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(54) **REFRIGERATION CYCLE DEVICE**

(57) When a shutoff valve is provided separately from an opening degree adjustment valve, there is a problem that the structure of a refrigeration cycle apparatus becomes complicated. A refrigeration cycle apparatus (1) includes a heat source unit (30), a plurality of utilization units (20 and 20a), a gas opening degree adjustment valve (82), and a control unit (40). The gas opening degree adjustment valve (82) is provided for the utilization unit (20). The utilization unit (20) includes a refrigerant sensor (61). The refrigerant sensor (61) detects leakage of a refrigerant. The control unit (40) controls the gas opening degree adjustment valve (82) to adjust an evaporation temperature or a condensation temperature in the utilization unit (20). When the refrigerant sensor (61) detects leakage of the refrigerant, the control unit (40) fully closes the gas opening degree adjustment valve (82) to block the refrigerant leaking from the utilization unit (20).

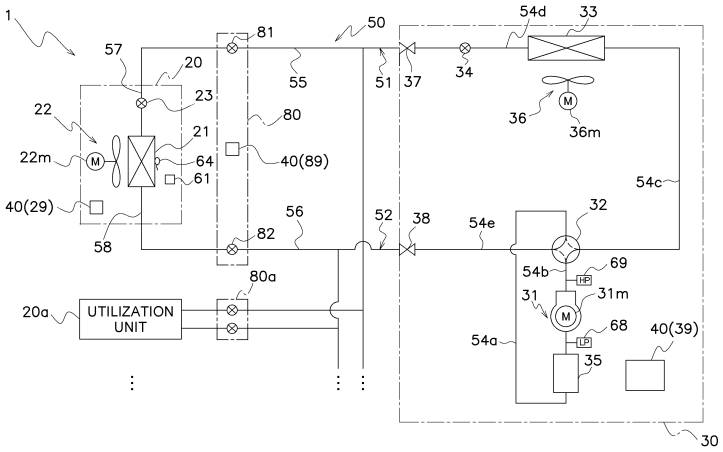

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a refrigeration cycle apparatus.

BACKGROUND ART

[0002] As disclosed in Patent Literature 1 (JP 2008-281304 A), there is a technique of controlling an opening degree adjustment valve provided for a utilization unit to control an evaporation temperature or a condensation temperature in the utilization unit.

SUMMARY OF THE INVENTION

<Technical Problem>

[0003] In preparation for leakage of a refrigerant in the utilization unit, it is desirable to provide the utilization unit with a shutoff valve that shuts off leakage of the refrigerant. However, when the shutoff valve is provided separately from the opening degree adjustment valve, there is a problem that the structure of the refrigeration cycle apparatus becomes complicated.

<Solution to Problem>

[0004] A refrigeration cycle apparatus according to a first aspect includes a heat source unit, a plurality of utilization units, a first opening degree adjustment valve, and a control unit. The heat source unit includes a compressor. The plurality of utilization units constitutes a refrigerant circuit together with the heat source unit. The plurality of utilization units includes a first utilization unit. The first opening degree adjustment valve is provided for the first utilization unit. The first utilization unit includes a first sensor. The first sensor detects leakage of a refrigerant. The control unit controls the first opening degree adjustment valve to adjust an evaporation temperature or a condensation temperature in the first utilization unit. When the first sensor detects leakage of the refrigerant, the control unit fully closes the first opening degree adjustment valve to block the refrigerant leaking from the first utilization unit.

[0005] When the first sensor detects leakage of the refrigerant in the refrigeration cycle apparatus according to the first aspect, the control unit fully closes the first opening degree adjustment valve to block the refrigerant leaking from the first utilization unit. As a result, the refrigeration cycle apparatus can simplify the structure of the refrigeration cycle apparatus by using the first opening degree adjustment valve as a shutoff valve that shuts off the refrigerant leaking from the first utilization unit.

[0006] A refrigeration cycle apparatus according to a second aspect is the refrigeration cycle apparatus according to the first aspect, in which the first opening degree adjustment valve is provided in a first refrigerant pipe on a gas side connected to the first utilization unit. When the first sensor detects leakage of the refrigerant, the control unit fully closes the first opening degree adjustment valve to block the refrigerant leaking from the first utilization unit through the first refrigerant pipe.

[0007] A refrigeration cycle apparatus according to a third aspect is the refrigeration cycle apparatus according to the first or second aspect, in which the control unit controls the first opening degree adjustment valve such that the evaporation temperature or the condensation temperature in the first utilization unit becomes a target evaporation temperature or a target condensation temperature.

[0008] A refrigeration cycle apparatus according to a fourth aspect is the refrigeration cycle apparatus according to any of the first to third aspects, in which when the first sensor detects leakage of the refrigerant, the control unit controls the compressor on the basis of a pressure fluctuation of the refrigerant flowing in the refrigerant circuit, the pressure fluctuation being caused by fully closing the first opening degree adjustment valve.

[0009] By such a configuration, the refrigeration cycle apparatus according to the fourth aspect can prevent the other utilization units from being damaged caused by increasing the pressure of the refrigerant flowing in the other utilization units.

[0010] A refrigeration cycle apparatus according to a fifth aspect is the refrigeration cycle apparatus according to any of the first to third aspects, in which when the first sensor detects leakage of the refrigerant, the control unit controls the compressor on the basis of a state of the first utilization unit.

[0011] By such a configuration, the refrigeration cycle apparatus according to the fifth aspect can prevent the other utilization units from being damaged caused by increasing the pressure of the refrigerant flowing in the other utilization units.

[0012] A refrigeration cycle apparatus according to a sixth aspect is the refrigeration cycle apparatus according to the fifth aspect, in which the state of the first utilization unit includes a capacity of the first utilization unit or an opening degree of the first opening degree adjustment valve.

[0013] A refrigeration cycle apparatus according to a seventh aspect is the refrigeration cycle apparatus according to the fifth aspect, in which the first utilization unit includes a second opening degree adjustment valve inside the first utilization unit. The state of the first utilization unit includes an opening degree of the second opening degree adjustment valve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

FIG. 1 is a diagram showing a refrigerant circuit of a

refrigeration cycle apparatus according to a first embodiment.
FIG. 2 is a control block diagram of the refrigeration cycle apparatus according to the first embodiment.
FIG. 3 is a diagram showing a refrigerant circuit of a refrigeration cycle apparatus according to a second embodiment.

