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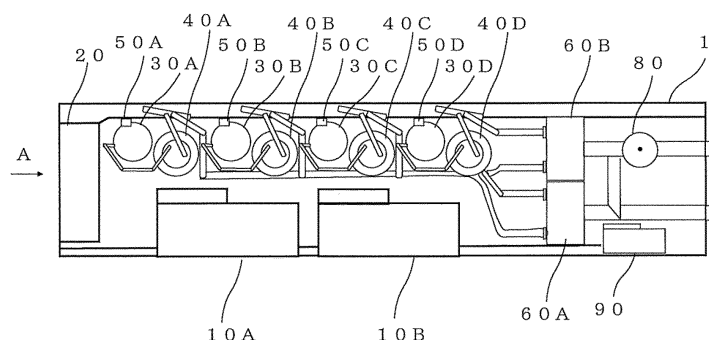
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(54) **CHILLING UNIT AND AIR CONDITIONING DEVICE**

(57) A chilling unit of the present disclosure includes a machine chamber being a housing with a rectangular bottom and accommodating therein devices forming each of a plurality of systems of refrigerant circuits, a plurality of heat-medium heat exchangers, each being configured to exchange heat between refrigerant and a heat medium serving as a heat delivering medium through the plurality of systems of refrigerant circuits, and each being configured to serve as a part of the devices

forming the refrigerant circuits, and a plurality of refrigerant circuit-side control boxes, each including an electric device configured to drive and control the devices forming the refrigerant circuits, wherein the plurality of refrigerant circuit-side control boxes are located next to each other in the machine chamber in a longitudinal direction thereof alongside one of longitudinal sides of the machine chamber.

FIG. 3



## Description

### Technical Field

**[0001]** The present disclosure relates to a chilling unit and an air-conditioning apparatus. The present disclosure particularly relates to a layout of devices and other components to be installed in a housing of the chilling unit.

### Background Art

**[0002]** There is a system including a chilling unit serving as a heat source unit, and a load unit. In this system, a heat-medium circulation circuit through which a heat medium including water or brine is circulated is formed between the chilling unit and the load unit to perform air-conditioning and other control. The chilling unit heats or cools the heat medium to supply heat to the load unit. The load unit provides heat supplied via the heat medium to a heat load. In an air-conditioning system, a load unit performs air-conditioning by heating or cooling air in the room.

**[0003]** There is a chilling unit, in which devices forming each of a plurality of independent refrigerant circuits are installed (see, for example, Patent Literature 1). In the chilling unit, control-system devices are also installed, such as a control board and a power module. The control board includes a controller to control the constituent devices of the refrigerant circuit, such as a compressor and an air-sending device. The power module constitutes an inverter device or other device. In general, control-system devices are accommodated in a control box. In a case where a chilling unit includes a plurality of independent systems of refrigerant circuits therein, a plurality of control boxes may be installed corresponding to the refrigerant circuits to be controlled.

### Citation List

#### Patent Literature

**[0004]** Patent Literature 1: Japanese Patent Publication No. 5401563

### Summary of Invention

#### Technical Problem

**[0005]** A worker may sometimes perform maintenance work on control-system devices, such as adjusting settings on the constituent devices of the refrigerant circuit or repairing problems. When a worker performs maintenance work on control-system devices accommodated in a plurality of control boxes, the worker needs to gain access to the control boxes from multiple sides of the chilling unit by moving from one side to the other side during the maintenance work. This results in degradation

in work efficiency, and impairs ease of work.

**[0006]** There may be some cases where a plurality of chilling units are arranged in parallel to each other. At this time, if a plurality of control boxes are located on opposite sides of each of the chilling units, workers may perform maintenance work on the chilling units in work-spaces overlapping one another. When the chilling units are arranged with a narrow spacing between them, it is difficult to ensure an adequate workspace for each of the workers. There may be a possibility that ease of work is impaired.

**[0007]** The present disclosure has been achieved to solve the above problems, and it is an object of the present disclosure to provide a chilling unit that can improve ease of work, and provide an air-conditioning apparatus.

#### Solution to Problem

**[0008]** A chilling unit according to one embodiment of the present disclosure includes a machine chamber being a housing with a rectangular bottom and accommodating therein devices forming each of a plurality of systems of refrigerant circuits, a plurality of heat-medium heat exchangers, each being configured to exchange heat between refrigerant and a heat medium serving as a heat delivering medium through the plurality of systems of refrigerant circuits, and each being configured to serve as a part of the devices forming the refrigerant circuits, and a plurality of refrigerant circuit-side control boxes, each including an electric device configured to drive and control the devices forming the refrigerant circuits, wherein the plurality of refrigerant circuit-side control boxes are located next to each other in the machine chamber in a longitudinal direction thereof alongside one of longitudinal sides of the machine chamber.

**[0009]** An air-conditioning apparatus according to another embodiment of the present disclosure forms a heat-medium circulation circuit through which a heat medium is circulated by connecting the chilling unit described above and an indoor unit by pipes, the indoor unit including an indoor heat exchanger and a flow-rate adjustment device, the indoor heat exchanger being configured to exchange heat between the heat medium and indoor air to be air-conditioned, the flow-rate adjustment device being installed corresponding to the indoor heat exchanger and configured to adjust a flow rate of the heat medium passing through the indoor heat exchanger.

#### Advantageous Effects of Invention

**[0010]** According to the embodiments of the present disclosure, the chilling unit is of a configuration in which the plurality of refrigerant circuit-side control boxes are located next to each other in a longitudinal direction of the machine chamber alongside only one of the longitudinal sides thereof. This configuration allows a worker to work on the refrigerant circuit-side control boxes on one

side of the machine chamber without moving to the other side during the work.

#### Brief Description of Drawings

##### [0011]

[Fig. 1] Fig. 1 illustrates the external appearance of a chilling unit according to Embodiment 1.

[Fig. 2] Fig. 2 illustrates the configuration of an air-conditioning apparatus, centering on the chilling unit according to Embodiment 1.

[Fig. 3] Fig. 3 is an explanatory diagram describing the device layout in a machine chamber of the chilling unit according to Embodiment 1.

[Fig. 4] Fig. 4 is an explanatory diagram describing the layout relationship between a power-supply terminal box and each refrigerant circuit-side control box in the machine chamber according to Embodiment 1.

