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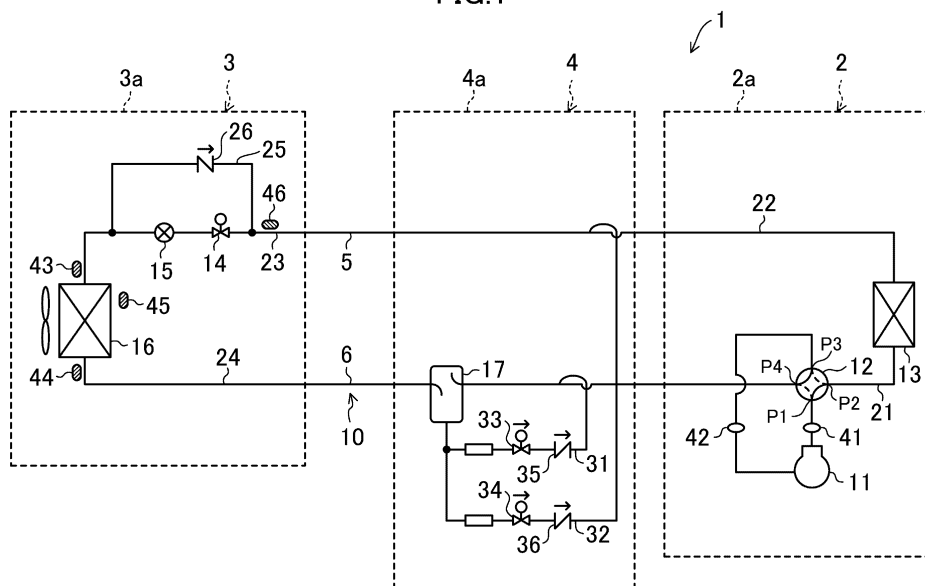
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(54) **GAS-LIQUID SEPARATION UNIT FOR REFRIGERATION DEVICE, AND REFRIGERATION DEVICE**

(57) A refrigeration apparatus (1), in which a heat-source-side unit (2) and a utilization-side unit (3) are connected, includes a gas-liquid separation unit (4) having a gas-liquid separator (17) connected to a gas-side connection pipe (6), a first oil return pipe (31)

connected to the gas-side connection pipe (6) from a bottom of a gas-liquid separator (17), and a first open/close valve (33) arranged at the first oil return pipe (31).

FIG.1



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a gas-liquid separation unit connected between a heat-source-side unit and a utilization-side unit of a refrigeration device (hereinafter refrigeration apparatus) with a refrigerant circuit, and a refrigeration apparatus including a gas-liquid separation unit connected between a heat-source-side unit and a utilization-side unit, or a refrigeration apparatus in which a heat-source-side unit includes a gas-liquid separation unit.

BACKGROUND ART

[0002] As shown in FIG. 4, conventionally, there has been known a refrigeration apparatus (50) including a refrigerant circuit (55) with a heat-source-side unit (2) and a utilization-side unit (cooling unit) (3) that are connected to each other by connection pipes (5, 6) (see, for example, Patent Document 1).

[0003] In his type of refrigeration apparatus (50), it is preferable to prevent wet operation with high wetness of refrigerant taken into a compressor at the time for start-up of cooling operation, for example, at the time of operation shift from a utilization-side-unit-off mode performing only blowing operation with cooling operation of an internal space of a utilization-side unit (3) stopped to a utilization-side-unit-on mode performing cooling of the internal space, or at the time of operation shift from a reverse cycle defrosting operation to the cooling operation.

[0004] Against this background, there has been proposed a refrigeration apparatus as the conventional refrigeration apparatus (50). As shown in FIG. 5, in this refrigeration apparatus, to make it possible for refrigerant to flow to an evaporator (cooling heat exchanger (16)) in the utilization-side unit (3) when the low pressure (LP) of a refrigerant circuit (55) drops below a predetermined value, for example, an open/close valve (cooling electromagnetic valve) (14) is arranged at a refrigerant inflow side of the evaporator (16) at the time of cooling operation (utilization-side-unit on) and controlled to open or close this open/close valve (14) in accordance with the variation in low pressure. This reduces the risk of excessive increase in flow rate of the refrigerant in the evaporator (16) at the time of operation shift from the utilization-side-unit off to the utilization-side-unit on or at the time of operation shift from reverse cycle defrosting operation to cooling operation, thereby keeping from wet operation.

[0005] FIG. 2 shows a refrigerant circuit. The reference characters (12) denote a four-way switching valve, the reference characters (13) denote a heat-source-side heat exchanger, and the reference characters (15) denote a cooling expansion valve (expansion mechanism). In the refrigerant circuit (55), the four-way switching valve (12) is switched to reverse the flow direction of refrigerant so that the reverse cycle defrosting operation is per-

formed.

CITATION LIST

5 PATENT DOCUMENTS

[0006] Patent Document 1: Japanese Unexamined Patent Publication No. 2010-223454

10 SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0007] The above-mentioned refrigeration apparatus (50) configured to reduce the risk of wet operation has exhibited the following problem: When a large-scale evaporator (cooling heat exchanger) (16) is used to enhance the dehumidification capacity or cooling capacity of the utilization-side unit (3) or to freeze (refrigerate) foods, for example, the operation time of the above open/close valve (14) increases, resulting in significantly long time required for start-up of the cooling operation.

[0008] In view of the foregoing background, it is therefore an object of the present disclosure to provide a refrigeration apparatus including a heat-source-side unit and a utilization-side unit connected to each other, where the risk of wet operation at the time for start-up of cooling operation can be reduced, and the time required for shift (time for start-up of cooling operation) from the reverse cycle defrosting operation to cooling operation or from the utilization-side-unit off to the utilization-side-unit on can be shortened compared to conventional cases even if, for example, the utilization-side unit includes a large-scale evaporator.

SOLUTION TO THE PROBLEM

[0009] According to the first aspect of the present disclosure, there is provided a gas-liquid separation unit connected to connection pipes (5, 6) between a heat-source-side unit (2) and a utilization-side unit (3) of a refrigeration apparatus (1).

[0010] The gas-liquid separation unit includes: a gas-liquid separator (17) connected to, of the connection pipes (5, 6), a gas-side connection pipe (6); a first oil return pipe (31) connected to a bottom of the gas-liquid separator (17) and to a position of the gas-side connection pipe (6) located closer to the heat-source-side unit (2) than the gas-liquid separator (17) is, the first oil return pipe (31) being configured to serve as an oil return pipe during a cooling operation during which a utilization-side heat exchanger (16) provided in the utilization-side unit (3) serves as an evaporator; and a first open/close valve (33) arranged at the first oil return pipe (31).

[0011] According to the first aspect, during the cooling operation of the refrigeration apparatus (1), high-pressure liquid refrigerant flows from the heat-source-side unit (2) through the liquid-side connection pipe (5) to the

utilization-side unit (3). Low-pressure gas refrigerant that has evaporated in the utilization-side heat exchanger (16) of the utilization-side unit (3) returns to the heat-source-side unit (2) through the gas-side connection pipe (6). The gas-side connection pipe (6) is provided with a gas-liquid separator (17) in which liquid refrigerant and oil are separated from gas refrigerant. The gas refrigerant flows out from the gas-liquid separator (17) through the gas-side connection pipe (6), and returns to the heat-source-side unit (2). The liquid refrigerant remains in the gas-liquid separator (17). The oil that has been separated from the gas refrigerant in the gas-liquid separator (17) flows into the gas-side connection pipe (6) through the first oil return pipe (31) from the bottom of the gas-liquid separator (17) by opening the first open/close valve (33), merges with the gas refrigerant flowing in the gas-side connection pipe (6), and returns to the heat-source-side unit (2).