DESCRIPTION OF EMBODIMENTS

<First embodiment>

(1) Overall configuration

[0015] A refrigeration cycle apparatus 1 constitutes a vapor compression refrigeration cycle and performs air conditioning of a target space. In the present embodiment, the refrigeration cycle apparatus 1 is a so-called multi-type air conditioning system for buildings. FIG. 1 is a diagram showing a refrigerant circuit 50 of the refrigeration cycle apparatus 1 according to the present embodiment. As shown in FIG. 1, the refrigeration cycle apparatus 1 mainly includes a heat source unit 30, a plurality of utilization units 20 and 20a, opening degree adjustment units 80 and 80a, and a control unit 40. The heat source unit 30 and the plurality of utilization units 20 and 20a are connected by a liquid refrigerant connection pipe 51 and a gas refrigerant connection pipe 52 to constitute the refrigerant circuit 50. The heat source unit 30, the plurality of utilization units 20 and 20a, and the opening degree adjustment units 80 and 80a are communicably connected by a communication line (not shown). In FIG. 1, the two utilization units 20 and 20a are shown as an example, but the number of the plurality of utilization units connected to the heat source unit 30 is arbitrary.

(2) Detailed configuration

(2-1) Utilization unit

[0016] Since the structures of the utilization units 20 and 20a are basically similar, the utilization unit 20 (first utilization unit) will be described below.

[0017] The utilization unit 20 is installed in the target space in a building in which the refrigeration cycle apparatus 1 is installed. The utilization unit 20 is a ceiling embedded unit, a ceiling pendant unit, a floor-standing unit, or the like. As shown in FIG. 1, the utilization unit 20 mainly includes a utilization heat exchanger 21, a utilization fan 22, a utilization expansion valve 23 (second opening degree adjustment valve), a utilization control unit 29, a refrigerant sensor 61 (first sensor), and a saturation temperature sensor 64. The utilization unit 20 also includes a liquid refrigerant pipe 57 that connects a liquid side end of the utilization heat exchanger 21 and a liquid refrigerant connection pipe 55 which is a branch of the liquid refrigerant connection pipe 51 toward the utilization unit 20. The utilization unit 20 includes a gas refrigerant pipe 58 that connects a gas side end of the utilization heat exchanger 21 and a gas refrigerant connection pipe 56 which is a branch of the gas refrigerant connection pipe 52 toward the utilization unit 20. The liquid refrigerant pipe 57 and the gas refrigerant pipe 58 are provided in the utilization unit 20.

(2-1-1) Utilization heat exchanger

[0018] The utilization heat exchanger 21 causes heat exchange between a refrigerant flowing in the utilization heat exchanger 21 and air in the target space. The utilization heat exchanger 21 is, for example, a fin-and-tube heat exchanger including a plurality of heat transfer fins and a plurality of heat transfer tubes.

(2-1-2) Utilization fan

[0019] The utilization fan 22 supplies air in the target space to the utilization heat exchanger 21. Examples of the utilization fan 22 include a centrifugal fan such as a turbo fan and a sirocco fan. As shown in FIG. 1, the utilization fan 22 is driven by a utilization fan motor 22m. The utilization fan motor 22m has the number of rotations controllable by an inverter.

(2-1-3) Utilization expansion valve

[0020] The utilization expansion valve 23 is a mechanism for controlling pressure and a flow rate of the refrigerant flowing in the liquid refrigerant pipe 57. The utilization expansion valve 23 is provided in the liquid refrigerant pipe 57. The utilization expansion valve 23 is a motor valve having an adjustable opening degree.

(2-1-4) Sensor

[0021] The refrigerant sensor 61 detects leakage of the refrigerant. The refrigerant sensor 61 is provided, for example, near the utilization heat exchanger 21.

[0022] The saturation temperature sensor 64 measures a temperature of the refrigerant flowing through the utilization heat exchanger 21. The saturation temperature sensor 64 measures an evaporation temperature of the refrigerant flowing through the utilization heat exchanger 21 during a cooling operation. The saturation temperature sensor 64 measures a condensation temperature of the refrigerant flowing through the utilization heat exchanger 21 during a heating operation. The saturation temperature sensor 64 is provided in the utilization heat exchanger 21.

(2-1-5) Utilization control unit

[0023] The utilization control unit 29 is communicably connected to various devices of the utilization unit 20 including the utilization expansion valve 23, the utilization fan motor 22m, the refrigerant sensor 61, and the satura-

tion temperature sensor 64.

[0024] The utilization control unit 29 includes a control arithmetic device and a storage device. Examples of the control arithmetic device include a processor such as a CPU and a GPU. Examples of the storage device include a storage medium such as a RAM, a ROM, and a flash memory. The control arithmetic device reads a program stored in the storage device and executes predetermined arithmetic processing in accordance with the program, to control behavior of various devices included in the utilization unit 20. The control arithmetic device is capable of writing an arithmetic result to the storage device, and reading information stored in the storage device, in accordance with the program.

[0025] The utilization control unit 29 is configured to be able to receive various signals transmitted from an operation remote controller (not shown). Examples of the various signals include signals for commanding a start or a stop of operation, and signals related to various settings. Examples of the signals related to the various settings include a signal relevant to a set temperature or a set air volume.

[0026] The utilization control unit 29 exchanges control signals, measurement signals, signals related to various settings, and the like with the heat source control unit 39 of the heat source unit 30 and the opening degree control unit 89 of the opening degree adjustment unit 80 via a communication line. The utilization control unit 29, the heat source control unit 39, and the opening degree control unit 89 cooperate with each other to function as the control unit 40.

(2-2) Heat source unit

[0027] The heat source unit 30 is installed on a rooftop of a building where the refrigeration cycle apparatus 1 is installed, for example. As illustrated in FIG. 1, the heat source unit 30 mainly includes a compressor 31, a flow path switching valve 32, a heat source heat exchanger 33, a heat source expansion valve 34, an accumulator 35, a heat source fan 36, a liquid shutoff valve 37, a gas shutoff valve 38, a heat source control unit 39, a suction pressure sensor 68, and a discharge pressure sensor 69. In addition, the heat source unit 30 includes a suction pipe 54a, a discharge pipe 54b, gas refrigerant pipes 54c and 54e, and a liquid refrigerant pipe 54d.

[0028] The suction pipe 54a connects the flow path switching valve 32 and a suction side of the compressor 31. The suction pipe 54a is provided with the accumulator 35. The discharge pipe 54b connects a discharge side of the compressor 31 and the flow path switching valve 32. The gas refrigerant pipe 54c connects the flow path switching valve 32 and a gas side end of the heat source heat exchanger 33. The liquid refrigerant pipe 54d connects a liquid side end of the heat source heat exchanger 33 and the liquid refrigerant connection pipe 51. The liquid refrigerant pipe 54d is provided with the heat source expansion valve 34. The liquid shutoff valve 37 is provided at a connection portion between the liquid refrigerant pipe 54d and the liquid refrigerant connection pipe 51. The gas refrigerant pipe 54e connects the flow path switching valve 32 and the gas refrigerant connection pipe 52. The gas shutoff valve 38 is provided at a connection portion between the gas refrigerant pipe 54e and the gas refrigerant connection pipe 52. The liquid shutoff valve 37 and the gas shutoff valve 38 are openable and closable manually.

