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(54) **REFRIGERATOR**

(57) A refrigerator 1 of an embodiment includes an outer box 2, an inner box 3 disposed with a space left between the inner box 3 and the outer box 2, a condenser 8 configuring a refrigerating cycle, and a heat radiation pipe 10 connected to the condenser 8, internally having a plurality of flow paths for a refrigerant, and formed into a flat shape.

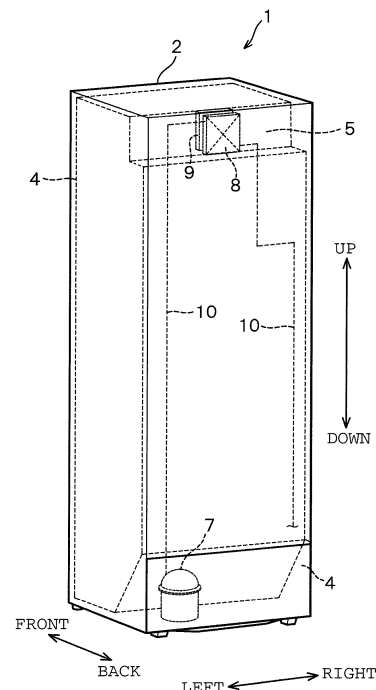


FIG. 1

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Description

Technical Field

[0001] Embodiments of the present invention relate to a refrigerator.

Background Art

[0002] A refrigerator includes a refrigerating cycle having a compressor and a condenser. The compressor and condenser have been conventionally installed in a so-called machine room (for example, refer to Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent Laid-Open No. 2014-238219

Summary of Invention

Technical Problem

[0004] However, in recent years, thermal insulation performance has been increased by adoption of a vacuum heat insulating member and the like, so that increase in size of a storage room has been achieved by making a wall part thin, and with increase in size of the storage room like this, reduction in size of the machine room has been required. As a result, it is becoming difficult to dispose a condenser having a large volume in the machine room.

[0005] Further, when the condenser itself is reduced in size to be housed in a machine room, it becomes difficult to earn a radiation amount with the condenser alone, and a heat radiation pipe is additionally required, but in order to provide a heat radiation pipe such as a copper pipe, for example, as conventionally, it is necessary to provide a large groove in the vacuum heat insulating member, and there is a fear that heat insulation performance is reduced and strength of the vacuum heat insulating member is reduced.

[0006] Therefore, a refrigerator is provided, which can increase a storage room in sizes, and can achieve energy saving by improving heat radiation from a heat radiation pipe.

Solution to Problem

[0007] A refrigerator of an embodiment includes an outer box, an inner box disposed with a space left between the inner box and the outer box, a condenser that configures a refrigerating cycle, and a heat radiation pipe that is connected to the condenser, internally includes a plurality of hollow portions configured to be flow paths

for a refrigerant, and is formed into a flat shape.

Brief Description of Drawings

[0008]

[Figure 1] Figure 1 is a view schematically illustrating a refrigerator of an embodiment.

[Figure 2] Figure 2 is a view schematically illustrating a vacuum heat insulating member.

[Figure 3] Figure 3 is a view schematically illustrating a condenser.

[Figure 4] Figure 4 is a view schematically illustrating a section of a heat radiation pipe.

[Figure 5] Figure 5 is a view schematically illustrating an arrangement mode of the heat radiation pipe.

[Figure 6] Figure 6 is a view 1 schematically illustrating another condenser in a second embodiment.

[Figure 7] Figure 7 is a view 2 schematically illustrating another condenser.

[Figure 8] Figure 8 is a view 3 schematically illustrating another condenser.

[Figure 9] Figure 9 is a view 4 schematically illustrating another condenser.

[Figure 10] Figure 10 is a view 5 schematically illustrating another condenser.

[Figure 11] Figure 11 is a view 6 schematically illustrating another condenser.

[Figure 12] Figure 12 is a view 6 schematically illustrating another condenser.

[Figure 13] Figure 13 is a view 1 schematically illustrating another connection example of a heat radiation pipe.

[Figure 14] Figure 14 is a view 2 schematically illustrating another connection example of the heat radiation pipe.

[Figure 15] Figure 15 is a view 3 schematically illustrating another connection example of the heat radiation pipe.

[Figure 16] Figure 16 is a view schematically illustrating a disposition mode of a sub condenser.

[Figure 17] Figure 17 is a view 1 schematically illustrating a positional relationship between a condenser and a fan.

[Figure 18] Figure 18 is a view 2 schematically illustrating the positional relationship between the condenser and the fan.

[Figure 19] Figure 19 is a view 3 schematically illustrating a positional relationship between the condenser and the fan.

[Figure 20] Figure 20 is a view schematically illustrating a refrigerator of a third embodiment.

[Figure 21] Figure 21 is a view schematically illustrating a machine room provided in a main body.

[Figure 22] Figure 22 is a view schematically illustrating a condenser in structure example A.

[Figure 23] Figure 23 is a view schematically illustrating a flow of a refrigerant in structure example A.

[Figure 24] Figure 24 is a view schematically illustrating a mounting mode of a connecting tube in structure example A.

[Figure 25] Figure 25 is a view schematically illustrating a structure of a condenser in structure example B.

[Figure 26] Figure 26 is a view schematically illustrating a flow of a refrigerant in structure example B.

[Figure 27] Figure 27 is a view schematically illustrating a mounting mode of a connecting tube in structure example B.

[Figure 28] Figure 28 is a view schematically illustrating a structure of a condenser in structure example C.

[Figure 29] Figure 29 is a view schematically illustrating a flow of a refrigerant in structure example C.

[Figure 30] Figure 30 is a view schematically illustrating a mounting mode of a connecting pipe in structure example C.

[Figure 31] Figure 31 is a view schematically illustrating a structure of a condenser in structure example D.

[Figure 32] Figure 32 is a view schematically illustrating an installation orientation of the condenser.

[Figure 33] Figure 33 is a view schematically illustrating a component disposition example in the machine room in installation example A.

[Figure 34] Figure 34 is a view schematically illustrating an example of the installation orientation of the condenser in installation example A.

[Figure 35] Figure 35 is a diagram schematically illustrating a component disposition example in the machine room in installation example B.

[Figure 36] Figure 36 is a view schematically illustrating an example of the installation orientation of the condenser in installation example B.

[Figure 37] Figure 37 is a view schematically illustrating a component disposition example in the machine room in installation example C.

[Figure 38] Figure 38 is a view schematically illustrating an example of the installation orientation of the condenser in installation example C.

[Figure 39] Figure 39 is a view schematically illustrating a component disposition example in the machine room in installation example D.

[Figure 40] Figure 40 is a view schematically illustrating an example of the installation orientation of the condenser in installation example D.

[Figure 41] Figure 41 is a view schematically illustrating an installation example of a cooling fan and a condenser in another example.

[Figure 42] Figure 42 is a view schematically illustrating another structure of the condenser.

[Figure 43] Figure 43 is a view schematically illustrating an example of the installation orientation of the condenser at a time of dropping defrosting water.

[Figure 44] Figure 44 is a view schematically illustrating another disposition example of the machine room.

Description of Embodiments

[0009] Hereinafter, a plurality of embodiments will be described with reference to the drawings.

(First embodiment)

[0010] Hereinafter, a first embodiment will be described with reference to Figure 1 to Figure 5.

[0011] As illustrated in Figure 1, a refrigerator 1 includes an outer box 2 that is formed substantially in a vertically longer rectangle, and an inner box 3 (also referred to Figure 2) that is housed inside the outer box 2 so as to overlap the outer box 2 with a space left between the outer box 2 and the inner box 3.

[0012] Further, the refrigerator 1 has a lower machine room 4 that is formed by the space between the outer box 2 and the inner box 3, at a lower side and a back side thereof. Further, the refrigerator 1 has an upper machine room 5 that is formed by the space between the outer box 2 and the inner box 3, at a ceiling side and the back side thereof. Further, the refrigerator 1 has one or more storage room such as a refrigerated room and a freezer compartment as is well known though not illustrated. In the present embodiment, the freezer compartment is provided in front of the lower machine room 4, and the refrigerated room is provided in front of the upper machine room 5. Hereinafter, directions shown by arrows in Figure 1 will be described as an up-and-down direction, a left-and-right direction and a front-and-back direction.

[0013] As illustrated in Figure 2, in the refrigerator 1, vacuum heat insulating members 6 are provided in a space between the outer box 2 and the inner box 3. The vacuum heat insulating member 6 is a heat insulating member boasting of high heat insulating performance by covering a core material with a film, and decompressing an inside of the covering, though detailed explanation is omitted. The vacuum heat insulating member 6 is bonded to an inner surface of the outer box 2 by an adhesive, a double-sided tape or the like though not illustrated. Further, shallow groove portions 6a in which heat radiation pipes 10 that will be described later are placed are provided in the vacuum heat insulating member 6.

[0014] Further, a foam heat insulating material 16 (refer to Figure 5) is filled in the space except for the vacuum heat insulating members 6, between the outer box 2 and the inner box 3. Note that Figure 2 illustrates only the vacuum heat insulating members 6 which are placed on a left and a right, a back and a bottom of the inner box 3, for simplification of explanation, but the vacuum heat insulating member 6 may be provided on the ceiling side. Further, a configuration in which only the vacuum heat insulating members 6 are provided on a left and right wall portion sides without filling the foam heat insulating material 16, or the like may be adopted.

[0015] As illustrated in Figure 1, a compressor 7 is disposed in the lower machine room 4. Further, in the upper machine room 5 a condenser 8 that is connected to the

compressor 7 and a fan 9 that cools the condenser 8 are disposed. A so-called refrigerating cycle is configured by the compressor 7, the condenser 8, an evaporator not illustrated and the like. Note that in the lower machine room 4 and the upper machine room 5, mechanical components and the like other than the compressor 7 and the condenser 8 are also disposed.

[0016] As illustrated in Figure 3, the condenser 8 has two headers 11 in a hollow cylindrical shape, a plurality of flat tubes 12 connecting the respective headers 11, fins 13 provided in a corrugated form among the flat tubes 12 and formed from a metal material or the like, connecting tubes 14 that are respectively provided at the respective headers 11, and an outer shape of the condenser is substantially formed into a shape of a thin rectangular parallelepiped. Inside the respective flat tubes 12, a plurality of refrigerant flow paths are respectively formed.

[0017] In the condenser 8, refrigerant flows respectively in insides of the respective flat tubes 12 toward the header 11 at an outlet at a right side in the drawing which is a downstream side in a flow of the refrigerant from the header 11 at an inlet at a left side in the drawing which is an upstream side in the flow of the refrigerant shown by arrow F. That is, the condenser 8 is of a so-called parallel multi-flow type. The condenser 8 is urged to radiate heat by the axial flow type fan 9 in the present embodiment. At this time, the fan 9 is disposed so as to be substantially parallel with a main body portion of the condenser 8, that is, so that blown air from the fan 9 efficiently hits the main body portion.

[0018] As illustrated in Figure 1, the heat radiation pipes 10 are connected to the inlet and the outlet of the condenser 8. Note that though not illustration in Figure 1, the heat radiation pipe 10 is connected via the connecting tube 14. Further, a position where the heat radiation pipe 10 is provided, and a route of the heat radiation pipe 10 are not limited to the positions and the routes illustrated in Figure 1.

[0019] As illustrated in Figure 4, the heat radiation pipe 10 has an outer shape thereof formed into a flat shape, and a plurality of hollow portions 10a formed therein, and the refrigerant flows in the hollow portions 10a. That is, the heat radiation pipe 10 has a structure similar to the flat tube 12 of the condenser 8. Note that a number and shapes of the hollow portions 10a provided in the heat radiation pipe 10 are not limited to the number and shapes illustrated in Figure 4. As illustrated in Figure 5, the heat radiation pipe 10 is housed in the groove portion 6a of the vacuum heat insulating member 6 in a state abutting on the inner surface of the outer box 2.

[0020] In the case of the refrigerator 1 of the configuration like this, the condenser 8 has a plurality of refrigerant flow paths in the flat tube 12, so that as compared with the conventional fin 13 tube type in which one refrigerant flow path is provided, a contact area of the refrigerant flowing inside and the flat tube 12 is large. As a result, heat of the refrigerant is efficiently transmitted to the flat tube 12. Further, the respective flat tubes 12 are

provided in a state of the fins 13 formed of a metal material contacting the flat tubes 12, so that heat of the flat tubes 12 is efficiently transmitted to the fins 13.

[0021] The fins 13 provided in the condenser 8 are each formed into a corrugated shape among the flat tubes 12, so that the fin 13 has a large surface area, and can efficiently perform heat radiation, that is, heat exchange by blown air from the fan 9. Consequently, the multi-flow type condenser 8 can efficiently transmit the heat of the refrigerant flowing inside to the fins 13. The heat is radiated by making most of the surface area, so that heat radiation efficiency is higher than the conventional fin 13 tube type.

[0022] Accordingly, if the heat radiation amount is the same as that of the conventional fin 13 tube type, the condenser 8 can be reduced in size. That is, a space necessary to house the condenser 8 can be decreased, in other words, increase in size of the storage room can be achieved.

[0023] Further, the condenser 8 has a large surface area that can be used in heat radiation, so that high heat radiation efficiency can be obtained, even with the fan 9 with an air amount being relatively low, that is, a comparatively small fan 9. Consequently, reduction in size of the fan 9 can be also achieved. That is, since heat radiation performance is enhanced, electric power which is consumed for heat radiation can be reduced, and energy saving can be achieved.

[0024] The condenser 8 is provided in the upper machine room 5 on the ceiling side and on the back side of the refrigerator 1. The ceiling side and the back side of the refrigerator 1 are positions which hands of the user hardly reach and tend to be a dead space, though it depends on the size of the refrigerator 1. Consequently, by providing the upper machine room 5 on the ceiling side and on the back side of the refrigerator 1 and disposing the condenser 8 in the upper machine room 5, the dead space can be effectively used.

[0025] Further, the condenser 8 is disposed in the upper machine room 5, whereby the space of the lower machine room 4 can be saved, and the lower machine room 4 can be reduced in size. Thereby, the storage room, that is, the freezer compartment which is provided in front of the lower machine room 4 in the present embodiment can be increased in size.

[0026] Further, the heat radiation pipe 10 has the outer shape formed into a flat shape, so that as compared with a cylindrical heat radiation pipe, the contact surface with the inner surface of the outer box 2 increases, and a depth of the groove portion 6a is small. Thereby, reduction in strength of the vacuum heat insulating member 6 can be reduced.

[0027] Further, the heat radiation pipe 10 is disposed between the outer box 2 and the vacuum heat insulating member 6, so that a heat leak to the storage rooms can be reduced.

[0028] Further, since the heat radiation performance of the condenser 8 is high, a required length of the heat

radiation pipe 10 can be made shorter than that of the conventional heat radiation pipe. Accordingly, not only raw material cost but also work cost at a manufacturing time can be reduced.

[0029] Further, the heat radiation pipe 10 is placed along the inner surface of the outer box 2 in the space between the outer box 2 and the inner box 3 and connects the compressor 7 and the condenser 8. Thereby, the refrigerant having a relatively high temperature flows inside of a surface of the refrigerator 1, and thereby can warm the surface of the refrigerator 1 with the temperature. That is, radiated heat from the condenser 8 can be used in prevention of condensation, and generation of due condensation on the surface of the refrigerator 1 can be restrained.

[0030] In this way, according to the refrigerator 1 including the outer box 2, the inner box 3 disposed with the space provided between the outer box 2 and the inner box 3, the multi-flow type condenser 8 having the flat tubes 12 in which a plurality of flow paths in which the refrigerant flows are formed, and the heat radiation pipes 10 connected to the condenser 8, each internally having the plurality of hollow portions 10a to be the flow paths for the refrigerant and formed into a flat shape, the machine room can be reduced in size, so that the storage room can be increased in size, and energy can be saved by improving heat radiation from the heat radiation pipes 10.

(Second embodiment)

[0031] Hereinafter, a second embodiment will be described with reference to Figure 6 to Figure 19. In the second embodiment, other shapes and the like of the condenser 8 shown in the first embodiment will be described.

[0032] The condenser 8 is not limited to the multi-flow type condenser shown in the first embodiment, but a fin tube type of condenser which is similar to the conventional condenser can be used.

[0033] Further, as illustrated in Figure 6, as the condenser 8, the turning-back type condenser 8 in which the connecting tubes 14 at the inlet and the outlet are provided at the same header 11 can be adopted. In this case, the header 11 is provided with a partitioned portion between the connecting tubes 14, and is configured so that the refrigerant which flows in from the connecting tube 14 at the inlet which is at the upper side in the drawing is turned back in the other header 11 and flows out from the connecting tube 14 at the outlet which is at the lower side in the drawing. Even when the turning-back type condenser 8 like this is adopted, heat radiation performance of the condenser 8 can be enhanced, so that the machine room can be reduced in size, and energy saving can be achieved by improving the heat radiation from the heat radiation pipe 10 as in the first embodiment.

[0034] Further, as illustrated in Figure 7, the meandering type condenser 8 can be adopted, in which the inlet

and the outlet are connected by causing the single flat tube 12 to meander. In this case, the headers 11 may be provided at a same side of the main body portion substantially in the shape of a rectangular parallelepiped as illustrated in Figure 7, or may be provided at diagonal sides of the main body portion substantially in the shape of a rectangular parallelepiped as illustrated in Figure 8. Even when the meandering type condenser 8 like this is adopted, heat radiation performance of the condenser 8 can be enhanced, so that the machine room can be reduced in size, and energy saving can be achieved by improving heat radiation from the heat radiation pipe 10, as in the first embodiment.

[0035] Further, as illustrated in Figure 9, a condenser can be adopted, which is formed to have a substantially trapezoidal outer shape as a whole including an inclined side by, for example, forming the header 11 at the inlet side obliquely, and changing lengths of the respective flat tubes 12, in the parallel type condenser 8. Further, as illustrated in Figure 10, a condenser can be adopted, which is formed to have a stepped outer shape by separating the header 11 at the inlet side and the header 11 at the outlet side in the turning-back type condenser 8. Further, as illustrated in Figure 11, a condenser can be adopted, which is formed to have a stepped outer shape by changing turn lengths of the flat tube 12 in the meandering type condenser 8.

[0036] Further, as illustrated in Figure 12, a condenser can be adopted, which is formed to have a substantially trapezoidal outer shape including an inclined side by gradually changing turn lengths in the meandering type condenser 8. Further, the condenser 8 can be formed in a shape having both of an inclined side and a stepped side, or a condenser can be adopted, which is formed in a shape provided with a recessed portion in an intermediate portion to avoid piping or the like in the meandering type condenser 8 illustrated in Figure 7, for example.

[0037] By adopting the condensers 8 other than the condenser in which the main body portion is rectangular in this way, a degree of freedom of disposition is enhanced by the condenser 8 being in a shape along a slanting surface of the lower machine room 4, for example, and the space can be effectively used. Thereby, a useless space is eliminated, and reduction in size of the machine room, that is, increase in size of the storage room can be achieved.

[0038] Further, as illustrated in Figure 13, the flat tube 12 in the meandering type condenser 8 and the heat radiation pipe 10 can be integrally formed. That is, by causing the heat radiation pipe 10 to meander, a part of the heat radiation pipe 10 may be used as the meandering type condenser 8. By the configuration like this, piping from the inlet to the outlet of the condenser 8 become same piping, that is, an internal flow path is in the same shape, and pressure loss can be reduced. In this case, when the heat radiation pipe 10 is connected via the connecting tube 14 as in the first embodiment, manufacturability and workability can be enhanced.

[0039] Further, as illustrated in Figure 14, the heat radiation pipe 10 may be branched. Thereby, the heat radiation pipe 10 can be placed widely inside of the surface of the refrigerator 1, it becomes possible to radiate heat by using an entire wall surface of the refrigerator 1, and enhancement in heat radiation performance and enhancement in dew condensation prevention performance can be expected. In this case, by branching the heat radiation pipe 10 at the inlet side of the condenser 8 where the refrigerant is in a gaseous state, the flow of the refrigerant can be prevented from being hindered. As a matter of course, the location where the heat radiation pipe 10 is branched is not limited to the inlet side, but the heat radiation pipe 10 connected to the outlet side may be branched.

[0040] Further, instead of branching the heat radiation pipe 10, a plurality of heat radiation pipes 10 can be connected to the header 11 as illustrated in Figure 15. By the configuration like this, the heat radiation pipe 10 can be widely placed inside the surface of the refrigerator 1, it becomes possible to radiate heat by using the entire wall surface of the refrigerator 1, and enhancement in the heat radiation performance and enhancement in the dew condensation prevention performance can be expected. The same is said of the parallel type condenser 8.

[0041] Further, as illustrated in Figure 16, a sub condenser 20 having a smaller heat radiation ability than the condenser 8 disposed in the upper machine room 5 is disposed in the lower machine room 4, and it can be made possible to connect the compressor 7 and an inlet of the sub condenser 20, connect an outlet of the sub condenser 20 and one of the heat radiation pipes 10, connect the heat radiation pipe 10 and an inlet of the condenser 8, and connect an outlet of the condenser 8 and the other heat radiation pipe 10. Thereby, the refrigerant having a relatively high temperature, which flows out from the compressor 7, is firstly cooled to a certain degree in the sub condenser 20, and thereafter flows inside the surface of the refrigerator 1 by the heat radiation pipe 10. Accordingly, heat leak into the storage room can be reduced. Further, since the sub condenser 20 can be compact, the lower machine room 4 can be prevented from being unnecessarily large.

[0042] As illustrated in Figure 17, the condenser 8 which has a plurality of, for example, two main body portions denoted by reference sign 8a may be used. In the case of the condenser 8, the condenser 8 is of a parallel type, and the flat tube 12 thereof is bent so-called edge-wise in a width direction. The condenser 8 has the main body portions 8a having the fins 13 respectively in front and rear of the bent portion of the flat tube 12. In the case of the condenser 8 like this, the fan 9 is disposed so that air is blown from the main body portion 8a at an outlet side (lower side in the drawing) at a relatively low temperature to the main body portion 8a at an inlet side (upper side in the drawing) at a relatively high temperature, that is, the fan 9 is disposed so that the inlet side for the refrigerant is located at a downstream side of a blown air

path formed by the fan 9, whereby heat radiation performance can be restrained from being reduced.

[0043] While in the first embodiment, the example in which the axial flow type fan 9 is disposed substantially parallel with the condenser 8 is shown, the centrifugal fan 9 can be adopted as illustrated in Figure 18. In the case of the centrifugal fan 9, air is blown to expand in a circumferential direction as shown by arrows B from the fan 9. Therefore, a degree of freedom of the disposition position of the condenser 8 to the fan 9 is enhanced. Further, even when it is necessary to dispose a plurality of condensers 8, air can be blown to the plurality of condensers 8 with only one fan 9.

[0044] Further, as illustrated in Figure 19, by forming the main body portion into a curved surface shape such as an arch shape along an outer shape of the fan 9, air blown from the fan 9 can be efficiently used. At this time, by forming the main body portion of the condenser 8 into the shape along a circumferential direction of the fan 9, the length of the main body portion can be made long, and a height can be made relatively small. Further, by disposing a plurality of centrifugal fans 9 by overlapping the centrifugal fans 9, air can be blown to an entire surface of the main body portion, to the condenser 8 at a height, for example, as illustrated in Figure 2 and the like.

[0045] In the first embodiment, the configuration in which the heat radiation pipe 10 is housed in the groove portion 6a of the vacuum heat insulating member 6, but a structure can be adopted, in which the heat radiation pipe 10 is pressed to the inner surface of the outer box 2 by the vacuum heat insulating member 6 without providing the groove portion 6a in the vacuum heat insulating member 6. Thereby, it is not necessary to provide the groove portion 6a in the vacuum heat insulating member 6, and the fear that strength is reduced can be further reduced.

(Third embodiment)

[0046] Hereinafter, a third embodiment will be described with reference to Figure 20 to Figure 44. In the third embodiment, other shapes and the like of the condenser 8 shown in the first embodiment will be described.

[0047] As illustrated in Figure 20, a refrigerator 101 has a main body 102 thereof formed into a substantially rectangle. The main body 102 has a back plate 103, a left side plate 104, a right side plate 105, a ceiling plate 106 and a bottom plate 107 (refer to Figure 21), and a front is opened. Opening in the front of the main body 102 is opened and closed by a door 110a (refer to Figure 21). The back plate 103, the left side plate 104, the right side plate 105, the ceiling plate 106 and the bottom plate 107 each has a structure using, for example, a vacuum heat insulating panel, a foamed polyurethane, or using them in combination, though not illustrated, and has a structure thermally insulating a storage room 110 (refer to Figure 21) from an outside of the refrigerator 101.

[0048] Hereinafter, in the present specification, as il-

illustrated in Figure 20, explanation will be made with a direction along the gravity in a state in which the refrigerator 101 is installed described as a up-and-down direction, with a direction from the left side plate 104 to the right side plate 105 in a state in which the refrigerator 101 is seen from a front described as a left-and-right direction, and a direction from the door 110a to a back plate 103 side described as a front-and-back direction.

[0049] A machine room 108 is provided in a lower part in the main body 102. In the back plate 103, the left side plate 104, the right side plate 105 and the bottom plate 107, opening portions 109 communicating with an inside of the machine room 108 are formed in positions corresponding to the machine room 108. The respective opening portions 109 function as suction ports for sucking air into the machine room 108 from outside, or exhaust ports for discharging air to outside from inside the machine room 108, when a cooling fan 120 (refer to Figure 21) is operated. Whether the opening portions 109 function as the suction ports or function as the exhaust ports is determined by a position of the cooling fan 120 in the machine room 108. Note that the opening portion 109 may be a simple slit, may be worked into a louver shape or the like, or may be provided with a dust filter or the like.

[0050] As illustrated in Figure 21, a compressor 111, a condenser 112, the cooling fan 120 and the like are installed in the machine room 108. These compressor 111 and condenser 112 configure a refrigerating cycle 121 with an evaporator not illustrated. In the machine room 108, other components than the compressor 111, the condenser 112 and the cooling fan 120 are also installed, though not illustrated. Further, as a matter of course, a control unit that controls the entire refrigerator 101 including the compressor 111, the condenser 112, the cooling fan 120 and the like is also provided in the main body 102. Further, the condenser 112 is connected to the heat radiation pipes 10 and the like shown in the first embodiment, though not illustrated.

[0051] The storage room 110 such as a vegetable room, for example, is provided in front of the machine room 108, and is opened and closed by the pull-out type door 110a. Further, above the machine room 108, the storage room 110 such as a freezer compartment, for example, is provided, and is opened and closed by the pull-out type door 110a. Further, though not illustrated, the storage room 110 such as a refrigerated room, for example, is provided above the main body 102, and is opened and closed by the rotating door 110a, for example. The machine room 108 and the respective storage rooms 110 are partitioned by heat insulating partition walls 110b because the compressor 111 and the condenser 112 generate heat.

[0052] In the present embodiment, a so-called multi-flow type condenser is used as the condenser 112 which is installed in the machine room 108. The multi-flow type condenser 112 is configured such that flat tubes 114 are connected between the headers 113 as illustrated in Figure 22 and the like, and a plurality of flow paths are pro-

vided in parallel in each of the flat tubes 114, though details will be described later. Hereinafter, the configuration will be described as a parallel type for convenience. Further, as the multi-flow type condenser 112, there is a condenser having a configuration in which the headers 113 are connected with the single flat tube 114 which meanders as illustrated in Figure 23 and the like. Hereinafter, the configuration will be referred to as a meandering type for convenience. Further, among the respective flat tubes 114, heat radiation fins 115 are provided.

[0053] Next, an operation of the above described configuration will be described.

