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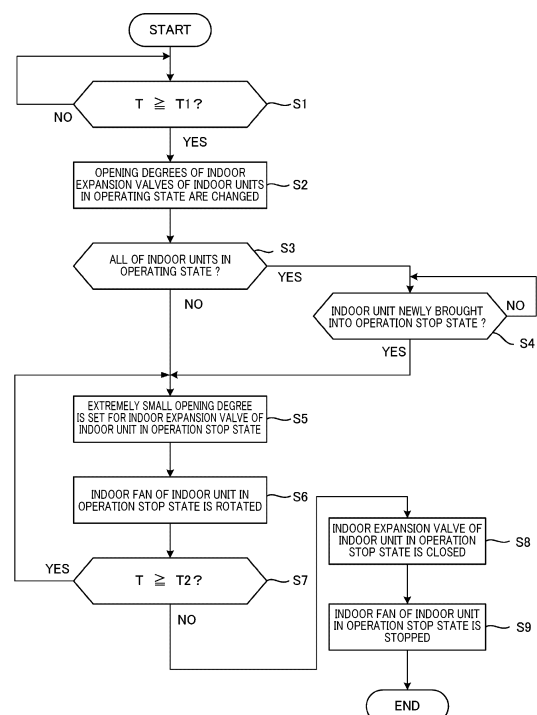
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(54) **REFRIGERATION CYCLE DEVICE**

(57) To provide a refrigeration cycle device that can suppress a disproportionation reaction of a working medium without impairing comfort for users.

A refrigeration cycle device 1 according to the present disclosure is a refrigeration cycle device that includes an outdoor unit 30 including a compressor 31, and that includes a plurality of indoor units 10 each including an expansion valve 15, wherein a working medium containing an ethylene-based fluoroolefin is used as refrigerant, the refrigeration cycle device includes a control unit 70, and when indoor units 10 of the plurality of indoor units 10 are in an operating state, and when a discharge temperature T from the compressor 31 is a predetermined temperature T_1 or higher, the control unit 70 opens the expansion valve 15 of an indoor unit 10 of indoor units 10 in an operation stop state.

FIG.4



Description

[Technical Field]

[0001] The present disclosure relates to a refrigeration cycle device. 5

[Background Art]

[0002] Patent Literature 1 discloses a refrigeration cycle device that uses refrigerant that is thermochemically unstable. In this refrigeration cycle device, when the temperature of the working medium discharged from a compressor has transient transition to a region where the temperature of the working medium discharged from the compressor is a predetermined value or higher, the temperature of the working medium discharged from the compressor is decreased by reducing the driving speed of the compressor. 10 15

[Citation List]

[Patent Literature]

[0003] [Patent Literature 1] Re-publication of PCT International Publication No. 2020/039707 25

[Summary of Invention]

[Technical Problem]

[0004] The present disclosure provides a refrigeration cycle device that can suppress a disproportionation reaction of a working medium without impairing comfort for users. 30 35

[Solution to Problem]

[0005] The content of Japanese Patent Application No. 2022-089807 filed on June 1, 2022 is incorporated herein in its entirety. 40

[0006] A refrigeration cycle device according to the present disclosure is a refrigeration cycle device including: an outdoor unit including a compressor; and a plurality of indoor units each including an expansion valve, wherein a working medium containing an ethylene-based fluoroolefin is used as refrigerant, the refrigeration cycle device includes a control unit, and when some indoor units of the plurality of indoor units are in an operating state, and when a discharge temperature from the compressor is a predetermined temperature or higher, the control unit opens the expansion valve of at least one of the indoor units in an operation stop state. 45 50

[Advantageous Effect of Invention]

[0007] The refrigeration cycle device according to the present disclosure can suppress a disproportionation 55

reaction of a working medium without impairing comfort for users.

[Brief Description of Drawings]

[0008]

[Figure 1] Figure 1 is a diagram showing the overall configuration of a refrigeration cycle device according to an embodiment 1.

[Figure 2] Figure 2 is a diagram of the refrigeration cycle of the refrigeration cycle device.

[Figure 3] Figure 3 is a block diagram of the refrigeration cycle device.

[Figure 4] Figure 4 is a flowchart showing actions of the refrigeration cycle device.

[Description of Embodiment]

20 (Findings and the like forming the basis of the present disclosure)

[0009] At the time when inventors arrived at the present disclosure, a refrigeration cycle device technique is required to use, as a working medium, refrigerant with a low global warming potential (GWP), such refrigerant being less likely to contribute to climate change. Therefore, in the art, there is a problem that refrigerant with a low GWP has high reactivity, thus being unstable. In view of the above, a technique has been proposed that makes unstable refrigerant stable for use by decreasing the temperature of the working medium by reducing the driving speed of the compressor. Under such circumstances, the inventors found the problem that a reduction in driving speed of the compressor affects operation performance of indoor units in an operating state, thus impairing comfort for users. To solve this problem, the inventors have arrived at the subject matter of the present disclosure. 30 35

[0010] The present disclosure provides a refrigeration cycle device that can suppress a disproportionation reaction of a working medium without impairing comfort for users.

[0011] Hereinafter, an embodiment will be described in detail with reference to drawings. However, detailed description beyond that which is necessary may be omitted. For example, the detailed description of an already well-known matter, or repeated description of substantially the same configuration may be omitted.

[0012] Attached drawings and the description made hereinafter are provided to allow those skilled in the art to sufficiently understand the present disclosure, and are not intended to limit the subject matter described in the Claims.

(Embodiment 1)

[1-1. Configuration]

[1-1-1. Overall configuration of refrigeration cycle device]

[0013] Figure 1 is a diagram schematically showing the overall configurations of refrigeration cycle devices 1 according to an embodiment 1. Each refrigeration cycle device 1 includes indoor units 10 and an outdoor unit 30. Each indoor unit 10 is a device disposed in the room of a building structure, such as an office building or a house, or a mobile body, such as a ship, and performs air conditioning to an indoor space. The outdoor unit 30 is a device mainly installed outdoors, and supplies a working medium to the indoor units 10 through a gas pipe 20 and a liquid pipe 40.

[0014] In the present embodiment, the refrigeration cycle device 1 is formed by connecting four indoor units 10 to one outdoor unit 30. The refrigeration cycle device 1 includes, in the rooms, manipulation units not shown in the drawing and corresponding to the respective indoor units 10, and the user sets, via the manipulation units, set temperatures or the like for the air conditioning operation performed by the corresponding indoor units 10. Hereinafter, the air conditioning operation including a cooling operation and a heating operation of the indoor unit 10 is simply referred to as "operation". In the present disclosure, the number of indoor units 10 forming one refrigeration cycle device 1 is not limited to four. Although Figure 1 shows the configuration in which three refrigeration cycle devices 1 individually perform air conditioning for the first floor F1, the second floor F2, and the third floor F3 of a building structure B, hereinafter, the description will be made for one refrigeration cycle device 1 for the sake of convenience of description.

[1-1-2. Configuration of refrigeration cycle circuit]

[0015] The refrigeration cycle device 1 uses, in a refrigeration cycle circuit, a working medium containing an ethylene-based fluoroolefin. Many of ethylene-based fluoroolefins have the characteristic of having a low GWP. In contrast, it is known that an ethylene-based fluoroolefin causes a disproportionation reaction when exposed to a discharge phenomenon under high temperature and high pressure. The occurrence of a disproportionation reaction may cause a rapid rise in pressure in the refrigeration cycle circuit. The detail of the working medium will be described later.

[0016] Figure 2 is a diagram of the refrigeration cycle of the refrigeration cycle device 1. As shown in Figure 2, the four indoor units 10 are connected in parallel to the outdoor unit 30 through the gas pipe 20 and the liquid pipe 40. Each indoor unit 10 includes an indoor heat exchanger 11, an indoor fan 13, and an indoor expansion valve 15. The indoor heat exchanger 11 is, for example, a fin

tube heat exchanger, and causes a working medium flowing therethrough to exchange heat with outside air. The indoor fan 13 is, for example, a centrifugal fan, is connected to the output shaft of an indoor fan motor 13a, being an electronically controllable motor, and rotates with the drive of the indoor fan motor 13a. The indoor fan 13 suctions indoor air into the indoor unit 10 with the rotation thereof, and causes the indoor air to be blown out to the room through the indoor heat exchanger 11. The indoor expansion valve (expansion valve) 15 is a valve in which opening/closing and an opening degree can be changed by electronic control. The indoor expansion valve 15 allows a working medium to flow therethrough when opened, and indoor expansion valve 15 cuts off the flow of the working medium when closed. Changes in the opening degree of the indoor expansion valve 15 change the flow rate of a working medium flowing through the corresponding indoor heat exchanger 11, and change the magnitude of a reduction in pressure, by the indoor expansion valve 15, of the working medium.

