



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
20.06.2018 Bulletin 2018/25

(51) Int Cl.:
F25B 1/00 (2006.01) **F24F 11/02** (2006.01)
F25B 6/02 (2006.01)

(21) Application number: **16835066.8**

(86) International application number:
PCT/JP2016/072935

(22) Date of filing: **04.08.2016**

(87) International publication number:
WO 2017/026369 (16.02.2017 Gazette 2017/07)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **10.08.2015 PCT/JP2015/072620**

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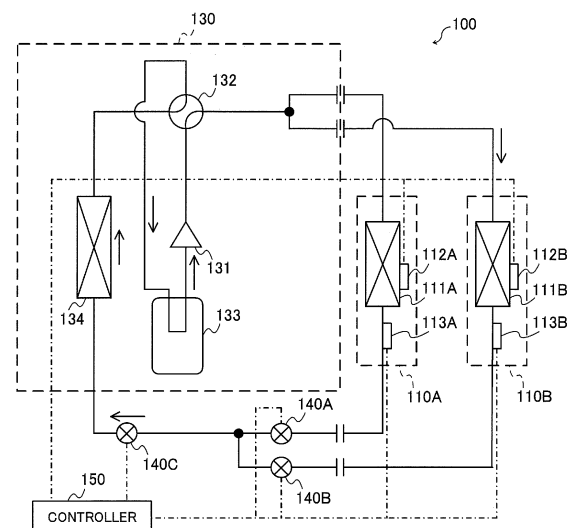
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(54) **MULTIPLE-TYPE AIR CONDITIONER**

(57) A multiple-type air conditioner (100) is provided with a first indoor unit (110A) and a second indoor unit (110B). When the first indoor unit (110A) is stopped and the second indoor unit (110B) operates with a second indoor heat exchanger (111B) functioning as a condenser, the opening degree of a first indoor expansion valve (140A) is increased if the ratio of a difference between a temperature detected by a first heat exchanger intermediate temperature detector (112A) and a temperature detected by a first heat exchanger outlet temperature detector (113A) to a difference between the temperature detected by the first heat exchanger intermediate temperature detector (112A) and the air temperature is greater than a target value, and the opening degree of the first indoor expansion valve (140A) is reduced if the ratio is lower than the target value.

FIG. 1



Description**TECHNICAL FIELD**

5 [0001] The present invention relates to a multiple-type air conditioner provided with a plurality of indoor units or outdoor units that can be operated and stopped separately.

BACKGROUND ART

10 [0002] Conventionally, known is a multiple-type air conditioner having indoor units and an outdoor unit. To prevent refrigerant stagnation, the conventional multiple-type air conditioner calculates a difference between the condensing temperature of a heat exchanger on the stopped side and a refrigerant temperature on the outlet side of the heat exchanger on the stopped side, and controls an expansion valve to open when the difference becomes less than a certain value (See the Patent Reference 1, for example).

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PRIOR ART REFERENCE**PATENT REFERENCE**

20 [0003] Patent Reference 1: Japanese Patent Application Publication No. H07-158989 (Page 6, Fig. 1)

SUMMARY OF THE INVENTION**PROBLEM TO BE SOLVED BY THE INVENTION**

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[0004] The conventional multiple-type air conditioner judges only whether the refrigerant is in stagnation in a heat exchanger on the stopped side, so that an expansion valve is controlled to open even in the case where the refrigerant does not become insufficient on the operating side although the refrigerant somewhat stagnates in the heat exchanger on the stopped side, for example even in the case where an outlet temperature is sufficiently lowered relative to an intermediate temperature in a heat exchanger on the operating side. As a result, in the conventional multiple-type air conditioner, a refrigerant circulation amount increases on the-stopped side and the room is unnecessarily warmed owing to natural heat radiation although the operation is stopped.

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[0005] Thus, an object of the present invention is to make it possible to operate a plurality of indoor units or outdoor units without causing capacity shortage and refrigerant insufficiency regardless of operating state, unit type, and the number of connected units.

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MEANS OF SOLVING THE PROBLEM

[0006] A multiple-type air conditioner according to one aspect of the present invention has: a first device that includes a first heat exchanger; a first detector to detect a temperature of a refrigerant in the first heat exchanger; a second detector to detect a temperature of the refrigerant flowing out of the first heat exchanger; a third detector to detect an air temperature outside the first device; an expansion valve for the refrigerant in the first device; a second device that includes a second heat exchanger, and operates and stops separately from the first device; and a control unit to increase an opening degree of the expansion valve if a ratio of a difference between the temperature detected by the first detector and the temperature detected by the second detector to a difference between the temperature detected by the first detector and the air temperature detected by the third detector is greater than a target value, and to reduce the opening degree of the expansion valve if the ratio is less than the target value, when the first device is stopped and the second device is operating with the second heat exchanger functioning as a condenser.

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[0007] A multiple-type air conditioner according to another aspect of the present invention has: a compressor; a first device that includes a first heat exchanger; a first expansion valve for a refrigerant in the first device; a first detector to detect a pressure of the refrigerant between the compressor and the first expansion valve; a second detector to detect a temperature of the refrigerant flowing out of the first heat exchanger; a third detector to detect an air temperature outside the first device; a second device that includes a second heat exchanger, and operates and stops separately from the first device; and a control unit to increase an opening degree of the first expansion valve if a ratio of a difference between a saturated liquid temperature corresponding to the pressure detected by the first detector and the temperature detected by the second detector to a difference between the saturated liquid temperature and the air temperature detected by the third detector is greater than a target value, and to reduce the opening degree of the first expansion valve if the ratio is less than the target value, when the first device is stopped and the second device is operating with the second

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heat exchanger functioning as a condenser.

EFFECTS OF THE INVENTION

[0008] According to one aspect of the present invention, it is possible to operate a plurality of indoor units or outdoor units without causing capacity shortage and refrigerant insufficiency regardless of operating state, unit type, and the number of connected units.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a block diagram representing schematically a configuration of a multiple-unit air conditioner according to an embodiment 1;

Fig. 2 is a schematic view representing an example of an indoor heat exchanger, a heat exchanger intermediate temperature detector, and a heat exchanger outlet temperature detector in the embodiment 1;

Fig. 3 is a schematic diagram representing a path configuration of indoor heat exchanger in the embodiment 1;

Fig. 4 is a schematic diagram for explaining a calculation value in the embodiment 1;

Fig. 5 is a schematic diagram representing a relationship between the calculation value and an opening degree of an indoor expansion valve in the embodiment 1;

Fig. 6 is a schematic diagram for explaining a target value in the embodiment 1;

Fig. 7 is a flowchart indicating operation of the multiple-type air conditioner of the embodiment 1;

Figs. 8(A) and 8(B) are schematic diagrams representing the conventional determination criteria for controlling an expansion valve;

Fig. 9 is a block diagram representing schematically a configuration of a first variation of the multiple-type air conditioner of the embodiment 1;

Fig. 10 is a block diagram representing schematically a configuration of a second variation of the multiple-type air conditioner of the embodiment 1;

Fig. 11 is a block diagram representing schematically a configuration of a multiple-type air conditioner according to an embodiment 2;

Fig. 12 is a flowchart indicating operation of the multiple-type air conditioner of the embodiment 2;

Fig. 13 is a block diagram representing schematically a configuration of a first variation of the multiple-type air conditioner of the embodiment 2;

Fig. 14 is a block diagram representing schematically a configuration of a second variation of the multiple-type air conditioner of the embodiment 2;

Fig. 15 is a block diagram representing schematically a configuration of a multiple-type air conditioner according to an embodiment 3; and

Fig. 16 is a flowchart indicating operation of the multiple-type air conditioner of the embodiment 3.

MODE FOR CARRYING OUT THE INVENTION

EMBODIMENT 1

[0010] Fig. 1 is a block diagram representing schematically a configuration of a multiple-type air conditioner 100 according to an embodiment 1.

[0011] The multiple-type air conditioner 100 has a first indoor unit 110A, a second indoor unit 110B, an outdoor unit 130, a first indoor expansion valve 140A, a second indoor expansion valve 140B, an auxiliary expansion valve 140C, and a controller 150. Here, when it is not necessary to differentiate between the first indoor unit 110A and the second indoor unit 110B, reference is made simply as an indoor unit 110. Further, when it is not necessary to differentiate between the first indoor expansion valve 140A and the second indoor expansion valve 140B, reference is made simply as an indoor expansion valve 140.

