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DESCRIPTION

TECHNICAL FIELD

[0001] The present invention relates to an outdoor unit and a refrigeration cycle apparatus.

BACKGROUND ART

[0002] Japanese Patent Laying-Open No. 2014-01917 (PTL 1) discloses a refrigeration apparatus having an intermediate injection flow path and a suction injection flow path. In this refrigeration apparatus, a portion of refrigerant flowing from a condenser toward an evaporator can be merged with the intermediate pressure refrigerant in a compressor using the intermediate injection flow path, and can also be merged with the low pressure refrigerant to be suctioned into the compressor in a suction flow path using the suction injection flow path. Accordingly, in a case where using the intermediate injection flow path leads to deterioration of operation efficiency, the suction injection flow path can be used to decrease the discharge temperature of the compressor.
US 2016/245560 A1 discloses an air-conditioning apparatus that includes a plurality of indoor units connected therein and enables each of the indoor units to perform cooling or heating selectively or enables the indoor units to perform cooling or heating simultaneously. Moreover, US 2016/245540 A1 reveals an outdoor unit according to the preamble of claim 1.
DE 11 2014 006218 T5 discloses a heat pump cycle device. Furthermore, DE 11 2014 006218 T5 reveals an outdoor unit according to the preamble of claim 1.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: Japanese Patent Laying-Open No. 2014-01917

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] In the refrigeration apparatus described in Japanese Patent Laying-Open No. 2014-01917 (PTL 1), when operation of a load device is stopped, for example, and thereby circulation of the refrigerant is blocked on the indoor unit side and a pump down operation is started to be performed on the load device side, the pressure in a liquid pipe of an outdoor unit increases. For example, when refrigerant such as CO_2 utilizing supercriticality is used, the discharge pressure of the compressor is high, and thus the pressure in a portion of the liquid pipe may exceed a design pressure.

[0005] An object of the present invention is to provide an outdoor unit and a refrigeration cycle apparatus improved to prevent a pressure exceeding a design pressure from being applied to a pipe.

SOLUTION TO PROBLEM

[0006] The object of the present invention is solved by an outdoor unit according to claim 1 and a refrigeration cycle apparatus according to claim 7. The present invention relates to an outdoor unit of a refrigeration cycle apparatus, the outdoor unit being connectable to a load device including a first expansion device and an evaporator.

The outdoor unit includes: a refrigerant outlet port and a refrigerant inlet port for connecting to the load device; a first flow path, which is a flow path from the refrigerant inlet port to the refrigerant outlet port, the first flow path being configured to form, together with the load device, a circulation flow path through which refrigerant circulates; a compressor, a condenser, and a second expansion device disposed on the first flow path; a second flow path configured to branch from a portion of the first flow path between the condenser and the second expansion device, and to return, to the compressor, the refrigerant that has passed through the condenser; a third expansion device and a receiver disposed on the second flow path in order from a branch point where the second flow path is branched from the first flow path; a third flow path configured to connect a portion of the first flow path between the second expansion device and the refrigerant outlet port, to a refrigerant inlet of the receiver; and an on-off valve disposed on the third flow path.

ADVANTAGEOUS EFFECTS OF INVENTION

[0007] According to the outdoor unit and the refrigeration cycle apparatus including the same of the present invention, it is possible to prevent a pressure in a pipe from exceeding a design pressure even when there is a sudden increase in pressure caused for example by a flow of the refrigerant being blocked on the load device side.

BRIEF DESCRIPTION OF DRAWINGS

[0008]

Fig. 1 is an overall configuration diagram of a refrigeration cycle apparatus according to the present invention.

Fig. 2 is a flowchart for illustrating control of a third expansion valve 71.

Fig. 3 is a flowchart for illustrating control of a flow rate control valve 72.

Fig. 4 is a flowchart for illustrating control of a second expansion valve 40.

Fig. 5 is a flowchart for illustrating control of an on-off valve 78.

DESCRIPTION OF EMBODIMENTS

[0009] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings. Although a plurality of embodiments will be described below, it is originally intended from the time of filing the present application to combine features described in the embodiments as appropriate. It should be noted that identical or corresponding parts in the drawings will be designated by the same reference characters, and the description thereof will not be repeated.

[0010] Fig. 1 is an overall configuration diagram of a refrigeration cycle apparatus according to the present embodiment. It should be noted that Fig. 1 functionally shows the connection relation and the arrangement configuration of devices in the refrigeration cycle apparatus, and does not necessarily show an arrangement in a physical space.

[0011] Referring to Fig. 1, a refrigeration cycle apparatus 1 includes an outdoor unit 2, a load device 3, and pipes 84 and 88. Outdoor unit 2 has a refrigerant outlet port PO2 and a refrigerant inlet port PI2 for connecting to load device 3. Load device 3 has a refrigerant outlet port PO3 and a refrigerant inlet port PI3 for connecting to outdoor unit 2. Pipe 84 connects refrigerant outlet port PO2 of outdoor unit 2 to refrigerant inlet port PI3 of load device 3. Pipe 88 connects refrigerant outlet port PO3 of load device 3 to refrigerant inlet port PI2 of outdoor unit 2.

[0012] Outdoor unit 2 of refrigeration cycle apparatus 1 is connectable to load device 3. Outdoor unit 2 includes a compressor 10 having a suction port G1, a discharge port G2, and an intermediate pressure port G3, a condenser 20, a fan 22, a heat exchanger 30, a second expansion valve 40, and pipes 80 to 83 and 89. Heat exchanger 30 has a first passage H1 and a second passage H2, and is configured to exchange heat between refrigerant flowing in first passage H1 and the refrigerant flowing in second passage H2.

[0013] Load device 3 includes a first expansion valve 50, an evaporator 60, pipes 85, 86, and 87, and an on-off valve 28. Evaporator 60 is configured to perform heat exchange between air and the refrigerant. In refrigeration cycle apparatus 1, evaporator 60 evaporates the refrigerant by absorbing heat from the air in a space to be cooled. First expansion valve 50 is, for example, a temperature expansion valve controlled independently of outdoor unit 2. It should be noted that first expansion valve 50 may be an electronic expansion valve which can decompress the refrigerant. On-off valve 28 is closed when load device 3 stops operation, to block the refrigerant.

