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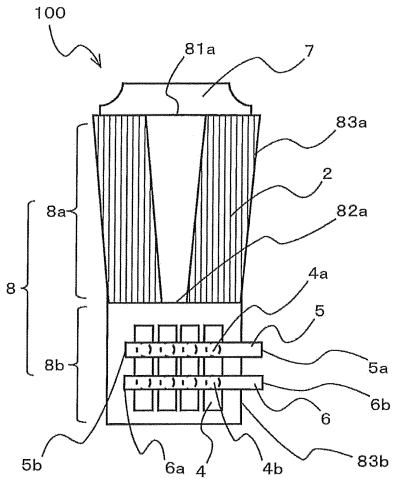
(54) **REFRIGERATION CYCLE DEVICE AND REFRIGERATION CYCLE SYSTEM**

(57) A refrigeration cycle apparatus 100 includes a casing 8 of a refrigerant circuit 10, a first heat-medium pipe 5, and a second heat-medium pipe 6. The casing 8 includes a first frame body 8a having such a tapered sectional shape in a vertical direction that an area of a lower surface part 82a is smaller than an area of an upper surface part 81a, and a second frame body 8b including a side surface part 83b having a rectangular sectional shape in a vertical direction and connected with a peripheral part of the lower surface part 82a of the first frame body 8a. The first heat-medium pipe 5 includes a first heat-medium inflow end part 5a and a first heat-medium outflow end part 5b, at least one of the first heat-medium inflow end part 5a and the first heat-medium outflow end part 5b being housed in the second frame body 8b. The second heat-medium pipe 6 includes a second heat-medium inflow end part 6a and a second heat-medium outflow end part 6b, at least one of the second heat-medium inflow end part 6a and the second heat-medium outflow end part 6b being housed in the second frame body 8b.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a refrigeration cycle apparatus that can exchange heat with a heat medium such as water or brine and a plurality of which can be connected with each other, and a refrigeration cycle system.

Background Art

[0002] Conventionally, a heat pump device, a connection port of a heat-medium heat exchanger of which is disposed outside of a casing, has been known as a refrigeration cycle apparatus that can exchange heat with a heat medium such as water or brine and a plurality of which can be connected with each other (for example, Patent Literature 1). In another known refrigeration cycle apparatus, the heat-medium pipe is included in the casing (for example, Patent Literature 2).

Citation List

Patent Literature

[0003]

Patent Literature 1: Japanese Patent Laid-open No. 2008-267724
Patent Literature 2: Japanese Patent Laid-open No. 2012-247168

Summary of Invention

Technical Problem

[0004] However, for the refrigeration cycle apparatus according to Patent Literature 1, the connection port of the heat-medium heat exchanger of which is disposed outside of the casing, additional work is needed to provide the heat-medium pipe outside of the casing. Thus, the refrigeration cycle apparatus according to Patent Literature 1 requires increased man-hour of connecting the refrigeration cycle apparatus with the heat-medium pipe, and makes it difficult to achieve installation space reduction when a plurality of the refrigeration cycle apparatuses are connected with each other. When a plurality of the refrigeration cycle apparatuses according to Patent Literature 2 are connected with each other, however, the casings of the refrigeration cycle apparatuses are disposed without a gap therebetween, and thus a sufficient work space necessary for connection of the heat-medium pipes cannot be provided.

[0005] The present invention is intended to overcome the above-described problems by providing a refrigeration cycle apparatus that can achieve installation space reduction when a plurality of refrigeration cycle apparatuses are connected with each other, and that can provide a sufficient work space necessary for connection of heat-medium pipes, and a refrigeration cycle system.

Solution to Problem

[0006] A refrigeration cycle apparatus according to an Embodiment of the present invention includes a refrigerant circuit in which a compressor, a first heat exchanger, a decompression device, and a second heat exchanger are connected with each other through refrigerant pipes, refrigerant circulates inside, and the second heat exchanger exchanges heat between the refrigerant and a heat medium; a casing housing the refrigerant circuit; a first heat-medium pipe including a first heat-medium bifurcation pipe for allowing the heat medium to flow into the second heat exchanger inside the casing; and a second heat-medium pipe including a second heat-medium bifurcation pipe for allowing the heat medium to flow out of the second heat exchanger inside the casing, the casing including a first frame body having such a tapered sectional shape in a vertical direction that an area of a lower surface part of the first frame body is smaller than an area of an upper surface part of the first frame body, and a second frame body having a rectangular sectional shape in the vertical direction and including a side surface part connected with a peripheral part of the lower surface part of the first frame body, the first heat-medium pipe including a first heat-medium inflow end part and a first heat-medium outflow end part, at least one of the first heat-medium inflow end part and the first heat-medium outflow end part being housed in the second frame body, the second heat-medium pipe including a second heat-medium inflow end part and a second heat-medium outflow end part, at least one of the second heat-medium inflow end part and the second heat-medium outflow end part being housed in the second frame body.

[0007] In a refrigeration cycle system according to another Embodiment of the present invention, a plurality of the above-described refrigeration cycle apparatuses are connected with each other, and a U-shaped pipe protection panel is attached to a part of a pipe positioned outside of the casing of the refrigeration cycle apparatus to cover and protect a front side, a back side, and an upper side of the part of the pipe.

[0008] In a refrigeration cycle system according to a further Embodiment of the present invention, a plurality of the above-described refrigeration cycle apparatuses are connected with each other, and a part of a pipe positioned outside of the casing of each refrigeration cycle apparatus is protected with racking.

Advantageous Effects of Invention

[0009] According to the present invention, a space is provided between second frame bodies when a plurality of refrigeration cycle apparatuses are installed. A first heat-medium pipe and a second heat-medium pipe of

each refrigeration cycle apparatus are disposed inside a casing. Thus, the present invention can provide a refrigeration cycle apparatus that can achieve installation space reduction when a plurality of the refrigeration cycle apparatuses are connected with each other, and that can provide a sufficient work space necessary for connection of heat-medium pipes, and a refrigeration cycle system.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a schematic refrigerant circuit diagram illustrating an exemplary refrigeration cycle apparatus 100 according to Embodiment 1 of the present invention.
[Fig. 2] Fig. 2 is a schematic view illustrating an internal configuration of the refrigeration cycle apparatus 100 according to Embodiment 1 of the present invention when viewed from front.
[Fig. 3] Fig. 3 is a schematic view illustrating external and internal configurations of a refrigeration cycle system 500 according to Embodiment 1 of the present invention when viewed from front.
[Fig. 4] Fig. 4 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 1 of the present invention when viewed from top.
[Fig. 5] Fig. 5 is a schematic view illustrating an external configuration of a conventional refrigeration cycle system 550.
[Fig. 6] Fig. 6 is a schematic view illustrating the internal configuration of the refrigeration cycle apparatus 100 according to Embodiment 2 of the present invention when viewed from front.
[Fig. 7] Fig. 7 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 2 of the present invention when viewed from front.
[Fig. 8] Fig. 8 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 2 of the present invention when viewed from top.
[Fig. 9] Fig. 9 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 3 of the present invention when viewed from front.
[Fig. 10] Fig. 10 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 3 of the present invention when viewed from top.
[Fig. 11] Fig. 11 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 4 of the present invention when viewed from front.
[Fig. 12] Fig. 12 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 4 of the present invention when viewed from top.

Description of Embodiments

Embodiment 1

[0011] The following describes a refrigeration cycle apparatus 100 according to Embodiment 1 of the present invention with reference to Figs. 1 and 2. Fig. 1 is a schematic refrigerant circuit diagram illustrating an example of the refrigeration cycle apparatus 100 according to Embodiment 1. Fig. 2 is a schematic view illustrating an internal configuration of the refrigeration cycle apparatus 100 according to Embodiment 1 when viewed from front. In the following drawings including Figs. 1 and 2, a dimensional relation between components and the shapes thereof are illustrated differently from those in reality in some cases. In the following drawings, any identical or similar members or parts are denoted by an identical reference sign, or the reference sign is omitted.

[0012] As illustrated in Fig. 1, the refrigeration cycle apparatus 100 according to Embodiment 1 includes a refrigerant circuit 10 in which a compressor 1, a first heat exchanger 2, a decompression device 3, and a second heat exchanger 4 are connected with each other through refrigerant pipes, and refrigerant circulates inside. The refrigeration cycle apparatus 100 according to Embodiment 1 also includes a first heat-medium pipe 5 for allowing a heat medium to flow into the second heat exchanger 4, and a second heat-medium pipe 6 for allowing the heat medium to flow out of the second heat exchanger 4.

[0013] The compressor 1 is a fluid machine configured to compress sucked low-pressure refrigerant and discharge the compressed refrigerant as high-pressure refrigerant. The compressor 1 may be, for example, a scroll compressor having a controllable rotational frequency.

[0014] The first heat exchanger 2 serves as a condenser in Fig. 1. The first heat exchanger 2 is, for example, an air-cooled condenser (air cooling condenser) capable of exchanging heat between the high-pressure refrigerant discharged from the compressor 1 and flowing inside the first heat exchanger 2 and outdoor air provided by a fan 7. The first heat exchanger 2 may be, for example, a fin-and-tube heat exchanger of a cross-fin type including a heat transfer tube and a plurality of fins.

[0015] The decompression device 3 expands and decompresses high-pressure liquid refrigerant and provides the refrigerant into the second heat exchanger 4. The decompression device 3 is an expansion valve such as a linear electronic expansion valve (LEV), the opening degree of which is adjustable in a multi-staged or continuous manner.