[0017] The outdoor unit 30 includes a compressor 31, a four-way valve 33, an outdoor heat exchanger 35, an outdoor fan 37, and an outdoor expansion valve 39. The compressor 31 is, for example, a scroll compressor, and suctions, compresses, and then discharges a gas working medium. A working medium temperature sensor 32 is attached in the vicinity of the discharge port of the compressor 31. The working medium temperature sensor 32 measures a discharge temperature T, which is the temperature of a working medium discharged from the compressor 31. The four-way valve 33 is a device that communicates with the discharge side of the compressor 31, the suction side of the compressor 31, the outdoor heat exchanger 35, and the gas pipe 20, and can switch the flow passage for the working medium by electronic control. By switching the flow passage for the working medium by the four-way valve 33, whether the indoor heat exchanger 11 serves as an evaporator or a condenser is switched. Consequently, whether the indoor unit 10 performs the cooling operation or the heating operation is switched.

[0018] The outdoor heat exchanger 35 is, for example, a fin tube heat exchanger, and causes a working medium flowing therethrough to exchange heat with outside air. The outdoor fan 37 is, for example, an axial-flow fan, is connected to the output shaft of an outdoor fan motor 37a, being an electronically controllable motor, and rotates with the drive of the outdoor fan motor 37a. The outdoor fan 37 suctions outside air into the outdoor unit 30 with the rotation thereof, and causes the suctioned outside air to be blown out to the outside the outdoor unit 30 through the outdoor heat exchanger 35. The outdoor expansion valve 39 is a valve in which the opening degree can be changed by electronic control, for example, and the outdoor expansion valve 39 reduces the pressure of a working medium passing through the outdoor expansion valve 39.

[0019] The gas pipe 20 is a refrigerant pipe that causes

the four-way valve 33 to communicate with the indoor expansion valves 15 included in the respective indoor units 10. A working medium flowing through the gas pipe 20 is mainly in a gas state. The liquid pipe 40 is a refrigerant pipe that causes the outdoor expansion valve 39 to communicate with the indoor heat exchangers 11 included in the respective indoor units 10. A working medium flowing through the liquid pipe 40 is mainly in a liquid state.

[1-1-3. Configuration of control system]

[0020] Figure 3 is a block diagram showing the configuration of the control system of the refrigeration cycle device 1. The four indoor units 10 have the same configuration and hence, in Figure 3, the detailed configuration of only one indoor unit 10 is described, and the detailed configuration of three indoor units 10 is omitted.

[0021] The indoor unit 10 includes a room temperature sensor 12, an indoor communication unit 14, and a motion sensor 16. The room temperature sensor 12 is a sensor that measures room temperature at a predetermined sampling rate. The indoor communication unit 14 is communication hardware corresponding to predetermined communication standards, such as a connector or a communication circuit, and communicates with the outdoor unit 30 through a control wiring. The motion sensor 16 is, for example, an infrared sensor, and senses a person present in the space in which the indoor unit 10 is installed.

[0022] The outdoor unit 30 includes an outdoor communication unit 34 and a control unit 70. The outdoor communication unit 34 is communication hardware corresponding to predetermined communication standards, such as a connector or a communication circuit, and communicates with the indoor communication unit 14 through a control wiring.

[0023] The control unit 70 controls actions of the respective components of the refrigeration cycle device 1. The control unit 70 includes an outdoor unit memory 71, an outdoor unit processor 73, and an outdoor unit interface 75.

[0024] The outdoor unit memory 71 is a memory that stores programs and data. The outdoor unit memory 71 stores various control programs, and data to be processed by the outdoor unit processor 73. The outdoor unit memory 71 has a nonvolatile storage area. The outdoor unit memory 71 may also have a volatile storage area to form a work area for the outdoor unit processor 73.

[0025] The outdoor unit processor 73 is a processor, such as a CPU or an MPU. When the outdoor unit processor 73 reads and executes the control program stored in the outdoor unit memory 71, the outdoor unit processor 73 serves as an equipment control unit 73a and a determination unit 73b.

[0026] The outdoor unit interface 75 is an interface that includes communication hardware corresponding to predetermined communication standards, such as a con-

nect or a communication circuit. The outdoor unit interface 75 communicates with the outdoor communication unit 34, the compressor 31, the four-way valve 33, the outdoor fan motor 37a, the outdoor expansion valve 39, and the working medium temperature sensor 32.

[0027] The equipment control unit 73a receives, as a signal, manipulation performed by the user on the manipulation unit not shown in the drawing and provided in the room, and performs the operation by controlling respective pieces of equipment of the refrigeration cycle device 1 in response to the received signal. The equipment control unit 73a controls, via the outdoor unit interface 75, the respective components of the outdoor unit 30, such as the outdoor communication unit 34, the compressor 31, the four-way valve 33, the outdoor fan motor 37a, and the outdoor expansion valve 39. The equipment control unit 73a also controls, via the outdoor communication unit 34 and the indoor communication unit 14, the respective components of each indoor unit 10, such as the indoor fan motor 13a and the indoor expansion valve 15, thus individually operating or stopping the operation of the four indoor units 10. The indoor unit 10 in an operation stop state includes the indoor unit 10 in a thermo-off operation state. A thermo-off operation is an operation performed when the determination unit 73b described later determines that room temperature data measured by the room temperature sensor 12 matches the set temperature set by the user. When the indoor unit 10 in a normal operation state shifts to the thermo-off operation state, the indoor expansion valve 15 of the indoor unit 10 is closed to prevent room temperature from being changed more than necessary.

[0028] The determination unit 73b receives data on the measured discharge temperature T from the working medium temperature sensor 32. The determination unit 73b also receives, via the outdoor communication unit 34 and the indoor communication unit 14, room temperature data measured by the room temperature sensor 12, and data transmitted from the motion sensor 16. As will be described later, the determination unit 73b performs various determinations based on various received data, and then causes, based on the results of the determinations, the equipment control unit 73a to change control performed on the respective pieces of equipment.

[1-1-4. Working medium]

[0029] Refrigerant used in the refrigeration cycle device 1 is a working medium containing an ethylene-based fluoroolefin. Ethylene-based fluoroolefins include, for example, any one or more of 1, 1, 2-trifluoroethylene (HFO1123), trans-1, 2-difluoroethylene (HFO1132(E)), cis-1, 2-difluoroethylene (HFO-1132(Z)), 1, 1-difluoroethylene (HFO-1132a), tetrafluoroethylene (CF₂ = CF₂, HFO1114), and monofluoroethylene (HFO-1141).

[0030] The above-mentioned working medium may contain two or more refrigerant components. That is, the above-mentioned working medium may contain an

ethylene-based fluoroolefin selected from the above-mentioned examples (for example, 1, 1, 2-trifluoroethylene), and a second refrigerant component. Examples of the second refrigerant component include one or more refrigerants selected from hydrofluorocarbons (HFC), hydrofluoroolefins (HFO), saturated hydrocarbons, carbon dioxide, and other refrigerants. Examples of hydrofluorocarbons include difluoromethane, difluoroethane, trifluoroethane, tetrafluoroethane, pentafluoroethane, pentafluoropropane, hexafluoropropane, heptafluoropropane, pentafluorobutane, and heptafluorocyclopentane. Examples of hydrofluoroolefins include monofluoropropene, trifluoropropene, tetrafluoropropene, pentafluoropropene, and hexafluorobutene. Although examples of saturated hydrocarbons include ethane, n-propane, cyclopropane, n-butane, cyclobutane, isobutane (2-methylpropane), methylcyclopropane, n-pentane, isopentane (2-methylbutane), neopentane (2, 2-dimethylpropane), and methylcyclobutane, other hydrocarbons may be used. The second refrigerant component may contain a plurality of components. That is, the second refrigerant component may contain two or more refrigerant components selected from hydrofluorocarbons, hydrofluoroolefins, saturated hydrocarbons, carbon dioxide, and other refrigerants.

[0031] The working medium used as refrigerant in the refrigeration cycle device 1 may contain a disproportionation inhibiting agent in addition to the refrigerant component. An example of the disproportionation inhibiting agent includes a saturated hydrocarbon. The working medium may contain a disproportionation inhibiting agent made of one or a plurality of components. Although examples of saturated hydrocarbons used as the disproportionation inhibiting agent include ethane, n-propane, cyclopropane, n-butane, cyclobutane, isobutane (2-methylpropane), methylcyclopropane, n-pentane, isopentane (2-methylbutane), neopentane (2, 2-dimethylpropane), and methylcyclobutane, other saturated hydrocarbons may be used. An example of a particularly preferable disproportionation inhibiting agent includes n-propane.