[0012] The first indoor unit 110A and the second indoor unit 110B can be operated and stopped separately.

[0013] As shown in Fig. 1, it is assumed that heating operation is performed when a refrigerant flows as shown by the solid arrows. In the multiple-type air conditioner 100, a plurality of indoor units 110 are connected to one outdoor unit 130. Although Fig. 1 shows one outdoor unit 130 and two indoor units 110, the numbers of these units are not limited to these. Further, in addition to the elements shown in Fig. 1, the multiple-type air conditioner 100 can be further provided with a device such as a pressure gauge, a gas-liquid separator, or a receiver.

[0014] The first indoor unit 110A has a first indoor heat exchanger 111A, a first heat exchanger intermediate temperature

detector 112A, and a first heat exchanger outlet temperature detector 113A.

[0015] The second indoor unit 110B has a second indoor heat exchanger 111B, a second heat exchanger intermediate temperature detector 112B, and a second heat exchanger outlet temperature detector 113B. The second indoor unit 110B can be operated and stopped separately from the first indoor unit 110A.

[0016] Here, the first indoor unit 110A and the second indoor unit 110B are constructed similarly. In detail, the first indoor heat exchanger 111A and the second indoor heat exchanger 111B are constructed similarly, and each of them is referred to as an indoor heat exchanger 111 when it is not necessary to differentiate each of them from each other. The first heat exchanger intermediate temperature detector 112A and the second heat exchanger intermediate temperature detector 112B are constructed similarly, and each of them is referred to as a heat exchanger intermediate temperature detector 112 when it is not necessary to differentiate each of them from each other. The first heat exchanger outlet temperature detector 113A and the second heat exchanger outlet temperature detector 113B are constructed similarly, and each of them is referred to as a heat exchanger outlet temperature detector 113 when it is not necessary to differentiate each of them from each other.

[0017] The indoor heat exchanger 111 performs heat exchange of the refrigerant. When heating operation is performed, the indoor heat exchanger 111 functions as a condenser.

[0018] The heat exchanger intermediate temperature detector 112 is a detector that detects the temperature of the refrigerant in the indoor heat exchanger 111 of the indoor unit 110, or in other words a heat exchanger intermediate temperature that is the temperature of the refrigerant during heat exchange in the indoor heat exchanger 111. The heat exchanger intermediate temperature can also be called a condensing temperature in the indoor heat exchanger 111 of the indoor unit 110.

[0019] The heat exchanger outlet temperature detector 113 is a detector that detects the temperature of the refrigerant that flows out of the indoor heat exchanger 111 of the indoor unit 110, or in other words a heat exchanger outlet temperature as a temperature of the refrigerant after heat exchange in the indoor heat exchanger 111.

[0020] Each of the heat exchanger intermediate temperature detectors 112 and the heat exchanger outlet temperature detectors 113 also functions as an outside air temperature detector for detecting an air temperature outside the indoor unit 110.

[0021] Fig. 2 is a schematic view representing an example of the indoor heat exchanger 111, the heat exchanger intermediate temperature detector 112, and the heat exchanger outlet temperature detector 113. Further, Fig. 3 is a schematic diagram representing a path configuration of the indoor heat exchanger 111. Although Figs. 2 and 3 illustrate a fin-and-tube type heat exchanger having three branched paths, the type and the number of branches of the indoor heat exchanger 111 are not limited to these.

[0022] As shown in Fig. 2, in the indoor heat exchanger 111, the refrigerant enters from an inlet T_i of a tube and exits from an outlet T_o of the tube. As shown in Fig. 2, the heat exchanger intermediate temperature detector 112 is provided in the middle of a path from the inlet T_i to the outlet T_o . Incidentally, heat exchanger intermediate temperature detectors 112 may be provided at a plurality of points in the path from the inlet T_i to the outlet T_o .

[0023] Further, at the time of heating operation, the refrigerant flows in from the inlet T_i in a state of heated gas or in a state of being rich in heated gas, is condensed by natural heat radiation or the like, and goes out of the outlet T_o , so that the outlet T_o side tends to be in a state of being rich in liquid in comparison with the inlet T_i side. Thus, it is more favorable to provide the heat exchanger intermediate temperature detector 112 at a position after the middle position between the inlet T_i and the outlet T_o of the indoor heat exchanger 111.

[0024] The heat exchanger outlet temperature detector 113 is provided at the outlet T_o of the indoor heat exchanger 111.

[0025] As shown in Fig. 3, the indoor heat exchanger 111 of the embodiment 1 has a first path having a first inlet T_{i1} from which the refrigerant enters and a first outlet T_{o1} from which the refrigerant exits; a second path having a second inlet T_{i2} from which the refrigerant enters and a second outlet T_{o2} from which the refrigerant exits; and a third path having a third inlet T_{i3} from which the refrigerant enters and a third outlet T_{o3} from which the refrigerant exits. In the case where the indoor heat exchanger 111 has a plurality of paths, it is possible that refrigerant stagnation occurs only in one path, and thus it is more favorable to provide a heat exchanger intermediate temperature detector 112 in each path.

[0026] Further, as described above, at the time of heating operation, the outlet T_o side tends to be in a state of being rich in liquid, in comparison with the inlet T_i side. Accordingly, as in the third path 111a indicated by a broken line, refrigerant stagnation tends to occur in a structure portion where the refrigerant is made to flow in the direction against gravity (being lifted upward) on the side of the third outlet T_{o3} in the path from the third inlet T_{i3} to the third outlet T_{o3} . Thus, it is favorable to give priority to attaching the heat exchanger intermediate temperature detector 112 to a path having such a structure portion.

[0027] In the embodiment 1, although the air temperature is detected by a heat exchanger outlet temperature detector 113 or a heat exchanger intermediate temperature detector 112 before starting the heating operation, it is possible to add an outside air temperature detector (not shown) for detecting a temperature outside an indoor unit 111.

[0028] To return to Fig. 1, the outdoor unit 130 has a compressor 131, a four-way valve 132, a liquid reservoir 133, and an outdoor heat exchanger 134.

[0029] The compressor 131 compresses the refrigerant.

[0030] The four-way valve 132 switches paths of the refrigerant.

[0031] The liquid reservoir 133 is a container for the refrigerant.

[0032] The outdoor heat exchanger 134 performs heat exchange of the refrigerant.

[0033] The indoor expansion valve 140 decreases the pressure of the refrigerant. The first indoor expansion valve 140A is an expansion valve corresponding to the first indoor unit 110A, namely an expansion valve for the refrigerant flowing in the first indoor unit 110A. The second indoor expansion valve 140B is an expansion valve corresponding to the second indoor unit 110B, namely an expansion valve for the refrigerant flowing in the second indoor unit 110B.

[0034] The auxiliary expansion valve 140C decreases the pressure of the refrigerant that flows in the first indoor unit 110A and the second indoor unit 110B. Here, the auxiliary expansion valve 140C plays an auxiliary role.

[0035] Here, the indoor expansion valves 140 and the auxiliary expansion valve 140C can be controlled in their opening and closing by the controller 150. For example, it is favorable that the indoor expansion valves 140 and the auxiliary expansion valve 140C are electronic expansion valves whose opening degrees can be adjusted in the range of 0% (fully closed) - 100% (fully open) by the controller 150.

[0036] The controller 150 is a control unit for controlling each part of the indoor units 110 and the outdoor unit 130. For example, the controller 150 is connected with the first heat exchanger intermediate temperature detector 112A, the second heat exchanger intermediate temperature detector 112B, the first heat exchanger outlet temperature detector 113A, the second heat exchanger outlet temperature detector 113B, the four-way valve 132, the first indoor expansion valve 140A, the second indoor expansion valve 140B, and the auxiliary expansion valve 140C, to control these devices.

[0037] Further, the controller 150 is controlled based on operating information for operating the outdoor unit 130 having the outdoor heat exchanger 134, the first indoor unit 110A having the first indoor heat exchanger 111A, and the second indoor unit 110B having the second indoor heat exchanger 111B. The operating information includes, for example, information indicating heating operation, information indicating cooling operation, ON or OFF information of the outdoor unit, and the like. The operating information is stored in a memory (not shown), and this memory may be provided inside of the controller 150 or outside of the controller 150.

