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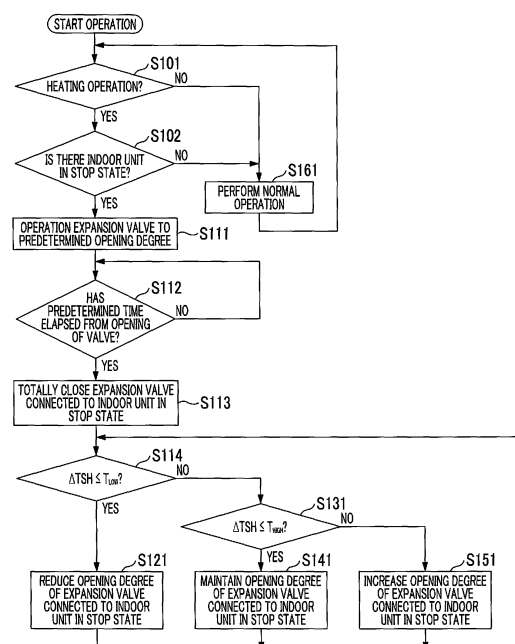
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(54) **AIR CONDITIONING OPERATION CONTROL DEVICE, AIR CONDITIONING SYSTEM, AIR CONDITIONING CONTROL METHOD, AND PROGRAM**

(57) An air conditioning operation control device comprises: an operation mode determination unit that determines whether an air conditioning main unit is in heating operation, wherein the air conditioning system main unit comprises a refrigerant circuit comprising one outdoor unit, a plurality of indoor units, and a plurality of expansion valves, each of which is provided in refrigerant outlet side during heating for each of the plurality of indoor units; a stop determination unit that determines whether there is an indoor unit that is stopped from among the plurality of indoor units when the operation mode determination unit has determined that the air conditioning system main unit is heating operation; and an expansion valve control unit that closes an expansion valve connected to the stopped indoor unit after the expansion valve was opened when the stop determination unit determined that the indoor has stopped.

FIG. 3



## Description

### Technical Field

**[0001]** The present invention relates to an air conditioning operation control device, an air conditioning system, an air conditioning operation control method, and a program.

**[0002]** This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2016-62595, filed March 25, 2016; the entire contents of which are incorporated herein by reference.

### Background Art

**[0003]** In a multi-type air conditioning system including a single outdoor unit and a plurality of indoor units, in a case where a heating operation is performed in a state in which some of the indoor units are stopped, an amount of a refrigerant flowing into a compressor may increase, and thus a lubricant of the compressor may be diluted with the refrigerant. If the lubricant is diluted, this may possibly influence on the stability of an operation of the compressor.

**[0004]** In contrast, a multi-room type air conditioner disclosed in PTL 1 causes a refrigerant to flow into an indoor unit which is stopped, and thus reduces an amount of the refrigerant flowing into a compressor. In the multi-room type air conditioner, an electromagnetic valve is provided in a refrigerant pipe of an entry way of each of two indoor heat exchangers. A throttle mechanism and a check valve are provided in parallel between a cooling inlet side electromagnetic valve which serves as an inlet side for the indoor heat exchanger during cooling, and the indoor heat exchanger. A capillary which returns a refrigerant to a compressor intake side pipe is provided between the cooling inlet side electromagnetic valve, and the throttle mechanism and the check valve.

**[0005]** In the multi-room type air conditioner disclosed in PTL 1, both of inlet and outlet electromagnetic valves are opened in an indoor heat exchanger which is being operated during a heating operation. On the other hand, only the cooling inlet side electromagnetic valve is opened in an indoor heat exchanger during stoppage. According to PTL 1, the inside of the indoor heat exchanger during stoppage is attracted to a compressor low pressure side by the capillary so as to be in low pressure, and thus a sufficient amount of a residual refrigerant can be stored.

### Citation List

#### Patent Literature

**[0006]** [PTL 1] Japanese Unexamined Patent Application Publication No. 01-139964

## Summary of Invention

### Technical Problem

**[0007]** The multi-room type air conditioner disclosed in PTL 1 requires a configuration in which the electromagnetic valves are provided in the refrigerant pipe on both sides of the entry way of the indoor heat exchanger, the throttle mechanism, the check valve, and the capillary are provided between the cooling inlet side electromagnetic valve and the indoor heat exchanger. If a simpler configuration is possible, device manufacturing cost can be reduced.

**[0008]** The present invention provides an air conditioning operation control device, an air conditioning system, an air conditioning operation control method, and a program, capable of providing the air conditioning system with a simpler configuration and reducing an amount of a refrigerant inflowing into a compressor.

### Solution to Problem

**[0009]** According to a first aspect of the present invention, there is provided an air conditioning operation control device including an operation mode determination portion that determines whether or not an air conditioning system main body is performing a heating operation, the air conditioning system main body including a single outdoor unit, a plurality of indoor units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating; a stop determination portion that determines whether or not there is a stopped indoor unit among the plurality of indoor units in a case where the operation mode determination portion determines that the air conditioning system main body is performing the heating operation; and an expansion valve control portion that opens an expansion valve connected to the stopped indoor unit and then closes the expansion valve in a case where the stop determination portion determines that there is the stopped indoor unit.

**[0010]** The expansion valve control portion may open the expansion valve connected to the stopped indoor unit to a predetermined opening degree, and may totally close the expansion valve after a predetermined time elapses from a state in which the expansion valve is opened to the predetermined opening degree.

**[0011]** The expansion valve control portion may close the expansion valve connected to the stopped indoor unit, and may then control an opening degree of the expansion valve on the basis of the temperature of a refrigerant flowing through the refrigerant circuit.

**[0012]** The expansion valve control portion may control an opening degree of the expansion valve on the basis of a difference between the temperature of the refrigerant flowing into the compressor and the temperature of the refrigerant discharged from the compressor and having flowed into an outdoor heat exchanger provided in the

outdoor unit.

**[0013]** The expansion valve control portion may control an opening degree of the expansion valve on the basis of the temperature of the refrigerant discharged from a compressor provided in the refrigerant circuit.

**[0014]** According to a second aspect of the present invention, there is provided an air conditioning system including an air conditioning system main body that includes a single outdoor unit, a plurality of indoor units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating; and any one of the air conditioning operation control devices.

**[0015]** According to a third aspect of the present invention, there is provided an air conditioning operation control method including a step of determining whether or not an air conditioning system main body is performing a heating operation, the air conditioning system main body including a single outdoor unit, a plurality of indoor units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating; a step of determining whether or not there is a stopped indoor unit among the plurality of indoor units in a case where the operation mode determination portion determines that the air conditioning system main body is performing the heating operation; a step of opening an expansion valve connected to the stopped indoor unit in a case where the stop determination portion determines that there is the stopped indoor unit; and a step of closing the expansion valve in an opened state.

**[0016]** According to a fourth aspect of the present invention, there is provided a program causing a computer to execute a step of determining whether or not an air conditioning system main body is performing a heating operation, the air conditioning system main body including a single outdoor unit, a plurality of indoor units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating; a step of determining whether or not there is a stopped indoor unit among the plurality of indoor units in a case where the operation mode determination portion determines that the air conditioning system main body is performing the heating operation; a step of opening an expansion valve connected to the stopped indoor unit in a case where the stop determination portion determines that there is the stopped indoor unit; and a step of closing the expansion valve in an opened state.