[0016] The second heat exchanger 4 serves as an evaporator (radiator) in Fig. 1. The second heat exchanger 4 is, for example, a fin-and-tube heat exchanger of a cross-fin type including a heat transfer tube and a plurality of fins. The second heat exchanger 4 according to Em-

bodiment 1 is configured to exchange heat between low-temperature and low-pressure two-phase refrigerant that flows in from the decompression device 3 and flows inside the second heat exchanger 4 and the heat medium that flows in from the first heat-medium pipe 5, flows inside the second heat exchanger 4, and flows out of the first heat-medium pipe 5. The first heat-medium pipe 5 (water inlet pipe) is connected with, for example, a heat-medium inflow port 4a provided at an end part of a heat transfer tube (not illustrated) of the second heat exchanger 4. The second heat-medium pipe 6 (water outlet pipe) is connected with, for example, a heat-medium outflow port 4b provided at an end part of a heat transfer tube (not illustrated) of the second heat exchanger 4. In the refrigeration cycle apparatus 100 according to Embodiment 1, the heat medium may be a liquid heat medium such as water or brine.

[0017] The refrigeration cycle apparatus 100 according to Embodiment 1 further includes the fan 7 configured to externally blow out air passing through the first heat exchanger 2. The fan 7 (fan for an air cooling condenser) guides airflow passing through the first heat exchanger 2 by rotational operation of the fan 7, and is, for example, a propeller fan.

[0018] As illustrated in Fig. 2, the refrigerant circuit 10 of the refrigeration cycle apparatus 100 according to Embodiment 1 is housed in a casing 8 including a first frame body 8a and a second frame body 8b.

[0019] The first frame body 8a has such a tapered sectional shape in the vertical direction that the area of a lower surface part 82a is smaller than the area of an upper surface part 81a. In other words, the first frame body 8a has a section in the vertical direction, the width of which in the horizontal direction decreases from the upper surface part 81 a to the lower surface part 82a, and has a side surface part 83a, a section of which in the vertical direction is tilted to the vertical direction. The first frame body may have any three-dimensional shape having such a tapered sectional shape in the vertical direction that the area of the lower surface part 82a is smaller than the area of the upper surface part 81a. For example, the three-dimensional shape of the first frame body 8a may be a four-sided pyramid trapezium.

[0020] The second frame body 8b includes a side surface part 83b having a rectangular sectional shape in the vertical direction and connected with a peripheral part of the lower surface part 82a of the first frame body 8a. In other words, the side surface part 83a of the first frame body 8a and the side surface part 83b of the second frame body 8b form a continuous side surface of the casing 8. The second frame body 8b has a section in the vertical direction, the width of which in the horizontal direction is smaller than the width of the upper surface part 81a of the section of the first frame body 8a in the horizontal direction. The three-dimensional shape of the second frame body 8b depends on the three-dimensional shape of the first frame body 8a. For example, when the three-dimensional shape of the first frame body 8a is a four-sided pyramid trapezium, the three-dimensional shape of the second frame body 8b is a cube.

[0021] The one or more first heat exchangers 2 are housed in the first frame body 8a. The side surface part 83a of the first frame body 8a is provided with a vent (not illustrated), and the first heat exchanger 2 is fixed inside of the side surface part 83a of the first frame body 8a. The first heat exchanger 2 has a sectional shape tilted in the vertical direction along the side surface part 83a of the first frame body 8a. As illustrated in Fig. 2, the two first heat exchangers 2 may be fixed inside of the opposed side surface parts 83a of the first frame body 8a.

[0022] The fan 7, which externally blows out air passing through the first heat exchanger 2, is disposed on the upper surface part 81a of the first frame body 8a. In other words, in Fig. 2, air sucked through the vent (not illustrated) provided to the side surface part 83a of the first frame body 8a is subjected to heat exchange at the first heat exchanger 2 and externally blown out by the fan 7.

[0023] The second frame body 8b houses the second heat exchanger 4. Although not illustrated in Fig. 2, the second frame body 8b is provided with a machine room 13 (refer to Fig. 4) of the refrigeration cycle apparatus 100, the machine room 13 housing, for example, the compressor 1 and the decompression device 3.

[0024] The first heat-medium pipe 5 is disposed inside of the second frame body 8b to allow the heat medium to flow into the second heat exchanger 4 for heat exchange. The second heat-medium pipe 6 is disposed to allow the heat medium after the heat exchange to flow out of the second heat exchanger 4. For example, in Fig. 2, the first heat-medium pipe 5 and the second heat-medium pipe 6 are disposed at vertically separated places, the first heat-medium pipe 5 being at the upper place, and the second heat-medium pipe 6 being at the lower place. The first heat-medium pipe 5 and the second heat-medium pipe 6 may be, for example, straight pipes.

[0025] The first heat-medium pipe 5 includes a first heat-medium inflow end part 5a and a first heat-medium outflow end part 5b as pipe connection ports. At least one of the first heat-medium inflow end part 5a and the first heat-medium outflow end part 5b is housed in the second frame body 8b. The second heat-medium pipe 6 includes a second heat-medium inflow end part 6a and a second heat-medium outflow end part 6b as pipe connection ports. At least one of the second heat-medium inflow end part 6a and the second heat-medium outflow end part 6b is housed in the second frame body 8b.

[0026] For example, one of the first heat-medium inflow end part 5a and the first heat-medium outflow end part 5b may protrude out of the casing 8, and the other end part may be housed in the casing 8. One of the second heat-medium inflow end part 6a and the second heat-medium outflow end part 6b may protrude out of the casing 8, and the other end part may be housed in the casing 8. In other words, one end part of the first heat-medium pipe 5 protrudes out of the casing 8, and the other end part is disposed at a position inside the casing 8. One

end part of the second heat-medium pipe 6 protrudes out of the casing 8, and the other end part is disposed at a position inside the casing 8.

[0027] The following describes operation of the refrigeration cycle apparatus 100 according to Embodiment 1.

[0028] High-temperature and high-pressure gas refrigerant discharged from the compressor 1 flows into the first heat exchanger 2. Having flowed into the first heat exchanger 2, the high-temperature and high-pressure gas refrigerant is subjected to heat exchange by releasing heat to air as a low-temperature medium, and becomes high-pressure liquid refrigerant. The high-pressure liquid refrigerant flows into the decompression device 3. Having flowed into the decompression device 3, the high-pressure liquid refrigerant is expanded and depressurized into low-temperature and low-pressure two-phase refrigerant. The low-temperature and low-pressure two-phase refrigerant flows into the second heat exchanger 4 and absorbs heat from a high-temperature medium flowing through the second heat exchanger 4, thereby evaporating into high-quality two-phase refrigerant or low-temperature and low-pressure gas refrigerant. Having flowed out of the second heat exchanger 4, the high-quality two-phase refrigerant or low-temperature and low-pressure gas refrigerant is sucked into the compressor 1. Having sucked into the compressor 1, the refrigerant is compressed into high-temperature and high-pressure gas refrigerant and discharged from the compressor 1. The heat medium cooled at the second heat exchanger 4 is circulated to a cooling load (for example, a heat exchanger of an indoor unit for an air-conditioning device) to exchange heat with a high-temperature medium (for example, indoor air). Having been subjected to the heat exchange, the high-temperature heat medium flows into the second heat exchanger 4 and is cooled through heat exchange with the low-temperature and low-pressure two-phase refrigerant flowing through the second heat exchanger 4. In the refrigeration cycle apparatus 100, a cooling operation is performed through repetition of the above-described cycle.

[0029] In the refrigeration cycle apparatus 100, the high-temperature and high-pressure gas refrigerant discharged from the compressor 1 may flow into the second heat exchanger 4 to perform a heating operation. In the heating operation, the heat medium heated at the second heat exchanger 4 is circulated to a heating load (for example, a heat exchanger of an indoor unit for an air-conditioning device) to exchange heat with a low-temperature medium (for example, indoor air). Having been subjected to the heat exchange, the low-temperature heat medium flows into the second heat exchanger 4 and is heated through heat exchange with high-temperature and high-pressure gas refrigerant flowing through the second heat exchanger 4.

[0030] The following describes, with reference to Figs. 3 and 4, a refrigeration cycle system 500 in which a plurality of the refrigeration cycle apparatuses 100 are connected with each other. Fig. 3 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 1 when viewed from front. Fig. 4 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 1 when viewed from top. Fig. 4 schematically illustrates an internal structure of the second frame body 8b from which the fan 7 and the first heat exchanger 2 are removed for sake of description in part of the refrigeration cycle system 500. Although not illustrated in Fig. 4, the refrigeration cycle apparatus 100 is provided with the four fans 7 on an upper surface when viewed from outside. The one or more first heat exchangers 2 are housed in the first frame body 8a below the four fans 7. As illustrated in Fig. 4, the second frame body 8b is provided with the machine room 13 housing the compressor 1 and other components (not illustrated in Fig. 4).

[0031] As illustrated in Figs. 3 and 4, the refrigeration cycle system 500 is composed of a plurality of the refrigeration cycle apparatuses 100 connected in series with each other by piping. In Figs. 3 and 4, the three refrigeration cycle apparatuses 100 are connected in series with each other by piping. In the refrigeration cycle system 500, the first heat-medium pipes 5 or the second heat-medium pipes 6 are connected with each other by piping through a connecting member 9 such as a pipe joint.