[Fig. 5] Fig. 5 is an explanatory diagram describing the configuration of a refrigerant circuit-side control box according to Embodiment 1.

#### Description of Embodiments

[0012] Hereinafter, a chilling unit and an air-conditioning apparatus according to embodiments of the present disclosure will be described with reference to the drawings. In the drawings below, like reference signs denote the like or corresponding components, and are common throughout the entire descriptions of the embodiments described below. In addition, the relationship of sizes of the constituent components in the drawings may differ from that of actual ones. The forms of the constituent elements represented throughout the entire specification are merely examples, and do not intend to limit the constituent elements to the forms described in the specification. In particular, the combination of constituent elements is not limited to only the combination in each embodiment, and the constituent elements described in one embodiment can be applied to another embodiment. Further, the level of the pressure and temperature is not particularly determined in relation to an absolute value, but is determined relative to the conditions or operation of a device or the like. When it is not necessary to distinguish or specify a plurality of devices of the same type that are distinguished from each other by subscripts, the subscripts may be omitted.

#### Embodiment 1.

[0013] Fig. 1 illustrates the external appearance of a chilling unit according to Embodiment 1. In Fig. 1, a chilling unit 100 is described as a typical heat source unit to supply heat to indoor units 200 serving as a load-side device which will be described later. In Embodiment 1, a heat medium that delivers heat supplied from the chilling

unit 100 and provides the heat to the indoor units 200 is assumed to be water. However, the heat medium is not limited to water, but may be brine or other fluids.

[0014] The chilling unit 100 includes a machine chamber 1, air heat exchangers 2, and outdoor fans 3. The machine chamber 1 is a housing in which devices forming the refrigerant circuit, and other devices are accommodated. Since the machine chamber 1 is provided at the lower portion of the chilling unit 100 to serve as a base portion supporting the chilling unit 100, the machine chamber 1 is the housing with a rectangular bottom. The machine chamber 1 in Embodiment 1 is the housing in the shape of a cuboid box. In the machine chamber 1, the direction extending along the longer side of the housing is defined as a longitudinal direction, while the direction extending along the shorter side of the housing is defined as a shorter-side direction. A direction perpendicular to the longitudinal direction and the shorter-side direction is defined as a height direction. The machine chamber 1 will be described later.

[0015] Each of the air heat exchangers 2 is one of the devices forming the refrigerant circuit. The air heat exchangers 2 are fin-and-tube heat exchangers to exchange heat between refrigerant and outdoor air. As will be described later, the chilling unit 100 in Embodiment 1 includes a plurality of systems of refrigerant circuits, that is, in this case, four systems of refrigerant circuits. Due to this configuration, in the chilling unit 100 in Embodiment 1, four air heat exchangers 2A to 2D are installed on the top of the machine chamber 1. The air heat exchanger 2A and the air heat exchanger 2B are paired together, while the air heat exchanger 2C and the air heat exchanger 2D are paired together. A pair of air heat exchangers 2 is located facing each other with the spacing between the air heat exchangers 2 being increased toward the top side, such that the pair of air heat exchangers 2 forms a V-shape when the chilling unit 100 is viewed from the shorter-side of the machine chamber 1 as illustrated by the arrow A. In the chilling unit 100 in Embodiment 1, two pairs of air heat exchangers 2 are located next to each other along the longitudinal direction of the machine chamber 1.

[0016] The outdoor fans 3 are propeller fans to cause the outdoor air to pass through the air heat exchangers 2. The outdoor fans 3 are located on the top side of the pair of air heat exchangers 2 at a position in the V-shape formed between the pair of air heat exchangers 2. The chilling unit 100 in Embodiment 1 includes four outdoor fans 3A to 3D.

[0017] Fig. 2 illustrates the configuration of an air-conditioning apparatus, centering on the chilling unit according to Embodiment 1. As illustrated in Fig. 2, the chilling unit 100 in Embodiment 1 includes four systems of refrigerant circuits. Two of the four systems of refrigerant circuits are grouped together to share a single unit of water heat exchanger 60. The chilling unit 100 has two groups, each including two systems of refrigerant circuits. In a heat-medium circulation circuit, two units of water

heat exchangers 60 are connected in series by pipes to cool or heat water that is a heat medium in two stages.

**[0018]** As illustrated in Fig. 2, in each system of refrigerant circuit in the chilling unit 100 in Embodiment 1, a compressor 30, a four-way valve 50, the air heat exchanger 2, an expansion valve 70, the water heat exchanger 60, and an accumulator 40 are connected by pipes respectively to form the refrigerant circuit. Examples of the refrigerant to be used include a single refrigerant such as R-22 and R-134a, a near-azeotropic refrigerant mixture such as R-410A and R-404A, and a non-azeotropic refrigerant mixture such as R-407C. Examples of the refrigerant to be used also include a refrigerant having a relatively small value of global warming potential, and represented by the chemical formula  $\text{CF}_3\text{CF}=\text{CH}_2$  containing a double bond, a mixture with this refrigerant, and a natural refrigerant such as  $\text{CO}_2$  and propane.

**[0019]** Compressors 30 (compressors 30A to 30D) compress suctioned refrigerant and discharge the compressed refrigerant. Each of the compressors 30 is driven through a compressor inverter drive device (not illustrated) and other devices. Each of the compressors 30 optionally changes the driving frequency on the basis of an instruction from a refrigerant circuit-side control device (not illustrated), and can thereby change the capacity of the compressor 30, which is the amount of refrigerant to be delivered per unit time. The inverter drive device and the refrigerant circuit-side control device are control-system devices accommodated in a refrigerant circuit-side control box 10 which will be described later.

**[0020]** Four-way valves 50 (four-way valves 50A to 50D) serve as a flow-passage switching device, and switch between flow directions of refrigerant depending on the mode of operation to be performed, on the basis of an instruction from the refrigerant circuit-side control device described above. For example, during cooling operation, each of the four-way valves 50 allows high-temperature high-pressure refrigerant discharged from the compressor 30 to flow into the air heat exchanger 2. During heating operation, each of the four-way valves 50 allows high-temperature high-pressure refrigerant discharged from the compressor 30 to flow into the water heat exchanger 60.