#### Advantageous Effects of Invention

**[0017]** According to the air conditioning operation control device, the air conditioning system, the air conditioning operation control method, and the program, it is possible to enable a configuration of the air conditioning system to be simpler, and also to reduce an amount of a refrigerant inflowing into a compressor.

#### Brief Description of Drawings

##### **[0018]**

5 Fig. 1 is a schematic configuration diagram illustrating a device configuration of an air conditioning system according to an embodiment of the present invention.

10 Fig. 2 is a schematic block diagram illustrating a functional configuration of an air conditioning operation control device according to the embodiment of the present invention.

15 Fig. 3 is a flowchart illustrating examples of process procedures in which the air conditioning operation control device according to the embodiment of the present invention controls an air conditioning system main body. Description of Embodiments

**[0019]** Hereinafter, an embodiment of the present invention is described, but the following embodiment is not intended to limit the present invention to the claims. It cannot be said that all combinations of features described in the embodiment are essential to solving means of the invention.

20 **[0020]** Fig. 1 is a schematic configuration illustrating a device configuration of an air conditioning system according to an embodiment of the present invention.

25 **[0021]** As illustrated in Fig. 1, an air conditioning system 1 includes an air conditioning operation control device 100, a first indoor unit 210a, a second indoor unit 210b, and an outdoor unit 220. The first indoor unit 210a includes a first indoor heat exchanger 211a and a first indoor heat exchanger temperature sensor 315a. The second indoor unit 210b includes a second indoor heat exchanger 211b and a second indoor heat exchanger temperature sensor 315b. The outdoor unit 220 includes an expansion valve side first service valve 221a, an expansion valve side second service valve 221b, a first expansion valve 222a, a second expansion valve 222b, an outdoor heat exchanger 223, a four-way valve 224, an accumulator 225, a compressor 226, a four-way valve side first service valve 227a, a four-way valve side second service valve 227b, a compressor intake side temperature sensor 311, an outdoor heat exchanger temperature sensor 312, a compressor outlet temperature sensor 313, and a compressor outlet pressure sensor 314.

30 **[0022]** The first indoor unit 210a and the second indoor unit 210b are collectively referred to as indoor units 210. The first indoor heat exchanger 211a and the second indoor heat exchanger 211b are collectively referred to as indoor heat exchangers 211. The first indoor heat exchanger temperature sensor 315a and the second indoor heat exchanger temperature sensor 315b are collectively referred to as indoor heat exchanger temperature sensors 315. The expansion valve side first service valve 221a and the expansion valve side second service valve 221b are collectively referred to as expansion valve side

service valves 221. The first expansion valve 222a and the second expansion valve 222b are collectively referred to as expansion valves 222. The four-way valve side first service valve 227a and the four-way valve side second service valve 227b are collectively referred to as four-way valve side service valves 227.

**[0023]** In the air conditioning system 1, constituent elements other than the air conditioning operation control device 100 are collectively referred to as an air conditioning system main body 200.

**[0024]** The first indoor unit 210a and the expansion valve side first service valve 221a are connected to each other via a first indoor unit side first pipe W11a. The second indoor unit 210b and the expansion valve side second service valve 221b are connected to each other via a second indoor unit side first pipe W11b. The expansion valve side first service valve 221a and the first expansion valve 222a are connected to each other via a first indoor unit side second pipe W12a. The expansion valve side second service valve 221b and the second expansion valve 222b are connected to each other via a second indoor unit side second pipe W12b. Each of the first expansion valve 222a and the second expansion valve 222b is connected to the outdoor heat exchanger 223 via a third pipe W13. The outdoor heat exchanger 223 and the four-way valve 224 are connected to each other via a fourth pipe W14. The four-way valve 224 and the accumulator 225 are connected to each other via a fifth pipe W15. The accumulator 225 and the compressor 226 are connected to each other via a sixth pipe W16 and a seventh pipe W17. A gas refrigerant passes through the sixth pipe W16. The refrigerant which becomes a liquid in the compressor 226 passes through the seventh pipe W17 so as to be accumulated in the accumulator 225. The compressor 226 and the four-way valve 224 are connected to each other via an eighth pipe W18. The four-way valve 224 is connected to the four-way valve side first service valve 227a and the four-way valve side second service valve 227b via a ninth pipe W19. The four-way valve side first service valve 227a and the first indoor unit 210a are connected to each other via a first indoor unit side tenth pipe W20a. The four-way valve side second service valve 227b and the second indoor unit 210b are connected to each other via a second indoor unit side tenth pipe W20b.

**[0025]** The first indoor unit side first pipe W11a and the second indoor unit side first pipe W11b are collectively referred to as first pipes W11. The first indoor unit side second pipe W12a and the second indoor unit side second pipe W12b are collectively referred to as second pipes W12. The first indoor unit side tenth pipe W20a and the second indoor unit side tenth pipe W20b are collectively referred to as tenth pipes W20.

**[0026]** The number of indoor units 210 provided in the air conditioning system 1 is not limited to two as illustrated in Fig. 1, and may be three or more. Also in this case, each of the indoor units 210 includes a single indoor heat exchanger 211. The outdoor unit 220 includes the ex-

pansion valve side service valves 221, the expansion valves 222, and the four-way valve side service valves 227 of the same number as the number of indoor units 210. The indoor heat exchangers 211 and the expansion valve side service valves 221 are connected to each other on a one-to-one basis via the first pipes W11. The expansion valve side service valves 221 and the expansion valves 222 are connected to each other on a one-to-one basis via the second pipes W12. Each of the expansion valves 222 and the outdoor heat exchanger 223 are connected to each other via the third pipe W13. The four-way valve 224 and each of the four-way valve side service valves 227 are connected to each other via the ninth pipe W19. The four-way valve side service valves 227 and the indoor units 210 are connected to each other on a one-to-one basis via the tenth pipes W20.

**[0027]** The air conditioning system 1 is a system adjusting the temperature of indoor air. Particularly, the air conditioning system 1 includes a plurality of indoor units 210, for example, the indoor units 210 provided in respective rooms, so as to adjust the temperature of air in a relatively wide range.

**[0028]** The air conditioning system 1 can switch between a heating operation and a cooling operation.

**[0029]** In the heating operation, a gas refrigerant compressed in the compressor 226 flows into the indoor heat exchangers 211 via the eighth pipe W18, the four-way valve 224, the ninth pipe W19, the four-way valve side service valves 227, and the tenth pipes W20 in this order. The gas refrigerant having flowed into the indoor heat exchangers 211 dissipates heat through heat exchange with indoor air and condenses. The refrigerant which becomes a liquid through condensation passes through the first pipes W11, the expansion valve side service valves 221, and the second pipes W12, so that the pressure thereof is reduced in the expansion valves 222, and then flows into the outdoor heat exchanger 223 via the third pipe W13.

**[0030]** As mentioned above, each of the expansion valves 222 is provided on the refrigerant outlet side during heating of each of the plurality of indoor heat exchangers 211. In other words, each of the expansion valves 222 is provided on the refrigerant outlet side during heating of each of the plurality of indoor units 210.