[0054] As can be imagined from Figure 21, for example, in order to increase a storage amount without causing increase in size of the main body 102, that is, in order to increase the storage room 110 in capacity, the machine room 108 is desirably reduced in size relatively. However, if the machine room 108 is reduced in size, the capacity of the machine room 108 decreases, so that a large component that can ensure a sufficient heat radiation amount cannot be installed.

[0055] In relation to this, in the present embodiment, the multi-flow type condenser 112 is adopted. Because the multi-flow type condenser 112 has a large surface area even though it is small in size, the multi-flow type condenser 112 can ensure a sufficient heat radiation amount, and can be installed in the machine room 108 reduced in size.

[0056] Incidentally, when the condenser 112 is installed, there are a plurality of points to keep in mind. For example, since the other components are also installed in the machine room 108 as described above, a disposition place for the condenser 112 may be restricted by positions of the other components, positions of the opening portions 109 and the like. Further, especially in the case of the refrigerator 101, the storage rooms 110 such as the refrigerated room and the freezer compartment are provided, so that it is necessary to restrain an influence of generated heat on the storage rooms 110. Further, in an actual manufacturing process, it is necessary to consider ease of connection to piping 117 (refer to Figure 23 and the like) that will be described later or the like.

[0057] That is, when the multi-flow type condenser 112 is installed into the refrigerator 101, it is not sufficient that the condenser 112 is compact, but originality and ingenuity are required in the installation place and the installed orientation. Hereinafter, a plurality of structures (structure examples A to D) of the condenser 112 will be described first, and thereafter, preferable installation examples (installation examples A to D) in the structure examples A to D will be described.

<Structure example A: parallel type structure in which a refrigerant flow is in one direction>

[0058] Structure example A which is a parallel type structure in which a flow of the refrigerant is in one direc-

tion will be described with reference to Figure 22 to Figure 24. Hereinafter, the condenser 112 of structure example A will be referred to as a condenser 112A for convenience by adding a suffix "A". Note that when common explanation is made in respective structure examples, explanation is made without attaching the suffix, and the same can be said of the respective structure examples that will be described later.

[0059] As illustrated in Figure 22, in the condenser 112A, a plurality of flat tubes 114 are provided in parallel between the two cylindrical headers 113. The respective flat tubes 114 has a plurality of flow paths formed inside thereof, and the respective flow paths communicate with the respective headers 113. Therefore, in the flat tubes 114, the refrigerant flows in parallel. Due to the structure like this, the condenser 112A is referred to as of a multi-flow type or a parallel-flow type.

[0060] The refrigerant that flows into one of the headers 113 which is at the inlet side flows in the flat tube 114 and reaches the other header 113 which is at the outlet side. At this time, the heat radiation fins 115 provided among the respective flat tubes 114 by forming, for example, a thin metal plate into a corrugated shape are in contact with the respective flat tubes 114, and therefore release heat of the respective flat tubes 114. Hereinafter, a site where the respective flat tubes 114 and the heat radiation fins 115 are disposed will be referred to as the main body portion 112a for convenience. The main body portion 112a can be regarded as having an outer edge substantially in a thin rectangular parallelepiped as a whole.

[0061] Hereinafter, a width direction of the main body portion 112a, that is, a direction from the one header 113 to the other header 113 will be referred to as an X-axis in Figure 22. Further, a height direction of the main body portion 112a, that is, a direction in which the cylindrical header 113 extends will be referred to as a Y-axis in Figure 22. Further, a thickness direction of the main body portion 112a, that is, a direction orthogonal to the X-axis and the Y-axis respectively will be referred to as a Z-axis. Further, directions of arrows indicating the X-axis, the Y-axis and the Z-axis in Figure 22 are positive directions, and explanation will be made by assigning the positive directions with the main body portion 112a as the reference with "+", and assigning negative directions that are opposite directions to the positive directions with "-".

[0062] Connecting tubes 116 are respectively provided in the respective headers 113. The connecting tube 116 is provided to perform connection with the piping 117 (refer to Figure 24), and is firmly connected to the header 113, but a side that is connected to the external piping 117 such as the heat radiation pipe 10 and the like, is formed into a pipe shape capable of curving and bending, for example, and is connected to the piping 117 by brazing, for example. Hereinafter, the connecting tube 116 at the inlet side for the refrigerant will be referred to as an inlet side connecting tube 116a for convenience, and the connecting tube 116 at an outlet side for the refrigerant

will be referred to as an outlet side connecting tube 116b for convenience. In this case, an orientation of the inlet side connecting tube 116a is substantially in an X- direction, and an orientation of the outlet side connecting tube 116b is substantially in an X+ direction.

[0063] In the case of the condenser 112A like this, as illustrated in Figure 23 by being simplified, the refrigerant flowing in from the inlet side connecting tube 116a flows in the respective flat tubes 114 toward the other header 113 as shown by the arrow F from the header 113 provided with the inlet side connecting tube 116a, and flows out from the outlet side connecting tube 116b. That is, in the case of the condenser 112A, the flow of the refrigerant is in one direction. At this time, the refrigerant is in a gaseous state when flowing into the inlet side connecting tube 116a, and is in a liquid state when flowing out from the outlet side connecting tube 116b by being condensed by the condenser 112.

[0064] Consequently, in the condenser 112, a temperature of the header 113 which is at the inlet side is relatively high, and a temperature of the header 113 which is at the outlet side is relatively low. Further, in the flat tube 114, a temperature at the inlet side is the highest, and the temperature becomes lower toward the outlet side. That is, in the main body portion 112a of the condenser 112 including the headers 113, a temperature distribution occurs.

[0065] When restrictions due to the installation place and the orientation for installation are not taken into consideration, the degrees of freedom of the orientations of the inlet side connecting tube 116a and the outlet side connecting tube 116b are considered to be relatively high. Specifically, as shown by the solid lines and the broken lines in Figure 24, the inlet side connecting tube 116a can be provided in various orientations such as the X- direction, Y+ direction, Z+ direction, and Z- direction with respect to the main body portion 112a. Similarly, the outlet side connecting tube 116b can be provided in various orientations such as the X+ direction, Y+ direction, Z+ direction, and Z-direction with respect to the main body portion 112a.

[0066] Note that though not illustrated in the drawings, the inlet side connecting tube 116a and the outlet side connecting tube 116b do not have to be strictly orthogonal or parallel to these directions, that is, the respective axes, but may be inclined to some degree, or may be oblique greatly with respect to the respective axes. Further, the outlet side connecting tube 116b can be provided in a region R illustrated in Figure 24, but in this case, the inlet and the outlet are close to each other, so that the refrigerant is unlikely to flow uniformly in all the flat tubes 114, and therefore, in the case of the condenser 112A, it is desirable to provide the inlet side connecting tube 116a and the outlet side connecting tube 116b diagonally as much as possible.

[0067] However, the piping 117 that is connected to each of the connecting tubes 116 corresponds to the orientation of the connecting tube 116 near the condenser

112. Consequently, when the inlet side connecting tube 116a is provided to extend in the X- direction, and the outlet side connecting tube 116b is provided to extend in the X+ direction as in Figure 24, for example, the piping 117 is connected from the X-direction, so that when the size including the piping 117 is considered, an actual installation space required at the time of installing the condenser 112A is required to some extent in the X-direction, that is, in the width direction of the main body portion 112a.

[0068] Likewise, when the inlet side connecting tube 116a is provided to extend in the Z+ direction, for example, the installation space is required to some extent in the Z-direction, that is, a thickness direction of the main body portion 112a. That is, the installation space is restricted by the orientations of the respective connecting tubes 116.

<Structure example B: parallel type structure in which flow of refrigerant is in two directions>

[0069] Parallel type structure example B in which the flow of the refrigerant is in two directions will be described with reference to Figure 25 to Figure 27.

[0070] As illustrated in Figure 25, the condenser 112B is in common to the condenser 112A in basic structure, and a plurality of flat tubes 114 are provided between the two cylindrical headers 113. In each of the flat tubes 114, a plurality of flow paths are formed inside thereof, and the respective flow paths communicate with the respective headers 113. Consequently, in the flat tube 114, the refrigerant flows in parallel. Further, among the respective flat tubes 114, the heat radiation fins 115 are provided.

[0071] However, in the case of the condenser 112B, one of the headers 113 is provided with both the inlet side connecting tube 116a and the outlet side connecting tube 116b, and a sealing portion 13a is provided between the inlet side connecting tube 116a and the outlet side connecting tube 116b. The sealing portion 13a seals an inside of the cylindrical header 113. That is, the sealing portion 13a divides the inside of the single cylindrical header 113 into two ranges. Further, the sealing portion 13a makes the number of flat tubes 114 at the inlet side relatively large, and makes the number of flat tubes 114 at the outlet side relatively small. This is because the refrigerant is in a gaseous state and has a large volume at the inlet side, whereas at the outlet side, the refrigerant is condensed to be in a liquid state and has a small volume. Thereby, efficiency can be enhanced.

[0072] In the case of the condenser 112B like this, as illustrated in Figure 26 by being simplified, a gaseous refrigerant flowing in from the inlet side connecting tube 116a flows in the respective flat tubes 114 which are located at the inlet side connecting tube 116a side from the sealing portion 13a toward the other header 113, thereafter passes inside the other header 113, flows in an opposite direction in the respective flat tubes 114 lo-

cated at the outlet side connecting tube 116b side from the sealing portion 13a, and thereafter flows out from the outlet side connecting tube 116b, as shown by the arrows F. That is, in the case of the condenser 112B, the flow of the refrigerant is in the two directions.

[0073] In the case of the condenser 112B, if the restrictions due to the installation place and the orientation for installation are not taken into consideration, the degree of freedom of the orientations of the inlet side connecting tube 116a and the outlet side connecting tube 116b is relatively high. More specifically, as shown by the solid lines and the broken lines in Figure 27, the inlet side connecting tube 116a can be provided in various orientations such as the X- direction, Y+ direction, Z+ direction, and Z-direction with respect to the main body portion 112a. Likewise, the outlet side connecting tube 116b can be provided in various orientations such as the X- direction, Y+ direction, Z+ direction, and Z- direction with respect to the main body portion 112a.

[0074] In the case of the condenser 112B, the piping 117 which is connected to each of the connecting tubes 116 corresponds to the orientation of the connecting tube 116 near the condenser 112, so that the installation space is restricted by the orientations of the respective connecting tubes 116. Note that though not illustrated, the inlet side connecting tube 116a and the outlet side connecting tube 116b may be inclined to some degree, or may be oblique greatly with respect to the respective axes.

<Structure example C: meandering type structure in which headers are provided at same side>

[0075] A meandering type structure in which the headers 113 are provided at the same side, that is, structure example C in which the inlet and the outlet for the refrigerant are disposed at the same side with respect to the main body portion 112a will be described with reference to Figure 28 to Figure 30.

[0076] As illustrated in Figure 28, in a condenser 112C, the single flat tube 114 is provided to meander between the two relatively compact cylindrical headers 113. In the flat tube 114, a plurality of flow paths are formed inside thereof, and the respective flow paths communicate with the respective headers 113. Consequently, in the flat tube 114, the refrigerant flows in parallel. Further, in spaces of the folded flat tube 114, the heat radiation fins 115 are provided. Further, in the case of the condenser 112C, the header 113 at the inlet side and the header 113 at the outlet side are provided by being located at a same side with respect to the main body portion 112a.

[0077] In the case of the condenser 112C like this, as illustrated in Figure 29 by being simplified, the gaseous refrigerant flowing in from the inlet side connecting tube 116a flows in the flat tube 114 toward the other header 113, and flows out from the outlet side connecting tube 116b, as shown by the arrows F. Note that as the orientation of the header 113, an orientation horizontal to the flat tube 114, an orientation coaxial with the flat tube 114

and the like are conceivable other than the orientation perpendicular to the flat tube 114 as in Figure 28, but the header 113 itself is relatively small in the case of the condenser 112C, so that the orientations of the connecting tubes 116 are considered to be the main cause of the problem of the space.

[0078] In the case of the condenser 112C, if the restrictions due to the installation place and the orientation for installation are not taken into consideration, the degree of freedom of the orientations of the inlet side connecting tube 116a and the outlet side connecting tube 116b are relatively high. More specifically, as shown by the solid lines and the broken lines in Figure 30, the inlet side connecting tube 116a can be provided in various orientations such as the Z+ direction, the X- direction, the Y+ direction, the Y- direction, and the Z+ direction, with respect to the main body portion 112a. Likewise, the outlet side connecting tube 116b can be provided in various orientations such as the Z+ direction, the X- direction, the Y+ direction, the Y- direction and Z+ direction, with respect to the main body portion 112a.

[0079] In the case of the condenser 112C, the piping 117 which is connected to each of the connecting tubes 116 corresponds to the orientation of the connecting tube 116 near the condenser 112, so that the installation space is restricted by the orientations of the respective connecting tubes 116. Note that though not illustrated, the inlet side connecting tube 116a and the outlet side connecting tube 116b may be inclined to some degree, or may be oblique greatly with respect to the respective axes.

<Structure example C: meandering type structure in which headers are provided at diagonal sides>

[0080] A meandering type structure in which the headers 113 are provided at diagonal sizes, that is, structure example D in which the inlet and the outlet for the refrigerant are disposed on a diagonal line with respect to the main body portion 112a will be described with reference to Figure 31.

[0081] As illustrated in Figure 31, a condenser 112D is substantially common to the condenser 112C, but the two cylindrical headers 113 are provided in positions diagonal to the main body portion 112a.

[0082] In the case of the condenser 112D, if the restrictions due to the installation place and the orientation for installation are not taken into consideration, the degree of freedom of the orientations of the inlet side connecting tube 116a and the outlet side connecting tube 116b are relatively high. More specifically, the inlet side connecting tube 116a can be provided in various orientations such as the Z+ direction, the X- direction, the Y+ direction, the Y- direction, and the Z- direction, with respect to the main body portion 112a. Likewise, the outlet side connecting tube 116b can be provided in various orientations such as the Z+ direction, the X+ direction, the Y+ direction, and Z- direction, with respect to the main body portion 112a.

[0083] In the case of the condenser 112D, the piping 117 which is connected to each of the connecting tubes 116 corresponds to the orientation of the connecting tube 116 near the condenser 112, so that the installation space is restricted by the orientations of the respective connecting tubes 116. Note that though not illustrated, the inlet side connecting tube 116a and the outlet side connecting tube 116b may be inclined to some degree, or may be oblique greatly to the respective axes.

[0084] The condensers 112 shown in the above described structure examples A to D have various orientations to install. For example, in the case of the condenser 112A, a state in which the condenser 112A is installed with a height direction of the main body portion 112a along the gravity direction, that is, a state in which the headers 113 are along the gravity direction, and the flat tubes 114 are horizontal to an installation surface is conceivable as illustrated in Figure 32(a). Note that in Figure 32, illustration of the connecting tube 116 is omitted.

[0085] Further, as illustrated in Figure 32(b), a state in which the condenser 112A is installed with a width direction of the main body portion 112a along the gravity direction, that is, a state in which the headers 113 are horizontal to the installation surface, and the flat tubes 114 are along the gravity direction is conceivable. Further, as illustrated in Figure 32(c), a state in which the condenser 112A is installed with the thickness direction of the main body portion 112a along the gravity direction, a state in which the condenser 112A is installed with the thickness direction of the main body portion 112a oblique to the gravity direction as illustrated in Figure 32(d) and the like are conceivable. Note that though not illustrated, a state (refer to Figure 39) in which the condenser 112A is installed with the headers 113 oblique to the gravity direction is also conceivable.

<Installation example A>

[0086] Hereinafter, an installation example A will be described with reference to Figure 33 and Figure 34.

[0087] Figure 33 illustrates the installation example A, and schematically illustrates a state of the machine room 108 seen from above. In the installation example A, the condenser 112 is installed so that the main body portion 112a is substantially parallel to the storage room 110 in front of the machine room 108. In this case, outside air is sucked from the opening portion 109 provided in the bottom plate 107 and cools the condenser 112, and thereafter, the air is discharged from the opening portion 109 provided in the left side plate 104 while cooling the compressor 111.

[0088] First, as described above, the storage rooms 110 are provided in front of and above the machine room 108, so that an influence of the radiated heat from the condenser 112 on the storage rooms 110 is desirably small. In this case, a distance to the storage room 110 at a front side of the machine room 108 is the same, so that it is conceivable to consider the influence on the stor-

age room 110 (refer to Figure 21) at an upper side of the machine room 108.

[0089] Further, since the condenser 112 condenses the gaseous refrigerant into a liquid state as described above, the outlet side connecting tube 116b is desirably located at a lower part. Further, the right side plate 105 exists at a right side in the drawing of the condenser 112, so that it is difficult to ensure a space at the right side of the condenser 112. Further, in order to reduce the size of the machine room 108, it is not preferable that the space upward of the condenser 112 increases.

[0090] In view of these matters for consideration, as illustrated in Figure 34(a) it is preferable to install the condenser 112A, for example, so that the headers 113 are along the gravity direction, provide the inlet side connecting tube 116a at the header 113 at the right side in the drawing of the main body portion 112a to extend in the Z+ direction (at a front side vertical to the sheet surface), and provide the outlet side connecting tube 116b at the header 113 at the left side in the drawing to extend in the Z+ direction shown by the solid line or the X- direction (left side in the drawing) shown by the broken line. Note that Figure 34 schematically illustrates a state seen from arrow XV in Figure 33.

[0091] By installing the condenser 112A in the state like this, the influence of generated heat on the storage room 110 at the upper side of the machine room 108 can be restrained, as compared with the case where the headers 113 are disposed up and down (refer to Figure 32(b)). Further, since the inlet side where the temperature becomes relatively high is disposed at the outer side, influence of generated heat on not only the storage room 110 but also the other components in the machine room 108 can be restrained more.

[0092] Further, since the inlet side connecting tube 116a is disposed at the upper side, and the outlet side connecting tube 116b is disposed at the lower side, the flow of the refrigerant which transitions from the gaseous state to the liquid state is not hindered by the gravity. Further, since a space relatively exists at the lower side in the drawing of the condenser 112 in Figure 33, so that the installation space is easily ensured, and it becomes easy to connect the piping 117. That is, in the case of the condenser 112A, disposition as illustrated in Figure 34(a) is considered to be preferable.

[0093] Further, in the case of the condenser 112B, for example, as illustrated in Figure 34(b), it is desirable to install the condenser 112B, so that the headers 113 are along the gravity direction, provide the inlet side connecting tube 116a at the header 113 at the right side in the drawing so that the inlet side connecting tube 116a extends in the Z+ direction, and provide the outlet side connecting tube 116b at a lower side with the sealing portion 13a therebetween so that the outlet side connecting tube 116b extends in the Z+ direction.

[0094] By installing the condenser 112B in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the

storage room 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained such as being able to easily connect the piping 117. That is, in the case of the condenser 112B, installation orientation and the structure as illustrated in Figure 34(b) is considered to be preferable.

[0095] Further, in the case of the condenser 112C, for example, as illustrated in Figure 34(c), the condenser 112C can be installed so that the respective headers 113 are located at the right side plate 105 side, the inlet side connecting tube 116a can be provided at the header 113 at an upper portion at the right side in the drawing of the main body portion 112a so as to extend in the Z+ direction, and the outlet side connecting tube 116b can be provided at the header 113 at a lower portion at the right side in the drawing of the main body portion 112a to extend in the Z+ direction.

[0096] By installing the condenser 112 in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage room 110 by the heat generated from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117. That is, in the case of the condenser 112C, the installation orientation and the structure as illustrated in Figure 34(c) are considered to be preferable.

[0097] Further, in the case of the condenser 112D, for example, as illustrated in Figure 34(d), the condenser 112D can be installed so that the headers 113 are located at the right side plate 105 side and a side diagonal to the right side plate 105 side, the inlet side connecting tube 116a can be provided at the header 113 at the upper portion at the right side in the drawing of the main body portion 112a so as to extend in the Z+ direction, and the outlet side connecting tube 116b can be provided at the header 113 at a lower portion at the left side in the drawing of the main body portion 112a to extend in the Z+ direction.

[0098] By installing the condenser 112D in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117. That is, in the case of the condenser 112D, the installation orientation and the structure as illustrated in Figure 34(d) are considered to be preferable.

<Installation example B>

[0099] Hereinafter, an installation example B will be described with reference to Figure 35 and Figure 36.

[0100] Figure 35 illustrates the installation example B, and schematically illustrates a state of the machine room 108 seen from above. In the installation example B, the

condenser 112 is installed so that the main body portion 112a is substantially perpendicular to the storage room 110 in front of the machine room 108. In this case, outside air is sucked from the opening portions 109 which are provided in the bottom plate 107 and the right side plate 105 and cools the condenser 112, and thereafter the air is discharged from the opening portion 109 provided in the left side plate 104 while cooling the compressor 111.

[0101] In this case, it is conceivable that the influence by the generated heat becomes smaller when the inlet side of the condenser 112 is separated from the storage room 110 at the front side of the machine room 108. Further, the back plate 103 exists at a lower side in the drawing of the condenser 112, so that it is considered to be difficult to ensure the installation space at the lower side in the drawing of the condenser 112.

[0102] In view of these matters for consideration, for example, in the case of the condenser 112A, it is preferable to install the condenser 112A so that the headers 113 are along the gravity direction and the header 113 at the inlet side is at the front side in the drawing (at the lower side illustrated in Figure 35), and provide the inlet side connecting tube 116a and the outlet side connecting tube 116b to extend in the Z+ direction (right side in the drawing) as shown by the solid line or the Z- direction (left side in the drawing) shown by the broken line, as illustrated in Figure 36(a). Note that Figure 36 schematically illustrates a state seen from arrow XVII in Figure 35, and in Figure 36(a), the orientation of the header 113 is schematically illustrated by the broken line. Further, in order to show whether the header 113 is at the front side or a back side in the drawing, whether the header 113 is at the front side or the back side is schematically shown in a mode in which the connecting tube 116 is connected to the header 113 shown by the broken line.

[0103] By installing the condenser 112A in the state like this, the inlet side where the temperature becomes relatively high is disposed at the back plate 103 side while the influence of the generated heat on the respective storage rooms 110 at the front side and the upper side of the machine room 108 is restrained, so that the influence of the generated heat on not only the storage rooms 110 but also the other components in the machine room 108 can be further restrained. Further, the inlet side connecting tube 116a is disposed at the upper side, and the outlet side connecting tube 116b is disposed at the lower side, so that the flow of the refrigerant that transitions to a liquid state from the gaseous state is not hindered by the gravity.

[0104] In this case, the cooling fan 120 is provided in a space (S) formed by the inlet side connecting tube 116a and the outlet side connecting tube 116b, that is, in a range less than a length of each of the inlet side connecting tube 116a and the outlet side connecting tube 116b that protrude from the main body portion 112a. Note that it is needless to say that the cooling fan 120 has such a size as to be housed in the space (S).

[0105] Thereby, space saving can be achieved. Fur-

ther, a space relatively exists at the right side in the drawing of the condenser 112 in Figure 35, so that the installation space is easily ensured, and it becomes easy to connect the piping 117. Further, when the inlet side connecting tube 116a and the outlet side connecting tube 116b are provided to extend in the Z- direction (left side of the drawing), the cooling fan 120 can be provided at that side, that is, at the left side in the drawing of the main body portion 112a. That is, in the case of the condenser 112A, disposition as illustrated in Figure 36(a) is considered to be preferable.

[0106] Further, for example, in the case of the condenser 112B, it is preferable to install the condenser 112B so that the headers 113 are along the gravity direction, and provide the inlet side connecting tube 116a and the outlet side connecting tube 116b at the header 113 which is on the front side of the drawing so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction (right side in the drawing) as illustrated by the solid line or in the Z- direction (left side in the drawing) as illustrated by the broken line, as illustrated in Figure 36(b).

[0107] By installing the condenser 112 in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage rooms 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117 and being able to achieve space saving. That is, in the case of the condenser 112B, the installation orientation and the structure as illustrated in Figure 36(b) are considered to be preferable.

[0108] Further, in the case of the condenser 112C, for example, as illustrated in Figure 36(c), it is preferable to install the condenser 112C so that the respective headers 113 are located at the back plate 103 side, provide the inlet side connecting tube 116a at the header 113 at the upper portion in the drawing of the main body portion 112a, and provide the outlet side connecting tube 116b at the header 113 at the lower side in the drawing of the main body portion 112a so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction shown by the solid line or in the Z- direction (left side in the drawing) shown by the broken line.

[0109] By installing the condenser 112 in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117 and being able to save space. That is, in the case of the condenser 112C, the installation orientation and the structure as illustrated in Figure 36(c) are considered to be preferable.

[0110] Further, in the case of the condenser 112D, for example, as illustrated in Figure 36(d), it is preferable to

install the condenser 112D so that the header 113 at the inlet side is located at the back plate 103 side and the header 113 at the outlet side is located at a diagonal side thereof, provide the inlet side connecting tube 116a at the header 113 at the upper portion in the drawing of the main body portion 112a and provide the outlet side connecting tube 116b at the header 113 at the lower part in the drawing of the main body portion 112a so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction shown by the solid line, or the Z-direction (left side in the drawing) shown by the broken line.

[0111] By installing the condenser 112 in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage rooms 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117 and being able to save space. That is, in the case of the condenser 112D, the installation orientation and the structure as illustrated in Figure 36(d) are considered to be preferable.

<Installation example C>

[0112] Hereinafter, an installation example C will be described with reference to Figure 37 and Figure 38.

[0113] Figure 37 illustrates the installation example C and schematically illustrates a state of the machine room 108 seen from above. In the installation example C, the condenser 112 is installed so that the main body portion 112a is parallel to the bottom plate 107. In this case, outside air is sucked from the opening portion 109 provided in the bottom plate 107 and cools the condenser 112, and thereafter the air is discharged from the opening portions 109 provided in the left side plate 104 and the back plate 103 while cooling the compressor 111.

[0114] In this case, the condenser 112 is relatively close to the storage room 110 at the front side of the machine room 108, so that it is conceivable that the influence by the generated heat is smaller when the inlet side of the condenser 112 is separated as much as possible. Further, the heat insulating partition wall 110b exists at an upper side in the drawing of the condenser 112, so that it is considered to be difficult to ensure the installation space at the upper side in the drawing of the condenser 112.

[0115] In view of these matters for consideration, for example, in the case of the condenser 112A, it is preferable to install the condenser 112A so that the headers 113 are substantially perpendicular to the gravity direction, and the header 113 at the inlet side is at the front side in the drawing (at the lower side in the drawing in Figure 37), and provide the inlet side connecting tube 116a and the outlet side connecting tube 116b so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction (upper side in the drawing) as shown by the solid lines, as illus-

trated in Figure 38(a). Note that Figure 38 schematically illustrates a state seen from the arrow XIX in Figure 37, and Figure 38(a) schematically illustrates the orientation of the header 113 by the broken line. Further, in order to show whether the header 113 is at the front side or a back side in the drawing, whether the header 113 is at the front side or the back side in the drawing is schematically shown by a mode in which the connecting tube 116 is connected to the header 113 shown by the broken line.

[0116] By installing the condenser 112A in the state like this, an influence of the generated heat on the storage room 110 at the front side of the machine room 108 can be restrained. Further, air that cools the header 113 at the inlet side where the temperature becomes relatively high is discharged to outside, so that the influence of the generated heat on the other components in the machine room 108 can be further restrained. In this case, in order to promote the flow of the refrigerant, the header 113 at which the inlet side connecting tube 116a is provided may be inclined more upward slightly than the header 113 at which the outlet side connecting tube 116b is provided (refer to Figure 32(d)).

