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

(11) EP 4 571 232 A1

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

(43) Date of publication:
18.06.2025 Bulletin 2025/25

(21) Application number: **23852546.3**

(22) Date of filing: **07.08.2023**

(51) International Patent Classification (IPC):
F28F 1/32 *(2006.01)* ***F25B 39/02*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F28F 1/325; F25B 39/00; F25B 39/02; F28F 1/32; F28F 17/005; F28F 21/084; F28F 2265/06; F28F 2265/22

(86) International application number:
PCT/JP2023/028822

(87) International publication number:
WO 2024/034584 (15.02.2024 Gazette 2024/07)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **12.08.2022 JP 2022129116**

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(54) **HEAT EXCHANGER**

(57) A heat exchanger (10) includes heat transfer tubes (20) and a plurality of fins (30). The heat transfer tube (20) extends in a first direction. The fin (30) includes a body portion (31) and collar portions (32). The collar portion (32) has a first portion (33), a second portion (34), and a third portion (35). The first portion (33) extends from the body portion (31) in the first direction. The second portion (34) extends from the first portion (33) toward the heat transfer tube (20). The third portion (35) extends from the second portion (34) in the first direction. The second portion (34) of a first fin (131) is in contact with a distal end portion of the collar portion (32) of a second fin (132) disposed adjacent to the first fin (131). The second portion (34) has, when viewed from the first direction, a portion where a distance between an inner peripheral surface (34a) and an outer peripheral surface (34b) is a first dimension (L1), and a portion where the distance is a second dimension (L2). The second dimension (L2) is greater than the first dimension (L1).

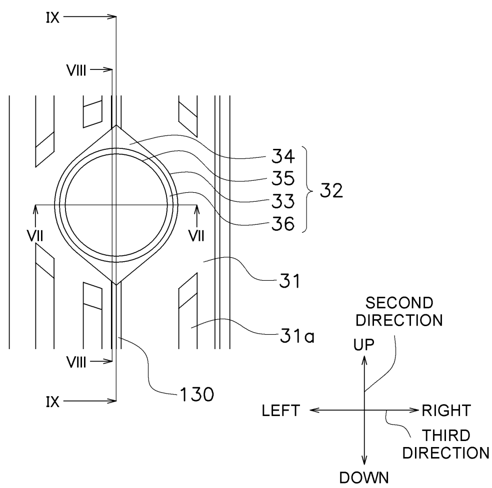

FIG. 5

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Description

Technical Field

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

Background Art

[0002] Conventionally, as disclosed in PTL 1 (Japanese Unexamined Patent Application Publication No. 2015-123458), a heat exchanger for an air-conditioning apparatus or the like includes fins having collar portions. A collar portion 10 in Fig. 1 of PTL 1 includes a dish-shaped seat portion 11, a vertical cylindrical portion 12 disposed above the seat portion 11, and a flare portion 13 disposed above the vertical cylindrical portion 12.

Summary of Invention

Technical Problem

[0003] The inventor of the present invention has found a problem that, when fins 1 illustrated in Fig. 1 of PTL 1 are stacked, in connection with the collar portion 10, the flare portion 13 of one fin 1 enters a concave portion of the vertical cylindrical portion 12 of another fin 1 that is disposed adjacent to the fin 1, and water tends to accumulate in a convex space formed within that concave portion.

Solution to Problem

[0004] A heat exchanger of a first aspect includes a heat transfer tube and a plurality of fins. The heat transfer tube extends in a first direction. The plurality of fins are stacked in the first direction. The plurality of fins each include a body portion and a collar portion. The body portion extends in a second direction that intersects the first direction. The collar portion allows the heat transfer tube to pass therethrough. The collar portion has a first portion, a second portion, and a third portion. The first portion extends from the body portion in the first direction. The second portion extends from the first portion toward the heat transfer tube. The third portion extends in the first direction from the second portion along the heat transfer tube. The second portion of a first fin is in contact with a distal end portion of the collar portion of a second fin disposed adjacent to the first fin. The second portion has, when viewed from the first direction: a portion where a distance between an inner peripheral surface and an outer peripheral surface is a first dimension; and a portion where the distance between the inner peripheral surface and the outer peripheral surface is a second dimension. The second dimension is greater than the first dimension.

[0005] In the heat exchanger of the first aspect, water tends to accumulate in a convex space formed by the first portion and the second portion of the first fin and the distal end portion of the collar portion of the second fin. However, according to the heat exchanger of the first aspect, water accumulated in the space defined by the portion having the first dimension of the first fin and the distal end portion of the collar portion of the second fin can be drained via the space defined by the portion having the second dimension of the first fin and the distal end portion of the collar portion of the second fin. Therefore, drainage of water from the space where water tends to accumulate can be facilitated.

[0006] A heat exchanger of a second aspect is the heat exchanger of the first aspect, in which the collar portion further has a fourth portion. The fourth portion extends radially outward from the third portion. The second portion of the first fin is in contact with the fourth portion of the second fin disposed adjacent to the first fin.

[0007] In the heat exchanger of the second aspect, the fourth portion allows the plurality of fins to be easily stacked in the first direction.

[0008] In addition, in the heat exchanger of the second aspect, the problem that water tends to accumulate in the convex space formed by the fourth portion of the second fin and the first portion and the second portion of the first fin is significant, so the effect of including the second portion is significant.

[0009] A heat exchanger of a third aspect is the heat exchanger of the first or the second aspect, in which the second dimension is a portion extending along the second direction.

[0010] In the heat exchanger of the third aspect, the portion having the second dimension is positioned in a direction in which the body portion extends. Therefore, a structure that causes water in the convex space to flow toward the space defined by the portion having the second dimension of the first fin and the distal end portion of the collar portion of the second fin can be easily achieved.

[0011] A heat exchanger of a fourth aspect is the heat exchanger of any one of the first to third aspects, in which the second portion has, when viewed from the first direction, an annular portion and a triangular portion. The annular portion has an annular shape. The triangular portion is continuous with a part of the annular portion and has a triangular shape. The triangular portion configures in the portion having the second dimension.

[0012] In the heat exchanger of the fourth aspect, a structure that causes water in the space defined by the annular portion of the first fin and the distal end portion of the collar portion of the second fin to flow toward the triangular portion can be easily achieved.

[0013] A heat exchanger of a fifth aspect is the heat exchanger of the fourth aspect, in which the triangular portion is disposed at a lower end portion of the second portion.

[0014] In the heat exchanger of the fifth aspect, since the portion having the second dimension is positioned at the lower end portion, water in the convex space can be discharged downward.

[0015] A heat exchanger of a sixth aspect is the heat exchanger of any one of the first to fifth aspects, in which, the fins are each provided with a drain rib. The drain rib extends from the convex space formed by the first portion and the second portion of the first fin and a distal end of the collar portion of the second fin.

[0016] In the heat exchanger of the sixth aspect, a structure where the drain rib discharges water in the convex space can be achieved.

[0017] A heat exchanger of a seventh aspect is the heat exchanger of the sixth aspect, in which the drain rib is connected to the portion having the second dimension.

[0018] In the heat exchanger of the seventh aspect, water accumulated in the space defined by the portion having the first dimension of the first fin and the distal end portion of the collar portion of the second fin can be drained from the drain rib via the space defined by the portion having the second dimension of the first fin and the distal end portion of the collar portion of the second fin.

[0019] A heat exchanger of an eighth aspect is the heat exchanger of the sixth or the seventh aspect, in which the drain rib is provided on the body portion. The drain rib protrudes in the first direction to the second portion.

[0020] In the heat exchanger of the eighth aspect, water in the convex space can be easily guided to the drain rib.

[0021] A heat exchanger of a ninth aspect is the heat exchanger of any one of the sixth to eighth aspects, in which the fin includes a plurality of collar portions. The drain rib extends in the second direction from a first collar portion to a collar portion disposed below the first collar portion.

[0022] In the heat exchanger of the ninth aspect, water in the convex space defined by the collar portions on the upper stage can be guided to the convex space defined by the collar portions on the lower stage through the drain rib.

[0023] A heat exchanger of a tenth aspect is the heat exchanger of any one of the first to ninth aspects, 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 the 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 cross-sectional view of the heat exchanger according to an embodiment of the present disclosure.

[Fig. 3] Fig. 3 is a perspective view of a fin included in the heat exchanger when viewed from the front.

[Fig. 4] Fig.4 is a plan view of the fin included in the heat exchanger when viewed from the rear.

[Fig. 5] Fig. 5 is a plan view of the vicinity of one collar portion of the heat exchanger when viewed from the front.

[Fig. 6] Fig. 6 is a view obtained by omitting a third portion and a fourth portion from Fig. 5 and hatching a second portion in Fig. 5.

[Fig. 7] Fig. 7 is a cross-sectional view taken along line VII-VII in Fig. 5.

[Fig. 8] Fig. 8 is a cross-sectional view taken along line VIII-VIII in Fig. 5.

[Fig. 9] Fig. 9 is a cross-sectional view taken along line IX-IX in Fig. 5.

[Fig. 10] Fig. 10 is a bottom view of the fin included in the heat exchanger when viewed from below.

[Fig. 11] Fig. 11 is a view illustrating a flow of water in Fig. 4.

[Fig. 12] Fig. 12 is a photograph of the vicinity of a conventional collar portion when viewed from the front.

[Fig. 13] Fig. 13 is a photograph of the vicinity of a plurality of conventional collar portions when viewed from the right.

[Fig. 14] Fig. 14 is a plan view of the vicinity of one collar portion of a heat exchanger of a modification when viewed from the front.

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 a 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 into contact with 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 out 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 out 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 11. Note that, in the following description, expressions indicating directions, such as "up", "down", "left", "right", "front", and "rear" are used as appropriate. These expressions indicate the respective directions in which the heat exchanger 10 is in an ordinary state of use, and are not intended to be limiting.

[0040] 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. The heat exchanger 10 of the present embodiment is a cross-fin tube heat exchanger.

[0041] As illustrated in Fig. 2, the heat exchanger 10 includes a heat transfer tube 20 and a plurality of fins 30. The heat transfer tube 20 extends in a first direction. The fins 30 are stacked in the first direction. Here, the first direction is the front-rear direction. The heat exchanger 10 causes heat exchange between a refrigerant that flows inside the heat transfer tube 20 and air that flows outside the heat transfer tube 20. The heat exchanger 10 causes heat exchange between air and the refrigerant without mixing the air and the refrigerant with each other.