**[0031]** The refrigerant having flowed into the outdoor heat exchanger 223 absorbs heat through heat exchange with outside air (outdoor air) and evaporates. The refrigerant which becomes a gas through evaporation flows into the compressor 226 via the fourth pipe W14, the four-way valve 224, the fifth pipe W15, the accumulator 225, and the sixth pipe W16 in this order, so as to be compressed. As mentioned above, the devices included in the air conditioning system main body 200 are connected to each other via the pipes so as to form a refrigerant circuit in which the refrigerant is circulated. Hereinafter, the heating operation of the air conditioning system 1 and the cooling operation of the air conditioning system 1 will also be respectively referred to as a heating operation of

the air conditioning system main body 200 and a cooling operation of the air conditioning system main body 200.

**[0032]** The seventh pipe W17 is a pipe through which a liquid refrigerant flowing into the compressor 226 or generated therein to flow into the accumulator 225.

**[0033]** The air conditioning system main body 200 is operated under the control of the air conditioning operation control device 100, and adjusts the temperature of indoor air.

**[0034]** Each of the indoor units 210 is provided in each room which is a temperature adjustment target.

**[0035]** The indoor heat exchangers 211 perform heat exchange between a refrigerant and indoor air. In the heating operation, a high-pressure gas refrigerant flows into each of the indoor heat exchangers 211, and dissipates heat through heat exchange with indoor air so as to condense. Therefore, the indoor heat exchanger 211 liquefies a gas refrigerant compressed by the compressor 226 so as to dissipate the condensation heat to the indoor air.

**[0036]** The outdoor unit 220 is provided outdoors, for example, a location where heat exchange with outside air is possible.

**[0037]** The expansion valve side service valves 221 and the four-way valve side service valves 227 are all used to black a refrigerant when the indoor units 210 are detached or the like.

**[0038]** The expansion valves 222 reduce the pressure of liquid refrigerants flowing through the expansion valves 222. The refrigerants easily evaporate through the pressure reduction. Each of the expansion valves 222 is formed of an adjustment valve. A flow rate of a refrigerant flowing through the expansion valve 222 can be adjusted by adjusting an opening degree of the expansion valve 222.

**[0039]** As the expansion valves 222, electronic expansion strings which open and close valves in response to pulse signals may be used. However, the type of expansion valve 222 is not limited to the electronic expansion valve, and may be an adjustment valve which can restrict a flow rate of a refrigerant so as to reduce the pressure thereof.

**[0040]** The outdoor heat exchanger 223 performs heat exchange between a refrigerant and outside air. In the heating operation, a low-pressure liquid refrigerant having undergone pressure reduction in the expansion valve 222 flows into the outdoor heat exchanger 223, and absorbs heat through heat exchange with outside air so as to evaporate. Therefore, the outdoor heat exchanger 223 absorbs vaporization heat from the outside air so as to vaporize the liquid refrigerant.

**[0041]** The four-way valve 224 switches between refrigerant flow paths so as to switch between the heating operation and the cooling operation. In the heating operation, the four-way valve 224 connects the eighth pipe W18 to the ninth pipe W19, and thus a refrigerant from the compressor 226 flows into the indoor heat exchangers 211. In the heating operation, the four-way valve 224

connects the fourth pipe W14 to the fifth pipe W15, and thus a refrigerant from the outdoor heat exchanger 223 flows into the compressor 226.

**[0042]** The accumulator 225 divides refrigerants flowing into the accumulator 225 into a liquid refrigerant and a gas refrigerant, and causes only the gas refrigerant to flow into the compressor 226. This is so that the liquid refrigerant flows into the compressor 226, and thus the compressor 226 fails.

**[0043]** The compressor 226 compresses the gas refrigerant.

**[0044]** The compressor intake side temperature sensor 311 measures the temperature of a refrigerant on an intake side (low-pressure side) of the compressor 226. For example, the compressor intake side temperature sensor 311 is provided at the fifth pipe W15, and measures the temperature of a refrigerant which flows into the compressor 226 from the four-way valve 224 via the accumulator 225.

**[0045]** The outdoor heat exchanger temperature sensor 312 measures the temperature of a refrigerant in the outdoor heat exchanger 223. For example, the outdoor heat exchanger temperature sensor 312 is provided at the third pipe W13, and measures the temperature of a refrigerant which flows into the outdoor heat exchanger 223 during the heating operation.

**[0046]** The compressor outlet temperature sensor 313 measures the temperature of a refrigerant on an outlet side (high-pressure side) of the compressor 226. For example, the compressor outlet temperature sensor 313 is provided at the eighth pipe W18, and measures the temperature of a refrigerant discharged from the compressor 226.

**[0047]** The compressor outlet pressure sensor 314 measures the pressure of a refrigerant compressed in the compressor 226. For example, the compressor outlet pressure sensor 314 is provided at the eighth pipe W18, and measures the pressure of a refrigerant discharged from the compressor 226.

**[0048]** Each of the indoor heat exchanger temperature sensors 315 measures the temperature of a refrigerant in the indoor heat exchanger 211. For example, the indoor heat exchanger temperature sensors 315 are provided at pipes of refrigerants inside the indoor heat exchangers 211, and measure the temperatures of refrigerants before condensing in the indoor heat exchangers 211.

**[0049]** The air conditioning operation control device 100 controls the air conditioning system main body 200. The air conditioning operation control device 100 is formed by using, for example, a computer.

**[0050]** Fig. 2 is a schematic block diagram illustrating a functional configuration of the air conditioning operation control device 100. As illustrated in Fig. 2, the air conditioning operation control device 100 includes a measured value acquisition section 110, a storage section 180, and a controller 190. The controller 190 includes an operation mode determination portion 191, a stop determination

portion 192, and an expansion valve control portion 193.

**[0051]** The measured value acquisition section 110 acquires measured values from the various sensors provided in the air conditioning system main body 200. The measured value acquisition section 110 is formed by using, for example, a communication circuit provided in the air conditioning operation control device 100.

**[0052]** The storage section 180 stores various pieces of data. The storage section 180 is formed by using, for example, a storage device provided in the air conditioning operation control device 100.

**[0053]** The controller 190 controls each section of the air conditioning operation control device 100 so as to control the air conditioning system main body 200. The controller 190 is realized, for example, by a central processing unit (CPU) of the air conditioning operation control device 100 reading a program from the storage section 180 and executing the program.

**[0054]** The operation mode determination portion 191 determines an operation mode (that is, an operation mode of the air conditioning system 1) of a cooling circuit of the air conditioning system main body 200. The operation mode mentioned here includes the heating operation and the cooling operation. Particularly, the operation mode determination portion 191 determines whether or not the air conditioning system main body 200 is performing the heating operation.

**[0055]** In a case where the operation mode determination portion 191 determines that the air conditioning system main body 200 is performing the heating operation, the stop determination portion 192 determines whether or not there is the indoor unit 210 which is stopped among the plurality of indoor units 210.

**[0056]** The stopped indoor unit 210 mentioned here is the indoor unit 210 on which a stop operation is performed by a user. In the stopped indoor unit 210, a blowing fan is stopped, and thus discharge of hot air or cold air is stopped. The stopped indoor unit 210 is also referred to as the indoor unit 210 in a stop state.