[0117] Further, the cooling fan 120 is provided in the space (S) formed by the inlet side connecting tube 116a and the outlet side connecting tube 116b. Thereby, space saving can be achieved. Further, it is conceivable that connection of the piping 117 is facilitated from above the condenser 112. That is, in the case of the condenser 112A, disposition as illustrated in Figure 36(a) is considered to be preferable.

[0118] Further, for example, in the case of the condenser 112B, it is preferable to install the condenser 112B so that the headers 113 are along the gravity direction, and provide the inlet side connecting tube 116a and the outlet side connecting tube 116b at the header 113 which is on the front side in the drawing so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction, as illustrated in Figure 38(b). By installing the condenser 112B in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117 and being able to save space. That is, in the case of the condenser 112B, the installation orientation and the structure as illustrated in Figure 38(b) are considered to be preferable.

[0119] Further, in the case of the condenser 112C, for example, as illustrated in Figure 38(c), it is preferable to provide the inlet side connecting tube 116a at the header 113 at the right side in the drawing of the main body portion 112a, that is, the side separated from the storage room 110, and provide the outlet side connecting tube 116b at the header 113 at the left side in the drawing of the main body portion 112a, that is, the side close to the storage room 110, so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in

the Z+ direction.

[0120] By installing the condenser 112 in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117 and being able to save space. That is, in the case of the condenser 112C, the installation orientation and the structure as illustrated in Figure 38(c) are considered to be preferable.

[0121] Further, in the case of the condenser 112D, for example, as illustrated in Figure 38(d), it is preferable to provide the inlet side connecting tube 116a and the outlet side connecting tube 116b at the header 113 at the front side in the drawing of the main body portion 112a, that is, the side separated from the storage room 110 so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction. By installing the condenser 112 in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117 and being able to save space. That is, in the case of the condenser 112D, the installation orientation and the structure as illustrated in Figure 38(d) are considered to be preferable.

<Installation example D>

[0122] Hereinafter, installation example D will be described with reference to Figure 39 and Figure 40.

[0123] Figure 39 illustrates an installation example D and schematically illustrates a state of the machine room 108 seen from a side. In the installation example D, the condenser 112 is installed substantially at a side close to an upper end of the heat insulating partition wall 110b so that the main body portion 112a is along an inclined portion of the heat insulating partition wall 110b. Further, the condenser 112 is installed at a side close to the right side plate 105, though not illustrated. In this case, outside air is sucked from the opening portion 109 provided in the bottom plate 107 and cools the condenser 112.

[0124] In this case, in the condenser 112, distances between the headers 113 and the storage room 110 in front of the machine room 108 are constant, whereas distances between the headers 113 and the storage room 110 at an upper portion of the machine room 108 differ depending on the positions of the headers 113. Consequently, in the case of the installation like this, it is conceivable that the influence by the generated heat on the storage rooms 110 can be restrained by providing the headers 113 at a lower side. On the other hand, if the header 113 at the inlet side is disposed at the lower side in the drawing, that is, the lower side in the gravity direction, there arises the fear of inhibiting the flow of the

refrigerant.

[0125] In view of these matters for consideration, for example, in the case of the condenser 112A, it is preferable to dispose the condenser 112A so that the headers 113 are along the heat insulating partition wall 110b, provide the inlet side connecting tube 116a at the header 113 which is at the right side in the drawing of the main body portion 112a and at the side close to the side plate so that the inlet side connecting tube 116a extends in the Z+ direction (substantially the front side in the drawing), and provide the outlet side connecting tube 116b at the header 113 at the left side in the drawing of the main body portion 112a so that the outlet side connecting tube 116b extends in the Z+ direction (substantially the front side in the drawing) shown by the solid line, or in the X-direction (left side in the drawing) shown by the broken line, as illustrated in Figure 40(a). Note that Figure 40 schematically illustrates a state seen from the back side of the refrigerator 101.

[0126] By installing the condenser 112A in the state like this, the influence of the generated heat on the storage room 110 at the upper side of the machine room 108 can be restrained. At this time, when the condenser 112A is assumed to be seen from the side, the state is substantially as in Figure 38(a), and the cooling fan 120 is disposed in the space (S) formed by the inlet side connecting tube 116a and the outlet side connecting tube 116b. Thereby, space saving can be achieved. That is, in the case of the condenser 112A, disposition as illustrated in Figure 40(a) is considered to be preferable.

[0127] Further, for example, in the case of the condenser 112B, it is preferable to install the condenser 112B so that the headers 113 are along the heat insulating partition wall 110b, and provide the inlet side connecting tube 116a and the outlet side connecting tube 116b at the header 113 which is on the right side of the drawing so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction, as illustrated in Figure 40(b). Further, in this case, it is also preferable to dispose the cooling fan 120 in the space (S) formed by the inlet side connecting tube 116a and the outlet side connecting tube 116b.

[0128] By installing the condenser 112 in the state like this, the installation space is ensured without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained, so that similar effects to the above described condenser 112A can be obtained, such as being able to easily connect the piping 117 and being able to save space. That is, in the case of the condenser 112B, the installation orientation and the structure as illustrated in Figure 40(b) are considered to be preferable.

[0129] Further, in the case of the condenser 112C, for example, as illustrated in Figure 40(c), it is preferable to provide the inlet side connecting tube 116a at the header 113 at the right side in the drawing of the main body portion 112a, and provide the outlet side connecting tube 116b at the header 113 at the left side in the drawing of

the main body portion 112a so that the inlet side connecting tube 116a and the outlet side connecting tube 116b extend in the Z+ direction. By installing the condenser 112 in the state like this, similar effects to the above described condenser 112A can be obtained, such as being able to save space, without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained. That is, in the case of the condenser 112C, the installation orientation and the structure as illustrated in Figure 40(c) are considered to be preferable.

[0130] Further, in the case of the condenser 112D, for example, as illustrated in Figure 40(d), it is preferable to provide the inlet side connecting tube 116a at the header 113 at the right side in the drawing of the main body portion 112a so that the inlet side connecting tube 116a extends in the Z+ direction, and provide the outlet side connecting tube 116b at the header 113 at the right side in the drawing of the main body portion 112a so that the outlet side connecting tube 116b extends in the Z+ direction shown by the solid line or in the X- direction (left side in the drawing) shown by the broken line.

[0131] By installing the condenser 112 in the state like this, similar effects to the above described condenser 112A can be obtained, such as being able to save space, without hindering the flow of the refrigerant while the influence on the storage room 110 by the generated heat from the condenser 112 is restrained. That is, in the case of the condenser 112D, the installation orientation and the structure as illustrated in Figure 40(d) are considered to be preferable.

[0132] Note that in the installation example D, the state in which the condenser 112 is close to the right side plate 105 is assumed, but in the case of a state in which the condenser 112 is close to the left side plate 104, the orientations of the inlet side connecting tube 116a and the outlet side connecting tube 116b can be set in the opposite way of thinking to the respective examples described above.

[0133] In this way, the refrigerator 101 of the present embodiment adopts the condensers 112 of different structures in accordance with the installation positions in the machine room 108.

[0134] According to the embodiments described above, effects as follows can be obtained.

[0135] The refrigerator 101 performs heat exchange of the refrigerating cycle 121 by using the multi-flow type condenser 112 having the flat tube 114 that is formed into a flat shape and has a plurality of flow paths in which a refrigerant flows formed inside thereof, and the headers 113 to be the inlet or the outlet for the refrigerant to the flat tube 114. Thereby, the multi-flow type condenser 112 is small in size with high performance, and therefore can be installed in the machine room 108 which is reduced in size. Accordingly, a necessary amount of radiated heat can be ensured by the condenser 112 installed in the machine room 108.

[0136] Further, the multi-flow type condenser 112 can

expect a heat radiation effect by about twice to three times as compared with those of the same volume, so that the structure can be simplified, and manufacturing cost can be reduced. Further, heat leak to the storage rooms is reduced, and contribution can be made to energy saving.

[0137] The condenser 112 may be disposed so that the direction in which the flat tube 114 extends is horizontal to an installation surface of the refrigerator 101, may be disposed so that the direction in which the flat tube 114 extends is perpendicular to the installation surface, may be disposed so that the main body portion 112a is horizontal to the installation surface, or may be disposed so that the main body portion 112a inclines to the installation surface. That is, an installation orientation of the condenser 112 can be set in accordance with the shape of the machine room 108, and the balance with the other components in the machine room 108. Thereby, the degree of freedom of installation can be enhanced.

[0138] The refrigerant flows into the condenser 112 in the installed state, from the upper side. Thereby, the refrigerant which is condensed to be in a liquid state moves downward by the gravity, so that the refrigerant can be efficiently liquefied, that is, the performance of the refrigerating cycle 121 can be enhanced.

[0139] The condenser 112 is disposed in the orientation in which the inlet side for the refrigerator separates from the storage room 110. Thereby, the storage room 110 or the heat insulating partition wall 110b can be restrained from being warmed by the generated heat from the condenser 112, and heat leak can be reduced.

[0140] The condenser 112 is disposed in the machine room 108 provided in the main body 102 of the refrigerator 101. In the machine room 108, the opening portions 109 for cooling the compressor 111 are provided, and introduction and discharge of outside air are facilitated. Consequently, by providing the condenser 112 in the machine room 108, cooling of the condenser 112 and discharge of the air that is heated by cooling the condenser 112 can be performed efficiently.

[0141] The condenser 112 has the connecting tube 116 which is the inlet or the outlet for the refrigerant, and is formed to have such a length as to protrude from the main body portion 112a in which the flat tube 114 is disposed. The cooling fan 120 which cools the condenser 112 is smaller than the outer shape of the main body portion 112a, is formed to be thinner than the protruded length of the connecting tube 116, and is disposed in the space (S. space) formed between the main body portion 112a and the tip ends of the connecting tubes 116.

[0142] Thereby, the cooling fan 120 can be installed in the space that is always necessary when the condenser 112 is installed, and space saving can be achieved.

[0143] Further, the multi-flow type condenser 112 is reduced in size and has high performance as described above, can effectively perform heat exchange with a relatively small amount of air, and therefore, can be sufficiently cooled by even the cooling fan 120 which is

housed in the space (S) formed by the main body portion 112a and the connecting tubes 116.

(Other embodiments)

[0144] The present invention is not limited to what are illustrated in the above described embodiments, and can be arbitrarily modified or expanded as follows, for example, within the range without departing from the scope of the present invention.

[0145] In the third embodiment, the example in which the one condenser 112 is cooled by the cooling fan 120 is shown, but a configuration in which two or more condensers 112 are cooled by the one cooling fan 120 may be adopted as illustrated in Figure 4, for example. In this case, as illustrated in Figure 41(a), for example, the condenser 112 may be disposed obliquely to the air blowing surface of the cooling fan 120 so that blown air from the cooling fan 120 may hit the respective condensers 112 as shown by arrows Y. Further, as illustrated in Figure 41(b), the condensers 112 may be disposed so as to overlap the air blowing surface so that the blown air from the cooling fan 120 may hit the respective condensers 112. Further, as illustrated in Figure 41(c), a plurality of condensers 112 may be disposed side by side at the air blowing surface.

[0146] By providing the plurality of condensers 112 in this way, the ability of the refrigerating cycle 121 can be enhanced, and space saving can be achieved by cooling the plurality of condensers 112 with the one cooling fan 120. In this case, condensers of a parallel type or condensers of a meandering type may be respectively provided, or condensers of a parallel type and condensers of a meandering type may be mixed together.

[0147] In the third embodiment, the condenser 112 having the one main body portion 112a is illustrated, but as illustrated in Figure 42, for example, the condenser 112 having a plurality of main body portions 112a may be used. Thereby, the ability of the refrigerating cycle 121 can be enhanced without causing excessive increase in size of the condenser 112. By them, the surface area of the condenser 112 can be earned, or the condenser 112 can be thinned, so that the space occupied by the condenser 112 can be decreased. Further, the heat radiation efficiency can be also enhanced.

[0148] Note that in Figure 42, the two main body portions 112a are shown, but three or more main body portions 112a may be included. Further, instead of piling the main body portions 112a over each other as in Figure 42, an angle may be provided between the main body portions 112a. Further, the plurality of main body portions 112a may be connected in series, or may be connected in parallel.

[0149] In the third embodiment, the example in which the condenser 112 is cooled by the cooling fan 120 is shown, but as illustrated in Figure 43, a configuration in which defrosting water (W) is dropped from above the condenser 112 may be adopted. Note that the defrosting

water is water that is generated when frost adhering to a cooler not illustrated is melted. Thereby, the condenser 112 can be efficiently cooled by the defrosting water.

[0150] At this time, if the orientation of the condenser 112 is set so that flat tube 114 is along the gravity direction, the defrosting water is urged to flow down along the flat tube 114 by the gravity and cooling water can efficiently cool the condenser without accumulating in the heat radiation fins 115.

[0151] In this case, a configuration may be adopted, in which the defrosting water is dropped to the main body portion 112a from a front, that is, from the direction of the Z-axis mentioned in the third embodiment. Further, a configuration in which the defrosting water (W) is always dropped may be adopted, or a configuration in which the defrosting water (W) is regularly dropped may be adopted. Thereby, clogging of the heat radiation fins 115 due to dust or the like can be prevented.

[0152] The configuration of the refrigerator 101 illustrated in the third embodiment is only an example, and the functions and dispositions may be different, such as the number of storage rooms 110 differing, and the freezer unit being provided at the lowermost part. Further, for example, Figure 21 and the like schematically illustrate the configurations and structures, and for example, the sizes, the installation places and the like of the compressor 111, the condenser 112, the cooling fan 120, the opening portions 109 and the like are not necessarily in the relations as illustrated in the drawings.

[0153] Further, as illustrated in Figure 44, the refrigerator 101 in which the machine room 108 is provided at an upper portion in the main body 102 may be adopted. That is, the shape and disposition in the main body 102, of the machine room 108 is not limited to what are illustrated in the embodiments. In the case of Figure 44, the condenser 112 is installed to be in the installation orientation substantially illustrated in Figure 36(a) when seen from the left side plate 104 side by facing the header 113 at the inlet side to the upper portion, and facing the header 113 at the outlet side to the lower portion, whereby the influence on the storage room 110 can be restrained, and space saving can be achieved.

[0154] The respective embodiments are presented as examples, and do not intend to restrict the scope of the invention. These novel embodiments can be carried out in various other modes, and various omissions, replacements and modifications can be made within the range without departing from the gist of the invention. The present embodiments and modifications of the embodiments are included in the scope and the gist of the invention, and are included in the invention described in the claims and the range equal to the invention.

Claims

1. A refrigerator, comprising:

- an outer box;
 an inner box disposed with a space left between the inner box and the outer box;
 a condenser that configures a refrigerating cycle; and
 a heat radiation pipe that is connected to the condenser, internally includes a plurality of hollow portions configured to be flow paths for a refrigerant, and is formed into a flat shape.
2. The refrigerator according to claim 1, wherein the condenser is of a multi-flow type having a flat tube in which a plurality of flow paths in which the refrigerant flows are formed, and the heat radiation pipe is formed integrally with the flat tube configuring the condenser.
3. The refrigerator according to claim 2, wherein the condenser has headers respectively at an inlet side and an outlet side for the refrigerant, and the heat radiation pipe is connected to the condenser via the headers.
4. The refrigerator according to any one of claims 1 to 3, further comprising:
 a vacuum heat insulating member provided between the outer box and the inner box, wherein the heat radiation pipe is provided between the vacuum heat insulating member and the outer box.
5. The refrigerator according to any one of claims 1 to 4, wherein the heat radiation pipe is provided by being branched into a plurality of branches from the condenser.
6. The refrigerator according to any one of claims 1 to 5, further comprising:
 a fan that blows air to the condenser, wherein the condenser is of a multi-flow type having a flat tube in which a plurality of flow paths in which the refrigerant flows are formed, is of a turning-back type in which the flat tube is turned back in a width direction, and is disposed so that an inlet side for the refrigerant is located at a downstream side of an air blowing path formed by the fan.
7. The refrigerator according to any one of claims 1 to 6, further comprising:
 a fan that blows air to the condenser, wherein the fan is of a centrifugal type.
8. The refrigerator according to claim 7, wherein the condenser is formed into a curved surface shape along an outer shape of the fan.
9. The refrigerator according to any one of claims 1 to 8, wherein the heat radiation pipe is placed along an inner surface of the outer box, in the space between the outer box and the inner box, and radiated heat from the condenser is used in prevention of dew condensation.
10. The refrigerator according to any one of claims 1 to 9, wherein the condenser is of a multi-flow type having a flat tube in which a plurality of flow paths in which the refrigerant flows are formed, is of a meandering type in which the flat tube meanders by being folded in a thickness direction, and is formed into a stepped shape, an inclined shape or a shape including both of a step and an inclination by changing turn lengths of the flat tube.
11. The refrigerator according to any one of claims 1 to 9, wherein the condenser is of a multi-flow type having a flat tube in which a plurality of flow paths in which the refrigerant flows are formed, and is of a parallel type in which a plurality of the flat tubes are disposed in parallel, and is formed into a stepped shape, an inclined shape or a shape including both of a step and an inclination by changing lengths of the flat tubes.
12. The refrigerator according to any one of claims 1 to 11, further comprising:
 a sub-condenser having a smaller heat radiation ability than the condenser, wherein the heat radiation pipe connects the sub-condenser and the condenser.