(2-2-1) Compressor

[0029] As shown in FIG. 1, the compressor 31 sucks a low-pressure refrigerant from the suction pipe 54a, compresses the refrigerant by a compression mechanism (not shown), and discharges the compressed refrigerant to the discharge pipe 54b.

[0030] The compressor 31 is, for example, a displacement compressor of a rotary type or a scroll type. The compressor 31 includes the compression mechanism driven by a compressor motor 31m. The compressor motor 31m has the number of rotations controllable by an inverter.

(2-2-2) Flow path switching valve

[0031] The flow path switching valve 32 is a mechanism that switches a refrigerant flow path between a first state and a second state. In the first state, the flow path switching valve 32 causes the suction pipe 54a to communicate with the gas refrigerant pipe 54e and causes the discharge pipe 54b to communicate with the gas refrigerant pipe 54c as indicated by a solid line in the flow path switching valve 32 in FIG. 1. In the second state, the flow path switching valve 32 causes the suction pipe 54a to communicate with the gas refrigerant pipe 54c and causes the discharge pipe 54b to communicate with the gas refrigerant pipe 54e as indicated by a broken line in the flow path switching valve 32 in FIG. 1.

[0032] During the cooling operation, the flow path switching valve 32 brings the refrigerant flow path into the first state. At this time, the refrigerant discharged from the compressor 31 flows in the refrigerant circuit 50 through the heat source heat exchanger 33, the heat source expansion valve 34, the utilization expansion valve 23, and the utilization heat exchanger 21 in the mentioned order, and returns to the compressor 31. In the first state, the heat source heat exchanger 33 functions as a condenser and the utilization heat exchanger 21 functions as an evaporator.

[0033] During the heating operation, the flow path switching valve 32 brings the refrigerant flow path into the second state. At this time, the refrigerant discharged from the compressor 31 flows in the refrigerant circuit 50 through the utilization heat exchanger 21, the utilization expansion valve 23, the heat source expansion valve 34, and the heat source heat exchanger 33 in the mentioned order, and returns to the compressor 31. In the second

state, the heat source heat exchanger 33 functions as an evaporator and the utilization heat exchanger 21 functions as a condenser.

(2-2-3) Heat source heat exchanger

[0034] The heat source heat exchanger 33 causes heat exchange between the refrigerant flowing through the heat source heat exchanger 33 and air around the heat source unit 30. The heat source heat exchanger 33 is, for example, a fin-and-tube heat exchanger including a plurality of heat transfer fins and a plurality of heat transfer tubes.

(2-2-4) Heat source expansion valve

[0035] The heat source expansion valve 34 is a mechanism for controlling pressure and a flow rate of the refrigerant flowing in the liquid refrigerant pipe 54d. As shown in FIG. 1, the heat source expansion valve 34 is provided in the liquid refrigerant pipe 54d. The heat source expansion valve 34 is a motor valve having an adjustable opening degree.

(2-2-5) Accumulator

[0036] The accumulator 35 is a container having a gas-liquid separation function of separating an incoming refrigerant into a gas refrigerant and a liquid refrigerant. As shown in FIG. 1, the accumulator 35 is disposed in the suction pipe 54a. The refrigerant flowing into the accumulator 35 is separated into a gas refrigerant and a liquid refrigerant, and the gas refrigerant collecting in an upper space flows into the compressor 31.

(2-2-6) Heat source fan

[0037] The heat source fan 36 supplies air around the heat source unit 30 to the heat source heat exchanger 33. The heat source fan 36 is, for example, an axial fan such as a propeller fan. As shown in FIG. 1, the heat source fan 36 is driven by a heat source fan motor 36m. The heat source fan motor 36m has the number of rotations controllable by an inverter.

(2-2-7) Sensor

[0038] The suction pressure sensor 68 is a sensor that measures a suction pressure of the compressor 31. The suction pressure sensor 68 is provided in the suction pipe 54a. The suction pressure is a refrigerant pressure corresponding to an evaporation pressure during the cooling operation.

[0039] The discharge pressure sensor 69 is a sensor that measures a discharge pressure of the compressor 31. The discharge pressure sensor 69 is provided in the discharge pipe 54b. The discharge pressure is a refrigerant pressure corresponding to a condensation pressure during the heating operation.

(2-2-8) Heat source control unit

[0040] The heat source control unit 39 is communicably connected to various devices included in the heat source unit 30, including the compressor motor 31m, the flow path switching valve 32, the heat source expansion valve 34, the heat source fan motor 36m, the suction pressure sensor 68, and the discharge pressure sensor 69.

[0041] The heat source control unit 39 includes a control arithmetic device and a storage device. Examples of the control arithmetic device include a processor such as a CPU and a GPU. Examples of the storage device include a storage medium such as a RAM, a ROM, and a flash memory. The control arithmetic device reads a program stored in the storage device and executes predetermined arithmetic processing in accordance with the program, to control behavior of various devices included in the heat source unit 30. The control arithmetic device is capable of writing an arithmetic result to the storage device, and reading information stored in the storage device, in accordance with the program.

[0042] The heat source control unit 39 exchanges control signals, measurement signals, signals related to various settings, and the like with the utilization control unit 29 of the utilization unit 20 and the opening degree control unit 89 of the opening degree adjustment unit 80 via a communication line. The heat source control unit 39, the utilization control unit 29, and the opening degree control unit 89 cooperate with each other to function as the control unit 40.

(2-3) Opening degree adjustment unit

[0043] Since the structures of the opening degree adjustment units 80 and 80a are basically similar, the opening degree adjustment unit 80 will be described below.

[0044] As shown in FIG. 1, the opening degree adjustment unit 80 is provided for the utilization unit 20. The opening degree adjustment unit 80 includes a liquid opening degree adjustment valve 81, a gas opening degree adjustment valve 82, and the opening degree control unit 89.

[0045] The liquid opening degree adjustment valve 81 is provided in the liquid refrigerant connection pipe 55 connected to the utilization unit 20. In other words, the liquid opening degree adjustment valve 81 is provided in the liquid refrigerant connection pipe 55 on a liquid side connected to the utilization unit 20.

[0046] The gas opening degree adjustment valve 82 is provided in the gas refrigerant connection pipe 56 connected to the utilization unit 20. In other words, the gas opening degree adjustment valve 82 (first opening degree adjustment valve) is provided in the gas refrigerant connection pipe 56 (first refrigerant pipe) on a gas side connected to the utilization unit 20.

