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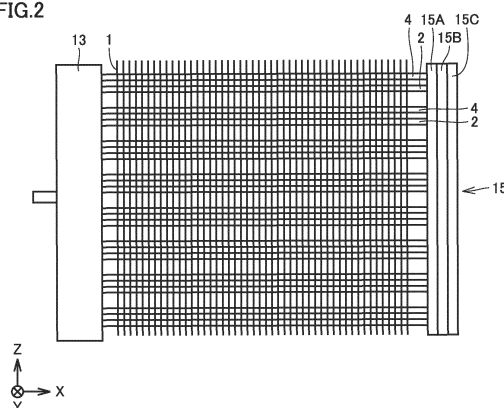
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(54) **HEAT EXCHANGER AND REFRIGERATION CYCLE DEVICE**

(57) A heat exchanger (100) includes a first heat exchange portion (11) and a second heat exchange portion (12) that are arranged side by side in a Y direction intersecting with a direction of gravity. The first heat exchange portion includes a plurality of first fins (1) and a plurality of first flat tubes (2), the first flat tubes being arranged side by side in the direction of gravity. The second heat exchange portion includes a plurality of second fins (3) and a plurality of second flat tubes (4), the plurality of second flat tubes (4) being arranged side by side in the direction of gravity. The heat exchanger further includes: a first header (13) connected to a first end of each of the first flat tubes; a second header (14) connected to a first end of each of the second flat tubes; and a third header (15) connected to each of the first flat tubes and each of the second flat tubes. When viewed in a Y direction, each of the second flat tubes is disposed not to overlap with each of the first flat tubes. The third header includes: a first plate (15A) provided with a plurality of first insertion holes (16) through which the second ends of the first flat tubes are respectively inserted and a plurality of second insertion holes (17) through which the second ends of the second flat tubes are respectively inserted; and a second plate (15B) provided with a plurality of communication spaces (18) each communicating with a corre-

sponding one of the first insertion holes and a corresponding one of the second insertion holes.

FIG.2



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a heat exchanger and a refrigeration cycle apparatus.

BACKGROUND ART

[0002] Japanese Patent Laying-Open No. 2015-113983 discloses a heat exchanger including: a first heat exchange element having a plurality of first flat tubes; a second heat exchange element having a plurality of second flat tubes; and a folded header at which refrigerant having passed through the first heat exchange element is turned and introduced into the second heat exchange element.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: Japanese Patent Laying-Open No. 2015-113983

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] In the above-mentioned heat exchanger, since each of the first flat tubes and each of the second flat tubes are disposed at the same height in the vertical direction, one of each first flat tube and each second flat tube is located downstream of the other in the ventilation direction. In other words, in the ventilation direction, the flat tubes disposed on the downstream side are located in the dead water zone formed behind the flat tubes disposed on the upstream side. As a result, in the above-mentioned heat exchanger, the heat exchange performance of the heat exchange element disposed downstream in the ventilation direction cannot be sufficiently exhibited.

[0005] A main object of the present disclosure is to provide a heat exchanger enhanced in heat exchange performance as compared with the above-mentioned conventional heat exchanger, and a refrigeration cycle apparatus including the heat exchanger.

SOLUTION TO PROBLEM

[0006] A heat exchanger according to a first aspect of the present disclosure includes: a first heat exchange portion and a second heat exchange portion arranged side by side in a first direction intersecting with a direction of gravity. The first heat exchange portion has: a plurality of first fins extending in the direction of gravity and arranged side by side in a second direction intersecting with the direction of gravity and the first direction; and a

plurality of first flat tubes mounted to intersect with each of the first fins and arranged side by side in the direction of gravity. The second heat exchange portion has: a plurality of second fins extending in the direction of gravity and arranged side by side in the second direction; and a plurality of second flat tubes mounted to intersect with each of the second fins and arranged side by side in the direction of gravity. The heat exchanger further includes: a first header connected to a first end of each of the first flat tubes; a second header connected to a first end of each of the second flat tubes; and a third header connected to a second end of each of the first flat tubes and a second end of each of the second flat tubes. When viewed in the first direction, each of the second flat tubes is disposed not to overlap with each of the first flat tubes. The third header has: a first plate provided with a plurality of first insertion holes through which the second ends of the first flat tubes are respectively inserted, and a plurality of second insertion holes through which the second ends of the second flat tubes are respectively inserted; and a second plate provided with a plurality of communication spaces each communicating with a corresponding one of the first insertion holes and a corresponding one of the second insertion holes.

[0007] A heat exchanger according to a second aspect of the present disclosure includes a first heat exchange portion and a second heat exchange portion arranged side by side in a first direction intersecting with a direction of gravity. The first heat exchange portion has: a plurality of first fins extending in the direction of gravity and arranged side by side in a second direction intersecting with the direction of gravity and the first direction; and a plurality of first flat tubes mounted to intersect with each of the first fins and arranged side by side in the direction of gravity. The second heat exchange portion has: a plurality of second fins extending in the direction of gravity and arranged side by side in the second direction; and a plurality of second flat tubes mounted to intersect with each of the second fins and arranged side by side in the direction of gravity. The heat exchanger further includes: a first header connected to a first end of each of the first flat tubes; a second header connected to a first end of each of the second flat tubes; and a third header connected to a second end of each of the first flat tubes and a second end of each of the second flat tubes, the third header being provided with a plurality of communication spaces each communicating with a corresponding one of the first flat tubes and a corresponding one of the second flat tubes. When viewed in the first direction, each of the second flat tubes is disposed not to overlap with each of the first flat tubes. At least one of the first flat tubes that is connected to one communication space of the communication spaces is located lower in the direction of gravity than at least one of the second flat tubes that is connected to the one communication space.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] The present disclosure can provide a heat exchanger improved in heat exchange performance as compared with the above-mentioned conventional heat exchanger, and a refrigeration cycle apparatus including the heat exchanger.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 is a top view of a heat exchanger according to a first embodiment.

Fig. 2 is a front view of the heat exchanger shown in Fig. 1.

Fig. 3 is a side view of the heat exchanger shown in Fig. 1.

Fig. 4 is a partial cross-sectional view for illustrating configurations of a first fin, a first flat tube, a second fin, and a second flat tube in the heat exchanger shown in Fig. 1.

Fig. 5 is a diagram for illustrating a first plate of a bridging header shown in Fig. 1.

Fig. 6 is a diagram for illustrating a second plate of the bridging header shown in Fig. 1.

Fig. 7 is a diagram for illustrating a third plate of the bridging header shown in Fig. 1.

Fig. 8 is an exploded perspective view for illustrating a connection relation among the first plate, the second plate, and the third plate of the bridging header shown in Fig. 1.

Fig. 9 is a partial cross-sectional view taken along a line indicated by an arrow IX-IX in Fig. 1.

Fig. 10 is a partial cross-sectional view showing a modification of the first plate, the second plate, and the third plate shown in Fig. 9.

Fig. 11 is a partial cross-sectional view for illustrating configurations of a first fin, a first flat tube, a second fin, and a second flat tube in a heat exchanger according to a second embodiment.

Fig. 12 is a diagram for illustrating a first plate of a bridging header in the heat exchanger according to the second embodiment.

Fig. 13 is a diagram for illustrating a second plate of the heat exchanger according to the second embodiment.

Fig. 14 is a top view of a heat exchanger according to a third embodiment.

Fig. 15 is a front view of the heat exchanger shown in Fig. 14.

Fig. 16 is a side view of the heat exchanger shown in Fig. 14.

Fig. 17 is a diagram for illustrating a first plate of a bridging header shown in Fig. 14.

Fig. 18 is a diagram for illustrating a second plate of the bridging header shown in Fig. 14.

Fig. 19 is a diagram for illustrating a third plate of the

bridging header shown in Fig. 14.

DESCRIPTION OF EMBODIMENTS

[0010] The following describes embodiments as examples of a heat exchanger according to the present disclosure with reference to the accompanying drawings. In the accompanying drawings, the same or corresponding portions are denoted by the same reference characters, and the description thereof will not be repeated. Further, in each of the figures, for convenience of explanation, an X direction, a Y direction, and a Z direction orthogonal to each other are introduced. The X direction and the Y direction corresponds to the horizontal direction while the Z direction corresponds to the direction of gravity.

First Embodiment

[0011] As shown in Figs. 1 to 3, a heat exchanger 100 according to the first embodiment includes a first heat exchange portion 11, a second heat exchange portion 12, a first header 13, a second header 14, and a third header (hereinafter, referred to as a bridging header) 15.

[0012] As shown in Figs. 1, 2, and 4, each of first heat exchange portion 11 and second heat exchange portion 12 is provided so as to exchange heat between the refrigerant flowing in the X direction (the second direction) and air flowing in the Y direction. First heat exchange portion 11 and second heat exchange portion 12 are arranged side by side in the Y direction (the first direction). In the following description, in the Y direction, the upstream side in the ventilation direction will be simply referred to as a windward side while the downstream side in the ventilation direction will be simply referred to as a leeward side. First heat exchanging portion 11 is disposed on the windward side relative to second heat exchanging portion 12.

[0013] As shown in Figs. 1, 2, and 4, first heat exchange portion 11 includes a plurality of first fins 1 and a plurality of first flat tubes 2. The plurality of first fins 1 extend in the Z direction and the Y direction, and are arranged side by side in the X direction. Each of first fins 1 is a plate fin. The plurality of first flat tubes 2 are mounted to intersect with each of the plurality of first fins 1, and are arranged side by side in the Z direction. The cross-sectional shape of each first flat tube 2 perpendicular to the X direction is a flat shape having a long-side direction and a short-side direction. The long-side direction of each first flat tube 2 corresponds to the Y direction. In first heat exchange portion 11, heat is exchanged between: air flowing in the Y direction between first fins 1 adjacent to each other; and the refrigerant flowing in the X direction through each first flat tube 2. A plurality of flow paths are formed inside each first flat tube 2. The flow paths each extend in the axial direction (the X direction) of each first flat tube 2 and are arranged side by side in the long-side direction of each first flat tube 2.

[0014] As shown in Figs. 1, 2, and 4, second heat ex-

change portion 12 includes a plurality of second fins 3 and a plurality of second flat tubes 4. The plurality of second fins 3 extend in the Z direction and the Y direction, and are arranged side by side in the X direction. Each second fin 3 is a plate fin. The plurality of second flat tubes 4 are mounted to intersect with each of the plurality of second fins 3 and are arranged side by side in the Z direction. The cross-sectional shape of each second flat tube 4 perpendicular to the X direction is a flat shape having a long-side direction and a short-side direction. In second heat exchange portion 12, heat is exchanged between: air flowing in the Y direction between second fins 3 adjacent to each other; and the refrigerant flowing in the X direction through each second flat tube 4. A plurality of flow paths are formed inside each second flat tube 4. The flow paths each extend in the axial direction (the X direction) of each second flat tube 4 and are arranged side by side in the long-side direction of each second flat tube 4.