[0014] Compressor 10 compresses the refrigerant suctioned from pipe 89, and discharges the compressed refrigerant to pipe 80. Compressor 10 can arbitrarily change a drive frequency by inverter control. Further, compressor 10 is provided with intermediate pressure port G3, and allows the refrigerant from intermediate pressure port G3 to flow into an intermediate portion of a compression process. Compressor 10 is configured to adjust a rotation speed according to a control signal from a controller 100. By adjusting the rotation speed of compressor 10, a circulation amount of the refrigerant is adjusted, and the capability of refrigeration cycle apparatus 1 can be adjusted. As compressor 10, various types of compressors can be adopted, and for example, a compressor of scroll type, rotary type, screw type, or the like can be adopted.

[0015] Condenser 20 is configured such that the high-temperature, high-pressure gas refrigerant discharged from compressor 10 performs heat exchange with outside air (heat dissipation). By this heat exchange, the refrigerant is condensed and transforms into a liquid phase. The refrigerant discharged from compressor 10 to pipe 80 is condensed and liquefied in condenser 20, and flows into pipe 81. Fan 22 for blowing the outside air is attached to condenser 20 in order to increase the efficiency of heat exchange. Fan 22 supplies condenser 20 with the outside air with which the refrigerant performs heat exchange in condenser 20. By adjusting the number of revolutions of fan 22, a refrigerant pressure on a discharge side of compressor 10 (a high pressure-side pressure) can be adjusted. Second expansion valve 40 is an electronic expansion valve which can decompress the refrigerant that has passed through condenser 20 and first passage H1 of heat exchanger 30.

[0016] Here, it is assumed that the refrigerant used for a refrigerant circuit of refrigeration cycle apparatus 1 is CO_2. However, when there occurs a state where a subcool is less likely to be ensured, another refrigerant may be used.

[0017] It should be noted that, in the present specification, for ease of description, a device which cools the refrigerant such as CO_2 in a supercritical state will also be referred to as condenser 20. Further, in the present specification, for ease of description, an amount of decrease from a reference temperature of the refrigerant in the supercritical state will also be referred to as a subcool.

[0018] A first flow path F1 from refrigerant inlet port PI2 to refrigerant outlet port PO2 via compressor 10, condenser 20, first passage H1 of heat exchanger 30, and second expansion valve 40 forms, together with a flow path on which first expansion valve 50 and evaporator 60 of load device 3 are disposed, a circulation flow path through which the refrigerant circulates.

Hereinafter, this circulation flow path will also be referred to as a "main refrigerant circuit" of a refrigeration cycle.

[0019] Outdoor unit 2 further includes pipes 91, 92, and 94 configured to cause the refrigerant to flow from a portion of the circulation flow path between an outlet of first passage H1 and second expansion valve 40 to an inlet of second passage H2, pipes 96 to 98 configured to cause the refrigerant to flow from an outlet of second passage H2 to suction port G1 or intermediate pressure port G3 of compressor 10, and a flow path switching unit 74 configured to be capable of selecting one of suction port G1 and intermediate pressure port G3 as a destination of the refrigerant flowing out from the outlet of second passage H2. Hereinafter, a second flow path F2 that branches from the main refrigerant circuit and delivers the refrigerant to compressor 10 via second passage H2 will also be referred to as an "injection flow path".

[0020] Outdoor unit 2 further includes a receiver 73 disposed on second flow path F2 and configured to store the refrigerant. A third expansion valve 71 is disposed between pipes 91 and 92, pipe 91 branching from the portion of the circulation flow path between the outlet of first passage H1 and second expansion valve 40, and pipe 92 connected to an inlet of receiver 73. Outdoor unit 2 further includes a degassing pipe 93 that connects a gas exhaust outlet of receiver 73 to second passage H2 and is configured to exhaust a refrigerant gas within receiver 73, a throttle device 70 disposed between degassing pipe 93 and pipe 94 leading to second passage H2, and a flow rate control valve 72 configured to adjust a flow rate of the refrigerant in pipe 94 connected to a liquid refrigerant exhaust outlet of receiver 73.

[0021] Pipe 91 is a pipe that branches from the main refrigerant circuit and causes the refrigerant to flow into receiver 73. Third expansion valve 71 is an electronic expansion valve which can decrease the pressure of the refrigerant at a high pressure portion of the main refrigerant circuit to an intermediate pressure. Receiver 73 is a container in which the refrigerant decompressed and having two phases is separated into a gas phase and a liquid phase, and which can store the refrigerant and adjust the circulation amount of the refrigerant in the main refrigerant circuit. Degassing pipe 93 connected to an upper portion of receiver 73 and pipe 94 connected to a lower portion of receiver 73 are pipes for taking out the refrigerant separated into gas refrigerant and liquid refrigerant within receiver 73, in a separated state. Flow rate control valve 72 adjusts a circulation amount of the liquid refrigerant to be exhausted from pipe 94, and thereby can adjust the amount of the refrigerant in receiver 73.

[0022] By providing receiver 73 on the injection flow path as described above, it becomes easy to ensure a subcool in pipes 82 and 83 which are liquid pipes. This is because, since receiver 73 generally includes the gas refrigerant therein and a refrigerant temperature reaches a saturation temperature, it is not possible to ensure a subcool if receiver 73 is disposed on pipe 82.

[0023] Further, if receiver 73 is provided at an intermediate pressure portion, it becomes possible to store the intermediate pressure liquid refrigerant within receiver 73 even when the pressure at the high pressure portion of the main refrigerant circuit is high and the refrigerant is in the supercritical state. Thus, the design pressure of the container of receiver 73 can be set to be lower than that of the high pressure portion, and cost reduction by thinning the container can also be achieved.