[0047] The liquid opening degree adjustment valve 81 and the gas opening degree adjustment valve 82 are motor valves having adjustable opening degrees. Furthermore, when the liquid opening degree adjustment valve 81 is fully closed, the liquid opening degree adjustment valve 81 functions as a shutoff valve that shuts off the refrigerant flowing through the liquid refrigerant connection pipe 55. When the gas opening degree adjustment valve 82 is fully closed, the gas opening degree adjustment valve 82 functions as a shutoff valve that shuts off the refrigerant flowing through the gas refrigerant connection pipe 56.

[0048] The opening degree control unit 89 is communicably connected to various devices of the opening degree adjustment unit 80 including the liquid opening degree adjustment valve 81 and the gas opening degree adjustment valve 82.

[0049] The opening degree control unit 89 includes a control arithmetic device and a storage device. Examples of the control arithmetic device include a processor such as a CPU and a GPU. Examples of the storage device include a storage medium such as a RAM, a ROM, and a flash memory. The control arithmetic device reads a program stored in the storage device and executes predetermined arithmetic processing in accordance with the program, to control behavior of various devices included in the heat source unit 30. The control arithmetic device is capable of writing an arithmetic result to the storage device, and reading information stored in the storage device, in accordance with the program.

[0050] The opening degree control unit 89 exchanges control signals, measurement signals, signals related to various settings, and the like with the utilization control unit 29 of the utilization unit 20 and the heat source control unit 39 of the heat source unit 30 via a communication line. The opening degree control unit 89, the utilization control unit 29, and the heat source control unit 39 cooperate with each other to function as the control unit 40.

(2-4) Control unit

[0051] The control unit 40 includes the utilization control unit 29, the heat source control unit 39, and the opening degree control unit 89. The control unit 40 controls the entire operation of the refrigeration cycle apparatus 1 by causing each control arithmetic device of the utilization control unit 29, the heat source control unit 39, and the opening degree control unit 89 to execute the program stored in each storage device.

[0052] FIG. 2 is a control block diagram of the refrigeration cycle apparatus 1 according to the present embodiment. As shown in Fig. 2, the control unit 40 is communicably connected to the utilization expansion valve 23, the utilization fan motor 22m, the refrigerant sensor 61, the saturation temperature sensor 64, the compressor motor 31m, the flow path switching valve 32, the heat source expansion valve 34, the heat source fan motor 36m, the suction pressure sensor 68, the discharge pressure sensor 69, the liquid opening degree adjustment valve 81, and the gas opening degree adjustment valve 82. The control unit 40 controls behavior of various devices included in the refrigeration cycle apparatus 1 on the basis of control signals received from an operation remote controller via the utilization unit 20, measurement signals of various sensors, and the like.

[0053] The control unit 40 mainly performs the cooling operation and the heating operation. The control unit 40 mainly has a refrigerant leak prevention function.

(2-4-1) Cooling operation

[0054] For example, when receiving an instruction to perform the cooling operation from the operation remote controller via the utilization unit 20, the control unit 40 switches the flow path switching valve 32 to the first state.

[0055] Then, the control unit 40 fully opens the heat source expansion valve 34, and controls the liquid opening degree adjustment valve 81, the gas opening degree adjustment valve 82, the compressor motor 31m, the utilization expansion valve 23, and the like so that the evaporation temperature as a measurement value of the saturation temperature sensor 64 becomes a target evaporation temperature. In particular, the control unit 40 controls the gas opening degree adjustment valve 82 to adjust the evaporation temperature of the refrigerant flowing through the utilization heat exchanger 21. For example, the control unit 40 increases the evaporation temperature of the refrigerant flowing through the utilization heat exchanger 21 by decreasing the opening degree of the gas opening degree adjustment valve 82. The target evaporation temperature is set in accordance with a set temperature received from the operation remote controller, for example.

[0056] When the behavior of various devices is controlled as described above, the refrigerant flows through the refrigerant circuit 50 during the cooling operation as follows.

[0057] When the compressor 31 is activated, a low-pressure gas refrigerant is sucked into the compressor 31 and is compressed by the compressor 31 into a high-pressure gas refrigerant. The high-pressure gas refrigerant is sent to the heat source heat exchanger 33 via the flow path switching valve 32, exchanges heat with air around the heat source unit 30 supplied by the heat source fan 36, and is condensed into a high-pressure liquid refrigerant. The high-pressure liquid refrigerant flows through the liquid refrigerant pipe 54d and passes through the heat source expansion valve 34. The high-pressure liquid refrigerant sent to the utilization unit 20 is decompressed at the utilization expansion valve 23 to have pressure close to the suction pressure of the compressor 31 and come into a refrigerant in a gas-liquid two-phase state, and is sent to the utilization heat exchanger 21. The refrigerant in the gas-liquid two-phase state exchanges heat, in the utilization heat exchanger 21, with air in the target space supplied into the utilization

heat exchanger 21 by the utilization fan 22 to be evaporated into a low-pressure gas refrigerant. The low-pressure gas refrigerant is sent to the heat source unit 30 via the gas refrigerant connection pipe 52, and flows into the accumulator 35 via the flow path switching valve 32. The low-pressure gas refrigerant having flowed into the accumulator 35 is sucked into the compressor 31 again. Air supplied to the utilization heat exchanger 21 is decreased in temperature through heat exchange with the refrigerant flowing in the utilization heat exchanger 21. Accordingly, the air cooled in the utilization heat exchanger 21 blows out into the target space.

(2-4-2) Heating operation

[0058] For example, when receiving an instruction to perform the heating operation from the operation remote controller via the utilization unit 20, the control unit 40 switches the flow path switching valve 32 to the second state.

[0059] Then, the control unit 40 controls the liquid opening degree adjustment valve 81, the gas opening degree adjustment valve 82, the compressor motor 31m, the utilization expansion valve 23, and the like so that the condensation temperature as a measurement value of the saturation temperature sensor 64 becomes a target condensation temperature. **In** particular, the control unit 40 controls the gas opening degree adjustment valve 82 to adjust the condensation temperature of the refrigerant flowing through the utilization heat exchanger 21. For example, the control unit 40 decreases the condensation temperature of the refrigerant flowing through the utilization heat exchanger 21 by decreasing the opening degree of the gas opening degree adjustment valve 82. The target condensation temperature is set in accordance with a set temperature received from the operation remote controller, for example. The control unit 40 controls the opening degree of the heat source expansion valve 34 such that the refrigerant flowing into the heat source heat exchanger 33 is decompressed to have pressure allowing evaporation in the heat source heat exchanger 33.