[0015] As shown in Figs. 1 and 4, each second fin 3 is spaced apart in the Y direction from each first fin 1. Each second fin 3 is disposed on the leeward side relative to each first fin 1. An end portion 3A located on the windward side of each second fin 3 is disposed on the leeward side relative to an end portion 1B located on the leeward side of each first fin 1.

[0016] As shown in Figs. 1 and 4, each second flat tube 4 is spaced apart in the Y direction from each first flat tube 2. Each second flat tube 4 is disposed on the leeward side relative to each first flat tube 2. An end portion located on the windward side of each second flat tube 4 is disposed on the leeward side relative to an end portion located on the leeward side of each first flat tube 2.

[0017] As shown in Fig. 2, each second fin 3 is disposed to overlap with each first fin 1 when viewed in the Y direction. Each second fin 3 is formed as a member separate from each first fin 1.

[0018] As shown in Figs. 2 and 4, each second flat tube 4 is disposed not to overlap with each first flat tube 2 when viewed in the Y direction. When viewed in the Y direction, each first flat tube 2 is disposed between two second flat tubes 4 adjacent to each other in the Z direction. When viewed in the Y direction, each second flat tube 4 is disposed between two first flat tubes 2 adjacent to each other in the Z direction.

[0019] As shown in Fig. 4, each first fin 1 has a continuous portion 1D disposed on one side (for example, on the windward side) in the Y direction and extending in the Z direction. Each first fin 1 is provided with a plurality of insertion holes 1C disposed on the other side (for example, on the leeward side) in the Y direction with respect to continuous portion 1D. Through each insertion hole 1C, each first flat tube 2 is inserted. Continuous portion 1D is located between an end portion 1A located on the windward side of first fin 1 and an end portion located on the windward side of each insertion hole 1C. Each insertion hole 1C is opened, for example, at end portion 1B located on the leeward side of first fin 1. Note that each

insertion hole 1C may not be opened at end portion 1B located on the leeward side of first fin 1.

[0020] As shown in Fig. 4, each second fin 3 has a continuous portion 3D disposed on one side (for example, on the windward side) in the Y direction and extending in the Z direction. Each second fin 3 is provided with a plurality of insertion holes 3C disposed on the other side (for example, on the leeward side) in the Y direction with respect to continuous portion 3D. Through each insertion hole 3C, each second flat tube 4 is inserted. Continuous portion 3D is located between end portion 3A located on the windward side of second fin 3 and the end portion located on the windward side of each insertion hole 3C. Each insertion hole 3C is opened, for example, at an end portion 3B located on the leeward side of second fin 3. Each insertion hole 3C may not be opened at end portion 3B located on the leeward side of second fin 3.

[0021] As shown in Figs. 1 and 2, first header 13 is connected to a first end of each first flat tube 2 in the Y direction. First header 13 allows merging of the refrigerant having flowed out of each first flat tube 2 or allows splitting of the refrigerant that is to flow into each first flat tube 2. Second header 14 is connected to the first end of each second flat tube 4 in the Y direction, and allows merging of the refrigerant having flowed out of each second flat tube 4 or allows splitting of the refrigerant that is to flow into each second flat tube 4. Second header 14 is disposed on the leeward side relative to first header 13.

[0022] As shown in Figs. 1 to 3, bridging header 15 is connected to the second end of each first flat tube 2 and the second end of each second flat tube 4. Bridging header 15 provides communication between each first flat tube 2 and each second flat tube 4 for refrigerant to flow therebetween.

[0023] As shown in Fig. 3, bridging header 15 is provided with: a plurality of first insertion holes 16 through which first flat tubes 2 are respectively inserted; a plurality of second insertion holes 17 through which second flat tubes 4 are respectively inserted; and a plurality of communication spaces 18 each communicating with a corresponding one of first insertion holes 16 and a corresponding one of second insertion holes 17. First insertion holes 16 are arranged side by side in the Z direction. Second insertion holes 17 are arranged side by side in the Z direction. Each second insertion hole 17 is spaced apart in the Y direction from each first insertion hole 16. Further, each second insertion hole 17 is spaced apart in the Z direction from each first insertion hole 16.

[0024] As shown in Figs. 3 and 6, each communication space 18 is provided to allow communication between one first insertion hole 16 and one second insertion hole 17 that is disposed adjacent to this one first insertion hole 16 in the Z direction and located above this one first insertion hole 16. In other words, each communication space 18 provides communication between one first flat tube 2 and one second flat tube 4 that is disposed adjacent to this one first flat tube 2 in the Z direction and

located above this one first flat tube 2, for refrigerant to flow therebetween.

[0025] As shown in Fig. 3, bridging header 15 includes a first plate 15A, a second plate 15B, and a third plate 15C. First plate 15A, second plate 15B, and third plate 15C are stacked in the X direction. First plate 15A is disposed on the side close to first heat exchange portion 11 and second heat exchange portion 12 with respect to second plate 15B and third plate 15C in the X direction. Third plate 15C is disposed on the side opposite to first heat exchange portion 11 and second heat exchange portion 12 with respect to first plate 15A and second plate 15B in the X direction. Second plate 15B is sandwiched between first plate 15A and third plate 15C in the X direction. First plate 15A, second plate 15B, and third plate 15C are connected and fixed to each other in a water-tight manner. The materials forming first plate 15A, second plate 15B, and third plate 15C include aluminum (Al), for example.

[0026] As shown in Figs. 3, 5, and 8, first plate 15A is provided with a plurality of through holes. The through holes provided in first plate 15A constitute first insertion holes 16 or second insertion holes 17. In other words, first insertion holes 16 and second insertion holes 17 are provided as through holes in first plate 15A. First insertion holes 16 and second insertion holes 17 each may be formed by any method and, for example, are formed by press working. First plate 15A serves as a connection plate connected to each first flat tube 2 and each second flat tube 4 in a water-tight manner.

[0027] As shown in Figs. 3, 6, and 8, second plate 15B is provided with a plurality of through holes. The inner space of each through hole provided in second plate 15B provides communication space 18. In other words, each communication space 18 is an inner space of each of the plurality of through holes provided in second plate 15B. When viewed in the X direction, each through hole provided in second plate 15B is provided to overlap with the entirety of one first insertion hole 16 and one second insertion hole 17. When viewed in the X direction, the opening end of each through hole provided in second plate 15B is located outside each of the opening ends of each first insertion hole 16 and each second insertion hole 17 provided in first plate 15A. Each through hole provided in second plate 15B may be formed by any method and, for example, are formed by press working. Second plate 15B is a flow path plate providing communication space 18 as a refrigerant flow path between first flat tube 2 and second flat tube 4.

[0028] As shown in Figs. 3 and 6, one first flat tube 2 connected to one communication space 18 is located lower in the Z direction than one second flat tube 4 connected to this one communication space 18. Specifically, the uppermost portion of one first flat tube 2 connected to one communication space 18 is located at the same height in the Z direction as the lowermost portion of one second flat tube 4 connected to this one communication space 18, or located lower than the lowermost portion.

[0029] The inner circumferential surface of each through hole provided in second plate 15B has a pair of inclined surfaces facing each other in the Z direction and inclined with respect to the X direction and the Y direction.

The pair of inclined surfaces is inclined gradually upward to the leeward side. The distance between the pair of inclined surfaces in the Z direction is larger than the width of each first insertion hole 16 in the Z direction and the width of each second insertion hole 17 in the Z direction.

[0030] As shown in Figs. 3, 7, and 8, third plate 15C is disposed on the side opposite to each first insertion hole 16 and each second insertion hole 17 with respect to each communication space 18, and closes one end of each communication space 18 in the X direction. In third plate 15C, no through hole is formed in a region overlapping with communication space 18 when viewed in the X direction. Third plate 15C forms what is called an outer shell plate.

[0031] As shown in Fig. 9, first plate 15A is smaller in thickness than second plate 15B. Third plate 15C is smaller in thickness than second plate 15B. First plate 15A is larger in thickness than third plate 15C, for example. First flat tube 2 is fixed to first plate 15A, for example, by a brazing material. In this case, after first flat tube 2 is inserted into first insertion hole 16 and second flat tube 4 is inserted into second insertion hole 17, first flat tube 2 and second insertion hole 17 are fixed to first plate 15A by a brazing material. Then, second plate 15B and third plate 15C are fixed to first plate 15A by a brazing material. In this way, each first flat tube 2, each second flat tube 4, and bridging header 15 are connected and fixed to each other in a water-tight manner.

<Functions and Effects>

[0032] In heat exchanger 100, each of second flat tubes 4 is disposed not to overlap with each of first flat tubes 2 when viewed in the Y direction. In other words, in heat exchanger 100, each second flat tube 4 disposed on the leeward side is not located in the dead water zone of each first flat tube 2 disposed on the windward side. Thus, the heat exchange performance of heat exchanger 100 is enhanced as compared with the heat exchange performance of the heat exchanger in which each first flat tube and each second flat tube are disposed at the same height in the vertical direction.

[0033] Further, bridging header 15 of heat exchanger 100 includes: first plate 15A provided with first insertion holes 16 through which the second ends of first flat tubes 2 are respectively inserted and second insertion holes 17 through which the second ends of second flat tubes 4 are respectively inserted; and second plate 15B provided with communication spaces 18 each communicating with a corresponding one of first insertion holes 16 and a corresponding one of second insertion holes 17.

[0034] In bridging header 15 as described above, each of first plate 15A and second plate 15B formed of separate plate members is provided with: first insertion holes

16 and second insertion holes 17 through which first flat tubes 2 and second flat tubes 4 are respectively inserted; and communication spaces 18 each providing communication between each first flat tube 2 and each second flat tube 4 for refrigerant to flow therebetween. Thus, the degree of freedom for the shapes of each first insertion hole 16, each second insertion hole 17, and each communication space 18 in bridging header 15 is enhanced as compared with the degree of freedom for the shape of the bridging header in which each first insertion hole, each second insertion hole, and each communication space are formed in one member. As a result, in bridging header 15, even when each second flat tube 4 is disposed not to overlap with each first flat tube 2 when viewed in the Y direction, the insertion margins for each first insertion hole 16 and each second insertion hole 17 can be readily ensured and the volume of each communication space 18 can be readily increased, as compared with the bridging header in which each first insertion hole, each second insertion hole, and each communication space are provided in one member.