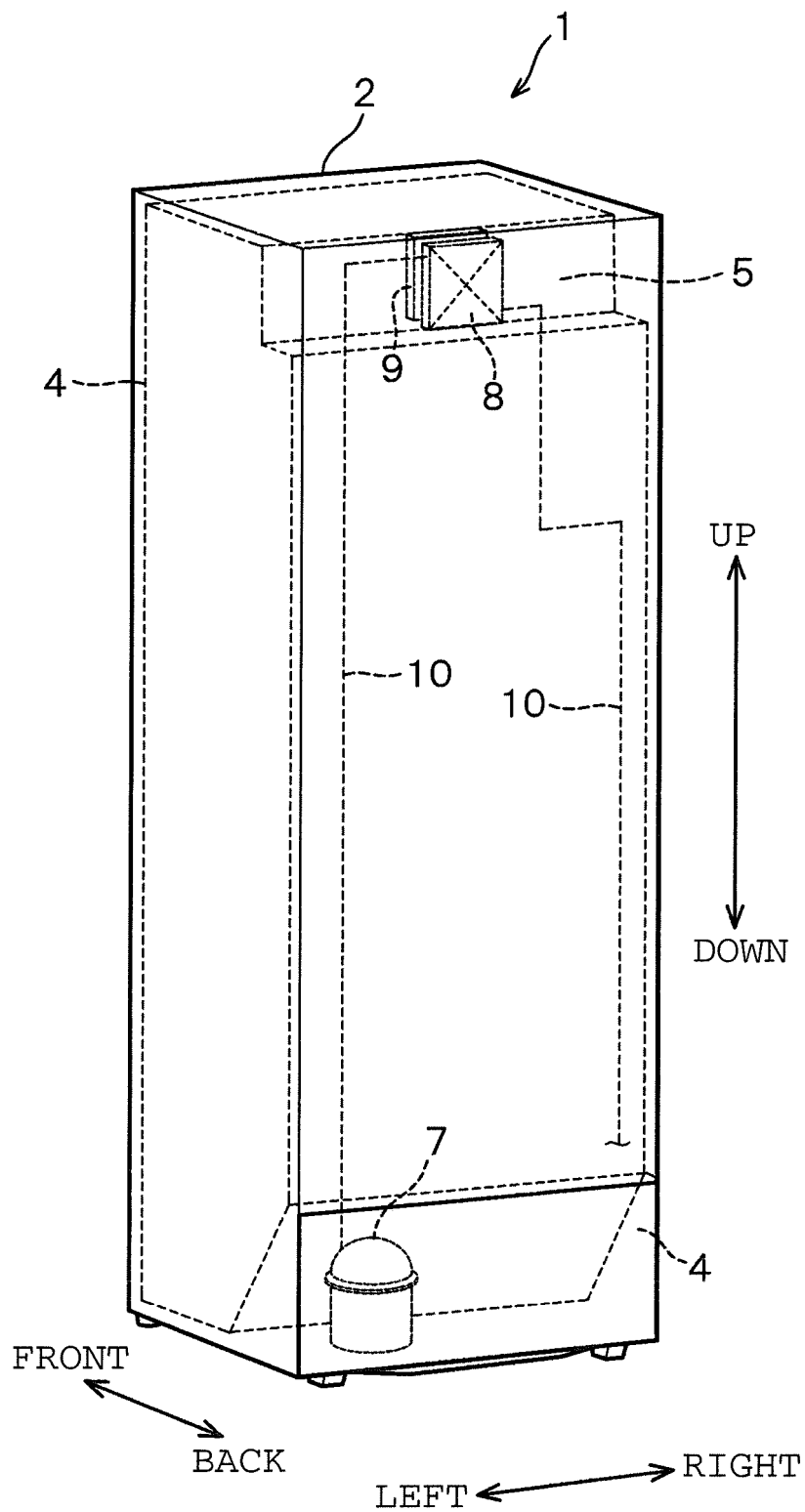


FIG. 1

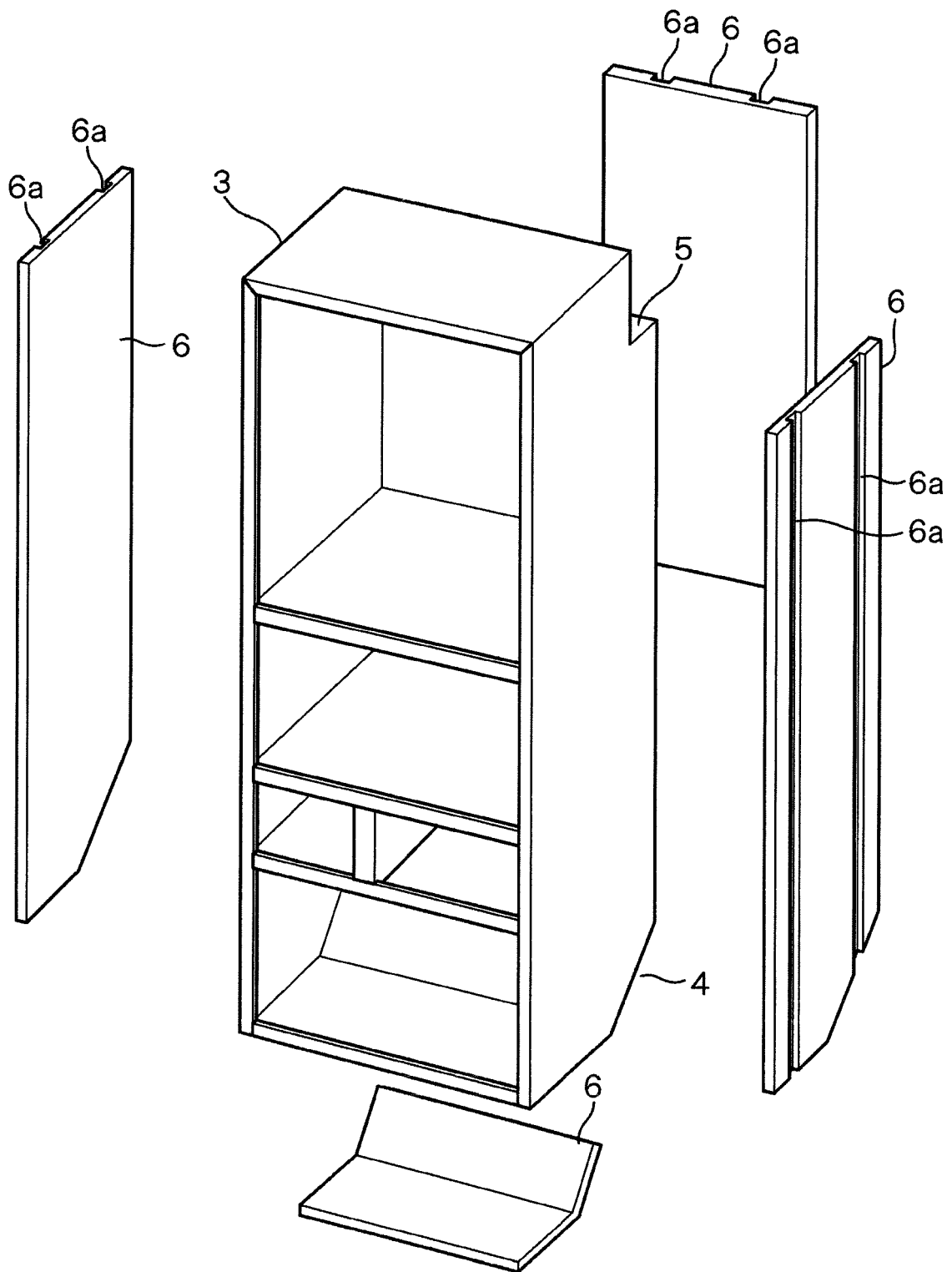


FIG. 2

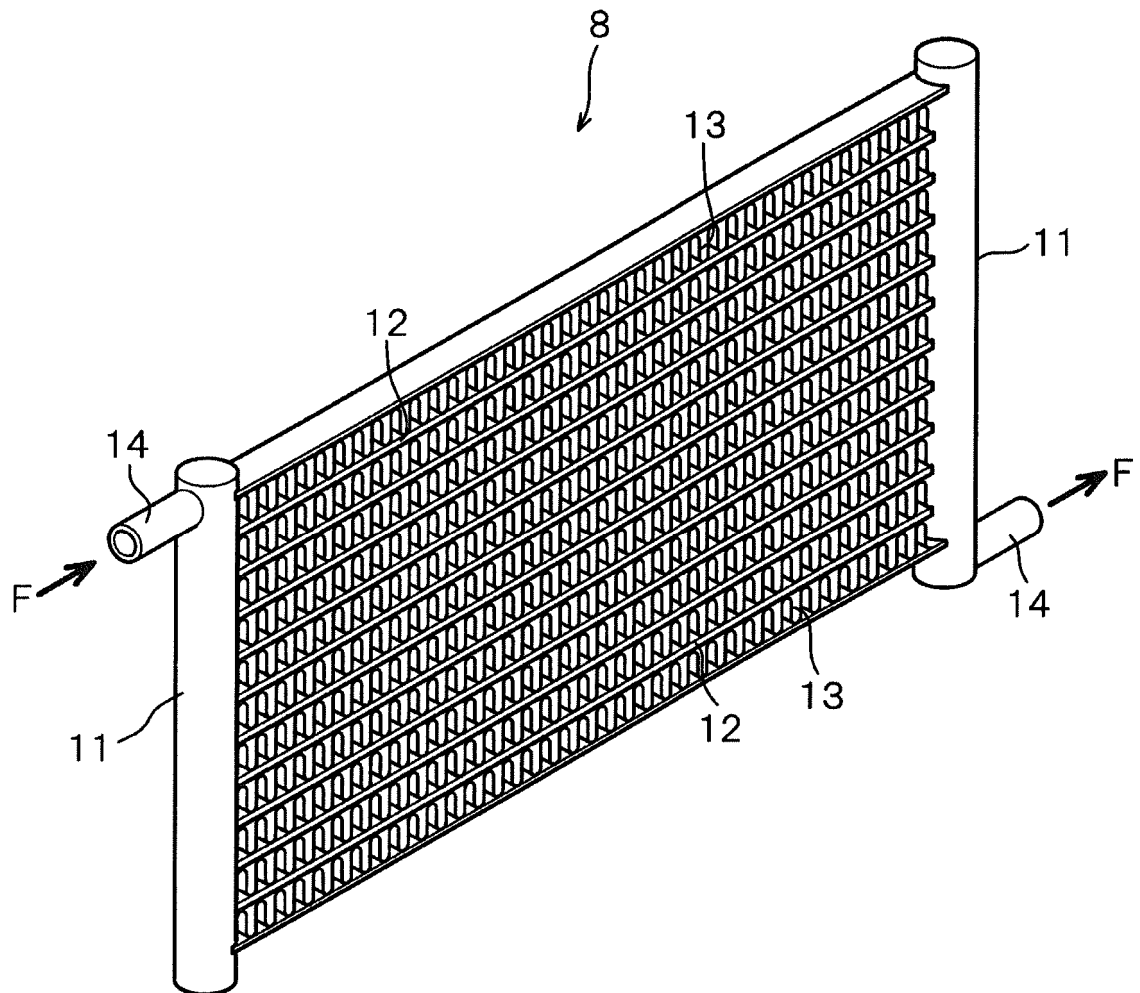


FIG. 3

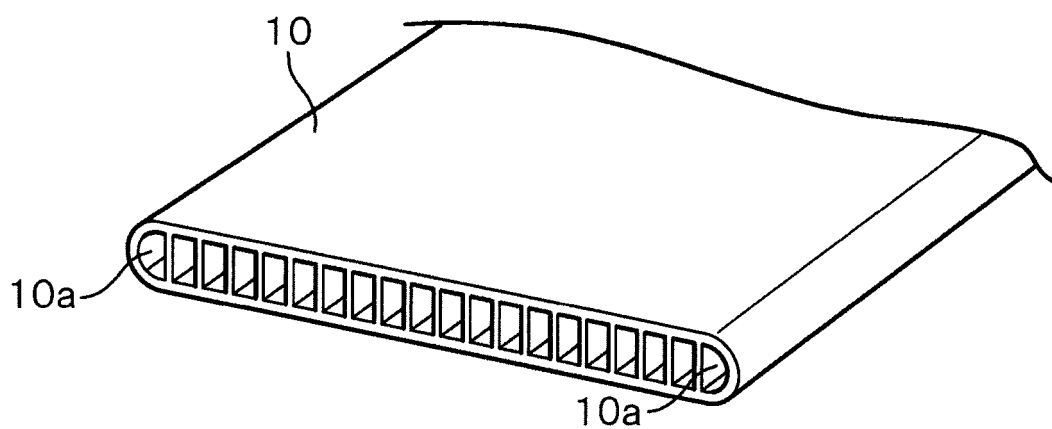


FIG. 4

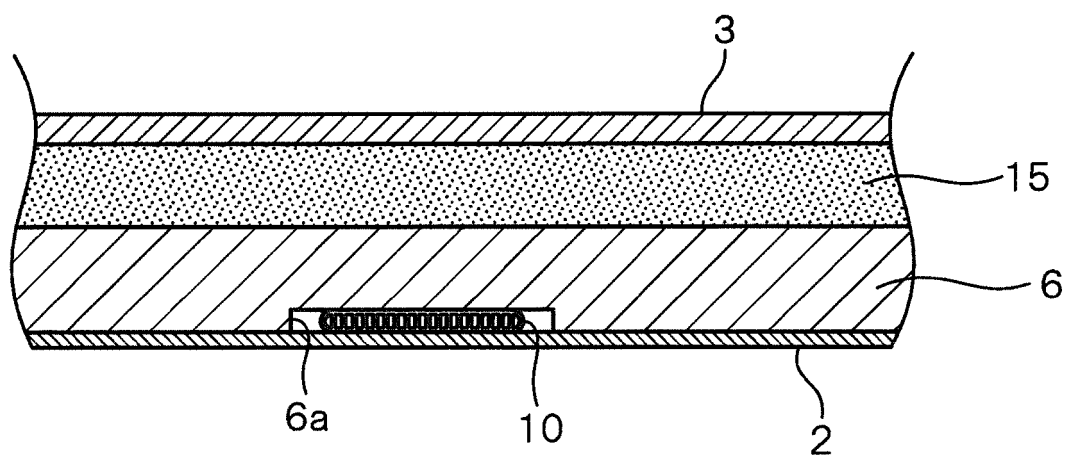


FIG. 5

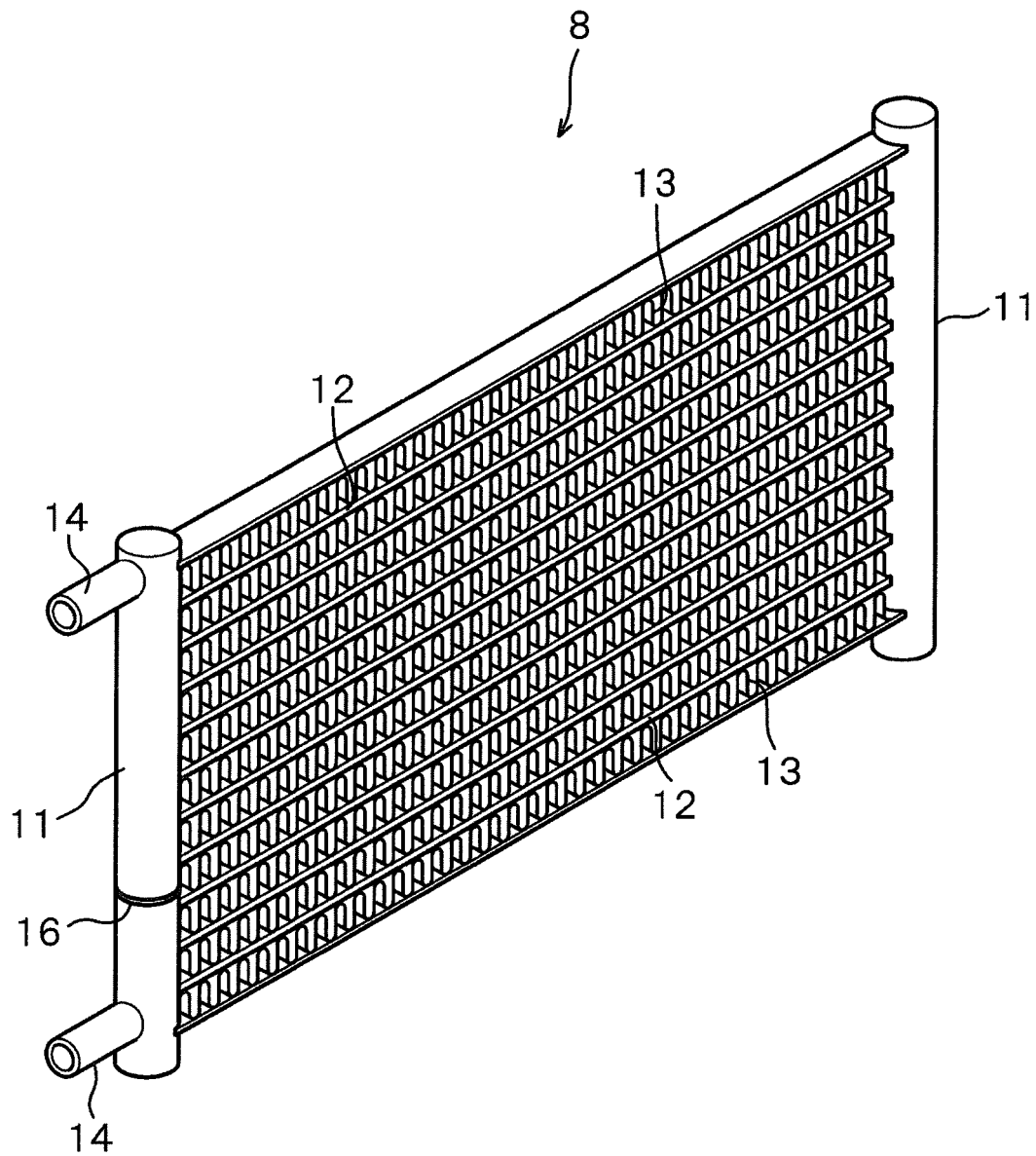


FIG. 6

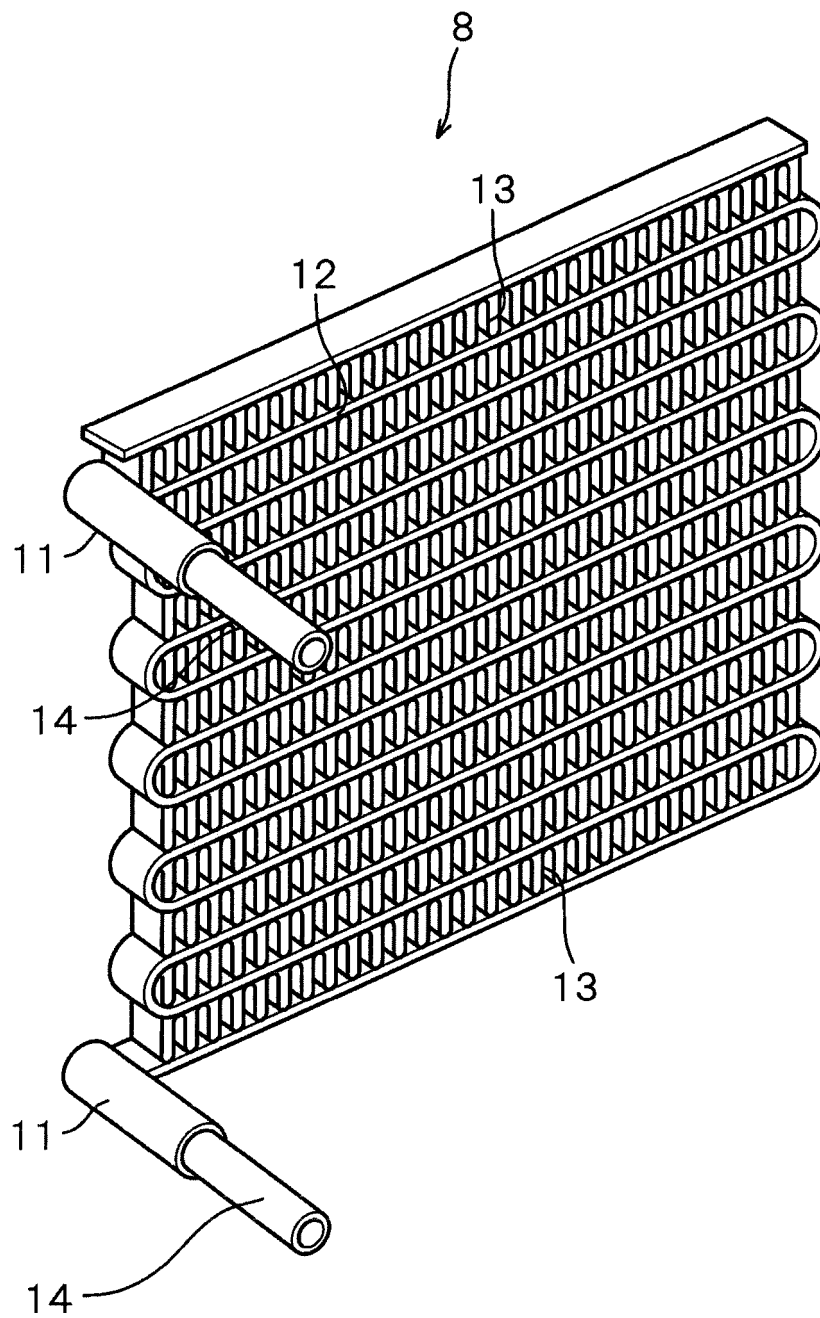


FIG. 7

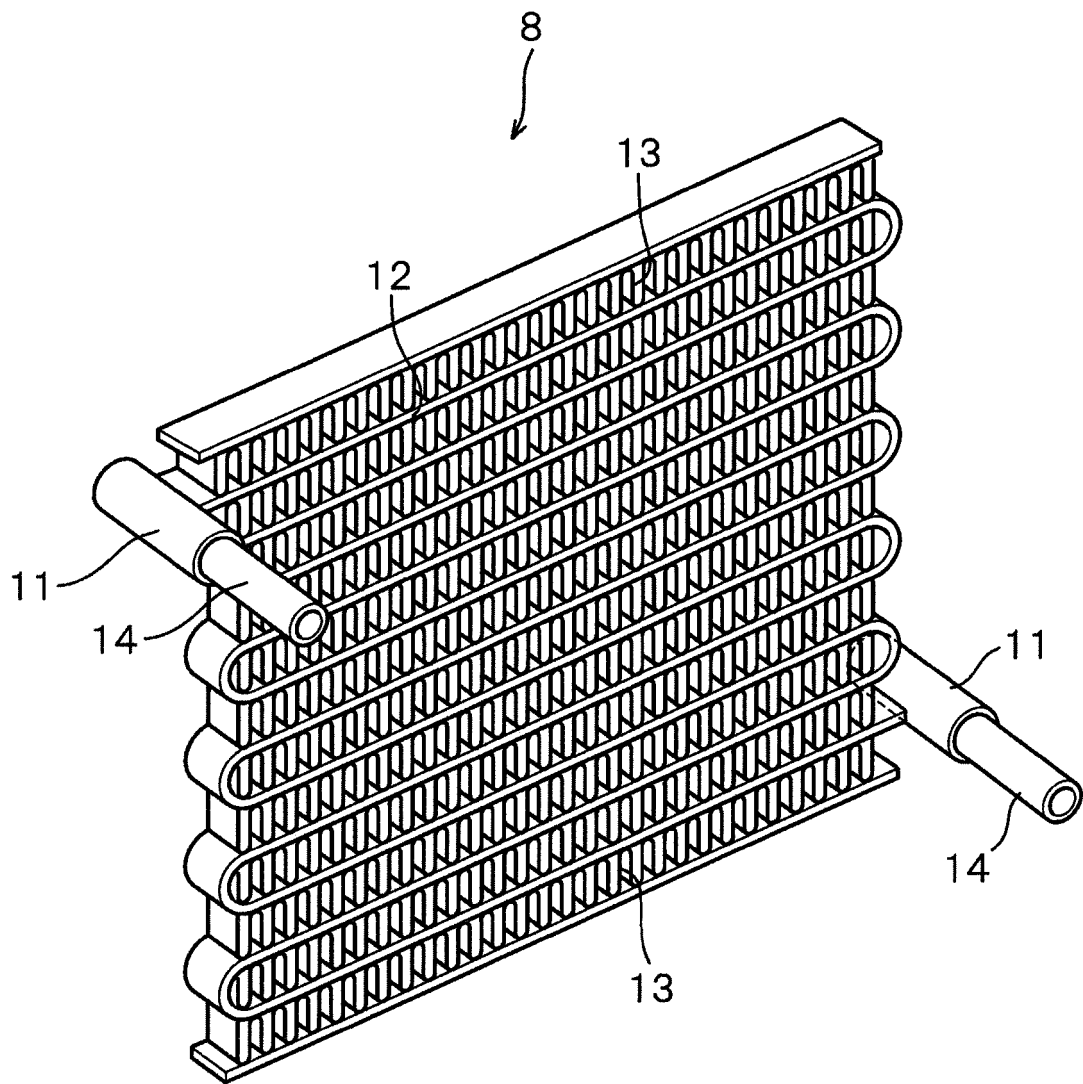


FIG. 8