[0024] Outdoor unit 2 further includes pressure sensors 110 to 112, temperature sensors 120 to 122, and controller 100 configured to control compressor 10, second expansion valve 40, third expansion valve 71, flow rate control valve 72, and flow path switching unit 74.

[0025] Pressure sensor 110 detects a pressure PL at the suction port portion of compressor 10, and outputs a detection value thereof to controller 100. Pressure sensor 111 detects a discharge pressure PH of compressor 10, and outputs a detection value thereof to controller 100. Pressure sensor 112 detects a pressure P1 in pipe 83 at an outlet of second expansion valve 40, and outputs a detection value thereof to controller 100.

[0026] By providing second expansion valve 40 to the liquid pipe, outdoor unit 2 can decompress the refrigerant pressure to be lower than or equal to the design pressure of load device 3 (for example, 4 MPa), and then deliver the refrigerant to load device 3. Thereby, even if refrigerant utilizing supercriticality such as CO_2 is used, a general-purpose product having the same design pressure as that of a conventional load device can be used as load device 3.

[0027] Temperature sensor 120 detects a discharge temperature TH of compressor 10, and outputs a detection value thereof to controller 100. Temperature sensor 121 detects a refrigerant temperature T1 in pipe 81 at an outlet of condenser 20, and outputs a detection value thereof to controller 100. Temperature sensor 122 detects a refrigerant temperature T2 at the outlet of first passage H1 on a cooled side of heat exchanger 30, and outputs a detection value thereof to controller 100.

[0028] Flow path switching unit 74 includes pipes 97 and 98 branching from pipe 96, a decompression device 77 disposed between pipes 97 and 98, and on-off valves 75 and 76 disposed on pipes 97 and 98, respectively.

[0029] Pipe 97 is connected between pipe 96 and intermediate pressure port G3, and on-off valve 75 is provided on pipe 97. Decompression device 77 and on-off valve 76 are disposed in series between the outlet of second passage H2 and suction port G1.

[0030] By on-off valves 75 and 76, the destination of the refrigerant in second flow path F2 can be switched between intermediate pressure port G3 and suction port G1 of compressor 10.

[0031] In the present embodiment, second flow path F2 controls discharge temperature TH of compressor 10 by causing the refrigerant decompressed and having two phases to flow into compressor 10. In addition, the amount of the refrigerant in the main refrigerant circuit can be adjusted by receiver 73 placed on second flow path F2. Further, second flow path F2 also ensures supercooling of the refrigerant in the main refrigerant circuit by heat exchange by heat exchanger 30. Controller 100 performs switching of the destination of the refrigerant by on-off valves 75 and 76 such that each purpose can be performed under each operation condition.

[0032] Outdoor unit 2 further includes a third flow path F3 connecting pipe 83 to pipe 92, and an on-off valve 78 provided on third flow path F3. On-off valve 78 is provided to avoid a sudden increase in pressure P1 in pipe 83 at the start of a pump down operation described later.

[0033] Controller 100 includes a CPU (Central Processing Unit) 102, a memory 104 (a ROM (Read Only Memory) and a RAM (Random Access Memory)), input/output buffers (not shown) for inputting/outputting various signals, and the like. CPU 102 expands programs stored in the ROM onto the RAM or the like and executes the programs. The programs stored in the ROM are programs describing processing procedures of controller 100. According to these programs, controller 100 performs control of the devices in outdoor unit 2. This control can be processed not only by software but also by dedicated hardware (electronic circuitry).

(Control during Normal Operation of Refrigeration Cycle Apparatus)

[0034] Controller 100 feedback-controls third expansion valve 71 such that discharge temperature TH of compressor 10 matches a target temperature.

[0035] Fig. 2 is a flowchart for illustrating control of third expansion valve 71. When discharge temperature TH of compressor 10 is higher than the target temperature (YES in S21), controller 100 increases a degree of opening of third expansion valve 71 (S22). Thereby, the refrigerant flowing into intermediate pressure port G3 or suction port G1 via receiver 73 increases, and thus discharge temperature TH decreases.

[0036] On the other hand, when discharge temperature TH of compressor 10 is lower than the target temperature (NO in S21 and YES in S23), controller 100 decreases the degree of opening of third expansion valve 71 (S24). Thereby, the refrigerant flowing into intermediate pressure port G3 or suction port G1 via receiver 73 decreases, and thus discharge temperature TH increases.

[0037] When discharge temperature TH is equal to the target temperature (NO in S21 and NO in S23), controller 100 maintains the degree of opening of third expansion valve 71 in the present state.

[0038] Thus, controller 100 controls the degree of opening of third expansion valve 71 such that discharge temperature TH of compressor 10 approaches the target temperature.

[0039] Further, controller 100 feedback-controls flow rate control valve 72 such that refrigerant temperature T1 at the outlet of condenser 20 matches a target temperature, in order to ensure a subcool SC of the refrigerant at the outlet of condenser 20.

[0040] Fig. 3 is a flowchart for illustrating control of flow rate control valve 72. When subcool SC determined by refrigerant temperature T1 at the outlet of condenser 20 and a pressure in condenser 20 (approximated by PH) is larger than a target value (YES in S31), controller 100 decreases a degree of opening of flow rate control valve 72 (S32). Thereby, the amount of the liquid refrigerant to be exhausted from receiver 73 decreases and the amount of the liquid refrigerant within receiver 73 increases, and thus the amount of the refrigerant circulating through the main refrigerant circuit decreases. Accordingly, refrigerant temperature T1 increases, and thus subcool SC decreases.

[0041] On the other hand, when subcool SC determined by refrigerant temperature T1 at the outlet of condenser 20 and the pressure in condenser 20 (approximated by PH) is smaller than the target value (NO in S31 and YES in S33), controller 100 increases the degree of opening of flow rate control valve 72 (S34). Thereby, the amount of the liquid refrigerant to be exhausted from receiver 73 increases and the amount of the liquid refrigerant stored in receiver 73 decreases, and thus the amount of the refrigerant circulating through the main refrigerant circuit increases. Accordingly, refrigerant temperature T1 decreases, and thus subcool SC increases.

