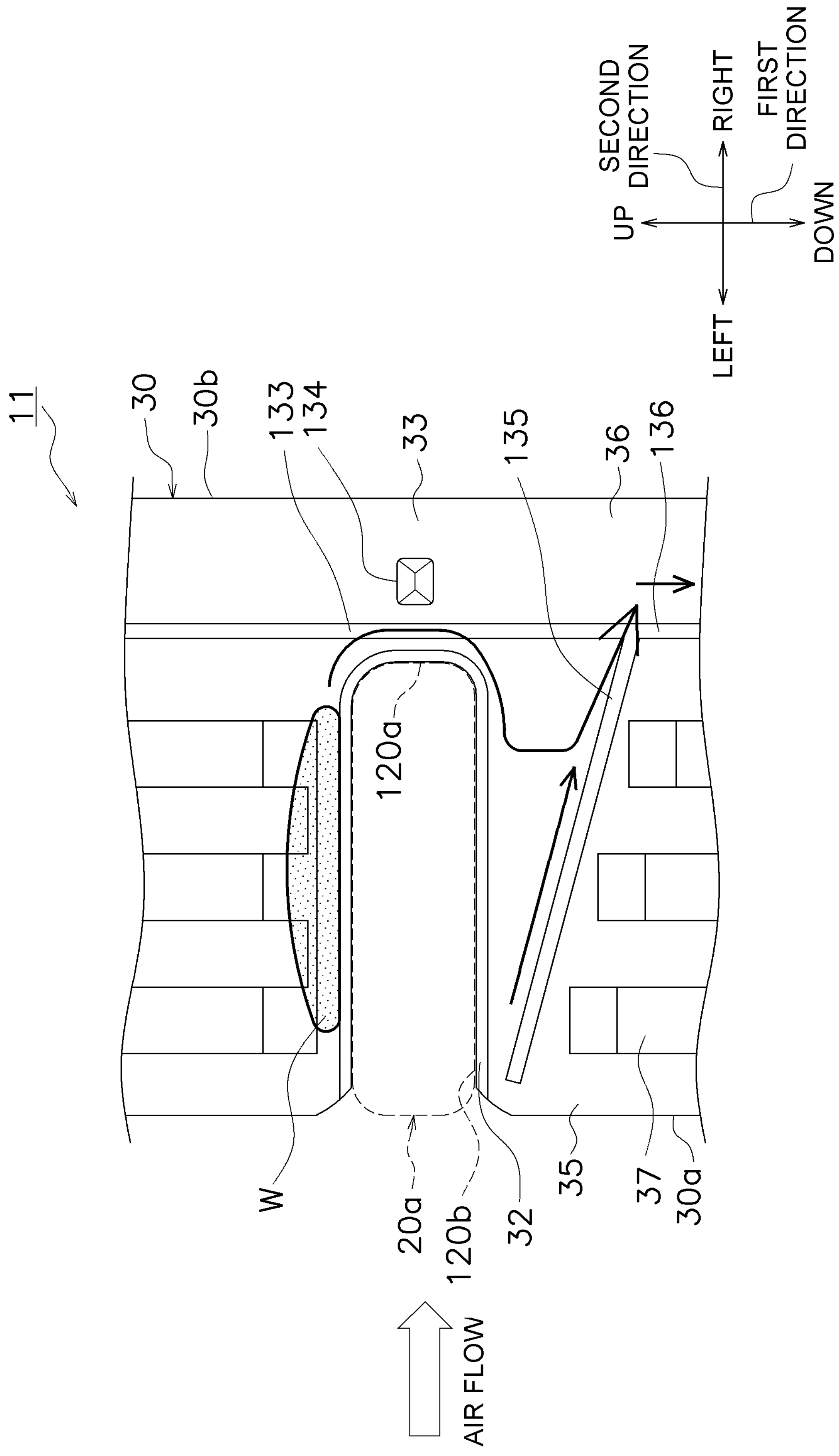
11
30
30b
133
134
33
135
36
136
120a
W
20a
120b
32
35
37
30a
AIR FLOW
SECOND DIRECTION
FIRST DIRECTION
UP
DOWN
LEFT
RIGHT