[0038] Further, the controller 150 controls at least one of the first indoor expansion valve 140A and the second indoor expansion valve 140B based on a calculation result obtained from detection results in the heat exchanger intermediate temperature detectors 112 and the heat exchanger outlet temperature detectors 113 of the indoor units 110. For example, when one of the indoor units 110 is stopped and the other is operated, the controller 150 controls the opening degree of the indoor expansion valve 140 so that a ratio of a difference between a temperature detected by the heat exchanger intermediate temperature detector 112 of the stopped indoor unit 110 and a temperature detected by the heat exchanger outlet temperature detector 113 of the stopped indoor unit 110 to a difference between the temperature detected by the heat exchange intermediate detector 112 of the stopped indoor unit 110 and an air temperature outside the stopped indoor unit 110 becomes a target value. For example, the controller 150 increases the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 when the ratio is greater than the target value, and reduces the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 when the ratio is less than the target value.

[0039] In the embodiment 1, an azeotropic refrigerant is sealed in a refrigeration cycle. It is possible to seal a pseudo-azeotropic refrigerant or a non-azeotropic refrigerant.

[0040] Although the above-described heat exchangers, namely, the first indoor heat exchanger 111A, the second indoor heat exchanger 111B, and the outdoor heat exchanger 134 are described as fin-and-tube type heat exchangers, these exchangers are not limited to this type. A plate type or a corrugated type may be used or a plurality of types of heat exchangers may be used in combination.

[0041] As for heat exchanger intermediate temperature, it is possible to provide a pressure detector (not shown) between the outlet of the compressor 131 and the inlet of the first indoor expansion valve 140A or the second indoor expansion valve 140B, to estimate (calculate) the heat exchanger intermediate temperature from a relational expression between the pressure and the saturation temperature of the refrigerant. Further, to improve the reliability of a detected result, it is more favorable to provide both the heat exchanger intermediate temperature detector 112 and the pressure detector. By this arrangement, the controller 150 can perform control using the heat exchanger intermediate temperature detected by either of the detectors. Further, if a value detected by either of the detectors is an abnormal value, for example, as in the case where temperatures detected by the respective detectors are greatly different from each other exceeding a predetermined threshold, the controller 150 can detect an abnormal state. When an abnormal state is detected, the controller 150 can perform processing such as stopping the operation of the indoor unit 110 for which the abnormality has been detected or giving notice of the abnormality, for example.

[0042] The above-described controller 150 can be implemented by a processing circuit. The processing circuit may be dedicated hardware or a central processing unit (CPU, which is also known as a central processor, a processing unit, an operation unit, a microprocessor, a microcomputer, a processor, or a DSP) that executes a program stored in a memory.

[0043] As the processing circuit that is dedicated hardware, for example, a single circuit, a composite circuit, a pro-

grammed processor, a parallelly-programmed processor, an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA), or a combination of these can be mentioned.

[0044] In the case where the processing circuit is a CPU, the functions of the controller 150 are implemented by software, firmware, or a combination of software and firmware. The software or the firmware is described as programs, and stored in a memory. The processing circuit implements a function of controlling each part by reading out a program stored in the memory and executing the program. Here, as the memory, for example, a non-volatile or volatile semiconductor memory such as Random Access Memory (RAM), Read Only Memory (ROM), flash memory, Erasable Programmable Read Only Memory (EPROM), or Electrically Erasable Programmable Read Only Memory (EEPROM), a magnetic disk, a flexible disk, an optical disk, a compact disc, a mini disc, or a Digital Versatile Disc (DVD) can be mentioned.

[0045] As for the functions of the controller 150, some functions can be implemented by dedicated hardware and the other functions by software or firmware.

[0046] Next will be described operation of the multiple-type air conditioner 100 according to the embodiment 1 having the above-described configuration.

[0047] The multiple-type air conditioner 100 of the embodiment 1 controls the opening degree of any of the first indoor expansion valve 140A, the second indoor expansion valve 140B, and the auxiliary expansion valve 140C through the controller 150 so that a calculation value calculated from the values detected by the first heat exchanger intermediate temperature detector 112A, the second heat exchanger intermediate temperature detector 112B, the first heat exchanger outlet temperature detector 113A, and the second heat exchanger outlet temperature detector 113B becomes the target value.

[0048] Here, the calculation value ε is obtained as a ratio of a temperature difference between temperatures detected by the heat exchanger intermediate temperature detector 112 and the heat exchanger outlet temperature detector 113 of the indoor unit 110 that is stopped at the time of heating operation, to a temperature difference between the temperature detected by the heat exchanger intermediate temperature detector 112 and an air temperature detected by the heat exchanger intermediate temperature detector 112 or the heat exchanger outlet temperature detector 113 before starting the heating operation. When this calculation value ε is "0", the refrigerant in the indoor heat exchanger 111 in the stopped indoor unit 110 is flowing in a two-phase state or a state of heated gas; or when this calculation value ε is "1", the refrigerant in the indoor heat exchanger 111 is flowing in a liquid state. As for the air temperature, if an outside air temperature detector (not shown) is added, it is more accurate to use a value of the outside air temperature detector as the air temperature.

[0049] Fig. 4 is a schematic diagram for explaining the calculation value ε .

[0050] In Fig. 4, the heat exchanger intermediate temperature detected by the heat exchanger intermediate temperature detector 112 of the stopped indoor unit 110 is denoted by stopped heat exchanger intermediate temperature T1, the heat exchanger outlet temperature detected by the heat exchanger outlet temperature detector 113 of the stopped indoor unit 110 is denoted by stopped heat exchanger outlet temperature T2, and the temperature detected by the heat exchanger intermediate temperature detector 112 or the heat exchanger outlet temperature detector 113 before starting the heating operation is denoted by air temperature T3. Then, the calculation value ε is calculated by the following equation (1).
[Eq. 1]

$$\varepsilon = (T1 - T2) / (T1 - T3) = X/Y \quad (1)$$

[0051] Here, as shown in Fig. 4, X is the difference between the stopped heat exchanger intermediate temperature T1 and the stopped heat exchanger outlet temperature T2, and Y is the difference between the stopped heat exchanger intermediate temperature T1 and the air temperature T3.

[0052] As shown in Fig. 4, when the stopped heat exchanger intermediate temperature T1 is equal to the stopped heat exchanger outlet temperature T2, the calculation value ε becomes "0". Thus, when the calculation value ε is "0", it is considered that, as the refrigerant is flowing in the two-phase state or the state of heated gas even in the neighborhood of the outlet of the indoor heat exchanger 111, refrigerant stagnation does not occur. On the other hand, when the stopped heat exchanger outlet temperature T2 and the air temperature T3 become equal to each other, the calculation value ε becomes "1". When the calculation value ε is "1", it is considered that, as the refrigerant in the neighborhood of the outlet of the indoor heat exchanger 111 is sufficiently cool, the refrigerant stagnation is occurring.

[0053] Fig. 5 is a schematic diagram representing a relation between the calculation value ε and the opening degree of the indoor expansion valve 140.

[0054] When the opening degree of the expansion valve is 100% or near to 100%, the amount of the refrigerant flowing into the stopped indoor unit 110 is large, so that the refrigerant is discharged remaining in the state of gas or the two-phase state although the heat is radiated naturally at the time of passing. In other words, when the calculated value ε is a value V1 close to "0", the supercooling degree (hereinafter referred to as SC) is small and the refrigerant stagnation

amount is small, while the amount of the refrigerant flowing into the indoor heat exchanger 111 of the stopped indoor unit 110 is large (the refrigerant circulation amount is large), so that there is a high possibility that heating capacity shortage occurs. Accordingly, the controller 150 performs control so that the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 may become smaller.

[0055] On the other hand, when the opening degree of the expansion valve is 0% or near to 0%, while no refrigerant or a small amount of the refrigerant flows into the stopped indoor unit 110, the refrigerant is condensed owing to natural heat radiation or the like at the time of passing, so that the refrigerant becomes a liquid and stays in the indoor heat exchanger 111 or the like. In other words, when the calculation value ε is a value V2 close to "1", SC is large and the amount of the refrigerant stagnating in the indoor heat exchanger 111 of the stopped indoor unit 110 is large (the circulation amount is small), so that there is a high possibility that the refrigerant becomes insufficient in the operating indoor unit 110. Accordingly, the controller 150 performs control so that the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 may become larger.