[0060] When the compressor 31 is activated, a low-pressure gas refrigerant is sucked into the compressor 31 and is compressed by the compressor 31 into a high-pressure gas refrigerant. The high-pressure gas refrigerant is sent to the utilization heat exchanger 21 via the flow path switching valve 32, exchanges heat with the air in the target space supplied to the utilization heat exchanger 21 by the utilization fan 22, and is condensed into a high-pressure liquid refrigerant. Air supplied to the utilization heat exchanger 21 is increased in temperature through heat exchange with the refrigerant flowing in the utilization heat exchanger 21. Accordingly, the air heated in the utilization heat exchanger 21 blows out into the target space. The high-pressure liquid refrigerant having passed through the utilization heat exchanger 21 is decompressed in the utilization expansion valve 23. The decompressed liquid refrigerant is sent to the heat source unit 30 via the liquid refrigerant connection pipe 51, and flows into the liquid refrigerant pipe 54d. The refrigerant flowing through the liquid refrigerant pipe 54d is decompressed in the heat source expansion valve 34 to have pressure close to the suction pressure of the compressor 31 and come into a refrigerant in the gas-liquid two-phase state, and flows into the heat source heat exchanger 33. The low-pressure refrigerant in the gas-liquid two-phase state having flowed into the heat source heat exchanger 33 exchanges heat with air around the heat source unit 30 supplied by the heat source fan 36 to be evaporated into a low-pressure gas refrigerant. The low-pressure gas refrigerant flows into the accumulator 35 via the flow path switching valve 32. The low-pressure gas refrigerant having flowed into the accumulator 35 is sucked into the compressor 31 again.

(2-4-3) Refrigerant leak prevention function

[0061] When the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 fully closes the liquid opening degree adjustment valve 81 to block the refrigerant leaking from the utilization unit 20 through the liquid refrigerant connection pipe 55. When the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 fully closes the gas opening degree adjustment valve 82 to block the refrigerant leaking from the utilization unit 20 through the gas refrigerant connection pipe 56. The control unit 40 may further fully close the utilization expansion valve 23.

[0062] When the liquid opening degree adjustment valve 81 and the gas opening degree adjustment valve 82 are fully closed, the pressure of the refrigerant flowing in the other utilization units (for example, the utilization unit 20a) increases, and there is a possibility that the other utilization units are damaged. Therefore, when the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 controls the compressor 31 on the basis of a pressure fluctuation of the refrigerant flowing in the refrigerant circuit 50 caused by fully closing the gas opening degree adjustment valve 82. For example, when a measurement value of the suction pressure sensor 68 increases by fully closing the gas opening degree adjustment valve 82, the control unit 40 decreases the number of rotations of the compressor motor 31m.

(3) Characteristics

[0063] (3-1)

Conventionally, there is a technique of controlling an opening degree adjustment valve provided for a utilization unit to control an evaporation temperature or a condensation temperature in the utilization unit. In preparation for leakage of a refrigerant in the utilization unit, it is desirable to provide the utilization unit with a shutoff valve that shuts off leakage of the refrigerant. However, when the shutoff valve is provided separately from the opening

degree adjustment valve, there is a problem that the structure of the refrigeration cycle apparatus becomes complicated.

[0064] The refrigeration cycle apparatus 1 according to the present embodiment includes the heat source unit 30, the plurality of utilization units 20 and 20a, the gas opening degree adjustment valve 82, and the control unit 40. The heat source unit 30 includes the compressor 31. The plurality of utilization units 20 and 20a constitutes the refrigerant circuit 50 together with the heat source unit 30. The plurality of utilization units 20 and 20a includes the utilization unit 20. The gas opening degree adjustment valve 82 is provided for the utilization unit 20. The utilization unit 20 includes the refrigerant sensor 61. The refrigerant sensor 61 detects leakage of the refrigerant. The control unit 40 controls the gas opening degree adjustment valve 82 to adjust the evaporation temperature or the condensation temperature in the utilization unit 20. When the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 fully closes the gas opening degree adjustment valve 82 to block the refrigerant leaking from the utilization unit 20.

[0065] When the refrigerant sensor 61 detects leakage of the refrigerant in the refrigeration cycle apparatus 1, the control unit 40 fully closes the gas opening degree adjustment valve 82 to block the refrigerant leaking from the utilization unit 20. As a result, the refrigeration cycle apparatus 1 can simplify the structure of the refrigeration cycle apparatus 1 by using the gas opening degree adjustment valve 82 as a shutoff valve that shuts off the refrigerant leaking from the utilization unit 20.

[0066] (3-2)

In the refrigeration cycle apparatus 1, the gas opening degree adjustment valve 82 is provided in the gas refrigerant connection pipe 56 on the gas side connected to the utilization unit 20. When the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 fully closes the gas opening degree adjustment valve 82 to block the refrigerant leaking from the utilization unit 20 through the gas refrigerant connection pipe 56.

[0067] (3-3)

In the refrigeration cycle apparatus 1, the control unit 40 controls the gas opening degree adjustment valve 82 such that the evaporation temperature or the condensation temperature in the utilization unit 20 becomes the target evaporation temperature or the target condensation temperature.

[0068] (3-4)

In the refrigeration cycle apparatus 1, when the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 controls the compressor 31 on the basis of a pressure fluctuation of the refrigerant flowing in the refrigerant circuit 50 caused by fully closing the gas opening degree adjustment valve 82.

[0069] As a result, the refrigeration cycle apparatus 1 can prevent the other utilization units from being damaged caused by increasing the pressure of the refrigerant flowing in the other utilization units as a result of fully closing the gas opening degree adjustment valve 82.

(4) Modifications

(4-1) Modification 1A

[0070] In the present embodiment, when the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 controls the compressor 31 on the basis of a pressure fluctuation of the refrigerant flowing in the refrigerant circuit 50 caused by fully closing the gas opening degree adjustment valve 82.

[0071] However, when the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 may control the compressor 31 on the basis of the state of the utilization unit 20 after fully closing the gas opening degree adjustment valve 82. The state of the utilization unit 20 includes the capacity of the utilization unit 20 or the opening degree of the gas opening degree adjustment valve 82. For example, when the capacity of the utilization unit 20 is relatively large, there is a high possibility that the pressure of the refrigerant flowing in the other utilization units increases by the control unit 40 fully closing the gas opening degree adjustment valve 82. Therefore, when the capacity of the utilization unit 20 is relatively large, the control unit 40 fully closes the gas opening degree adjustment valve 82 and then decreases the number of rotations of the compressor motor 31m. For example, when the opening degree of the gas opening degree adjustment valve 82 before being fully closed is relatively large, there is a high possibility that the pressure of the refrigerant flowing in the other utilization units increases by the control unit 40 fully closing the gas opening degree adjustment valve 82. Therefore, when the opening degree of the gas opening degree adjustment valve 82 before being fully closed is relatively large, the control unit 40 fully closes the gas opening degree adjustment valve 82 and then decreases the number of rotations of the compressor motor 31m.