[0012] According to the second aspect of the present disclosure, in the first aspect, there are provided: a second oil return pipe (32) connected to the bottom of the gas-liquid separator (17) and to, of the connection pipes (5, 6), a liquid-side connection pipe (5); and a second open/close valve (34) arranged at the second oil return pipe (32), wherein the second oil return pipe (32) serves as an oil return pipe during a defrosting operation during which the utilization-side heat exchanger (16) serves as the condenser.

[0013] According to the second aspect, during the reverse cycle defrosting operation of the refrigeration apparatus (1), high-pressure gas refrigerant flows from the heat-source-side unit (2) through the gas-side connection pipe (6) to the utilization-side unit (3). High-pressure liquid refrigerant that has dissipated heat in the utilization-side heat exchanger (16) serves as a radiator during defrosting in the utilization-side unit (3) returns to the heat-source-side unit (2) through the liquid-side connection pipe (5). The gas-side connection pipe (6) includes a gas-liquid separator (17) in which oil is separated from gas refrigerant. The oil that has been separated from the gas refrigerant in the gas-liquid separator (17) flows into the liquid-side connection pipe (5) through the second oil return pipe (32) from the bottom of the gas-liquid separator (17) by opening the second open/close valve (34), and merges with the liquid refrigerant flowing in the liquid-side connection pipe (5), returns to the heat-source-side unit (2). The function during the cooling operation is similar to that of the first aspect.

[0014] According to the third aspect of the present disclosure, a refrigeration apparatus comprises a heat-source-side unit (2), a utilization-side unit (3), and a gas-liquid separation unit (4) connected to connection pipes (5, 6) between the heat-source-side unit (2) and the utilization-side unit (3), in which the gas-liquid separation unit (4) is the gas-liquid separation unit (4) set forth in the first aspect, and the first oil return pipe (31) is connected to, of the connection pipes (5, 6), a gas-side connection pipe (6).

[0015] According to this third aspect, like in the first aspect, during the cooling operation of the refrigeration apparatus, high-pressure liquid refrigerant flows from the heat-source-side unit (2) through the liquid-side connection pipe (5) to the utilization-side unit (3). Low-pressure gas refrigerant that has evaporated in the heat-source-side heat exchanger (16) of the utilization-side unit (3) returns to the heat-source-side unit (2) through the gas-side connection pipe (6). The gas-side connection pipe (6) includes a gas-liquid separator (17) in which liquid refrigerant and oil are separated from gas refrigerant. The gas refrigerant flows out from the gas-liquid separator (17) through the gas-side connection pipe (6), and returns to the heat-source-side unit (2). The liquid refrigerant remains in the gas-liquid separator (17). The oil that has been separated from the gas refrigerant in the gas-liquid separator (17) flows into the gas-side connection pipe (6) through the first oil return pipe (31) from the bottom of the gas-liquid separator (17) by opening the first open/close valve (33), merges with the gas refrigerant flowing in the gas-side connection pipe (6), and returns to the utilization-side unit (3).

[0016] According to the fourth aspect of the present disclosure, a refrigeration apparatus comprises a heat-source-side unit (2), a utilization-side unit (3), and a gas-liquid separation unit (4) connected to connection pipes (5, 6) between the heat-source-side unit (2) and the utilization-side unit (3), in which the gas-liquid separation unit (4) is the gas-liquid separation unit (4) set forth in the second aspect, and the first oil return pipe (31) is connected to, of the connection pipes (5, 6), the gas-side connection pipe (6), the second oil return pipe (32) is connected to, of the connection pipes (5, 6), a liquid-side connection pipe (5).

[0017] According to the fourth aspect, like in the second aspect, during the reverse cycle defrosting operation of the refrigeration apparatus, high-pressure gas refrigerant flows from the heat-source-side unit (2) through the gas-side connection pipe (6) to the utilization-side unit (3). High-pressure liquid refrigerant that has dissipated heat in the utilization-side heat exchanger (16) serving as a radiator during defrosting in the utilization-side unit (3) returns to the heat-source-side unit (2) through the liquid-side connection pipe (5). The gas-side connection pipe (6) includes a gas-liquid separator (17) in which oil is separated from gas refrigerant. The oil that has been separated from the gas refrigerant in the gas-liquid separator (17) flows into the liquid-side connection pipe (5) through the second oil return pipe (32) from the bottom of the gas-liquid separator (17) by opening the second open/close valve (34), and merges with the liquid refrigerant flowing in the liquid-side connection pipe (5), returns to the heat-source-side unit (2). The function during the cooling operation is similar to that of the third aspect.

[0018] According to the fifth aspect of the present disclosure, in the third or the fourth aspect, the utilization-side unit (3) includes a plurality of utilization-side units connected in parallel with respect to the heat-source-side

unit (2) and the gas-liquid separation unit (4).

[0019] According to the fifth aspect, in the refrigeration apparatus in which the plurality of the utilization-side units (3) are connected to the heat-source-side unit (2) in parallel, the same flows of the refrigerant and the oil are achieved thorough the gas-liquid separator (17) as that of the third or the fourth aspect.

[0020] According to the sixth aspect of the present disclosure, in the third or the fourth aspect, the gas-liquid separation unit (4) serves as a unit including a casing (4a) other than that of the heat-source-side unit (2), or as a unit arranged in a casing (2a) of the heat-source-side unit (2).

[0021] In the sixth aspect, in a refrigeration apparatus in which the gas-liquid separation unit (4) is arranged in a casing (4a) other than that of the heat-source-side unit (2) or in the casing (2a) of the heat-source-side unit (2), the same flows of the refrigerant and the oil are achieved thorough the gas-liquid separator (17) as that of the third or the fourth aspect.

ADVANTAGES OF THE INVENTION

[0022] According to the first aspect of the present disclosure, the gas-liquid separation unit (4) is connected between the heat-source-side unit (2) and the utilization-side unit (3). Further, the gas-liquid separator (17) separates liquid refrigerant and oil from gas refrigerant. Accordingly, it is possible to reduce the risk of wet operation even in a case in which a large-scale evaporator (utilization-side heat exchanger (16)) is used. At the time of shift from the utilization-side-unit off to the utilization-side-unit on or at the time of shift from the reverse cycle defrosting operation to the cooling operation, the opening and closing operation of the open/close valve at the inflow side of the evaporator (16) can be omitted. Accordingly, it is possible to make the time required for the shift to the cooling operation (time for start-up of the cooling operation) shorter than a conventional case.