(2-2) Detailed configuration

(2-2-1) Heat transfer tube

[0042] The heat exchanger 10 of the present embodiment includes a plurality of heat transfer tubes 20. The plurality of heat transfer tubes 20 are arranged in a second direction. The second direction intersects the first direction. Here, the second direction is orthogonal to the first direction. Specifically, the second direction is the vertical direction.

[0043] The heat transfer tube 20 allows a refrigerant to flow therethrough. The heat transfer tube 20 has a cylindrical shape. Here, the heat transfer tube 20 is a round tube.

[0044] The heat transfer tube 20 is formed with a through hole allowing the refrigerant that exchanges heat with indoor air in the heat exchanger 10 to pass therethrough. The through hole extends through the heat transfer tube 20 along the first direction. Here, the first direction is the longitudinal direction of the heat transfer tube 20. The heat transfer tube 20 is made of, for example, aluminum or an aluminum alloy. (2-2-2) Fin

[0045] The fins 30 increase the heat transfer area between the heat transfer tubes 20 and indoor air, and enhance heat exchange between the refrigerant and the indoor air. The fin 30 is in contact with the heat transfer tubes 20. The fin 30 is made of, for example, aluminum or an aluminum alloy.

[0046] The plurality of fins 30 are arranged in the first direction. The fins 30 are disposed so as to intersect (here, orthogonal to) an extending direction of the heat transfer tubes 20. In the present embodiment, the plurality of fins 30 are disposed in parallel and at equal intervals. Note that, in Fig. 2, two adjacent fins 30 are illustrated as a first fin 131 and a second fin 132.

[0047] The fin 30 has a one-surface 30a illustrated in Fig. 3 and a the-other-surface 30b illustrated in Fig. 4. Here, the one-surface 30a is a front surface when viewed from the front in the first direction. The the-other-surface 30b is a rear surface when viewed from the rear in the first direction.

[0048] As illustrated in Figs. 2 to 10, the plurality of fins 30 each include a body portion 31 and collar portions 32. The body portion 31 extends in the second direction that intersects the first direction. Here, the body portion 31 extends in the vertical direction that is the second direction orthogonal to the first direction. In the present embodiment, the vertical direction is the gravity direction. The body portion 31 is a flat plate-shaped member.

[0049] As illustrated in Figs. 3 and 4, the body portion 31 is formed with notches 31a for enhancing heat transfer. A plurality of notches 31a are arranged in a third direction orthogonal to the first direction. Here, the third direction is the left-right direction. In addition, the notches 31a extend in the second direction. Here, the notches 31a protrude frontward. In other words, the notch 31a protrudes from the one-surface 30a of the fin 30 toward the the-other-surface 30b of an adjacent fin 30.

[0050] As illustrated in Fig. 2, the collar portion 32 allows the heat transfer tube 20 to pass therethrough. Specifically, the collar portion 32 has a through hole for allowing the heat transfer tube 20 to pass therethrough.

[0051] As illustrated in Figs. 2 to 10, the collar portion 32 has a first portion 33, a second portion 34, a third portion 35, and a fourth portion 36. The first portion 33, the second portion 34, the third portion 35, and the fourth portion 36 are formed of one member. Here, the first portion 33, the second portion 34, the third portion 35, and the fourth portion 36 are formed by nesting.

[0052] The first portion 33 extends from the body portion 31 in the first direction. Here, the first portion 33 is orthogonal to the body portion 31.

[0053] The second portion 34 extends from the first portion 33 toward the heat transfer tube 20. In other words, the second portion 34 extends in the second direction. Here, the second portion 34 is orthogonal to the first portion 33. The second portion will be described later.

[0054] The third portion 35 extends in the first direction from the second portion 34 along the heat transfer tube 20. The third portion 35 is in contact with the heat transfer tube 20. Here, the third portion 35 is orthogonal to the second portion 34.

[0055] The fourth portion 36 extends radially outward from the third portion 35. In other words, the fourth portion 36 extends in the second direction. Here, the fourth portion 36 is orthogonal to the third portion 35.

[0056] As illustrated in Fig. 2, the second portion 34 of the first fin 131 is in contact with a distal end portion of the collar portion 32 of the second fin 132 disposed adjacent to the first fin 131. Here, the second portion 34 of the first fin is in contact with the fourth portion 36 of the second fin disposed adjacent to the first fin. The second portion 34 and the fourth portion 36 extend in the same direction.

[0057] Here, the second portion 34 will be described. As illustrated in Figs. 5 and 6, the second portion 34 has, when viewed from the first direction (from the front in Figs. 5 and 6) (in front view), a portion where a distance between an inner peripheral surface 34a and an outer peripheral surface 34b is a first dimension L1, and a portion where the distance between the inner peripheral surface 34a and the outer peripheral surface 34b is a second dimension L2. As illustrated in Figs. 6 to 8, the second dimension L2 is greater than the first dimension L1.

[0058] In Fig. 6, the first dimension L1 is a dimension of the portion extending along the third direction orthogonal to the first direction. Specifically, the portion having the first dimension L1 is positioned at at least a left end portion and a right end portion. Here, the portion having the first dimension L1 is a portion of the second portion 34 where triangular portions 34d, described later, are not disposed.

[0059] The second dimension L2 is a dimension of the portion extending along the second direction. Specifically, the portion having the second dimension L2 is positioned at at least one of an upper end portion and a lower end portion. Here, the portion having the second dimension L2 is the upper end portion and is the lower end portion, of the second portion 34.

[0060] In the present embodiment, the second portion 34 has a drop shape when viewed from the first direction (from the front in Figs. 5 and 6). In other words, the second portion 34 has, when viewed from the first direction (from the front in Figs. 5 and 6), an annular portion 34c having an annular shape and the triangular portions 34d each having a triangular shape. The triangular portion 34d is continuous with a part of the annular portion 34c. In Figs. 5 and 6, the triangular portion 34d has a V shape.

[0061] The annular portion 34c is a region surrounded by two concentric circles. The annular portion 34c is positioned on the entire perimeter of the second portion 34. The portion having the first dimension L1 is formed solely by the annular portion 34c not including the triangular portions 34d. Therefore, in the present embodiment, the first dimension L1 has a constant value.

[0062] The portion having the second dimension L2 is formed of the triangular portion 34d and the annular portion 34c. Therefore, in the present embodiment, the second dimension L2 does not have a constant value. Specifically, the second dimension L2 has a value greater than the first dimension L1 of the annular portion 34c, and the value varies depending on the position. A maximum value of the second dimension L2 is, for example, not less than twice the first dimension L1. Here, the maximum value of the second dimension L2 is a distance extending downward (toward the inner peripheral surface 34a) from an upper end of the second portion 34 and also a distance extending upward (toward the inner peripheral surface 34a) from a lower end of the second portion 34.

[0063] The triangular portion 34d is disposed at the lower end portion of the second portion 34. Specifically, the triangular portion 34d has a shape extending downward. Here, the triangular portion 34d is also disposed at the upper end portion of the second portion 34. Specifically, the triangular portion 34d also has a shape extending upward.

[0064] Note that the first dimension L1 is, for example, 0.5 mm or more and 0.9 mm or less. The second dimension L2 is, for example, 1.0 mm or more and 1.9 mm or less. The maximum value of the second dimension L2 is, for example, 1.5 mm or more and 1.9 mm or less.

[0065] As illustrated in Figs. 3 to 6, 9, and 10, the fin 30 is provided with drain ribs 130. The drain rib 130 extends from a convex space S formed by the first portion 33 and the second portion 34 of the first fin 131 and a distal end of the collar portion 32 of the second fin 132 illustrated in Fig. 2. The drain rib 130 causes water in the convex space S to flow in the second direction (here, downward).

[0066] In the present embodiment, the convex space S is formed by the first portion 33 and the second portion 34 of the first fin 131 and the fourth portion 36 of the second fin 132. Specifically, the distal end (the fourth portion 36 in Fig. 2) of the collar portion 32 of the second fin 132 enters a concave portion around the collar portion 32 of the first fin 131 disposed adjacent to the second fin 132, so that the convex space S is formed within the concave portion.

[0067] Specifically, the convex space S has a drop shape when viewed from the first direction (here, from the front). In other words, the convex space S includes, when viewed from the first direction, an annular space and triangular spaces. The annular space is provided on the entire perimeter. The triangular spaces are continuous with the annular space. In the present embodiment, the triangular space is provided at the upper end portion and the lower end portion.

[0068] Note that the convex space S formed by the first portion 33 of the first fin 131, the portion having the first dimension L1 of the second portion 34 of the first fin 131, and the fourth portion 36 of the second fin 132 is, for example, 0.1 mm or more and 0.3 mm or less. The convex space S formed by the first portion 33 of the first fin 131, the portion having the second dimension L2 of the second portion 34 of the first fin 131, and the fourth portion 36 of the second fin 132 is, for example, 0.4 mm or more and 1.4 mm or less. The convex space S formed by the first portion 33 of the first fin 131, the portion (the upper end portion or the lower end portion) having the maximum value of the second dimension L2 of the second portion 34 of the first fin 131, and the fourth portion 36 of the second fin 132 is, for example, 1.1 mm or more and 1.4 mm or less.

[0069] As illustrated in Figs. 3, 4, and 9, the drain rib 130 are provided on the body portion 31. As illustrated in Figs. 3, 4, 9, and 10, the drain rib 130 protrudes in the first direction. Here, the drain rib 130 protrudes frontward. Specifically, the drain rib 130 protrudes from the one-surface 30a of the fin 30 toward the the-other-surface 30b of an adjacent fin 30. In the present embodiment, as illustrated in Figs. 9 and 10, the drain rib 130 protrudes in the first direction to the second portion 34. In other words, the height of the drain rib 130 in the first direction is the same as the height of the second portion 34. Further, in other words, the position of the drain rib 130 in the first direction is the same as the position of the second portion 34 in the first direction.

[0070] Specifically, the drain rib 130 has a ridge shape when viewed from a one-surface 30a (front surface) side as illustrated in Figs. 3 and 10, and has a groove shape when viewed from a the-other-surface 30b (rear surface) side as illustrated in Figs. 4 and 10. In the present embodiment, the drain rib 130 has a V shape when viewed from below.