FIG. 6

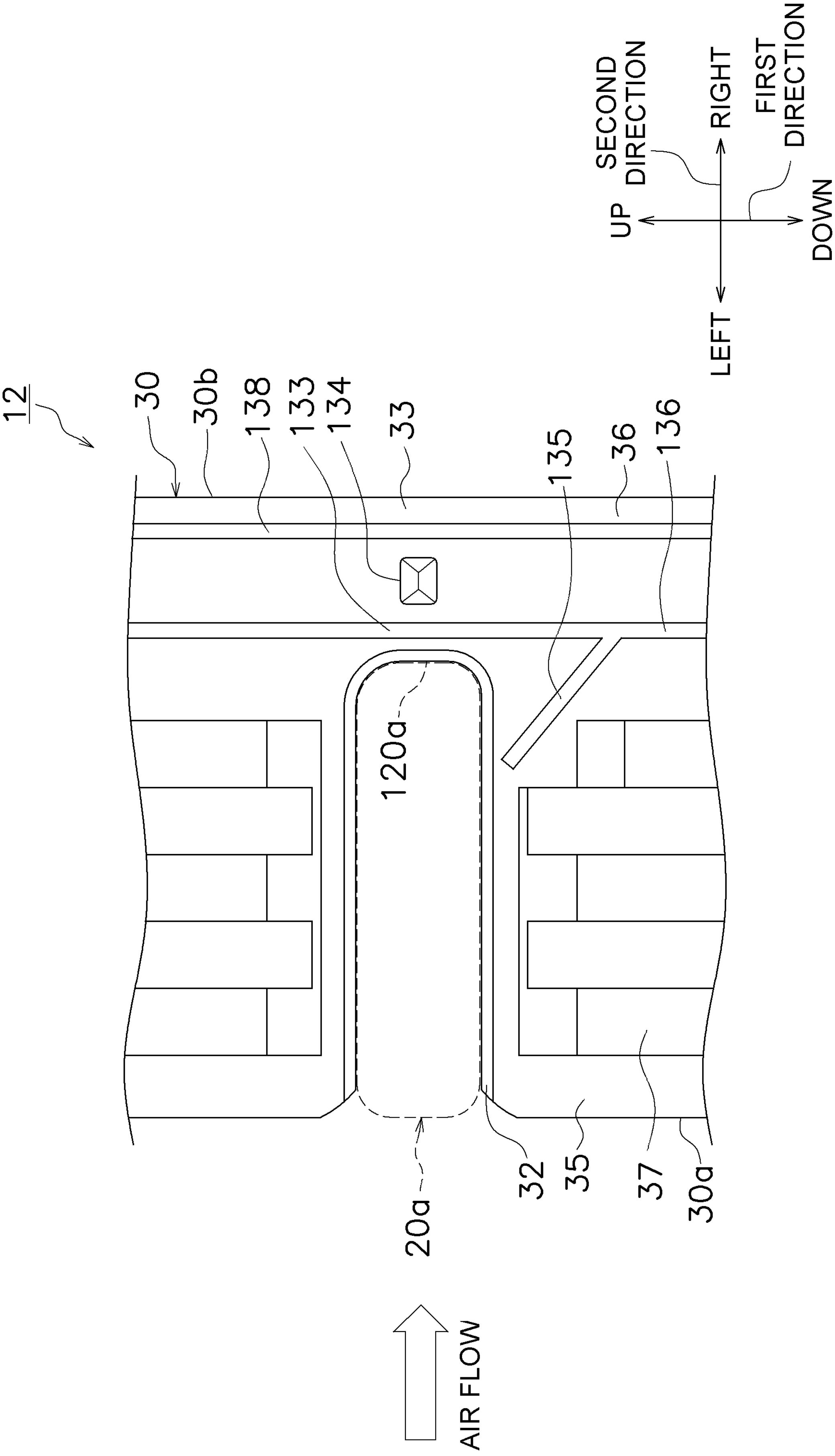
12
30
30b
138
133
134
33
135
36
136
120a
20a
32
35
37
30a
AIR FLOW
SECOND DIRECTION
RIGHT
LEFT
UP
DOWN
FIRST DIRECTION

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/025837

A. CLASSIFICATION OF SUBJECT MATTER

F28F 1/32(2006.01)i; ***F28F 17/00***(2006.01)i
FI: F28F1/32 Y; F28F1/32 P; F28F1/32 V; F28F17/00 501C

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; F28F17/00

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2018/003123 A1 (MITSUBISHI ELECTRIC CORPORATION) 04 January 2018 (2018-01-04) paragraphs [0019]-[0035], fig. 1-2	1-2
Y	paragraphs [0018]-[0036], [0047]-[0051], [0071]-[0078], fig. 1-2, 8	3-10
Y	WO 2018/073898 A1 (MITSUBISHI ELECTRIC CORPORATION) 26 April 2018 (2018-04-26) paragraphs [0056]-[0058], fig. 7	3-10
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 090175/1981 (Laid-open No. 000180/1983) (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 05 January 1983 (1983-01-05), entire text, all drawings	1-10

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

* Special categories of cited documents:
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"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	Date of mailing of the international search report
04 August 2023	**22 August 2023**

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

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/025837

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2018/003123 A1	04 January 2018	US 2019/0383567 A1 paragraphs [0029]-[0053], [0064]-[0068], [0092]-[0099], fig. 1-2, 8 GB 2565486 A	
WO 2018/073898 A1	26 April 2018	(Family: none)	
JP 58-000180 U1	05 January 1983	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2018003123 A **[0002] [0105]**