[0072] The state of the utilization unit 20 may include the opening degree of the utilization expansion valve 23. For example, when the opening degree of the utilization expansion valve 23 before the gas opening degree adjustment valve 82 is fully closed is relatively large, there is a high possibility that the pressure of the refrigerant flowing in the other utilization units increases by the control unit 40 fully closing the gas opening degree adjustment valve 82. Therefore, when the opening degree of the utilization expansion valve 23 before the gas opening degree adjustment valve 82 is fully closed is relatively large, the control unit 40 fully closes the gas opening degree adjustment valve 82 and then decreases the number of rotations of the compressor motor 31m.

[0073] As a result, the refrigeration cycle apparatus 1 can prevent the other utilization units from being damaged caused by increasing the pressure of the refrigerant flowing in the other utilization units as a result of fully closing the gas opening degree adjustment valve 82.

[0074] When the refrigerant sensor 61 detects leakage of the refrigerant, the control unit 40 may control the compressor 31 on the basis of the state of the utilization unit 20 and then fully close the gas opening degree adjustment valve 82.

(4-2) Modification 1B

[0075] The opening degree adjustment unit 80 may be provided for each of the plurality of utilization units connected to the heat source unit 30, or may be provided for some of the plurality of utilization units.

(4-3) Modification 1C

[0076] For example, the refrigeration cycle apparatus 1 may be a multi-type air conditioning system for buildings in which the plurality of utilization units connected to the heat source unit 30 can independently perform the cooling operation and the heating operation.

[0077] (4-4)

The embodiment of the present disclosure has been described above. Various modifications to modes and details should be available without departing from the gist and the scope of the present disclosure recited in the claims.

<Second embodiment>

[0078] Differences from the first embodiment will be mainly described below.

[0079] FIG. 3 is a diagram showing the refrigerant circuit 50 of the refrigeration cycle apparatus 1 according to the present embodiment. As shown in FIG. 3, an opening degree adjustment unit 801 in the present embodiment does not include the liquid opening degree adjustment valve 81 unlike the opening degree adjustment unit 80 in the first embodiment.

[0080] When the cooling operation and the heating operation are performed, the utilization expansion valve 23 also functions as the liquid opening degree adjustment valve 81.

[0081] As a result, the refrigeration cycle apparatus 1 can simplify the structure of the refrigeration cycle apparatus 1 by using the gas opening degree adjustment valve 82 as a shutoff valve that shuts off the refrigerant leaking from the utilization unit 20.

[0082] The opening degree adjustment unit 801 may be provided for each of the plurality of utilization units connected to the heat source unit 30, or may be provided for some of the plurality of utilization units. As illustrated in FIG. 3, different types of opening degree adjustment units may be provided for the plurality of utilization units, for example, the opening degree adjustment unit 801 may be provided for the utilization unit 20, and the opening degree adjustment unit 80a may be provided for the utilization unit 20a.

[0083] The embodiment of the present disclosure has been described above. Various modifications to modes and details should be available without departing from the gist and the scope of the present disclosure recited in the claims.

REFERENCE SIGNS LIST

[0084]

1: refrigeration cycle apparatus
20: utilization unit (first utilization unit)
20a: utilization unit
23: utilization expansion valve (second opening degree adjustment valve)
30: heat source unit
31: compressor
40: control unit
50: refrigerant circuit
56: gas refrigerant connection pipe (first refrigerant pipe)
61: refrigerant sensor (first sensor)
82: gas opening degree adjustment valve (first opening degree adjustment valve)

CITATION LIST

PATENT LITERATURE

[0085] Patent Literature 1: JP 2008-281304 A

Claims

1. A refrigeration cycle apparatus (1) comprising:

a heat source unit (30) including a compressor (31);
a plurality of utilization units (20, 20a) that includes a first utilization unit (20) and constitutes a refrigerant circuit (50) together with the heat source unit;
a first opening degree adjustment valve (82) provided for the first utilization unit; and
a control unit (40),
wherein the first utilization unit includes a first sensor (61) that detects leakage of a refrigerant,
the control unit controls the first opening degree adjustment valve to adjust an evaporation temperature or a condensation temperature in the first utilization unit, and
when the first sensor detects leakage of the refrigerant, the control unit fully closes the first opening degree adjustment valve to block the refrigerant leaking from the first utilization unit.

2. The refrigeration cycle apparatus (1) according to claim 1, wherein

the first opening degree adjustment valve is provided in a first refrigerant pipe (56) on a gas side connected to the first utilization unit, and

when the first sensor detects leakage of the refrigerant, the control unit fully closes the first opening degree adjustment valve to block the refrigerant leaking from the first utilization unit through the first refrigerant pipe.

3. The refrigeration cycle apparatus (1) according to claim 1 or 2, wherein the control unit controls the first opening degree adjustment valve such that the evaporation temperature or the condensation temperature in the first utilization unit becomes a target evaporation temperature or a target condensation temperature.

4. The refrigeration cycle apparatus (1) according to any one of claims 1 to 3, wherein when the first sensor detects leakage of the refrigerant, the control unit controls the compressor on a basis of a pressure fluctuation of the refrigerant flowing in the refrigerant circuit, the pressure fluctuation being caused by fully closing the first opening degree adjustment valve.