[0071] As illustrated in Figs. 3 and 4, the drain rib 130 extends in the second direction. In the present embodiment, the drain rib 130 extends in the vertical direction, and here, extends in the gravity direction.

[0072] Specifically, the drain rib 130 extends in the second direction from a first collar portion 32 to a collar portion 32 disposed below the first collar portion 32. Here, between the first collar portion 32 and a second collar portion 32 that are disposed adjacent to each other in the vertical direction, the drain rib 130 extends from the lower end of the second portion of the upper first collar portion 32 to the upper end of the second portion 34 of the lower second collar portion 32.

[0073] The drain rib 130 is connected to the portion having the second dimension L2 of the second portion 34. Specifically, the drain rib 130 is connected to the triangular portion 34d of the second portion 34. More specifically, the drain rib 130 is connected to a pointed portion of the triangular portion 34d of the second portion 34. The drain rib 130 extends from the triangular space within the convex space S.

(2-3) Operation

[0074] 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 heat transfer tubes 20 of the heat exchanger 10 that serves as the indoor heat exchanger 231 in the refrigerant circuit 210. Then, the refrigerant that flows inside the through holes of the heat transfer tubes 20 exchanges heat with indoor air that flows outside the heat transfer tubes 20. During this operation, condensation water (hereinafter, also referred to as water) may be generated on the fins 30. This water tends to accumulate in the convex space S formed by the first portion 33 and the second portion 34 of the first fin 131 and the fourth portion 36 that is the distal end portion of the collar portion 32 of the second fin 132.

[0075] However, in the present embodiment, the second portion 34 of the fin 30 has, when viewed in the first direction, the portion where the distance between the inner peripheral surface 34a and the outer peripheral surface 34b is the first dimension L1, and the portion where the distance between the inner peripheral surface 34a and the outer peripheral surface 34b is the second dimension L2 greater than the first dimension L1. This structure can guide water accumulated in the space defined by the portion having the first dimension L1 of the first fin 131 and the fourth portion 36 of the second fin 132 to the space defined by the portion having the second dimension L2 of the first fin 131 and the fourth portion 36 of the second fin 132.

[0076] In addition, in the present embodiment, the fin 30 includes the drain ribs 130. The drain rib 130 extends from the convex space S formed by the first portion 33 and the second portion 34 of the first fin 131 and the fourth portion 36 that is the distal end of the collar portion 32 of the second fin 132. Since the drain rib 130 extends from the convex space S, water accumulated in the convex space S can be guided to the drain rib 130. The drain rib 130 drains water.

[0077] Specifically, as illustrated in Fig. 11, water accumulated in the annular space within the convex space S is guided to the triangular space disposed below the annular space. The annular space is defined by the portion having the first dimension L1 of the first fin 131 and the fourth portion 36 of the second fin 132, while the triangular space is defined by the portion having the second dimension L2 of the first fin 131 and the fourth portion 36 of the second fin 132. Since the drain rib 130 is connected to the portion having the second dimension L2, water guided to the triangular space formed by the portion having the second dimension L2 is further guided to the drain rib 130. As a result, water flows along the groove, formed on the the-other-surface 30b side, of the drain rib 130 and flows to the collar portion 32 disposed below the drain rib 130. In this manner, condensation water attached on the fin 30 flows downward.

(3) Features

(3-1)

[0078] The inventor of the present invention has found a problem unique to the heat exchanger 10 that includes the collar portion 32 having the first portion 33, the second portion 34, and the third portion 35, with the second portion 34 of the first fin 131 being in contact with the distal end portion of the collar portion 32 of the second fin 132 disposed adjacent to the first fin 131. Specifically, the inventor of the present invention has found a problem that, as illustrated in Figs. 12 and 13, in a conventional fin 330 that does not have a portion having the second dimension L2, water tends to accumulate in the convex space S formed by the first portion 33 and the second portion 34 of the first fin 131 and the distal end portion of the collar portion 32 of the second fin 132. In order to solve this problem, the heat exchanger 10 of the present embodiment has been conceived as a result of intensive studies.

[0079] The heat exchanger 10 according to the present embodiment includes the heat transfer tube 20 and the plurality of fins 30. The heat transfer tube 20 extends in the first direction. The plurality of fins 30 are stacked in the first direction. The plurality of fins 30 each include the body portion 31 and the collar portion 32. The body portion 31 extends in the second direction that intersects the first direction. The collar portion 32 allows the heat transfer tube 20 to pass therethrough. The collar portion 32 has the first portion 33, the second portion 34, and the third portion 35. The first portion 33 extends from the body portion 31 in the first direction. The second portion 34 extends from the first portion 33 toward the heat transfer tube 20. The third portion 35 extends in the first direction from the second portion 34 along the heat transfer tube 20. The second portion 34 of the first fin 131 is in contact with the distal end portion of the collar portion 32 of the second fin 132 disposed adjacent to the first fin 131. The second portion 34 has, when viewed from the first direction, a portion where the distance between the inner peripheral surface 34a and the outer peripheral surface 34b is the first dimension L1, and a portion where the distance between the inner peripheral surface 34a and the outer peripheral surface 34b is the second dimension L2. The second dimension L2 is greater than the first dimension L1.

[0080] According to the heat exchanger 10 of the present embodiment, water accumulated in the space defined by the portion having the first dimension L1 of the first fin 131 and the distal end portion of the collar portion 32 of the second fin 132 can be drained via the space defined by the portion having the second dimension L2 of the first fin 131 and the distal end portion of the collar portion 32 of the second fin 132. Therefore, drainage of water from the convex space S where water tends to accumulate can be facilitated.

[0081] In this manner, water accumulation on the fin 30 can be suppressed, and drainage performance can be improved, thereby enabling a reduction in the duration for which the heat exchanger 10 remains in a wet state. Therefore, corrosion of the heat transfer tube 20 and the fins 30 can be suppressed. In addition, the generation of mold in the heat exchanger 10 can be suppressed, thereby enabling a reduction in odor issues.

(3-2)

[0082] In the heat exchanger 10 of the present embodiment, the collar portion 32 further has the fourth portion 36. The fourth portion 36 extends radially outward from the third portion 35. The second portion 34 of the first fin 131 is in contact with the fourth portion 36 of the second fin 132 disposed adjacent to the first fin 131.

[0083] Here, the fourth portion 36 allows the plurality of fins 30, 131, 132 to be easily stacked in the first direction.

[0084] In addition, the problem that water tends to accumulate in the convex space S formed by the fourth portion 36 of the second fin 132 and the first portion 33 and the second portion 34 of the first fin 131 is pronounced, so the effect of including the second portion 34 in the present embodiment is significant.

(3-3)

[0085] In the heat exchanger 10 of the present embodiment, the second dimension L2 is a portion extending along the second direction.

[0086] Here, the portion having the second dimension L2 is positioned in a direction in which the body portion 31 extends. Therefore, a structure that causes water in the convex space S to flow toward the space defined by the portion having the second dimension L2 of the first fin 131 and the distal end portion of the collar portion 32 of the second fin 132 can be easily achieved.

(3-4)

[0087] In the heat exchanger 10 of the present embodiment, the second portion 34 has, when viewed from the first direction, the annular portion 34c and the triangular portion 34d. The annular portion 34c has an annular shape. The triangular portion 34d is continuous with a part of the annular portion 34c and has a triangular shape. The triangular portion 34d configures the portion having the second dimension L2.

[0088] Here, a structure that causes water in the space defined by the annular portion 34c of the first fin 131 and the distal end portion of the collar portion 32 of the second fin 132 to flow toward the triangular portion 34d can be easily achieved.

(3-5)

[0089] In the heat exchanger 10 of the present embodiment, the triangular portion 34d is disposed at the lower end portion of the second portion 34.

[0090] Here, since the portion having the second dimension L2 is positioned at the lower end portion, water in the convex space S can be discharged downward.

(3-6)

[0091] In the heat exchanger 10 of the present embodiment, the triangular portion 34d is disposed at the upper end portion and the lower end portion of the second portion 34.

[0092] Here, since the portion having the second dimension L2 is positioned at the upper end portion, water from above can easily flow to the left and right in the annular portion 34c. This water flows from the left and right in the annular portion 34c to the triangular portion 34d positioned at the lower end portion. Therefore, the water in the convex space S can be smoothly discharged downward.

(3-7)

[0093] In the heat exchanger 10 of the present embodiment, the fin 30 is provided with the drain rib 130. The drain rib 130 extends from the convex space S formed by the first portion 33 and the second portion 34 of the first fin 131 and the distal end of the collar portion 32 of the second fin 132.

[0094] In the heat exchanger 10 of the present embodiment, a structure where the drain rib 130 discharges water from the convex space S can be achieved.

(3-8)

[0095] In the heat exchanger 10 of the present embodiment, the drain rib 130 is continuous with the portion having the second dimension L2.

[0096] In this manner, the fin 30 has a structure that guides water from the portion having the second dimension L2 to the drain rib 130. This structure can easily guide water in the convex space S to the drain rib 130.

(3-9)

[0097] In the heat exchanger 10 of the present embodiment, the drain rib 130 is provided on the body portion 31. The drain rib 130 protrudes in the first direction to the second portion 34.

[0098] This structure can easily guide water in the convex space S to the drain rib 130.

(3-10)

[0099] In the heat exchanger 10 of the present embodiment, the fin 30 includes a plurality of collar portions 32. The drain rib 130 extends in the second direction from the first collar portion 32 to the collar portion 32 disposed below the first collar portion 32.

[0100] Here, water in the convex space S defined by the collar portions 32 on the upper stage can be guided to the convex space S defined by the collar portions 32 on the lower stage through the drain rib 130.

(3-11)

[0101] In the heat exchanger 10 of the present embodiment, the heat exchanger 10 is included in the indoor unit 230 of the air-conditioning apparatus 200. In this manner, the heat exchanger 10 of the present embodiment is suitably used as the indoor heat exchanger 231 disposed indoors.

(4) Modifications

(4-1) Modification 1

[0102] In the above-described embodiment, the portion having the second dimension L2 (in Figs. 3 to 6, the triangular portion 34d) is disposed at both end portions in the second direction, but the present invention is not limited thereto. In the present modification, as illustrated in Fig. 14, the portion having the second dimension L2 is disposed only at the lower end portion. In other words, the triangular portion 34d is not disposed at the upper end portion, but is disposed only at the lower end portion.