[0032] As illustrated in Fig. 4, in Embodiment 1, the first heat-medium pipe 5 includes a first heat-medium bifurcation pipe 5c for allowing the heat medium to flow into the second heat exchanger 4 inside the casing 8. The second heat-medium pipe 6 includes a second heat-medium bifurcation pipe 6c for allowing the heat medium to flow out of the second heat exchanger 4 inside the casing 8. The first heat-medium bifurcation pipe 5c is bifurcated from the first heat-medium pipe 5 and connected with the heat-medium inflow port 4a of the second heat exchanger 4. The second heat-medium bifurcation pipe 6c is bifurcated from the second heat-medium pipe 6 and connected with the heat-medium outflow port 4b of the second heat exchanger 4. Each second heat exchanger 4 is connected with both of the first heat-medium bifurcation pipe 5c and the second heat-medium bifurcation pipe 6c, but in Fig. 4, any one of the first heat-medium bifurcation pipe 5c and the second heat-medium bifurcation pipe 6c is omitted for sake of description. Alternatively, the first heat-medium bifurcation pipe 5c may be bifurcated on a side closer to the heat-medium inflow port 4a to achieve connection with a plurality of the heat-medium inflow ports 4a, or may be connected with the single heat-medium inflow port 4a. Similarly, the second heat-medium bifurcation pipe 6c may be bifurcated on a side closer to the heat-medium outflow port 4b to achieve connection with a plurality of the heat-medium outflow ports 4b, or may be connected with the single heat-medium outflow port 4b.

[0033] The following describes any effect of the present invention according to Embodiment 1.

[0034] As described above, the refrigeration cycle ap-

paratus 100 according to Embodiment 1 includes: the refrigerant circuit 10 in which the compressor 1, the first heat exchanger 2, the decompression device 3, and the second heat exchanger 4 are connected with each other through refrigerant pipes, refrigerant circulates inside, and the second heat exchanger 4 exchanges heat between the refrigerant and the heat medium; the casing 8 that houses the refrigerant circuit 10; the first heat-medium pipe 5 including the first heat-medium bifurcation pipe 5c for allowing the heat medium to flow into the second heat exchanger 4 inside the casing 8; and the second heat-medium pipe 6 including the second heat-medium bifurcation pipe 6c for allowing the heat medium to flow out of the second heat exchanger 4 inside the casing 8. The casing 8 includes the first frame body 8a having such a tapered sectional shape in the vertical direction that the area of the lower surface part 82a is smaller than the area of the upper surface part 81a, and the second frame body 8b having a rectangular sectional shape in the vertical direction and including a side surface part connected with the peripheral part of the lower surface part of the first frame body 8a. The first heat-medium pipe 5 includes the first heat-medium inflow end part 5a and the first heat-medium outflow end part 5b, at least one of the first heat-medium inflow end part 5a and the first heat-medium outflow end part 5b being housed in the second frame body 8b. The second heat-medium pipe 6 includes the second heat-medium inflow end part 6a and the second heat-medium outflow end part 6b, at least one of the second heat-medium inflow end part 6a and the second heat-medium outflow end part 6b being housed in the second frame body 8b.

[0035] Conventionally disclosed is a refrigeration cycle apparatus that achieves work reduction, work man-hour reduction, and installation space reduction when heat-medium pipes are laid at an installation place where a plurality of refrigeration cycles are installed.

[0036] For example, in a known refrigeration cycle apparatus, a connection port of a heat-medium heat exchanger protrudes out of a casing. The following describes this conventional example with reference to Fig. 5. Fig. 5 is a schematic view illustrating an external configuration of a conventional refrigeration cycle system 550.

[0037] In this conventional refrigeration cycle system 550, a plurality of devices 570 each including a heat-medium heat exchanger inside are connected with a first on-site water pipe 560a and a second on-site water pipe 560b. For example, when the first on-site water pipe 560a and the second on-site water pipe 560b are connected by piping with a connection port of the heat-medium heat exchanger of each device 570 above the device 570, a heat-medium pipe requires an extension length d of 1000 mm approximately from the device 570. Thus, it is difficult to reduce an installation space when the heat-medium pipe is installed outside of the casing. In addition, the heat-medium pipe is installed on site, which increases the man-hour of connection work for the heat-medium pipe at the installation place and complicates piping work.

[0038] When the heat-medium pipe is included in the casing of the refrigeration cycle apparatus, casings of the devices are disposed without a gap therebetween, which makes it difficult to provide a sufficient work space.

[0039] In the refrigeration cycle apparatus 100 according to Embodiment 1, however, the casing 8 includes the first frame body 8a having such a tapered sectional shape in the vertical direction that the area of a lower surface part is smaller than the area of an upper surface part, and the second frame body 8b having a rectangular sectional shape in the vertical direction and including a side surface part connected with the peripheral part of the lower surface part of the first frame body 8a. With this configuration, when the casings 8 of a plurality of the refrigeration cycle apparatuses 100 are disposed in contact with each other, a sufficient space can be provided between the second frame bodies 8b of the casings 8. This facilitates, for example, connection work or separation work for the first heat-medium pipes 5 and the second heat-medium pipes 6 when the refrigeration cycle apparatuses 100 are connected with each other. In addition, the first heat-medium pipes 5 and the second heat-medium pipes 6 are disposed in the second frame bodies 8b of the casings 8, which also facilitates the connection work or separation work. Moreover, a sufficient work space for maintenance such as repair and inspection can be provided in the machine room 13, which leads to improvement of durability of the refrigeration cycle apparatus 100.

[0040] In the refrigeration cycle apparatus 100 according to Embodiment 1, the first heat-medium pipe and the second heat-medium pipe are disposed inside the second frame body of the casing 8, which eliminates the need for a heat-medium pipe for on-site layout and enables omission of pipe work. Since no pipe is needed for on-site layout, cost reduction can be achieved through reduction of a pipe space and a pipe length.

[0041] In the refrigeration cycle apparatus 100 according to Embodiment 1, the heat medium may be water or brine. This configuration can ensure safety when the heat medium leaks in a load-side heat exchanger such as a heat exchanger of an indoor unit through which the heat medium circulates.

[0042] In the refrigeration cycle apparatus 100 according to Embodiment 1, the first heat exchanger 2 may serve as an air-cooled condenser configured to exchange heat between refrigerant and air, the second heat exchanger 4 may serve as an evaporator, the first heat exchanger 2 may be housed in the first frame body 8a, and the second heat exchanger may be housed in the second frame body 8b. Since the second heat exchanger is housed in the second frame body 8b, this configuration can achieve reduction of the pipe space.

[0043] The refrigeration cycle apparatus 100 according to Embodiment 1 may further include the fan 7 disposed on the upper surface part 81a of the first frame body 8a and configured to externally blow out air passing

through the first heat exchanger 2. The one or more first heat exchangers 2 may be disposed on an inner side surface part of the first frame body 8a and exchange heat the air sucked through the side surface part 83a of the first frame body 8a. With this configuration, the first heat exchanger 2 exchanges heat with air sucked through the side surface part 83a of the tapered first frame body 8a, and the air subjected to the heat exchange is discharged upward through the fan 7. When a plurality of the refrigeration cycle apparatuses 100 are connected with each other, air flow is not blocked by the casings 8 of other refrigeration cycle apparatuses 100, which leads to efficient heat exchange.

[0044] In the refrigeration cycle apparatus 100 according to Embodiment 1, one of the first heat-medium inflow end part 5a and the first heat-medium outflow end part 5b may protrude out of the casing 8, and the other end part may be housed in the casing 8. Similarly, one of the second heat-medium inflow end part 6a and the second heat-medium outflow end part 6b may protrude out of the casing 8, and the other end part may be housed in the casing 8. With this configuration, the first heat exchanger 2 exchanges heat with air sucked through the side surface part 83a of the tapered first frame body 8a, and the air subjected to the heat exchange is discharged upward through the fan 7. When a plurality of the refrigeration cycle apparatuses 100 are connected with each other, air flow is not blocked by the casings 8 of other refrigeration cycle apparatuses 100, which leads to efficient heat exchange. With this configuration, when a plurality of the refrigeration cycle apparatuses 100 are installed, the first heat-medium pipes 5 can be directly connected with each other by piping, and the second heat-medium pipes 6 can be directly connected with each other by piping, which leads to reduction of the number of connecting members for pipe connection.

[0045] In the refrigeration cycle apparatus 100 according to Embodiment 1, the heat medium may be water, and the second heat exchanger 4 may be a water-cooled evaporator. This configuration can provide further safety of the load-side heat exchanger such as a heat exchanger of an indoor unit through which the heat medium circulates.

Embodiment 2

[0046] Embodiment 2 of the present invention describes, with reference to Figs. 6 to 8, a modification of the refrigeration cycle apparatus 100 according to Embodiment 1 described above. Fig. 6 is a schematic view illustrating the internal configuration of the refrigeration cycle apparatus 100 according to Embodiment 2 when viewed from front. Fig. 7 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 2 when viewed from front. Fig. 8 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 2 when viewed from top. Figs. 6 to 8 correspond to Figs. 2 to 4 described in the above-described Embodiment 1.

[0047] As illustrated in Figs. 6 to 8, in the refrigeration cycle apparatus 100 according to Embodiment 2 of the present invention, the first heat-medium inflow end part 5a and the first heat-medium outflow end part 5b as pipe connection ports are housed in the casing 8. The second heat-medium inflow end part 6a and the second heat-medium outflow end part 6b as pipe connection ports are housed in the casing 8. In other words, each pipe connection port is disposed at a position inside the casing 8. In the refrigeration cycle system 500 in which a plurality of the refrigeration cycle apparatuses 100 are installed, coupling pipes 15 connect between the first heat-medium pipes 5 and between the second heat-medium pipes 6, and each connection part is fixed by the connecting member 9 such as a pipe joint.

[0048] According to Embodiment 2, there is no protrusion from the casing 8 of the refrigeration cycle apparatus 100, which facilitates transport and installation work of the refrigeration cycle apparatus 100.