[0035] As a result, in heat exchanger 100 including bridging header 15 described above, the heat exchange performance can be readily enhanced as compared with the heat exchanger including the bridging header in which each first insertion hole, each second insertion hole, and each communication space are provided in one member.

[0036] In heat exchanger 100, first plate 15A is smaller in thickness than second plate 15B. This makes it possible to simultaneously increase the volume of each communication space 18 and the insertion margins for each first insertion hole 16 and each second insertion hole 17, as compared with the case in which the thickness of first plate 15A is equal to or larger than the thickness of second plate 15B.

[0037] In heat exchanger 100, one first flat tube 2 connected to one communication space 18 is located lower in the Z direction than one second flat tube 4 connected to this one communication space 18.

[0038] In this way, when refrigerant flows from second flat tube 4 to first flat tube 2 through communication space 18, gravity acts on this refrigerant in the flow direction of the refrigerant. In such heat exchanger 100, as compared with the heat exchanger in which each first flat tube and each second flat tube are disposed at the same height in the vertical direction, the pressure loss of the gas-liquid two-phase refrigerant having flowed out of second flat tube 4 is reduced, so that the heat exchange performance is enhanced.

<Modification>

[0039] Each communication space 18 only needs to provide communication between at least one first flat tube 2 and at least one second flat tube 4 for refrigerant to flow therebetween. Each communication space 18 may be formed, for example, to provide communication be-

tween the plurality of first flat tubes 2 and the plurality of second flat tubes 4 for refrigerant to flow therebetween.

[0040] Second plate 15B may be provided with a plurality of recesses in place of the plurality of through holes. In this case, each communication space 18 is formed of an inner space of a recess provided in second plate 15B. Bridging header 15 may not include third plate 15C and may be formed as a multilayer body of first plate 15A and second plate 15B.

[0041] As shown in Fig. 10, a plurality of recesses 15D may be provided in the surface of third plate 15C on the side close to second plate 15B. Each of the plurality of recesses 15D is provided to overlap with each of the through holes provided in second plate 15B when viewed in the X direction. The region of third plate 15C where no recess 15D is provided is formed to overlap with the region of second plate 15B where no through hole is provided when viewed in the X direction. In this case, the inner space of each recess 15D provided in third plate 15C communicates with the inner space of each through hole provided in second plate 15B, and each communication space 18 is formed of the above-mentioned two inner spaces.

[0042] In bridging header 15, second plate 15B may be configured as a multilayer body formed of a plurality of plates. As long as the entire thickness of second plate 15B is larger than the thickness of first plate 15A, the thickness of each plate forming second plate 15B may be equal to or smaller than the thickness of first plate 15A.

[0043] In this way, the pressure resistance of second plate 15B can be enhanced without impairing the formability of second plate 15B as compared with the case in which second plate 15B is formed as one plate.

[0044] Further, in bridging header 15, the plurality of first insertion holes 16, the plurality of second insertion holes 17, and the plurality of communication spaces 18 may be provided in one member. Bridging header 15 as described above may be formed by laser processing, for example.

Second Embodiment

[0045] A heat exchanger according to the second embodiment has basically the same configuration and exhibits basically the same effect as those of heat exchanger 100 according to the first embodiment, but is different from heat exchanger 100 in that each first flat tube 2 and each second flat tube 4 have upper surfaces 2A and 4A, respectively, inclined with respect to the horizontal direction and that each communication space 18 extends along upper surfaces 2A and 4A, as shown in Figs. 11 to 13.

[0046] The angle formed by upper surface 2A with respect to the horizontal direction is 5 degrees or more and 45 degrees or less, for example. The angle formed by upper surface 4A with respect to the horizontal direction is 5 degrees or more and 45 degrees or less, for example. The angle formed by upper surface 2A of first flat tube 2

with respect to the horizontal direction is, for example, equal to the angle formed by upper surface 4A of second flat tube 4 with respect to the horizontal direction. Upper surface 2A of one first flat tube 2 connected to one communication space 18 is, for example, disposed to be flush with upper surface 4A of one second flat tube 4 connected to this one communication space 18.

[0047] In the heat exchanger according to the second embodiment, each first flat tube 2 and each second flat tube 4 have upper surfaces 2A and 4A, respectively, inclined with respect to the horizontal direction, and each communication space 18 extends along upper surfaces 2A and 4A, and thereby, imbalance in distribution of the refrigerant from communication space 18 to the flow paths of first flat tubes 2 is suppressed.

[0048] Note that modifications similar to those of the heat exchanger according to the first embodiment are allowable also in the heat exchanger according to the second embodiment.

Third Embodiment

[0049] A heat exchanger 101 according to the third embodiment has basically the same configuration and exhibits basically the same effect as those of heat exchanger 100 according to the first embodiment, but is different from heat exchanger 100 in that bridging header 15 is divided into a plurality of sections as shown in Figs. 14 to 16.

[0050] Bridging header 15 is divided into a first bridging header 19 disposed above in the Z direction and a second bridging header 20 disposed below in the Z direction. The plurality of first flat tubes 2 are divided into first flat tubes 2 of a first group disposed above and first flat tubes 2 of a second group disposed below first flat tubes 2 of the first group. The plurality of second flat tubes 4 are divided into second flat tubes 4 of a first group disposed above and second flat tubes 4 of a second group disposed below second flat tubes 4 of the first group.

[0051] First bridging header 19 is connected to each of the second ends of first flat tubes 2 of the first group and each of the second ends of second flat tubes 4 of the first group, and allows merging of the refrigerant having flowed out of each of second flat tubes 4 of the first group and also allows splitting of the refrigerant that is to flow into each of first flat tubes 2 of the first group.

[0052] Second bridging header 20 is connected to each of the second ends of first flat tubes 2 of the second group and each of the second ends of second flat tubes 4 of the second group, and allows merging of the refrigerant having flowed out of each of second flat tubes 4 of the second group and also allows splitting of the refrigerant that is to flow into each of first flat tubes 2 of the second group.

[0053] First bridging header 19 includes a first plate 19A, a second plate 19B, and a third plate 19C. First plate 19A, second plate 19B, and third plate 19C have the same configurations as those of first plate 15A, sec-

ond plate 15B, and third plate 15C described above.

[0054] Second bridging header 20 includes a first plate 20A, a second plate 20B, and a third plate 20C. First plate 20A, second plate 20B, and third plate 20C have the same configurations as those of first plate 15A, second plate 15B, and third plate 15C described above.

[0055] First plates 19A and 20A are configured as plate members different from each other, for example. Second plates 19B and 20B are configured as plate members different from each other, for example. Third plates 19C and 20C are configured as plate members different from each other, for example. Note that first plates 19A and 20A may be configured as one plate member. Second plates 19B and 20B may be configured as one plate member. Third plates 19C and 20C may be configured as one plate member, for example.

[0056] As shown in Fig. 16, a plurality of through holes are provided in each of first plates 19A and 20A. Each through hole provided in each of first plates 19A and 20A constitutes a first insertion hole 21 or a second insertion hole 22. In other words, each first insertion hole 21 and each second insertion hole 22 are provided as a through hole in each of first plates 19A and 20A.

[0057] As shown in Fig. 17, second plates 19B and 20B each are provided with a plurality of through holes. The inner space of each through hole provided in each of second plates 19B and 20B provides a communication space 23. Each communication space 23 is an inner space of each of the plurality of through holes provided in each of second plates 19B and 20B. When viewed in the X direction, each through hole provided in each of second plates 19B and 20B is formed to overlap with the entirety of one first insertion hole 21 and one second insertion hole 22. When viewed in the X direction, the opening end of each through hole provided in each of second plates 19B and 20B is located outside each of the opening ends of each first insertion hole 21 and each second insertion hole 22 provided in each of first plates 19A and 20A.

[0058] As shown in Figs. 16 and 18, one first flat tube 2 connected to one communication space 23 is located lower in the Z direction than one second flat tube 4 connected to this one communication space 23. Specifically, the uppermost portion of one first flat tube 2 connected to one communication space 18 is disposed at the same height in the Z direction as the lowermost portion of one second flat tube 4 connected to this one communication space 18, or located lower than the lowermost portion.

[0059] The inner circumferential surface of each through hole provided in each of second plates 19B and 20B has a pair of inclined surfaces facing each other in the Z direction and inclined with respect to the X direction and the Y direction. The pair of inclined surfaces is inclined gradually upward to the leeward side. The distance between the pair of inclined surfaces in the Z direction is larger than the width of each first insertion hole 21 in the Z direction and the width of each second insertion hole 22 in the Z direction.

[0060] As shown in Figs. 15 and 19, third plates 19C and 20C each are disposed on the side opposite to each first insertion hole 21 and each second insertion hole 22 with respect to each communication space 23, and close one end of each communication space 23 in the X direction. In each of third plates 19C and 20C, no through hole is provided in a region overlapping with communication space 23 when viewed in the X direction.

[0061] Note that modifications similar to those of the heat exchanger according to the first embodiment are allowable also in heat exchanger 101 according to the third embodiment.

Fourth Embodiment

<Refrigeration Cycle Apparatus>

[0062] A refrigeration cycle apparatus 200 according to the fourth embodiment includes any one of the heat exchangers according to the first to third embodiments as an evaporator. Refrigeration cycle apparatus 200 mainly includes a compressor 111, heat exchangers 100, 101, a heat exchanger 113, and an expansion valve 114. In refrigeration cycle apparatus 200, second header 14 serves as an inflow portion of refrigerant, and first header 13 serves as an outflow portion of refrigerant. In each of heat exchangers 100 and 101 serving as evaporators, the refrigerant flows through second header 14, second heat exchange portion 12, bridging header 15, first heat exchange portion 11, and first header 13 in this order. The gas-liquid two-phase refrigerant that has been condensed in heat exchanger 113 and then decompressed by expansion valve 114 flows into second header 14. The gas-liquid two-phase refrigerant exchanges heat with air flowing in the Y direction through second heat exchange portion 12 and first heat exchange portion 11 and thereby evaporates and turns into gas-phase refrigerant. This gas-phase refrigerant flows out of first header 13 and is suctioned into compressor 111. Note that refrigeration cycle apparatus 200 may further include a four-way valve 112 for switching the flow direction of the refrigerant. Four-way valve 112 switches the operation mode between an operation mode in which heat exchanger 100, 101 serves as an evaporator and an operation mode in which heat exchanger 100, 101 serves as a condenser.