**[0057]** The expansion valve control portion 193 controls an opening degree of the expansion valve 222. Particularly, in a case where the stop determination portion 192 determines that there is the stopped indoor unit 210, the expansion valve control portion 193 opens the expansion valve 222 connected to the stopped indoor unit 210, and then closes the expansion valve 222.

**[0058]** For example, the expansion valve control portion 193 opens the expansion valve 222 connected to the stopped indoor unit 210 to a predetermined opening degree. Alternatively, the expansion valve control portion 193 may totally open the expansion valve 222.

**[0059]** The expansion valve control portion 193 totally closes the expansion valve 222 after a predetermined time elapses from a state in which the expansion valve 222 is opened to the predetermined opening degree. Alternatively, the expansion valve control portion 193 may close the expansion valve 222 to a predetermined opening degree.

**[0060]** A timing at which the expansion valve control portion 193 closes the expansion valve 222 is not limited to a timing after a predetermined time elapses from a state in which the expansion valve 222 is opened to a predetermined opening degree. For example, the expansion valve control portion 193 may close the expansion valve 222 after a predetermined time elapses from starting of an operation of the air conditioning system 1. Alternatively, the expansion valve control portion 193 may close the expansion valve 222 at a timing at which the pressure of a refrigerant in the indoor heat exchanger 211 is equal to or higher than predetermined pressure.

**[0061]** The expansion valve control portion 193 opens the expansion valve 222 connected to the stopped indoor unit 210, and thus a high-density refrigerant compressed by the compressor 226 can be caused to flow into the indoor heat exchanger 211 of the indoor unit 210. Thereafter, the expansion valve control portion 193 closes the expansion valve 222 connected to the indoor unit 210, and thus the high-density refrigerant can be stored in the indoor heat exchanger 211 of the indoor unit 210. Consequently, an amount of a refrigerant flowing through the refrigerant circuit of the air conditioning system main body 200 can be reduced, and thus an amount of the refrigerant flowing into the compressor 226 can be reduced.

**[0062]** The expansion valve control portion 193 closes the expansion valve 222 connected to the stopped indoor unit 210, and then controls an opening degree of the expansion valve 222 on the basis of the temperature of a refrigerant after being compressed by the compressor 226.

**[0063]** Here, in a case where the temperature of a refrigerant after being compressed by the compressor 226 is high, an amount of the refrigerant flowing through the refrigerant circuit may be insufficient, and thus the efficiency of heat exchange may be reduced. Therefore, the expansion valve control portion 193 increases an opening degree of the expansion valve 222 so as to increase an amount of a refrigerant flowing through the refrigerant circuit. Consequently, it is expected that the efficiency of heat exchange is improved.

**[0064]** On the other hand, in a case where the temperature of a refrigerant after being compressed by the compressor 226 is low, an amount of the refrigerant flowing through the refrigerant circuit may be large, and thus an amount of the refrigerant flowing into the compressor 226 may be large. If an amount of the refrigerant flowing into the compressor 226 is large, a lubricant of the compressor 226 may be diluted with the refrigerant, and this may influence the stability of an operation of the compressor 226. Therefore, the expansion valve control portion 193 reduces an opening degree of the expansion valve 222 so as to reduce an amount of a refrigerant flowing through the refrigerant circuit. Consequently, it is possible to reduce an amount of a refrigerant flowing into the compressor 226, and thus to prevent a situation in which a lubricant of the compressor 226 is diluted with the refrigerant,

and this influences the stability of an operation of the compressor 226.

**[0065]** Next, a description will be made of an operation of the air conditioning system 1 with reference to Fig. 3.

**[0066]** Fig. 3 is a flowchart illustrating an example of a process procedure in which the air conditioning operation control device 100 controls the air conditioning system main body 200. If a power source of the air conditioning system 1 is turned on, and thus an operation is started, the air conditioning operation control device 100 starts the process illustrated in Fig. 3. If the power source of the air conditioning system 1 is turned off, the air conditioning operation control device 100 finishes the process in Fig. 3.

**[0067]** In the process in Fig. 3, the operation mode determination portion 191 determines whether or not the air conditioning system main body 200 is performing a heating operation (step S101).

**[0068]** In a case where it is determined that the heating operation is being performed (step S101: YES), the stop determination portion 192 determines whether or not there is the indoor unit 210 in a stop state (step S102).

**[0069]** In a case where it is determined that there is the indoor unit 210 in a stop state (step S102: YES), the expansion valve control portion 193 adjusts an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state to a predetermined opening degree (step S111).

**[0070]** In a case where the air conditioning system 1 includes three or more indoor units 210, a plurality of indoor units 210 in a stop state may be present. In this case, the expansion valve control portion 193 adjusts opening degrees of the expansion valves 222 connected to all of the indoor units 210 in a stop state, to predetermined opening degrees. Alternatively, in a case where a capacity of each of the indoor units 210 accumulating a refrigerant is sufficiently large, the expansion valve control portion 193 may adjust opening degrees of the expansion valves 222 connected to some of the indoor units 210 in a stop state, to predetermined opening degrees.

**[0071]** After step S111, the expansion valve control portion 193 determines whether or not a predetermined time has elapsed from opening of the expansion valve 222 in step S111 (step S112). For example, the expansion valve control portion 193 is provided with a timer, and measures an elapsed time from adjustment of an opening degree of the expansion valve 222 is completed in step S111. The expansion valve control portion 193 determines whether or not a measured time in the timer reaches a predetermined time.

**[0072]** In a case where it is determined that the predetermined time has not elapsed from opening of the expansion valve 222 (step S112: NO), the process returns to step S112. In other words, the expansion valve control portion waits for the predetermined time to have elapsed.

**[0073]** On the other hand, in a case where it is determined that the predetermined time has elapsed from opening of the expansion valve 222 (step S112: YES),

the expansion valve control portion 193 totally closes the expansion valve 222 opened in step S111 (step S113).

**[0074]** After step S113, the expansion valve control portion 193 determines whether or not a difference obtained by subtracting a temperature measurement value in the outdoor heat exchanger temperature sensor 312 from a temperature measurement value in the compressor intake side temperature sensor 311 is equal to or less than a predetermined threshold value  $T_{LOW}$  (step S114).

**[0075]** Hereinafter, the difference obtained by subtracting a temperature measurement value in the outdoor heat exchanger temperature sensor 312 from a temperature measurement value in the compressor intake side temperature sensor 311 is indicated by  $\Delta TSH$ . The threshold value  $T_{LOW}$  is a preset threshold value as a lower limit value of an allowable range of  $\Delta TSH$ .

**[0076]** In a case where it is determined that  $\Delta TSH$  is equal to or less than the threshold value  $T_{LOW}$  (step S114: YES), the expansion valve control portion 193 reduces an opening degree of the expansion valve 222 connected to the indoor unit 210 (the indoor unit 210 of which an opening degree is adjusted in step S111) in a stop state (step S121). For example, in a case where the expansion valve 222 is an electronic expansion valve, the valve is closed by a predetermined number of pulses.