Embodiment 3

[0049] Embodiment 3 of the present invention describes, with reference to Figs. 9 and 10, an example of the refrigeration cycle system 500 in which a plurality of the refrigeration cycle apparatuses 100 according to the above-described embodiments are installed. Fig. 9 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 3 when viewed from front. Fig. 10 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 3 when viewed from top. Fig. 9 corresponds to Fig. 3 described in the above-described Embodiment 1 and Fig. 7 described in the above-described Embodiment 2, and Fig. 10 corresponds to Fig. 4 described in the above-described Embodiment 1 and Fig. 8 described in the above-described Embodiment 2.

[0050] In the refrigeration cycle system 500 according to Embodiment 3, a plurality of the refrigeration cycle apparatuses 100 are connected with each other, and a U-shaped pipe protection panel 20 is attached to a part of a pipe positioned outside of the casing 8 of each refrigeration cycle apparatus 100 to cover and protect a front side, a back side, and an upper side of the part of the pipe.

[0051] The pipe protection panel 20 is used to protect a pipe and avoid damage on the pipe by external impact, and may be, for example, a U-shaped box panel covering and protecting a front side, a back side, and an upper side of a part of a pipe positioned outside of the casing 8 of the refrigeration cycle apparatus 100. The pipe protection panel 20 may be made of, for example, a steel plate.

[0052] In the refrigeration cycle system 500 according to Embodiment 3, only a part of a pipe positioned outside

of the casing 8 of each refrigeration cycle apparatus 100 is covered by the pipe protection panel 20 to protect the pipe, thereby improving durability of the refrigeration cycle system 500. In addition, the number of required pipe protection panels can be reduced and thus the number of attachment processes at an installation place can be reduced as compared to a conventional device, a heat-medium pipe of which is externally installed.

Embodiment 4

[0053] Embodiment 4 of the present invention describes, with reference to Figs. 11 and 12, an example of the refrigeration cycle system 500 in which a plurality of the refrigeration cycle apparatuses 100 according to the above-described embodiments are installed. Fig. 11 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 4 when viewed from front. Fig. 12 is a schematic view illustrating external and internal configurations of the refrigeration cycle system 500 according to Embodiment 4 when viewed from top. Fig. 11 corresponds to Fig. 3 described in the above-described Embodiment 1 and Fig. 7 described in the above-described Embodiment 2, and Fig. 12 corresponds to Fig. 4 described in the above-described Embodiment 1 and Fig. 8 described in the above-described Embodiment 2.

[0054] In the refrigeration cycle system 500 according to Embodiment 4, a plurality of the refrigeration cycle apparatuses 100 are connected with each other, and a racking part 30 is provided to a part of a pipe positioned outside of the casing 8 of each refrigeration cycle apparatus 100 to protect the part of the pipe.

[0055] In the refrigeration cycle system 500 according to Embodiment 4, a part of a pipe positioned outside of the casing 8 of each refrigeration cycle apparatus 100 is provided with the racking part 30 to achieve pipe protection such as temperature keeping or cooling by covering the pipe with heat insulating material and wrapping the pipe with a protection member made of, for example, aluminum, stainless steel, steel plate, or coating material.

[0056] In the refrigeration cycle system 500 according to Embodiment 4, only a part of a pipe positioned outside of the casing 8 of each refrigeration cycle apparatus 100 is provided with racking to protect the pipe, thereby improving durability of the refrigeration cycle system 500. In addition, the number of protection materials required for racking can be reduced and thus the number of attachment processes at an installation place can be reduced as compared to a conventional device, a heat-medium pipe of which is externally installed.

Other embodiments

[0057] The prevent invention is not limited to the above-described embodiments, but various kinds of modifications are possible. For example, in the refrigeration cycle apparatus according to the above-described embodiments, a refrigerant flow switching device (for example, a four-way valve) may be provided to achieve an air-conditioning unit capable of performing switching between a cooling operation and a heating operation.

[0058] The above-described embodiments may be applied in combination with each other.

Reference Signs List

[0059]

1 compressor, 2 first heat exchanger, 3 decompression device, 4 second heat exchanger, 4a heat-medium inflow port, 4b heat-medium outflow port, 5 first heat-medium pipe, 5a first heat-medium inflow end part, 5b first heat-medium outflow end part, 5c first heat-medium bifurcation pipe, 6 second heat-medium pipe, 6a second heat-medium inflow end part, 6b second heat-medium outflow end part, 6c second heat-medium bifurcation pipe, 7 fan, 8 casing, 8a first frame body, 8b second frame body, 9 connecting member, 10 refrigerant circuit, 13 machine room, 15 coupling pipe, 20 pipe protection panel, 30 racking part, 81a upper surface part, 82a lower surface part, 83a side surface part of the first frame body, 83b side surface part of the second frame body, 100 refrigeration cycle apparatus, 500 refrigeration cycle system, 550 conventional refrigeration cycle system, 560a first on-site water pipe, 560b second on-site water pipe, 570 conventional device.

Claims

1. A refrigeration cycle apparatus comprising:

a refrigerant circuit in which a compressor, a first heat exchanger, a decompression device, and a second heat exchanger are connected with each other through refrigerant pipes, refrigerant circulates inside, and the second heat exchanger exchanges heat between the refrigerant and a heat medium;
a casing housing the refrigerant circuit;
a first heat-medium pipe including a first heat-medium bifurcation pipe for allowing the heat medium to flow into the second heat exchanger inside the casing; and
a second heat-medium pipe including a second heat-medium bifurcation pipe for allowing the heat medium to flow out of the second heat exchanger inside the casing,
the casing including
a first frame body having such a tapered sectional shape in a vertical direction that an area of a lower surface part of the first frame body is smaller than an area of an upper surface part of the first frame body, and

a second frame body having a rectangular sectional shape in the vertical direction and including a side surface part connected with a peripheral part of the lower surface part of the first frame body,
the first heat-medium pipe including a first heat-medium inflow end part and a first heat-medium outflow end part, at least one of the first heat-medium inflow end part and the first heat-medium outflow end part being housed in the second frame body,
the second heat-medium pipe including a second heat-medium inflow end part and a second heat-medium outflow end part, at least one of the second heat-medium inflow end part and the second heat-medium outflow end part being housed in the second frame body.

2. The refrigeration cycle apparatus of claim 1, wherein the heat medium is water or brine.

3. The refrigeration cycle apparatus of claim 1 or 2, wherein the first heat exchanger serves as an air-cooled condenser configured to exchange heat between the refrigerant and air, the second heat exchanger serves as an evaporator, the first heat exchanger is housed in the first frame body, and the second heat exchanger is housed in the second frame body.

4. The refrigeration cycle apparatus of claim 3, further comprising a fan disposed on the upper surface part of the first frame body and configured to externally blow out air passing through the first heat exchanger, wherein the one or more first heat exchangers are disposed on an inner side surface part of the first frame body and exchanges heat with air sucked through a side surface part of the first frame body.

5. The refrigeration cycle apparatus of any one of claims 1 to 4, wherein one of the first heat-medium inflow end part and the first heat-medium outflow end part protrudes out of the casing, and the other end part is housed in the casing.

6. The refrigeration cycle apparatus of any one of claims 1 to 4, wherein the first heat-medium inflow end part and the first heat-medium outflow end part are housed in the casing.

7. The refrigeration cycle apparatus of any one of claims 1 to 6, one of the second heat-medium inflow end part and the second heat-medium outflow end part protrudes out of the casing, and an other end part is housed in the casing.

8. The refrigeration cycle apparatus of any one of claims 1 to 6, wherein the second heat-medium inflow end part and the second heat-medium outflow end part are housed in the casing.

9. The refrigeration cycle apparatus of any one of claims 1 to 8, wherein the heat medium is water, and the second heat exchanger is a water-cooled evaporator.

10. A refrigeration cycle system in which a plurality of the refrigeration cycle apparatuses of any one of claims 1 to 9 are connected with each other, and a U-shaped pipe protection panel is attached to a part of a pipe positioned outside of the casing of the refrigeration cycle apparatus to cover and protect a front side, a back side, and an upper side of the part of the pipe.

11. A refrigeration cycle system in which a plurality of the refrigeration cycle apparatuses of any one of claims 1 to 9 are connected with each other, and a part of a pipe positioned outside of the casing of the refrigeration cycle apparatus is protected with racking.