[0042] When subcool SC is equal to the target value (NO in S31 and NO in S33), controller 100 maintains the degree of opening of flow rate control valve 72 in the present state.

[0043] Thus, controller 100 controls the degree of opening of flow rate control valve 72 such that refrigerant temperature T1 at the outlet of condenser 20 approaches the target temperature.

[0044] Further, when CO_2 is used as the refrigerant, controller 100 performs control of compressor 10 and second expansion valve 40 to use a supercritical region of the refrigerant. For example, when an outside air temperature is higher than a supercritical temperature of the refrigerant as in summer, controller 100 increases the rotation speed of compressor 10 to be higher than that for spring or autumn, to increase the pressure at the high pressure portion of the main refrigerant circuit. By performing decompression in second expansion valve 40, load device 3 can be used in common with a device used with an ordinary refrigerant. On this occasion, second expansion valve 40 is controlled as described below.

[0045] Controller 100 feedback-controls second expansion valve 40 such that pressure P1 matches a target pressure. This target pressure is set to be substantially the same as a pressure in a case where an ordinary refrigerant such as R410 is used.

[0046] Fig. 4 is a flowchart for illustrating control of second expansion valve 40. When pressure P1 is higher than the target pressure (YES in S41), controller 100 decreases a degree of opening of second expansion valve 40 (S42). Thereby, the amount of decompression by second expansion valve 40 increases, and thus pressure P1 decreases.

[0047] On the other hand, when pressure P1 is lower than the target pressure (NO in S41 and

YES in S43), controller 100 increases the degree of opening of second expansion valve 40 (S44). Thereby, the amount of decompression by second expansion valve 40 decreases, and thus pressure P1 increases.

[0048] When pressure P1 is equal to the target pressure (NO in S41 and NO in S43), controller 100 maintains the degree of opening of second expansion valve 40 in the present state.

[0049] Since pressure P1 is controlled as described above, the pressure within load device 3 can be set to be lower than or equal to the design pressure of the device used with an ordinary refrigerant, and load device 3 can be used in common with a load device for a conventional machine which uses refrigerant such as R410A.

(Control of Switching of Injection Flow Path)

[0050] When temperature sensor 120 detects an excessive increase in discharge temperature TH of compressor 10, controller 100 opens on-off valve 75 and closes on-off valve 76 to increase the amount of injection to compressor 10 and prevent a further increase in the discharge temperature.

[0051] On this occasion, if an intermediate pressure PM increases with an increase in evaporation temperature or the like with on-off valve 75 being opened, the saturation temperature of the refrigerant increases, and thus the temperature of the refrigerant passing through second passage H2 of heat exchanger 30 also increases, resulting in an insufficient cooling in heat exchanger 30. Thus, there may be a case where it is impossible to ensure the subcool of the refrigerant in second expansion valve 40.

[0052] Accordingly, controller 100 monitors refrigerant temperature T2 at temperature sensor 122 with on-off valve 75 being opened, and when it is detected that the subcool of the refrigerant cannot be ensured, controller 100 closes on-off valve 75 and opens on-off valve 76. Thereby, the refrigerant in second flow path F2 is merged with the refrigerant on a low pressure side to decrease intermediate pressure PM, and a temperature difference in heat exchanger 30 can be ensured.

[0053] Since decompression is performed on the main refrigerant circuit by third expansion valve 71, the devices such as receiver 73 disposed on second flow path F2 can have a low design pressure, and thus manufacturing cost can be reduced. Even in a case where the devices have a low design pressure, when a pressure sensor 113 detects an increase in intermediate pressure PM during operation due to overcharging of the refrigerant, an increase in outside air temperature, or the like, it is possible to take a safety measure that releases pressure to the low pressure side by opening on-off valve 76.

(Control during Pump Down Operation)

[0054] Next, control during a pump down operation will be described. The pump down operation is an operation to transfer the refrigerant from load device 3 to outdoor unit 2 and store the refrigerant therein, by placing on-off valve 28 or the like on pipe 85 through which the liquid refrigerant flows in the main refrigerant circuit, and operating compressor 10 with pipe 85 being blocked. The pump down operation is performed, for example, by closing second expansion valve 40 or on-off valve 28 before stopping operation, and thereafter operating compressor 10.

[0055] Generally, a signal for instructing to start the pump down operation is not transmitted particularly from load device 3 to outdoor unit 2, and the pump down operation is performed in outdoor unit 2 by continuing a normal operation.

[0056] In the pump down operation, when on-off valve 28 is closed and pressure PL at the low pressure portion detected by pressure sensor 110 decreases to a set value, controller 100 is configured to stop compressor 10 and stop a pump down. Since compressor 10 is configured such that the refrigerant may not pass therethrough when it is stopped, the refrigerant does not flow back to load device 3.

[0057] However, when first expansion valve 50 is closed or on-off valve 28 is closed during the normal operation, pressure P1 in pipes 83, 84, and 85 increases suddenly. When pressure P1 exceeds the design pressure of pipes 83, 84, and 85 and load device 3, problems such as leak of the refrigerant may occur. Thus, it is necessary to control pressure P1 within a range in which it does not exceed the design pressure.

[0058] Accordingly, controller 100 temporarily opens on-off valve 78 to prevent a sudden increase in pressure P1.

[0059] In the following, control of on-off valve 78 performed during a pump down will be described. Fig. 5 is a flowchart for illustrating control of on-off valve 78.

[0060] In step S51, controller 100 determines whether or not pressure P1 exceeds the design pressure. The design pressure herein is a pressure that can be tolerated for a short time, and may be set to be somewhat lower than an actual design pressure.

[0061] When pressure P1 does not exceed the design pressure in step S51 (NO in S51), there is no need to decrease pressure P1, and thus controller 100 closes on-off valve 78 in step S56, and advances the processing to step S57.

[0062] On the other hand, when it is detected that pressure P1 exceeds the design pressure in step S51 (YES in S51), controller 100 performs the processing in steps S52 to S55 to prevent a sudden increase in pressure P1.