**[0021]** The air heat exchangers 2 (air heat exchangers 2A to 2D) exchange heat between refrigerant and the outside air as described above. During heating operation to heat water, each of the air heat exchangers 2 functions as an evaporator, and exchanges heat between air and low-pressure refrigerant having flowed into the air heat exchanger 2 through the expansion valve 70 to evaporate and vaporize the refrigerant. During cooling operation to cool water, each of the air heat exchangers 2 functions as a condenser, and exchanges heat between air and low-pressure refrigerant having flowed into the air heat exchanger 2 through the compressor 30 to condense and liquefy the refrigerant. The outdoor fans 3 (outdoor fans 3A to 3D) deliver air to the air heat exchangers 2 to help

heat exchange between the refrigerant and the air, as described above. The outdoor fans 3 are driven through a fan inverter drive device (not illustrated) and other devices. Each of the outdoor fans 3 optionally changes the driving frequency on the basis of an instruction from the refrigerant circuit-side control device described above, and can thereby change the airflow amount. In Fig. 2, the air heat exchanger 2 and the outdoor fan 3 are brought into one-to-one correspondence, but are not particularly limited to this configuration.

**[0022]** The water heat exchangers 60 (water heat exchangers 60A and 60B) serve as a heat-medium heat exchanger, and exchange heat between refrigerant and water that is a heat medium. Each of the water heat exchangers 60 serves as a flow passage of the two systems of refrigerant circuits, and also serves as a flow passage of the heat-medium circulation circuit. Therefore, the water heat exchanger 60 is a device forming the refrigerant circuit, while being a device forming the heat-medium circulation circuit. For example, the water heat exchanger 60 functions as a condenser during heating operation, and exchanges heat between water and refrigerant having flowed into the water heat exchanger 60 through the compressor 30 to condense and liquefy the refrigerant, or to condense the refrigerant to be brought into a two-phase gas-liquid state, thereby heating the water. In contrast, the water heat exchanger 60 functions as an evaporator during cooling operation, and exchanges heat between water and refrigerant having flowed into the water heat exchanger 60 through the expansion valve 70 to evaporate and vaporize the refrigerant, thereby cooling the water.

**[0023]** Expansion valves 70 (expansion valves 70A to 70D) serve as an expansion device and, for example, change the opening degree to adjust the pressure and other conditions of refrigerant passing through the water heat exchangers 60. Each of the expansion valves 70 in Embodiment 1 is made up of an electronic expansion valve that can change the opening degree on the basis of an instruction from the refrigerant circuit-side control device described above. However, the expansion valve 70 is not limited to being made up of this electronic expansion valve. For example, the expansion valve 70 may also be a thermostatic expansion valve that can change the opening degree on the basis of the temperature of refrigerant.

**[0024]** Accumulators 40 (accumulators 40A to 40D) are provided on the suction side of the compressors 30 to accumulate therein extra refrigerant for the refrigerant circuit.

**[0025]** The pump 80 is one of the devices forming the heat-medium circulation circuit. The pump 80 draws water and applies a pressure to the water to be delivered and circulated through the heat-medium circulation circuit. A pump inverter drive device (not illustrated) optionally changes the driving frequency on the basis of an instruction from a pump-side control device (not illustrated), and can thereby change the capacity of the pump

80. The pump inverter drive device and the pump-side control device are control-system devices accommodated in a pump control box 90 which will be described later.

**[0026]** The indoor units 200 deliver conditioned air to a room space to be air-conditioned. The indoor units 200 (indoor units 200A and 200B) in Embodiment 1 illustrated in Fig. 2 include indoor heat exchangers 201 (indoor heat exchangers 201A and 201B), indoor flow-rate adjustment devices 202 (indoor flow-rate adjustment devices 202A and 202B), and indoor fans 203 (indoor fans 203A and 203B). The indoor heat exchangers 201 and the indoor flow-rate adjustment devices 202 are the devices forming the heat-medium circulation circuit. Fig. 2 illustrates the air-conditioning apparatus including two units of indoor units 200, however, the number of indoor units 200 is not particularly limited.

**[0027]** Each of the indoor flow-rate adjustment devices 202 is made up of, for example, a two-way valve that can control the opening degree (opening area) of the valve, and other elements. The indoor flow-rate adjustment device 202 controls the flow rate of water flowing into/out of the indoor heat exchanger 201 by adjusting the opening degree of the valve. On the basis of the temperature of water flowing into the indoor unit 200, and the temperature of water flowing out of the indoor unit 200, the indoor flow-rate adjustment device 202 adjusts the amount of water passing through the indoor heat exchanger 201, such that the indoor heat exchanger 201 can exchange heat by the amount of heat according to a heat load in the room. When the indoor heat exchanger 201 does not need to exchange heat with the heat load, such as when the indoor unit 200 stops operation or turns the thermostat OFF, then the indoor flow-rate adjustment device 202 can fully close the valve to stop water supply to prevent the water from flowing into/out of the indoor heat exchanger 201. In Fig. 2, the indoor flow-rate adjustment device 202 is installed on a pipe through which water flows out of the indoor heat exchanger 201. However, the installation of the indoor flow-rate adjustment device 202 is not limited to this location. For example, the indoor flow-rate adjustment device 202 may be installed on a pipe through which water flows into the indoor heat exchanger 201.

**[0028]** The indoor heat exchanger 201 exchanges heat between water and the indoor air in the room space supplied from the indoor fan 203. When water cooler than air passes through a heat transfer tube, then the air is cooled and consequently the room space is cooled. The indoor fan 203 causes the air in the room space to pass through the indoor heat exchanger 201, thereby generating a flow of air returning to the room space.

**[0029]** Fig. 3 is an explanatory diagram describing the device layout in the machine chamber of the chilling unit according to Embodiment 1. Fig. 3 illustrates the interior of the machine chamber 1 when the interior of the machine chamber 1 is viewed from the top side. As described above, the machine chamber 1 of the chilling unit 100 in Embodiment 1 includes the devices forming the

refrigerant circuit, the devices forming the heat-medium circulation circuit, and the control-system devices configured to control these devices. Fig. 3 illustrates four compressors 30 (compressors 30A to 30D), four accumulators 40 (accumulators 40A to 40D), and four four-way valves 50 (four-way valves 50A to 50D). Fig. 3 also illustrates two water heat exchangers 60 (water heat exchangers 60A and 60B). The machine chamber 1 further includes four expansion valves 70 (expansion valves 70A to 70D) although the four expansion valves 70 are not illustrated in Fig. 3.