[0063] Although the embodiments of the present disclosure have been described as above, the above-described embodiments can also be variously modified. Further, the scope of the present disclosure is not limited to the above-described embodiments. The scope of the present disclosure is defined by the terms of the claims and is intended to include any modifications within the meaning and scope equivalent to the terms of the claims.

REFERENCE SIGNS LIST

[0064] 1 first fin, 1A, 1B, 3A, 3B end portion, 1C, 3C

insertion hole, 1D, 3D continuous portion, 2 first flat tube, 2A, 4A upper surface, 3 second fin, 4 second flat tube, 11 first heat exchange portion, 12 second heat exchange portion, 13 first header, 14 second header, 15 bridging header, 15A, 19A, 20A first plate, 15B, 19B, 20B second plate, 15C, 19C, 20C third plate, 15D recess, 16, 21 first insertion hole, 17, 22 second insertion hole, 18, 23 communication space, 19 first bridging header, 20 second bridging header, 100, 101 heat exchanger.

Claims

1. A heat exchanger comprising:

a first heat exchange portion and a second heat exchange portion arranged side by side in a first direction intersecting with a direction of gravity, the first heat exchange portion having

a plurality of first fins extending in the direction of gravity and arranged side by side in a second direction intersecting with the direction of gravity and the first direction, and a plurality of first flat tubes mounted to intersect with each of the first fins and arranged side by side in the direction of gravity,

the second heat exchange portion having

a plurality of second fins extending in the direction of gravity and arranged side by side in the second direction, and a plurality of second flat tubes mounted to intersect with each of the second fins and arranged side by side in the direction of gravity,

the heat exchanger further comprising:

a first header connected to a first end of each of the first flat tubes;
a second header connected to a first end of each of the second flat tubes; and
a third header connected to a second end of each of the first flat tubes and a second end of each of the second flat tubes, wherein
when viewed in the first direction, each of the second flat tubes is disposed not to overlap with each of the first flat tubes, and
the third header has

a first plate provided with a plurality of first insertion holes through which the second ends of the first flat tubes are respectively inserted, and a plurality of

second insertion holes through which the second ends of the second flat tubes are respectively inserted, and a second plate provided with a plurality of communication spaces each communicating with a corresponding one of the first insertion holes and a corresponding one of the second insertion holes.

2. The heat exchanger according to claim 1, wherein at least one of the first flat tubes that is connected to one communication space of the communication spaces is located lower in the direction of gravity than at least one of the second flat tubes that is connected to the one communication space.

3. A heat exchanger comprising:

a first heat exchange portion and a second heat exchange portion arranged side by side in a first direction intersecting with a direction of gravity, the first heat exchange portion having

a plurality of first fins extending in the direction of gravity and arranged side by side in a second direction intersecting with the direction of gravity and the first direction, and a plurality of first flat tubes mounted to intersect with each of the first fins and arranged side by side in the direction of gravity,

the second heat exchange portion having

a plurality of second fins extending in the direction of gravity and arranged side by side in the second direction, and a plurality of second flat tubes mounted to intersect with each of the second fins and arranged side by side in the direction of gravity,

the heat exchanger further comprising:

a first header connected to a first end of each of the first flat tubes;
a second header connected to a first end of each of the second flat tubes; and
a third header connected to a second end of each of the first flat tubes and a second end of each of the second flat tubes, the third header being provided with a plurality of communication spaces each communicating with a corresponding one of the first flat tubes and a corresponding one of the second flat tubes, wherein when viewed in the first direction, each of

the second flat tubes is disposed not to overlap with each of the first flat tubes, and at least one of the first flat tubes that is connected to one communication space of the communication spaces is located lower in the direction of gravity than at least one of the second flat tubes that is connected to the one communication space.

4. The heat exchanger according to claim 3, wherein the third header has

a first plate provided with a plurality of first insertion holes through which the second ends of the first flat tubes are respectively inserted, and a plurality of second insertion holes through which the second ends of the second flat tubes are respectively inserted, and a second plate provided with the communication spaces.

5. The heat exchanger according to any one of claims 1, 2, and 4, wherein the first plate is smaller in thickness than the second plate.

6. The heat exchanger according to any one of claims 1, 2, 4, and 5, wherein the second plate is configured as a multilayer body formed of a plurality of plate members.

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

each of the first flat tubes and the second flat tubes has an upper surface inclined with respect to a horizontal direction, and each of the communication spaces extends along the upper surface.

8. The heat exchanger according to any one of claims 1 to 7, wherein

each of the first fins and the second fins has a continuous portion disposed on one side in the first direction and extending in the direction of gravity,
each of the first fins and the second fins is provided with a plurality of insertion holes disposed on the other side in the first direction with respect to the continuous portion, each of the first flat tubes or each of the second flat tubes being inserted through a corresponding one of the insertion holes, and
the first heat exchange portion and the second heat exchange portion are disposed such that the first direction extends in a ventilation direction and the continuous portion is located upstream from the insertion holes in the ventilation

direction.