[0063] In step S52, controller 100 determines whether or not pressure P1 in pipe 83 is higher than a pressure P2 in pipe 92 of the injection flow path.

[0064] When P1 is not higher than P2 (NO in S52), pressure P1 in pipe 83 does not decrease even through on-off valve 78 is opened. Thus, in step S53, controller 100 opens on-off valve 76 and closes on-off valve 75 to decrease a pressure in second flow path F2. Then, the processing proceeds to step S54.

[0065] When P1 is higher than P2 (YES in S52), pressure P1 in pipe 83 can be decreased by opening on-off valve 78. Thus, the processing proceeds to step S54, without performing the processing in step S53.

[0066] It should be noted that pipe 96 and intermediate pressure port G3 may be directly connected, without providing flow path switching unit 74. In this case, the processing in steps S52 and S53 is not performed, and when it is determined as YES in step S51, the processing promptly proceeds to step S54.

[0067] In step S54, controller 100 opens on-off valve 78 and closes flow rate control valve 72, to introduce the intermediate pressure in second flow path F2 into pipe 83 and decrease pressure P1. This can prevent pressure P1 from exceeding the design pressure of pipes 83 and 84 and load device 3.

[0068] Preferably, further in step S55, controller 100 decreases the rotation speed of compressor 10 to suppress a further increase in pressure P1 in pipe 83, although controller 100 does not necessarily have to perform this step. It should be noted that, when pressure P1 temporarily increases suddenly, the processing in step S55 is performed, and thereafter pressure P1 decreases, the processing in step S56 may be followed by the processing for returning the rotation speed of compressor 10 to the original rotation speed, in order to reduce time for the pump down operation.

[0069] Then, in step S57, the processing is temporarily returned to a main routine, and thereafter the processing in the flowchart of Fig. 5 is performed repeatedly.

[0070] Finally, the present embodiment will be summarized with reference to the drawings again. As shown in Fig. 1, the present disclosure relates to outdoor unit 2 of refrigeration cycle apparatus 1, outdoor unit 2 being connectable to load device 3 including first expansion valve 50 corresponding to the "first expansion device" and evaporator 60. Outdoor unit 2 includes refrigerant outlet port PO2 and refrigerant inlet port PI2 for connecting to load device 3, first flow path F1, compressor 10, condenser 20, second expansion valve 40 corresponding to the "second expansion device", second flow path F2, third expansion valve 71 corresponding to the "third expansion device", receiver 73, third flow path F3, and on-off valve 78. First flow path F1, which is a flow path from refrigerant inlet port PI2 to refrigerant outlet port PO2, is configured to form, together with load device 3, a circulation flow path through which refrigerant circulates. Compressor 10, condenser 20, and second expansion valve 40 are disposed on first flow path F1. Second flow path F2 is configured to branch from a portion of first flow path F1 between condenser 20 and second expansion valve 40, and to return, to compressor 10, the refrigerant that has passed through condenser 20. Third expansion valve 71 and receiver 73 are disposed on second flow path F2 in order from a branch point where second flow path F2 is branched from first flow path F1. Third flow path F3 is configured to connect a portion of first flow path F1 between second expansion valve 40 and refrigerant outlet port PO2, to a refrigerant inlet of receiver 73. On-off valve 78 is disposed on third flow path F3.

[0071] As shown in Fig. 5, on-off valve 78 is configured to be opened when pressure P1 at the portion of first flow path F1 between second expansion valve 40 and refrigerant outlet port PO2 exceeds a threshold value corresponding to the design pressure (YES in S51).

[0072] Since third flow path F3 and on-off valve 78 are provided as described above, even if pressure P1 increases suddenly at the start of a pump down operation, pressure P1 can be quickly decreased. Thereby, the pipes and load device 3 having a low design pressure can be used even when refrigerant such as CO_2 which uses the supercritical region is used at the high pressure portion.

[0073] Further, by disposing receiver 73 on second flow path F2, even the refrigerant such as CO_2 which uses the supercritical region can be stored in receiver 73, in the state of liquid refrigerant. Furthermore, supercooling at the pipe portion through which the liquid refrigerant flows can also be ensured, improving the performance of the refrigeration cycle apparatus.

[0074] Outdoor unit 2 further includes flow rate control valve 72 disposed on second flow path F2 and configured to adjust an exhaust flow rate of the liquid refrigerant from receiver 73.

[0075] Outdoor unit 2 further includes heat exchanger 30 having first passage H1 and second passage H2 and configured to exchange heat between the refrigerant flowing in first passage H1 and the refrigerant flowing in second passage H2. First passage H1 of heat exchanger 30 is disposed between condenser 20 and the branch point at which pipe 91 branches from pipe 82 on first flow path F1, and second passage H2 of heat exchanger 30 is disposed between flow rate control valve 72 and compressor 10 on second flow path F2.

[0076] Compressor 10 has discharge port G2, suction port G1, and intermediate pressure port G3. Outdoor unit 2 further includes flow path switching unit 74 configured to switch, to one of intermediate pressure port G3 and suction port G1, a destination of the refrigerant that has passed through second flow path F2. As shown in Fig. 5, when pressure P1 at a portion of first flow path F1 downstream of second expansion valve 40 becomes lower than pressure P2 in receiver 73 (NO in S52), flow path switching unit 74 is configured to select suction port G1 as the destination.

[0077] With such a configuration, when the pressure in receiver 73 increases, the pressure in receiver 73 can be decreased. Thereby, an operation situation where the pressure in receiver 73 increases can be permitted, and the operation range can be expanded.

[0078] Outdoor unit 2 further includes pressure sensor 112 configured to detect pressure P1 at the portion of first flow path F1 downstream of second expansion valve 40, and controller 100 configured to control compressor 10 and on-off valve 78. As shown in Fig. 5, when pressure P1 detected by pressure sensor 112 changes from a state where pressure P1 is lower than a threshold value to a state where pressure P1 is higher than the threshold value (YES in S51), controller 100 is configured to open on-off valve 78 (S54) and decrease the rotation speed of compressor 10 (S55).