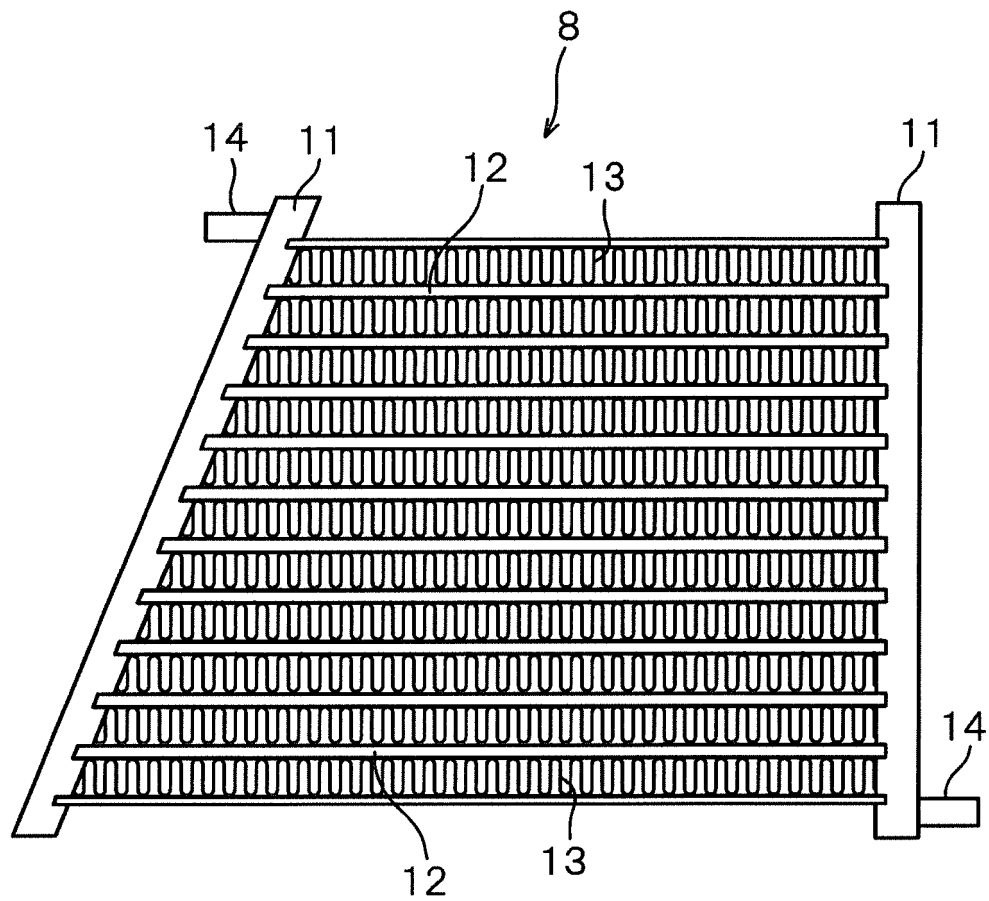


FIG. 9

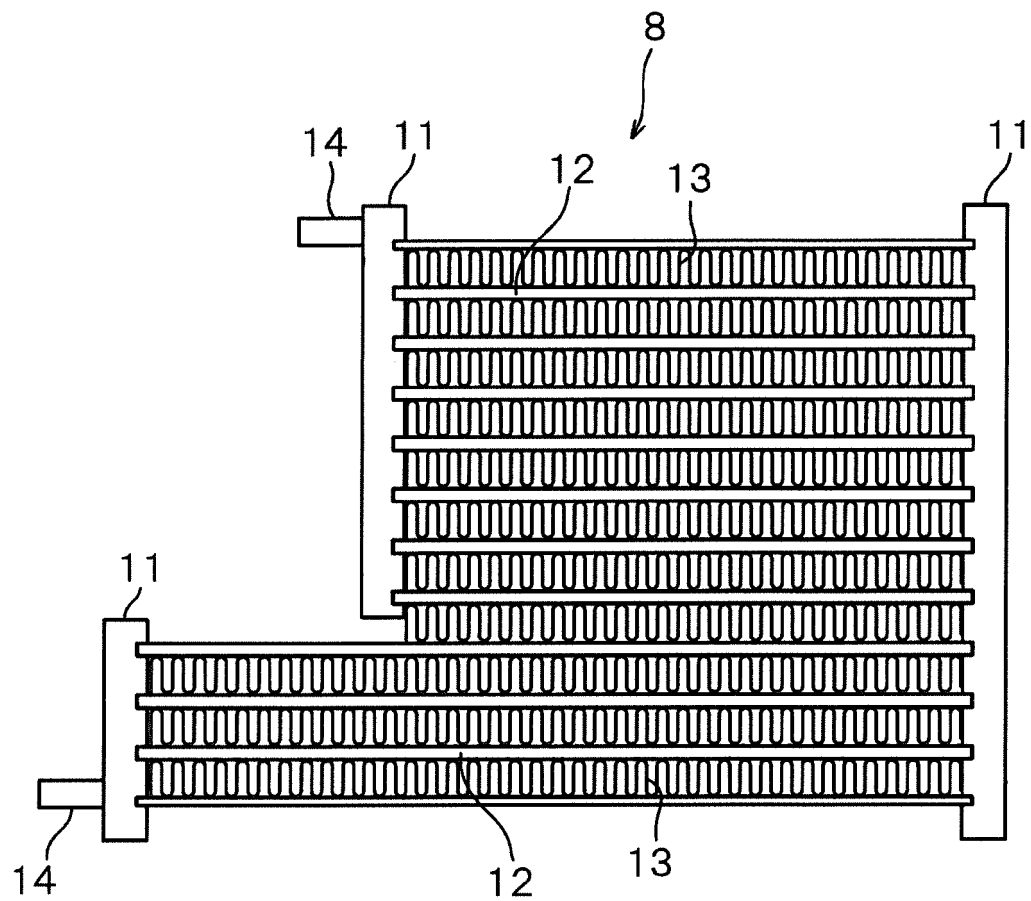


FIG. 10

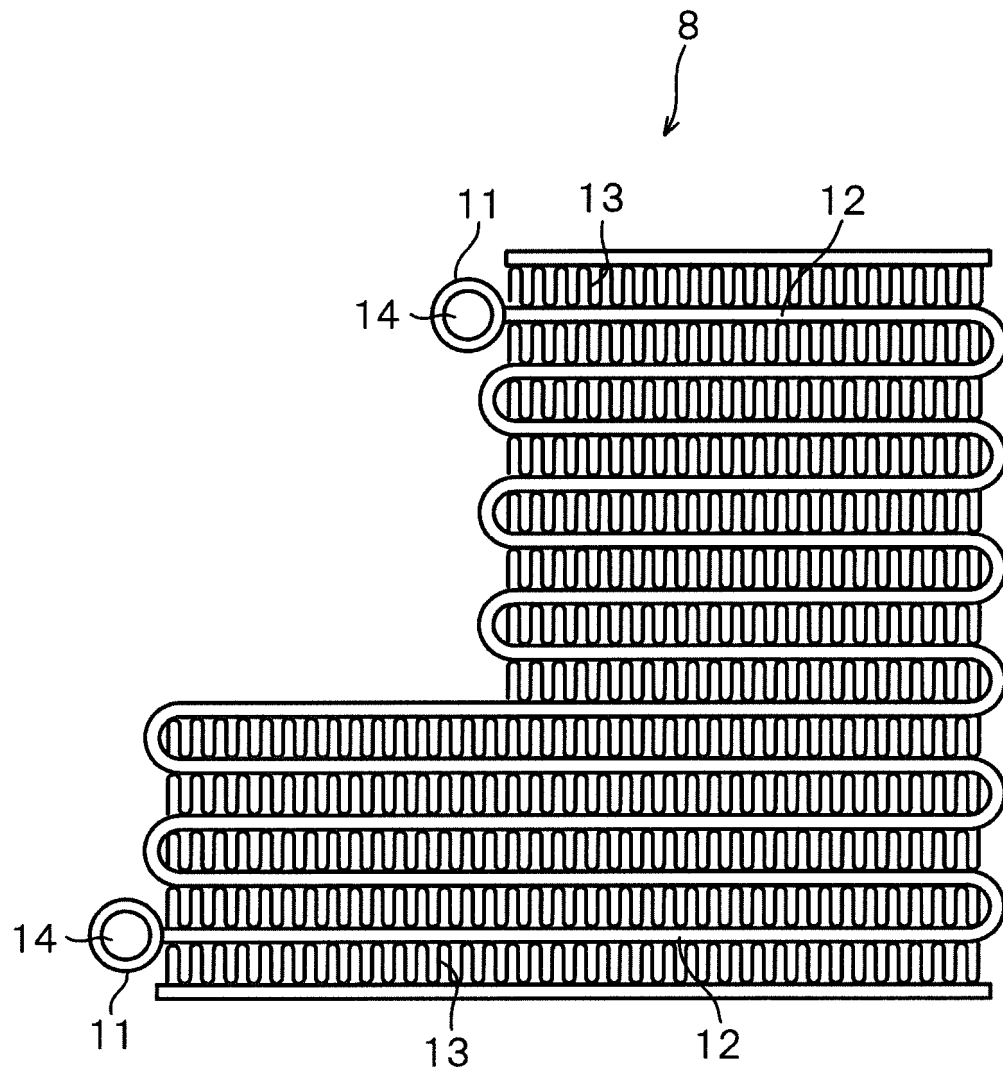


FIG. 11

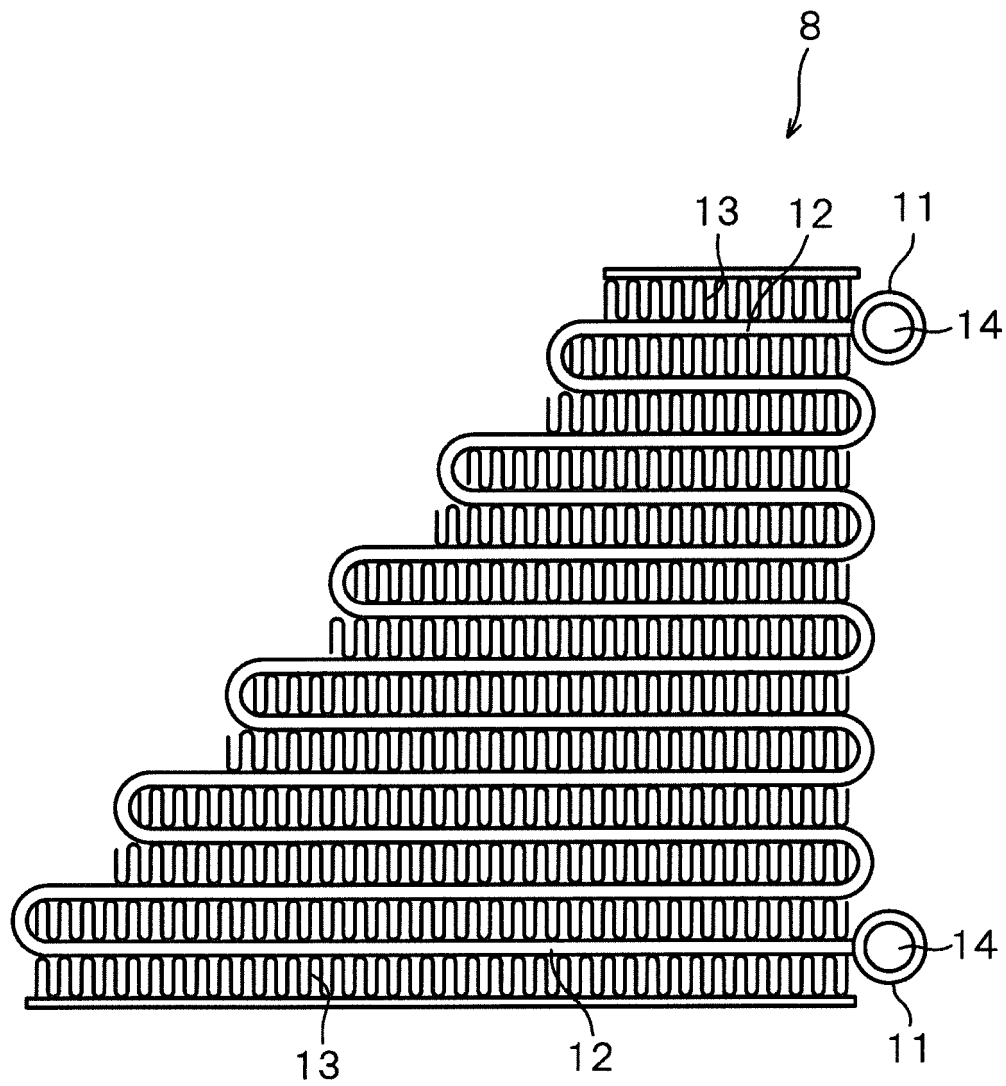


FIG. 12

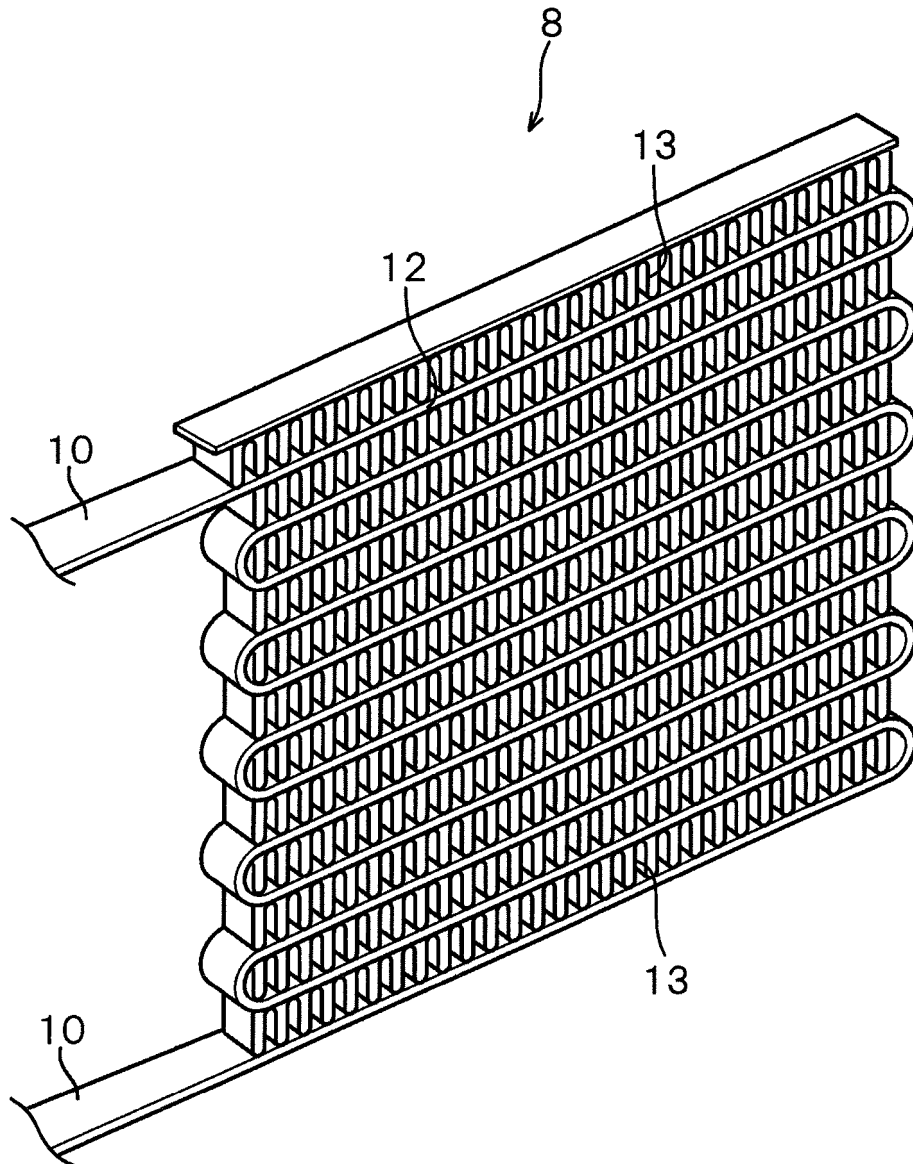


FIG. 13

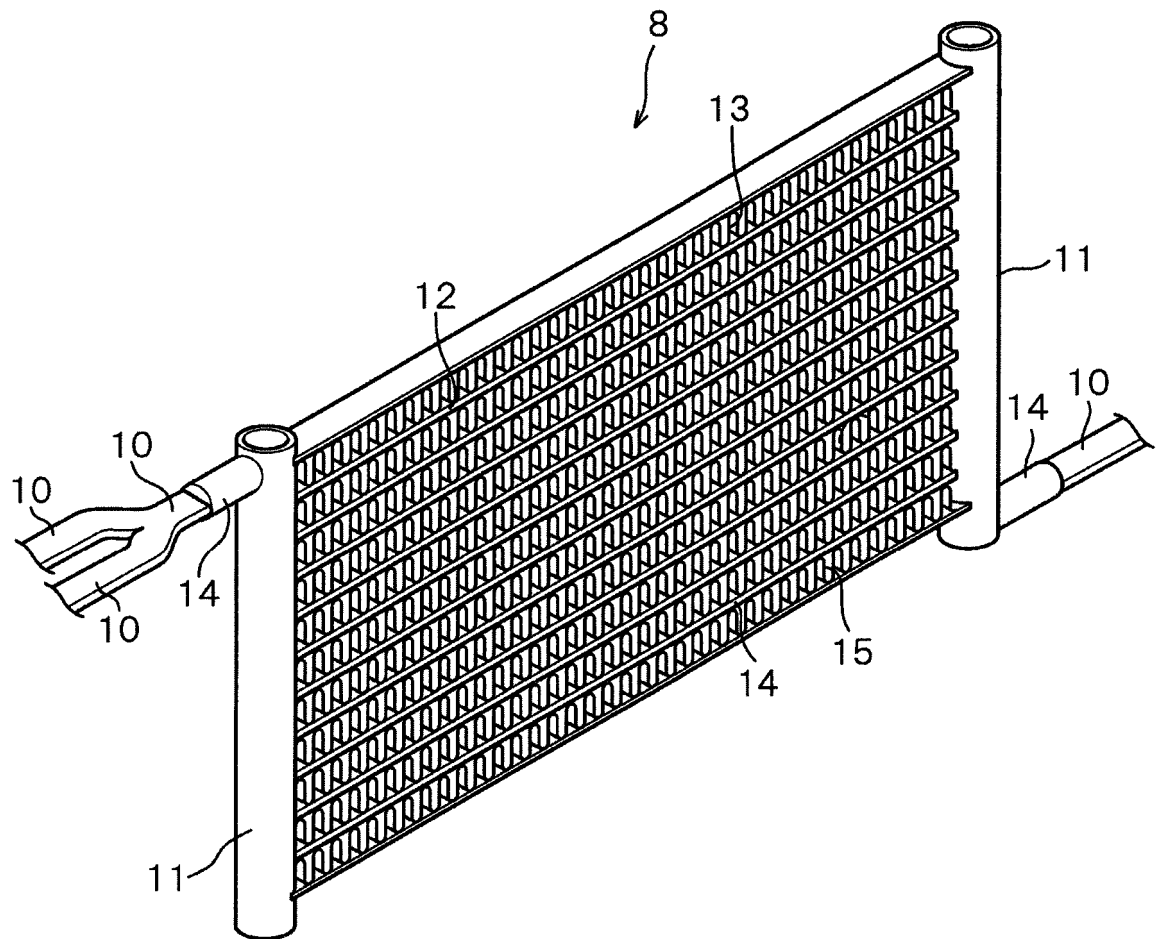


FIG. 14

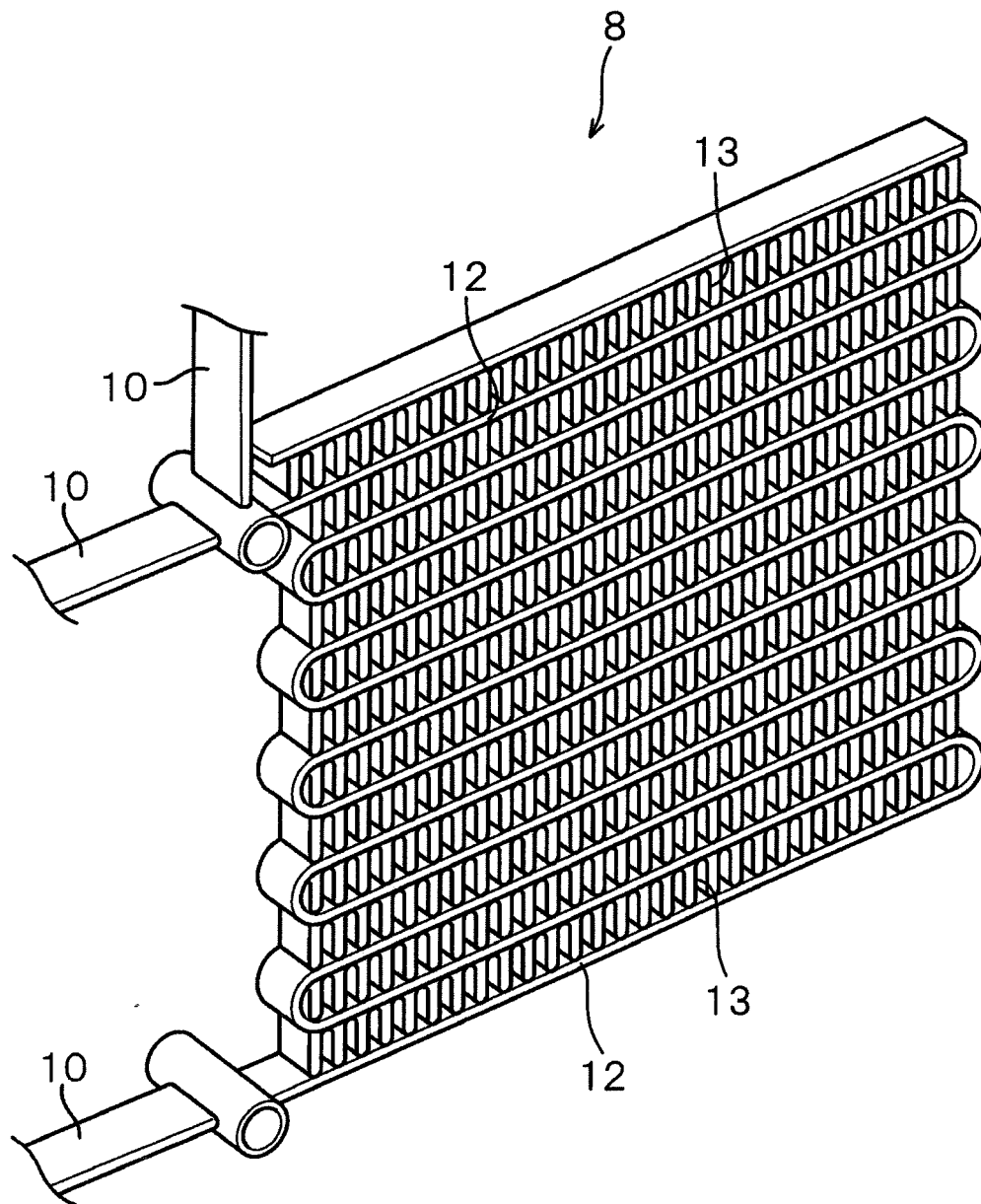


FIG. 15

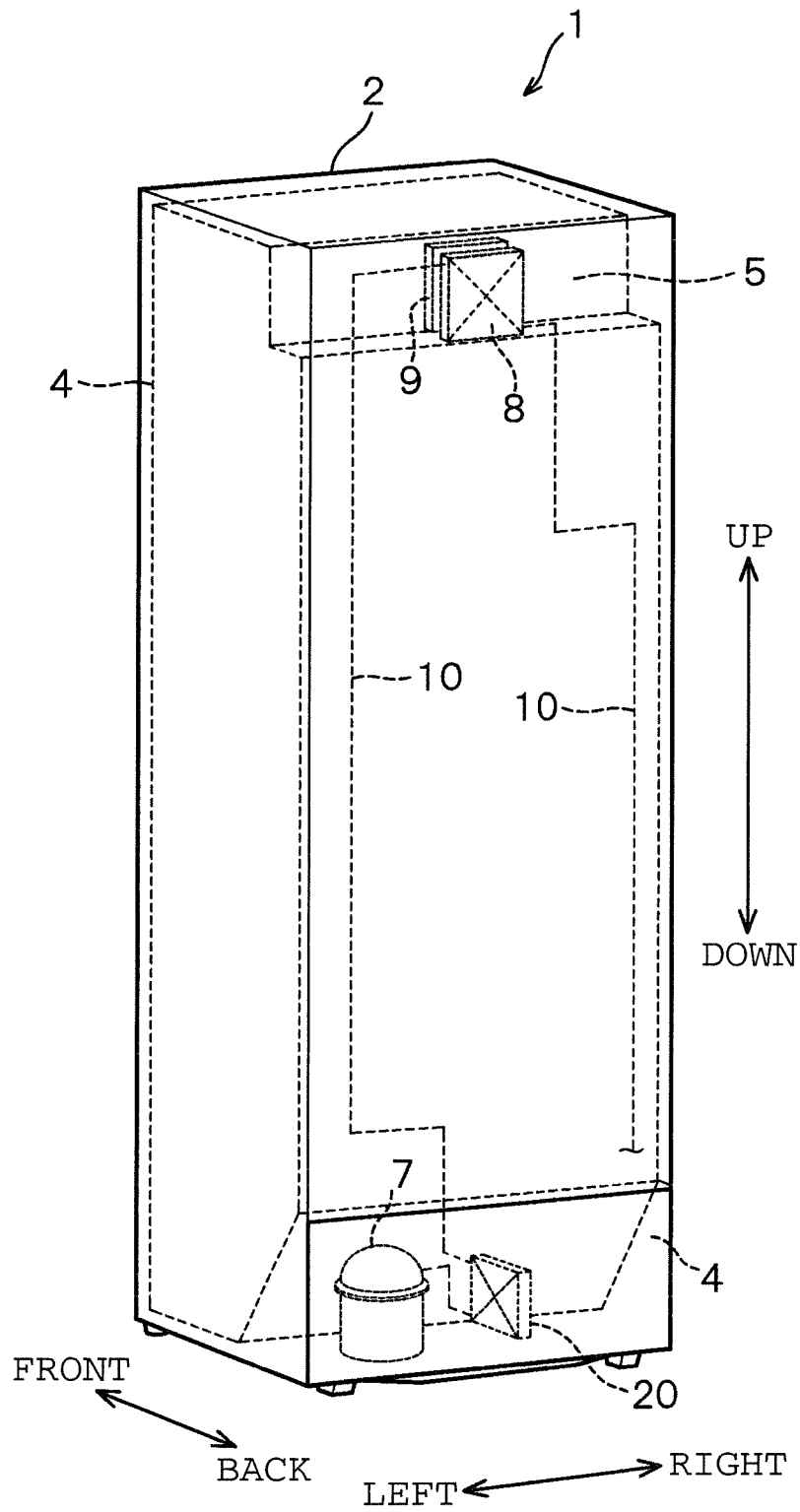