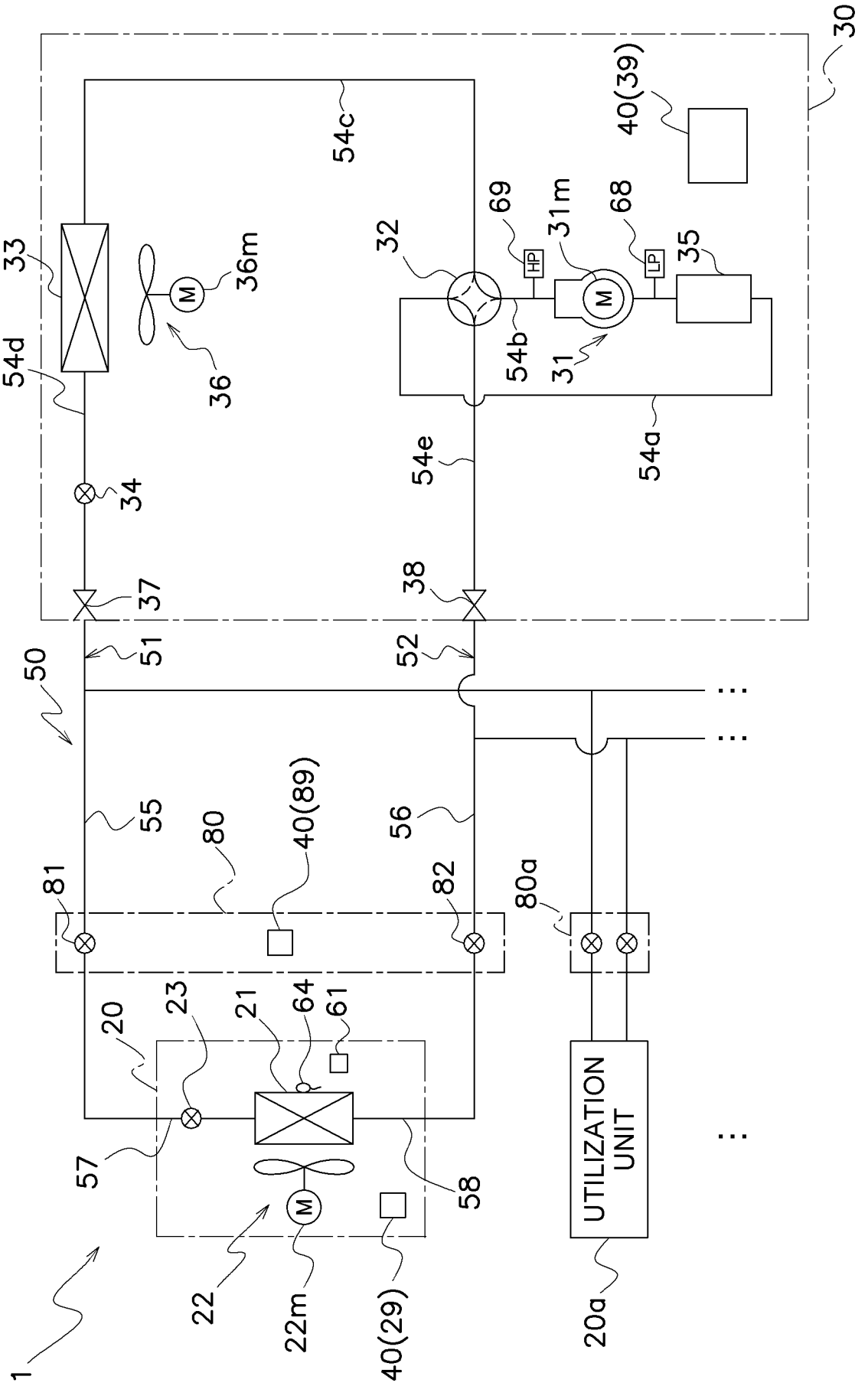
5. The refrigeration cycle apparatus (1) according to any one of claims 1 to 3, wherein when the first sensor detects leakage of the refrigerant, the control unit controls the compressor on a basis of a state of the first utilization unit.

6. The refrigeration cycle apparatus (1) according to claim 5, wherein the state of the first utilization unit includes a capacity of the first utilization unit or an opening degree of the first opening degree adjustment valve.

7. The refrigeration cycle apparatus (1) according to claim 5, wherein

the first utilization unit includes a second opening degree adjustment valve (23) inside the first utilization unit, and

the state of the first utilization unit includes an opening degree of the second opening degree adjustment valve.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LP
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36m
M
54d
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54a
54e
34
38
37
51
52
50
55
80
40(89)
56
81
82
80a
20
23
21
64
61
57
58
UTILIZATION UNIT
1
22
22m
40(29)
20a