(4-2) Modification 2

[0103] In the above-described embodiment, the triangular space within the convex space S is, when viewed from the first direction, provided at both end portions in the second direction, but the present invention is not limited thereto. In the present modification, the triangular space within the convex space S is provided only at the lower end portion. In other words, the annular space is provided at the upper end portion of the convex space S.

(4-3) Modification 3

[0104] In the above-described embodiment, the triangular portion 34d has a V shape when viewed from the first direction, but the present invention is not limited thereto. The triangular portion 34d of the present modification has a U shape.

(4-4) Modification 4

[0105] In the above-described embodiment, the drain rib 130 has a V shape when viewed from below, but the present invention is not limited thereto. The drain rib 130 of the present modification has a U shape when viewed from below.

(4-5) Modification 5

[0106] In the above-described embodiment, water is drained from the drain rib 130 via the space defined by the portion having the second dimension L2 of the first fin 131 and the fourth portion of the second fin 132, but the drainage mechanism is not limited thereto.

(4-6) Modification 6

[0107] In the above-described embodiment, the collar portion 32 has the first portion 33, the second portion 34, the third portion 35, and the fourth portion 36, but the fourth portion 36 may be omitted.

(4-7) Modification 7

[0108] In the above-described embodiment, the fin 30 is formed with the notches 31a for enhancing heat transfer, but the shape, number, arrangement, and the like of the notches 31a are not limited. The notch 31a may extend in a direction that intersects the second direction. In addition, the notch 31a may protrude rearward.

(4-8) Modification 8

[0109] 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.

(4-9) Modification 9

[0110] 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.

[0111] 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

[0112]

10	HEAT EXCHANGER
20	HEAT TRANSFER TUBE
30,131,132	FIN
31	BODY PORTION
32	COLLAR PORTION
33	FIRST PORTION
34	SECOND PORTION
34a	INNER PERIPHERAL SURFACE
34b	OUTER PERIPHERAL SURFACE
34c	ANNULAR PORTION
34d	TRIANGULAR PORTION
35	THIRD PORTION
36	FOURTH PORTION
130	DRAIN RIB
200	AIR-CONDITIONING APPARATUS
230	INDOOR UNIT

Citation List

Patent Literature

[0113] PTL 1: Japanese Unexamined Patent Application Publication No. 2015-123458

Claims

1. A heat exchanger (10) comprising:

a heat transfer tube (20) extending in a first direction; and
a plurality of fins (30, 131, 132) stacked in the first direction, wherein
the plurality of the fins each include:

a body portion (31) extending in a second direction that intersects the first direction; and
a collar portion (32) that allows the heat transfer tube to pass therethrough,
the collar portion has:

a first portion (33) extending from the body portion in the first direction;
a second portion (34) extending from the first portion toward the heat transfer tube; and
a third portion (35) extending in the first direction from the second portion along the heat transfer tube,
the second portion of a first fin (131) in the fins is in contact with a distal end portion of the collar portion of a second fin (131) in the fins disposed adjacent to the first fin, and
the second portion has, when viewed from the first direction:

a portion where a distance be-

tween an inner peripheral surface (34a) and an outer peripheral surface (34b) is a first dimension (L1); and
a portion where the distance between the inner peripheral surface and the outer peripheral surface is a second dimension (L2) greater than the first dimension.

2. The heat exchanger according to claim 1, wherein

the collar portion further has a fourth portion (36) extending radially outward from the third portion, and
the second portion of the first fin is in contact with the fourth portion of the second fin disposed adjacent to the first fin.

3. The heat exchanger according to claim 1 or 2, wherein the second dimension is a portion extending along the second direction.

4. The heat exchanger according to any one of claims 1 to 3, wherein
the second portion has, when viewed from the first direction:

an annular portion (34c) having an annular shape; and
a triangular portion (34d) that is continuous with a part of the annular portion and has a triangular shape, and
the triangular portion configures in the portion having the second dimension.

5. The heat exchanger according to claim 4, wherein the triangular portion is disposed at a lower end portion of the second portion.

6. The heat exchanger according to any one of claims 1 to 5, wherein

the fins are each provided with a drain rib (130), and
the drain rib extends from a convex space (S) formed by the first portion and the second portion of the first fin and a distal end of the collar portion of the second fin.

7. The heat exchanger according to claim 6, wherein the drain rib is connected to the portion having the second dimension.

8. The heat exchanger according to claim 6 or 7, wherein

the drain rib is provided on the body portion, and
the drain rib protrudes in the first direction to the second portion.

9. The heat exchanger according to any one of claims 6 to 8, wherein

the fin includes a plurality of the collar portions, and
the drain rib extends in the second direction from a first collar portion in the collar portions to a collar portion disposed below the first collar portion.

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).