[0056] That is to say, the controller 150 should control the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 so that the calculation value ε may become the target value TV between "0" and "1". In detail, if the calculation value ε is less than the target value TV, the opening degree of the indoor expansion valve 140 corresponding to the indoor unit 110 is reduced; or if the calculation value ε is greater than the target value TV, the opening degree of the indoor expansion valve 140 corresponding to the indoor unit 110 is increased.

[0057] Here, the target value TV for the calculation value ε is first set to a predetermined initial value (for example, $\varepsilon = 0.8$), and is changed depending on the operating status.

[0058] Fig. 6 is a schematic diagram for explaining the target value TV.

[0059] The heat exchanger intermediate temperature detected by the heat exchanger intermediate temperature detector 112 of the operating indoor unit 110 is denoted by operating heat exchanger intermediate temperature T4, and the heat exchanger outlet temperature detected by the heat exchanger outlet temperature detector 113 of the operating indoor unit 110 is denoted by operating heat exchanger outlet temperature T5.

[0060] When the refrigerant stagnates in the stopped indoor unit 110 and becomes insufficient in the operating indoor unit 110, a temperature difference between the operating heat exchanger intermediate temperature T4 and the operating heat exchanger outlet temperature T5 becomes small. Accordingly, the controller 150 judges whether the temperature difference between the operating heat exchanger intermediate temperature T4 and the operating heat exchanger outlet temperature T5 is greater than or equal to a predetermined threshold (here, "0"), and changes the target value TV when the temperature difference is less than the threshold. For example, the controller 150 changes the target value TV to a value less than the present value. Accordingly, the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 becomes larger, and the circulation amount of the refrigerant increases.

[0061] Since it is more desirable that the expansion valve is throttled so that the refrigerant may not be made to flow as much as possible into the indoor unit 110 that is stopped at the time of the heating operation, the initial value of the target value TV of the calculation value ε is favorably set in the range of $0.5 \leq \varepsilon \leq 1.0$, and more favorably in the range of $0.8 \leq \varepsilon \leq 1.0$.

[0062] Fig. 7 is a flowchart indicating operation of the multiple-type air conditioner 100 of the embodiment 1.

[0063] First, the controller 150 refers to the operating information stored in the memory (not shown) so as to check operation or stop of the outdoor unit 130, the first indoor unit 110A, and the second indoor unit 110B (S10). Here, it is assumed that the first indoor unit 110A is in an operating state and the second indoor unit 110B is in a stopped state.

[0064] Next, the controller 150 detects the indoor air temperature through the heat exchanger intermediate temperature detector 112 or the heat exchanger outlet temperature detector 113 of the indoor unit 110 in the stopped state (S11). Here, the second heat exchanger intermediate temperature detector 112B or the second heat exchanger outlet temperature detector 113B of the second indoor unit 110B in the stopped state is used to detect the indoor air temperature. In the case where an outside air temperature detector (not shown) is provided, an air temperature obtained from the outside air temperature detector can be used.

[0065] Next, the controller 150 makes the compressor 131 operate (S12), and sets the predetermined initial value (for example, $\varepsilon = 0.8$) as the target value to be compared with the calculation value ε (S13). By operating the compressor 131, the heating operation is started.

[0066] Further, the controller 150 controls the indoor expansion valves 140 to have predetermined opening degrees (S14). In particular, the controller 150 sets the indoor expansion valve 140 corresponding to the indoor unit 110 in the operating state to have an opening degree appropriate to the load applied to the indoor unit 110 in the operating state. Here, the controller 150 sets the opening degrees of the first indoor expansion valve 140A corresponding to the first indoor unit 110A in the operating state and the auxiliary expansion valve 140C to predetermined values.

[0067] The controller 150 obtains the heat exchanger intermediate temperatures and the heat exchanger outlet temperatures from the heat exchanger intermediate temperature detector 112 and the heat exchanger outlet temperature detector 113 of the indoor unit 110 in the operating state and the heat exchanger intermediate temperature detector 112 and the heat exchanger outlet temperature detector 113 of the indoor unit 110 in the stopped state (S15). For example,

the controller 150 obtains the temperatures from the first heat exchanger intermediate temperature detector 112A, the second heat exchanger intermediate temperature detector 112B, the first heat exchanger outlet temperature detector 113A, and the second heat exchanger outlet temperature detector 113B.

[0068] Next, the controller 150 calculates the calculation value ε by using the air temperature obtained in step S11 and the heat exchanger intermediate temperature and the heat exchanger outlet temperature of the indoor unit 110 in the stopped state among the temperatures obtained in step S15 (S16). Here, the heat exchanger intermediate temperature and the heat exchanger outlet temperature of the second indoor unit 110B are used.

[0069] Next, the controller 150 judges whether the calculation value ε calculated in step S16 is less than or equal to the target value (S17). If the calculation value ε is greater than the target value (No in S17), the processing proceeds to step S18; or if the calculation value ε is less than or equal to the target value (Yes in S17), the processing proceeds to step S19.

[0070] In step S18, since the refrigerant stagnation amount is large in the indoor unit 110 in the stopped state and there is a high possibility that the refrigerant becomes insufficient in the indoor unit 110 in the operating state, the controller 150 increases the opening degree of the indoor expansion valve 140 corresponding to the indoor unit 110 in the stopped state so as to open that indoor expansion valve 140. Here, the controller 150 increases the opening degree of the second indoor expansion valve 140B corresponding to the second indoor unit 110B that is in the stopped state. For example, the controller 150 adds a predetermined value to the opening degree of the second indoor expansion valve 140B; or the opening degree of the second indoor expansion valve 140B is multiplied by a predetermined value so as to increase the opening degree in question. Then, the processing returns to step S15.

[0071] In step S19, the controller 150 judges whether the calculation value calculated in step S16 is greater than or equal to the target value. If the calculation value ε is less than the target value (No in S19), the processing proceeds to step S20. Or, if the calculation value ε is greater than or equal to the target value (Yes in S19), the processing proceeds to step S21.

[0072] In step S20, since the refrigerant stagnation amount is small in the indoor unit 110 in the stopped state, the refrigerant circulation amount is large, and there is a high possibility that the capacity shortage of the indoor unit 110 in the operating state occurs, the controller 150 reduces the opening degree of the indoor expansion valve 140 corresponding to the indoor unit 110 in the stopped state so as to throttle that indoor expansion valve 140. Here, the controller 150 reduces the opening degree of the second indoor expansion valve 140B corresponding to the second indoor unit 110B that is in the stopped state. For example, the controller subtracts a predetermined value from the opening degree of the second indoor expansion valve 140B; or the opening degree of the second indoor expansion valve 140B is multiplied by a predetermined value so as to reduce the opening degree in question. Then, the processing returns to step S15.

[0073] In step S21, the controller 150 judges whether a temperature difference between the heat exchanger intermediate temperature and the heat exchanger outlet temperature of the indoor unit 110 in the operating state among the temperatures obtained in step S15 is greater than or equal to "0", or in other words whether the supercooling degree is greater than or equal to "0". Here, the controller 150 judges whether a temperature difference obtained by subtracting the heat exchanger outlet temperature of the first indoor unit 110A in the operating state from the heat exchanger intermediate temperature of that indoor unit 110A is greater than or equal to "0". If the temperature difference is greater than or equal to "0" (Yes in S21), the processing is ended, and the controller 150 continues the heating operation. If the temperature difference is less than "0" (No in S21), the processing proceeds to step S22.

[0074] In step S22, the controller 150 changes the target value so that the supercooling degree of the indoor unit 110 in the operating state may become greater than or equal to "0". Here, the controller 150 lessens the target value. For example, the controller 150 subtracts a predetermined value (for example, a value greater than "0" and less than or equal to "0.1") from the current target value. Then, the processing returns to step S15. By subtracting such a value, it is possible to perform the heating operation without circulating the refrigerant unnecessarily in the indoor unit 110 in the stopped state.

[0075] Since the multiple-type air conditioner 100 of the embodiment 1 is constructed as described above, it is possible, regardless of unit type and the number of connected units, to make the expansion valve opening degrees minimum as far as possible while allowing heating operation without causing capacity shortage and refrigerant insufficiency of the operating indoor unit 110, by controlling at the time of the heating operation the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 so that the calculating value ε calculated from the values of the temperature detectors 112, 113 provided in the stopped indoor unit 110 becomes the set target value.