FIG. 1

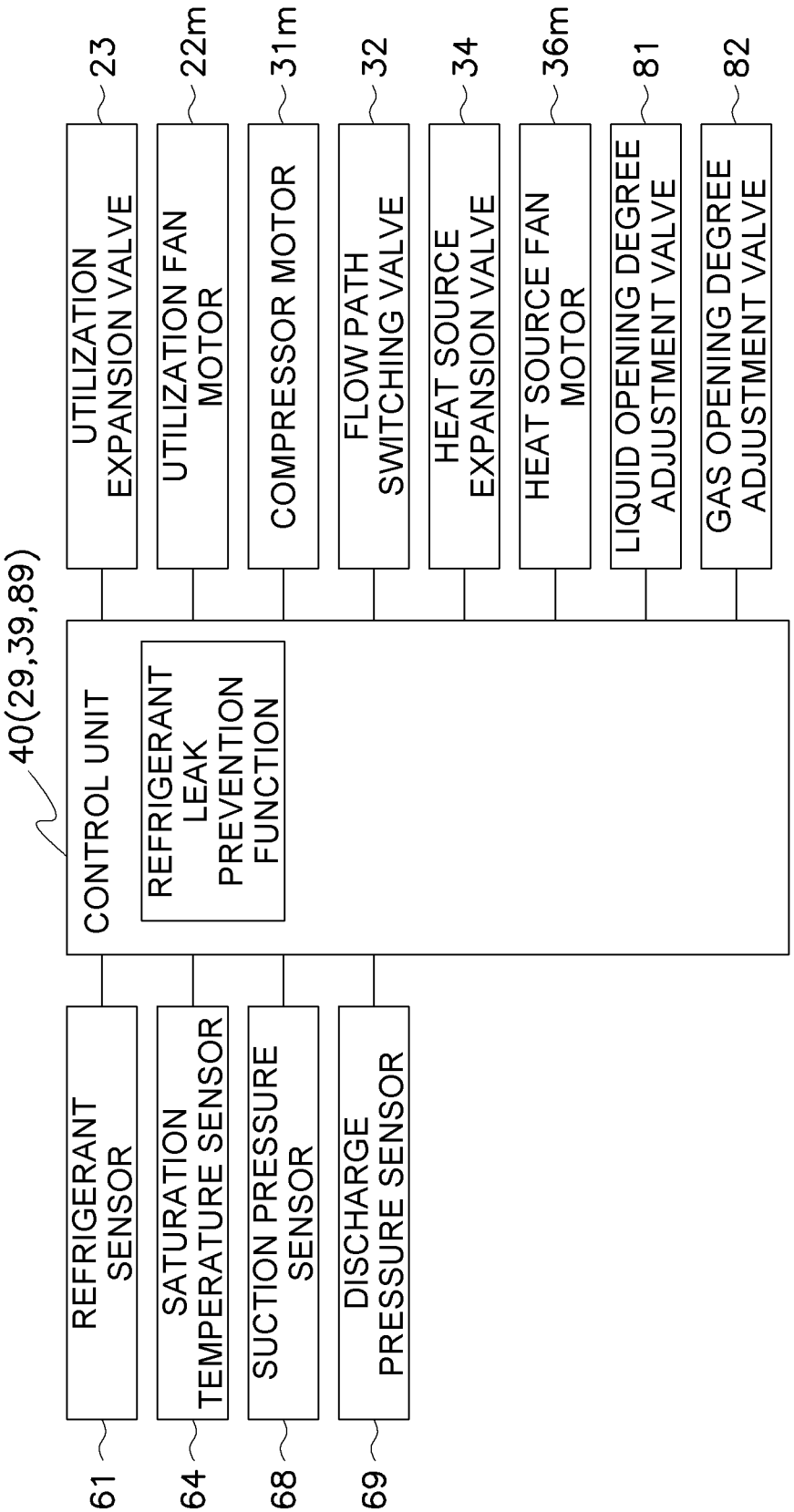
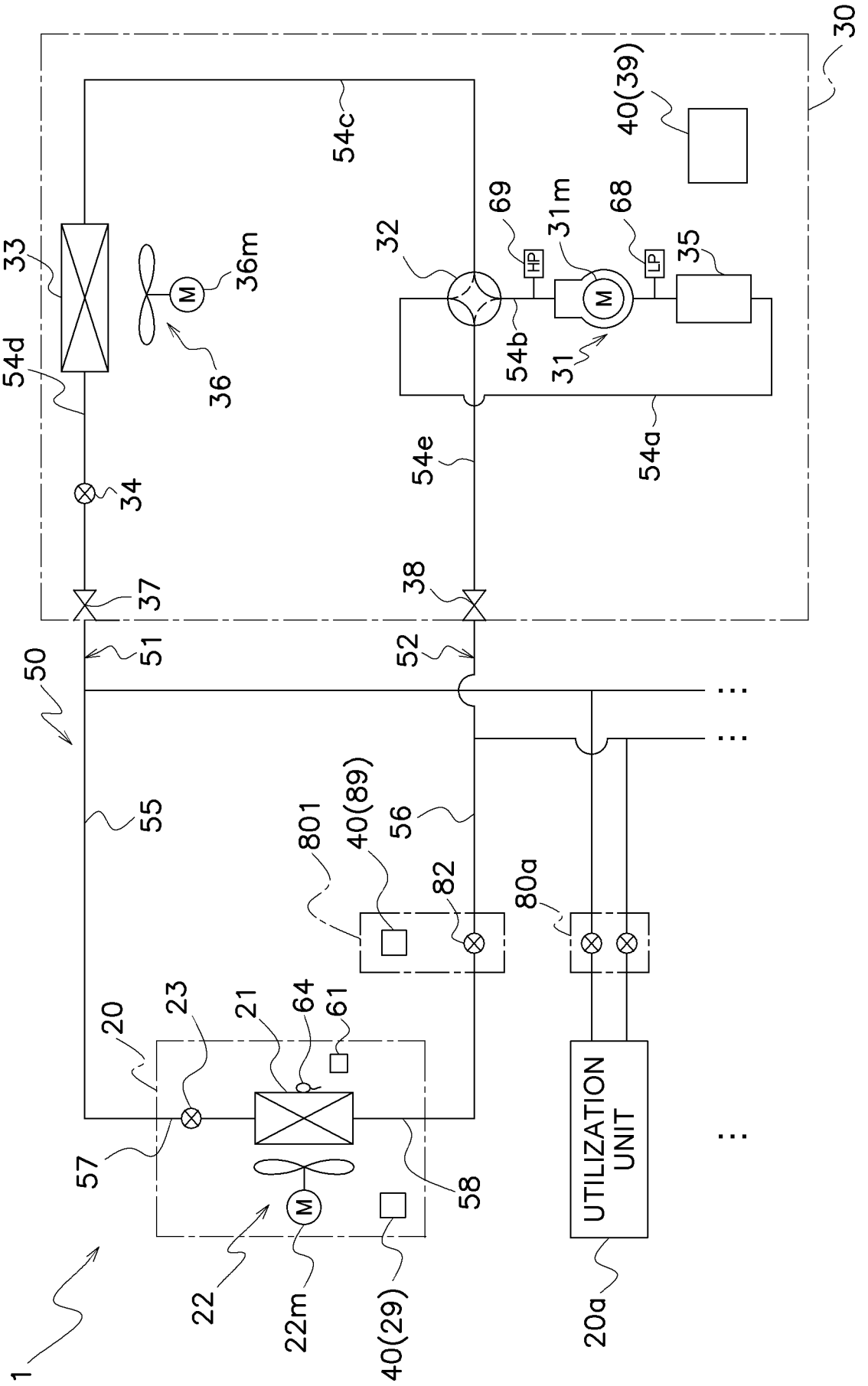

40(29,39,89)
CONTROL UNIT
REFRIGERANT LEAK PREVENTION FUNCTION
UTILIZATION EXPANSION VALVE
23
UTILIZATION FAN MOTOR
22m
COMPRESSOR MOTOR
31m
FLOW PATH SWITCHING VALVE
32
HEAT SOURCE EXPANSION VALVE
34
HEAT SOURCE FAN MOTOR
36m
LIQUID OPENING DEGREE ADJUSTMENT VALVE
81
GAS OPENING DEGREE ADJUSTMENT VALVE
82
REFRIGERANT SENSOR
61
SATURATION TEMPERATURE SENSOR
64
SUCTION PRESSURE SENSOR
68
DISCHARGE PRESSURE SENSOR
69

FIG. 2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M
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54d
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54e
34
38
37
51
52
50
55
801
40(89)
56
82
80a
20
23
21
64
61
57
58
UTILIZATION UNIT
1
22
22m
40(29)
20a

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2024/032206

A. CLASSIFICATION OF SUBJECT MATTER

F25B 1/00(2006.01)i; ***F25B 49/02***(2006.01)i
FI: F25B1/00 304W; F25B49/02 520M; F25B1/00 371Z

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)

F25B1/00-49/04

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 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

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 2018/062547 A1 (DAIKIN INDUSTRIES, LTD.) 05 April 2018 (2018-04-05) paragraphs [0039]-[0107], fig. 1-12	1-3
Y	paragraphs [0039]-[0107], fig. 1-12	1-7
Y	JP 07-332795 A (MATSUSHITA SEIKO CO., LTD.) 22 December 1995 (1995-12-22) paragraphs [0088]-[0099], fig. 17-18	1-7
A	WO 2019/064566 A1 (DAIKIN INDUSTRIES, LTD.) 04 April 2019 (2019-04-04) entire text, all drawings	1-7
A	JP 2022-543000 A (DAIKIN INDUSTRIES, LTD.) 07 October 2022 (2022-10-07) entire text, all drawings	1-7
A	JP 02-223774 A (KABUSHIKI KAISHA TOSHIBA) 06 September 1990 (1990-09-06) entire text, all drawings	1-7

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 October 2024	**05 November 2024**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/032206

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2018/062547 A1	05 April 2018	US 2019/0234660 A1 paragraphs [0050]-[0118], fig. 1-12 EP 3521721 A1 CN 109790995 A	
JP 07-332795 A	22 December 1995	(Family: none)	
WO 2019/064566 A1	04 April 2019	US 2020/0318875 A1 EP 3690352 A1 CN 111094871 A	
JP 2022-543000 A	07 October 2022	WO 2021/085529 A1 EP 3816542 A1 US 2022/0275983 A1 CN 114303032 A	
JP 02-223774 A	06 September 1990	(Family: none)	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008281304 A **[0002] [0085]**