[0032] The disproportionation inhibiting agent may be, for example, a haloalkane with the number of carbons of either one or two. Haloalkanes with the number of carbons of one, that is, halomethanes, may be used as the disproportionation inhibiting agent. Although examples of halomethanes include (mono) iodomethane (CH₃I), diiodomethane (CH₂I₂), dibromomethane (CH₂Br₂), bromomethane (CH₃Br), dichloromethane (CH₂Cl₂), chloriodomethane (CH₂CI), dibromochloromethane (CHBr₂Cl), tetraiodomethane (CI₄), carbon tetrabromide (CBr₄), bromotrichloromethane (CBrCl₃), dibromodichloromethane (CBr₂Cl₂), tribromofluoromethane (CBr₃F), fluorodiiodomethane (CHF₂I), difluorodiiodomethane (CF₂I₂), dibromodifluoromethane (CBr₂F₂), and trifluoriodomethane (CF₃I), other halomethanes may be used. Haloalkanes with the number of carbons of two, that is, haloethanes,

may be used as the disproportionation inhibiting agent. Examples of haloethanes include 1, 1, 1-trifluoro-2-iodoethane (CF₃CH₂I), monoiodoethane (CH₃CH₂I), monobromoethane (CH₃CH₂Br), and 1, 1, 1-triiodoethane (CH₃CI₃).

[0033] The working medium may contain a plurality of disproportionation inhibiting agents selected from the above-mentioned saturated hydrocarbons and the above-mentioned haloalkanes. The working medium may contain one kind of saturated hydrocarbon, or may be a working medium containing two or more kinds of saturated hydrocarbons. The working medium may contain one kind of haloalkane, or may be a working medium containing two or more kinds of haloalkanes.

[0034] A preferred example of the working medium includes a mixture containing 1, 1, 2-trifluoroethylene and n-propane. This working medium may contain the second refrigerant component described above, or may contain other components.

[0035] The above-mentioned each working medium may contain unavoidable impurities. Examples of the unavoidable impurities include various additives, such as a stabilizing agent added for the purpose of stabilization during transportation or during storage, the residue or by-product of a synthetic raw material of the refrigerant component, and substances mixed for other reasons.

[0036] The mass ratio between 1, 1, 2-trifluoroethylene and n-propane contained in the working medium may be suitably changed. The capacity of the refrigeration cycle correlates to the mass ratio of refrigerant component contained in the working medium. Accordingly, to maintain the capacity of the refrigeration cycle, it is desirable to have a configuration in which n-propane, being the disproportionation inhibiting agent, is contained in the working medium at 40 mass% or less.

[1-2. Action]

[0037] The action and the manner of operation of the refrigeration cycle device 1 having the above-mentioned configuration will be described hereinafter.

[0038] A predetermined temperature T₁ used in the description made hereinafter is determined according to, for example, heat resistance of an insulating paper inserted between a magnet wire and an electromagnetic steel sheet in the stator of a motor forming the compressor 31, the magnet wire and the electromagnetic steel sheet generating a magnetic field by energization. For example, when a heat resistance class, specified by JIS C 4003, of an insulating paper is a heat resistance class B, a heat resistance temperature is 130°C. When the insulating paper is placed under a temperature condition higher than this heat resistance temperature, insulation between the magnet wire and the electromagnetic steel sheet is broken, thus increasing a possibility of occurrence of a discharge phenomenon that may cause a disproportionation reaction. The temperature condition of the insulating paper is substantially equal to the dis-

charge temperature T and hence, the refrigeration cycle device 1 changes the action thereof depending on whether the measured value of the discharge temperature T is the predetermined temperature $T1$ or higher.

[0039] In the present embodiment, an insulating paper in a heat resistance class E specified by JIS C 4003 is used, and the heat resistance temperature of this insulating paper is 120°C . The predetermined temperature $T1$ is 115°C obtained by giving a margin for safety of approximately 5K to this heat resistance temperature. In the case in which the temperature of the working medium is 150°C or higher, a risk of occurrence of a disproportionation reaction increases irrespective of the heat resistance temperature of the insulating paper. Therefore, even in the case in which an insulating paper having a heat resistance temperature of 150°C or higher is used, the predetermined temperature $T1$ is set to a temperature obtained by giving a margin for safety to 150°C . That is, the predetermined temperature $T1$ is set based on whichever is lower of a temperature having a high risk of occurrence of a discharge phenomenon or a temperature having a high risk of occurrence of a disproportionation reaction due to a high temperature itself.

[0040] Figure 4 is a flowchart of the refrigeration cycle device 1, and shows actions of the refrigeration cycle device 1. Hereinafter, the description will be made by taking, as an example, the case in which, of the four indoor units 10 of the refrigeration cycle device 1, a plurality of indoor units 10 are in an operating state at the start point of the flowchart in Figure 4.

[0041] In this state, the equipment control unit 73a activates the compressor 31 to cause a working medium to circulate through the refrigeration cycle circuit. In addition, the equipment control unit 73a closes the indoor expansion valves 15 provided in indoor units 10 in an operation stop state, and opens the indoor expansion valves 15 provided in indoor units 10 in an operating state. Consequently, the working medium that circulates with the drive of the compressor 31 does not flow into the indoor units 10 in an operation stop state, but flows only to the indoor units 10 in an operating state.

[0042] The equipment control unit 73a also controls the indoor expansion valves 15 such that each indoor expansion valve 15 provided in the indoor unit 10 in an operating state has a larger opening degree substantially in proportion to required condensing capacity or required evaporating capacity for each indoor unit 10. A larger difference between the set temperature and room temperature, and a larger number of revolutions of the indoor fan 13 mainly require each indoor unit 10 to have a larger condensing capacity and a larger evaporating capacity.

[0043] In addition to the above, the equipment control unit 73a causes, of the indoor units 10 in an operating state, the indoor units 10 having higher pressure losses dP to have a larger opening degree of the indoor expansion valve 15 of each indoor unit 10, the pressure loss dP being generated in the working medium in the area from the compressor 31 to each indoor unit 10. Consequently,

the indoor units 10 having higher pressure losses dP have a larger opening degree of the indoor expansion valve 15 per condensing capacity or evaporating capacity of each indoor unit 10. The pressure loss dP mainly depends on the installation state of the refrigeration cycle device 1, such as the length of the refrigerant pipe from the compressor 31 to the indoor unit 10, the diameter of the refrigerant pipe, the number and curvature of bent portions of the refrigerant pipe, and the height of the indoor unit 10 relative to the compressor 31.

[0044] The equipment control unit 73a may control the indoor expansion valves 15 assuming that, for example, an indoor unit 10 having a longer length of the refrigerant pipe between the outdoor unit 30 and the indoor unit 10 is the indoor unit 10 having a higher pressure loss dP . A configuration may be adopted in which the order of the lengths of the refrigerant pipes between the outdoor unit 30 and the respective indoor units 10 is determined by the worker at the time of installing the refrigeration cycle device 1, for example, and the order based on the determination is stored in the outdoor unit memory 71. In the same manner, information on the orders or the like of the diameters of the refrigerant pipes, the number and curvatures of bent portions of the refrigerant pipes, and the heights of the indoor units 10, and the combination of the above may be used instead of the above-mentioned information on the order of the lengths of the refrigerant pipes. Alternatively, a configuration may be adopted in which the pressure of the working medium in the refrigerant pipe in the vicinity of each indoor unit 10 in an operating state is measured, and the equipment control unit 73a controls the indoor expansion valves 15 assuming that an indoor unit 10 having a smaller measured value of the pressure of the working medium in the refrigerant pipe is the indoor unit 10 having a higher pressure loss dP . A configuration may be adopted in which the pressure of the working medium in the refrigerant pipe in the vicinity of each indoor unit 10 is measured by, for example, a pressure sensor not shown in the drawing and connected to the indoor unit 10, and is transmitted to the equipment control unit 73a via the indoor communication unit 14 and the outdoor communication unit 34. In this case, the equipment control unit 73a can control the indoor expansion valves 15 by taking into account the pressure loss dP , with not only factors determined at the time of installing the refrigeration cycle device 1, but also factors, such as an air conditioning load, for example.