FIG. 16

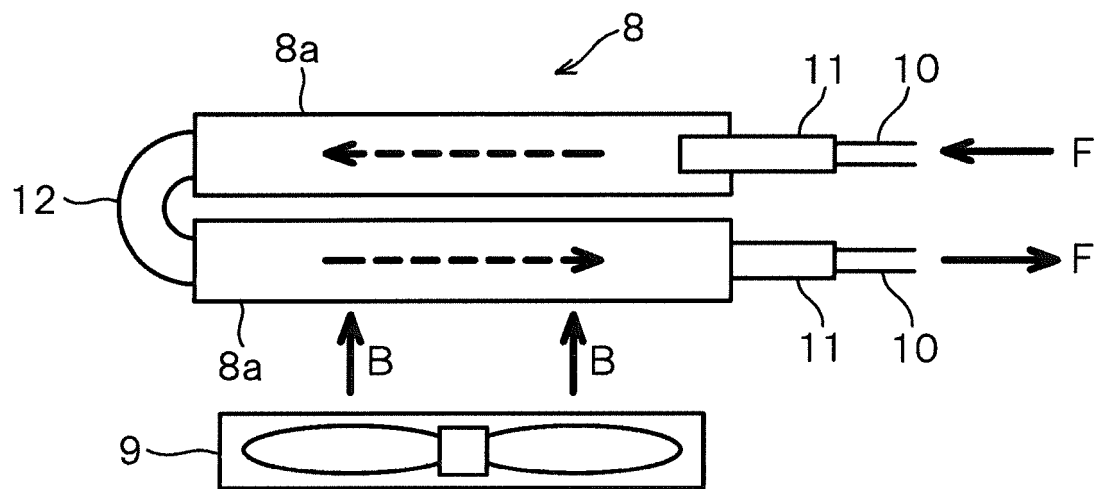


FIG. 17

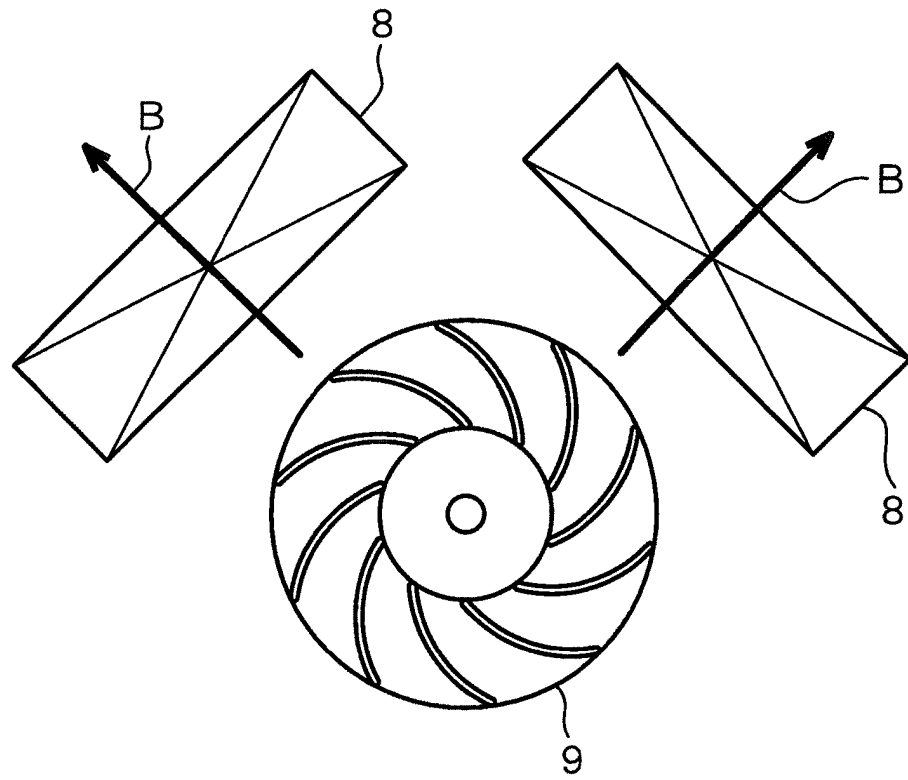


FIG. 18

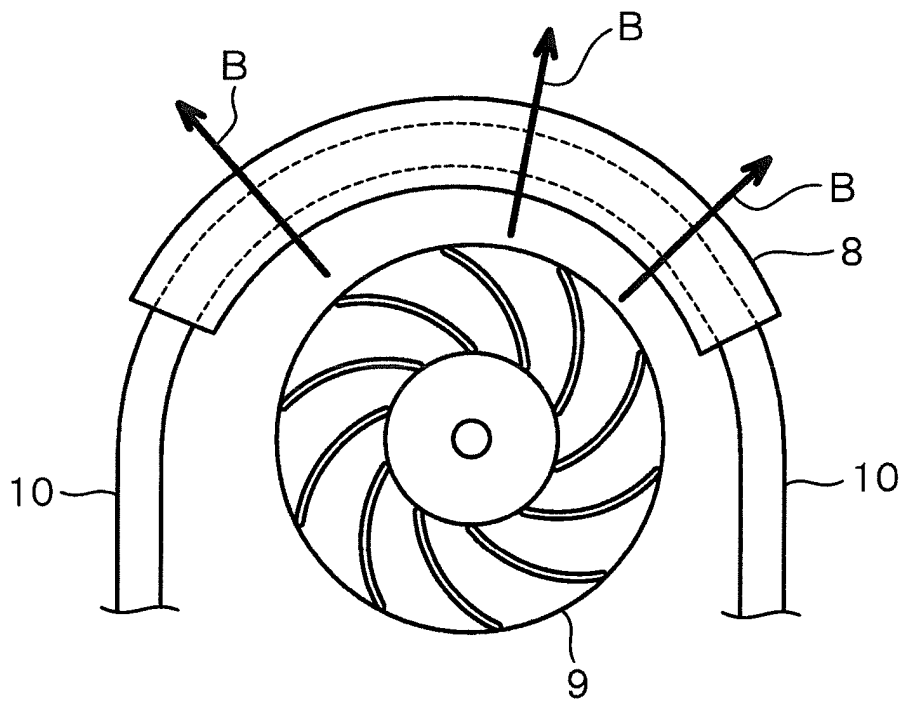


FIG. 19

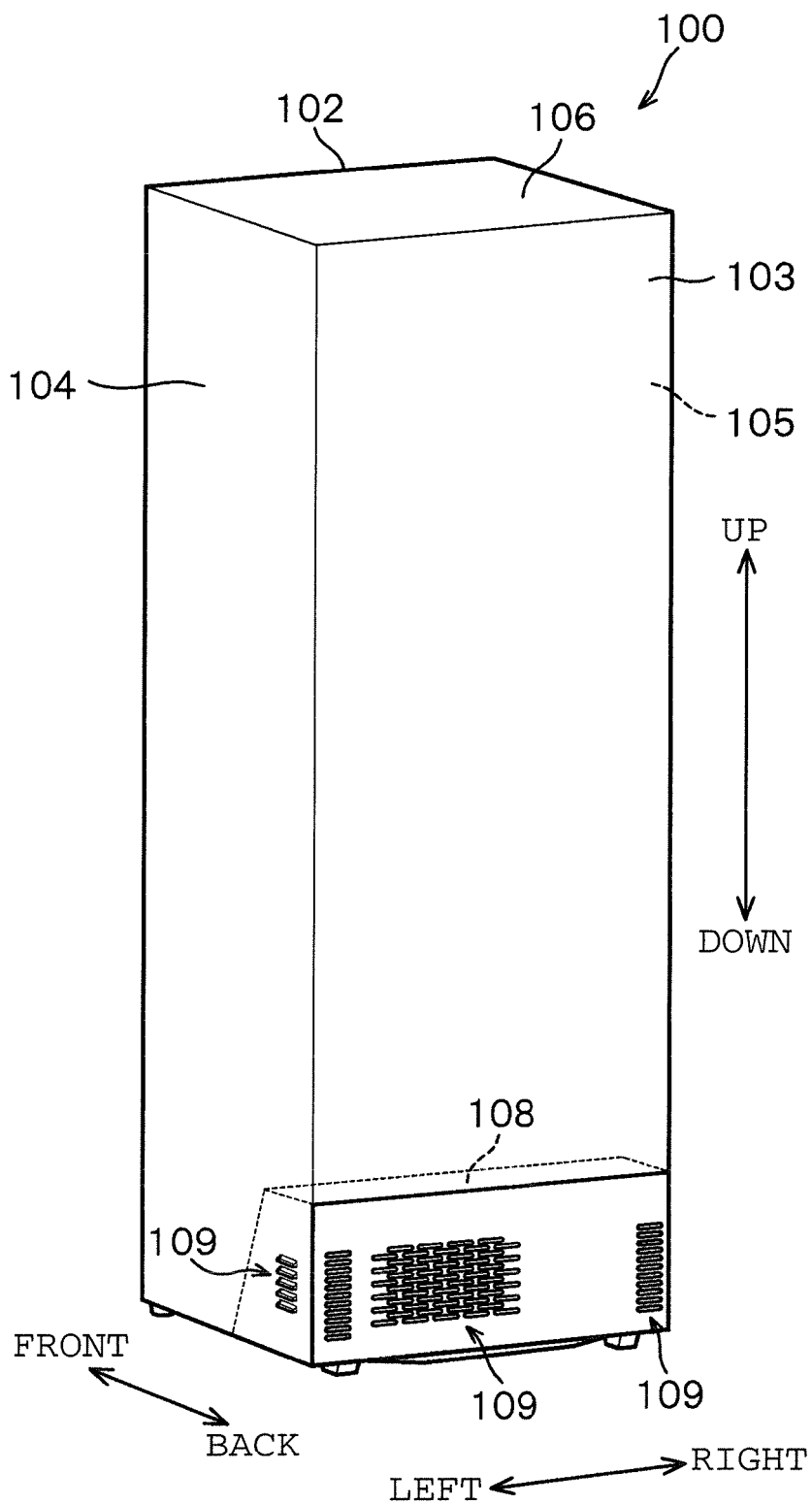


FIG. 20

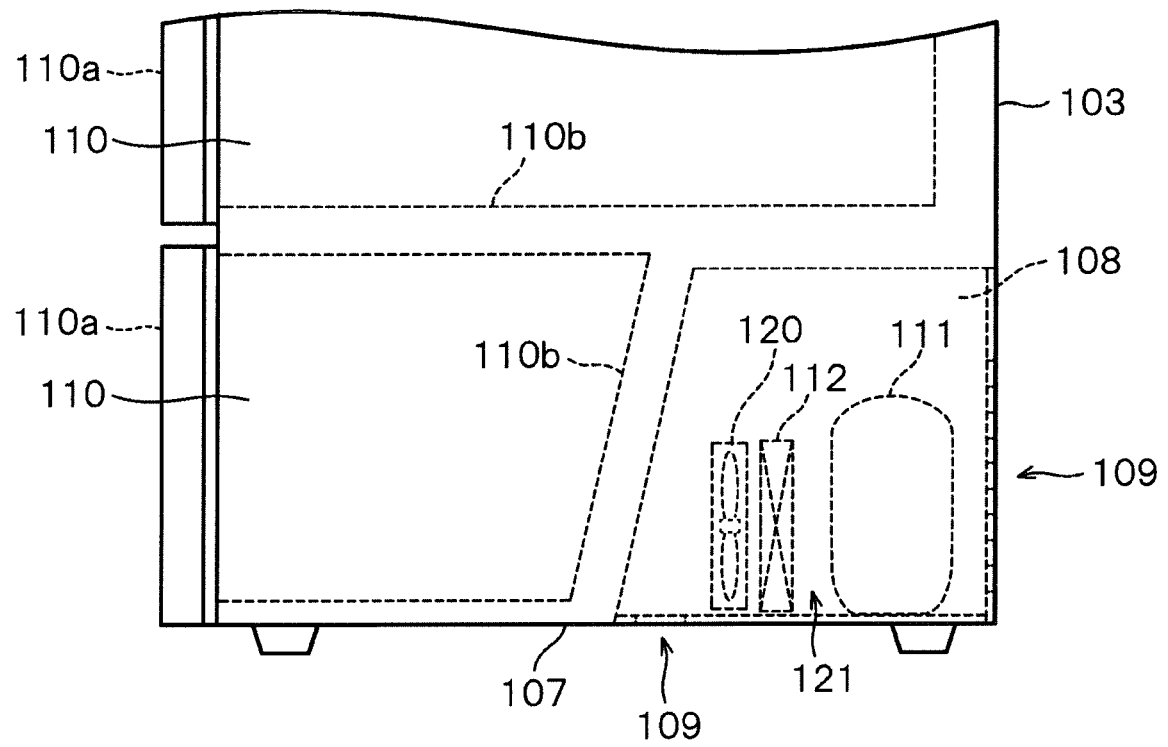


FIG. 21

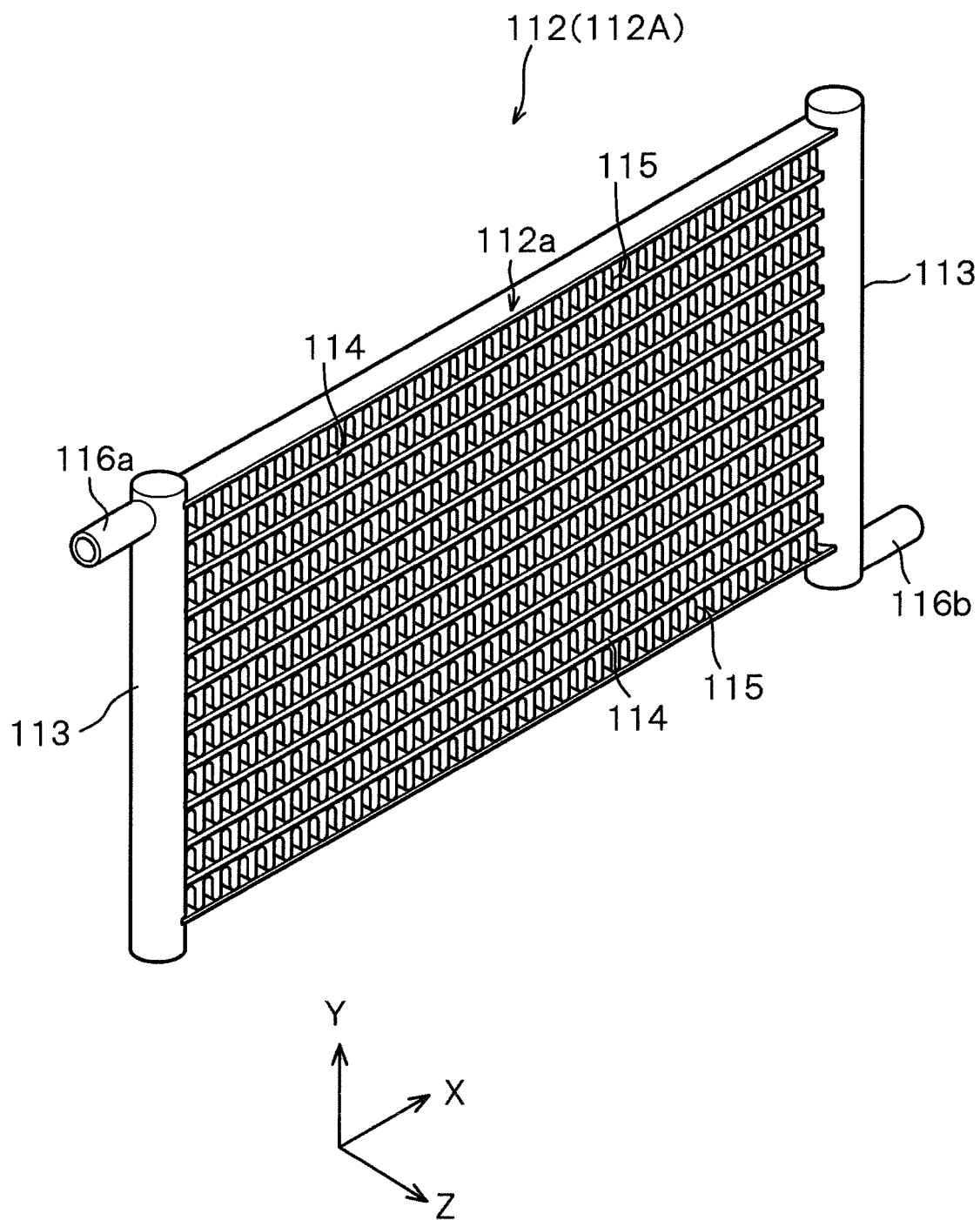


FIG. 22

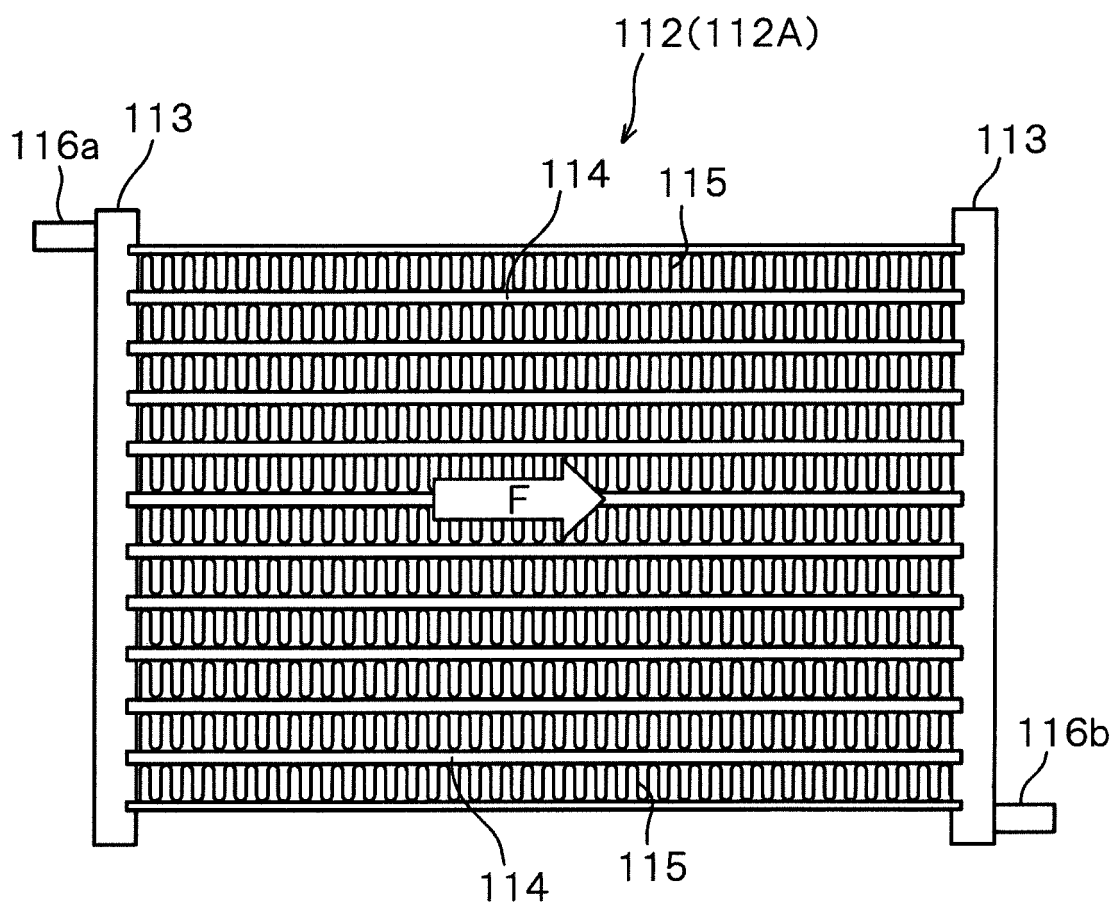


FIG. 23

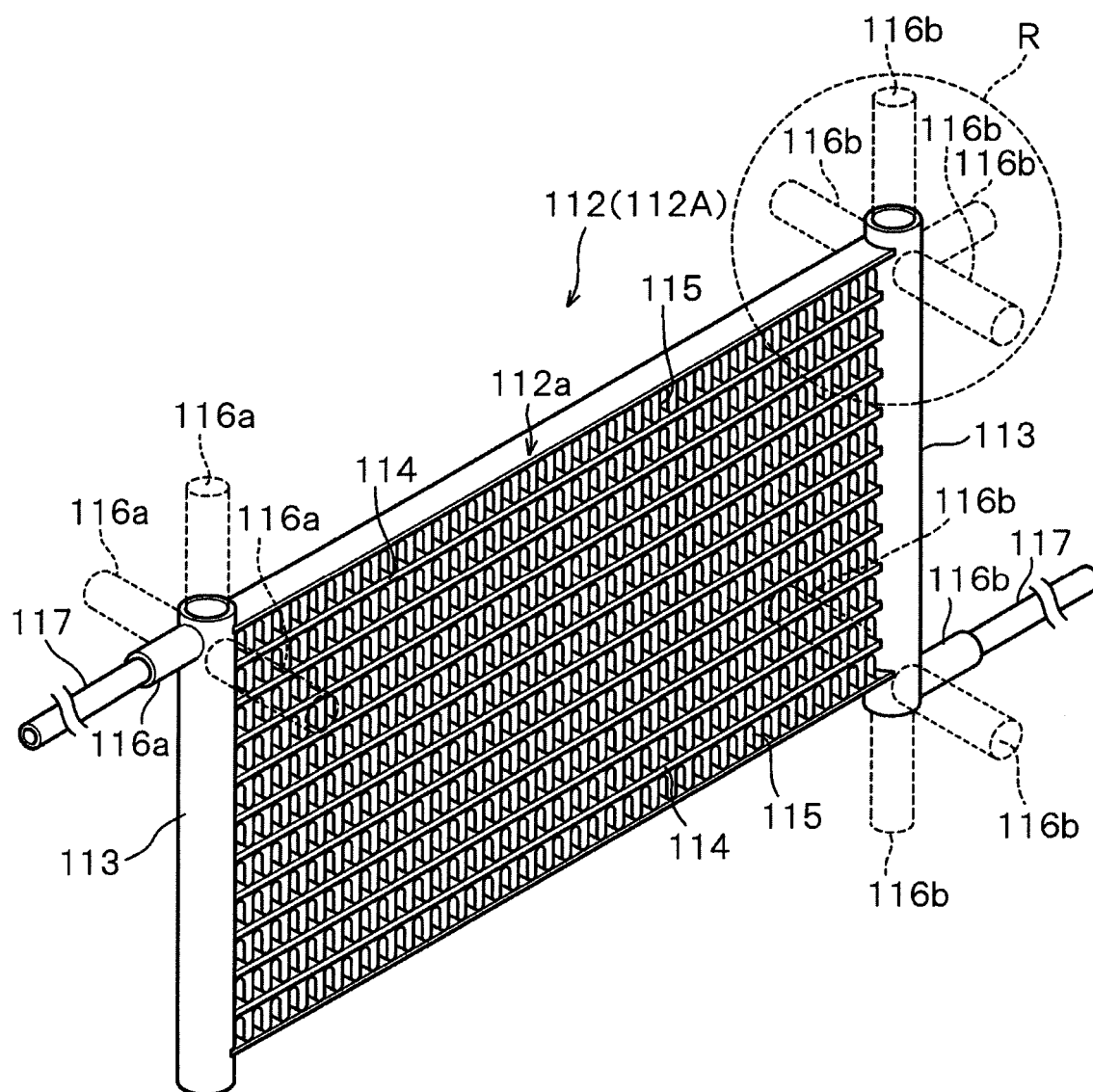