[0023] According to the second aspect, in addition to the effect obtained through the first aspect, during the reverse cycle defrosting operation, oil contained in high-pressure gas refrigerant flowing in the gas-side connection pipe (6) is separated from the gas refrigerant in the gas-liquid separator (17), and returns to the heat-source-side unit (2) through the liquid-side connection pipe (5). As described above, in the defrosting operation, the gas-liquid separator (17) of the gas-liquid separation unit (4) serves as an oil separator. Hence, it is possible to reduce the risk of oil shortage in the compressor disposed in the heat-source-side unit (2).

[0024] Further, according to the first and the second aspects, the gas-liquid separation unit (4) can be retrofitted to an existing refrigeration apparatus. Accordingly, it is possible to reduce the risk of the wet operation due to fluid flow back of the existing refrigeration apparatus, and to shorten the time for start-up of the cooling operation.

[0025] According to the third aspect, like in the first aspect, the gas-liquid separation unit (4) is connected between the heat-source-side unit (2) and the utilization-side unit (3). Further, the gas-liquid separator (17) separates liquid refrigerant and oil from gas refrigerant. Accordingly, it is possible to reduce the risk of the wet operation even in a case in which a large-scale evaporator (utilization-side heat exchanger (16)) is used. At the time of operation shift from the utilization-side-unit off to the utilization-side-unit on or at the time of operation shift from the reverse cycle defrosting operation to the cooling operation, the opening and closing operation of the open/close valve can be omitted. Accordingly, it is possible to shorten the time required for the above operation shifts (time for start-up of the cooling operation).

[0026] According to the fourth aspect, like in the second aspect, during the reverse cycle defrosting operation, oil contained in high-pressure gas refrigerant flowing in the gas-side connection pipe (6) is separated from the gas refrigerant in the gas-liquid separator (17), and returns to the heat-source-side unit (2) through the liquid-side connection pipe (5). As described above, in the defrosting operation, the gas-liquid separator (17) of the gas-liquid separation unit (4) serves as an oil separator. Hence, it is possible to reduce the risk of oil shortage in the compressor disposed in the heat-source-side unit (2).

[0027] According to the fifth aspect, in the refrigeration apparatus in which the plurality of the utilization-side units (3) are connected parallel to the heat-source-side unit (2), like in the third aspect, it is possible to reduce the risk of the wet operation and to shorten the time of operation shift from the utilization-side-unit off to the utilization-side-unit on. Accordingly, like in the fourth aspect, it is possible to reduce the risk of oil shortage of the compressor during the defrosting operation.

[0028] According to the sixth aspect, in a refrigeration apparatus in which the gas-liquid separation unit (4) is arranged in a casing (4a) other than that of a heat-source-side unit (2) or in the casing (2a) of the heat-source-side unit (2), like in the third aspect, it is possible to reduce the risk of the wet operation and to shorten the time of operation shift from the utilization-side-unit off to the utilization-side-unit on. Accordingly, like in the fourth aspect, it is possible to reduce the risk of oil shortage of the compressor during the defrosting operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

[FIG. 1] FIG. 1 is a view of a refrigerant circuit of a refrigeration apparatus according to an embodiment.
[FIG. 2] FIG. 2 is a view of a refrigerant circuit of a refrigeration apparatus according to a first variation of the embodiment.

[FIG. 3] FIG. 3 is a view of a refrigerant circuit of a refrigeration apparatus according to a second variation of the embodiment.

[FIG. 4] FIG. 4 is a view of a refrigerant circuit of a conventional refrigeration apparatus.

[FIG. 5] FIG. 5 shows a time chart illustrating a condition of an operation of an open/close valve at an inflow side of an evaporator arranged in the conventional refrigeration apparatus.

DESCRIPTION OF EMBODIMENTS

[0030] In the following, embodiments will be described in detail with reference to the drawings.

[0031] The refrigeration apparatus (1) of this embodiment includes a refrigerant circuit (10) that performs a refrigeration cycle in which refrigerant circulates, as shown in FIG. 1. This refrigeration apparatus (1) includes a heat-source-side unit (2), a utilization-side unit (3), and a gas-liquid separation unit (4) connected to connection pipes (a liquid-side connection pipe (5) and a gas-side connection pipe (6)) between the heat-source-side unit (2) and the utilization-side unit (3). These units (2, 3, 4) are connected to each other by a refrigerant pipe, constituting the above refrigerant circuit (10). The parts of the heat-source-side unit (2) are housed in a first casing (2a). The parts of the utilization-side unit (3) are housed in a second casing (3a). The parts of the gas-liquid separation unit (4) are housed in a third casing (4a).

[0032] In the refrigerant circuit (10), a compressor (11), a four-way switching valve (12), a heat-source-side heat exchanger (13), a cooling electromagnetic valve (14), a cooling expansion valve (expansion mechanism) (15), a utilization-side heat exchanger (16), and a gas-liquid separator (17) are sequentially connected by the refrigerant pipe.

[0033] The compressor (11), the four-way switching valve (12), and the heat-source-side heat exchanger (13) are disposed in the heat-source-side unit (2). The cooling electromagnetic valve (14), the cooling expansion valve (expansion mechanism) (15), and the utilization-side heat exchanger (16) are disposed in the utilization-side unit (3). The gas-liquid separator (17) is disposed in the gas-liquid separation unit (4).

[0034] The compressor (11) has its discharge side connected to a first port (P1) of the four-way switching valve (12). The four-way switching valve (12) includes a second port (P2) that is connected to a gas-side end of the heat-source-side heat exchanger (13). The four-way switching valve (12) includes a third port (P3) that is connected to the inlet side of the compressor (11). The four-way switching valve (12) includes a fourth port (P4) that is connected to a gas-side end of the utilization-side heat exchanger (16) through the gas-side connection pipe (6).

[0035] The four-way switching valve (12) is configured to be switched between a first position (the position in the case of a communication state marked by a solid line of FIG. 1) during cooling operation and a second position (the position in the case of another communication state marked by a dashed line of FIG. 1) during defrosting operation. In the first position, the first port (P1) and the

second port (P2) communicate with each other, while the third port (P3) and the fourth port (P4) communicate with each other. In the second position, the first port (P1) and the fourth port (P4) communicate with each other, while the second port (P2) and the third port (P3) communicate with each other.

[0036] The heat-source-side heat exchanger (13) has its gas-side end connected to the heat-source-side gas pipe (21) and its liquid-side end connected to a heat-source-side liquid pipe (22). The heat-source-side liquid pipe (22) is connected to the cooling electromagnetic valve (14) of the utilization-side unit (3) through the liquid-side connection pipe (5).

[0037] The utilization-side unit (3) includes a utilization-side liquid pipe (23) connected to the liquid-side connection pipe (5) and a utilization-side gas pipe (24) connected to the gas-side connection pipe (6). The utilization-side liquid pipe (23) is connected to the liquid-side end of the utilization-side heat exchanger (16). The utilization-side gas pipe (24) is connected to the gas-side end of the utilization-side heat exchanger (16). In the utilization-side liquid pipe (23), the cooling electromagnetic valve (14) and the cooling expansion valve (15) are arranged in this order viewed from the liquid-side connection pipe (5). The utilization-side liquid pipe (23) is connected to a bypass passage (25) that bypasses the cooling electromagnetic valve (14) and the cooling expansion valve (15). The bypass passage (25) includes a check valve (26) that allows the refrigerant to flow from the utilization-side heat exchanger (16) to the liquid-side connection pipe (5) and prevents the refrigerant from flowing in the reverse direction.