[0076] Further, the multiple-type air conditioner 100 changes the target value so that a temperature difference (supercooling degree) between the heat exchanger intermediate temperature obtained from the heat exchanger intermediate temperature detector 112 of the operating indoor unit 110 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 110 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 100 controls the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 so that the changed target value may be achieved, thereby minimizing the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 210 as far as possible, regardless of unit

type and the number of the indoor units 110.

[0077] Further, the multiple-type air conditioner 100 changes the target value so that the temperature difference (supercooling degree) between the heat exchanger intermediate temperature obtained from the heat exchanger intermediate temperature detector 112 of the operating indoor unit 110 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 110 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 100 controls the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 so that the changed target value may be achieved, thereby preventing the operating indoor unit 110 from falling into capacity shortage regardless of unit type and the number of the indoor units 100.

[0078] Further, the multiple-type air conditioner 100 changes the target value so that the temperature difference (supercooling degree) between the heat exchanger intermediate temperature obtained from the heat exchanger intermediate temperature detector 112 of the operating indoor unit 110 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 110 may become greater than or equal to 0 °C; and the multiple-type air conditioner 100 controls the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 so that the changed target value may be achieved, thereby ensuring that the refrigerant is a liquid refrigerant when the refrigerant flows into the indoor expansion valve 140 corresponding to the operating indoor unit 110.

[0079] Further, the multiple-type air conditioner 100 changes the target value so that the temperature difference (supercooling degree) between the heat exchanger intermediate temperature obtained from the heat exchanger intermediate temperature detector 112 of the operating indoor unit 110 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 110 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 100 controls the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 so that the changed target value may be achieved, and surely makes the refrigerant flowing into the indoor expansion valve 140 corresponding to the operating indoor unit 110 liquid, thereby reducing noise generated when the refrigerant flows in as a two-phase flow.

[0080] Further, the multiple-type air conditioner 100 minimizes the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 as far as possible without causing capacity shortage and refrigerant insufficiency of the operating indoor unit 110, thereby making the indoor heat exchanger 111 of the stopped indoor unit 110 hold surplus refrigerant.

[0081] Further, in the multiple-type air conditioner 100, since the surplus refrigerant is held in the indoor heat exchanger 111 of the stopped indoor unit 110, it is possible to shorten the rise time required for cooling operation or heating operation at startup.

[0082] Further, in the multiple-type air conditioner 100, since the surplus refrigerant is held in the indoor heat exchanger 111 of the stopped indoor unit 110, it is possible at the time of mounting the liquid reservoir 133 to reduce the size of the liquid reservoir 133 (for example, an accumulator or a receiver) having a role of holding the surplus refrigerant; or it is possible even to omit the liquid reservoir 133.

[0083] Further, in the multiple-type air conditioner 100, by reducing the size of the liquid reservoir 133 or by omitting the liquid reservoir 133, it is possible to reduce costs.

[0084] Further, in the multiple-type air conditioner 100, by minimizing the amount of the refrigerant in the stopped indoor unit 110 while preventing capacity shortage and refrigerant insufficiency of the operating indoor unit 110 regardless of unit type and the number of the connected indoor units 110, it is possible to reduce unnecessary heating owing to natural heat radiation.

[0085] Figs. 8(A) and 8(B) are schematic diagrams representing the determination criterion for controlling an expansion valve, which is described in the Patent Reference 1 as the conventional technique.

[0086] In the Patent Reference 1, the expansion valve is controlled to open when a difference between the stopped heat exchanger intermediate temperature T7 which is the heat exchanger intermediate temperature of the stopped indoor unit and the stopped heat exchanger outlet temperature T8 which is the heat exchanger outlet temperature of that indoor unit exceeds a predetermined threshold H and a difference between the operating heat exchanger intermediate temperature T9 which is the heat exchanger intermediate temperature of the operating indoor unit and the stopped heat exchanger intermediate temperature T7 exceeds a predetermined threshold J. According to this control, the refrigerant circulation amount on the stopped side increases and thus the room is unnecessarily heated owing to natural heat radiation in spite of the stopped state.

[0087] In contrast, in the embodiment 1, the opening degrees of the expansion valves are controlled so that the refrigerant circulation amount may be minimized as far as possible without causing refrigerant stagnation on the stopped side. Therefore, unnecessary heating of the room does not occur.

[0088] Fig. 9 is a block diagram representing schematically a configuration of a first variation of the multiple-type air conditioner of the embodiment 1.

[0089] The multiple-type air conditioner 100#1 of the first variation has a first indoor unit 110A, a second indoor unit 110B, an outdoor unit 130#1, a first indoor expansion valve 140A, a second indoor expansion valve 140B, an auxiliary

expansion valve 140C, and a controller 150. The multiple-type air conditioner 100#1 is different from the multiple-type air conditioner 100 of the embodiment 1 in the outdoor unit 130#1, and thus the outdoor unit 130#1 will be described in the following.

[0090] The outdoor unit 130#1 of the first variation has a compressor 131, a four-way valve 132, and an outdoor heat exchanger 134. The outdoor unit 130#1 has a similar configuration to the outdoor unit 130 of the embodiment 1, except that the liquid reservoir 133 is not provided.

[0091] Fig. 10 is a block diagram representing schematically a configuration of a second variation of the multiple-type air conditioner of the embodiment 1.

[0092] The multiple-type air conditioner 100#2 of the second variation has a first indoor unit 110A, a second indoor unit 110B, an outdoor unit 130#1, a first indoor expansion valve 140A, a second indoor expansion valve 140B, an auxiliary expansion valve 140C, and a controller 150. The multiple-type air conditioner #2 is different from the multiple-type air conditioner 100 of the embodiment 1 in that the auxiliary expansion valve 140C is not provided and the outdoor unit 130#1 is not provided with the liquid reservoir 133.

[0093] In the above-described embodiment 1, the indoor expansion valves 140, the auxiliary expansion valve 140C, and the controller 150 can be included in the outdoor unit 130 or in the indoor units 110.

EMBODIMENT 2

[0094] Fig. 11 is a block diagram representing schematically a configuration of a multiple-type air conditioner 200 according to an embodiment 2.

[0095] The multiple-type air conditioner 200 has a first indoor unit 210A, a second indoor unit 210B, an outdoor unit 130, a first indoor expansion valve 140A, a second indoor expansion valve 140B, an auxiliary expansion valve 140C, and a controller 250.

[0096] The multiple-type air conditioner 200 of the embodiment 2 has a similar configuration to the multiple-type air conditioner 100 of the embodiment 1 except for the first indoor unit 210A, the second indoor unit 210B, and the controller 250. Thus, in the following, the first indoor unit 210A, the second indoor unit 210B, and the controller 250 will be mainly described.

[0097] In the embodiment 2 also, the first indoor unit 210A and the second indoor unit 210B can be operated and stopped separately.

[0098] As shown in Fig. 11, it is assumed that heating operation is performed when refrigerant flows as shown by the solid arrows.

[0099] The first indoor unit 210A has a first indoor heat exchanger 111A, a first heat exchanger outlet temperature detector 113A, and a first pressure detector 214A.

[0100] The first indoor unit 210A of the embodiment 2 has a similar configuration to the first indoor unit 110A of the embodiment 1 except that the first pressure detector 214A is further provided and the first heat exchanger intermediate temperature detector 112A is not provided. Thus, in the following, the first pressure detector 214A will be mainly described.

[0101] The second indoor unit 210B has a second indoor heat exchanger 111B, a second heat exchanger outlet temperature detector 113B, and a second pressure detector 214B. The second indoor unit 210B can be operated and stopped separately from the first indoor unit 210A.

[0102] The second indoor unit 210B of the embodiment 2 has a similar configuration to the second indoor unit 110B of the embodiment 1 except that the second pressure detector 214B is further provided and the second heat exchanger intermediate temperature detector 112B is not provided. Thus, in the following, the second pressure detector 214B will be mainly described.

[0103] The first indoor unit 210A and the second indoor unit 210B are constructed similarly, and each of them is referred to as an indoor unit 210 when it is not necessary to differentiate each of them from each other. Further, the first pressure detector 214A and the second pressure detector 214B are constructed similarly, and each of them is referred to as a pressure detector 214 when it is not necessary to differentiate each of them from each other.

[0104] The pressure detector 214 is a detector for detecting a pressure on the condensation side (high pressure side), in other words, a condensation side pressure which is a pressure of the refrigerant after compression by the compressor 131.