[0045] During a period in which the refrigeration cycle device 1 performs a normal operation as described above, the working medium temperature sensor 32 continues to measure, at the predetermined sampling rate, the discharge temperature T of the working medium discharged from the compressor 31, and then transmits data on the measured value to the determination unit 73b. The determination unit 73b determines whether the received measured value of the discharge temperature T is the predetermined temperature $T1$ or higher (step S1).

When it is determined that the measured value of the discharge temperature T is less than the predetermined temperature T1 (step S1: NO), the refrigeration cycle device 1 continues the normal operation. In contrast, when it is determined that the measured value of the discharge temperature T is the predetermined temperature T1 or higher (step S1: YES), the process shifts to step S2.

[0046] In step S2, the equipment control unit 73a causes, of the indoor units 10 in an operating state, the indoor units having lower pressure losses dP from the compressor 31 to have a larger opening degree of the indoor expansion valve 15. Consequently, in the refrigeration cycle circuit, the working medium quickly moves from the high pressure side to the low pressure side. Therefore, the pressure on the high pressure side rapidly decreases in the refrigeration cycle circuit.

[0047] In step S3, the determination unit 73b determines whether all of four indoor units 10 of the refrigeration cycle device 1 are in an operating state. When the determination unit 73b determines that all of the indoor units 10 are in an operating state (step S3: YES), the process shifts to step S4. When the determination unit 73b determines that not all of the indoor units 10 of the refrigeration cycle device 1 are in an operating state (step S3: NO), that is, some of the indoor units 10 are in an operating state, but other indoor units 10 are not in an operating state, the process shifts to step S5.

[0048] In step S4, the determination unit 73b determines whether the indoor unit 10 that is in an operating state is newly brought into an operation stop state. Examples of the case in which the indoor unit 10 is newly brought into an operation stop state include the case in which the indoor unit 10 in an operating state is brought into an operation stop state by the manipulation performed by the user, and the case in which the indoor unit 10 in an operating state is shifted to the thermo-off operation. When the determination unit 73b determines that the indoor unit 10 in an operating state is newly brought into an operation stop state (step S4: YES), the process shifts to step S5. The determination unit 73b repeats the determination in step S4 until the indoor unit 10 is newly brought into an operation stop state.

[0049] In step S5, the equipment control unit 73a opens the indoor expansion valve 15 of at least one of the indoor units 10 in an operation stop state. Consequently, a pressure on the high pressure side of the refrigeration cycle circuit can be easily released to the low pressure side through the indoor expansion valve 15 that is opened.

[0050] The opening degree of the indoor expansion valve 15 that is opened in step S5 may be an opening degree smaller than the minimum opening degree, being the minimum value of the opening degree for the indoor unit 10 in an operating state. Hereinafter, such an opening degree is referred to as "extremely small opening degree". The range of the opening degree adopted during the operation of the indoor unit 10 is determined by, for

example, the relationship between the opening degree of the indoor expansion valve 15 and a Cv value specified by JIS B 0100. To be more specific, the range of the opening degree of the indoor expansion valve 15 adopted during the operation of the indoor unit 10 is a region where a Cv curve plotted with the opening degree of the indoor expansion valve 15 on an axis and the Cv value on the other axis forms a substantially straight line and, in the present embodiment, such a region is where the opening degree is approximately 5% or more. The minimum opening degree is the minimum opening degree in this region and hence, the minimum opening degree is approximately 5%. In the case of the present embodiment, in the region where the opening degree is approximately 5% or less, the Cv value rapidly changes relative to the change in the opening degree of the indoor expansion valve 15, the Cv value indicating flowability of a fluid. Therefore, the region where the opening degree is approximately 5% or less is not suitable for control of the flow rate of the working medium. Accordingly, in the present embodiment, when the indoor unit 10 is in an operating state, the equipment control unit 73a performs control in such a way as to prevent the opening degree of the corresponding indoor expansion valve 15 from becoming approximately 5% or less.

[0051] In step S5, a configuration may be adopted in which, of the indoor expansion valves 15 of the indoor units 10 in an operation stop state, the number and the opening degree of indoor expansion valves 15 that are opened are set according to the discharge temperature T. For example, a configuration may be adopted in which the total of the opening degrees of the indoor expansion valves 15 that are opened in step S5 is controlled in such a way as to correlate to a temperature range by which the discharge temperature T exceeds the predetermined temperature T1. With such a configuration, when the discharge temperature T is a high temperature, a pressure on the high pressure side in the refrigeration cycle circuit can be released more easily and hence, it is possible to effectively suppress occurrence of a disproportionation reaction. However, from the viewpoint of energy efficiency, it is preferable to perform a control such that the total of the opening degrees of the indoor expansion valves 15 of the indoor units 10 that are brought into an operation stop state is equal to or less than the total of the opening degrees of the indoor expansion valves 15 of the indoor units 10 in an operating state.

[0052] In step S5, the equipment control unit 73a may close, of the indoor units 10 in an operation stop state, the indoor expansion valve 15 of the indoor unit 10 where the motion sensor 16 senses a person, and may set, to an extremely small opening degree, the opening degree of the indoor expansion valve 15 of the indoor unit 10 where the motion sensor 16 senses no person. With such a configuration, it is possible to suppress a situation in which, due to the rotation of the indoor fan 13 of the indoor unit 10 in an operation stop state in step S6

described later, discomfort is caused for a person present near the indoor unit 10.

[0053] In step S6, the indoor fan motor 13a of the indoor unit 10 that is in an operation stop state and that includes the indoor expansion valve 15 opened in step S5 starts to be driven by a control performed by the equipment control unit 73a. Consequently, the indoor fan 13 is rotated, so that the working medium in the indoor heat exchanger 11 exchanges heat with air. Accordingly, the temperature of the working medium in the refrigeration cycle device 1 decreases. In this case, a configuration may be adopted in which the equipment control unit 73a sets the number of revolutions of the indoor fan motor 13a of the indoor unit 10 in which the motion sensor 16 detects no person to be lower than the number of revolutions of the indoor fan motor 13a of the indoor unit 10 in which the motion sensor 16 detects a person. With such a configuration, it is possible to suppress a situation in which, due to high-speed rotation of the indoor fan 13 of the indoor unit 10 in an operation stop state, discomfort is caused for a person present near the indoor unit 10.

[0054] Thereafter, the refrigeration cycle device 1 repeats actions of step S5 and step S6 until the discharge temperature T becomes less than a second temperature T2 described later (step S7: NO). When the indoor unit 10 in an operating state is newly brought into an operation stop state during such a period, the equipment control unit 73a sets the opening degree of the indoor expansion valve 15 of the indoor unit 10 newly brought into an operation stop state to an extremely small opening degree, and rotates the indoor fan 13 by driving the indoor fan motor 13a. When the operation of the indoor unit 10 is stopped due to the shift of the indoor unit 10 in an operating state to the thermo-off operation state, there is a high possibility of a person being present near the indoor unit 10. Therefore, a configuration may be adopted in which the equipment control unit 73a sets the number of revolutions of the indoor fan motor 13a of the indoor unit 10 brought into an operation stop state due to the shift to the thermo-off operation to be lower than the number of revolutions of the indoor fan motor 13a of the indoor unit 10 brought into an operation stop state due to the manipulation performed by the user, for example.

[0055] In step S7, the determination unit 73b determines whether the discharge temperature T is the second temperature T2 or higher. The second temperature T2 is a temperature lower than the predetermined temperature T1 by approximately 0K to 20K, and is 105°C in the present embodiment. When it is determined by the determination unit 73b that the discharge temperature T is the second temperature T2 or higher (step S7: YES), the process shifts to step S5. In contrast, when it is determined by the determination unit 73b that the discharge temperature T is less than the second temperature T2 (step S7: NO), the process shifts to step S8.

[0056] When the indoor expansion valve 15 of the indoor unit 10 in an operation stop state is in an open state, the indoor expansion valve 15 is closed in step S8.

[0057] In step S9, when the indoor fan motor 13a of the indoor unit 10 in an operation stop state is in a driven state, the drive of the indoor fan motor 13a is stopped, so that the rotation of the indoor fan 13 is stopped. Consequently, the refrigeration cycle device 1 returns to the actions for the normal operation.

[1-3. Advantageous effects and the like]

[0058] As described above, in the present embodiment, in the refrigeration cycle device 1 that includes the outdoor unit 30 including the compressor 31, and that includes the plurality of indoor units 10 each including the indoor expansion valve 15, a working medium containing an ethylene-based fluoroolefin is used as refrigerant, the refrigeration cycle device 1 includes the control unit 70, and when indoor units 10 of the plurality of indoor units 10 are in an operating state, and when the discharge temperature T from the compressor 31 is the predetermined temperature T1 or higher, the control unit 70 opens the indoor expansion valve 15 of at least one of the indoor units 10 in an operation stop state.