[0038] The gas-liquid separator (17) disposed in the gas-liquid separation unit (4) is connected to, of the above connection pipes (5, 6), the gas-side connection pipe (6). The gas-liquid separation unit (4) includes, in addition to the gas-liquid separator (17), a first oil return pipe (31) that has one end connected to the bottom of the gas-liquid separator (17) and the other end connected to a position of the gas-side connection pipe (6) located closer to the heat-source-side unit (2) than the gas-liquid separator (17) is. The first oil return pipe (31) includes a first electromagnetic valve (first open/close valve) (33). The first oil return pipe (31) is configured to serve as an oil return pipe during a cooling operation during which a utilization-side heat exchanger (16) provided in the utilization-side unit (3) serves as an evaporator. The first oil return pipe (31) includes a first oil return check valve (35) at a position closer to the gas-side connection pipe (6) than the first electromagnetic valve (33) is. The first oil return check valve (35) allows the refrigerant to flow from the gas-liquid separator (17) to the gas-side connection pipe (6) and prevents refrigerant from flowing in the reverse direction.

[0039] The gas-liquid separation unit (4) includes a second oil return pipe (32) that has one end connected to the bottom of the gas-liquid separator (17) and the other end connected to the liquid-side connection pipe

(5) in the gas-liquid separation unit (4). The second oil return pipe (32) includes a second electromagnetic valve (second open/close valve) (34). The second oil return pipe (32) is configured to serve as an oil return pipe during a defrosting operation during which the utilization-side heat exchanger (16) serves as the condenser. The second oil return pipe (32) includes a second oil return check valve (36) at a position closer to the liquid-side connection pipe (5) than the second electromagnetic valve (34) is. The second oil return check valve allows the refrigerant to flow from the gas-liquid separator (17) to the liquid-side connection pipe (5) and prevents refrigerant from flowing in the reverse direction.

[0040] Although not shown in details, the main body of the gas-liquid separator (17) is made of a tubular container. The gas-side connection pipe (6) is connected to the outer wall surface of the main body of the gas-liquid separator (17) in a direction substantially parallel to a tangent direction. The gas-side connection pipe (6) is configured such that swirl flow is generated in the gas-liquid separator (17) by refrigerant flowing therein, and serves to effectively separate gas refrigerant from lubricant.

[0041] In this embodiment, the gas-liquid separation unit (4) includes a casing (third casing (4a)) other than the first casing (2a) of the heat-source-side unit (2).

[0042] The refrigerant circuit (10) includes a plurality of sensors for measuring the temperature, the pressure etc. of the refrigerant. The heat-source-side unit (2) includes a high-pressure pressure sensor (41) disposed on a discharge pipe of the compressor (11), and a low-pressure pressure sensor (42) disposed on a suction pipe of the compressor (11). The utilization-side unit (3) further includes an evaporator inlet temperature sensor (43), an evaporator outlet temperature sensor (44), an inlet air temperature sensor (45) and a defrosting refrigerant temperature sensor (46). The evaporator inlet temperature sensor (43) measures the refrigerant temperature at the inlet side of the utilization-side heat exchanger (16) serving as an evaporator at the time of the cooling operation. The evaporator outlet temperature sensor (44) measures the refrigerant temperature at the outlet side of the utilization-side heat exchanger (16) at the time of the cooling operation. The inlet air temperature sensor (45) measures the inlet air temperature of the utilization-side heat exchanger (16) at the time of the cooling operation. The defrosting refrigerant temperature sensor (46) measures the refrigerant temperature at the time of the defrosting operation.

-Operation-

[0043] In the following, the operation of the refrigeration apparatus (1) is described.

<Cooling Operation>

[0044] At the time of cooling operation, the four-way

switching valve (12) is switched to a first position marked by the solid line of FIG. 1. The cooling electromagnetic valve (14) is set to "open", the cooling expansion valve (15) is set to a state of superheating control (state in which the opening degree is controlled with the degree of superheating of the outlet refrigerant of the evaporator (the utilization-side heat exchanger (16)) serving as a target value), the first electromagnetic valve (33) is set to "open", and the second electromagnetic valve (34) is set to "close".

[0045] In this state, the refrigerant that has been discharged from the compressor (11) flows into the heat-source-side heat exchanger (13) and dissipates heat. In the utilization-side unit (3), the high-pressure refrigerant that has dissipated heat in the heat-source-side heat exchanger (13) passes through the cooling electromagnetic valve (14), is depressurized at the cooling expansion valve (15), absorbs heat from inside air in the utilization-side unit heat exchanger (16), and evaporates. In this manner, the inside air is cooled in the utilization-side heat exchanger (16). The gas refrigerant that has thus evaporated flows through the gas-side connection pipe (6) toward the heat-source-side unit (2).

[0046] The gas-side connection pipe (6) includes the gas-liquid separator (17). The gas-liquid separator (17) separates liquid refrigerant and oil from the gas refrigerant. The gas refrigerant flows out from the gas-liquid separator (17), passes through the gas-side connection pipe (6), returns to the heat-source-side unit (2) and is taken into the compressor (11) through the four-way switching valve (12). The liquid refrigerant remains in the gas-liquid separator (17).

[0047] The oil that has been separated from the gas refrigerant in the gas-liquid separator (17) flows into the gas-side connection pipe (6) through the first oil return pipe (31) from the bottom of the gas-liquid separator (17) by opening the first open/close valve (33), merges with the gas refrigerant flowing in the gas-side connection pipe (6) to return to the heat-source-side unit (2), and is taken in the compressor (11) through the four-way switching valve (12).

[0048] The cooling operation is performed such that refrigerant circulates in the refrigerant circuit (10) in the above manner. The inside air is cooled through the circulation of the refrigerant.

<Defrosting Operation>

[0049] In the defrosting operation, the four-way switching valve (12) is switched to the second position marked by the dashed line shown in FIG. 1. The cooling electromagnetic valve (14) is set to "open", the cooling expansion valve (15) is set to open at a "predetermined opening degree", the first electromagnetic valve (33) is set to "close", and the second electromagnetic valve (34) is set to "open".

[0050] In this state, the refrigerant that has been discharged from the compressor (11) flows into the gas-

liquid separator (17). In the gas-liquid separator (17), the refrigerant and oil are separated from each other. The refrigerant from the gas-liquid separator (17) flows into the utilization-side heat exchanger (16) in the utilization-side unit (3), and dissipates heat. The high-pressure refrigerant that has thus dissipated heat in the utilization-side heat exchanger (16) is depressurized at the cooling expansion valve (15), passes through the cooling electromagnetic valve (14), absorbs heat from the inside air in the heat-source-side heat exchanger (13), and evaporates. The gas refrigerant thus evaporated passes through the four-way switching valve (12), and is taken in the compressor (11).

[0051] The oil that has been separated from the refrigerant in the gas-liquid separator (17) flows into the liquid-side connection pipe (5) through the second oil return pipe (32) from the bottom of the gas-liquid separator (17) by opening the second open/close valve (34), merges with the liquid refrigerant flowing in the liquid-side connection pipe (5), returns to the heat-source-side unit (2), passes through the heat-source-side heat exchanger (13) and the four-way switching valve (12), and is taken into the compressor (11).