[0105] Here, it is favorable that the pressure detector 214 is provided between a discharge part (outlet) of the compressor 131 and an inlet of the first indoor expansion valve 140A or the second indoor expansion valve 140B, and it is more favorable that the pressure detector 214 is provided after an outlet of the indoor heat exchanger 111 as shown in Fig. 11, for example just after the outlet.

[0106] The pressure detectors 214 may be provided at a plurality of positions between the discharge part of the compressor 131 and the first indoor expansion valve 140A or the second indoor expansion valve 140B.

[0107] Further, it is possible that one compressor detector 214 is provided in the path from the compressor 131 to the first indoor expansion valve 140A or the second indoor expansion valve 140B.

[0108] The controller 250 controls the indoor units 210 and the outdoor unit 130.

[0109] For example, the controller 250 is connected with the first heat exchanger outlet temperature detector 113A, the second heat exchanger outlet temperature detector 113B, the first pressure detector 214A, the second pressure detector 214B, the four-way valve 132, the first indoor expansion valve 140A, the second indoor expansion valve 140B, and the auxiliary expansion valve 140C, to control these devices.

[0110] Further, the controller 250 controls at least one of the first indoor expansion valve 140A and the second indoor expansion valve 140B based on a calculation result obtained from detection results in the heat exchanger outlet temperature detector 113 and the pressure detector 214 of the indoor unit 210. In the embodiment 2, as a temperature of the refrigerant in the indoor heat exchanger 111, the controller 250 uses the saturated liquid temperature corresponding to the pressure detected by the pressure detector 214.

[0111] Next, will be described operation of the multiple air conditioner 200 according to the embodiment 2 having the above-described configuration.

[0112] The basic operation of the multiple-type air conditioner 200 of the embodiment 2 are similar to those of the embodiment 1. However, since the first pressure detector 214A and the second pressure detector 214B are attached, it is possible to detect the pressures on the high pressure sides. Accordingly, highly accurate control can be performed regardless of the kind of refrigerant (azeotropic, pseudo-azeotropic, or non-azeotropic refrigerant) when the controller 250 controls the opening degree of the indoor expansion valve 140 on the stopped side so that the calculation value ε calculated by using the value of the saturated liquid temperature obtained from the relation between the refrigerant pressure and the refrigerant saturated temperature may become the target value.

[0113] Further, the calculation value ε is calculated by the following equation (2) in which the saturated liquid temperature determined by the pressure obtained from the pressure detector 214 of the indoor unit 210 that is stopped at the time of heating operation is denoted by saturated liquid temperature T11, the heat exchanger outlet temperature detected by the heat exchanger outlet temperature detector 113 of the stopped indoor unit 210 is denoted by stopped heat exchanger outlet temperature T12, and a temperature detected before starting the heating operation by the heat exchanger outlet temperature detector 113 that is stopped at the time of the heating operation is denoted by air temperature T13.

[Eq. 2]

$$\varepsilon = (T11 - T12) / (T11 - T13) \quad (2)$$

[0114] That is to say, in the embodiment 2, the calculation value ε is a ratio of a difference between the saturated liquid temperature T11 and the stopped heat exchanger outlet temperature T12 to a difference between the saturated liquid temperature T11 and the air temperature T13.

[0115] When the calculation value ε is "0", the refrigerant in the indoor heat exchanger 111 of the stopped indoor unit 210 is flowing in a two-phase state or a state of heated gas; when the calculation value ε is "1", the refrigerant in the heat exchanger 111 of the stopped indoor unit 210 is flowing in a liquid state. As for the air temperature, if an outside air temperature detector (not shown) is added, it is more favorable to use a value detected by the outside air temperature detector.

[0116] Fig. 12 is a flowchart indicating operation of the multiple air conditioner of the embodiment 2.

[0117] First, the controller 250 refers to operating information stored in the memory (not shown) so as to check operation or stop of the outdoor unit 130, the first indoor unit 210A, and the second indoor unit 210B (S30). Here, it is assumed that the first indoor unit 210A is in an operating state and the second indoor unit 210B is in a stopped state.

[0118] Next, the controller 250 detects the indoor air temperature through the heat exchanger outlet temperature detector 113 of the indoor unit 210 in the stopped state (S31). Here, the second heat exchanger outlet temperature detector 113B of the second indoor unit 210 in the stopped state is used to detect the indoor air temperature. In the case where an outside temperature detector (not shown) is provided, an air temperature obtained from the outside temperature detector can be used.

[0119] Next, the controller 250 makes the compressor 131 operate (S32), and sets a predetermined initial value (for example, $\varepsilon = 0.8$) as the target value to be compared with the calculation value ε (S33). By operating the compressor 131, heating operation is started.

[0120] Further, the controller 250 controls the indoor expansion valve 140 corresponding to the indoor unit 210 in the operating state to have an opening degree appropriate for the load applied to the indoor unit 210 in the operating state (S34). Here, the controller 250 sets the opening degrees of the first indoor expansion valve 140A corresponding to the first indoor unit 210A in the operating state and the auxiliary expansion valve 140C to predetermined values.

[0121] Next, the controller 250 obtains the condensation side pressures from the pressure detector 214 of the indoor unit 210 in the operating state and the pressure detector 214 of the indoor unit 210 in the stopped state, and the heat

exchanger outlet temperatures from the heat exchanger outlet temperature detector 113 of the indoor unit 210 in the operating state and the heat exchanger outlet temperature detector 113 of the indoor unit 210 in the stopped state (S35).

[0122] Next, the controller 250 calculates the saturated liquid temperature from the condensation side pressure of the indoor unit 210 in the stopped state between the condensation side pressures obtained in the step S35. Then, the controller 250 calculates the calculation value ε by using the calculated saturated liquid temperature, the air temperature obtained in step S11, and the heat exchanger outlet temperature of the indoor unit 210 in the stopped state among the temperatures obtained in step S35 (S36).

[0123] Next, the controller 150 judges whether the calculation value calculated in the step S36 is less than or equal to the target value (S37). If the calculation value ε is greater than the target value (No in S37), the processing proceeds to step S38; or if the calculation value ε is less than or equal to the target value (Yes in S37), the processing proceeds to step S39.

[0124] In step S38, since the refrigerant stagnation amount is large in the indoor unit 210 in the stopped state and there is a high possibility that the refrigerant becomes insufficient in the indoor unit 210 in the operating state, the controller 250 increases the opening degree of the indoor expansion valve 140 corresponding to the indoor unit 210 in the stopped state so as to open that indoor expansion valve 140. Then, the processing returns to step S35.

[0125] In step S39, the controller 250 judges whether the calculation value calculated in step S36 is greater than or equal to the target value. If the calculation value ε is less than the target value (No in S39), the processing proceeds to step S40; or if the calculation value ε is greater than or equal to the target value (Yes in S39), the processing proceeds to step S41.

[0126] In step S40, since the refrigerant stagnation amount is small in the indoor unit 210 in the stopped state, the refrigerant circulation amount becomes large and there is a high possibility that the capacity shortage of the indoor unit 210 in the operating state occurs, the controller 250 reduces the opening degree of the indoor expansion valve 140 corresponding to the indoor unit 210 in the stopped state so as to throttle that indoor expansion valve 140. Here, the controller 250 reduces the opening degree of the second indoor expansion valve 140B corresponding to the indoor unit 210B in the stopped state. Then, the processing returns to step S35.

[0127] In step S41, the controller 250 calculates the saturated liquid temperature from the condensation side pressure of the indoor unit 210 in the operating state between the condensation side pressures obtained in step S35. Then, the controller 250 judges whether a temperature difference between the calculated saturated liquid temperature and the heat exchanger outlet temperature of the indoor unit 210 in the operating state among the temperatures obtained in step S35 is greater than or equal to "0", or in other words whether the supercooling degree is greater than or equal to "0". Here, the controller 250 judges whether a temperature difference between the saturated liquid temperature of the first indoor unit 210A in the operating state and the heat exchanger outlet temperature of that indoor unit 210A is greater than or equal to "0". If the temperature difference is greater than or equal to "0" (Yes in S41), the processing is ended, and the controller 250 continues the operation. If the temperature difference is less than "0" (No in S41), the processing proceeds to step S42.