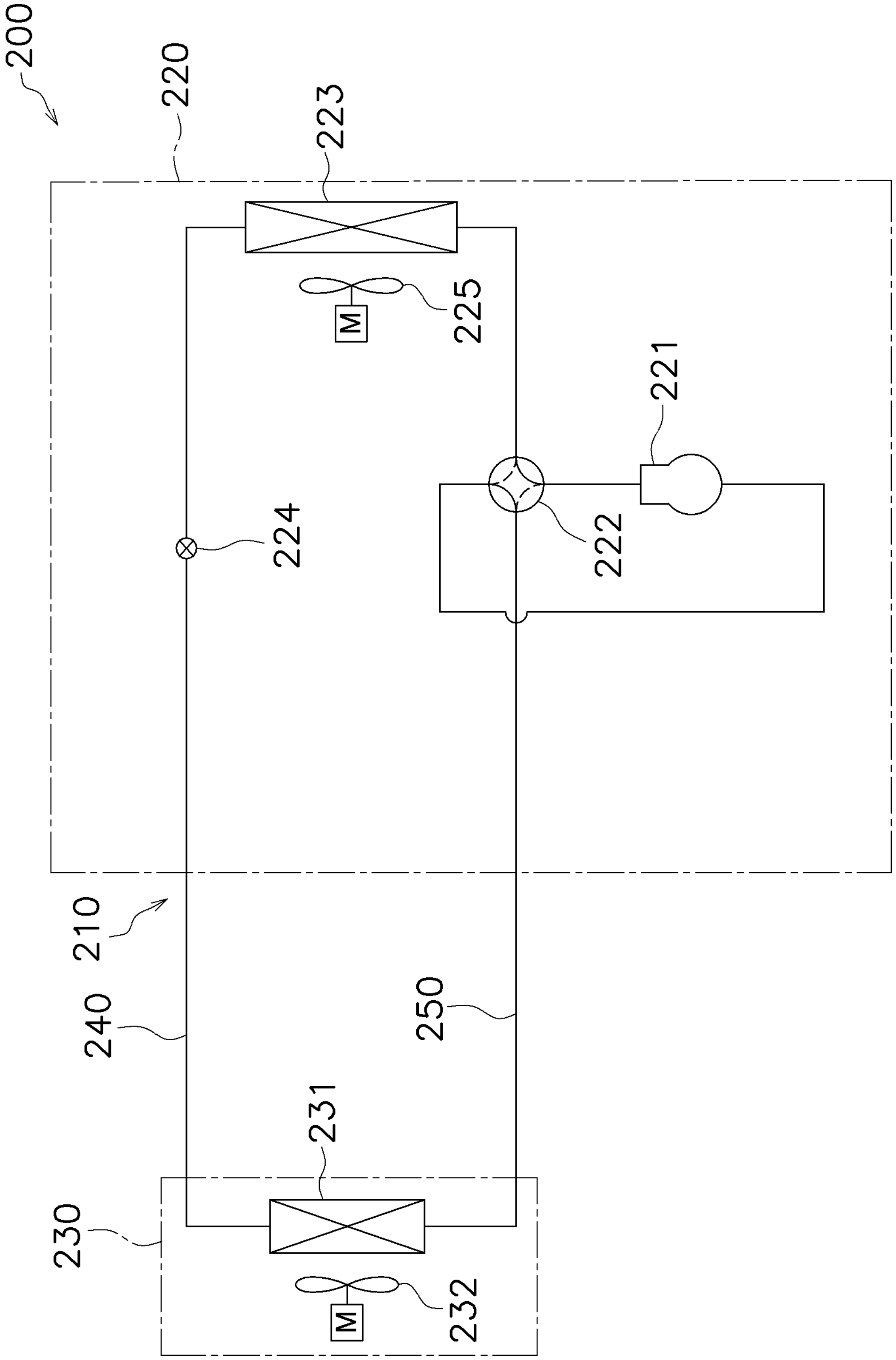


FIG. 1

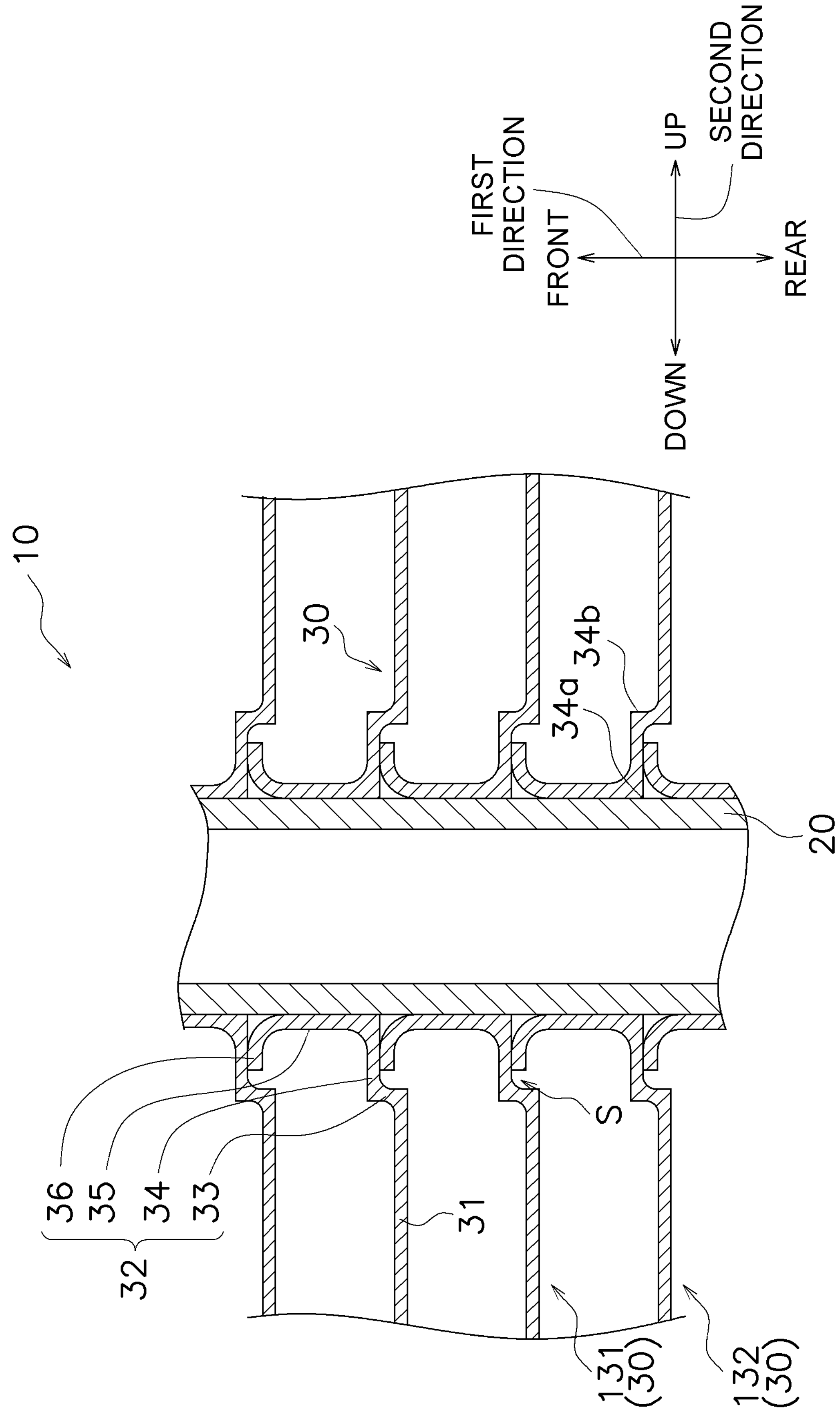

10
FIRST
DIRECTION
SECOND
DIRECTION
UP
DOWN
FRONT
REAR
30
34a
34b
20
36
35
34
33
32
31
S
131
(30)
132
(30)

FIG. 2

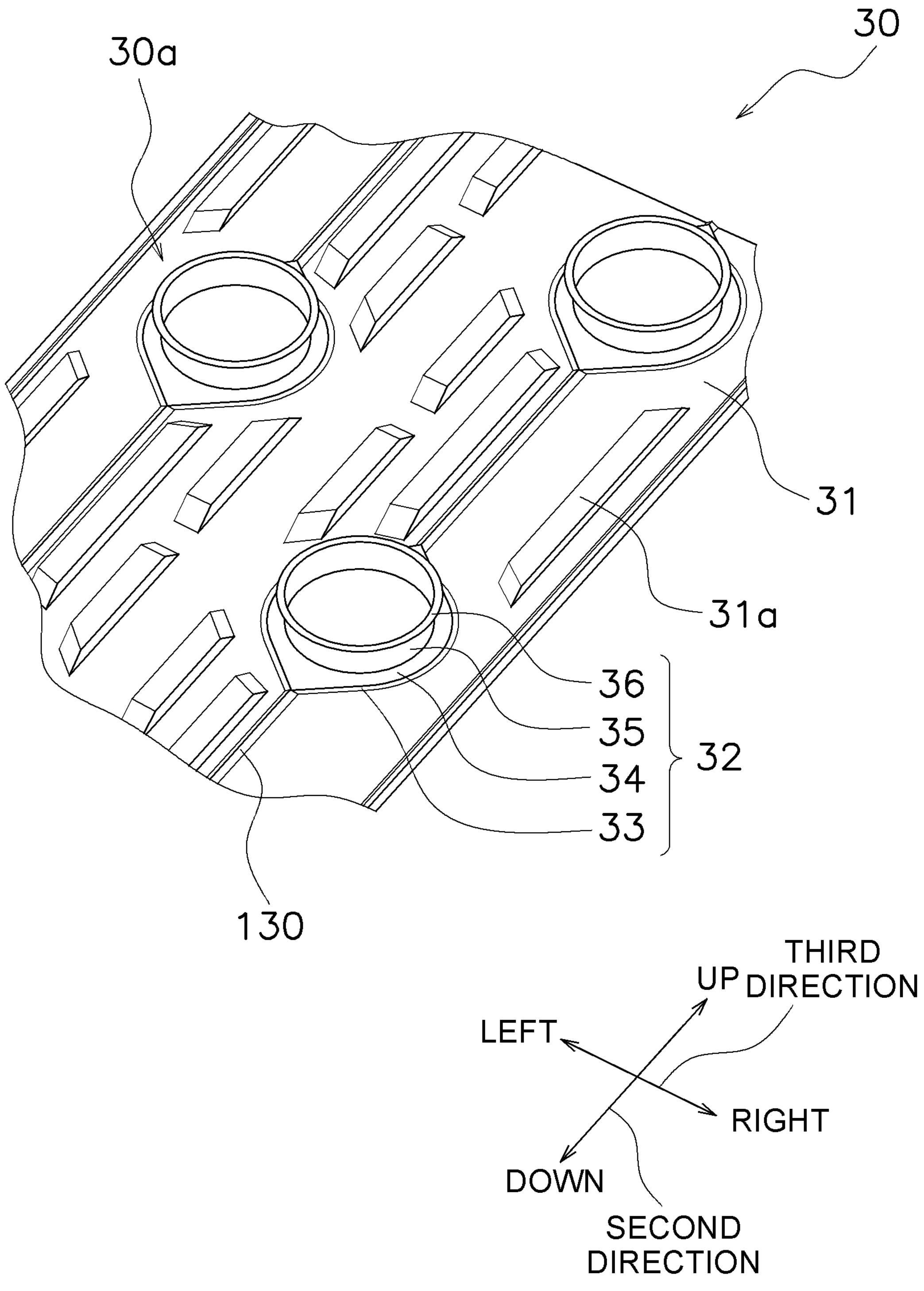

30
30a
31