**[0077]** In other words, in a case where it is determined that  $\Delta TSH$  is less than the lower limit value of the allowable range, the expansion valve control portion 193 reduces an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state, so as to increase an amount of a refrigerant accumulated in the indoor unit 210. Consequently, an amount of the refrigerant flowing through the refrigerant circuit of the air conditioning system main body 200 is reduced. Particularly, an amount of the refrigerant flowing into the compressor 226 is reduced.

**[0078]** After step S121, the process returns to step S114.

**[0079]** On the other hand, in a case where it is determined that  $\Delta TSH$  is more than the threshold value  $T_{LOW}$  in step S114 (step S114: NO), the expansion valve control portion 193 determines whether or not  $\Delta TSH$  is equal to or less than a predetermined threshold value  $T_{HIGH}$  (step S131). The threshold value  $T_{HIGH}$  is a preset threshold value as an upper limit value of the allowable range of  $\Delta TSH$ , and a relationship of " $T_{HIGH} > T_{LOW}$ " is satisfied.

**[0080]** In a case where it is determined that  $\Delta TSH$  is equal to or less than the threshold value  $T_{HIGH}$  (step S131: YES), the expansion valve control portion 193 maintains an opening degree of the expansion valve 222 connected to the indoor unit 210 (the indoor unit 210 of which an opening degree is adjusted in step S111) in a stop state (step S141).

**[0081]** In other words, in a case where it is determined that  $\Delta TSH$  is within the allowable range, the expansion valve control portion 193 maintains an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state, so as to maintain an amount of a

refrigerant accumulated in the indoor unit 210. Consequently, an amount of the refrigerant flowing through the refrigerant circuit of the air conditioning system main body 200 is also maintained.

**[0082]** After step S141, the process returns to step S114.

**[0083]** In a case where it is determined that  $\Delta TSH$  is more than the threshold value  $T_{HIGH}$  in step S131 (step S131: NO), the expansion valve control portion 193 increases an opening degree of the expansion valve 222 connected to the indoor unit 210 (the indoor unit 210 of which an opening degree is adjusted in step S111) in a stop state (step S151). For example, in a case where the expansion valve 222 is an electronic expansion valve, the valve is opened by a predetermined number of pulses.

**[0084]** In other words, in a case where it is determined that  $\Delta TSH$  is more than the upper limit value of the allowable range, the expansion valve control portion 193 increases an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state, so as to reduce an amount of a refrigerant accumulated in the indoor unit 210. Consequently, an amount of the refrigerant flowing through the refrigerant circuit of the air conditioning system main body 200 is increased.

**[0085]** After step S151, the process returns to step S114.

**[0086]** On the other hand, in a case where it is determined that the heating operation is not being performed in step S101 (step S101: NO), the air conditioning system main body 200 performs a normal operation under the control of the air conditioning operation control device 100 (step S161). In the normal operation, the air conditioning system 1 does not perform a process for storing a refrigerant in the indoor unit 210 in a stop state.

**[0087]** In a case where it is determined that there is no indoor unit 210 in a stop state in step S102 (step S102: NO), the process also proceeds to step S161.

**[0088]** The process returns to step S101 in a state in which the air conditioning system main body 200 performs the normal operation in step S161. For example, in a case where the air conditioning system main body 200 performs the normal operation, the controller 190 periodically proceeds to step S101. Alternatively, whenever a user's operation for changing an operation mode of the air conditioning system 1 is performed, and the user's operation for stopping any of the indoor units 210 is performed, the controller 190 may proceed to step S101.

**[0089]** In any of steps S111 to S151, in a case where the user's operation for changing an operation mode of the air conditioning system 1 is performed, or the user's operation for stopping any of the indoor units 210 is performed, the process proceeds to step S101 through an interrupt process.

**[0090]** As in the above steps S114 and S131, in a case where the expansion valve control portion 193 controls an opening degree of the expansion valve 222 on the

basis of a measured value in the compressor intake side temperature sensor 311 and a measured value in the outdoor heat exchanger temperature sensor 312, regarding a process of storing a refrigerant in the indoor unit 210 in a stop state, the compressor outlet temperature sensor 313, the compressor outlet pressure sensor 314, and the indoor heat exchanger temperature sensors 315 are not essential.

**[0091]** On the other hand, a measured value referred to when the expansion valve control portion 193 controls an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state is not limited to measured values in the compressor intake side temperature sensor 311 and the outdoor heat exchanger temperature sensor 312.

**[0092]** For example, the expansion valve control portion 193 may control an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state on the basis of a measured value in the compressor outlet temperature sensor 313. Specifically, in step S114, the expansion valve control portion 193 may determine whether or not a measured value in the compressor outlet temperature sensor 313 is equal to or smaller than a compressor outlet temperature lower limit threshold value. Here, the compressor outlet temperature lower limit threshold value is a preset threshold value as an outlet temperature lower limit value of the compressor 226. In step S131, the expansion valve control portion 193 determines whether or not a measured value in the compressor outlet temperature sensor 313 is equal to or smaller than a compressor outlet temperature upper limit threshold value. Here, the compressor outlet temperature upper limit threshold value is a preset threshold value as an outlet temperature upper limit value of the compressor 226.

**[0093]** In this case, regarding a process of storing a refrigerant in the indoor unit 210 in a stop state, the compressor intake side temperature sensor 311, the outdoor heat exchanger temperature sensor 312, the compressor outlet pressure sensor 314, and the indoor heat exchanger temperature sensors 315 are not essential.

**[0094]** Alternatively, the expansion valve control portion 193 may control an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state on the basis of a measured value in the compressor outlet temperature sensor 313 and a measured value in the compressor outlet pressure sensor 314. For example, in step S114, the expansion valve control portion 193 may determine whether or not a measured value in the compressor outlet temperature sensor 313 is equal to or smaller than a compressor outlet temperature lower limit threshold value, and is equal to or smaller than a compressor outlet pressure lower limit threshold value. Here, the compressor outlet pressure lower limit threshold value is a preset threshold value as an outlet pressure lower limit value of the compressor 226. For example, in step S131, the expansion valve control portion 193 determines whether or not a measured value in the compres-

sor outlet temperature sensor 313 is equal to or smaller than a compressor outlet temperature upper limit threshold value, and is equal to or smaller than a compressor outlet pressure upper limit threshold value. Here, the compressor outlet pressure upper limit threshold value is a preset threshold value as an outlet pressure upper limit value of the compressor 226.

**[0095]** In this case, regarding a process of storing a refrigerant in the indoor unit 210 in a stop state, the compressor intake side temperature sensor 311, the outdoor heat exchanger temperature sensor 312, and the indoor heat exchanger temperature sensors 315 are not essential.

**[0096]** Alternatively, the expansion valve control portion 193 may control an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state on the basis of a measured value in the outdoor heat exchanger temperature sensor 312 and a measured value in the compressor outlet temperature sensor 313. For example, in step S114, the expansion valve control portion 193 may determine whether or not a difference obtained by subtracting a measured value in the outdoor heat exchanger temperature sensor 312 from a measured value in the compressor outlet temperature sensor 313 is equal to or less than a predetermined lower limit threshold value. In step S131, the expansion valve control portion 193 determines whether or not the difference obtained by subtracting a measured value in the outdoor heat exchanger temperature sensor 312 from a measured value in the compressor outlet temperature sensor 313 is equal to or less than a predetermined upper limit threshold value.