FIG. 1

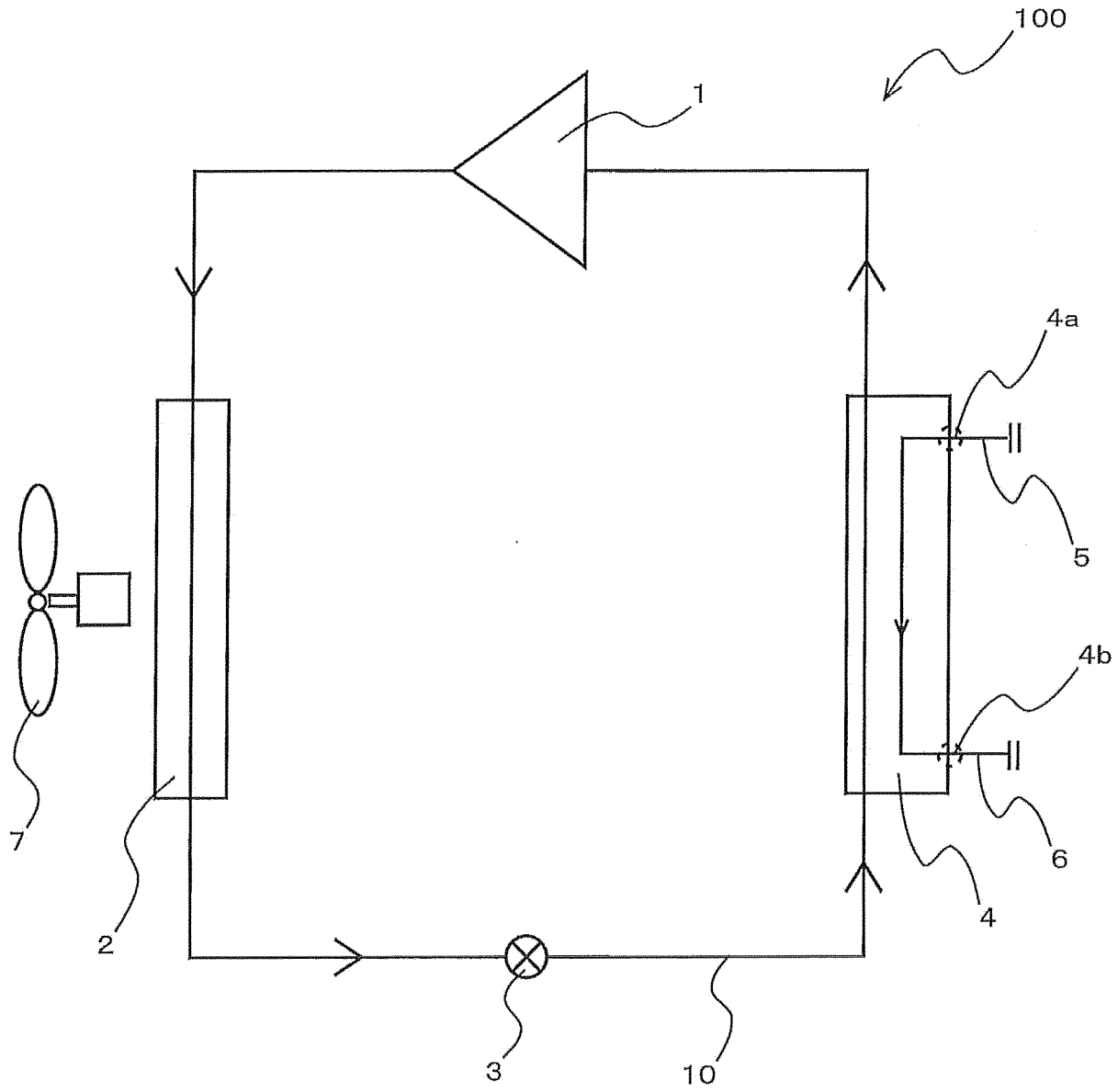

FIG. 2

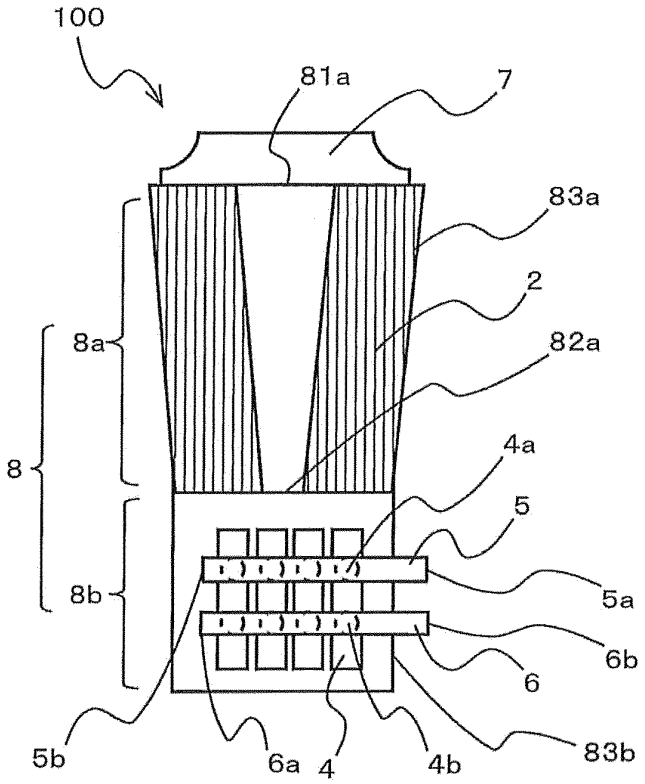
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FIG. 3

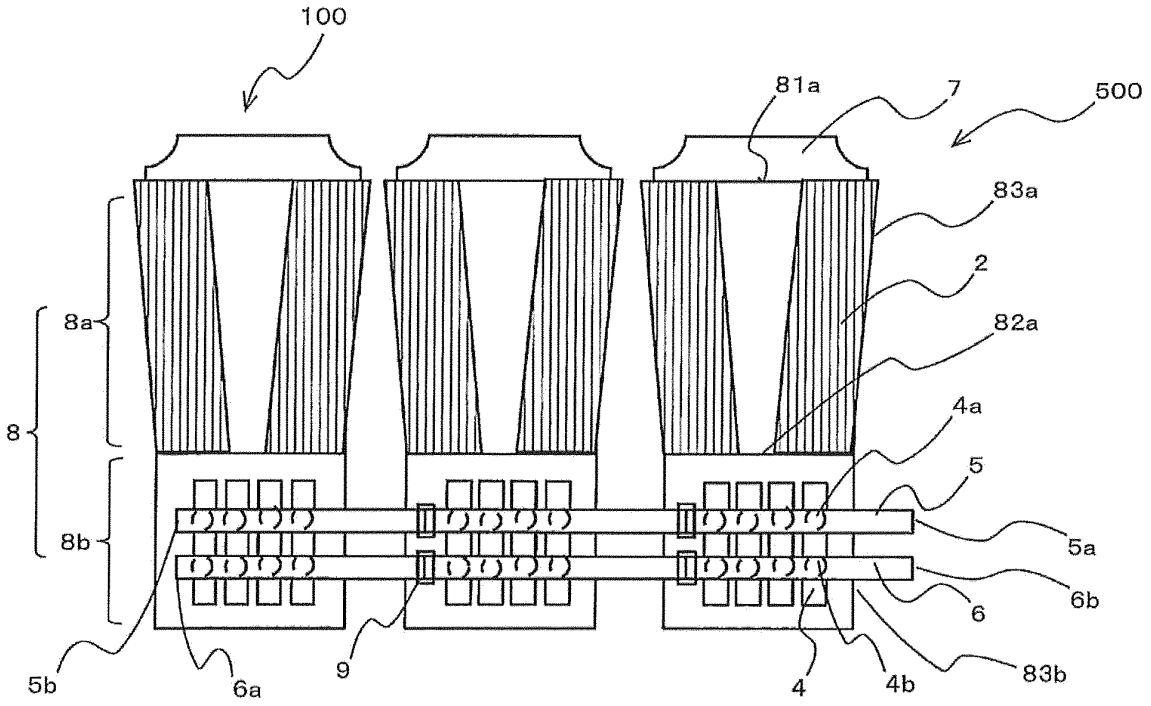
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FIG. 4