[0059] With such a configuration, the indoor expansion valve 15 of the indoor unit 10 in an operation stop state is opened and hence, the pressure in the refrigeration cycle circuit decreases. Accordingly, it is possible to suppress occurrence of a disproportionation reaction without impairing comfort for users of the air conditioning.

[0060] When any of the indoor units 10 in an operating state is brought into an operation stop state, the control unit 70 opens the indoor expansion valve 15 of the indoor unit 10 that is brought into an operation stop state.

[0061] With such a configuration, the indoor expansion valve 15 of the indoor unit 10 that is brought into an operation stop state is opened without being closed and hence, it is possible to suppress a rapid rise in pressure in the refrigeration cycle circuit, which is caused by a decrease in the number of indoor units 10 in an operating state. Accordingly, it is possible to suppress occurrence of a disproportionation reaction without impairing comfort for users of the air conditioning.

[0062] The control unit 70 rotates, of indoor units 10 in an operation stop state, the indoor fan 13 of the indoor unit 10 in which the indoor expansion valve 15 is in an open state.

[0063] With such a configuration, it is possible to decrease the temperature of the working medium in the refrigeration cycle circuit. Consequently, it is possible to suppress occurrence of a disproportionation reaction without impairing convenience for users of the air conditioning.

[0064] The control unit 70 sets the opening degree of the indoor expansion valve 15 of at least one of the indoor units 10 in an operation stop state to an extremely small opening degree.

[0065] With such a configuration, it is possible to reduce the flow rate of the working medium passing through the indoor unit 10 in an operation stop state, and it is

possible to decrease the pressure in the refrigeration cycle circuit. Accordingly, it is possible to reduce energy loss caused by the working medium flowing through the indoor unit 10 in an operation stop state, and it is possible to suppress occurrence of a disproportionation reaction.

[0066] The extremely small opening degree is the opening degree smaller than the minimum opening degree of the indoor expansion valve 15 of the indoor unit 10 in an operating state.

[0067] With such a configuration, it is possible to reduce the flow rate of the working medium passing through the indoor unit 10 in an operation stop state, and it is possible to decrease the pressure in the refrigeration cycle circuit. Accordingly, it is possible to reduce energy loss caused by the working medium flowing through the indoor unit 10 in an operation stop state, and it is possible to suppress occurrence of a disproportionation reaction.

[0068] The control unit 70 causes, of the indoor units 10 in an operating state, the indoor units 10 having higher pressure losses dP from the compressor 31 to have a larger opening degree of the indoor expansion valve 15 per condensing capacity or evaporating capacity of each indoor unit 10.

[0069] With such a configuration, the total of required condensing capacities or required evaporating capacities of all of the indoor units 10 changes and hence, even in the case in which a discharge amount from the compressor 31 changes, it is possible to suppress an excessive rise in pressure in the refrigeration cycle circuit. Further, in the case in which the indoor unit 10 is in a cooling operation state, it is possible to suppress a rise in the cooling/heating degree of the working medium flowing out from the indoor unit 10 and hence, it is possible to suppress a rise in discharge temperature T from the compressor 31. Accordingly, it is possible to suppress occurrence of a disproportionation reaction.

[0070] When the indoor units 10 of the plurality of indoor units 10 are in an operating state, and when the discharge temperature T is the predetermined temperature $T1$ or higher, the control unit 70 causes, of the indoor units 10 in an operating state, the indoor units 10 having lower pressure losses dP from the compressor 31 to have a larger opening degree of each indoor expansion valve 15.

[0071] With such a configuration, it is possible to promptly move refrigerant on the high pressure side in the refrigeration cycle circuit to the low pressure side. Consequently, particularly in the case in which the number of indoor units 10 in an operating state is reduced when the refrigeration cycle device 1 is in operation under a condition of a high air conditioning load, for example, it is possible to suppress an excessive rise in pressure in the refrigeration cycle circuit. Accordingly, it is possible to suppress occurrence of a disproportionation reaction.

(Another embodiment)

[0072] As described above, the embodiment 1 has

been described as an example of the technique disclosed herein. However, the technique of the present disclosure is not limited to the embodiment 1, and is also applicable to embodiments in which a modification, a replacement, an addition, or an omission is made. In addition, a new embodiment may be formed by combining the respective constitutional elements described in the above-mentioned embodiment 1.

[0073] Hereinafter, another embodiment will be exemplified.

[0074] In the embodiment 1, when the control unit 70 determines that the discharge temperature T is the predetermined temperature $T1$ or higher (step S1: YES), and when some of the indoor units 10 are in an operating state (step S3: NO), the control unit 70 opens the indoor expansion valve 15 of the indoor unit 10 in an operation stop state. However, such a configuration is merely an example. For example, a configuration may be adopted in which when there is the indoor unit 10 in an operation stop state, irrespective of the discharge temperature T , the indoor expansion valve 15 of at least one indoor unit 10 in an operation stop state is always in an open state, and the opening degree of such an indoor expansion valve 15 is an extremely small opening degree.

[0075] That is, the refrigeration cycle device 1 may be configured such that, in the refrigeration cycle device that includes the outdoor unit 30 including the compressor 31, and that includes the plurality of indoor units 10 each including the indoor expansion valve 15, a working medium containing an ethylene-based fluoroolefin is used as refrigerant, and when indoor units 10 of the plurality of indoor units 10 are in an operating state, the opening degree of the indoor expansion valve 15 of at least one of the indoor units 10 in an operation stop state is always set to an extremely small opening degree.

[0076] With such a configuration, the indoor expansion valve 15 of the indoor unit 10 in an operation stop state is in an open state and hence, the pressure in the refrigeration cycle circuit decreases. Accordingly, it is possible to suppress occurrence of a disproportionation reaction without impairing comfort for users of the air conditioning.

[0077] In the embodiment 1, the description has been made that the discharge temperature T of the working medium discharged from the compressor 31 is measured by the working medium temperature sensor 32. However, such a configuration is merely an example. For example, a configuration may be adopted in which a pressure sensor not shown in the drawing is mounted on the discharge side of the compressor 31 and, by making use of high correlation between the temperature and the pressure of the working medium, an estimated value of the discharge temperature T is calculated from the pressure value measured by the pressure sensor.

[0078] In the embodiment 1, the description has been made that when the discharge temperature T becomes less than the second temperature $T2$ (step S7: NO), the control unit 70 closes the indoor expansion valve 15 of the indoor unit 10 in an operation stop state. However, such a

configuration is merely an example. For example, a configuration may be adopted in which when the control unit 70 opens the indoor expansion valve 15 of the indoor unit 10 in an operation stop state (step S5), this indoor expansion valve 15 is closed after the lapse of the predetermined time period from when this indoor expansion valve 15 is opened. Consequently, it is possible to suppress a rapid rise in pressure in the refrigeration cycle circuit, and it is possible to eliminate a situation in which the working medium continues to flow, for a long time period, through the indoor unit 10 in an operation stop state. Accordingly, it is possible to suppress occurrence of a disproportionation reaction, and it is possible to enhance energy efficiency of the refrigeration cycle device 1.

[0079] In the embodiment 1, the description has been made that the motion sensor 16 is an infrared sensor. However, such a configuration is merely an example. For example, a configuration may be adopted in which the motion sensor 16 is a camera and, based on video data, the refrigeration cycle device 1 determines whether a person is present near the indoor unit 10. Alternatively, a configuration may be adopted in which the motion sensor 16 is an ultrasonic sensor and, based on intensity of reflection of the generated ultrasonic waves, the refrigeration cycle device 1 determines whether a person is present near the indoor unit 10.

[0080] The outdoor unit processor 73 may be formed of a plurality of processors, or may be formed of a single processor. The outdoor unit processor 73 may be hardware programmed to achieve a corresponding function unit. That is, the outdoor unit processor 73 is, for example, an ASIC (Application Specific Integrated Circuit) or an FPGA (Field Programmable Gate Array).

[0081] The respective components shown in Figure 3 are merely examples, and a specific embodiment is not particularly limited. That is, it is not always necessary to individually mount corresponding hardware to each component and, needless to say, a configuration may be adopted in which functions of the respective components are achieved by one processor performing a program. Some functions achieved by software in the embodiment described above may be achieved by hardware, or some functions achieved by hardware may be achieved by software. In addition, specific detailed configurations of the respective components of the indoor unit 10 and the outdoor unit 30 are also suitably changeable without departing from the gist of the present disclosure.