31a
36
35
34
33
32
130
UP
THIRD
DIRECTION
LEFT
RIGHT
DOWN
SECOND
DIRECTION

FIG. 3

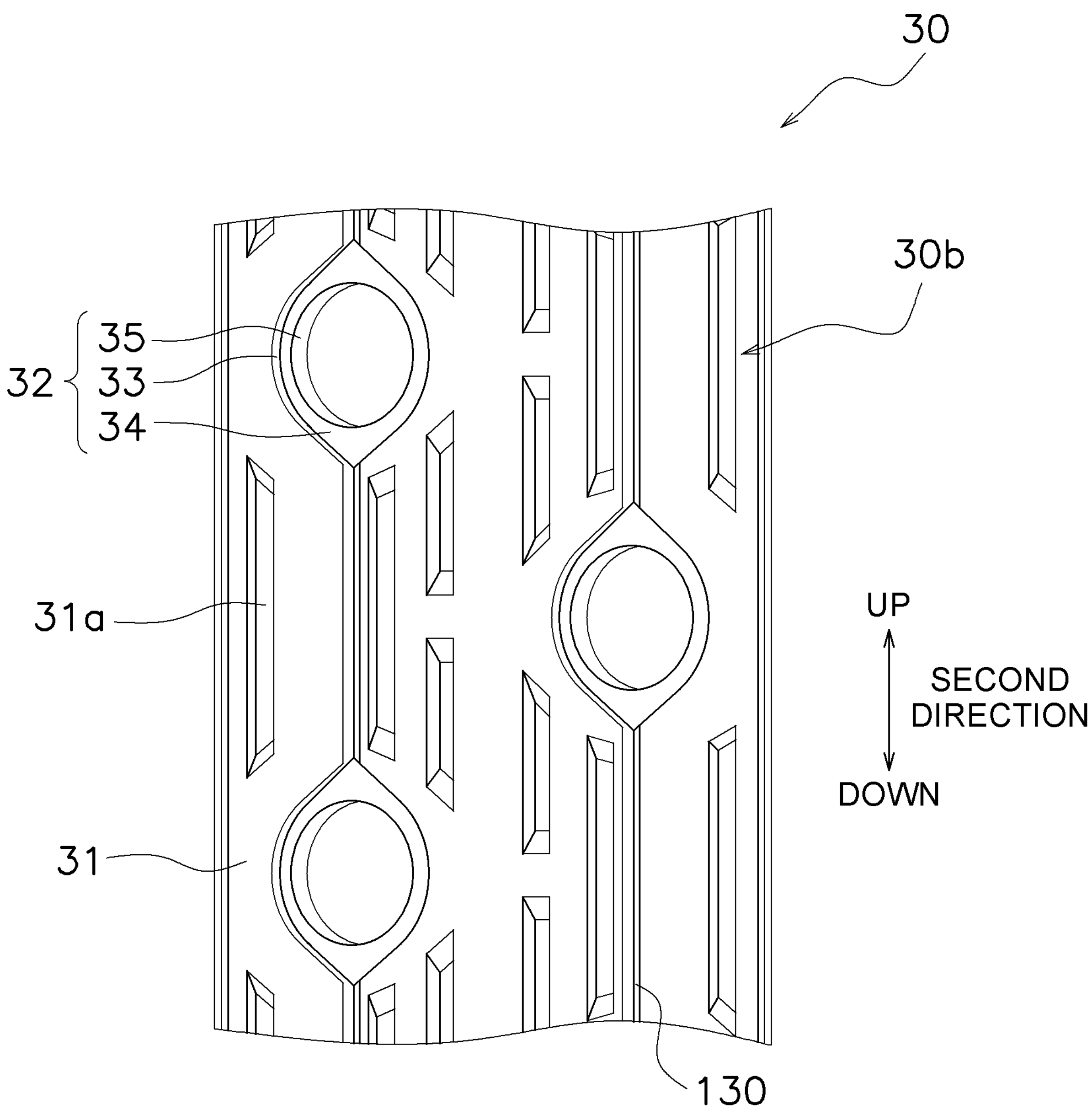


FIG. 4

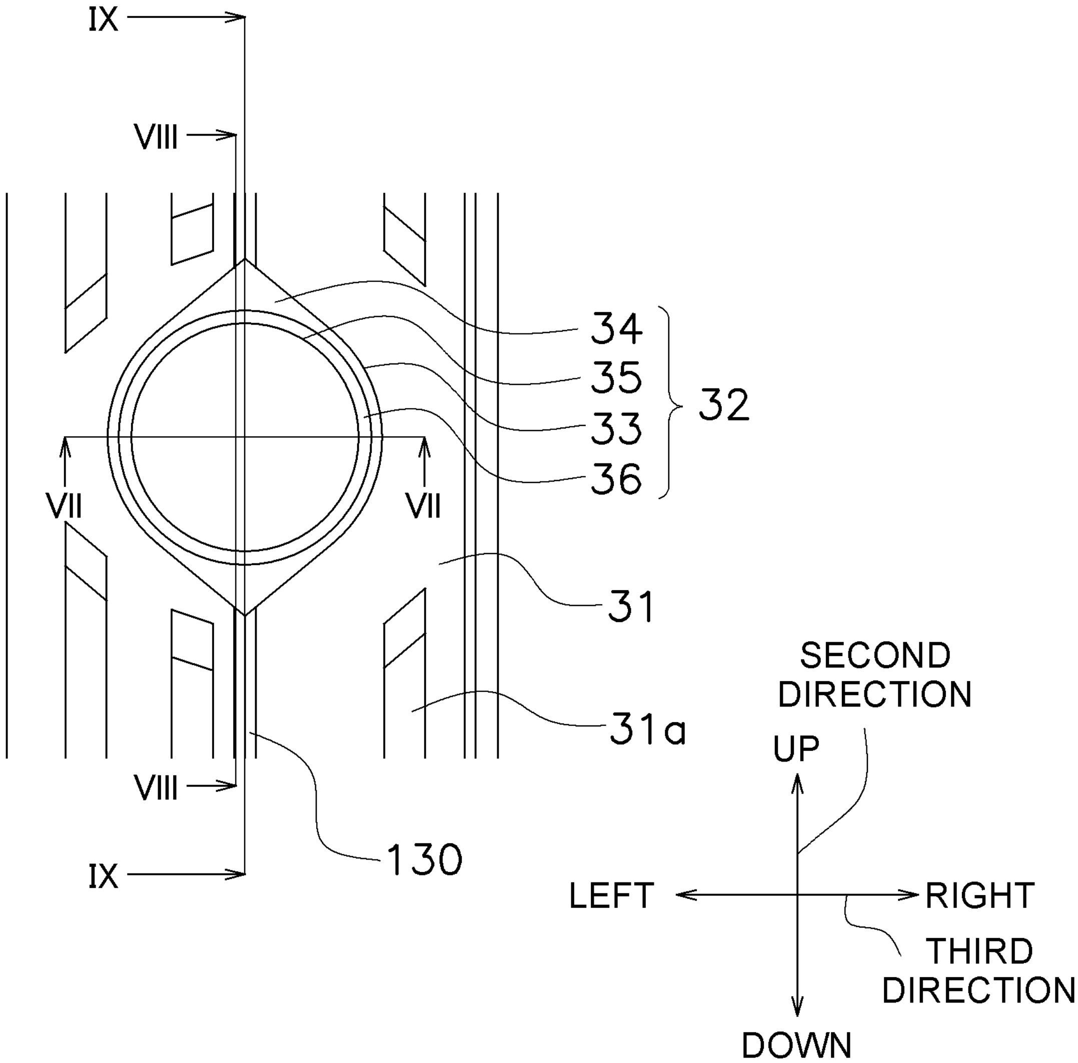
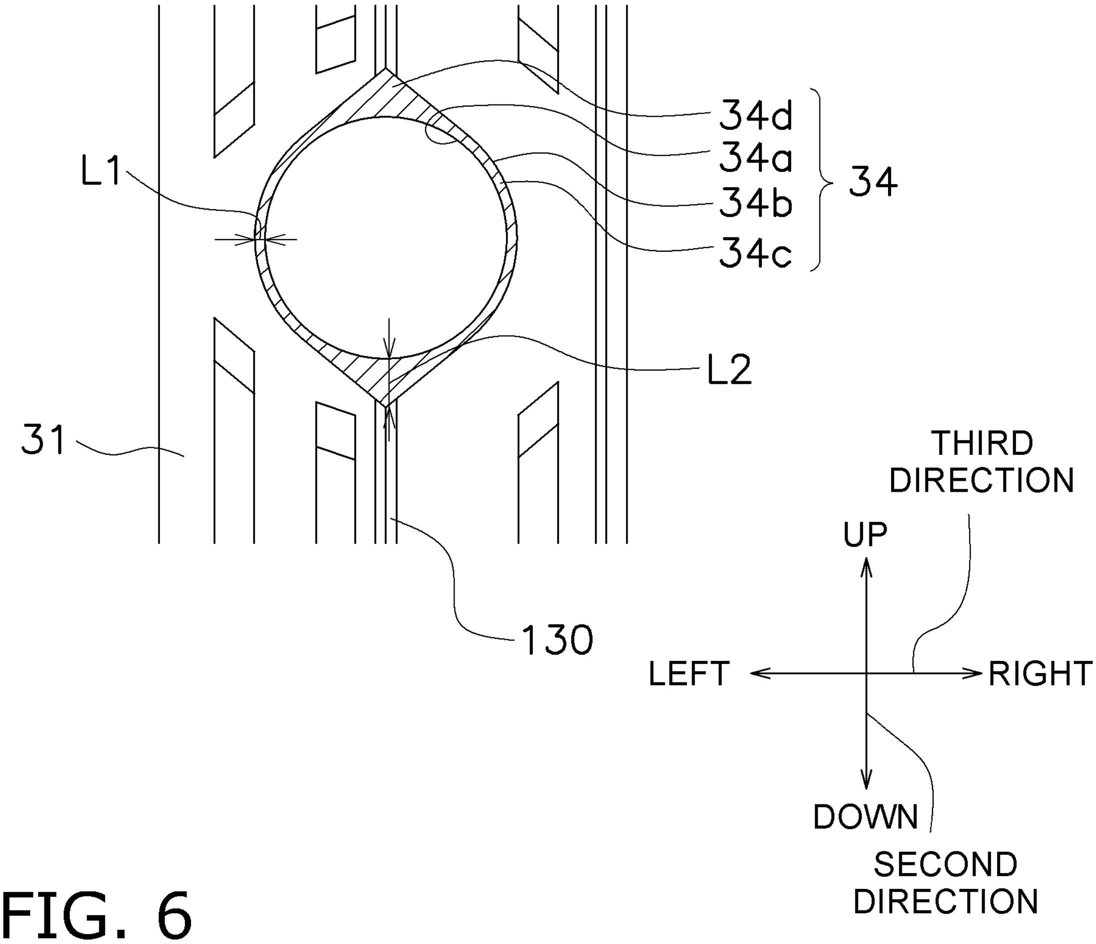
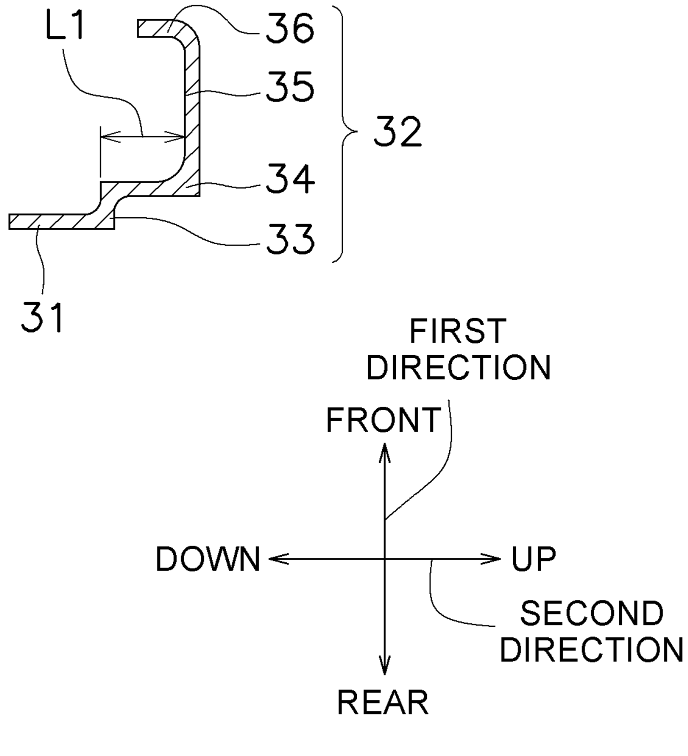