[0079] Since on-off valve 78 cooperates with compressor 10 as described above, even if pressure P1 increases suddenly, pressure P1 can be quickly decreased.

[0080] Although the present embodiment has been described by illustrating a refrigerating machine including refrigeration cycle apparatus 1, refrigeration cycle apparatus 1 may be utilized in an air conditioner or the like.

[0081] It should be understood that the embodiment disclosed herein is illustrative and non-restrictive in every respect. The scope of the present invention is defined by the scope of the claims, rather than the description of the embodiment described above, and is intended to include any modifications within the scope of the claims.

REFERENCE SIGNS LIST

[0082] 1: refrigeration cycle apparatus; 2: outdoor unit; 3: load device; 10: compressor; 20: condenser; 22: fan; 28, 75, 76, 78: on-off valve; 30: heat exchanger; 40: second expansion valve; 50: first expansion valve; 60: evaporator; 70: throttle device; 71: third expansion valve; 72: flow rate control valve; 73: receiver; 74: flow path switching unit; 77: decompression device; 80 to 85, 88, 89, 91, 92, 94, 96 to 98: pipe; 93: degassing pipe; 100: controller; 104: memory; 110 to 113: pressure sensor; 120 to 122: temperature sensor; F1: first flow path; F2: second flow path; F3: third flow path; G1: suction port; G2: discharge port; G3: intermediate pressure port; H1: first passage; H2: second passage; PI2, PI3: refrigerant inlet port; PO2, PO3: refrigerant outlet port.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- JP2014001917A **[0002] [0003] [0004]**
- US2016245560A1 **[0002]**
- US2016245540A1 **[0002]**
- DE112014006218T5 **[0002] [0002]**

Patentkrav

1. Udendørsenhed (2) af et kølekredsløbsapparat (1), hvor udendørsenheden (2) kan forbindes med en belastningsindretning (3), der inkluderer en første ekspansionsindretning (50) og en fordamper (60), hvilken udendørsenhed (2) omfatter:

en kølemiddeludløbsport (PO2) og en kølemiddelindløbsport (PI2) til forbindelse til belastningsindretningen (3);

en første flowbane (F1), som er en flowbane fra kølemiddelindløbsporten (PI2) til kølemiddeludløbsporten (PO2), hvor den første flowbane (F1) er konfigureret til sammen med belastningsindretningen (3) at danne en cirkulationsflowbane, gennem hvilken kølemidlet cirkulerer;

en kompressor (10), en kondensator (20) og en anden ekspansionsindretning (40) anbragt på den første flowbane (F1);

en anden flowbane (F2) konfigureret til at forgrene sig fra en del af den første flowbane (F1) mellem kondensatoren (20) og den anden ekspansionsindretning (40), og til at returnere, til kompressoren (10), kølemidlet, der har passeret gennem kondensatoren (20); og

en tredje ekspansionsindretning (71) og en modtager (73) anbragt på den anden flowbane (F2) i rækkefølge fra et forgreningspunkt, hvor den anden flowbane (F2) er forgrenet fra den første flowbane (F1), **kendetegnet ved** yderligere at omfatte

en tredje flowbane (F3) konfigureret til at forbinde en del af den første flowbane (F1) mellem den anden ekspansionsindretning (40) og kølemiddeludløbsporten (PO2) til et kølemiddelindløb på modtageren (73); og

en afspærringsventil (78) anbragt på den tredje flowbane (F3).

2. Udendørsenheden ifølge krav 1, hvor afspærringsventilen (78) er konfigureret til at blive åbnet, når et tryk ved delen af den første flowbane (F1) mellem den anden ekspansionsindretning (40) og kølemiddeludløbsporten (PO2) overstiger en tærskelværdi.

3. Udendørsenheden ifølge krav 1, yderligere omfattende en flowhastighedsstyre-ventil (72) anbragt på den anden flowbane (F2) og konfigureret til at justere en udtømningsflowhastighed af flydende kølemiddel fra modtageren (73).

4. Udendørsenheden ifølge krav 3, yderligere omfattende en varmeveksler (30) med en første passage (H1) og en anden passage (H2) og konfigureret til at udveksle varme mellem kølemidlet, der strømmer i den første passage (H1) og kølemidlet, der strømmer i den anden passage (H2), hvor

den første passage (H1) af varmeveksleren (30) er anbragt mellem kondensatoren (20) og forgreningspunktet på den første flowbane (F1), og den anden passage (H2) af varmeveksleren (30) er anbragt mellem flowhastighedsstyreventilen (72) og kompressoren (10) på den anden flowbane (F2).

5. Udendørsenheden ifølge krav 1, hvor

kompressoren (10) har en udledningsport (G2), en sugeport (G1) og en mellemliggende trykport (G3),

udendørsenheden (2) yderligere omfatter en flowbaneomskiftningsenhed (74) konfigureret til at omskifte, til en af den mellemliggende trykport (G3) og sugeporten (G1), en destination af kølemidlet, der er passeret gennem den anden flowbane (F2), og

flowbaneomskiftningsenheden (74) er konfigureret til at vælge sugeporten (G1) som destinationen, når et tryk ved en del af den første flowbane (F1) nedstrøms for den anden ekspansionsanordning (40) bliver lavere end et tryk i modtageren (73).

6. Udendørsenheden ifølge krav 1, yderligere omfattende:

en tryksensor (112) konfigureret til at detektere et tryk ved en del af den første flowbane (F1) nedstrøms for den anden ekspansionsindretning (40); og

en styreenhed (100) konfigureret til at styre kompressoren (10) og afspærringsventilen (78), hvor,

når en detekteringsværdi for tryksensoren (112) skifter fra en tilstand, hvor detekteringsværdien er lavere end en tærskelværdi, til en tilstand, hvor detekteringsværdien er højere end tærskelværdien, styreenheden (100) er konfigureret til at åbne afspærringsventilen (78) og reducere en rotationshastighed for kompressoren (10).

7. Kølekredsløbsapparat (1) omfattende:

udendørsenheden (2) ifølge et hvilket som helst af kravene 1 til 6; og

belastningsindretningen (3).