**[0030]** Furthermore, the machine chamber 1 includes the pump 80 that is the device forming the heat-medium circulation circuit through which water that is a heat medium is circulated. The machine chamber 1 further includes two refrigerant circuit-side control boxes 10 (refrigerant circuit-side control boxes 10A and 10B), in each of which the control-system devices and other devices are accommodated. The machine chamber 1 still further includes the pump control box 90 and a power-supply terminal box 20.

**[0031]** In the machine chamber 1 of the chilling unit 100 in Embodiment 1, the power-supply terminal box 20 is located nearest the arrow A-side illustrated in Figs. 1 and 3. Next to the power-supply terminal box 20, along-side one of the longitudinal sides extending in the longitudinal direction of the machine chamber 1, a plurality of refrigerant circuit-side control boxes 10 are located next to each other in the longitudinal direction of the machine chamber 1. The refrigerant circuit-side control boxes 10 will be described later. In addition, the devices forming the refrigerant circuit are located on the other longitudinal side of the machine chamber 1 opposite to the side on which the plurality of refrigerant circuit-side control boxes 10 are located. In the machine chamber 1 in Embodiment 1, the compressor 30, the accumulator 40, the four-way valve 50, and the expansion valve 70 are arranged collectively for each system of refrigerant circuit, and the systems of refrigerant circuits are located next to one another along the longitudinal direction. The compressors 30 and the accumulators 40 both have a relatively large volume, and thus are located next to each other along the other longitudinal side of the machine chamber 1. Therefore, the compressors 30 and the accumulators 40 are located in parallel to the plurality of refrigerant circuit-side control boxes 10 in the short-side direction of the machine chamber 1. Further, next to the plurality of refrigerant circuit-side control boxes 10, and next to the compressors 30 and the accumulators 40, a plurality of water heat exchangers 60 are located, that are the devices forming the refrigerant circuit, while being the devices forming the heat-medium circulation circuit. The pump 80 and the pump control box 90, both of which form the heat-medium circulation circuit, are located at a position furthest from the arrow A-side. Therefore, the devices of the refrigerant circuit, and the devices of the heat-medium circulation circuit are located separately from each other with the water heat exchangers 60 serving as

the boundary between these devices.

**[0032]** In the power-supply terminal box 20, a power-supply terminal (not illustrated) is accommodated. In the refrigerant circuit-side control boxes 10 and the pump control box 90, the electric devices, such as an inverter device including a power module to drive the devices, and a control board including a controller, are supplied with power through the power-supply terminal connected to the outside wire. For example, in a case where a plurality of chilling units 100 are installed, respective machine chambers 1 of the chilling units 100 are located with their longitudinal sides facing each other. Therefore, if a power-supply terminal is provided somewhere on the longitudinal side of the chilling unit 100, it is difficult to connect the outside wire to the power-supply terminal. For this reason, the power-supply terminal box 20 is accommodated in the machine chamber 1 at one end portion thereof located nearest the arrow A-side, such that the power-supply terminal can be seen from the short side of the machine chamber 1, and thus the outside wire can be easily connected to the power-supply terminal.

**[0033]** In contrast, the pump 80 is accommodated in the machine chamber 1 at another end portion thereof located furthest from the arrow A-side on the other side of the end portion in which the power-supply terminal box 20 is accommodated. The pump 80 is one of the devices forming the heat-medium circulation circuit. Next to the pump 80, the plurality of water heat exchangers 60 are located, which are the devices forming the refrigerant circuit, and also forming the heat-medium circulation circuit. For example, the pump 80 and the plurality of water heat exchangers 60 accommodated in the machine chamber 1 of the chilling unit 100 need to be connected by pipes to another device including the devices forming the heat-medium circulation circuit. In view of that, the pump 80 is accommodated in the machine chamber 1 at another end portion thereof located furthest from the arrow A-side, such that heat-medium pipes connected to the pump 80 and the plurality of water heat exchangers 60 can be seen from the shorter-side face of the machine chamber 1, and thus the another device is easily connected to the heat-medium pipes. The pump control box 90 is located at a position adjacent to the pump 80 on the longitudinal side of the machine chamber 1, that is, on the same side on which the plurality of refrigerant circuit-side control boxes 10 are located. Therefore, a worker can perform maintenance of the electric devices in the pump control box 90 without the need for moving to the other longitudinal side.

**[0034]** Fig. 4 is an explanatory diagram describing the layout relationship between the power-supply terminal box and each refrigerant circuit-side control box in the machine chamber according to Embodiment 1. In Embodiment 1, in one refrigerant circuit-side control box 10, the devices configured to drive and control a group of two systems of refrigerant circuits are accommodated. Therefore, the chilling unit 100 in Embodiment 1 has two refrigerant circuit-side control boxes 10A and 10B ac-

commodated in the machine chamber 1. A power supply line 21 extending from the power-supply terminal box 20 is connected to each refrigerant circuit-side control box 10.

**[0035]** As illustrated in Figs. 3 and 4, in the machine chamber 1 of the chilling unit 100 in Embodiment 1, the plurality of refrigerant circuit-side control boxes 10 are located next to each other in the longitudinal direction of the machine chamber 1 alongside one of the longitudinal sides of the machine chamber 1. The plurality of refrigerant circuit-side control boxes 10 are located next to each other alongside one of the longitudinal sides of the machine chamber 1, so that a worker can work on the plurality of refrigerant circuit-side control boxes 10 in a workspace on one of the longitudinal sides of the machine chamber 1. This eliminates the need for a worker to work in separated spaces on opposite longitudinal sides. Thus, the worker can perform maintenance and other work on the plurality of refrigerant circuit-side control boxes 10 in a workspace on one of the longitudinal sides without moving to the other longitudinal side. Even in a case where a plurality of chilling units 100 are installed next to one another in the shorter-side direction, the workspaces for the chilling units 100 do not overlap one another. This allows a plurality of workers to smoothly perform maintenance and other work on the plurality of chilling units 100.