[0082] The step units of the actions shown in Figure 4 are obtained by dividing the actions according to the main process content to facilitate understanding of the actions of the respective components of the refrigeration cycle device 1, and the actions are not limited by the manner of division or the name of the processing units. The actions may be divided into a larger number of step units corresponding to the process content. Alternatively, the actions may be divided such that one step unit includes more processes. The order of the steps may be suitably

changed within the scope of not interfering with the gist of the present disclosure.

[Configuration supported by the above-mentioned embodiment]

[0083] The above-mentioned embodiment supports the following configurations.

(Supplement)

[0084] (Technique 1) A refrigeration cycle device including: an outdoor unit including a compressor; and a plurality of indoor units each including an expansion valve, the refrigeration cycle device being characterized in that a working medium containing an ethylene-based fluoroolefin is used as refrigerant, the refrigeration cycle device includes a control unit, and when some indoor units of the plurality of indoor units are in an operating state, and when a discharge temperature from the compressor is a predetermined temperature or higher, the control unit opens the expansion valve of at least one of the indoor units in an operation stop state.

[0085] Consequently, the expansion valve of the indoor unit in an operation stop state is opened and hence, the pressure in the refrigeration cycle circuit decreases. Accordingly, it is possible to suppress occurrence of a disproportionation reaction without impairing comfort for users of the air conditioning.

[0086] (Technique 2) The refrigeration cycle device according to technique 1, characterized in that when any of the indoor units in the operating state is brought into the operation stop state, the control unit opens the expansion valve of the indoor unit that is brought into the operation stop state.

[0087] Consequently, the expansion valve of the indoor unit that is brought into an operation stop state is opened without being closed and hence, it is possible to suppress a rapid rise in pressure in the refrigeration cycle circuit, which is caused by a decrease in the number of indoor units in an operating state. Accordingly, it is possible to suppress occurrence of a disproportionation reaction without impairing comfort for users of the air conditioning.

[0088] (Technique 3) The refrigeration cycle device according to technique 1 or 2, characterized in that the control unit rotates, of the indoor units in the operation stop state, an indoor fan of the indoor unit in which the expansion valve is in an open state.

[0089] Consequently, it is possible to decrease the temperature of the working medium in the refrigeration cycle circuit. Thus, it is possible to suppress occurrence of a disproportionation reaction without impairing convenience for users of the air conditioning.

[0090] (Technique 4) The refrigeration cycle device according to any one of techniques 1 to 3, characterized in that the control unit sets, to an extremely small opening degree, an opening degree of the expansion valve of at

least one of the indoor units in the operation stop state.

[0091] Consequently, it is possible to reduce the flow rate of the working medium passing through indoor unit in an operation stop state, and it is possible to decrease the pressure in the refrigeration cycle circuit. Accordingly, it is possible to reduce energy loss caused by the working medium flowing through indoor unit in an operation stop state, and it is possible to suppress occurrence of a disproportionation reaction.

[0092] (Technique 5) The refrigeration cycle device according to technique 4, characterized in that the extremely small opening degree is an opening degree smaller than a minimum opening degree of the expansion valve of the indoor units in the operating state.

[0093] Consequently, it is possible to reduce the flow rate of the working medium passing through the indoor unit in an operation stop state, and it is possible to decrease the pressure in the refrigeration cycle circuit. Accordingly, it is possible to reduce energy loss caused by the working medium flowing through the indoor unit in an operation stop state, and it is possible to suppress occurrence of a disproportionation reaction.

[0094] (Technique 6) The refrigeration cycle device according to any one of techniques 1 to 5, characterized in that the control unit causes, of the indoor units in the operating state, the indoor units having higher pressure losses from the compressor to have a larger opening degree of the expansion valve per condensing capacity or evaporating capacity of each of the indoor units.

[0095] Consequently, the total of required condensing capacities or required evaporating capacities of all of the indoor units changes and hence, even in the case in which a discharge amount from the compressor changes, it is possible to suppress an excessive rise in pressure in the refrigeration cycle circuit. Further, in the case in which the indoor unit is in a cooling operation state, it is possible to suppress a rise in the cooling/heating degree of the working medium flowing out from the indoor unit and hence, it is possible to suppress a rise in discharge temperature from the compressor. Accordingly, it is possible to suppress occurrence of a disproportionation reaction.

[0096] (Technique 7) The refrigeration cycle device according to any one of techniques 1 to 6, characterized in that when some indoor units of the plurality of indoor units are in the operating state, and when the discharge temperature is the predetermined temperature or higher, the control unit causes, of the indoor units in the operating state, the indoor units having lower pressure losses from the compressor to have a larger opening degree of the expansion valve.

[0097] Consequently, it is possible to promptly move refrigerant on the high pressure side in the refrigeration cycle circuit to the low pressure side. Thus, particularly in the case in which the number of indoor units in an operating state is reduced when the refrigeration cycle device is in operation under a condition of a high air conditioning load, for example, it is possible to suppress

an excessive rise in pressure in the refrigeration cycle circuit. Accordingly, it is possible to suppress occurrence of a disproportionation reaction.

[0098] (Technique 8) A refrigeration cycle device including: an outdoor unit including a compressor; and a plurality of indoor units each including an expansion valve, the refrigeration cycle device being characterized in that a working medium containing an ethylene-based fluoroolefin is used as refrigerant, and when some indoor units of the plurality of indoor units are in an operating state, an opening degree of the expansion valve of at least one of the indoor units in an operation stop state is always set to an extremely small opening degree.

[0099] Consequently, the expansion valve of the indoor unit in an operation stop state is opened and hence, the pressure in the refrigeration cycle circuit decreases. Accordingly, it is possible to suppress occurrence of a disproportionation reaction without impairing comfort for users of the air conditioning.

[Industrial Applicability]

[0100] The present disclosure is applicable to a refrigeration cycle device that uses a working medium containing an ethylene-based fluoroolefin. To be more specific, the present disclosure is applicable to an air conditioner or the like that uses a working medium containing an ethylene-based fluoroolefin.

[Reference Signs List]

[0101]

1	refrigeration cycle device
10	indoor unit
11	indoor heat exchanger
12	room temperature sensor
13	indoor fan
13a	indoor fan motor
14	indoor communication unit
15	indoor expansion valve (expansion valve)
16	motion sensor
20	gas pipe
30	outdoor unit
31	compressor
32	working medium temperature sensor
33	four-way valve
34	outdoor communication unit
35	outdoor heat exchanger
37	outdoor fan
37a	outdoor fan motor
39	outdoor expansion valve
40	liquid pipe
70	control unit
71	outdoor unit memory
73	outdoor unit processor
73a	equipment control unit
73b	determination unit

75 outdoor unit interface
B building structure

indoor units in the operating state, the indoor units having lower pressure losses from the compressor to have a larger opening degree of the expansion valve.

Claims

1. A refrigeration cycle device comprising:
 - an outdoor unit including a compressor; and
 - a plurality of indoor units each including an expansion valve, wherein
 - a working medium containing an ethylene-based fluoroolefin is used as refrigerant, the refrigeration cycle device includes a control unit, and
 - when some indoor units of the plurality of indoor units are in an operating state, and when a discharge temperature from the compressor is a predetermined temperature or higher, the control unit opens the expansion valve of at least one of the indoor units in an operation stop state.
2. The refrigeration cycle device according to claim 1, wherein when any of the indoor units in the operating state is brought into the operation stop state, the control unit opens the expansion valve of the indoor unit that is brought into the operation stop state.
3. The refrigeration cycle device according to claim 1, wherein
 - the control unit rotates, of the indoor units in the operation stop state, an indoor fan of the indoor unit in which the expansion valve is in an open state.
4. The refrigeration cycle device according to claim 1, wherein the control unit sets, to an extremely small opening degree, an opening degree of the expansion valve of at least one of the indoor units in the operation stop state.
5. The refrigeration cycle device according to claim 4, wherein the extremely small opening degree is an opening degree smaller than a minimum opening degree of the expansion valve of the indoor units in the operating state.
6. The refrigeration cycle device according to claim 1, wherein the control unit causes, of the indoor units in the operating state, the indoor units having higher pressure losses from the compressor to have a larger opening degree of the expansion valve per condensing capacity or evaporating capacity of each of the indoor units.
7. The refrigeration cycle device according to claim 1, wherein when some indoor units of the plurality of indoor units are in the operating state, and when the discharge temperature is the predetermined temperature or higher, the control unit causes, of the

5 8. A refrigeration cycle device comprising:

an outdoor unit including a compressor; and
a plurality of indoor units each including an expansion valve, wherein
a working medium containing an ethylene-based fluoroolefin is used as refrigerant, and
when some indoor units of the plurality of indoor units are in an operating state, an opening degree of the expansion valve of at least one of the indoor units in an operation stop state is always set to an extremely small opening degree.