**[0097]** In this case, regarding a process of storing a refrigerant in the indoor unit 210 in a stop state, the compressor intake side temperature sensor 311, the compressor outlet pressure sensor 314, and the indoor heat exchanger temperature sensors 315 are not essential.

**[0098]** Alternatively, the expansion valve control portion 193 may control an opening degree of the expansion valve 222 connected to the indoor unit 210 in a stop state on the basis of a measured value in the outdoor heat exchanger temperature sensor 312 and measured value in the indoor heat exchanger temperature sensor 315. For example, in step S114, the expansion valve control portion 193 may determine whether or not a difference obtained by subtracting a measured value in the outdoor heat exchanger temperature sensor 312 from a measured value in the indoor heat exchanger temperature sensor 315 is equal to or less than a predetermined lower limit threshold value. Specifically, the expansion valve control portion 193 calculates an average value of measured values in the indoor heat exchanger temperature sensors 315 provided in the indoor units 210 during an operation, and subtracts a measured value in the outdoor heat exchanger temperature sensor 312 from the average value. The expansion valve control portion 193 determines whether or not a difference obtained through subtraction is equal to or less than the predetermined

lower limit threshold value. In step S131, the expansion valve control portion 193 determines whether or not the difference obtained through subtraction is equal to or less than the predetermined upper limit threshold value.

**[0099]** In this case, regarding a process of storing a refrigerant in the indoor unit 210 in a stop state, the compressor intake side temperature sensor 311, the compressor outlet temperature sensor 313, and the compressor outlet pressure sensor 314 are not essential.

**[0100]** As mentioned above, the operation mode determination portion 191 determines whether or not the air conditioning system main body 200 is performing the heating operation. In a case where the operation mode determination portion 191 determines that the air conditioning system main body 200 is performing the heating operation, the stop determination portion 192 determines whether or not there is the stopped indoor unit 210. If the stop determination portion 192 determines that there is the stopped indoor unit 210, the expansion valve control portion 193 opens the expansion valve 222 connected to the stopped indoor unit 210, and then closes the expansion valve 222.

**[0101]** Consequently, the stopped indoor unit 210 can store a refrigerant, and thus an amount of the refrigerant flowing into the compressor 226 can be reduced. The expansion valve control portion 193 controls the expansion valve 222, and thus the stopped indoor unit 210 can store a refrigerant. The expansion valves 222 may be provided on the outlet sides during the heating operation of the indoor heat exchangers 211, and expansion valves are not required to be provided on the inlet sides, and thus it is possible to relatively simplify a configuration of the air conditioning system 1. Since a capillary returning a refrigerant to the compressor intake side pipe is not required to be provided on the outlet sides during the heating operation of the indoor heat exchangers 211, and the refrigerant is stored in the indoor unit 210 in a stop state, a receiver tank for storing a refrigerant is not required to be separately provided. Also from the viewpoint thereof, it is possible to relatively simplify a configuration of the air conditioning system 1.

**[0102]** The expansion valve control portion 193 can change an amount of a refrigerant flowing through the refrigerant circuit by changing an opening degree of the expansion valve 222. If the expansion valve control portion 193 changes an opening degree of the expansion valve 222, an amount of a refrigerant flowing through the refrigerant circuit may be immediately changed, and thus the responsiveness is high.

**[0103]** The expansion valve control portion 193 opens the expansion valve 222 connected to the stopped indoor unit 210 to a predetermined opening degree, and totally closes the expansion valve 222 after a predetermined time elapses from a state in which the expansion valve 222 is opened to the predetermined opening degree.

**[0104]** Consequently, the expansion valve control portion 193 can accumulate a refrigerant in the indoor unit 210 in a stop state through a simple process of opening

the expansion valve 222 to a predetermined opening degree and then totally closing the expansion valve.

**[0105]** The expansion valve control portion 193 closes the expansion valve 222 connected to the stopped indoor unit 210, and then controls an opening degree of the expansion valve 222 on the basis of the temperature of a refrigerant flowing through the refrigerant circuit of the air conditioning system main body 200.

**[0106]** Consequently, the expansion valve control portion 193 can detect that an amount of a refrigerant flowing through the refrigerant circuit is reduced, and the efficiency of heat exchange is reduced, and can thus increase an amount of the refrigerant flowing through the refrigerant circuit.

**[0107]** Consequently, the expansion valve control portion 193 can detect that an amount of a refrigerant flowing through the refrigerant circuit is increased, and an amount of the refrigerant flowing into the compressor 226, and can thus reduce an amount of the refrigerant flowing through the refrigerant circuit.

**[0108]** For example, the expansion valve control portion 193 controls an opening degree of the expansion valve 222 on the basis of a difference between the temperature of a refrigerant flowing into the compressor 226 and the temperature of a refrigerant which is discharged from the compressor 226 and flows into the outdoor heat exchanger 223.

**[0109]** Consequently, the expansion valve control portion 193 can control an opening degree of the expansion valve 222 on the basis of a result of simple calculation of calculating a difference between temperature measurement values in the sensors. For example, the expansion valve control portion 193 may compare a difference obtained by subtracting a temperature measurement value in the outdoor heat exchanger temperature sensor 312 from a temperature measurement value in the compressor intake side temperature sensor 311 with a threshold value, and may control an opening degree of the expansion valve 222 on the basis of a comparison result.

**[0110]** Alternatively, the expansion valve control portion 193 may control an opening degree of the expansion valve 222 on the basis of the temperature of a refrigerant discharged from the compressor 226.

**[0111]** Consequently, the expansion valve control portion 193 can control an opening degree of the expansion valve 222 on the basis of a result of simple calculation using a temperature measurement value in the sensor. For example, the expansion valve control portion 193 may control an opening degree of the expansion valve 222 on the basis of a result of simple calculation of comparing a temperature measurement value in the compressor outlet temperature sensor 313 with a threshold value.

**[0112]** A program for realizing all or some of the functions of the controller 190 may be recorded on a computer readable recording medium, and a process in each unit may be performed by reading the program recorded on

the recording medium to a computer system and executing the program. The "computer system" mentioned here includes an OS or hardware such as peripheral devices.

**[0113]** The "computer readable recording medium" indicates a portable medium such as a flexible disk, a magnetooptical disc, a ROM, or a CD-ROM, and a storage device such as a hard disk built into the computer system. The program may realize some of the functions, and the functions may be realized through a combination with a program recorded in the computer system in advance.

**[0114]** As mentioned above, the embodiment of the present invention has been described in detail with reference to the drawings, but a specific configuration is not limited to the embodiment and includes design changes or the like within the scope without departing from the spirit of the invention.

#### Industrial Applicability

**[0115]** According to the air conditioning operation control device, the air conditioning system, the air conditioning operation control method, and the program, it is possible to enable a configuration of the air conditioning system to be simpler, and also to reduce an amount of a refrigerant inflowing into a compressor.