IX
VIII
34
35
33
36
32
VII
VII
31
31a
VIII
IX
130
SECOND
DIRECTION
UP
LEFT
RIGHT
THIRD
DIRECTION
DOWN

FIG. 5



L1
34d
34a
34b
34c
34
L2
31
130
THIRD DIRECTION
UP
LEFT
RIGHT
DOWN
SECOND DIRECTION

FIG. 6



L1
36
35
32
34
33
31
FIRST DIRECTION
FRONT
DOWN
UP
SECOND DIRECTION
REAR

FIG. 7

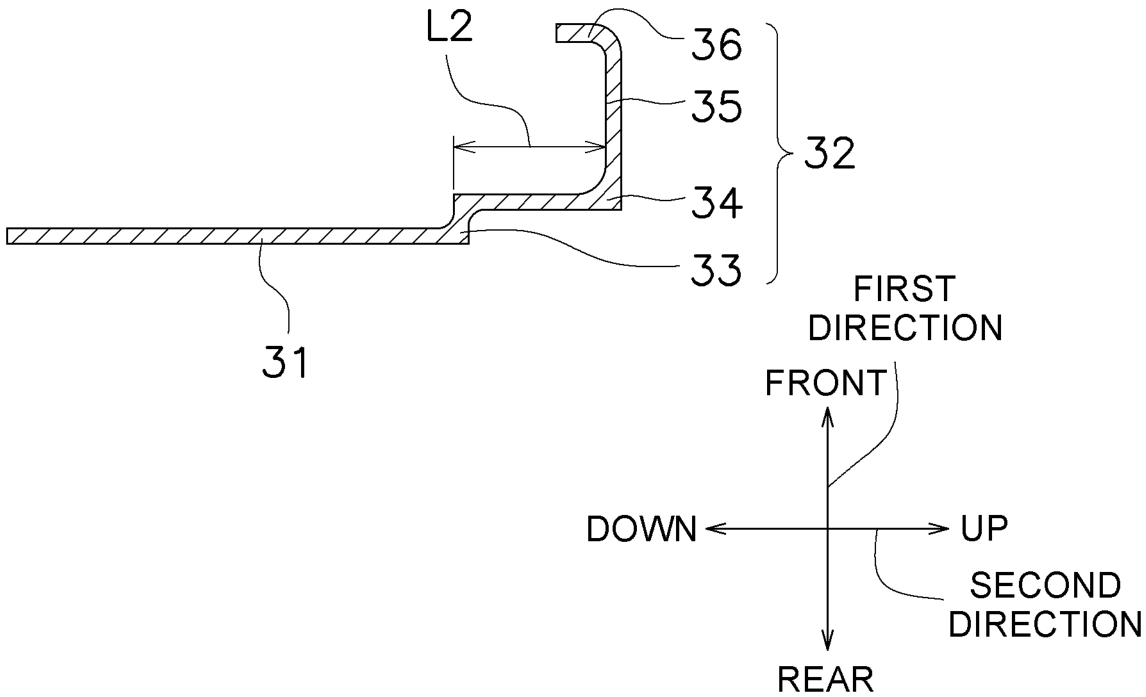

L2
36
35
32
34
33
31
FIRST DIRECTION
FRONT
DOWN
UP
SECOND DIRECTION
REAR

FIG. 8

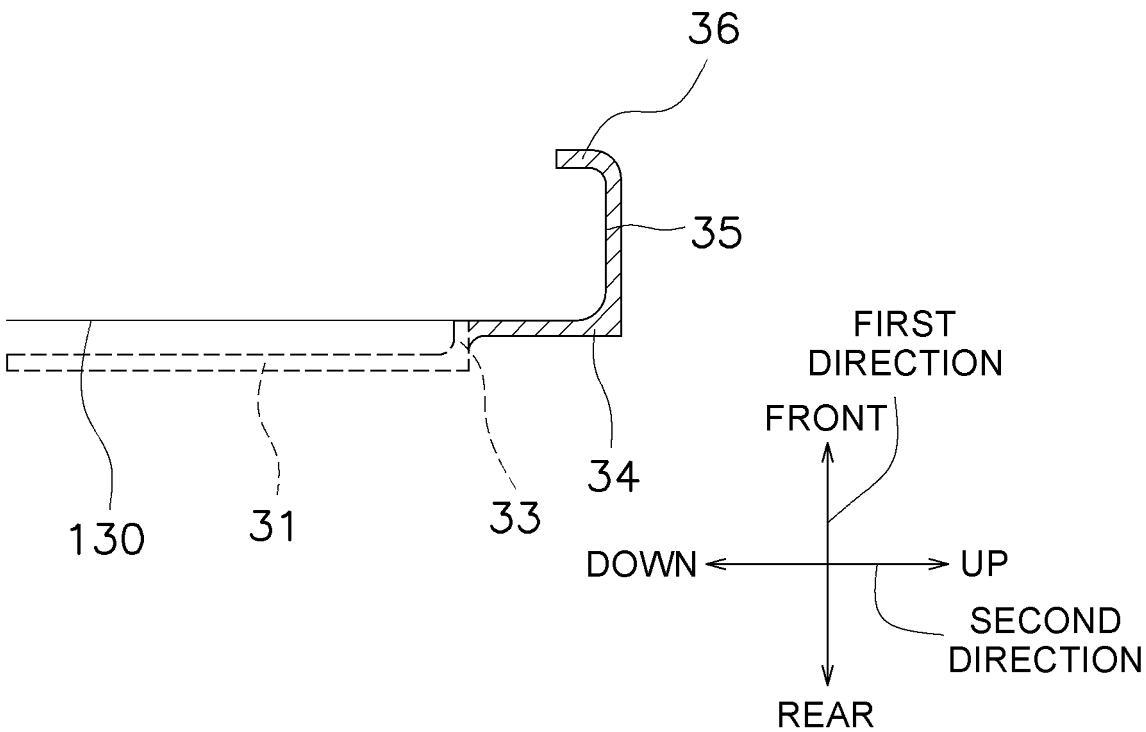

36
35
FIRST DIRECTION
FRONT
130
31
33
34
DOWN
UP
SECOND DIRECTION
REAR

FIG. 9

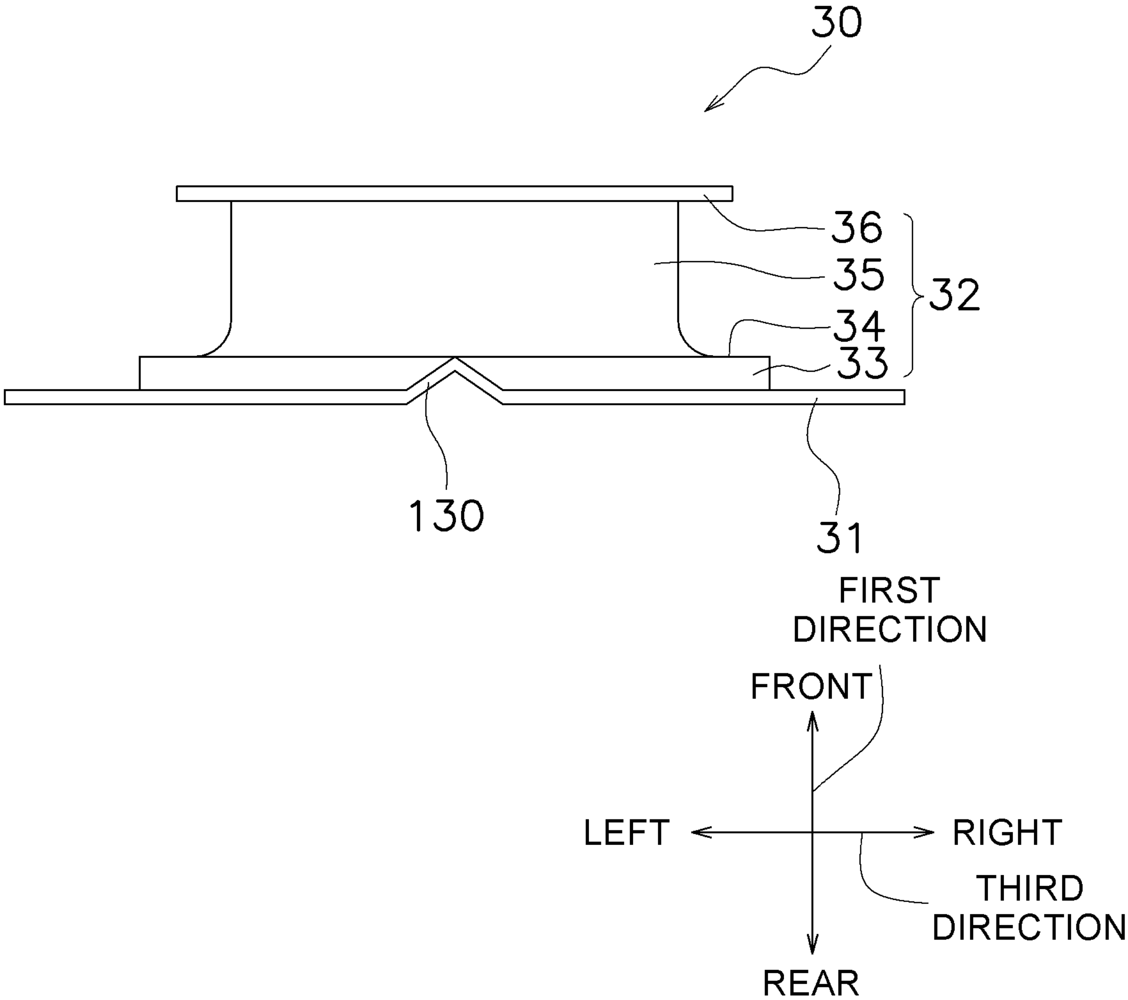

30
36
35
34
33
32
130
31
FIRST
DIRECTION
FRONT
LEFT
RIGHT
THIRD
DIRECTION
REAR

FIG. 10

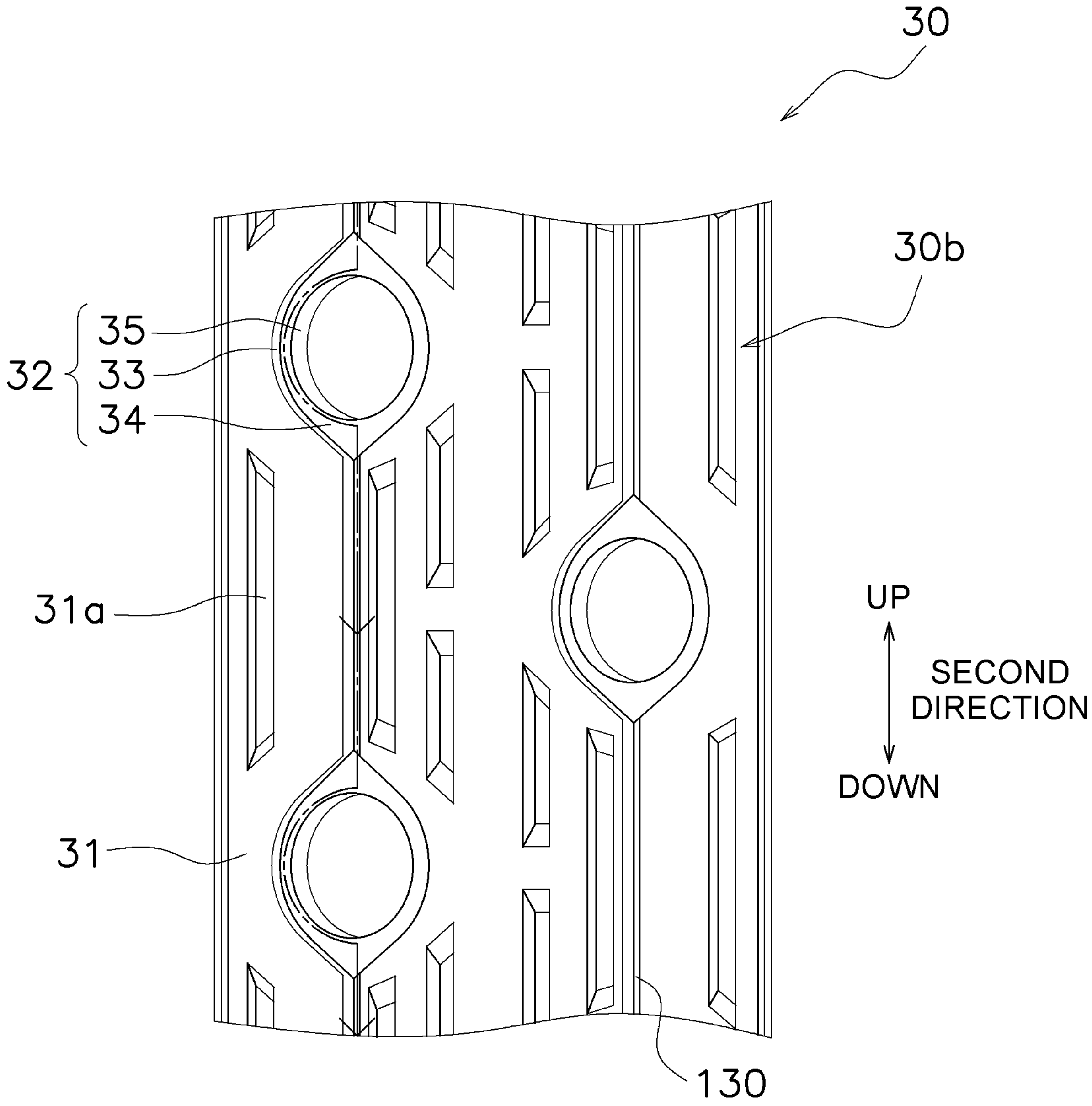


FIG. 11

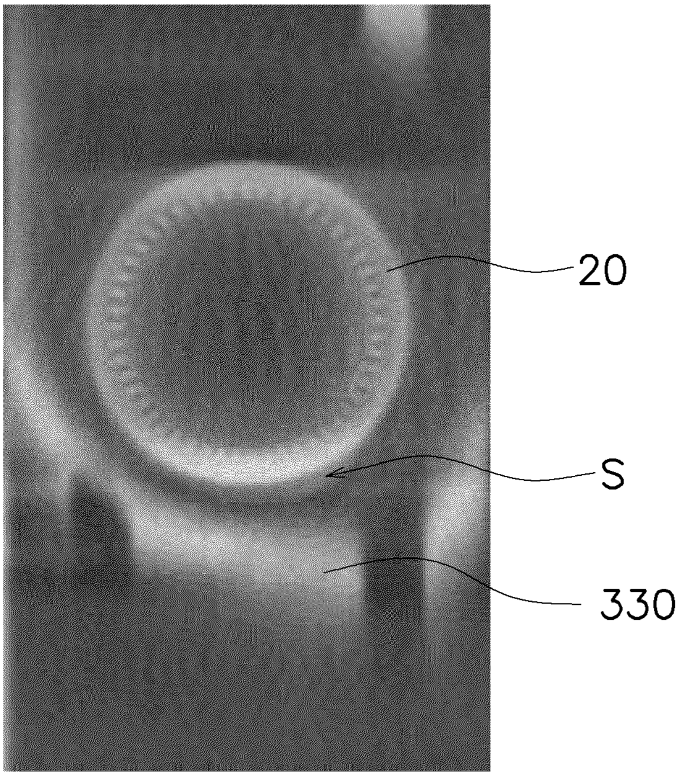


FIG. 12

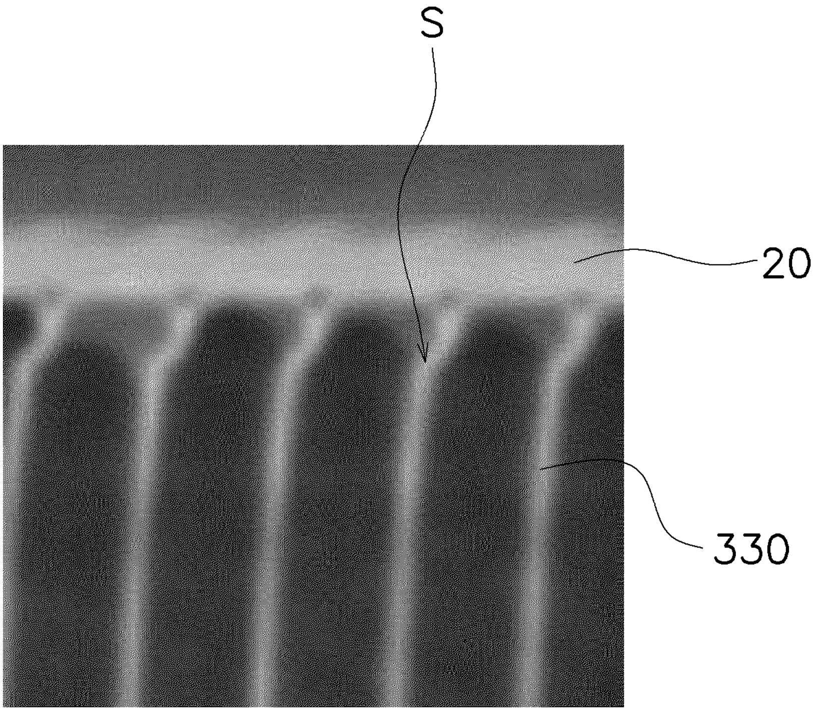


FIG. 13

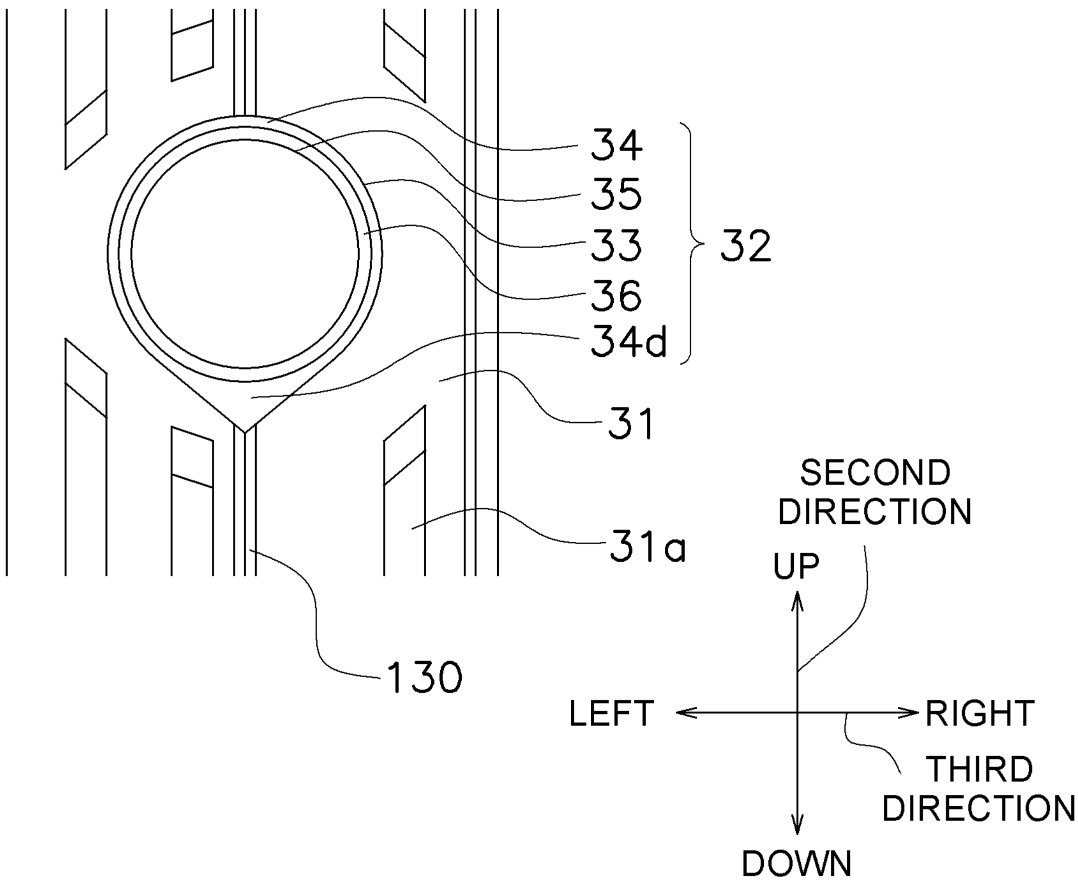

34
35
33
36
34d
32
31
31a
130
SECOND DIRECTION
UP
LEFT
RIGHT
THIRD DIRECTION
DOWN

FIG. 14

INTERNATIONAL SEARCH REPORT

International application No. **PCT/JP2023/028822**

A. CLASSIFICATION OF SUBJECT MATTER

F28F 1/32(2006.01)i; ***F25B 39/02***(2006.01)i
FI: F28F1/32 D; F28F1/32 Y; F28F1/32 F; F25B39/02 J

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; F25B39/00-39/04; F28F17/00; F28D1/00-13/00