**[0036]** Each of the refrigerant circuit-side control boxes 10 includes a compression-board heat sink 11 (compression-board heat sinks 11A and 11B) and a fan-board heat sink 12 (fan-board heat sinks 12A and 12B). Each of the refrigerant circuit-side control boxes 10 further includes a heat-sink cooling fan 13 (heat-sink cooling fans 13A and 13B). The compression-board heat sink 11, the fan-board heat sink 12, and the heat-sink cooling fan 13 are installed on the outside of the refrigerant circuit-side control box 10.

**[0037]** Fig. 5 is an explanatory diagram describing the configuration of the refrigerant circuit-side control box according to Embodiment 1. Fig. 5 illustrates the refrigerant circuit-side control box 10 viewed from the side. The compression-board heat sink 11 is in contact with a power module included in the compressor inverter drive device configured to drive the compressor 30 and accommodated in the refrigerant circuit-side control box 10 to transfer heat generated by the power module driving the devices. The fan-board heat sink 12 is in contact with a power module included in the fan inverter drive device configured to drive the outdoor fans 3 and accommodated in the refrigerant circuit-side control box 10 to transfer heat generated by the power module driving the devices. As illustrated in Fig. 5, the heat-sink cooling fan 13 delivers air to the compression-board heat sink 11 and the fan-board heat sink 12 from below them to help transfer heat from the compression-board heat sink 11 and the fan-board heat sink 12. The heat-sink cooling fan 13 forms a flow of air that flows from the lower portion of the heat sinks toward the upper portion thereof, so that heat can

be efficiently transferred from the heat sinks.

**[0038]** In the machine chamber 1 of the chilling unit 100 in Embodiment 1, a plurality of refrigerant circuit-side control boxes 10 of the same configuration (refrigerant circuit-side control boxes 10A and 10B) are located next to each other along the longitudinal direction. As illustrated in Fig. 4, this allows the compression-board heat sink 11A and the fan-board heat sink 12A to be located separately from the compression-board heat sink 11B and the fan-board heat sink 12B in the machine chamber 1, instead of the compression-board heat sink 11A and the fan-board heat sink 12A being located in proximity to the compression-board heat sink 11B and the fan-board heat sink 12B. Therefore, this can prevent the temperature from increasing in a particular area of the machine chamber 1, and can reduce variations in the temperature in the machine chamber 1.

**[0039]** As described above, the chilling unit 100 in Embodiment 1 is of a configuration in which a plurality of refrigerant circuit-side control boxes 10 are located next to each other in the longitudinal direction of the machine chamber 1 alongside one of the longitudinal sides of the machine chamber 1. The plurality of refrigerant circuit-side control boxes 10 are arranged alongside only one side of the machine chamber 1, so that a worker can perform maintenance and other work on the plurality of refrigerant circuit-side control boxes 10 on one side of the machine chamber 1 without moving to the other side. In addition, even in a case where a plurality of chilling units 100 are installed, the workspaces for the chilling units 100 do not overlap one another, so that workers can perform maintenance work on the chilling units 100 without interfering with each other. Further, the plurality of refrigerant circuit-side control boxes 10 are located next to each other along the longitudinal direction of the machine chamber 1, and this can ensure an adequate workspace for workers. Furthermore, the plurality of refrigerant circuit-side control boxes 10 are located next to each other along the longitudinal direction of the machine chamber 1, and this allows the compression-board heat sink 11 and the fan-board heat sink 12 in each of the refrigerant circuit-side control boxes 10 to be located separately from those in another refrigerant circuit-side control box 10. This can reduce variations in the temperature in the machine chamber 1.

#### Embodiment 2.

**[0040]** In the chilling unit 100 in Embodiment 1 described above, the machine chamber 1 has been explained as being a housing in the shape of a cuboid box with a rectangular bottom. However, the machine chamber 1 is not limited to being this housing. For example, the machine chamber 1 may be a housing in the shape of a box with a trapezoidal cross section when viewed from the short side, or may be a housing in the shape of truncated square pyramid.

**[0041]** In Embodiment 1 described above, the chilling

unit 100 of a commonly-called "dual configuration" has been explained, in which two systems of refrigerant circuits are grouped together to share a single unit of water heat exchanger 60. However, the configuration of the chilling unit 100 is not limited thereto. The chilling unit 100 may be of a commonly-called "single configuration" in which refrigerant is circulated through a single system of refrigerant circuit such that a single unit of water heat exchanger 60 exchanges heat between the refrigerant and a heat medium.

**[0042]** In the chilling unit 100 in Embodiment 1 described above, the heat-sink cooling fan 13 is driven to deliver air to cool the compression-board heat sink 11 and the fan-board heat sink 12. However, the chilling unit 100 is not limited to this cooling method. For example, in the machine chamber 1 of the chilling unit 100, the refrigerant circuit-side control boxes 10 are located on one of the longitudinal sides, while the devices forming the refrigerant circuit are located on the other longitudinal side, as described above. In view of this layout, the compression-board heat sink 11 and the fan-board heat sink 12 may be in direct contact with a refrigerant pipe on the suction side of the compressor 30, through which low-temperature refrigerant passes, in the refrigerant circuit, or may be in contact with the refrigerant pipe through a medium, to transfer heat. Alternately, the compression-board heat sink 11 and the fan-board heat sink 12 may be in direct contact with the accumulator 40, or in contact with the accumulator 40 through a medium. A contact of the heat sinks with the refrigerant pipe or other device can be employed in combination with the heat-sink cooling fan 13. For example, when the heat sinks are brought into contact with the refrigerant pipe through a medium, grease or other material is applied or a plate is attached to the refrigerant pipe to increase the contact area.

**[0043]** The chilling unit 100 in Embodiment 1 described above is of a configuration in which the pump 80 and the pump control box 90 are accommodated in the machine chamber 1. However, the chilling unit 100 is not limited to this configuration. The chilling unit 100 may also be of a configuration in which the chilling unit 100 does not include the pump 80 or the pump control box 90.