#### Reference Signs List

##### **[0116]**

1 AIR CONDITIONING SYSTEM

100 AIR CONDITIONING OPERATION CONTROL DEVICE

110 MEASURED VALUE ACQUISITION SECTION

180 STORAGE SECTION

190 CONTROLLER

191 OPERATION MODE DETERMINATION PORTION

192 STOP DETERMINATION PORTION

193 EXPANSION VALVE CONTROL PORTION

#### **Claims**

1. An air conditioning operation control device comprising:

an operation mode determination portion that determines whether or not an air conditioning system main body is performing a heating operation, the air conditioning system main body

- including a single outdoor unit, a plurality of indoor units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating; 5  
 a stop determination portion that determines whether or not there is a stopped indoor unit among the plurality of indoor units in a case where the operation mode determination portion determines that the air conditioning system main body is performing the heating operation; and 10  
 an expansion valve control portion that opens an expansion valve connected to the stopped indoor unit and then closes the expansion valve in a case where the stop determination portion determines that there is the stopped indoor unit. 15
2. The air conditioning operation control device according to claim 1, 20  
 wherein the expansion valve control portion opens the expansion valve connected to the stopped indoor unit to a predetermined opening degree, and totally closes the expansion valve after a predetermined time elapses from a state in which the expansion valve is opened to the predetermined opening degree. 25
3. The air conditioning operation control device according to claim 1 or 2, 30  
 wherein the expansion valve control portion closes the expansion valve connected to the stopped indoor unit, and then controls an opening degree of the expansion valve on the basis of the temperature of a refrigerant flowing through the refrigerant circuit. 35
4. The air conditioning operation control device according to claim 3, 40  
 wherein the expansion valve control portion controls the opening degree of the expansion valve on the basis of a difference between the temperature of the refrigerant flowing into a compressor provided in the refrigerant circuit and the temperature of the refrigerant discharged from the compressor and having flowed into an outdoor heat exchanger provided in the outdoor unit. 45
5. The air conditioning operation control device according to claim 3, 50  
 wherein the expansion valve control portion controls the opening degree of the expansion valve on the basis of the temperature of the refrigerant discharged from a compressor provided in the refrigerant circuit.
6. An air conditioning system comprising: 55  
 an air conditioning system main body that includes a single outdoor unit, a plurality of indoor

units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating; and  
 the air conditioning operation control device according to any one of claims 1 to 5.

7. An air conditioning operation control method comprising:

a step of determining whether or not an air conditioning system main body is performing a heating operation, the air conditioning system main body including a single outdoor unit, a plurality of indoor units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating;  
 a step of determining whether or not there is a stopped indoor unit among the plurality of indoor units in a case where the operation mode determination portion determines that the air conditioning system main body is performing the heating operation;  
 a step of opening an expansion valve connected to the stopped indoor unit in a case where the stop determination portion determines that there is the stopped indoor unit; and  
 a step of closing the expansion valve in an opened state.

8. A program causing a computer to execute:

a step of determining whether or not an air conditioning system main body is performing a heating operation, the air conditioning system main body including a single outdoor unit, a plurality of indoor units, and a refrigerant circuit including a plurality of expansion valves respectively provided on refrigerant outlet sides of the plurality of indoor units during heating;  
 a step of determining whether or not there is a stopped indoor unit among the plurality of indoor units in a case where the operation mode determination portion determines that the air conditioning system main body is performing the heating operation;  
 a step of opening an expansion valve connected to the stopped indoor unit in a case where the stop determination portion determines that there is the stopped indoor unit; and  
 a step of closing the expansion valve in an opened state.