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	JP 2008-111646 A (DAIKIN IND., LIMITED) 15 May 2008 (2008-05-15) particularly, paragraphs [0058]-[0062], fig. 2, 10-13	1-5
Y		6-10
X	JP 9-119792 A (HIDAKA SEIKI KABUSHIKI KAISHA) 06 May 1997 (1997-05-06) particularly, paragraphs [0007]-[0011], fig. 1-4	1-2, 10
Y	US 5752567 A (YORK INTERNATIONAL CORPORATION) 19 May 1998 (1998-05-19) particularly, column 2, line 41 to column 4, line 9, fig. 1-6	6-10
A	JP 8-86584 A (FUJITSU GENERAL LIMITED) 02 April 1996 (1996-04-02) particularly, paragraphs [0009]-[0015], fig. 1-3	6-10

☐ 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
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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
11 September 2023	**19 September 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/JP2023/028822

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2008-111646 A	15 May 2008	US 2010/0089557 A1 particularly, paragraphs [0113]-[0117], fig. 2, 10-13 WO 2008/041635 A1 EP 2072939 A1 KR 10-2009-0075706 A AU 2007303342 A1 CN 101523148 A	
JP 9-119792 A	06 May 1997	(Family: none)	
US 5752567 A	19 May 1998	AU 3926897 A	
JP 8-86584 A	02 April 1996	(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

- JP 2015123458 A **[0002] [0113]**