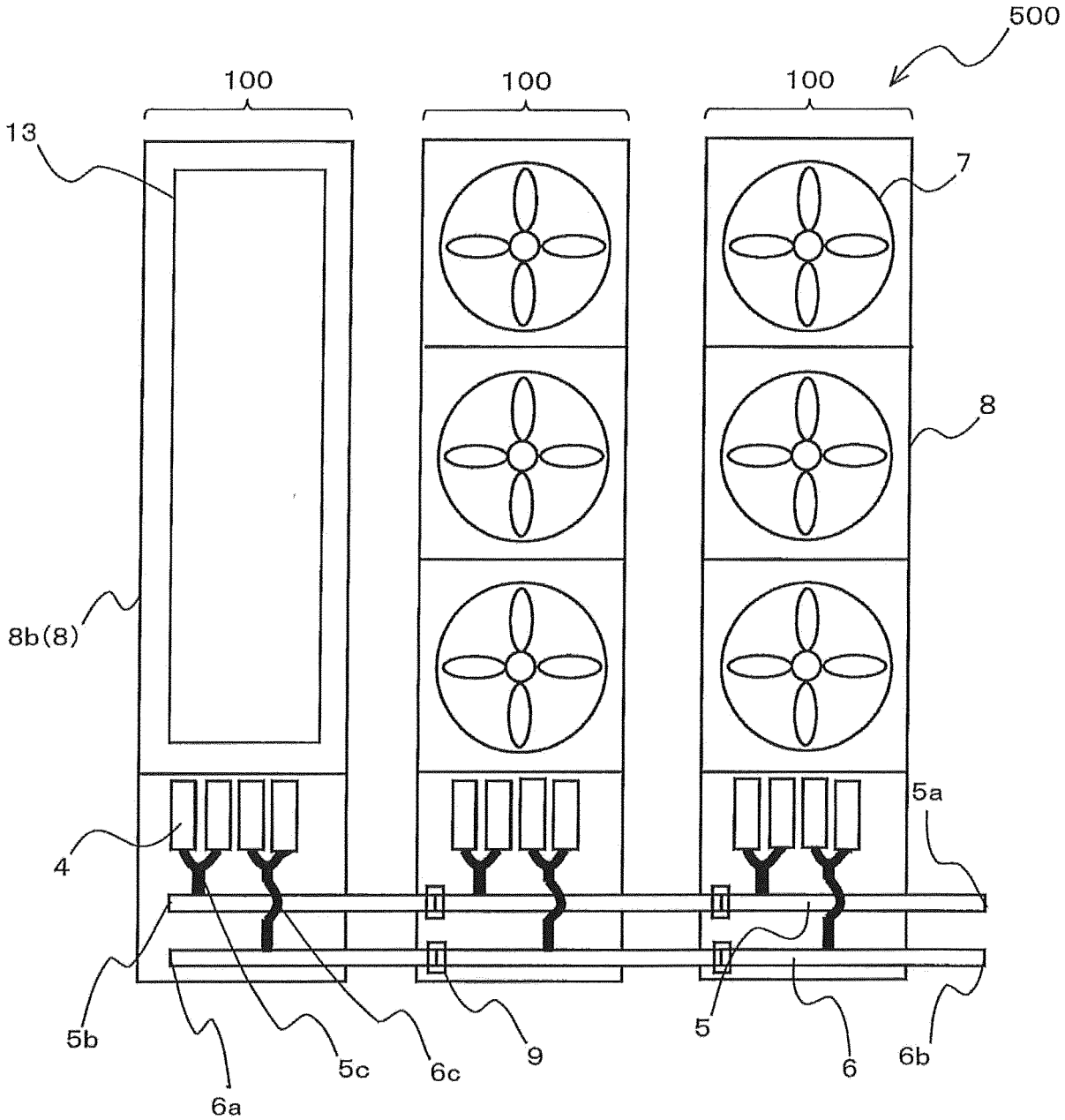
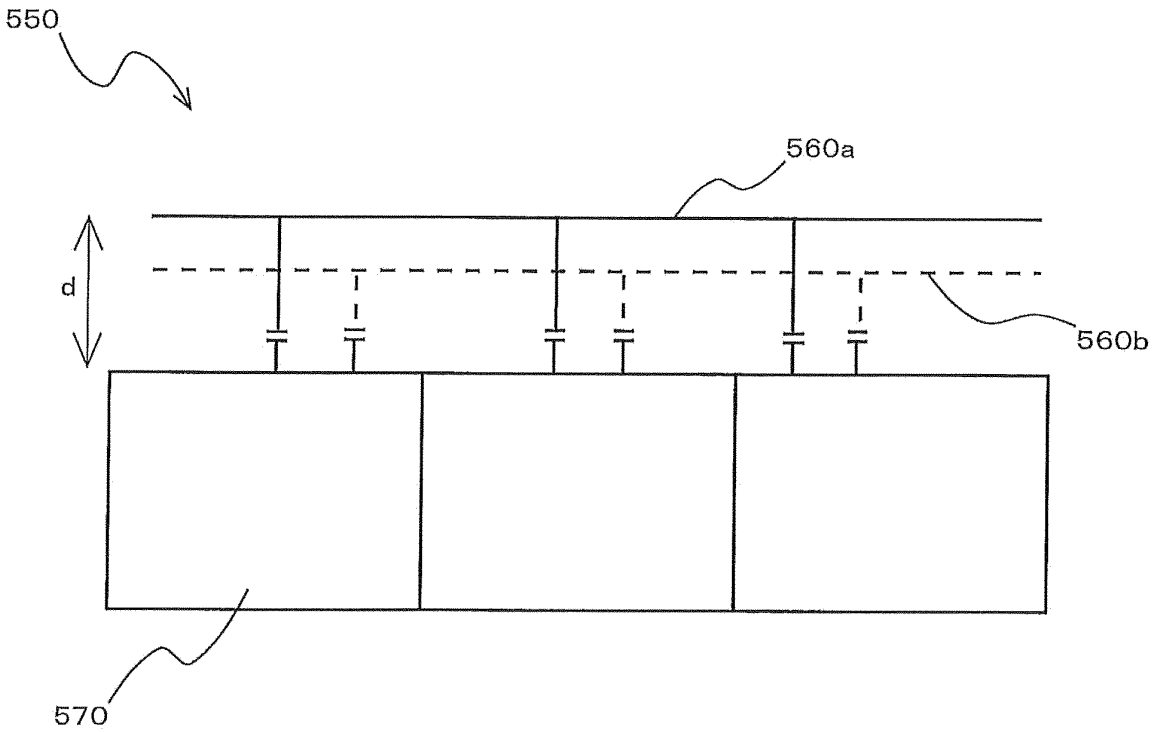


FIG. 5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560b
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FIG. 6

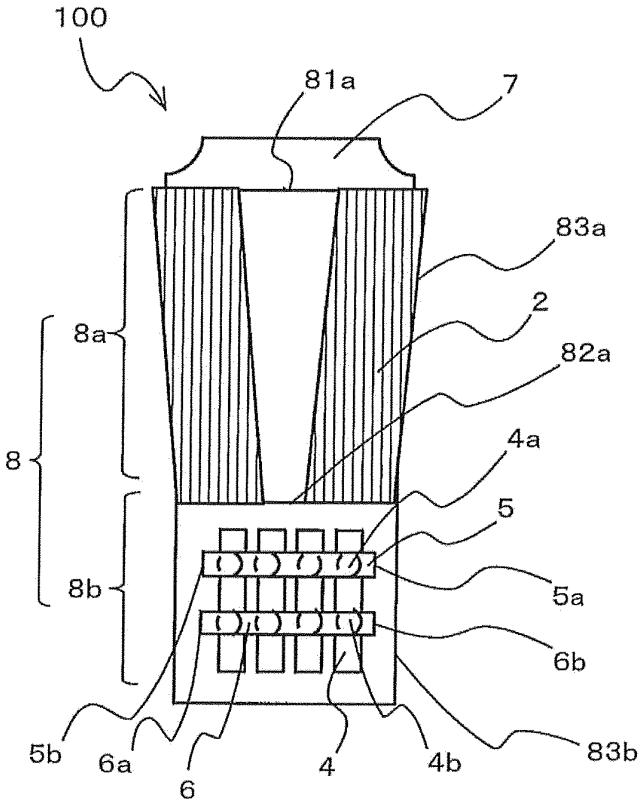
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FIG. 7