9. A refrigeration cycle apparatus comprising the heat exchanger according to any one of claims 1 to 8 as an evaporator.

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FIG.1

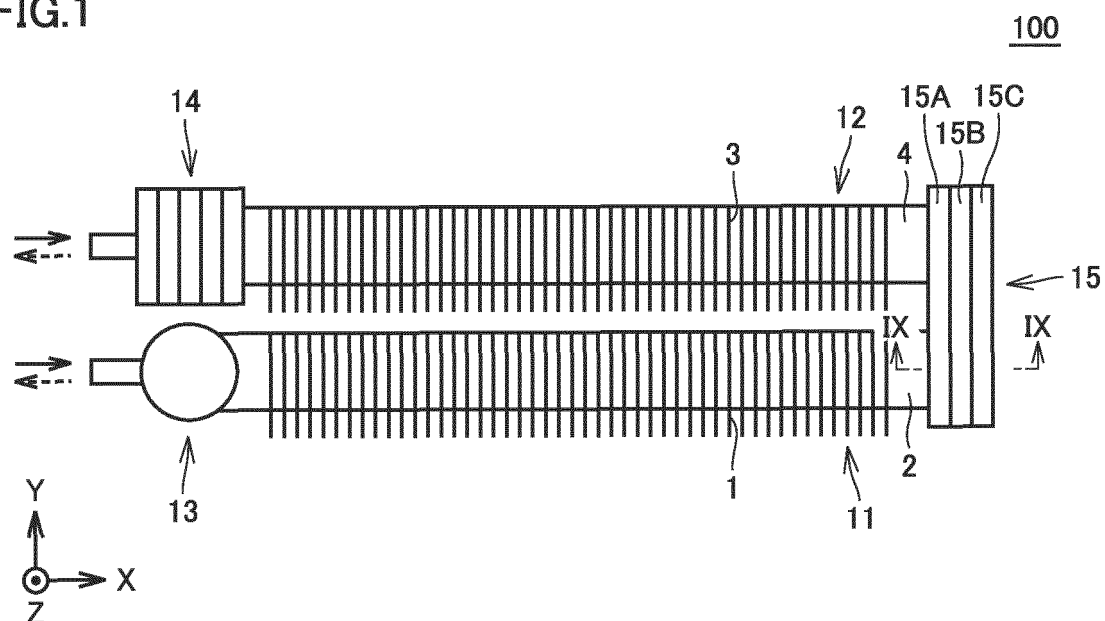


FIG.2

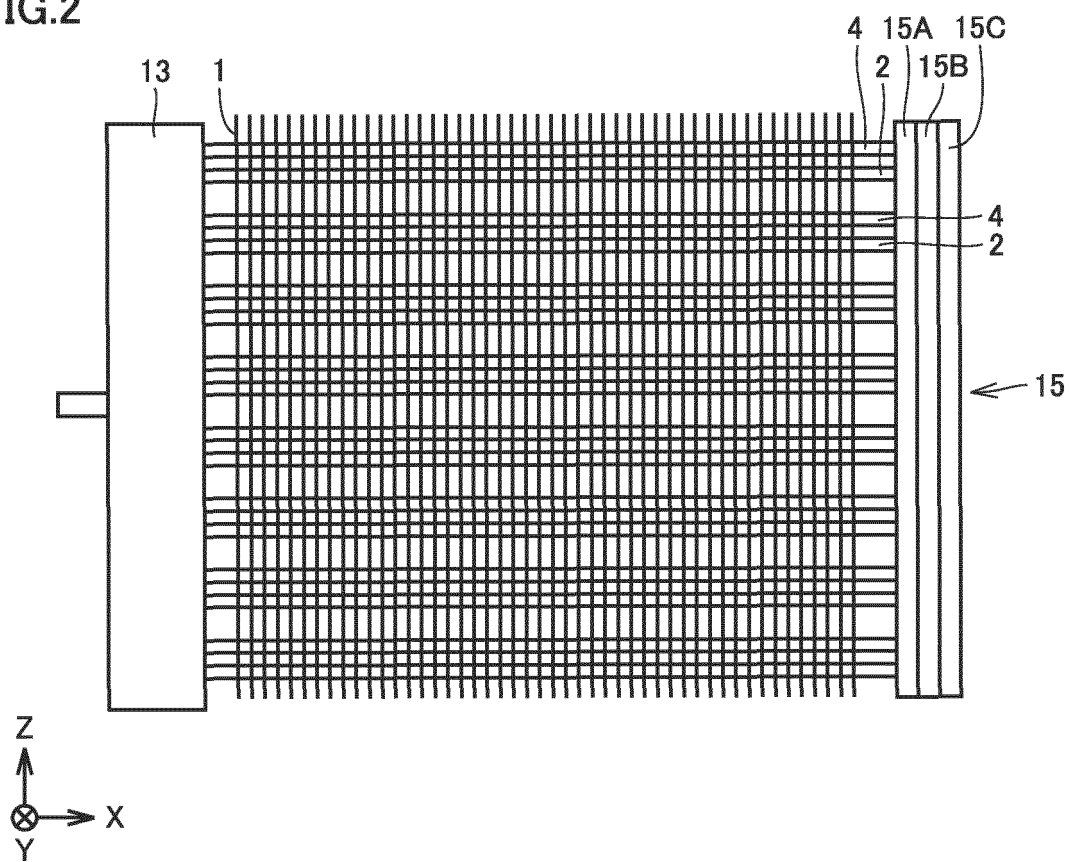


FIG.3

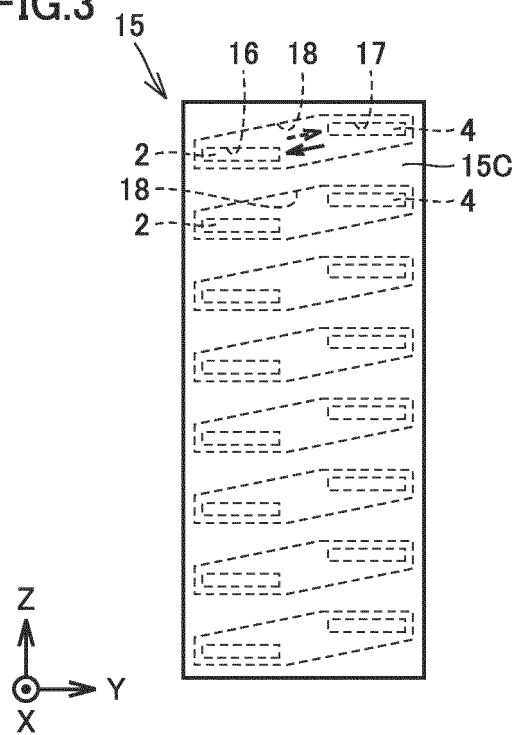


FIG.4

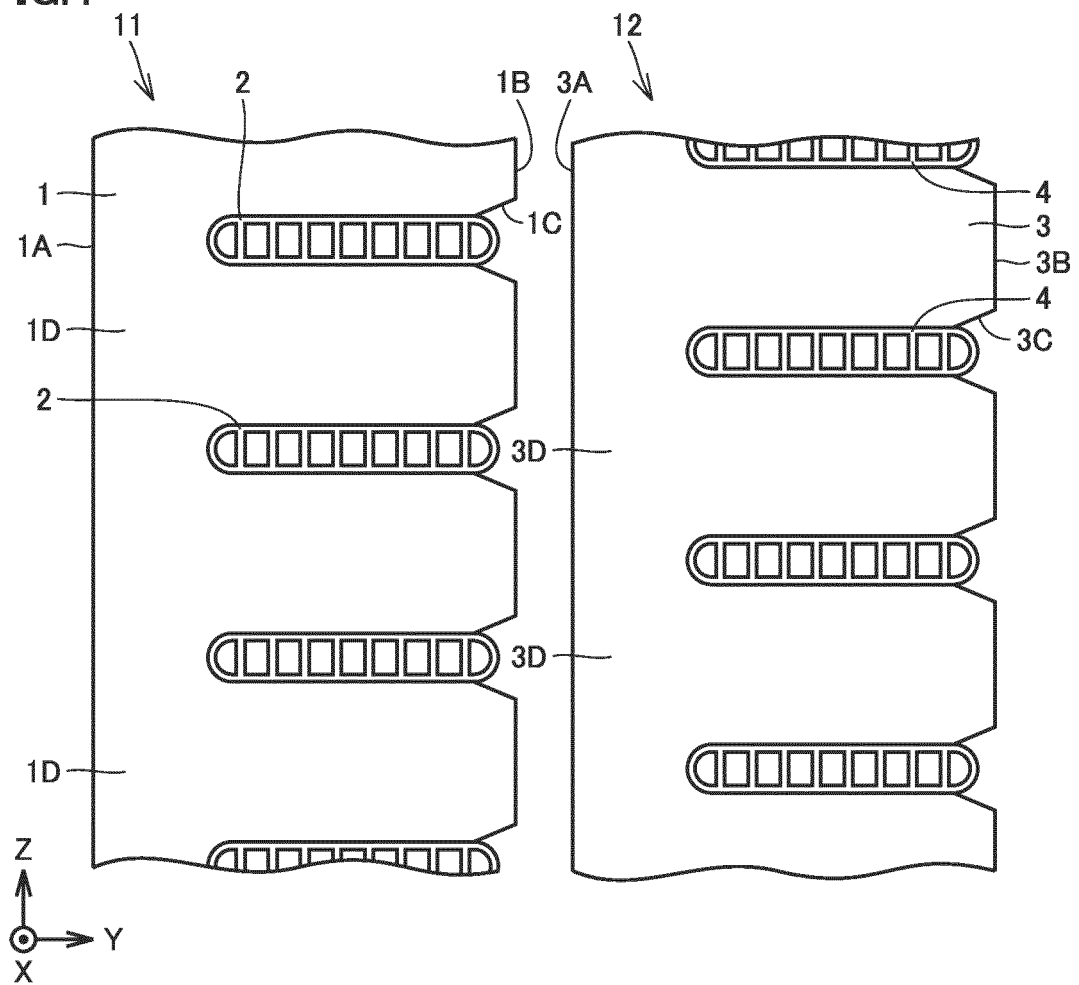


FIG.5

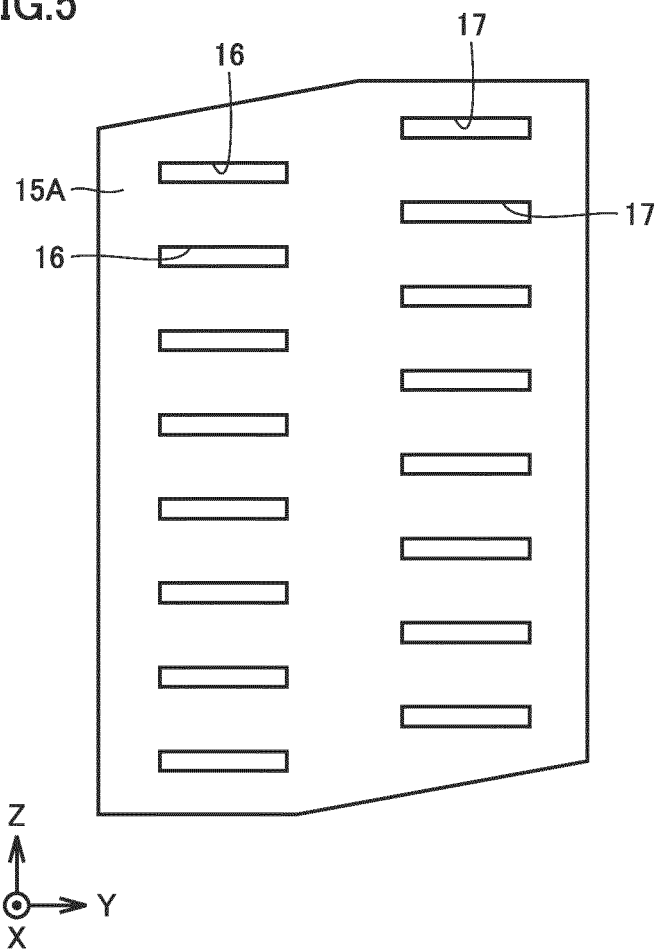


FIG.6

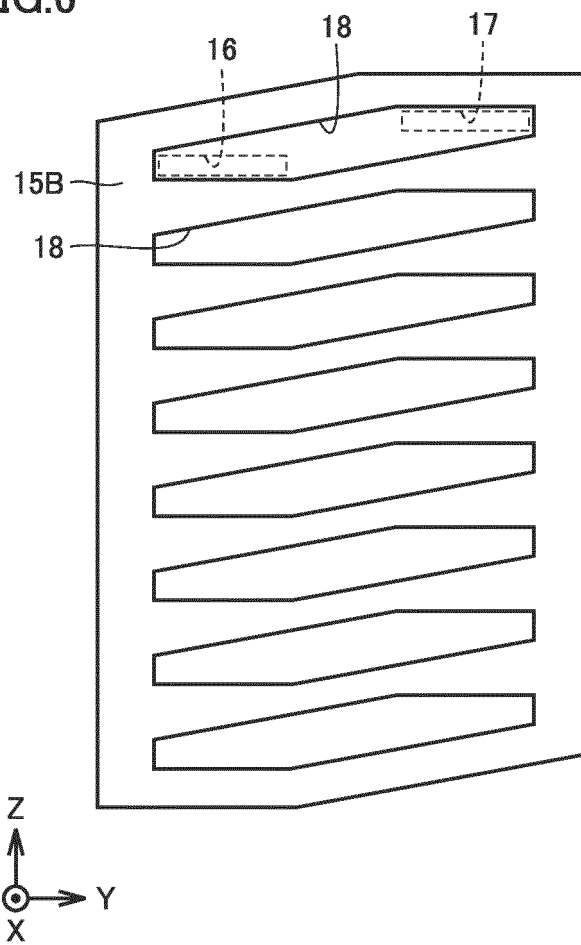
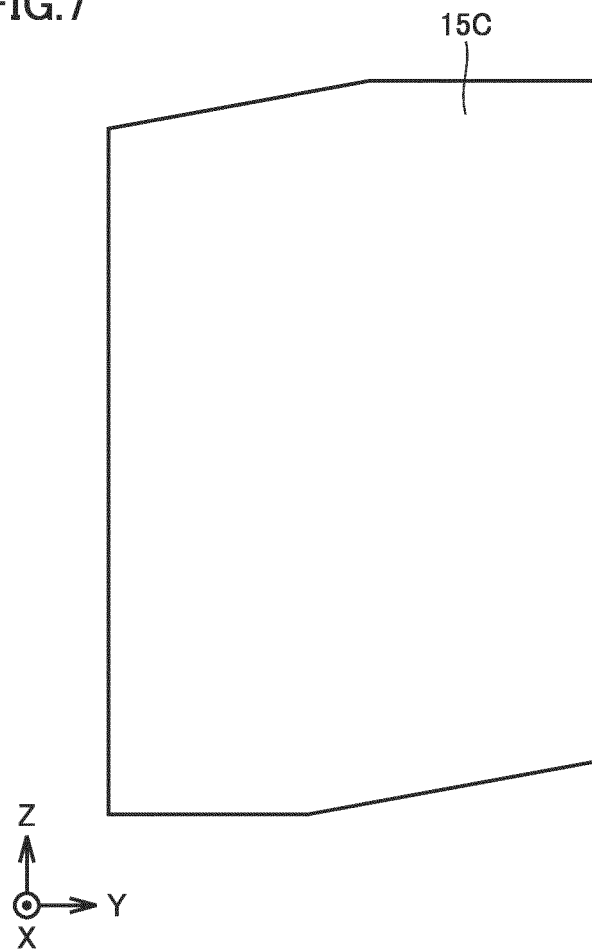