[0128] In step S42, the controller 250 changes the target value so that the supercooling degree of the indoor unit 210 in the operating state may become greater than or equal to "0" (S42). Here, the controller 250 reduces the target value. For example, the controller 250 subtracts a predetermined value (for example, a value greater than "0" and less than or equal to "0.1") from the current target value. Then, the processing returns to step S35. By subtracting such a value, it is possible to perform the heating operation without unnecessarily circulating the refrigerant in the indoor unit 210 in the stopped state.

[0129] Since the multiple-type air conditioner 200 of the embodiment 2 is constructed as described above, it is possible, regardless of unit type and the number of connected units, to minimize the opening degree of the expansion valve 140 corresponding to the stopped indoor unit 210 as far as possible while allowing heating operation without causing capacity shortage and refrigerant insufficiency of the operating indoor unit 210, by controlling, at the time of the heating operation, the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 210 so that the calculation value ε calculated from the values of the pressure detector 214 provided on the condensation side and the heat exchanger outlet temperature detector 113 provided in the stopped indoor unit 210 may become the set target value.

[0130] Further, the multiple-type air conditioner 200 changes the target value so that a temperature difference (supercooling degree) between the saturated liquid temperature obtained from the pressure detector 214 of the operating indoor unit 210 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 210 becomes greater than or equal to 0 °C. Then, when the multiple-type air conditioner 200 controls the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 210 so that the changed target value is realized, it is possible to minimize the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 210 as far as possible, regardless of unit type and the number of the indoor units 210.

[0131] Further, the multiple-type air conditioner 200 changes the target value so that the temperature difference (supercooling degree) between the saturated liquid temperature obtained from the pressure detector 214 of the operating

indoor unit 210 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 210 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 200 controls the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 210 so that the changed target value may be achieved, thereby preventing the operating indoor unit 210 from falling into capacity shortage regardless of unit type and the number of the indoor units 210.

[0132] Further, the multiple-type air conditioner 200 changes the target value so that the temperature difference (supercooling degree) between the saturated liquid temperature obtained from the pressure detector 214 of the operating indoor unit 210 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 210 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 200 controls the opening degree of the indoor expansion valve 140 of the stopped indoor unit 210 so that the changed target value may be realized, thereby ensuring that the refrigerant is a liquid refrigerant when the refrigerant flows into the indoor expansion valve 140 corresponding to the operating indoor unit 210.

[0133] Further, the multiple-type air conditioner 200 changes the target value so that the temperature difference (supercooling degree) between the saturated liquid temperature obtained from the pressure detector 214 of the operating indoor unit 210 and the heat exchanger outlet temperature obtained from the heat exchanger outlet temperature detector 113 of that indoor unit 210 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 200 controls the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 210 so that the changed target value may be achieved, and thereby the refrigerant flowing into the indoor expansion valve 140 corresponding to the operating indoor unit 210 is surely liquid. As a result, it is possible to reduce noise generated when the refrigerant flows in as two-phase flow.

[0134] Further, the multiple-type air conditioner 200 minimizes the opening degree of the indoor expansion valve 140 corresponding to the stopped indoor unit 110 as far as possible without causing capacity shortage and refrigerant insufficiency of the operating indoor unit 210, thereby making the indoor heat exchanger 111 of the stopped indoor unit 210 hold surplus refrigerant.

[0135] Further, since the multiple-type air conditioner 200 calculates the saturated liquid temperature by using the value detected by the pressure detector 214, it is possible to calculate the calculation value ε without providing a heat exchanger intermediate temperature detector such as those employed in the embodiment 1.

[0136] Further, since the multiple-type air conditioner 200 calculates the saturated liquid temperature by using the value detected by the pressure detector 214, it is possible to calculate the calculation value ε without being affected by temperature gradient in the case where an azeotropic refrigerant is sealed.

[0137] Fig. 13 is a block diagram representing schematically a configuration of a first variation of the multiple-type air conditioner 200 of the embodiment 2.

[0138] The multiple-type air conditioner 200#1 of the first variation has a first indoor unit 210A, a second indoor unit 210B, an outdoor unit 130#1, a first indoor expansion valve 140A, a second indoor expansion valve 140B, an auxiliary expansion valve 140C, and a controller 250. Since the multiple-type air conditioner 200#1 is different in the outdoor unit 130#1 from the multiple-type air conditioner 200 of the embodiment 2, the outdoor unit 130#1 will be described in the following.

[0139] The outdoor unit 130#1 of the first variation has a compressor 131, a four-way valve 132, and an outdoor heat exchanger 134. The outdoor unit 130#1 of the first variation has a similar configuration to that of the outdoor unit 130 of the embodiment 2, except that the liquid reservoir 133 is not provided.

[0140] Fig. 14 is a block diagram representing schematically a configuration of a second variation of the multiple-type air conditioner 200 of the embodiment 2.

[0141] The multiple-type air conditioner 200#2 of the second variation has a first indoor unit 210A, a second indoor unit 210B, an outdoor unit 130#1, a first indoor expansion valve 140A, a second indoor expansion valve 140B, and a controller 250. The multiple-type air conditioner 200#2 is different from the multiple-type air conditioner 200 of the embodiment 2 in that the auxiliary expansion valve 140C is not provided and the outdoor unit 130#1 is not provided with the liquid reservoir 133.

EMBODIMENT 3

[0142] Fig. 15 is a block diagram representing schematically a configuration of a multiple-type air conditioner 300 according to an embodiment 3.

[0143] The multiple-type air conditioner 300 has a first indoor unit 310A, a second indoor unit 310B, an Xth indoor unit 310X (X is an integer greater than or equal to 3), a first outdoor unit 330A, a second outdoor unit 330B, a first indoor expansion valve 340A, a second indoor expansion valve 340B, an Xth indoor expansion valve 340X, a first outdoor expansion valve 341A, a second outdoor expansion valve 341B, and a controller 350.

[0144] In the embodiment 3, the first indoor unit 310A - the Xth indoor unit 310X can be operated and stopped separately. Further, the first outdoor unit 330A and the second outdoor unit 330B can be operated and stopped separately.

[0145] In the embodiment 3, cooling operation is performed when the first outdoor unit 330A is operated, the second outdoor unit 330B is stopped, and the refrigerant flows as shown by the solid arrows shown in Fig. 15.

[0146] The first indoor expansion valve 340A, the second indoor expansion valve 340B, and the Xth indoor expansion valve 340X are constructed similarly, and each of them is referred to as an indoor expansion valve 340 when it is not necessary to differentiate each of them from one another. Furthermore, the first outdoor expansion valve 341A and the second outdoor expansion valve 341B are also constructed similarly, and each of them is referred to as an outdoor expansion valve 341 when it is not necessary to differentiate each of them from one another.

[0147] The first indoor unit 310A is provided with a first indoor heat exchanger 311A.

[0148] The second indoor unit 310B is provided with a second indoor heat exchanger 311B.

[0149] The Xth indoor unit 310X is provided with an Xth indoor heat exchanger 311X.

[0150] Here, the first indoor unit 310A, the second indoor unit 310B, and the Xth indoor unit 310X are constructed similarly. In detail, the first indoor heat exchanger 311A, the second indoor heat exchanger 311B, and the Xth indoor heat exchanger 311X are constructed similarly, and each of them is referred to as an indoor heat exchanger 311 when it is not necessary to differentiate each of them from one another. Also, each of the first indoor unit 310A, the second indoor unit 310B, and the Xth indoor unit 310X is referred to as an indoor unit 310 when it is not necessary to differentiate each of them from one another.

[0151] The indoor heat exchanger 311 performs heat exchange of the refrigerant.

[0152] Although three or more indoor units 310 are provided in the embodiment 3, it is possible that the number of the provided indoor units 310 is two or more.

[0153] The first outdoor unit 330A has a first compressor 331A, a first four-way valve 332A, a first liquid reservoir 333A, a first outdoor heat exchanger 334A, a first outdoor heat exchanger intermediate temperature detector 335A, and a first outdoor heat exchanger outlet temperature detector 336A.

[0154] The second outdoor unit 330B has a second compressor 331B, a second four-way valve 332B, a second liquid reservoir 333B, a second outdoor heat exchanger 334B, a second outdoor heat exchanger intermediate temperature detector 335B, and a second outdoor heat exchanger outlet temperature detector 336B. The second outdoor unit 330B can be operated and stopped separately from the first outdoor unit 330A.