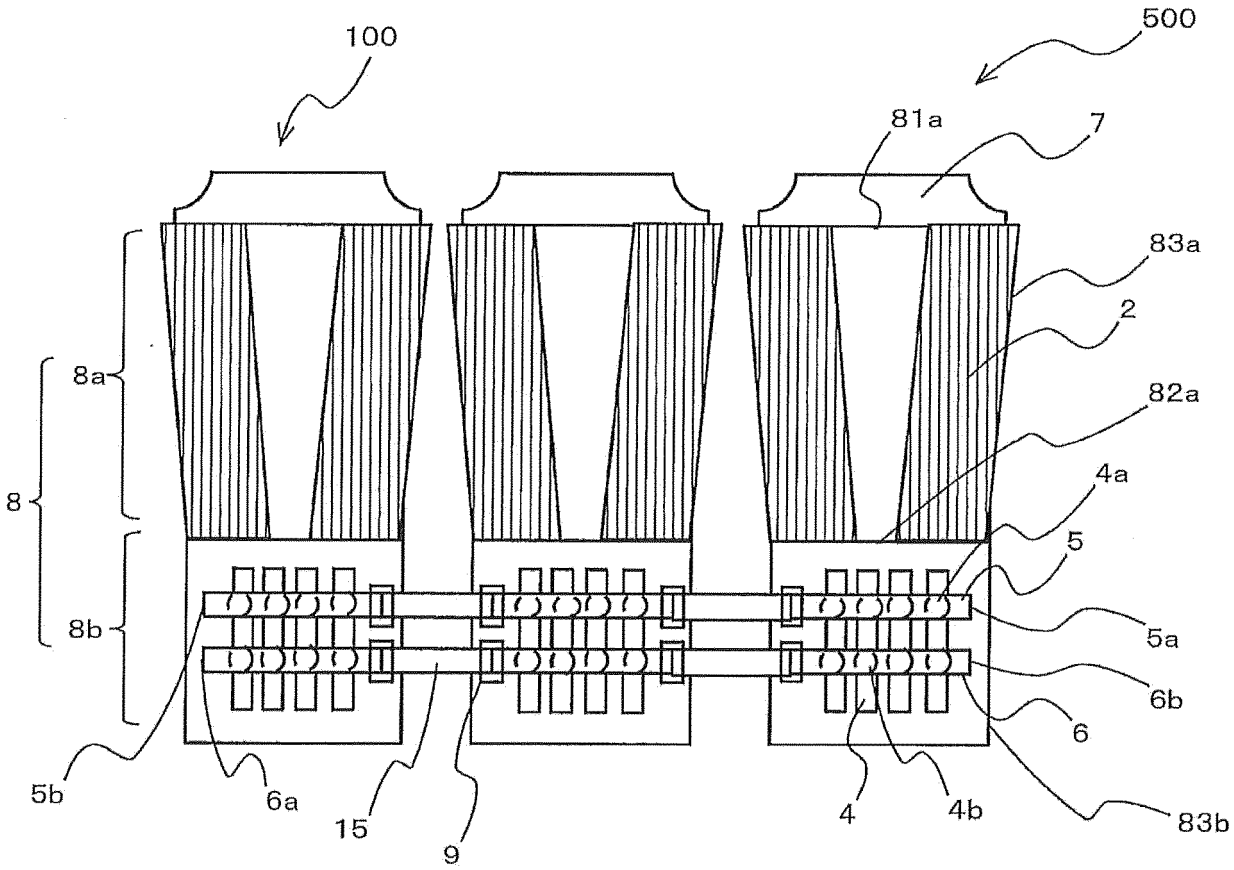


FIG. 8

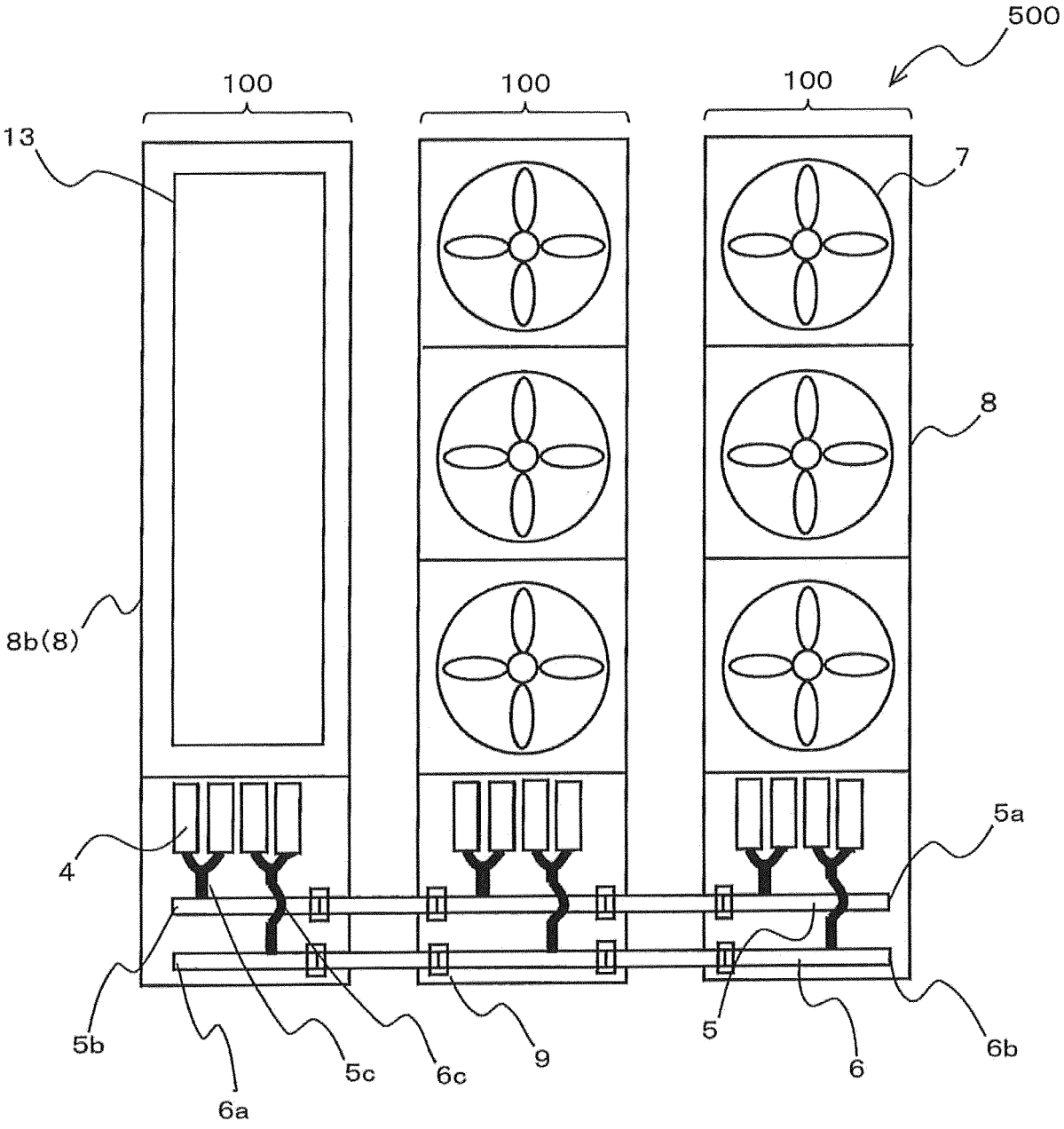


FIG. 9

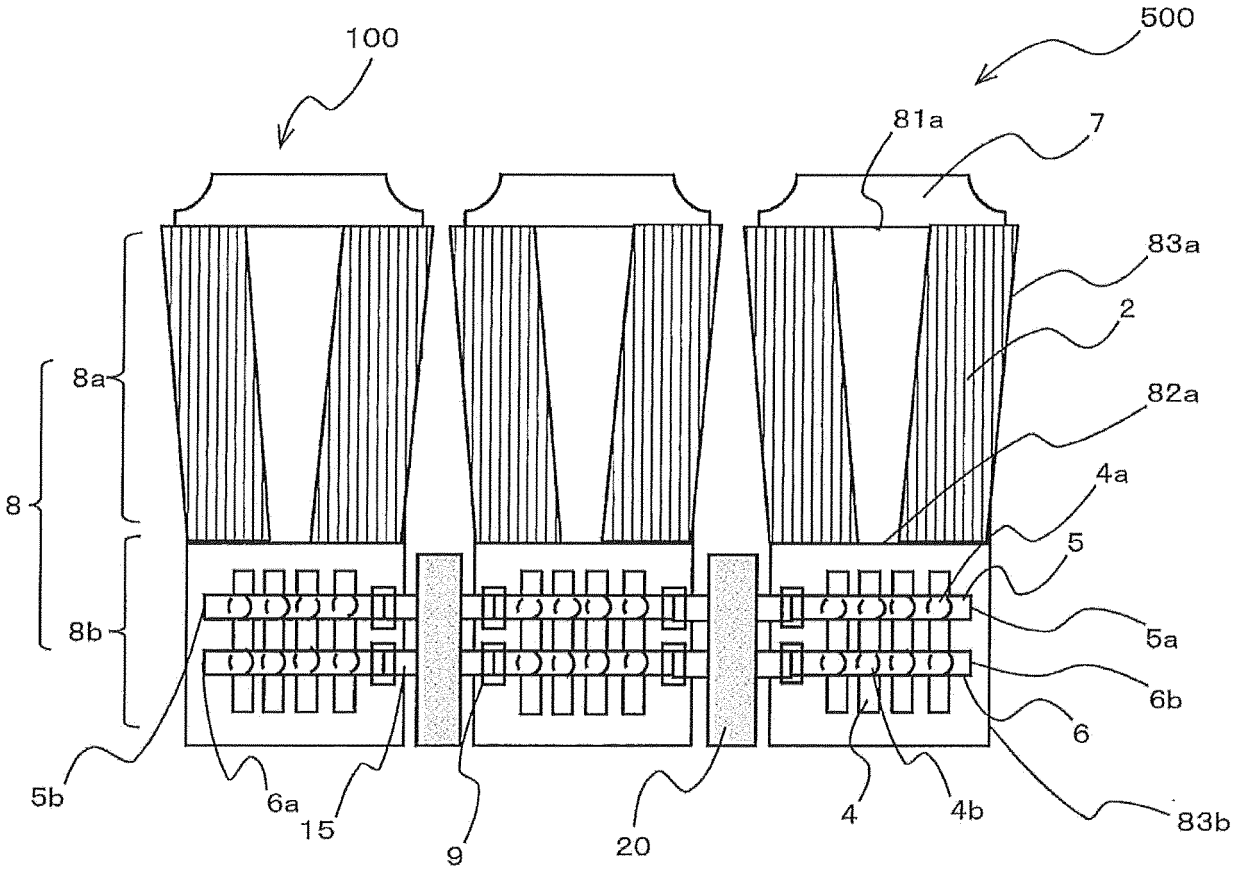


FIG. 10

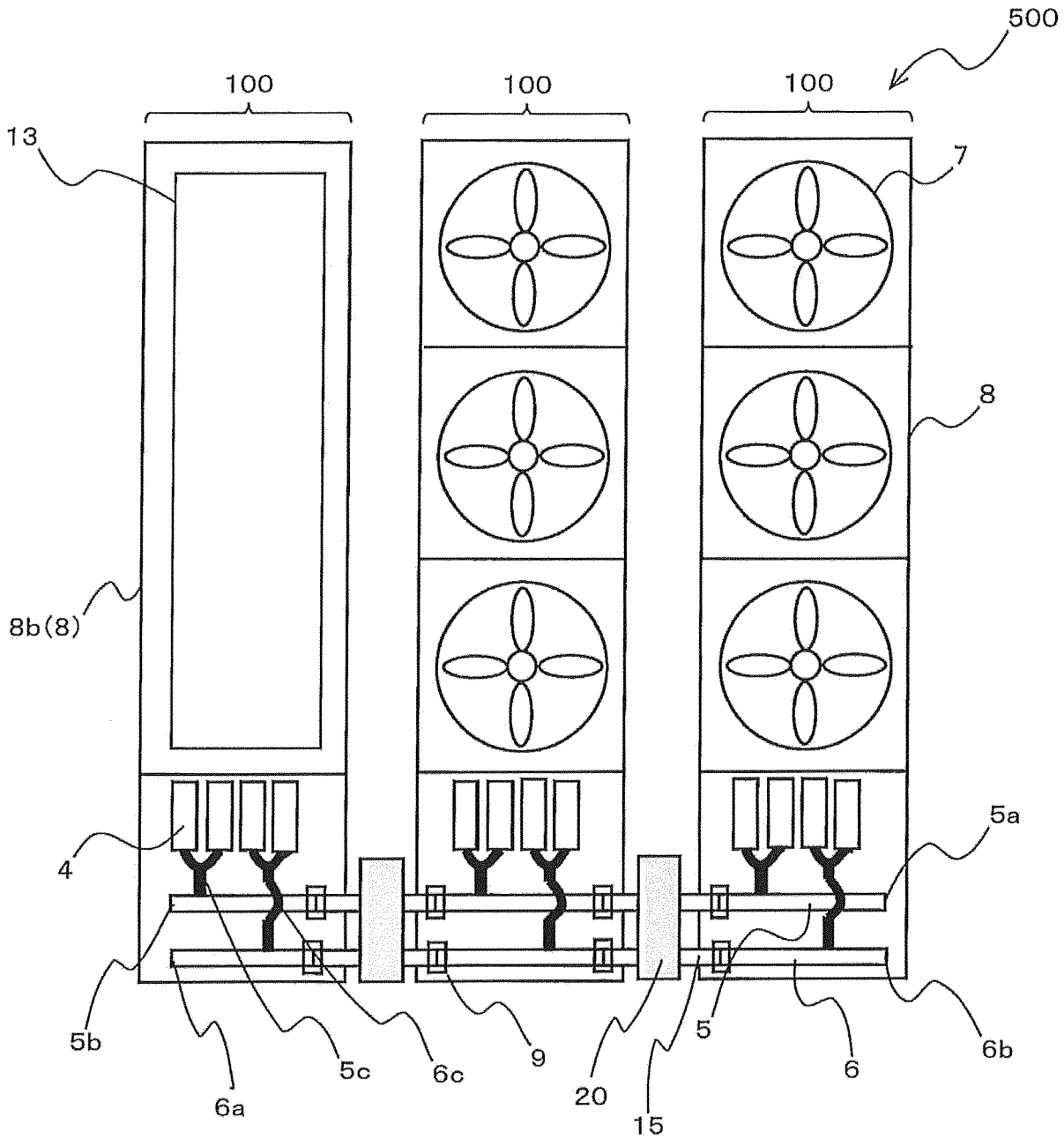


FIG. 11

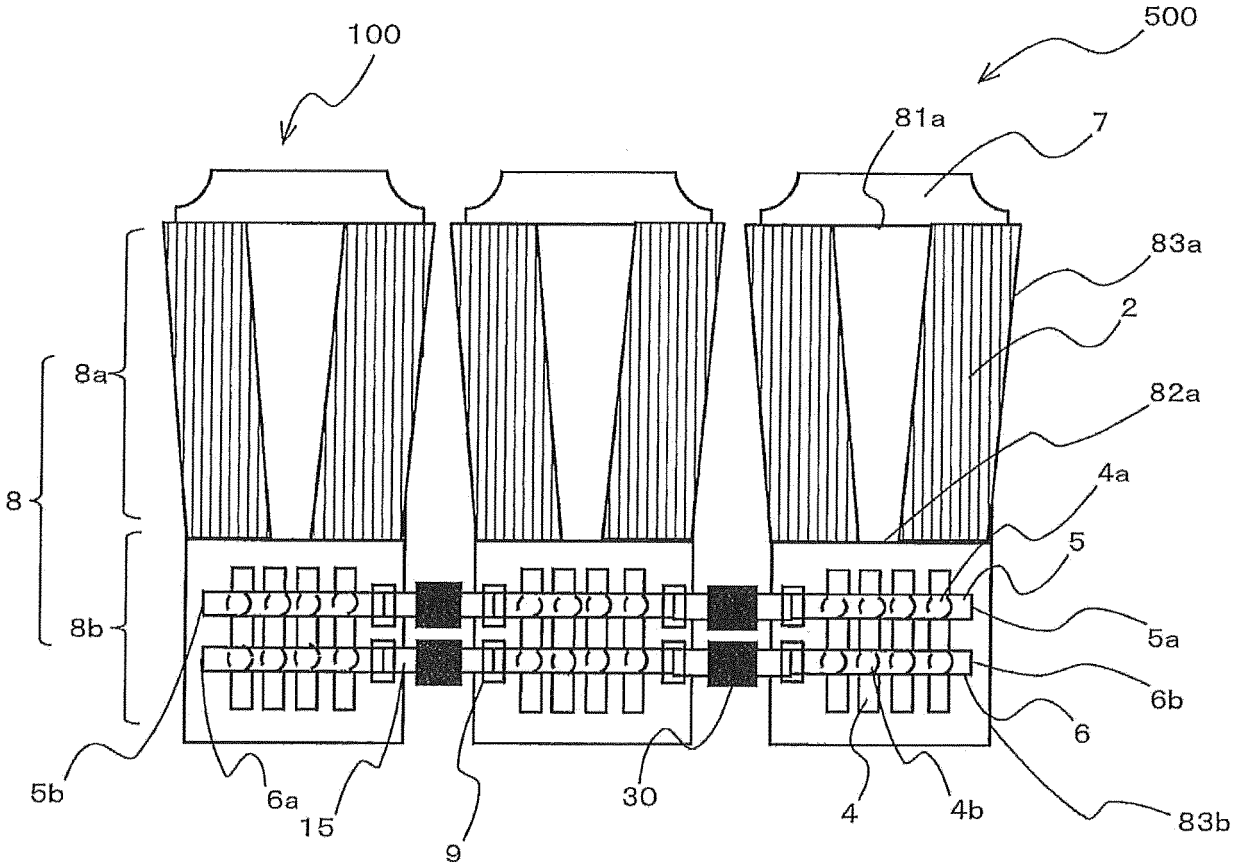
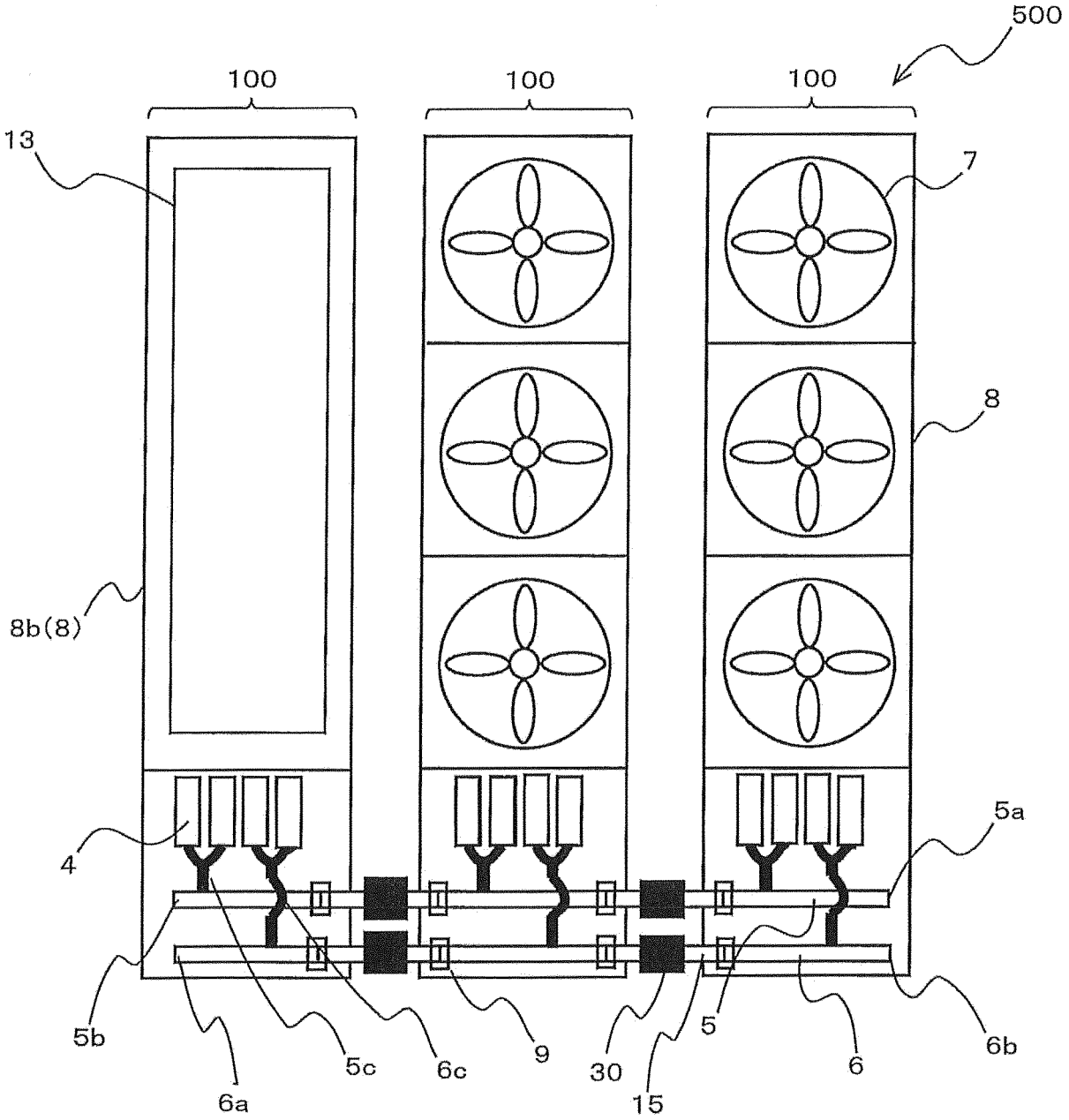


FIG. 12



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/066690

A. CLASSIFICATION OF SUBJECT MATTER
F25B41/00(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)
F25B41/00

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 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2012-247168 A (Mitsubishi Electric Corp.), 13 December 2012 (13.12.2012), paragraphs [0011] to [0028]; fig. 1 to 5 & CN 102809251 A & KR 10-2012-0134057 A	1-9,11 10
Y A	WO 2013/094049 A1 (Nihon Itomic Co., Ltd.), 27 June 2013 (27.06.2013), paragraphs [0001], [0021] to [0038]; fig. 1 to 7 & CN 104011473 A & KR 10-2014-0101363 A	1-9,11 10

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 August 2015 (11.08.15)	18 August 2015 (18.08.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

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Patent documents cited in the description

- JP 2008267724 A **[0003]**
- JP 2012247168 A **[0003]**