FIG. 24

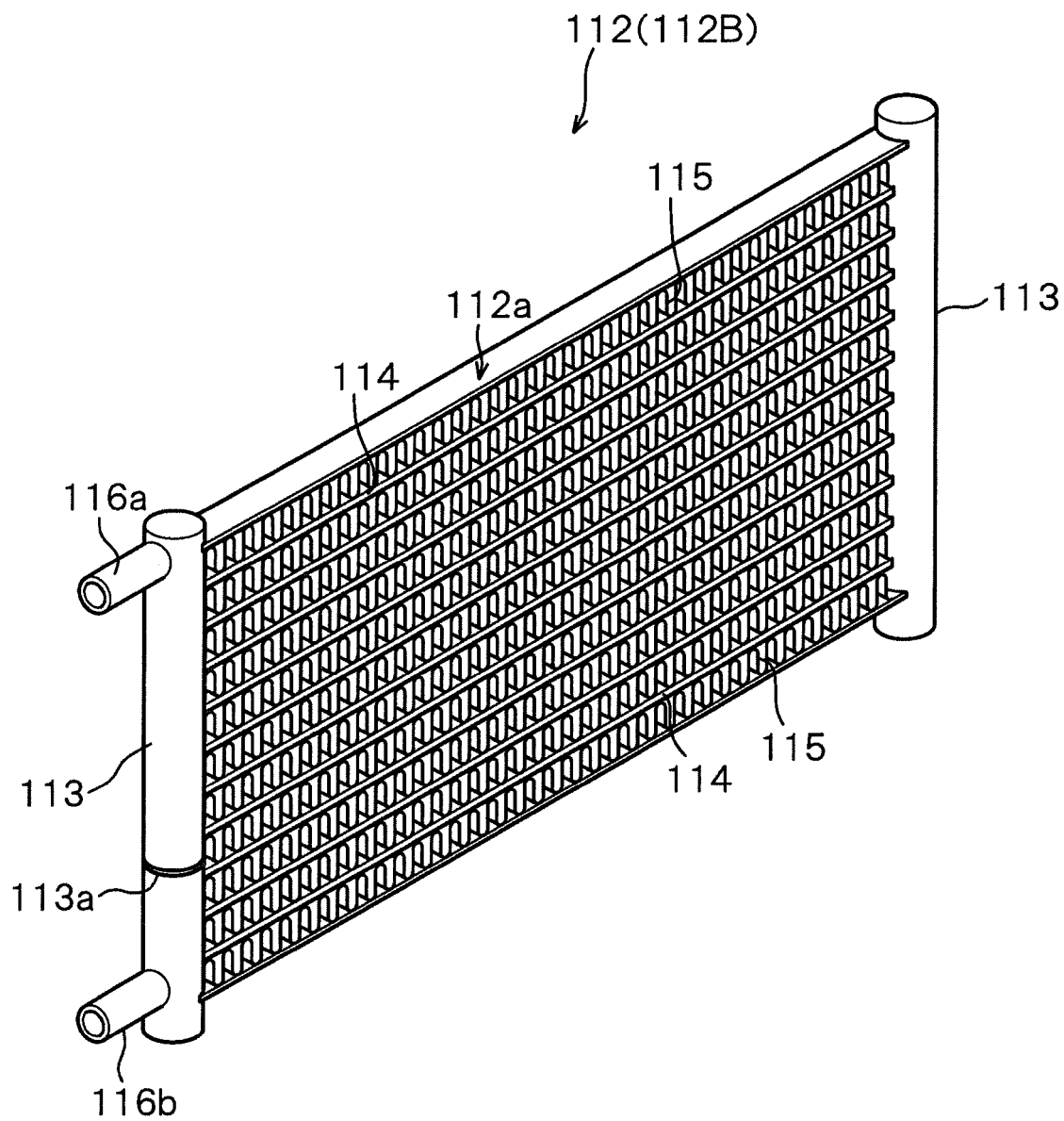


FIG. 25

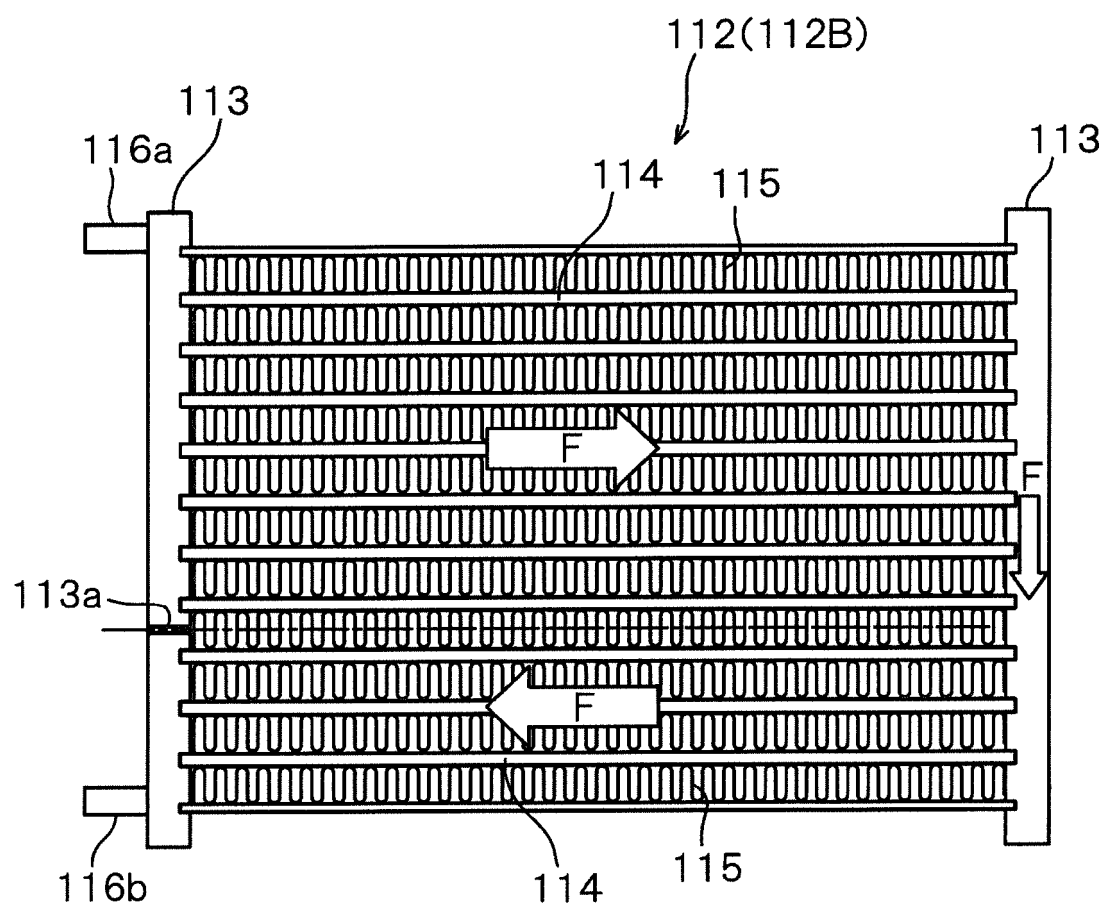


FIG. 26

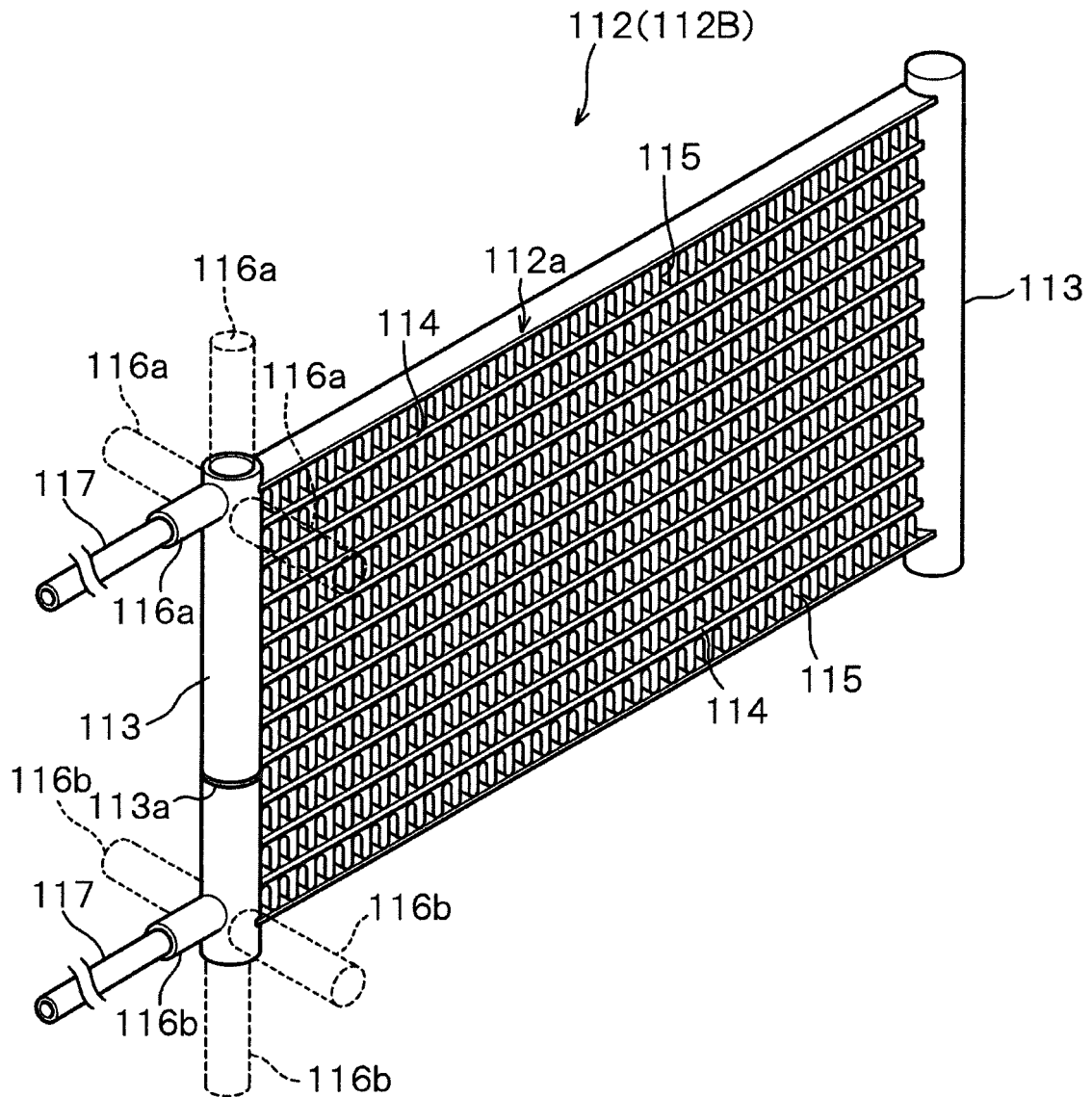


FIG. 27

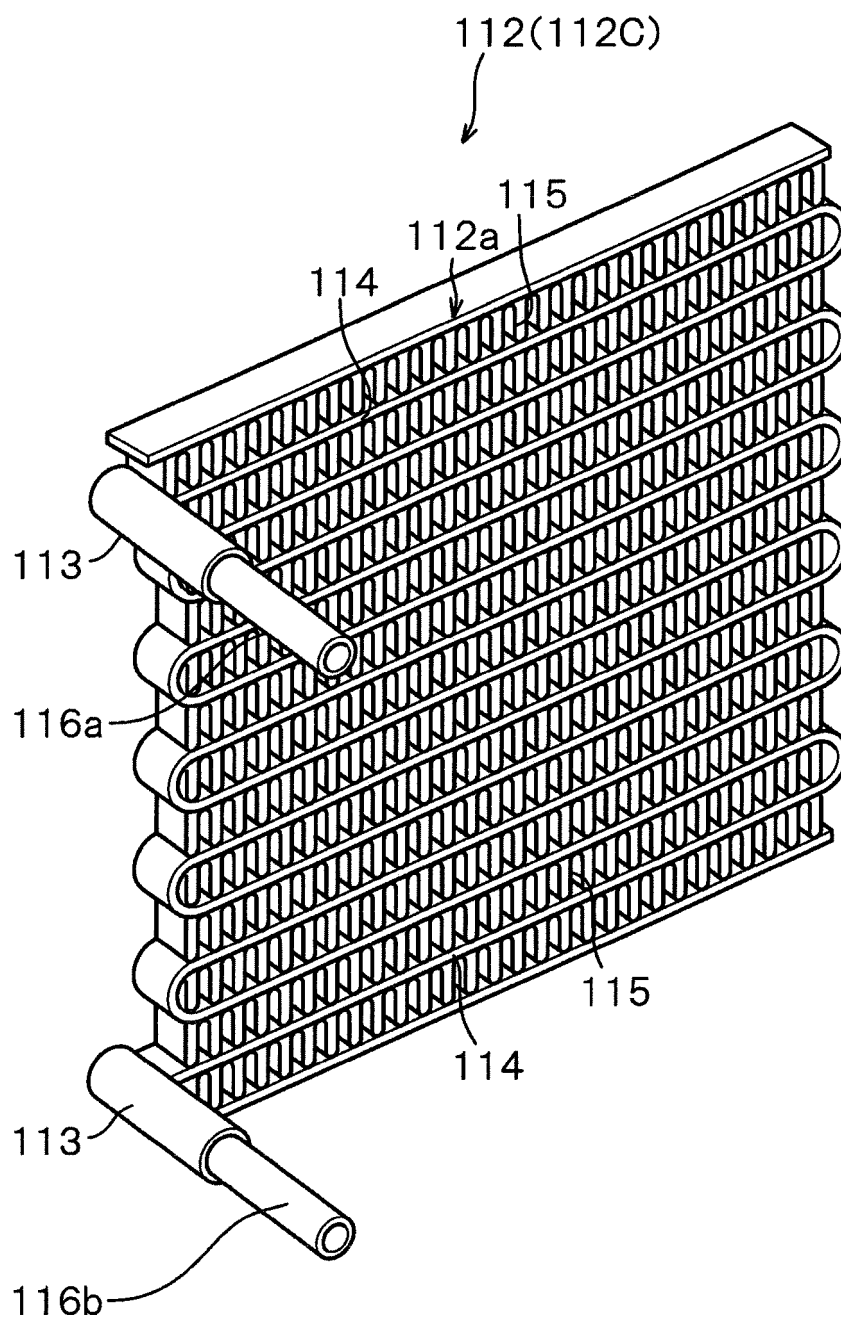


FIG. 28

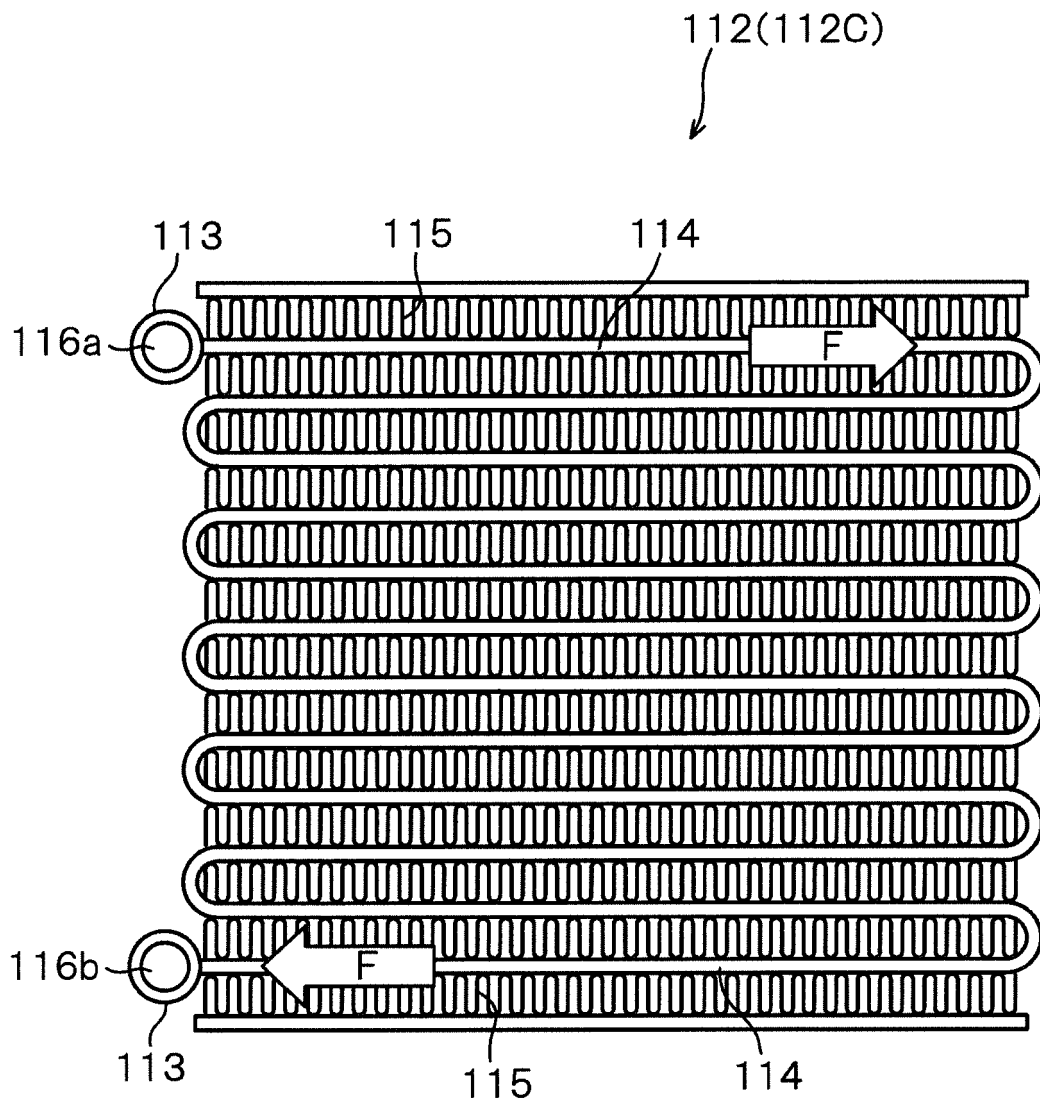


FIG. 29

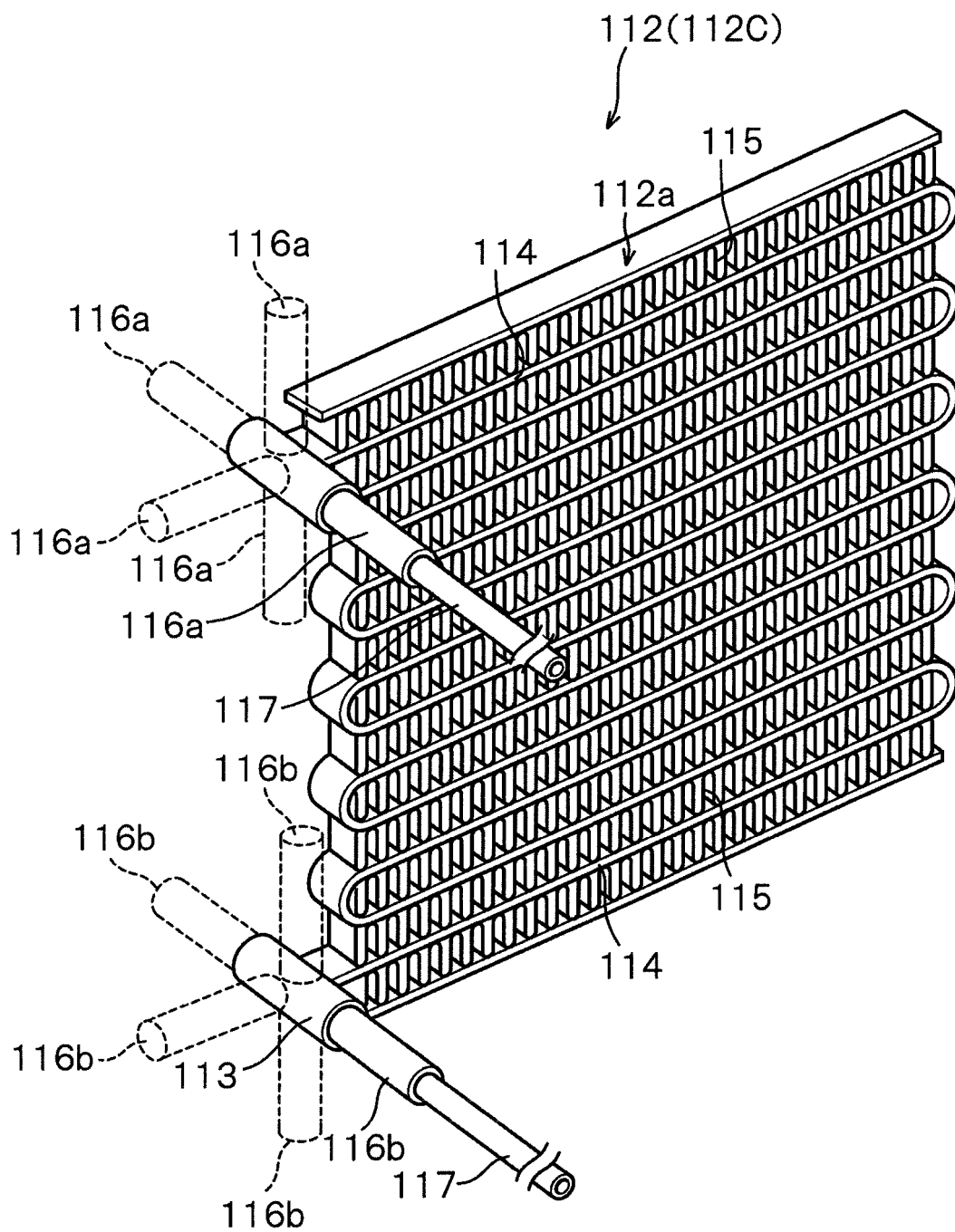


FIG. 30

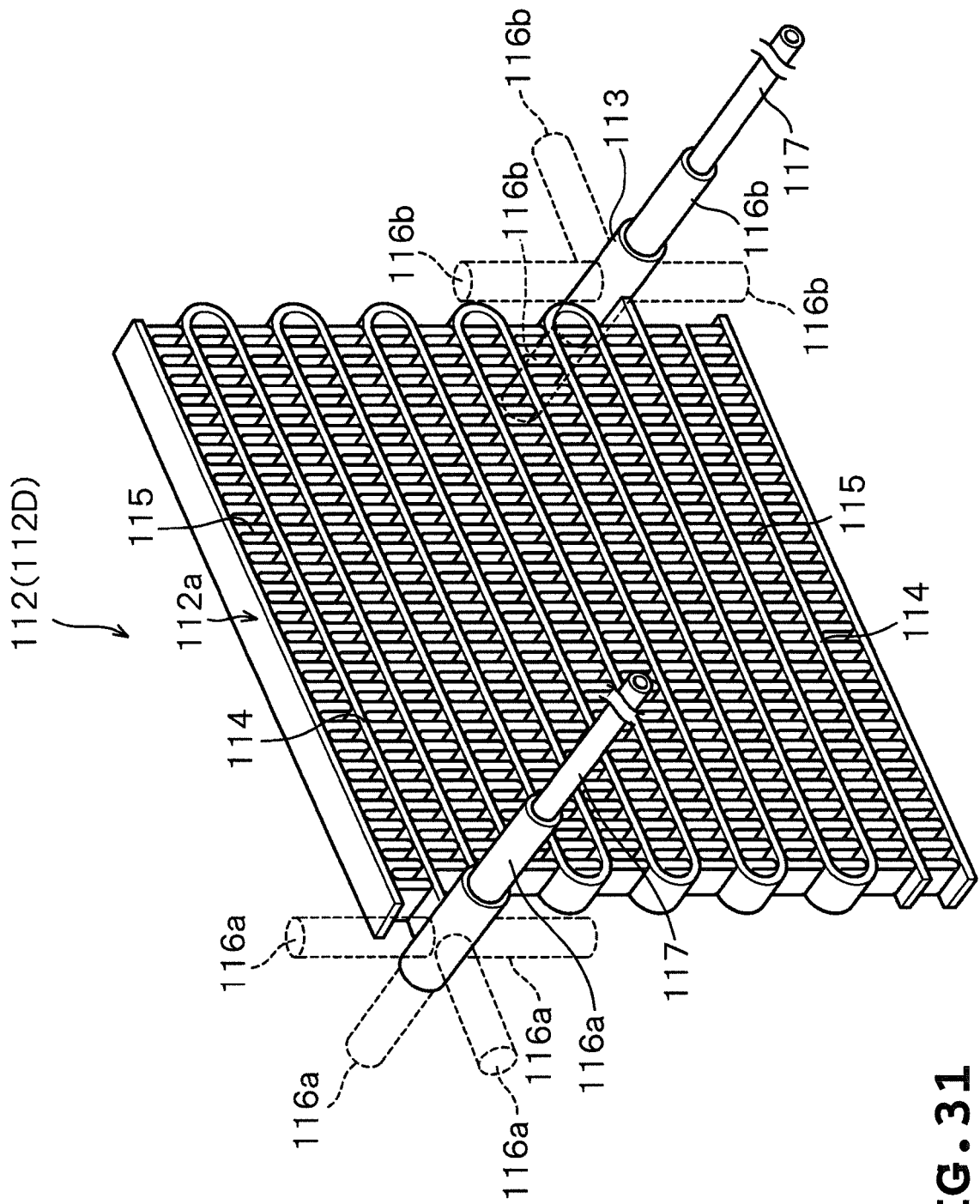
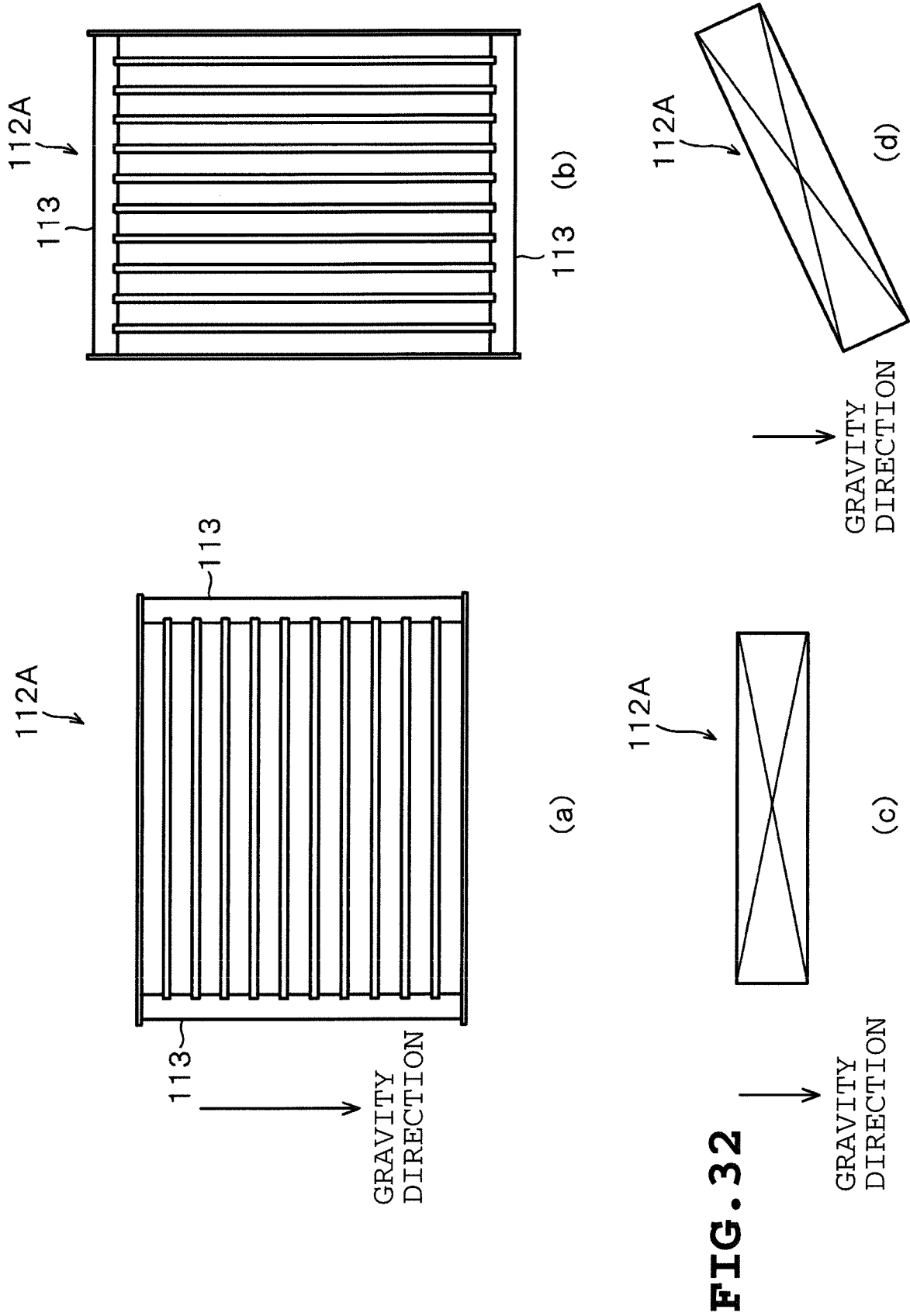