[0052] The defrosting operation is performed such that refrigerant circulates in the refrigerant circuit in the above manner. Frost attached on the utilization-side heat exchanger (17) is defrosted by warm thermal energy of the refrigerant.

-Advantages of Embodiment-

[0053] According to this embodiment, the gas-liquid separation unit (4) having a casing other than that of the heat-source-side unit (2) is connected between the heat-source-side unit (2) and the utilization-side unit (3). In the gas-liquid separator (17), the liquid refrigerant and the oil are separated from the gas refrigerant so that the liquid refrigerant is stored in the gas-liquid separator (17) during the cooling operation. Accordingly, it is possible to reduce the risk of the wet operation even if a large-scale evaporator (utilization-side heat exchanger (16)) is used. At the time of operation shift from the utilization-side-unit off to the utilization-side-unit on or at the time of operation shift from the reverse cycle defrosting operation to the cooling operation, the opening and closing operation of the open/close valve at the inflow side of the evaporator in a conventional device can be omitted (i.e., the time for the operation of the opening and closing of the open/close valve is no longer necessary). Accordingly, it is possible to shorten the time for shift to the cooling operation (time for start-up of the cooling operation).

[0054] According to this embodiment, at the time of the reverse cycle defrosting operation, the oil contained in the high-pressure gas refrigerant flowing in the gas-side connection pipe (6) is separated from the gas refrigerant in the gas-liquid separator (17), and returns to the heat-source-side unit (2) through the liquid-side connection pipe (5). As described above, in the defrosting operation,

the gas-liquid separator (17) of the gas-liquid separation unit (4) serves as an oil separator. Hence, it is possible to reduce the risk of oil shortage of the compressor disposed in the heat-source-side unit (2).

-Variations of Embodiment-

-First Variation-

[0055] According to the above embodiment, the refrigeration apparatus (1) has been described in which the gas-liquid separation unit (4) is connected between the heat-source-side unit (2) and the utilization-side unit (3). The present disclosure is not limited thereto. It is also possible to provide a refrigeration apparatus (1) including a heat-source-side unit (2) and a utilization-side unit (3) connected through connection pipes (5, 6) to which a gas-liquid separation unit (4) is connected to the connection pipes (5,6) as a retrofit optional unit.

-Second Variation-

[0056] As shown in FIG. 2, the refrigeration apparatus (1) may include, with respect to the above heat-source-side unit (2) and the gas-liquid separation unit (4), a plurality of (two in the figure) utilization-side units (3) connected in parallel.

[0057] Also in this second variation, the gas-liquid separation unit (4) has the same configuration as the embodiment shown in FIG. 1. Accordingly, this second variation provides the refrigeration apparatus (1) with the utilization-side units (3) connected in parallel that allows the time for operation shift from the utilization-side-unit off to the utilization-side-unit on or for operation shift from the reverse cycle defrosting operation to the cooling operation to be shortened, thereby making it possible to reduce the risk of oil shortage of the compressor at the time of defrosting operation.

-Third Variation-

[0058] As shown in FIG. 3, the gas-liquid separation unit (4) of the refrigeration apparatus (1) may be configured as a unit arranged in the first casing (2a) of the heat-source-side unit (2). In FIG. 3, the third casing (4a) of the gas-liquid separation unit (4) is arranged in the first casing (2a) of the heat-source-side unit (2). However, the third casing (4a) may not be necessarily arranged.

[0059] Also in this third variation, the gas-liquid separation unit (4) itself has the same configuration as in the embodiment shown in FIG. 1. Accordingly, this third variation provides the refrigeration apparatus with the gas-liquid separation unit (4) arranged in the casing (2a) of the heat-source-side unit (2) that allows the time for operation shift from the utilization-side-unit off to the utilization-side-unit on or for operation shift from the reverse cycle defrosting operation to the cooling operation to be shortened, thereby making it possible to reduce the risk

of oil shortage in the compressor at the time of defrosting operation.

-Fourth Variation-

[0060] The refrigeration apparatus (1) may be configured through combination of the second and the third variations. Specifically, a plurality of utilization-side units (3) are connected in parallel with respect to the heat-source-side unit (2) that includes the gas-liquid separation unit (4) formed therein. Also the configuration described above can produce the same effect as in the third and fourth variations.

«Other Embodiments»

[0061] The above-described embodiment may be modified as follows.

[0062] In the above embodiment, the gas-liquid separation unit (4) includes the first oil return pipe (31) connected to the bottom of the gas-liquid separator (17) and to a position of the gas-side connection pipe (6) closer to the heat-source-side unit (2) than the gas-liquid separator (17) is, and the second oil return pipe (32) connected to the bottom of the gas-liquid separator (17) and to a position of the liquid-side connection pipe (5) located closer to the heat-source-side unit (2) than the gas-liquid separator (17) is. The first oil return pipe (31) includes the first open/close valve (33). The second oil return pipe (32) includes the second open/close valve (34). The first oil return pipe (31) serves as an oil return pipe at the time of the cooling operation. The second oil return pipe (32) serves as an oil return pipe at the time of the defrosting operation. However, in the case of a gas-liquid separation unit (4) arranged in a refrigeration apparatus in which no reverse cycle defrosting operation is performed, the second oil return pipe (32) and the second open/close valve (34) may be omitted. Also in this case, it is possible to prevent the wet operation at the time of start-up of the cooling operation, and to shorten the time for operation shift from the utilization-side-unit off to the utilization-side-unit on (time for start-up of the cooling operation) compared to conventional cases even if a large-scale evaporator of the utilization-side unit is used.

[0063] Note that the foregoing description of the embodiments is a merely preferred example in nature, and is not intended to limit the scope, application, or uses of the present disclosure.

INDUSTRIAL APPLICABILITY

[0064] As described above, the present disclosure is useful for a gas-liquid separation unit connected between a heat-source-side unit and a utilization-side unit of a refrigeration apparatus with a refrigerant circuit, and for a refrigeration apparatus including a gas-liquid separation unit connected between a heat-source-side unit and a utilization-side unit.

DESCRIPTION OF REFERENCE CHARACTERS

[0065]

- | | | |
|----|----|-----------------------------|
| 5 | 1 | Refrigeration Apparatus |
| | 2 | Heat-Source-Side Unit |
| | 3 | Utilization-Side Unit |
| | 4 | Gas-liquid Separation Unit |
| | 5 | Liquid-Side Connection Pipe |
| 10 | 6 | Gas-Side Connection Pipe |
| | 17 | Gas-Liquid Separator |
| | 31 | First Oil Return Pipe |
| | 32 | Second Oil Return Pipe |
| | 33 | First Open/Close Valve |
| 15 | 34 | Second Open/Close Valve |