DRAWINGS

FIG.1

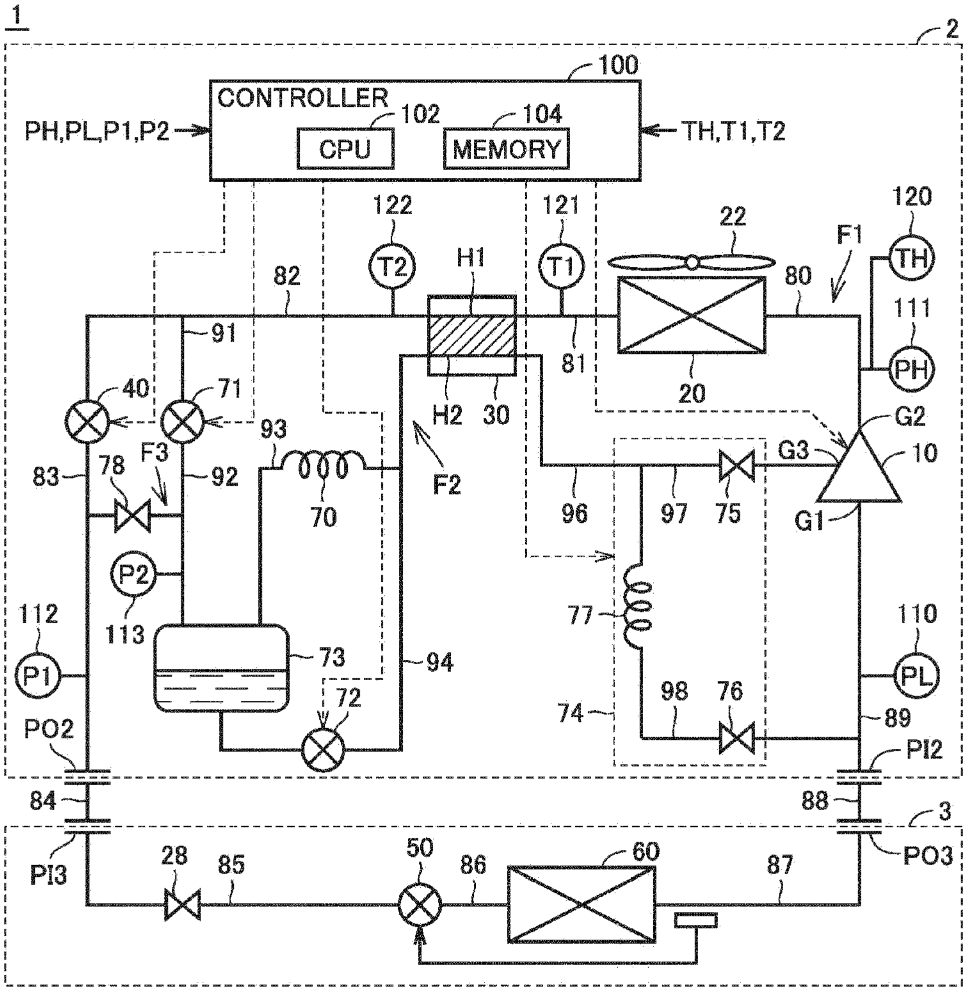


FIG.2

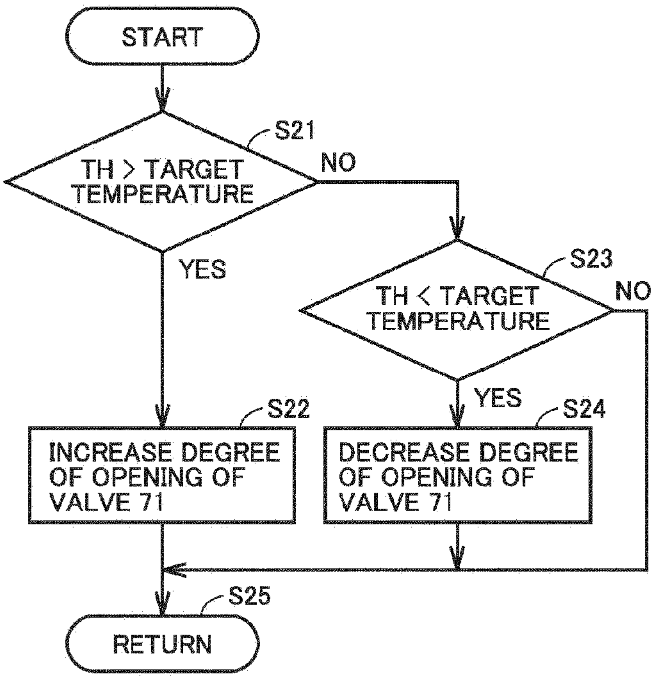

START
S21
TH > TARGET TEMPERATURE
NO
YES
S23
TH < TARGET TEMPERATURE
NO
YES
S22
INCREASE DEGREE OF OPENING OF VALVE 71
S24
DECREASE DEGREE OF OPENING OF VALVE 71
S25
RETURN

FIG.3

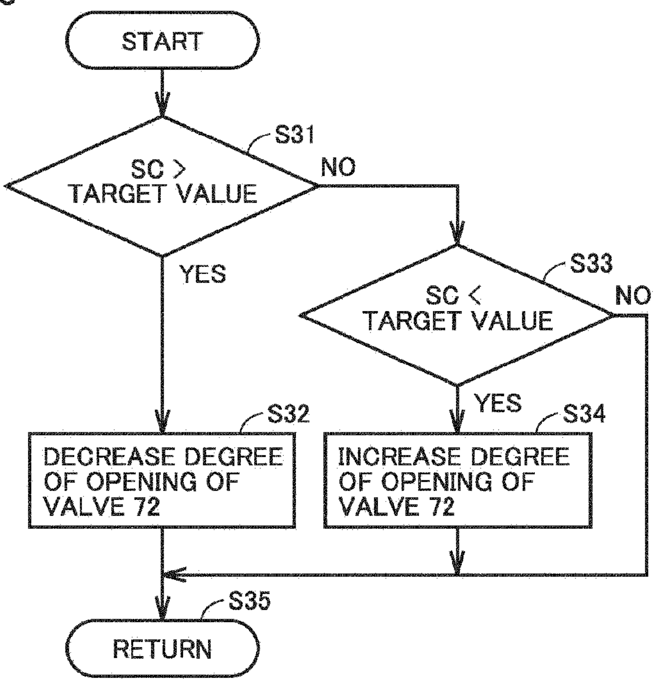

START
S31
SC > TARGET VALUE
NO
YES
S33
SC < TARGET VALUE
NO
YES
S32
DECREASE DEGREE OF OPENING OF VALVE 72
S34
INCREASE DEGREE OF OPENING OF VALVE 72
S35
RETURN