FIG.7



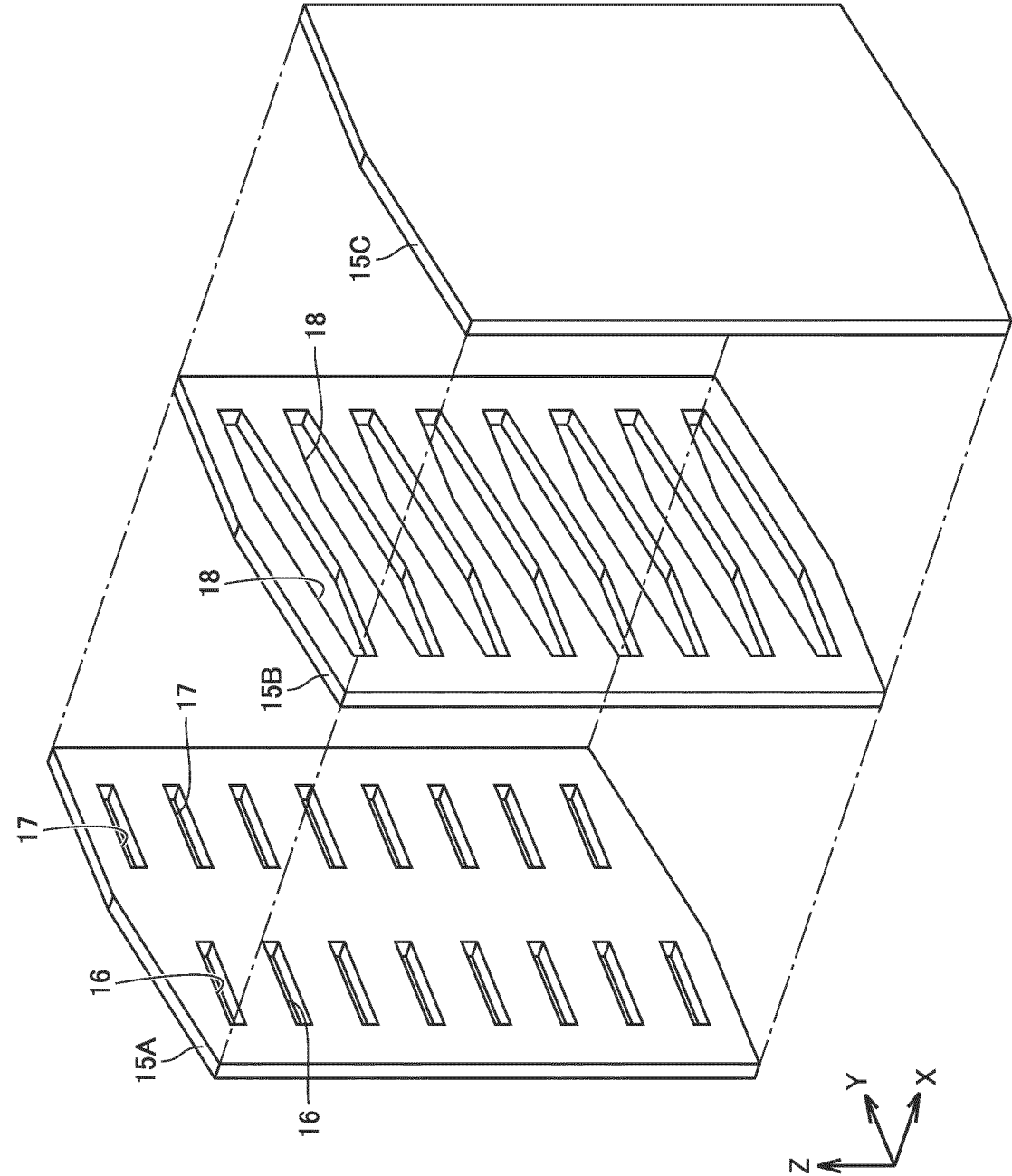


FIG.8

FIG.9

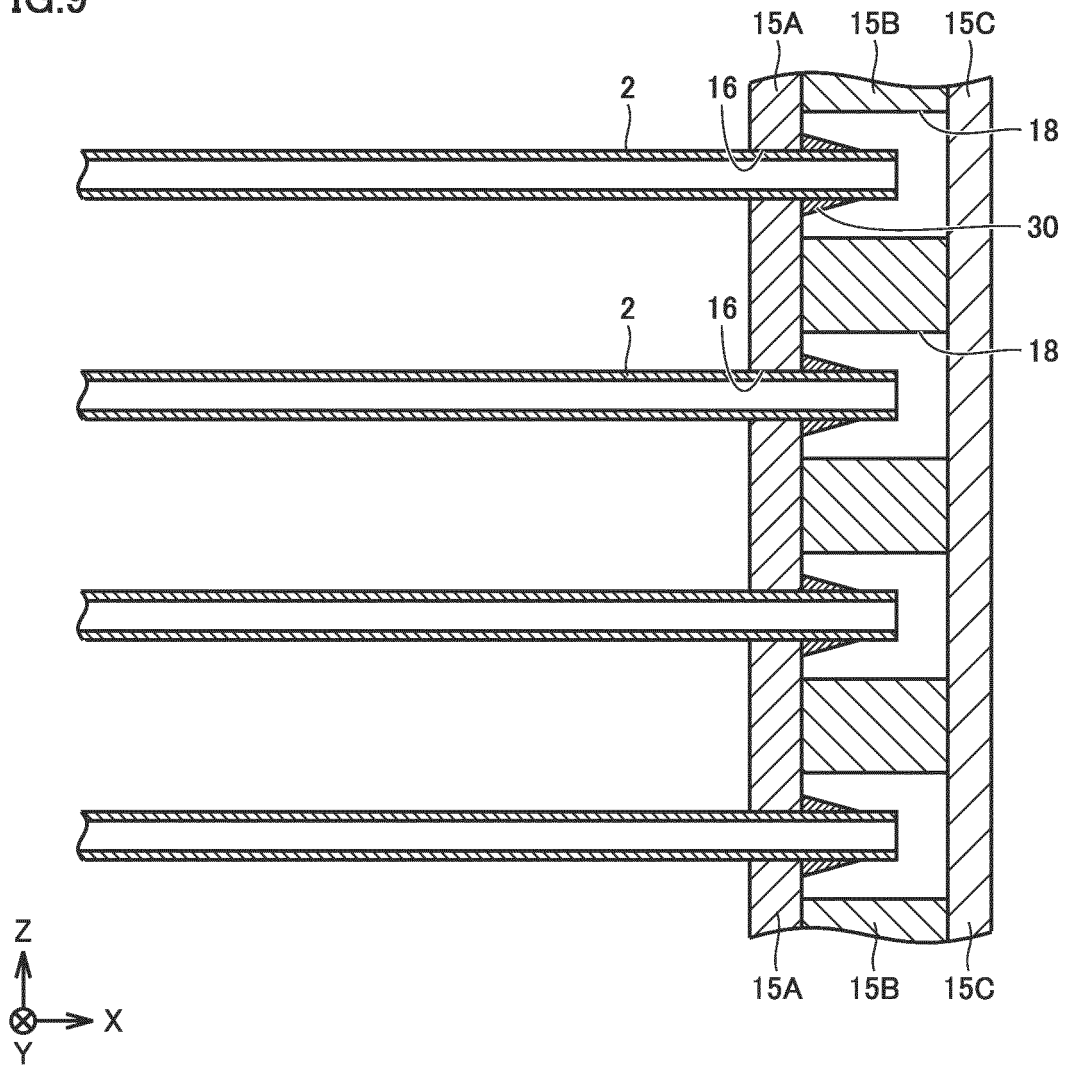


FIG.10

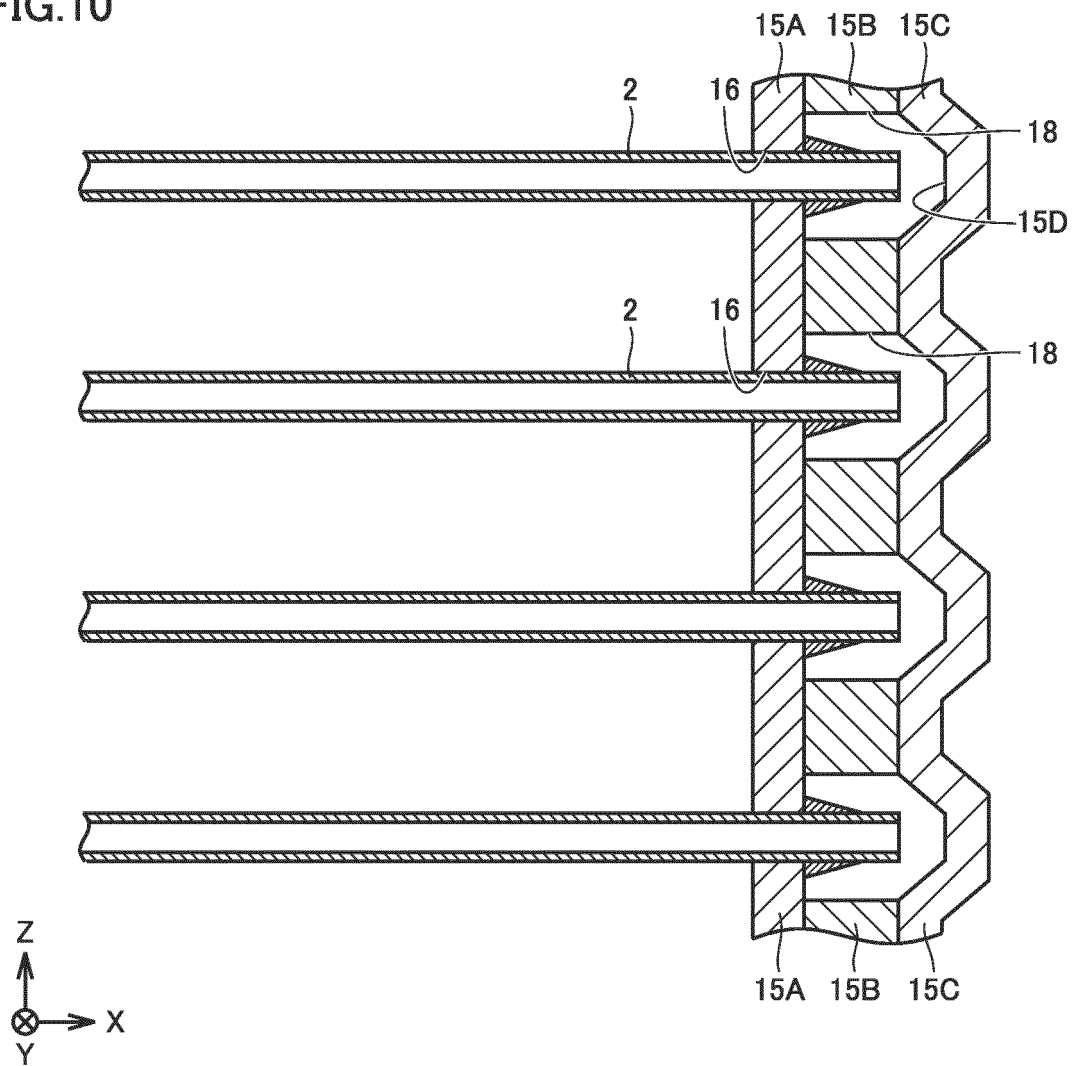


FIG.11

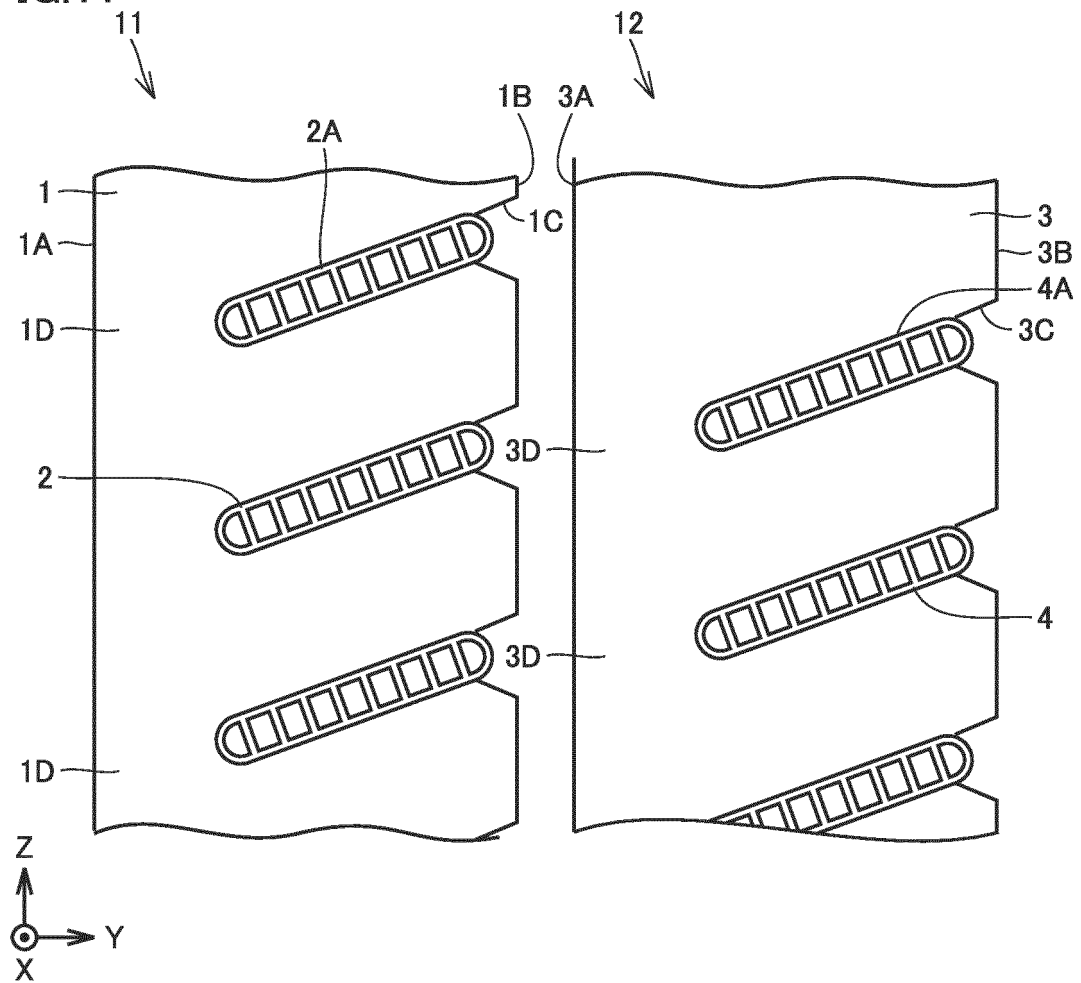


FIG.12

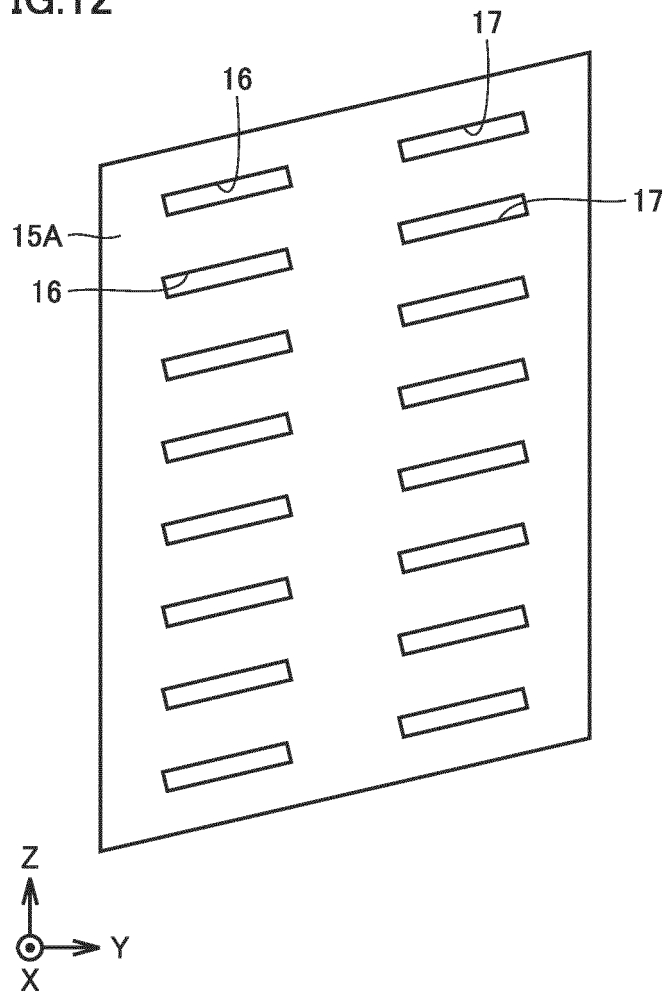


FIG.13

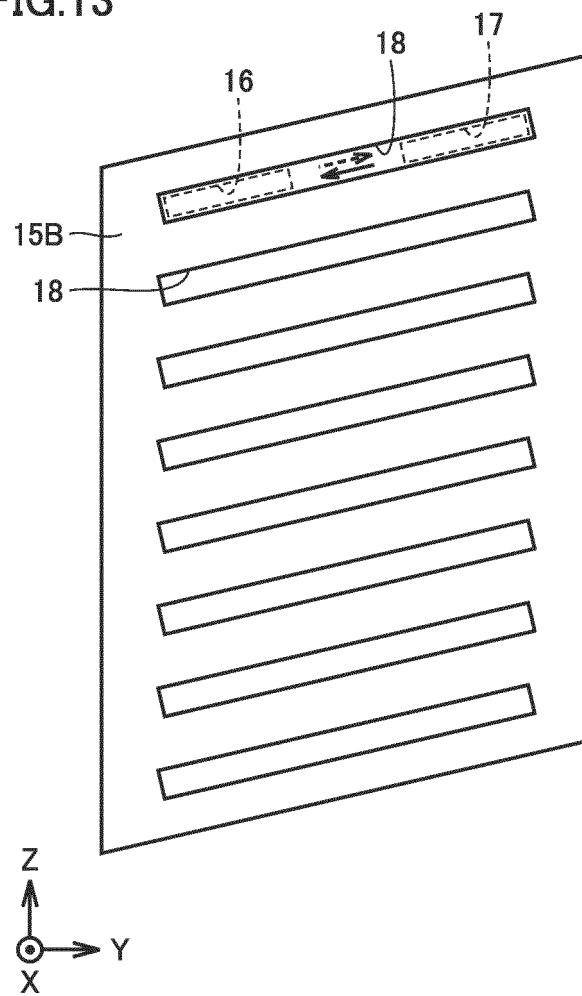


FIG.14

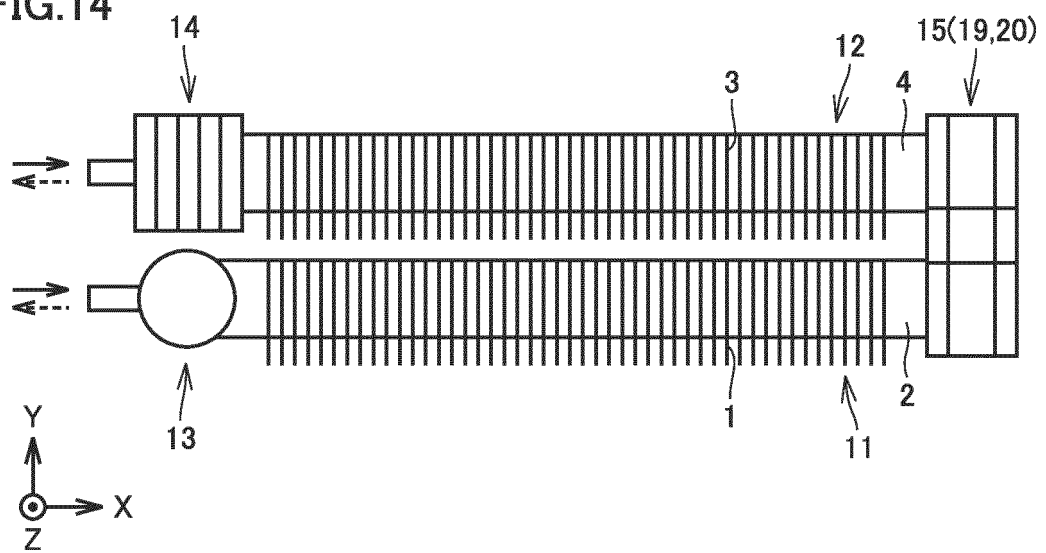


FIG.15

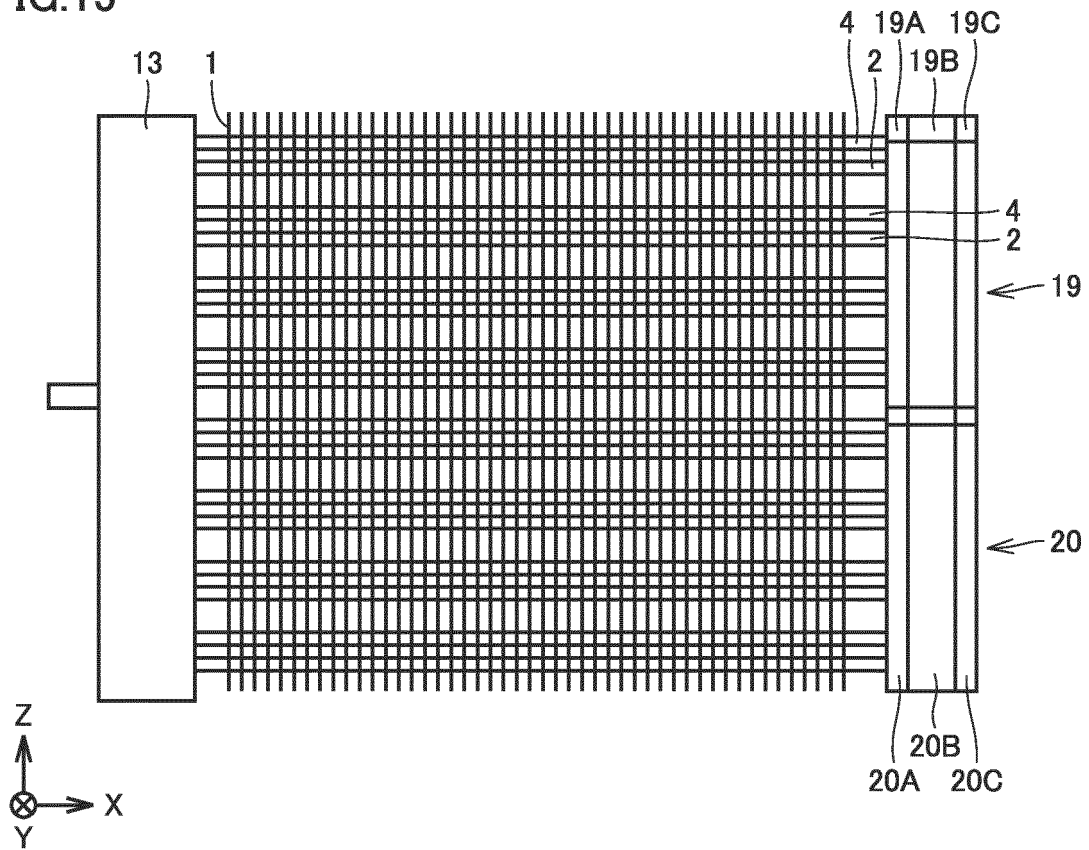
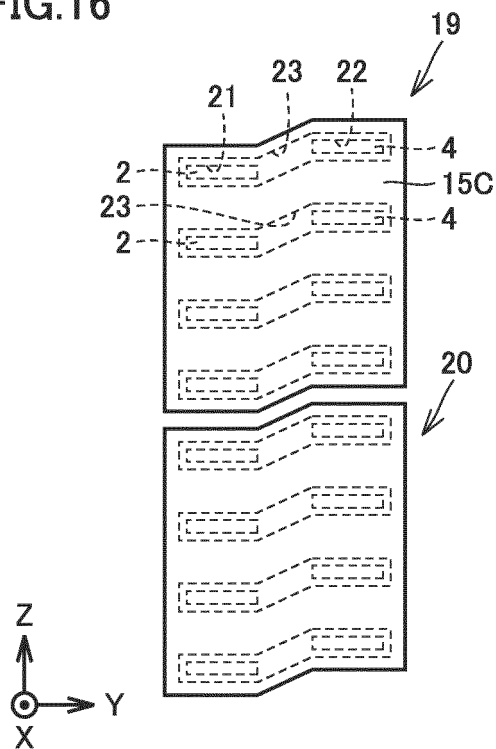


FIG.16



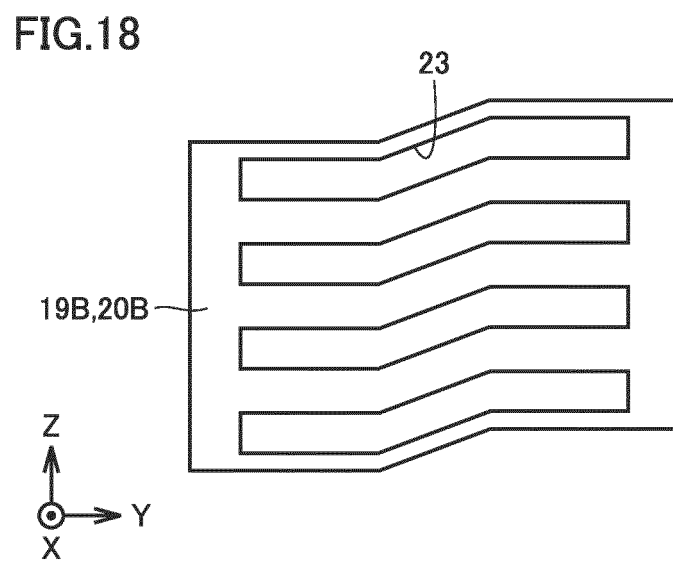
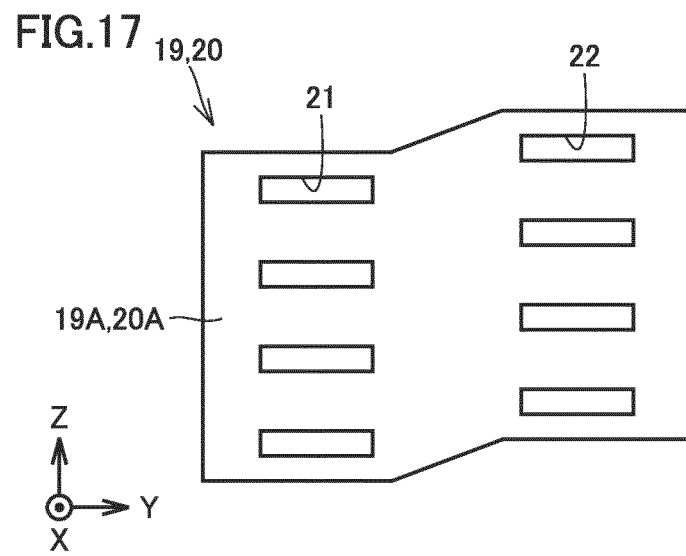
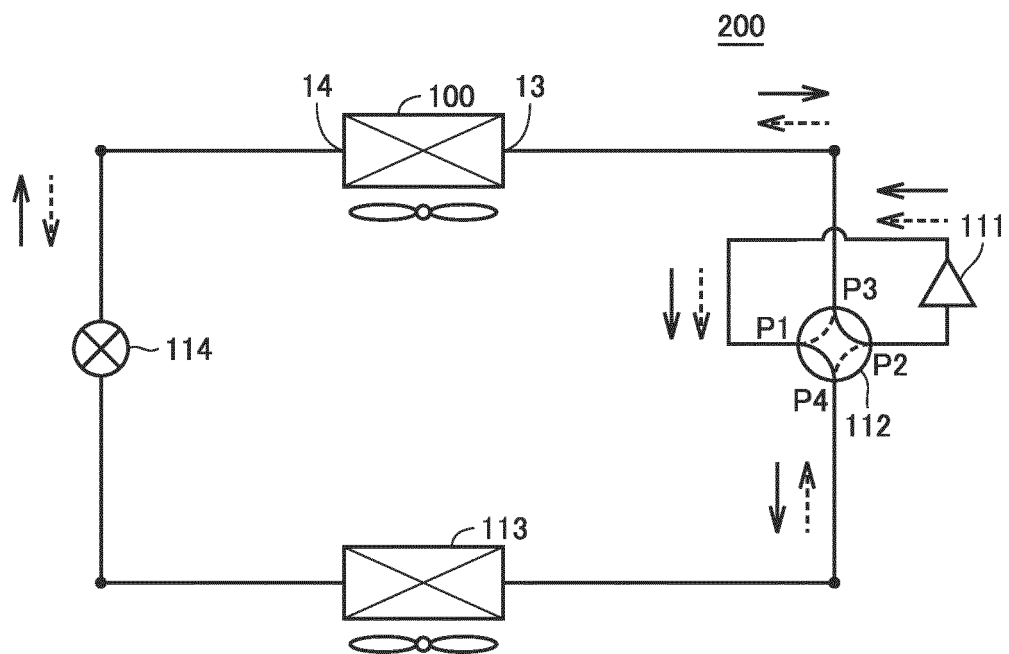


FIG.19



5	INTERNATIONAL SEARCH REPORT		International application No. PCT/JP2020/039355
	A. CLASSIFICATION OF SUBJECT MATTER Int. Cl. F25B39/02 (2006.01) i, F28D1/053 (2006.01) i FI: F25B39/02 G, F28D1/053 A		
10	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) Int. Cl. F25B39/02, F28D1/053		