Claims

- | | | |
|----|----|---|
| 20 | 1. | A gas-liquid separation unit connected to connection pipes (5, 6) between a heat-source-side unit (2) and a utilization-side unit (3) of a refrigeration apparatus (1), the gas-liquid separation unit comprising: |
| 25 | | a gas-liquid separator (17) connected to, of the connection pipes (5, 6), a gas-side connection pipe (6); |
| 30 | | a first oil return pipe (31) connected to a bottom of the gas-liquid separator (17) and to a position of the gas-side connection pipe (6) located closer to the heat-source-side unit (2) than the gas-liquid separator (17) is, the first oil return pipe (31) being configured to serve as an oil return pipe during a cooling operation during which a utilization-side heat exchanger (16) provided in the utilization-side unit (3) serves as an evaporator; and |
| 35 | | a first open/close valve (33) arranged at the first oil return pipe (31). |
| 40 | 2. | The gas-liquid separation unit of claim 1, further comprising: |
| 45 | | a second oil return pipe (32) connected to the bottom of the gas-liquid separator (17) and to, of the connection pipes (5, 6), a liquid-side connection pipe (5); and |
| 50 | | a second open/close valve (34) arranged at the second oil return pipe (32), wherein the second oil return pipe (32) is configured to serve as an oil return pipe during a defrosting operation during which the utilization-side heat exchanger (16) serves as the condenser. |
| 55 | 3. | A refrigeration apparatus comprising a heat-source-side unit (2), a utilization-side unit (3), and a gas-liquid separation unit (4) connected to connection pipes (5, 6) between the heat-source-side unit (2) |

and the utilization-side unit (3),
the gas-liquid separation unit (4) being the gas-liquid
separation unit (4) set forth in claim 1, and
the first oil return pipe (31) being connected to, of
the connection pipes (5, 6), a gas-side connection
pipe (6). 5

4. A refrigeration apparatus comprising a heat-source-
side unit (2), a utilization-side unit (3), and a gas-
liquid separation unit (4) connected to connection
pipes (5, 6) between the heat-source-side unit (2)
and the utilization-side unit (3),
the gas-liquid separation unit (4) being the gas-liquid
separation unit (4) set forth in claim 2, and
the first oil return pipe (31) being connected to, of
the connection pipes (5, 6), the gas-side connection
pipe (6), the second oil return pipe (32) being con-
nected to, of the connection pipes (5, 6), a liquid-side
connection pipe (5). 10
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5. The refrigeration apparatus of claim 3 or 4, wherein
the utilization-side unit (3) includes a plurality of uti-
lization-side units (3) connected in parallel with re-
spect to the heat-source-side unit (2) and the gas-
liquid separation unit (4). 25

6. The refrigeration apparatus of claim 3 or 4, wherein
the gas-liquid separation unit (4) serves as a unit
including a casing (4a) other than that of the heat-
source-side unit (2), or as a unit arranged in a casing
(2a) of the heat-source-side unit (2). 30