FIG. 31



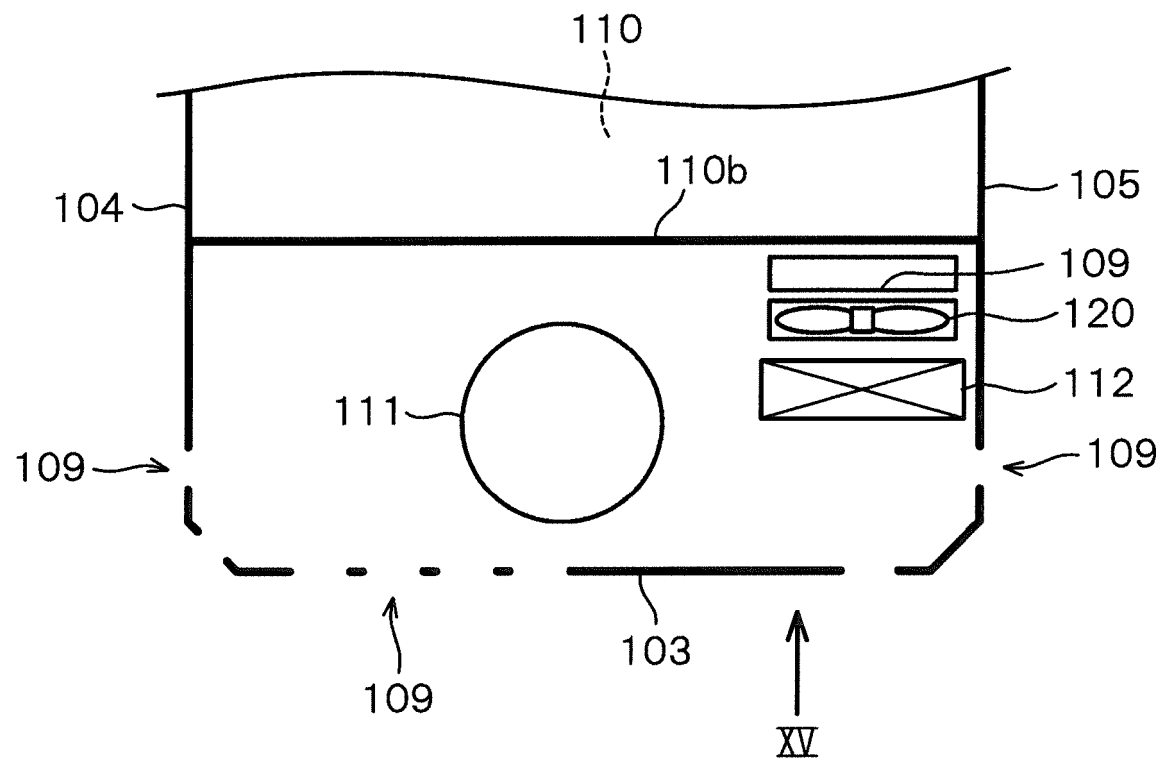


FIG. 33

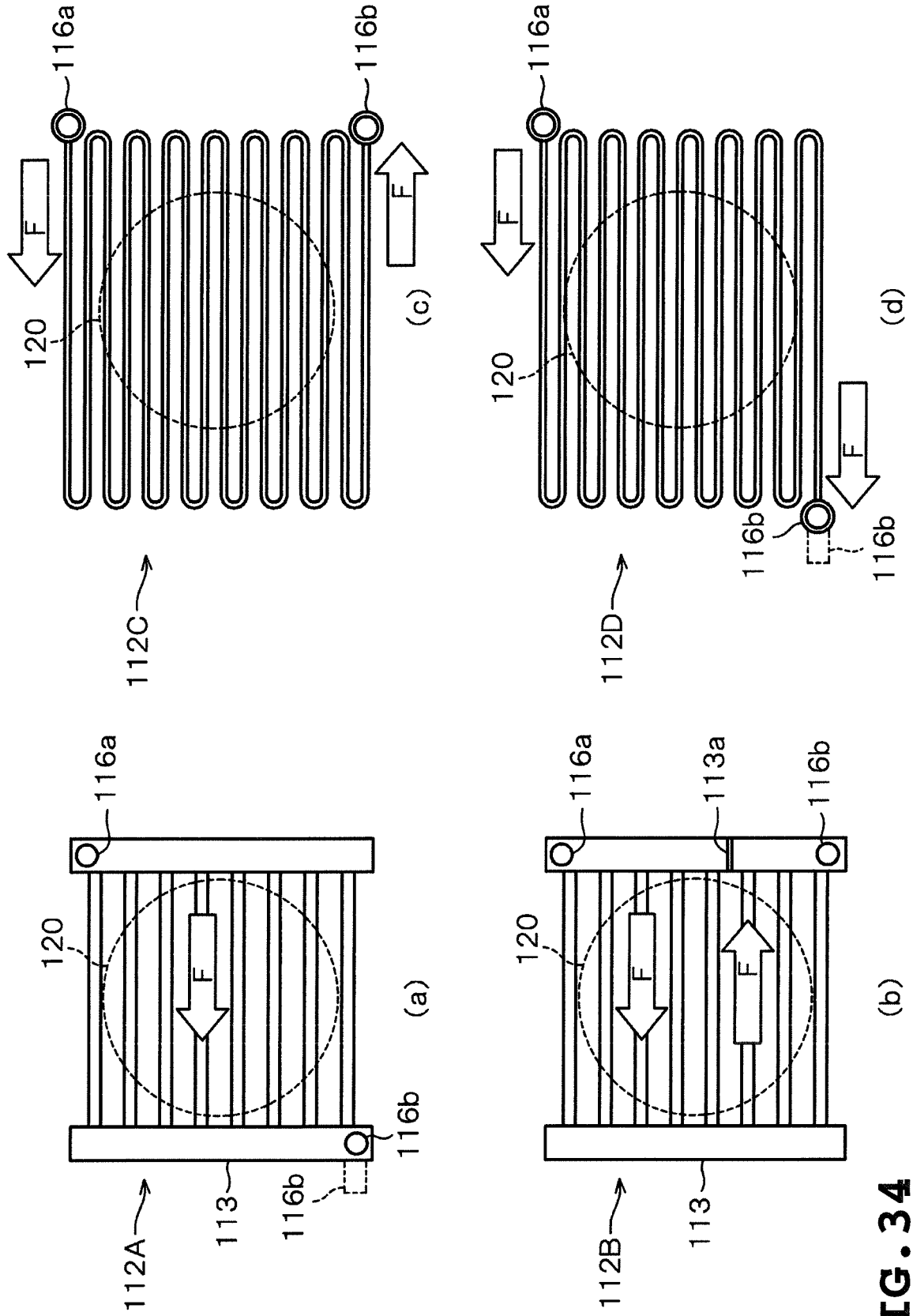


FIG. 34

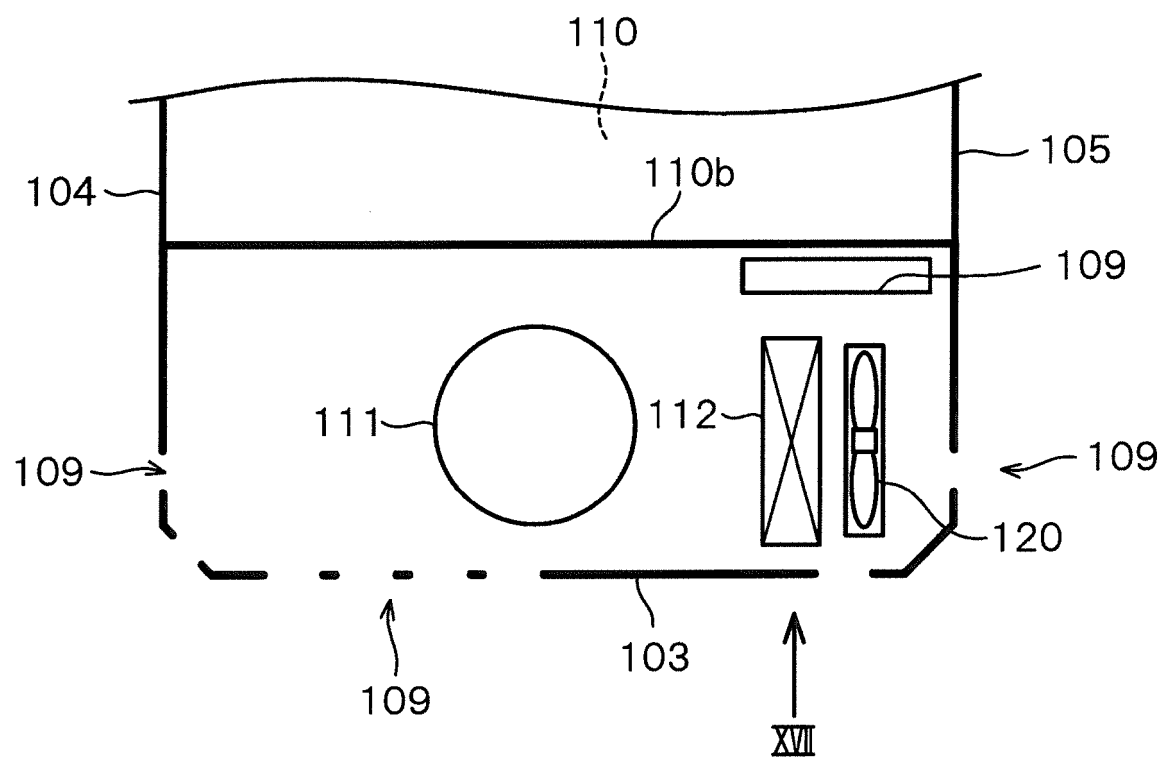


FIG. 35

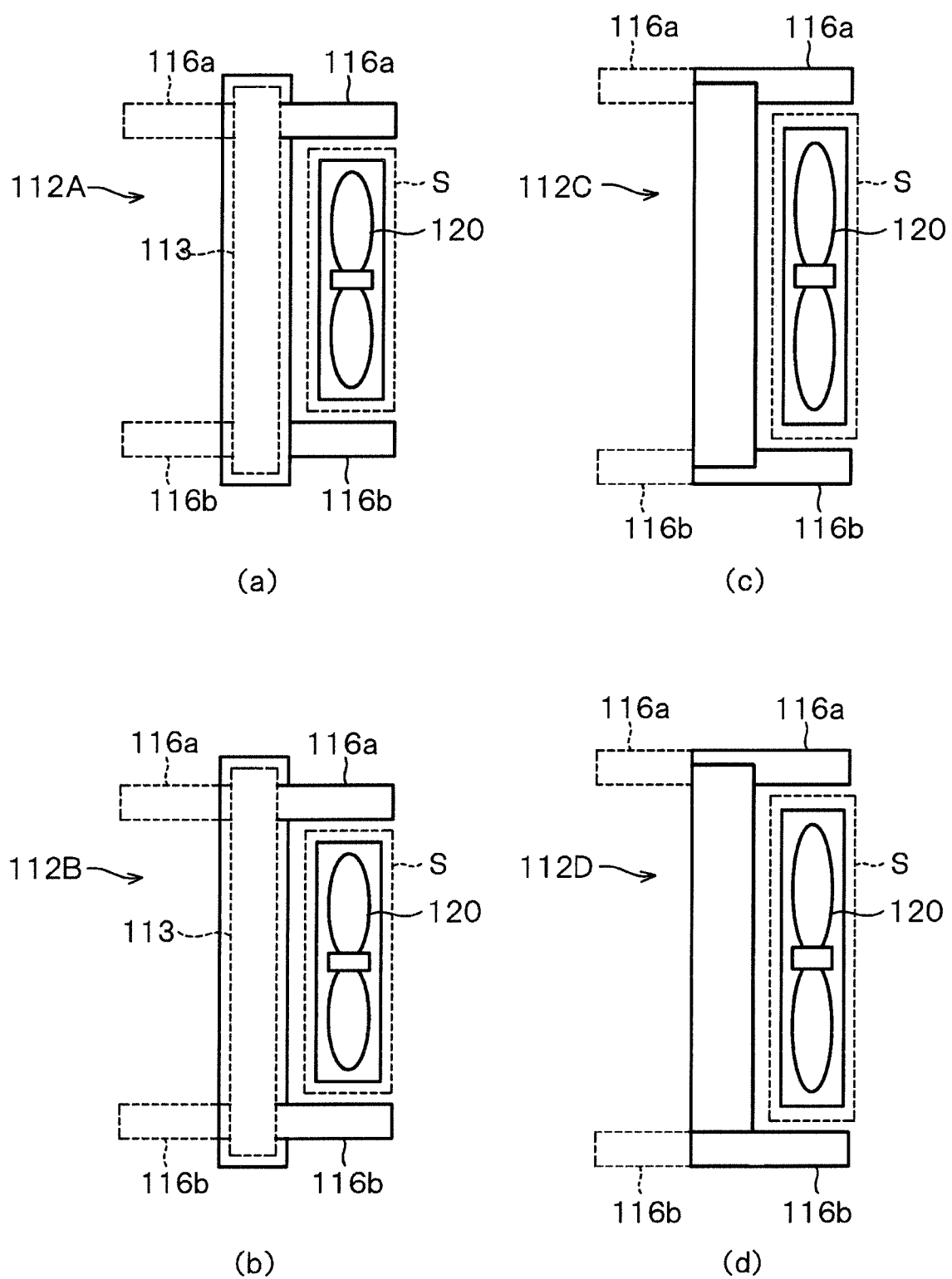


FIG. 36

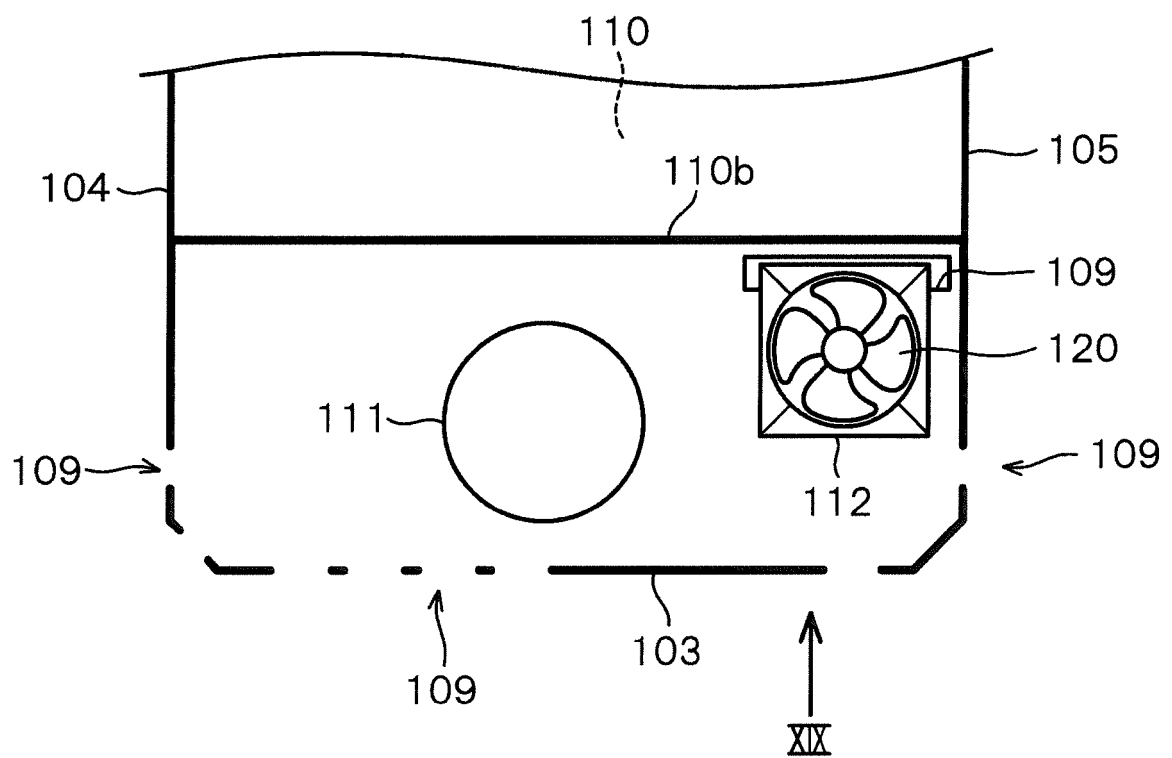


FIG. 37

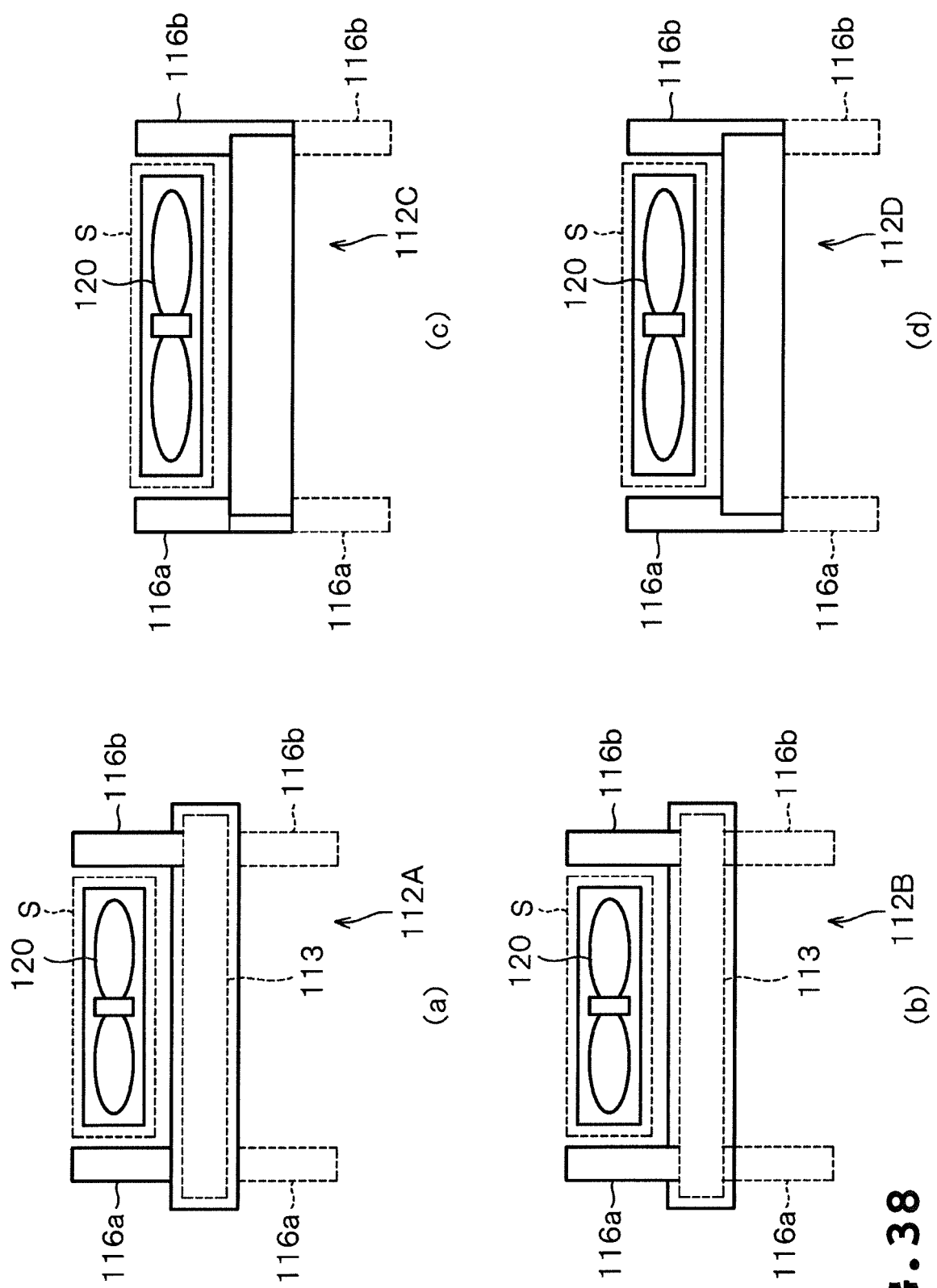


FIG. 38

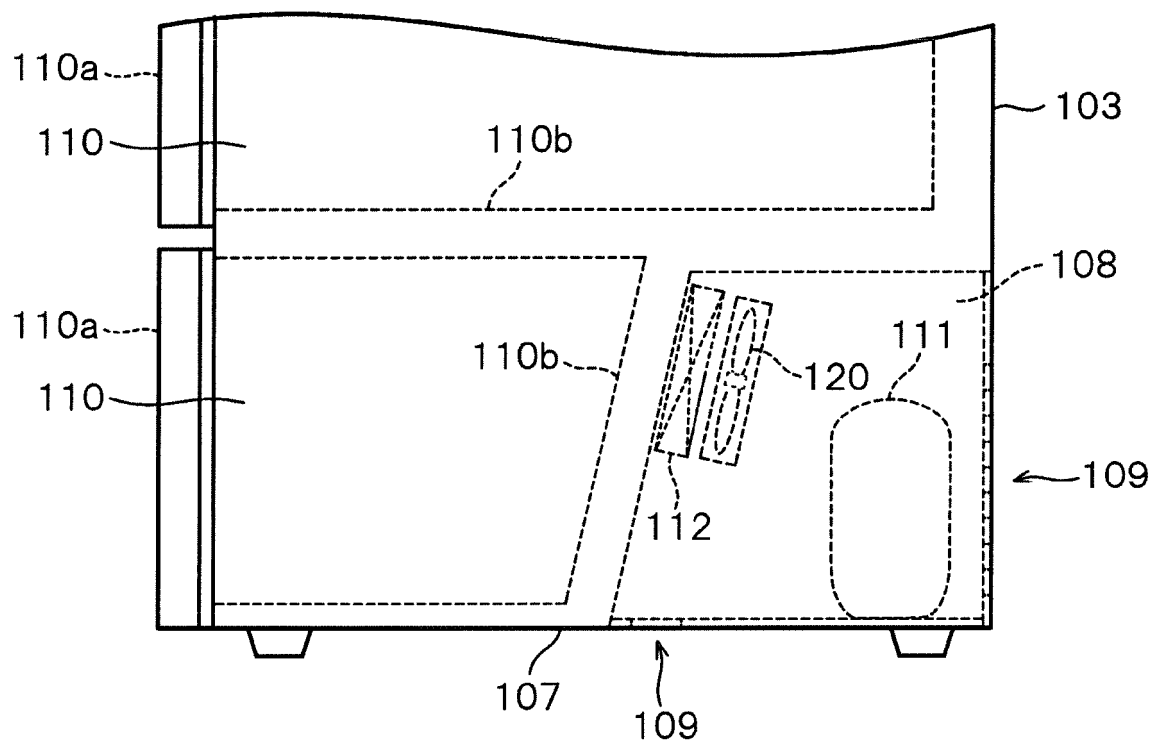


FIG. 39

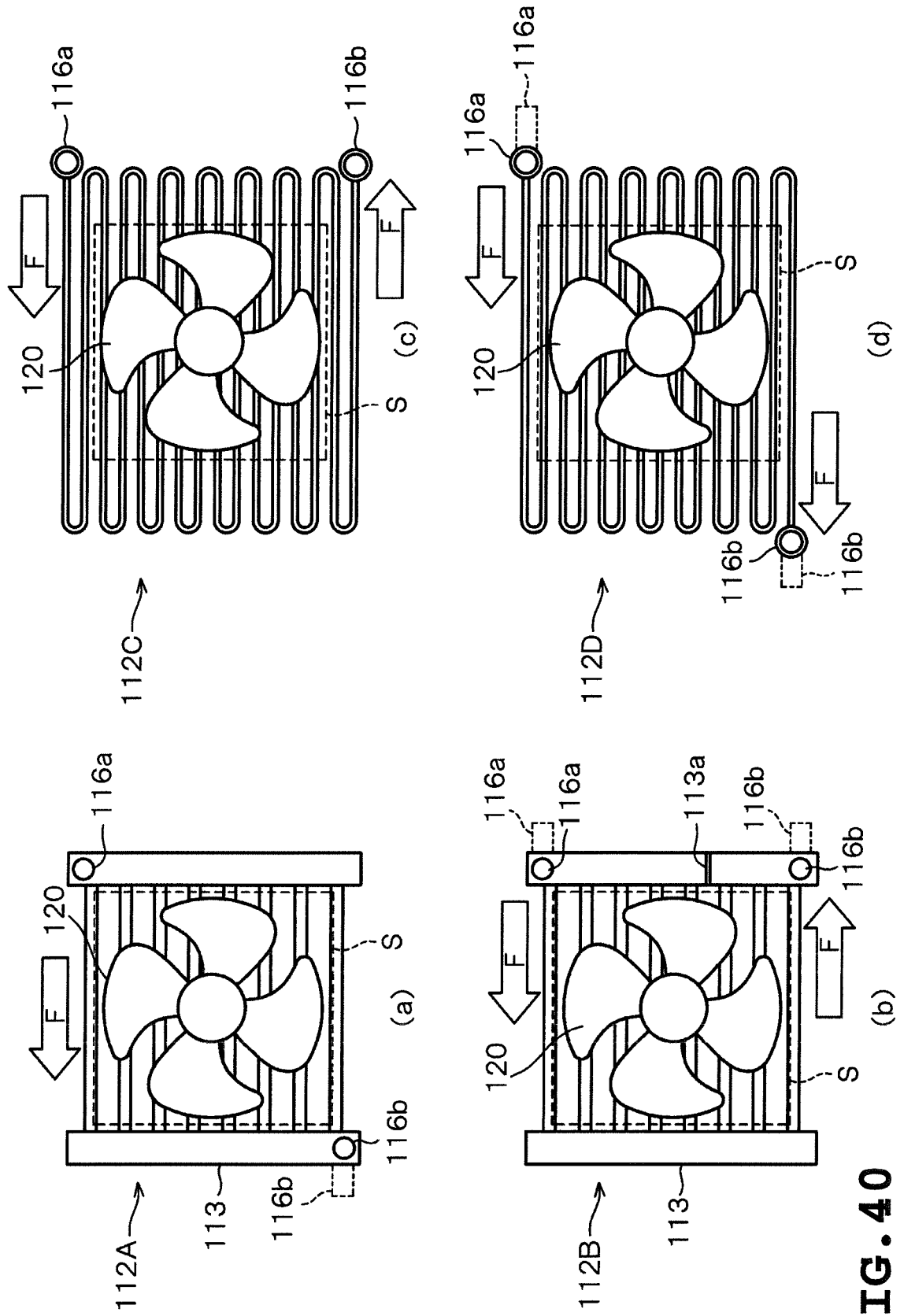


FIG. 40

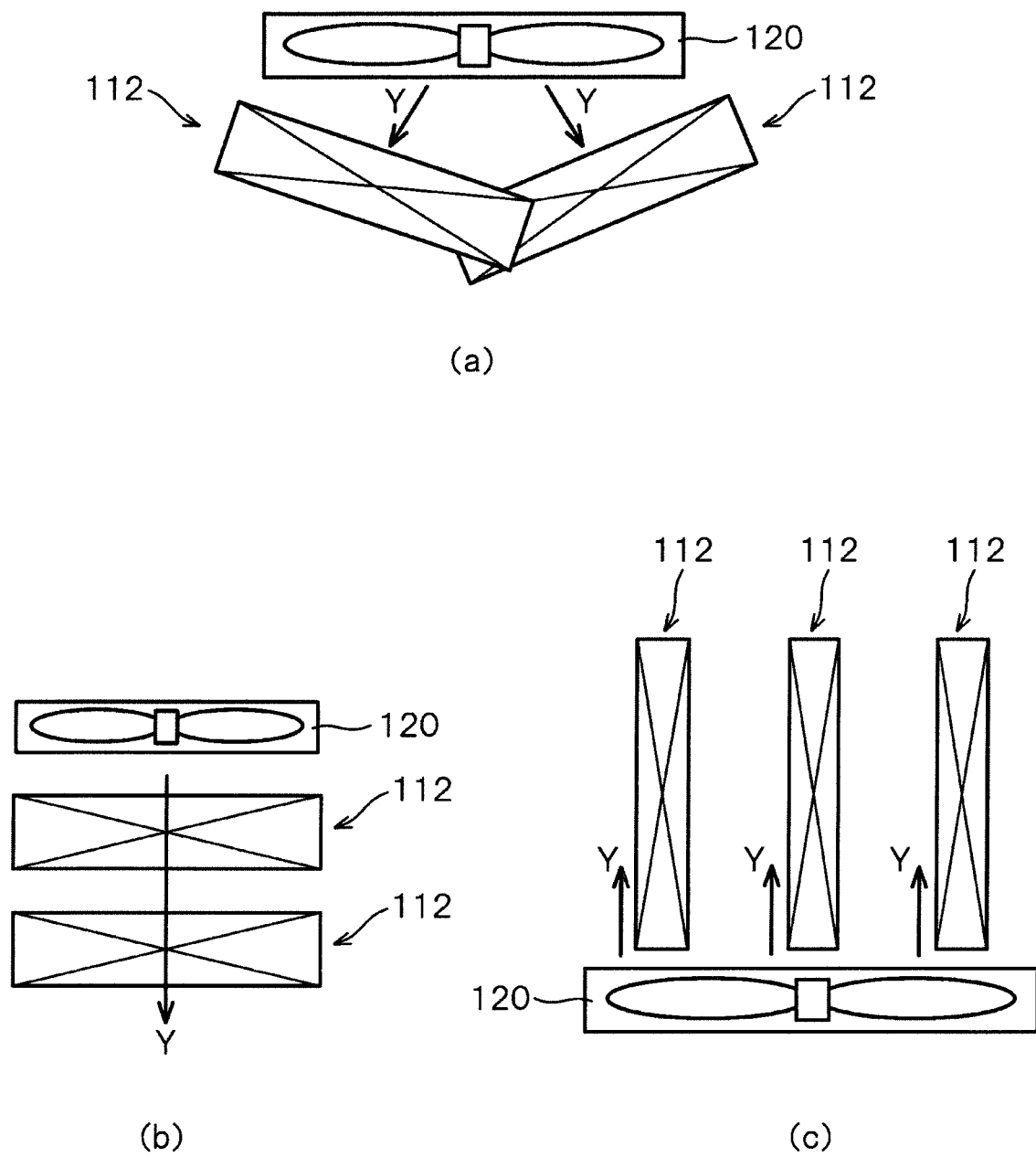
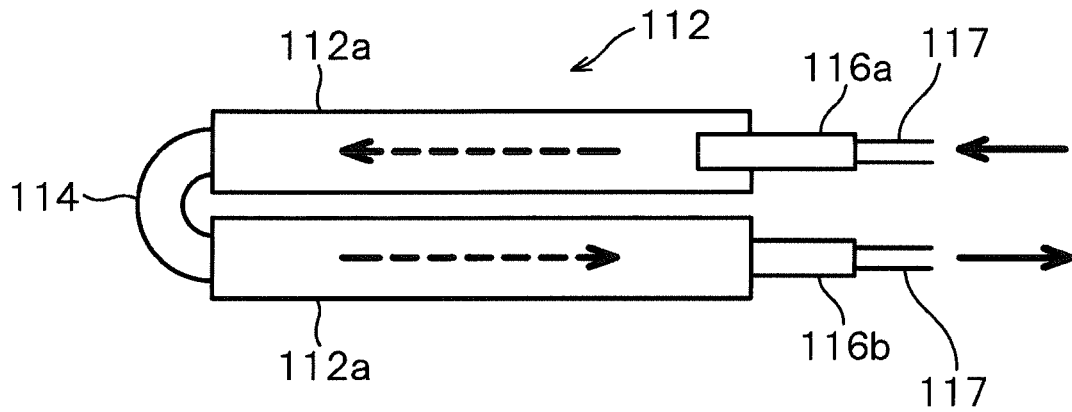
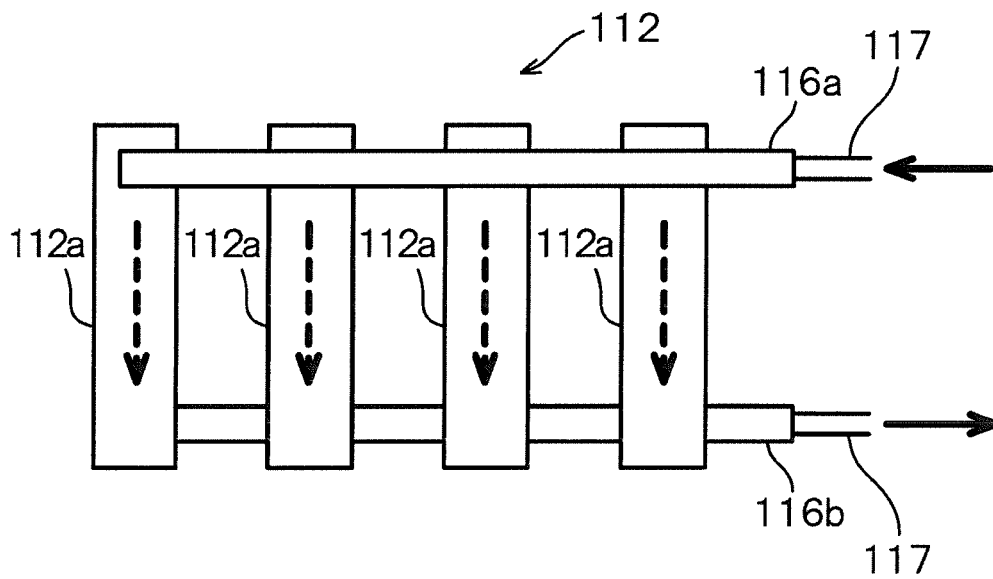


FIG. 41

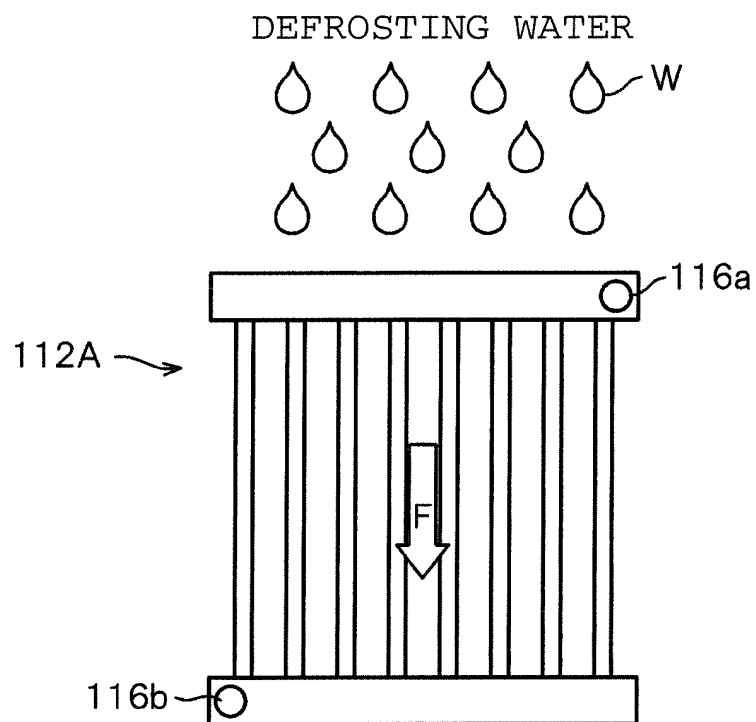


(a)

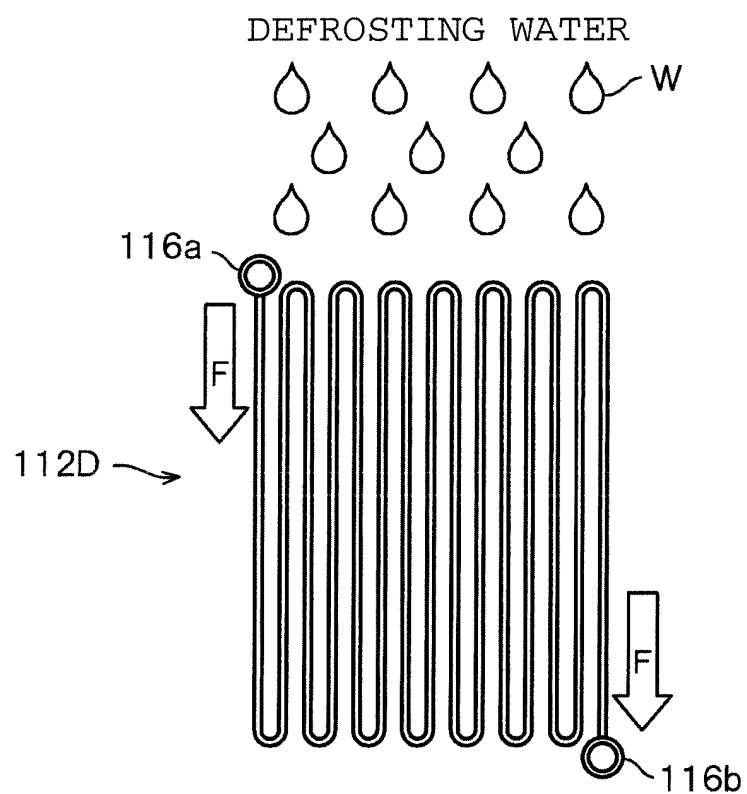


(b)

FIG. 42



(a)



(b)

FIG. 43

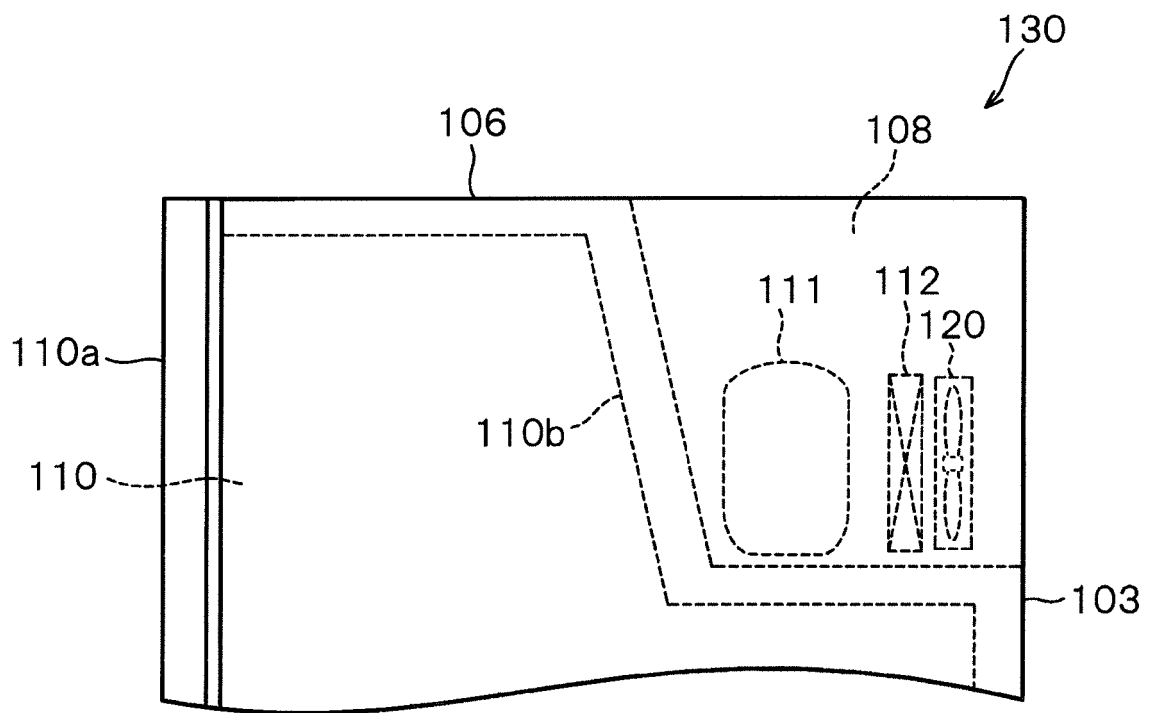


FIG. 44

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/016032

A. CLASSIFICATION OF SUBJECT MATTER

F25D19/00(2006.01)i, *F25B39/04*(2006.01)i, *F25D11/00*(2006.01)i, *F25D21/14*
(2006.01)i, *F28D1/047*(2006.01)i, *F28D1/053*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25D19/00, *F25B39/04*, *F25D11/00*, *F25D21/14*, *F28D1/047*, *F28D1/053*

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2015-052400 A (Hitachi Appliances, Inc.), 19 March 2015 (19.03.2015), paragraphs [0012] to [0033], [0048] to [0051], [0062]; fig. 1 to 9 (Family: none)	1-12
Y	CN 104359255 A (HEFEI HUALING CO., LTD.), 18 February 2015 (18.02.2015), claims; fig. 1 to 4 (Family: none)	1-12
Y	CN 103925744 A (ANHUI KONKA TONGCHUANG HOUSEHOLD APPLIANCES CO., LTD.), 16 July 2014 (16.07.2014), claims; fig. 1 to 2 (Family: none)	1-12

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

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Date of the actual completion of the international search
10 July 2017 (10.07.17)

Date of mailing of the international search report
25 July 2017 (25.07.17)

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/JP2017/016032

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 023229/1989 (Laid-open No. 115668/1990) (Showa Aluminum Corp.), 17 September 1990 (17.09.1990), specification, page 1; fig. 1 to 3 (Family: none)	2-12
Y	JP 09-026252 A (Sharp Corp.), 28 January 1997 (28.01.1997), claims; fig. 1 to 4 (Family: none)	2-12
Y	CN 104493449 A (ZHEJIANG KANGSHENG HEAT EXCHANGER CO., LTD.), 08 April 2015 (08.04.2015), claims; figures (Family: none)	2-12
Y	CN 101769656 A (ZHEJIANG KANGSHENG CO., LTD.), 07 July 2010 (07.07.2010), claims; fig. 1 to 4 (Family: none)	2-12
Y	CN 104390395 A (HEFEI HUALING CO., LTD.), 04 March 2015 (04.03.2015), claims; fig. 1 to 4 (Family: none)	2-12
Y	JP 2012-200769 A (Mitsubishi Aluminum Co., Ltd.), 22 October 2012 (22.10.2012), paragraph [0002]; fig. 1 to 2 (Family: none)	2-12
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 152900/1989 (Laid-open No. 096574/1991) (Showa Aluminum Corp.), 02 October 1991 (02.10.1991), specification, page 1; fig. 1 to 5 (Family: none)	2-12
Y	JP 04-340070 A (Showa Aluminum Corp.), 26 November 1992 (26.11.1992), claims; fig. 1 to 2, 4 (Family: none)	2-12

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/016032

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-178081 A (Matsushita Electric Industrial Co., Ltd.), 12 July 2007 (12.07.2007), claims; fig. 1 to 14 (Family: none)	5-12
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 082414/1982 (Laid-open No. 186387/1983) (Hitachi, Ltd.), 10 December 1983 (10.12.1983), claims; fig. 3 to 4 (Family: none)	12
A	JP 2013-155910 A (Hitachi Appliances, Inc.), 15 August 2013 (15.08.2013), entire text; all drawings (Family: none)	1-12
A	US 2014/0008044 A1 (SAMSUNG ELECTRONICS CO., LTD.), 09 January 2014 (09.01.2014), entire text; all drawings & EP 2682705 A2 & KR 10-2014-0006681 A & CN 103528274 A	1-12

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014238219 A [0003]