FIG. 1

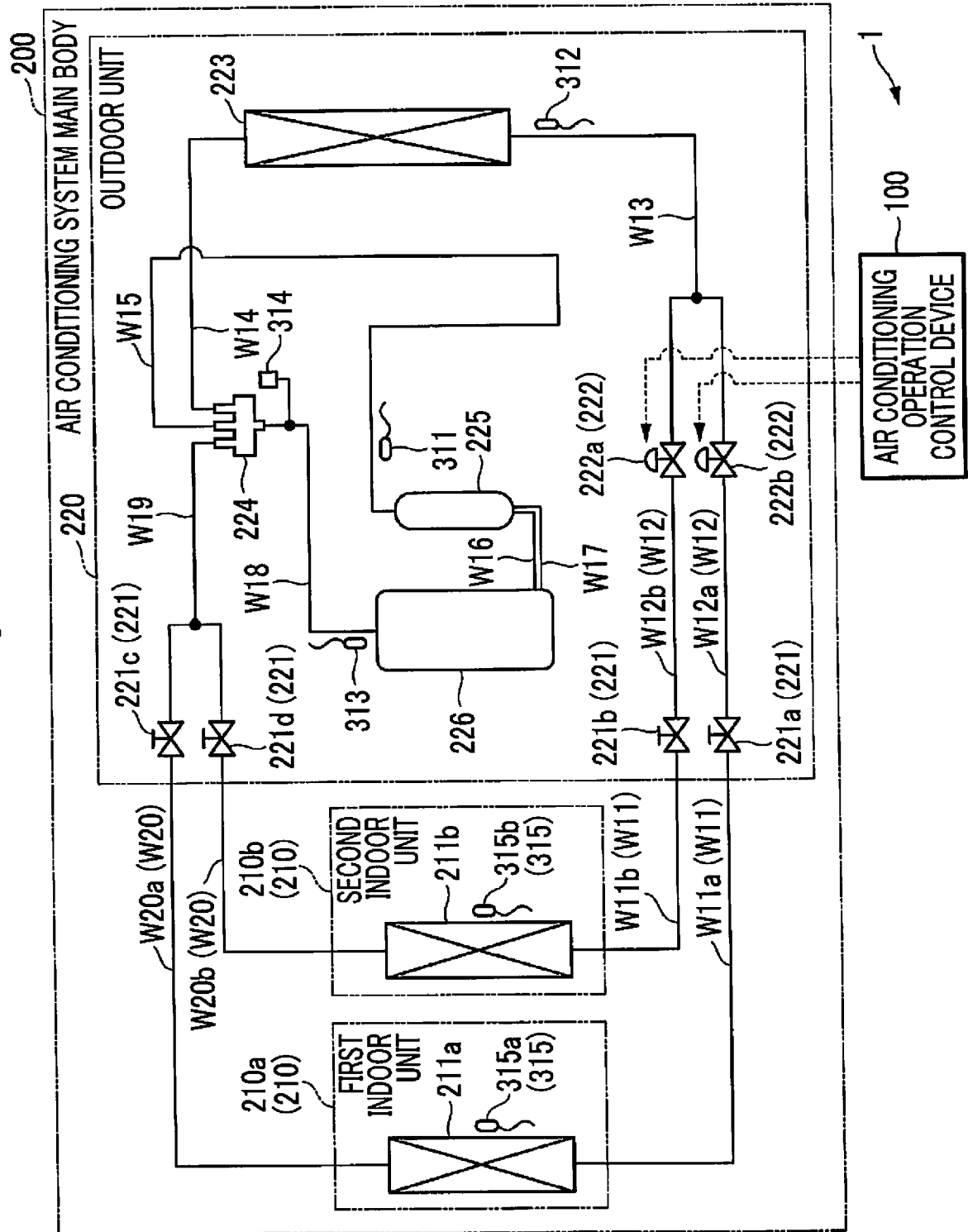


FIG. 2

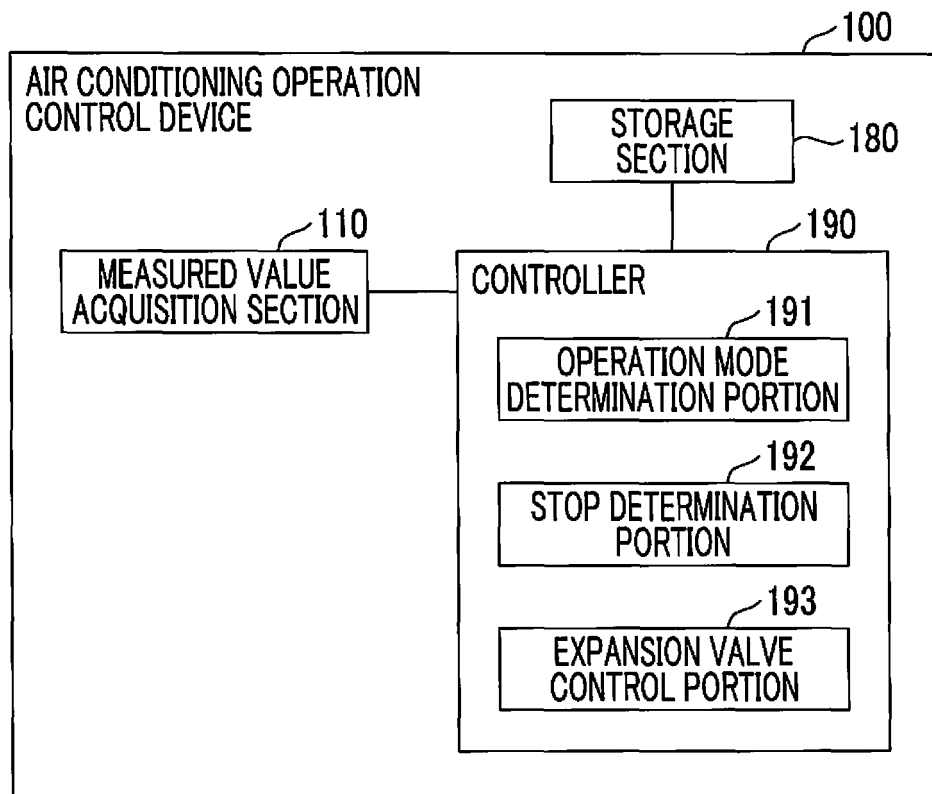
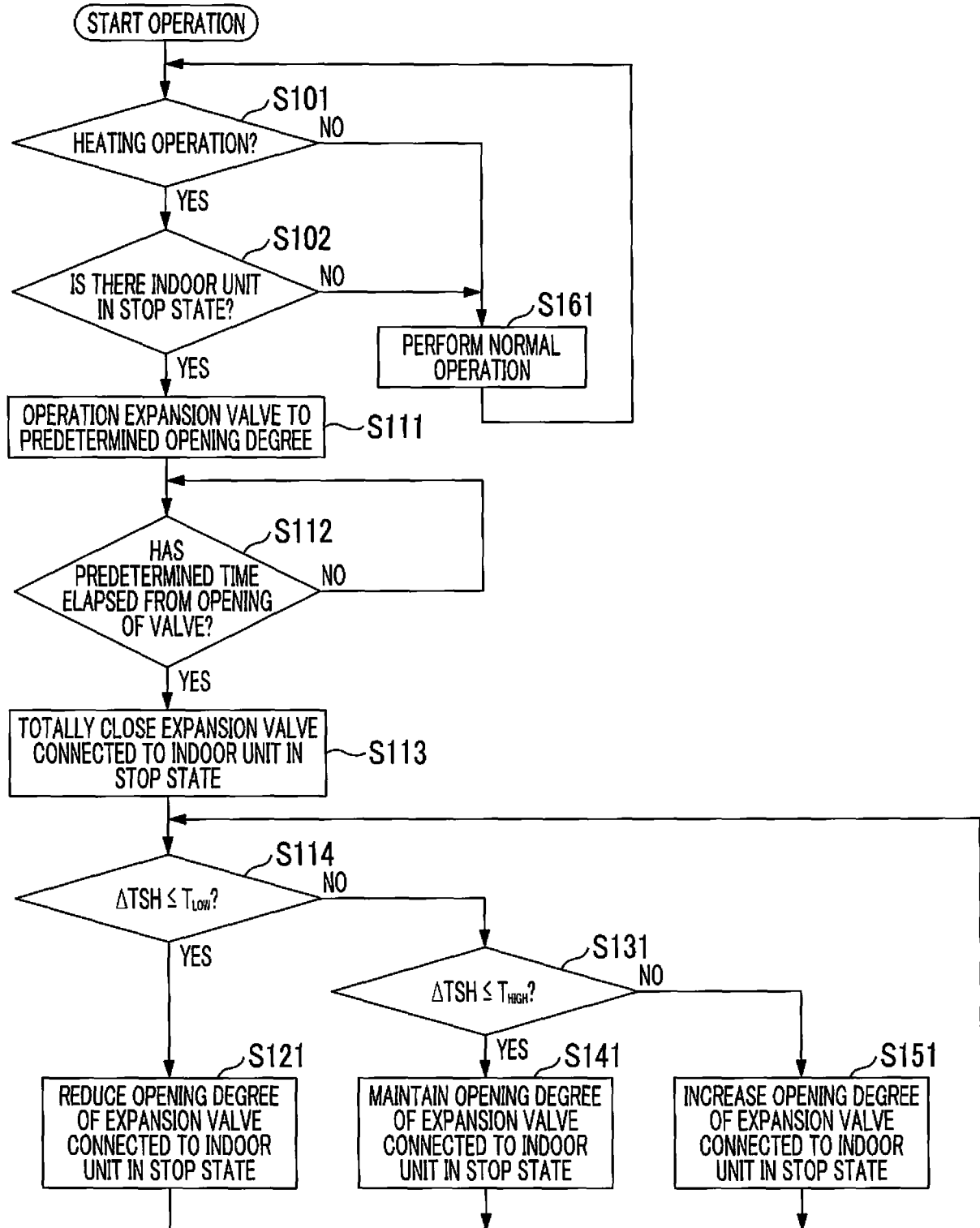


FIG. 3



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/011138

## A. CLASSIFICATION OF SUBJECT MATTER

F25B1/00(2006.01)i, F24F11/02(2006.01)i, F25B13/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B1/00, F24F11/02, F25B13/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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. |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
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| X<br>Y    | JP 63-233259 A (Hitachi, Ltd.),<br>28 September 1988 (28.09.1988),<br>page 3, upper right column, line 19 to page 4,<br>upper left column, line 11; fig. 1 to 2<br>(Family: none)     | 1, 6-8<br>2-5         |

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

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"A" document defining the general state of the art which is not considered to be of particular relevance

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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

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

Date of the actual completion of the international search  
29 May 2017 (29.05.17)Date of mailing of the international search report  
06 June 2017 (06.06.17)Name and mailing address of the ISA/  
Japan Patent Office  
3-4-3, Kasumigaseki, Chiyoda-ku,  
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/011138

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                        | Relevant to claim No. |
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**REFERENCES CITED IN THE DESCRIPTION**

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