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FIG. 1

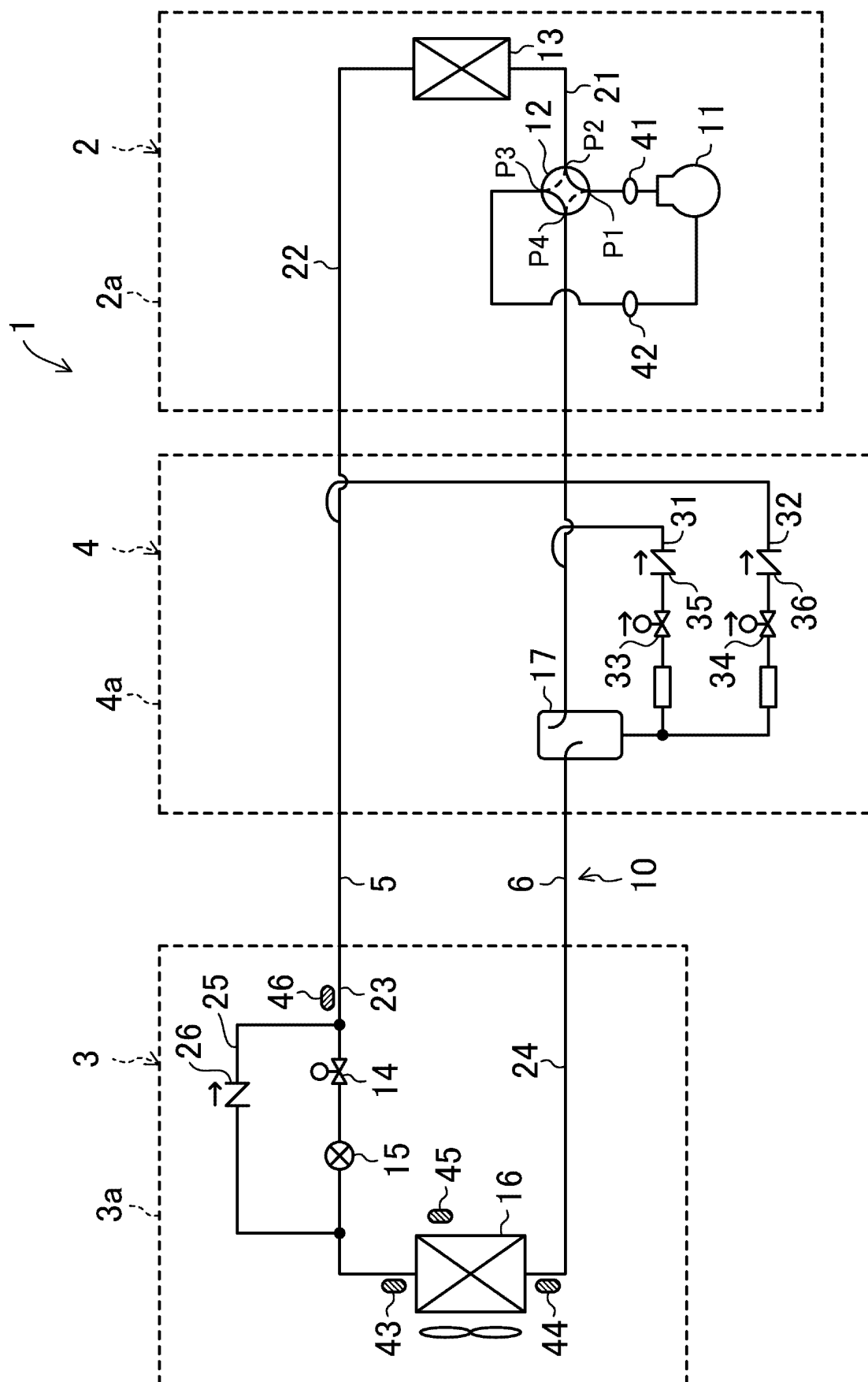


FIG.2

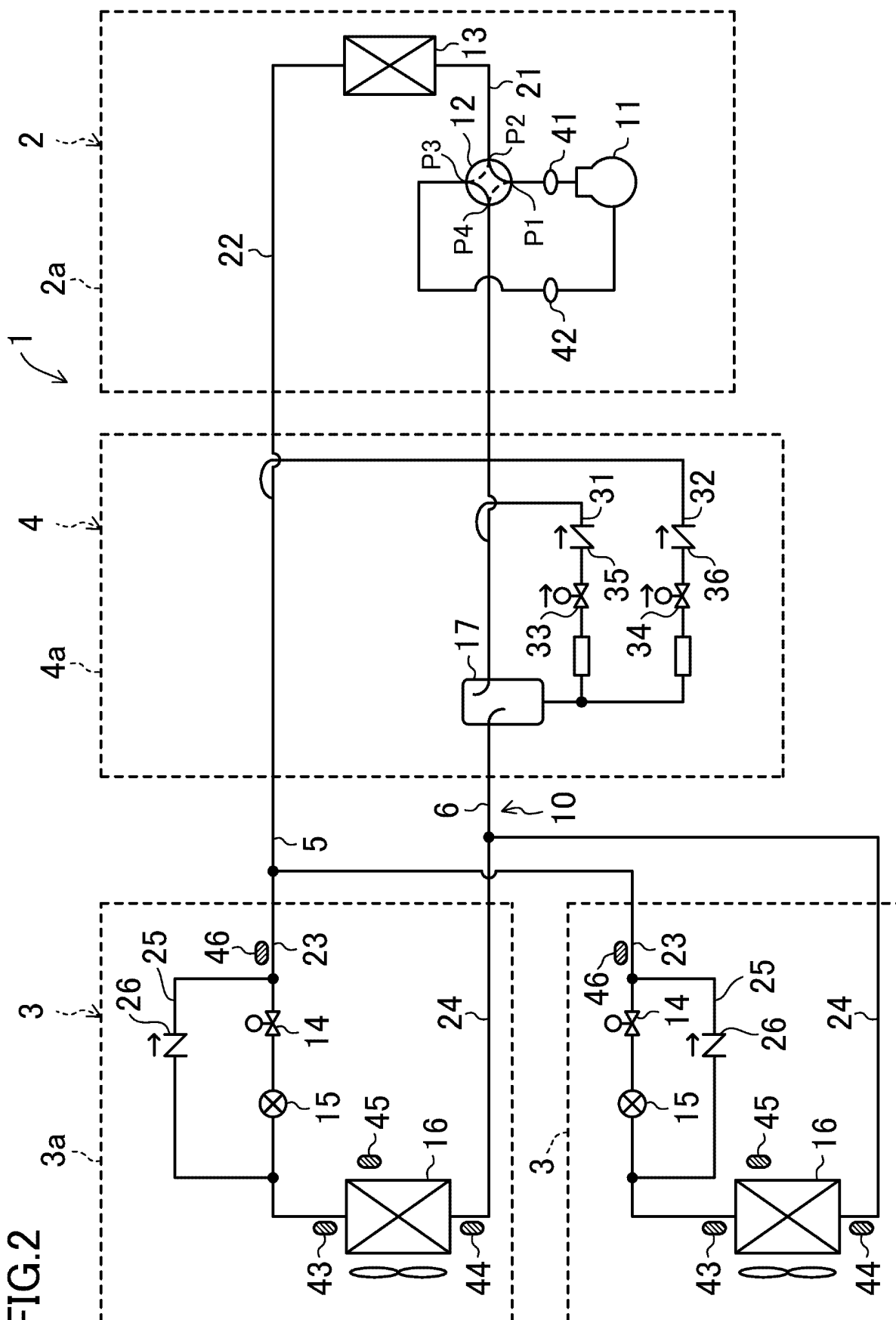


FIG.3

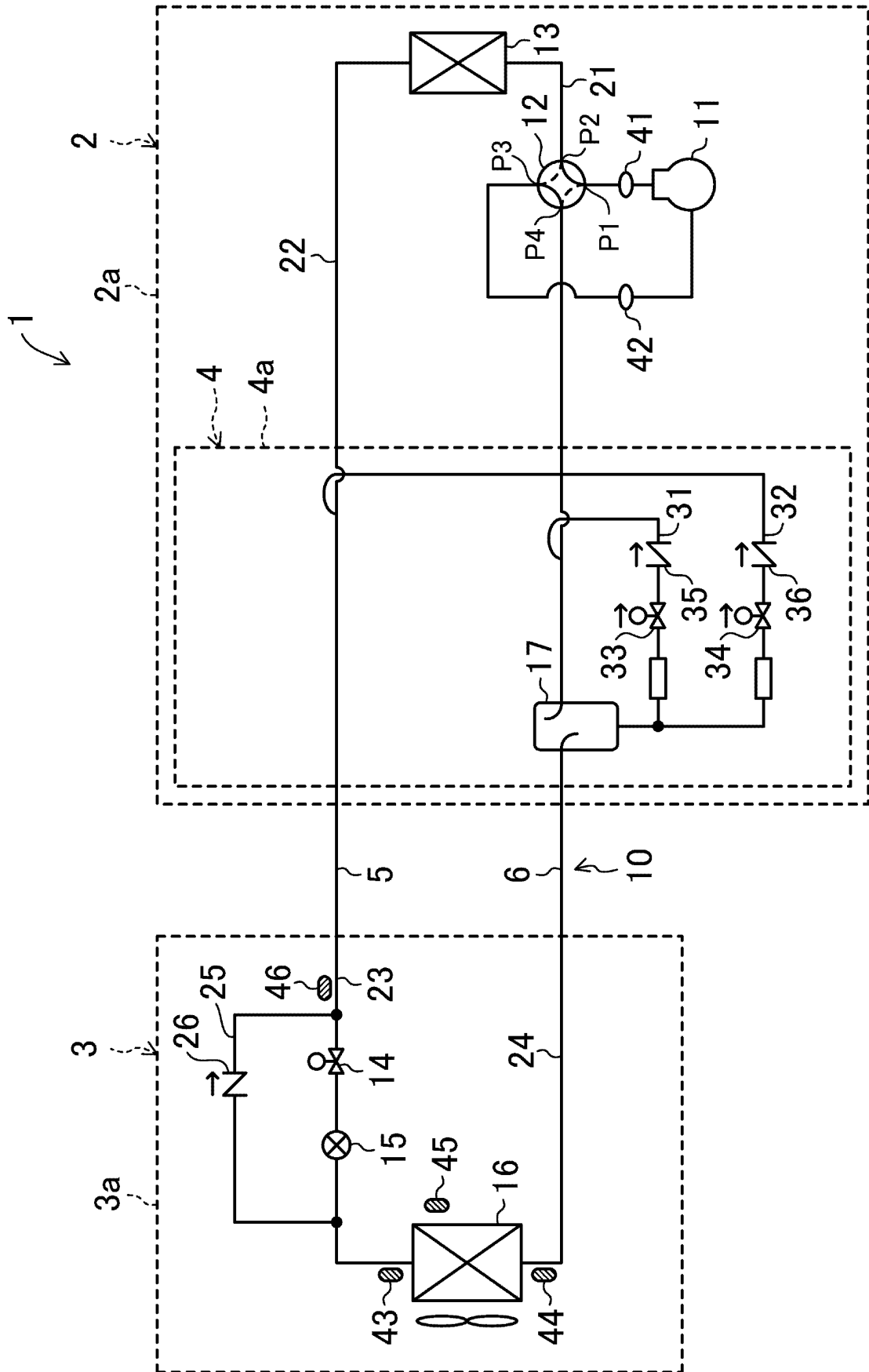


FIG.4

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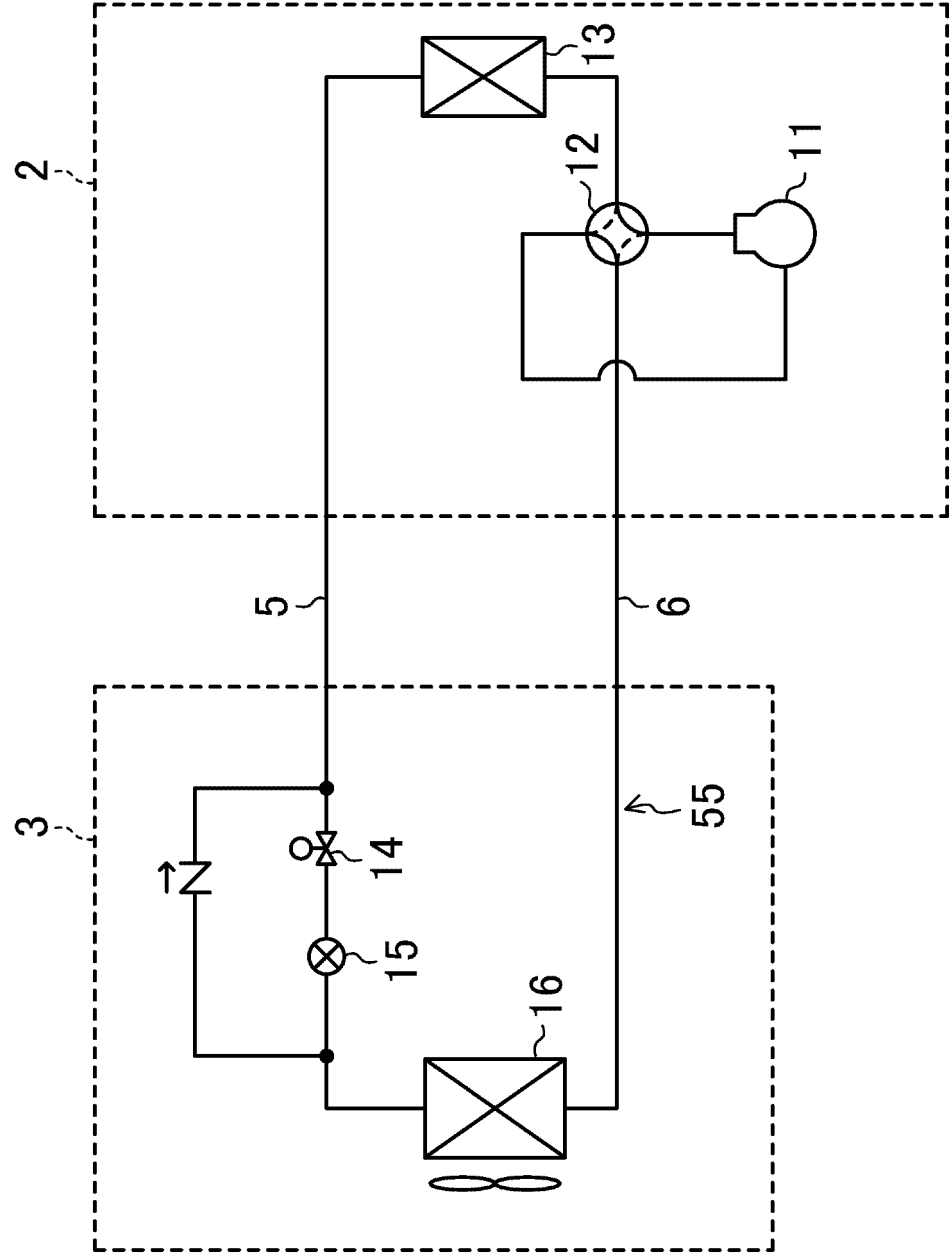
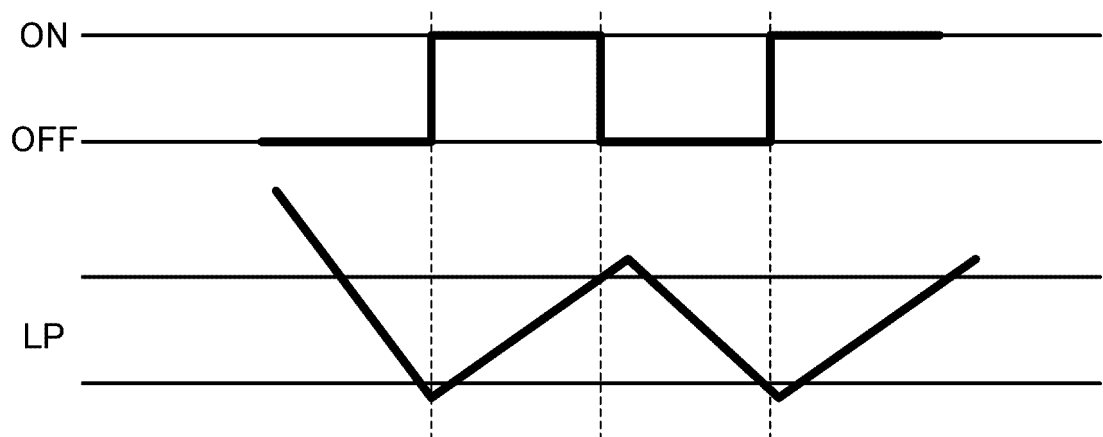


FIG.5

COOLING ELECTROMAGNETIC VALVE



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/020814

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F25B1/00 (2006.01) i, F25B13/00 (2006.01) i, F25B43/02 (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. F25B1/00, F25B13/00, F25B43/02

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 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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 2014-214913 A (MITSUBISHI ELECTRIC CORP.) 17 November 2014, claims, paragraphs [0002], [0013], [0018]-[0032], fig. 1-5 (Family: none)	1, 3, 5-6 2, 4
Y A	JP 63-116072 A (DAIKIN INDUSTRIES, LTD.) 20 May 1988, page 3, upper left column, line 3 to page 4, lower right column, line 3, fig. 1-2 (Family: none)	1, 3, 5-6 2, 4
Y	JP 2004-108715 A (MITSUBISHI ELECTRIC CORP.) 08 April 2004, fig. 1 (Family: none)	5



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