#### Reference Signs List

**[0044]** 1: machine chamber, 2, 2A, 2B, 2C, 2D: air heat exchanger, 3, 3A, 3B, 3C, 3D: outdoor fan, 10, 10A, 10B: refrigerant circuit-side control box, 11, 11A, 11B: compression-board heat sink, 12, 12A, 12B: fan-board heat sink, 13, 13A, 13B: heat-sink cooling fan, 20: power-supply terminal box, 21: power supply line, 30, 30A, 30B, 30C, 30D: compressor, 40, 40A, 40B, 40C, 40D: accumulator, 50, 50A, 50B, 50C, 50D: four-way valve, 60, 60A, 60B: water heat exchanger, 70, 70A, 70B, 70C, 70D: expansion valve, 80: pump, 90: pump control box, 100: chilling unit, 200, 200A, 200B: indoor unit, 201, 201A, 201B: indoor heat exchanger, 202, 202A, 202B: indoor flow-rate adjustment device, 203, 203A, 203B: indoor fan

**Claims****1.** A chilling unit comprising

a machine chamber being a housing with a rectangular bottom and accommodating therein 5

devices forming each of a plurality of systems of refrigerant circuits, a plurality of heat-medium heat exchangers, each being configured to exchange heat between refrigerant and a heat medium serving as a heat delivering medium through the plurality of systems of refrigerant circuits, and each being configured to serve as a part of the devices forming the refrigerant circuits, and 10  
a plurality of refrigerant circuit-side control boxes, each including an electric device configured to drive and control the devices forming the refrigerant circuits, wherein 15

the plurality of refrigerant circuit-side control boxes are located next to each other in the machine chamber in a longitudinal direction thereof alongside one of longitudinal sides of the machine chamber. 25

**2.** The chilling unit of claim 1, wherein the machine chamber accommodates therein a compressor and an accumulator of the devices forming the refrigerant circuits, the compressor being configured to compress and discharge the refrigerant, the accumulator being configured to store therein the refrigerant, and the compressor and the accumulator in the plurality of systems of refrigerant circuits are located alongside an other longitudinal side of the machine chamber in parallel to the refrigerant circuit-side control boxes in a short-side direction of the machine chamber. 30  
35  
40

**3.** The chilling unit of claim 2, wherein

on an outside of each of the refrigerant circuit-side control boxes, a heat sink is installed, the heat sink being configured to transfer heat generated by the electric device, and 45  
the heat sink is installed in contact with at least one of the accumulator and a pipe on a suction side of the compressor in the refrigerant circuits. 50

**4.** The chilling unit of any one of claims 1 to 3, wherein

the machine chamber further accommodates therein a pump and a pump control box, the pump being configured to apply a pressure to the heat medium to deliver the heat medium, the pump control box including an electric device 55

configured to drive and control the pump, and the pump control box is located on a same side as the longitudinal side on which the plurality of refrigerant circuit-side control boxes are located.

**5.** The chilling unit of any one of claims 1 to 4, wherein two systems of refrigerant circuits each being one of the plurality of systems of refrigerant circuits are connected in parallel to one of the heat-medium heat exchangers, and the plurality of heat-medium heat exchangers are connected in series to a flow passage of the heat medium.

**6.** An air-conditioning apparatus forming a heat-medium circulation circuit through which a heat medium is circulated by connecting, by pipes,

the chilling unit of any one of claims 1 to 5 and an indoor unit including an indoor heat exchanger and a flow-rate adjustment device, the indoor heat exchanger being configured to exchange heat between the heat medium and indoor air to be air-conditioned, the flow-rate adjustment device being installed corresponding to the indoor heat exchanger and configured to adjust a flow rate of the heat medium passing through the indoor heat exchanger.