FIG.4

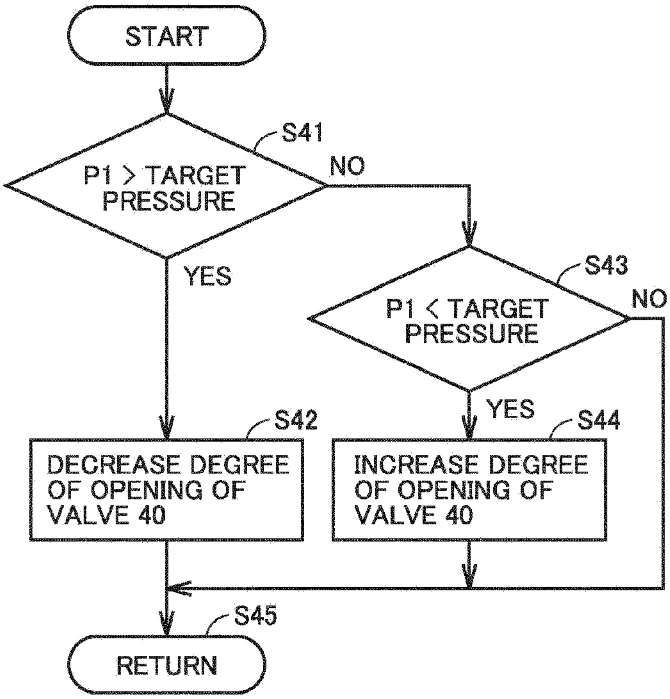
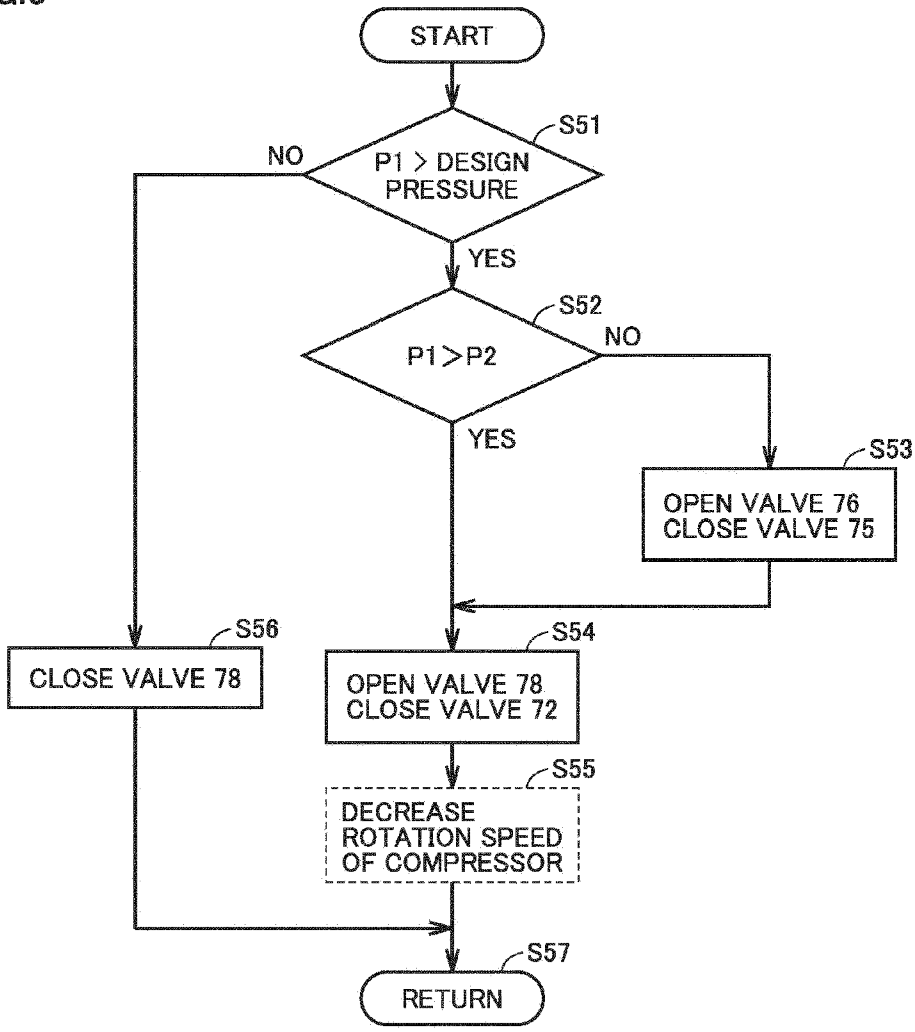

START
S41
P1 > TARGET PRESSURE
NO
YES
S43
P1 < TARGET PRESSURE
NO
YES
S42
DECREASE DEGREE OF OPENING OF VALVE 40
S44
INCREASE DEGREE OF OPENING OF VALVE 40
S45
RETURN

FIG.5


START
S51
P1 > DESIGN PRESSURE
NO
YES
S52
P1>P2
NO
YES
S53
OPEN VALVE 76
CLOSE VALVE 75
S56
CLOSE VALVE 78
S54
OPEN VALVE 78
CLOSE VALVE 72
S55
DECREASE ROTATION SPEED OF COMPRESSOR
S57
RETURN