15	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 1971-2020 Registered utility model specifications of Japan 1996-2020 Published registered utility model applications of Japan 1994-2020		
20	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.
25	X	WO 2019/142617 A1 (DAIKIN INDUSTRIES, LTD.) 25	1-4, 9
	Y	July 2019 (2019-07-25), paragraphs [0031]-[0141], fig. 1-18	5-8
30	Y	WO 2015/097876 A1 (MITSUBISHI ELECTRIC CORP.) 02	5-8
		July 2015 (2015-07-02), paragraphs [0013]-[0036], fig. 1-9	
35	Y	WO 2017/126019 A1 (MITSUBISHI ELECTRIC CORP.) 27	7-8
		July 2017 (2017-07-27), paragraphs [0016]-[0043], fig. 1-6	
	Y	WO 2020/044391 A1 (MITSUBISHI ELECTRIC CORP.) 05	7-8
		March 2020 (2020-03-05), fig. 4	
40	☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "I" 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		
50	Date of the actual completion of the international search 07.12.2020		Date of mailing of the international search report 15.12.2020
55	Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan		Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2020/039355
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2016/103437 A1 (MITSUBISHI ELECTRIC CORP.) 30 June 2016 (2016-06-30), paragraph [0024], fig. 4	8

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		paragraphs [0020]-	
		[0096], fig. 1-9	
WO 2017/126019 A1	27.07.2017	US 2018/0372429 A1	
		paragraphs [0036]-	
		[0086], fig. 1-6	
		EP 3406996 A1	
		CN 108474623 A	
WO 2020/044391 A1	05.03.2020	(Family: none)	
WO 2016/103437 A1	30.06.2016	EP 3239640 A1	
		paragraph [0032],	
		fig. 4	

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

REFERENCES CITED IN THE DESCRIPTION

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