FIG. 1

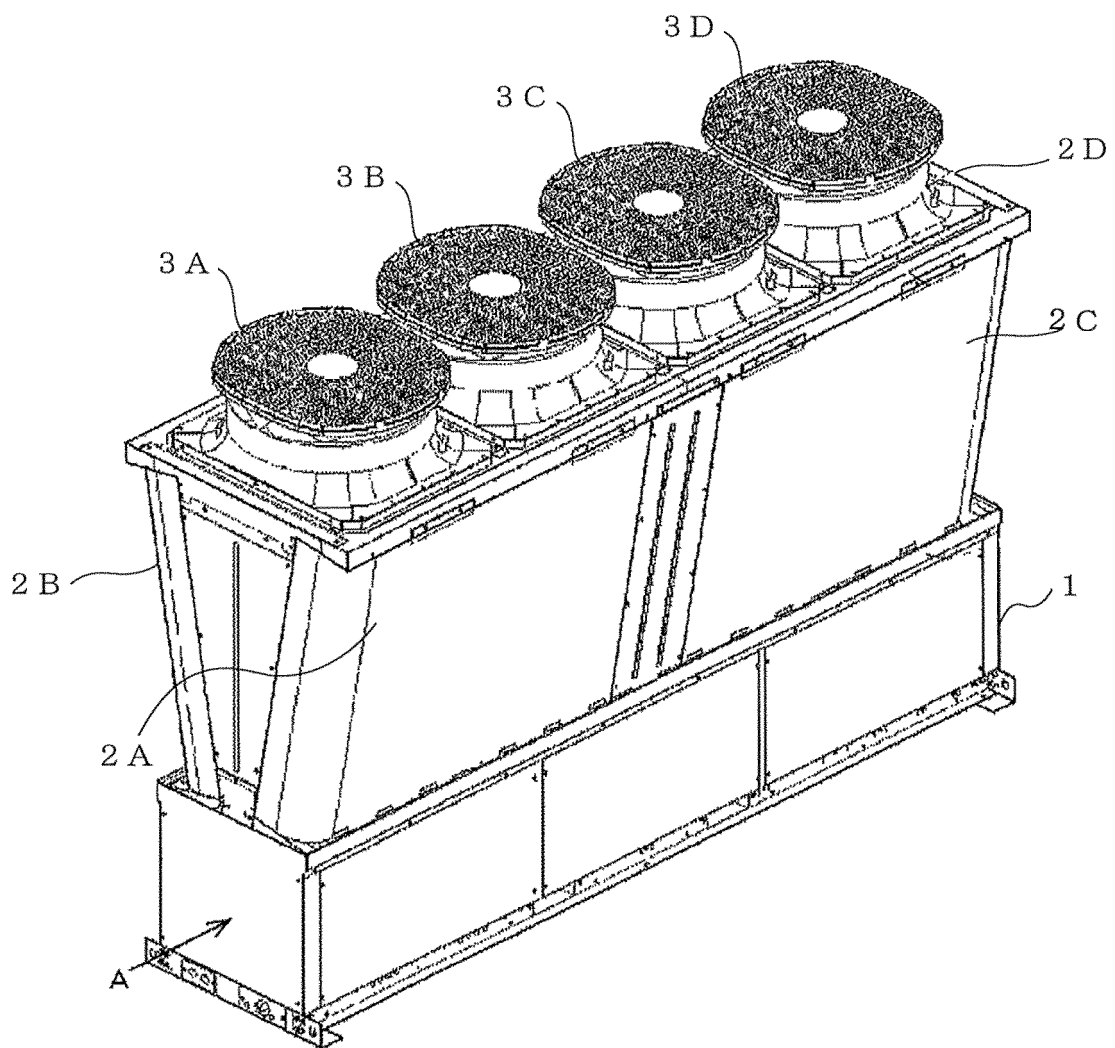


FIG. 2

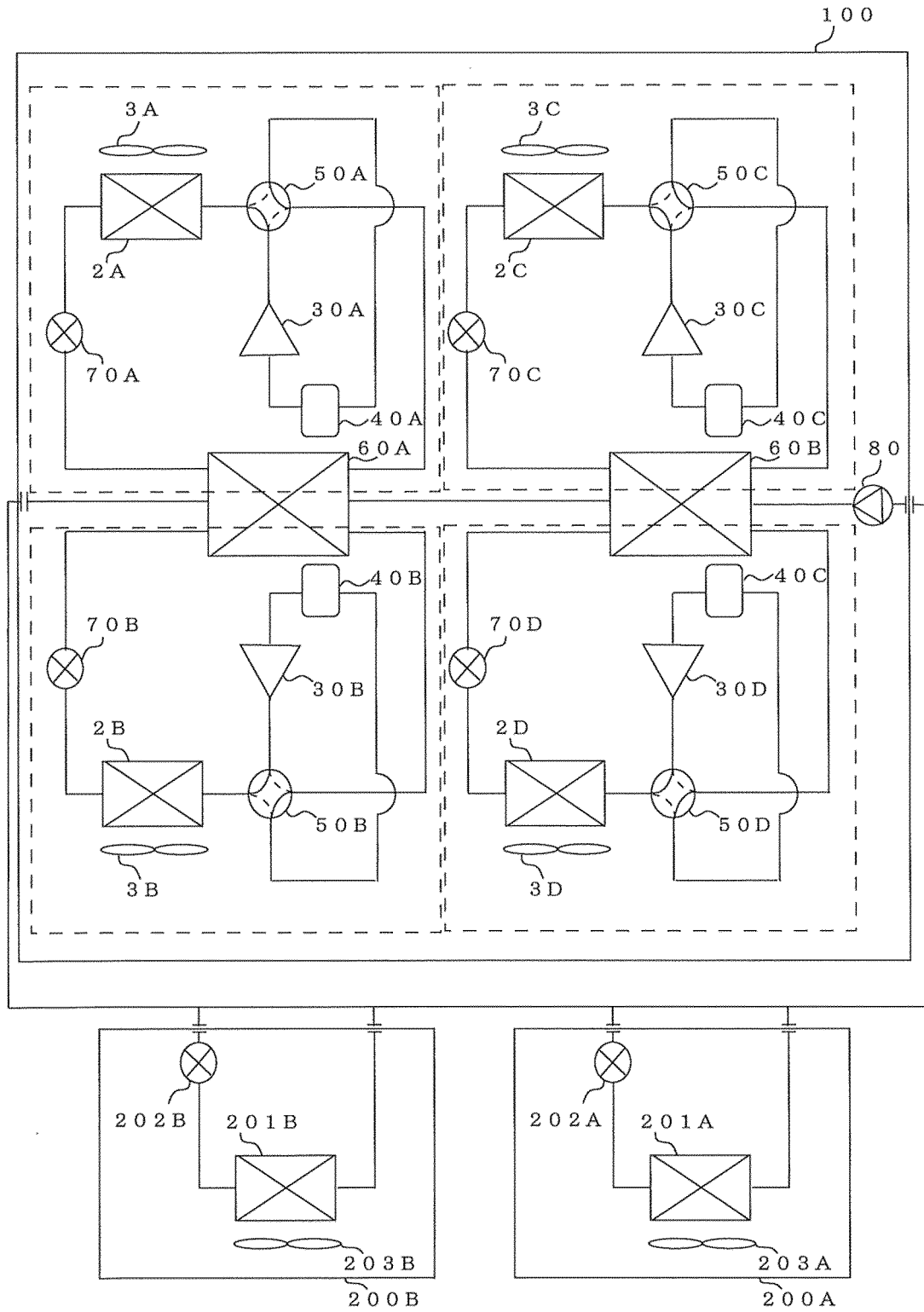


FIG. 3

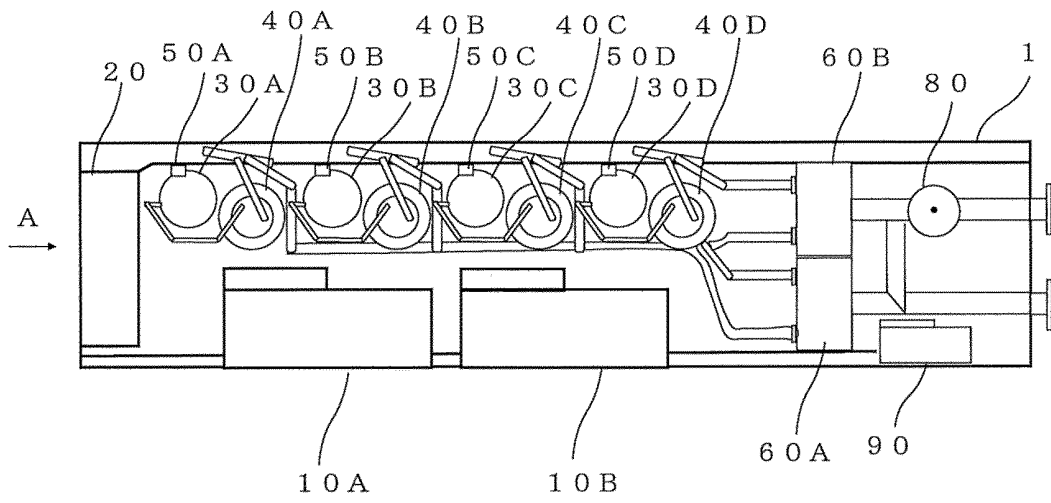


FIG. 4

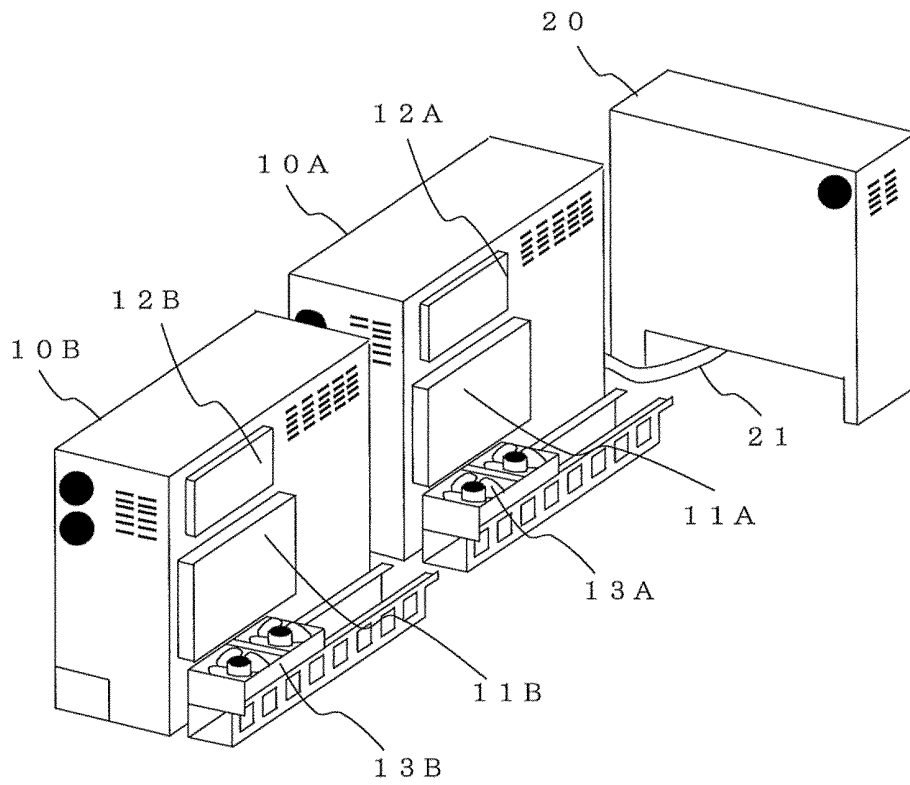
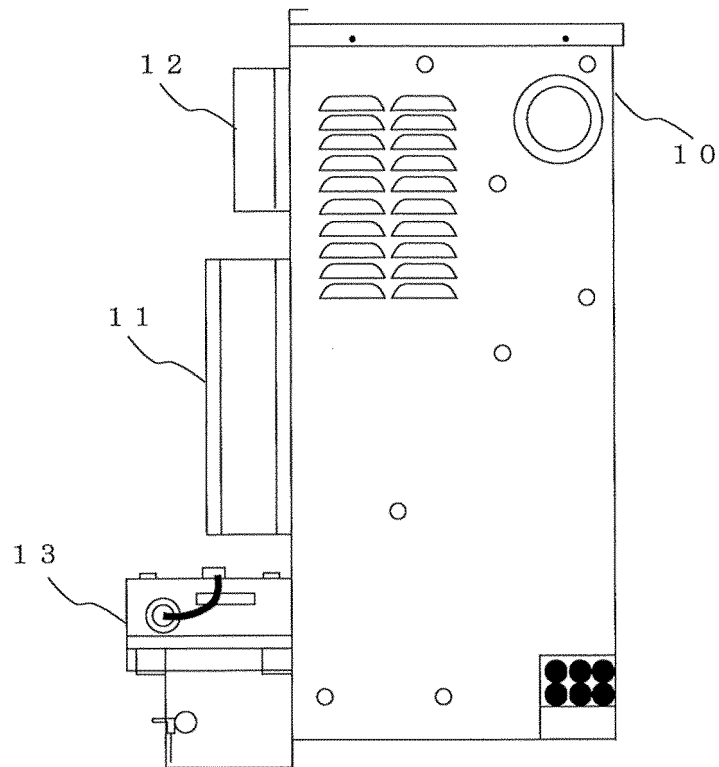


FIG. 5



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/031089

## A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F24F1/22 (2011.01) i, F25B49/02 (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)

Int.Cl. F24F1/22, F25B49/02

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                        | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | WO 2019/138910 A1 (MITSUBISHI HEAVY INDUSTRIES THERMAL SYSTEMS LTD.) 18 July 2019, paragraphs [0013]-[0039], fig. 1-5<br>(Family: none)   | 1-2                   |
| Y         | JP 5-187724 A (MITSUBISHI ELECTRIC CORPORATION) 27 July 1993, paragraphs [0008]-[0012], fig. 1-3<br>(Family: none)                        | 3-6                   |
| Y         | JP 2018-169144 A (MITSUBISHI HEAVY INDUSTRIES THERMAL SYSTEMS LTD.) 01 November 2018, paragraphs [0005], [0022], fig. 1<br>(Family: none) | 4-6                   |



Further documents are listed in the continuation of Box C.



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"&amp;" document member of the same patent family

Date of the actual completion of the international search  
30.09.2019Date of mailing of the international search report  
08.10.2019Name and mailing address of the ISA/  
Japan Patent Office  
3-4-3, Kasumigaseki, Chiyoda-ku,  
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/031089

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 4-39547 A (TOSHIBA CORPORATION) 10 February 1992, page 3, lower left column, lines 1-7, fig. 1 (Family: none)                                      | 6                     |
| A         | JP 2018-54249 A (DAIKIN INDUSTRIES, LTD.) 05 April 2018, entire text, all drawings<br>& WO 2018/061549 A1 & EP 3502592 A1 & CN 109791011 A            | 1-6                   |
| A         | WO 2011/099629 A1 (TOSHIBA CARRIER CORPORATION) 18 August 2011, entire text, all drawings<br>& CN 102753895 A & KR 10-2012-0116973 A & CN 105004027 A | 1-6                   |

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

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 5401563 B [0004]