08 August 2018 (08.08.2018)Date of mailing of the international search report
28 August 2018 (28.08.2018)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/020814

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 2004-301461 A (HITACHI, LTD.) 28 October 2004, fig. 1-2 (Family: none)	5
Y	WO 2016/203507 A1 (MITSUBISHI ELECTRIC CORP.) 22 December 2016, fig. 1-2 (Family: none)	5
Y	JP 2012-013278 A (SANYO ELECTRIC CO., LTD.) 19 January 2012, fig. 1 (Family: none)	5
Y	WO 2014/111044 A1 (SICHUAN CHANGHONG ELECTRIC GROUP CO., LTD.) 24 July 2014, fig. 3A & CN 103062841 A	5
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 062040/1988 (Laid-open No. 167555/1989) (DAIKIN INDUSTRIES, LTD.) 24 November 1989, entire text, all drawings (Family: none)	1-6
A	JP 05-215417 A (DAIKIN INDUSTRIES, LTD.) 24 August 1993, entire text, all drawings (Family: none)	1-6
A	JP 2013-029236 A (DAIKIN INDUSTRIES, LTD.) 07 February 2013, entire text, all drawings (Family: none)	1-6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 123448/1983 (Laid-open No. 32585/1985) (DAIKIN INDUSTRIES, LTD.) 05 March 1985, entire text, all drawings (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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