FIG.1

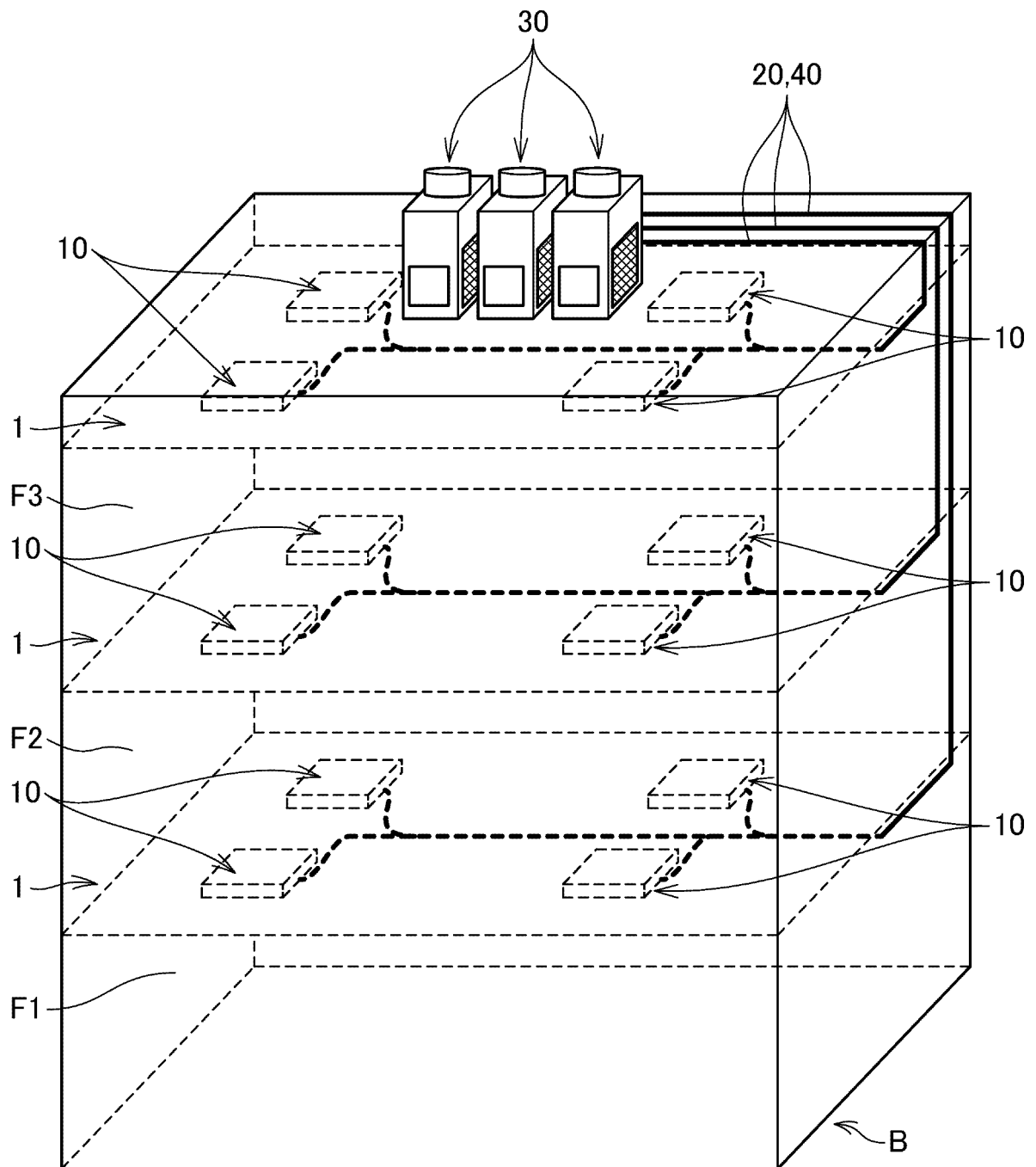


FIG.2

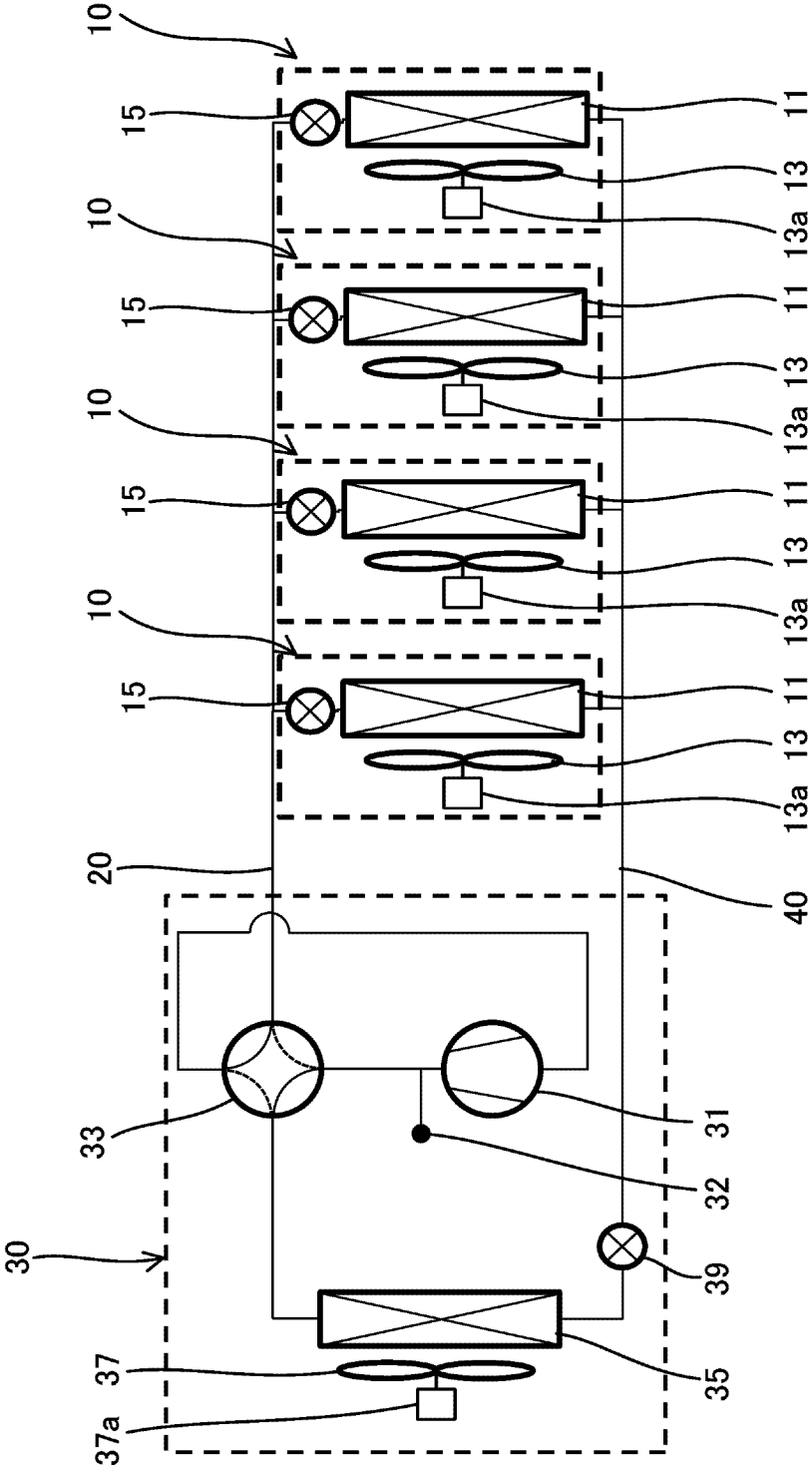


FIG.3

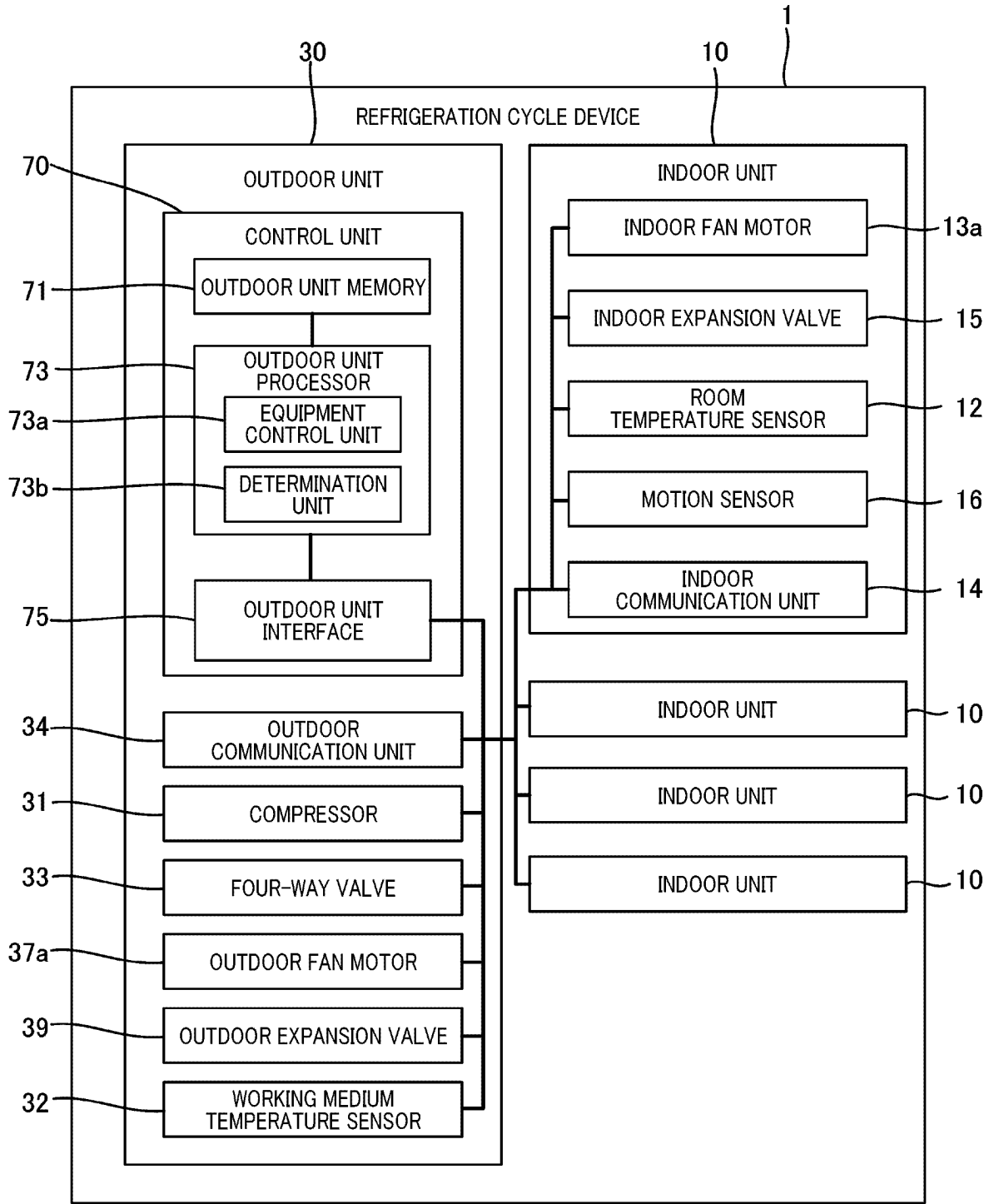
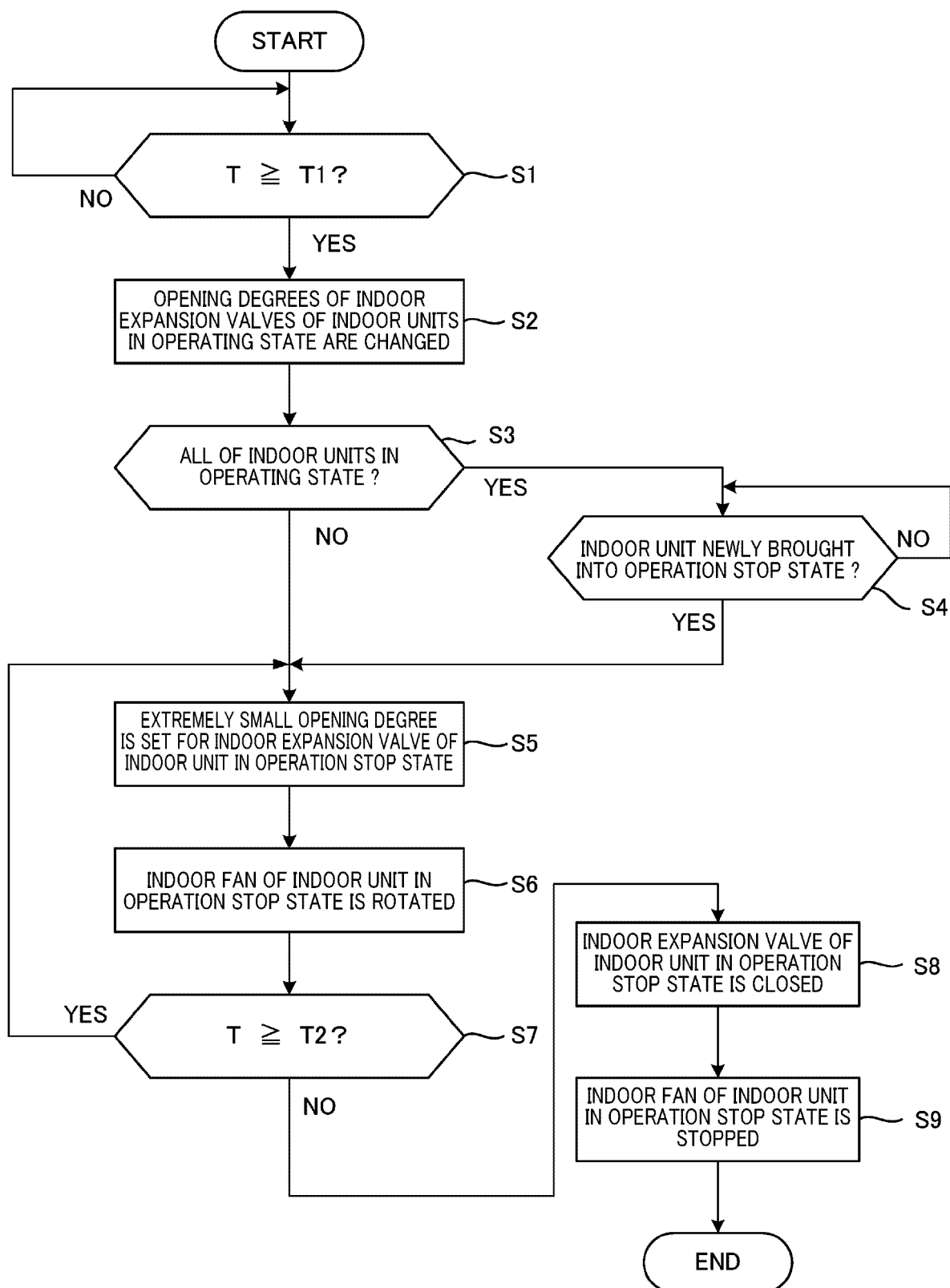


FIG.4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2023/020155

A. CLASSIFICATION OF SUBJECT MATTER

F25B 5/02(2006.01)i; *F25B 1/00*(2006.01)i

FI: F25B1/00 304P; F25B1/00 396Z; F25B5/02 510E

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)

F24F11/00-11/89; F25B1/00; F25B5/02; F25B6/02

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2023

Registered utility model specifications of Japan 1996-2023

Published registered utility model applications of Japan 1994-2023

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 8-35710 A (MITSUBISHI HEAVY IND., LTD.) 06 February 1996 (1996-02-06) paragraphs [0001]-[0053], fig. 1, 3	1-6
A		7
Y	WO 2015/174054 A1 (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 19 November 2015 (2015-11-19) paragraphs [0073]-[0081]	1-6, 8
Y	JP 2020-91080 A (MITSUBISHI ELECTRIC CORP.) 11 June 2020 (2020-06-11) paragraphs [0034]-[0036], fig. 1	8

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
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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	

Date of the actual completion of the international search

19 July 2023

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/020155

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WO 2015/174054 A1	19 November 2015	US 2017/0138645 A1 paragraphs [0090]-[0098] EP 3144601 A1 CN 106461279 A	
JP 2020-91080 A	11 June 2020	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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