[0155] Here, the first outdoor unit 330A and the second outdoor unit 330B are constructed similarly. In detail, the first compressor 331A and the second compressor 331B are constructed similarly, and each of them is referred to as a compressor 331 when it is not necessary to differentiate each of them from each other. The first four-way valve 332A and the second four-way valve 332B are constructed similarly, and each of them is referred to as a four-way valve 332 when it is not necessary to differentiate each of them from each other. The first liquid reservoir 333A and the second liquid reservoir 333B are constructed similarly, and each of them is referred to as a liquid reservoir 333 when it is not necessary to differentiate each of them from each other. The first outdoor heat exchanger 334A and the second outdoor heat exchanger 334B are constructed similarly, and each of them is referred to as an outdoor heat exchanger 334 when it is not necessary to differentiate each of them from each other. The first outdoor heat exchanger intermediate temperature detector 335A and the second outdoor heat exchanger intermediate temperature detector 335B are constructed similarly, and each of them is referred to as an outdoor heat exchanger intermediate temperature detector 335 when it is not necessary to differentiate each of them from each other. The first outdoor heat exchanger outlet temperature detector 336A and the second outdoor heat exchanger outlet temperature detector 336B are constructed similarly, and each of them is referred to as an outdoor heat exchanger outlet temperature detector 336 when it is not necessary to differentiate each of them from each other.

[0156] Also, each of the first outdoor unit 330A and the second outdoor unit 330B is referred to as an outdoor unit 330 when it is not necessary to differentiate each of them from each other.

[0157] In the embodiment 3, when one of the first outdoor unit 330A and the second outdoor unit 330B, for example the first outdoor unit 330A, is operated and the second outdoor unit 330B is stopped, and at least one of the first indoor unit 310A - the Xth indoor unit 310A is operated, the refrigerant flows in from the high pressure side of the stopped second outdoor unit 330B and is condensed while flowing in the second outdoor heat exchanger 334B, so that the refrigerant stays in that heat exchanger 334B. Furthermore, under the condition that the outdoor air temperature is low, the refrigerant is more likely to be condensed in the stopped second outdoor unit 330B (the outdoor heat exchanger 334B) because of the greater temperature difference in comparison with that at the time of higher temperature, and thus refrigerant stagnation tends to occur.

[0158] The compressor 331 compresses the refrigerant.

[0159] The four-way valve 332 switches a path of the refrigerant.

[0160] The liquid reservoir 333 is a container for the refrigerant.

[0161] The outdoor heat exchanger 334 performs heat exchange of the refrigerant. At the time of cooling operation, the outdoor heat exchanger 334 functions as a condenser.

[0162] The outdoor heat exchanger intermediate temperature detector 335 is a detector for detecting the temperature of the refrigerant in the outdoor heat exchanger 334, or in other words a heat exchanger intermediate temperature which

is the temperature of the refrigerant during heat exchange in the outdoor heat exchanger 334. The heat exchanger intermediate temperature can also be called the condensing temperature in the outdoor heat exchanger 334 of the outdoor unit 330.

[0163] Here, at the time of cooling operation, on the refrigerant inlet side of the outdoor heat exchanger 334, the refrigerant flows in a state of heated gas or in a state of being rich in heated gas. Since such refrigerant is condensed owing to natural heat radiation or the like in the outdoor heat exchangers 334, the refrigerant tends to be in a state of being rich in liquid on the outlet side of the outdoor heat exchanger 334 in comparison with the inlet side. Accordingly, it is more favorable to place the outdoor heat exchanger intermediate temperature detector 335 at a position after the middle position between the inlet and the outlet of the corresponding outdoor heat exchanger 334.

[0164] The outdoor heat exchanger outlet temperature detector 336 is a detector for detecting the temperature of the refrigerant that comes out of the corresponding outdoor heat exchanger 334, or in other words a heat exchanger outlet temperature which is the temperature of the refrigerant after heat exchange in the corresponding outdoor heat exchanger 334.

[0165] The indoor expansion valve 340 decreases the pressure of the refrigerant. The first indoor expansion valve 340A decreases the pressure of the refrigerant of the first indoor unit 310A. The second indoor expansion valve 340B decreases the pressure of the refrigerant of the second indoor unit 310B. The Xth indoor expansion valve 340X decreases the pressure of the refrigerant of the Xth indoor unit 310X.

[0166] The outdoor expansion valve 341 decreases the pressure of the refrigerant. The first outdoor expansion valve 341A is an expansion valve corresponding to the first outdoor unit 330A, or an expansion valve for the refrigerant flowing in the first outdoor unit 330A. The second outdoor expansion valve 341B is an expansion valve corresponding to the second outdoor unit 330B, or an expansion valve for the refrigerant flowing in the second outdoor unit 330B.

[0167] Here, the indoor expansion valve 340 and the outdoor expansion valve 341 can be controlled in their opening and closing by the controller 150. For example, it is favorable that the indoor expansion valve 340 and the outdoor expansion valve 341 are electronic expansion valves whose opening degrees can be adjusted in the range of 0% (fully closed) - 100% (fully open) by the controller 350.

[0168] The controller 350 controls the indoor units 310, the outdoor units 330, the indoor expansion valve 340, and the outdoor expansion valve 341. In particular, the controller 350 controls at least one of the first outdoor expansion valve 341A and the second outdoor expansion valve 341B based on a calculation result obtained from detection results in the outdoor heat exchanger intermediate temperature detector 335 and the outdoor heat exchanger outlet temperature detector 336 of the outdoor unit 330.

[0169] Although, in the above, the outdoor heat exchanger intermediate temperature detector 335 detects the heat exchanger intermediate temperature, it is possible to provide a pressure detector (not shown) between the outlet of the compressor 331 and the outdoor expansion valve 341 so that the controller 350 estimates the heat exchanger intermediate temperature from the relational expression between the pressure and the saturation temperature of the refrigerant, based on the refrigerant pressure detected by the pressure detector. Further, to improve the reliability of the detected result, it is more favorable to provide both the heat exchanger intermediate temperature detector 335 and the pressure detector.

[0170] Next will be described operation of the multiple-unit air conditioner 300 according to the embodiment 3 having the above-described configuration.

[0171] Although the basic operation of the multiple-unit air conditioner 300 of the embodiment 3 is similar to those of the embodiment 1, the difference lies in that the multiple-type air conditioner 300 is configured to have two or more outdoor units 300. The multiple-type air conditioner 300 controls the opening degrees of the outdoor expansion valves 341 so that the operating indoor unit 310 may not fall into refrigerant insufficiency and capacity shortage owing to the refrigerant remaining in the outdoor heat exchanger 334 of the outdoor unit 330 that is stopped at the time of cooling operation.

[0172] In the multiple-type air conditioner 300 of the embodiment 3, the outdoor unit 330 is provided with the outdoor heat exchanger intermediate temperature detector 335 and the outdoor heat exchanger outlet temperature detector 336. In the multiple-type air conditioner 300 of the embodiment 3, the controller 350 controls the opening degree of at least one of the first outdoor expansion valve 341A and the second outdoor expansion valve 341B so that the calculation value calculated from the values detected by the outdoor heat exchanger intermediate temperature detectors 335 and the outdoor heat-exchange outdoor temperature detectors 336 may become the target value.

[0173] Here, the calculation value ε is obtained as a ratio of a temperature difference between temperatures detected by the outdoor heat exchanger intermediate temperature detector 335 and outdoor heat exchanger outlet temperature detector 336 of the outdoor unit 330 that is stopped at the time of cooling operation to a temperature difference between the temperature detected by the outdoor heat exchanger intermediate temperature detector 335 and an air temperature detected by the outdoor heat exchanger intermediate temperature detector 335 or the outdoor heat exchanger outlet temperature detector 336 of that outdoor unit 330 before starting the cooling operation. When this calculation value ε is "0", the refrigerant in the outdoor heat exchanger 334 in the stopped outdoor unit 330 is flowing in a two-phase state or a state of heated gas; or when this calculation value ε is "1", the refrigerant in that outdoor heat exchanger 334 is flowing

in a liquid state. As for the air temperature, if an outside air temperature detector (not shown) is added, it is more favorable to use a value of the outside air temperature detector as the air temperature.

[0174] The calculation value ε is calculated by the following equation (3) when the heat exchanger intermediate temperature detected by the outdoor heat exchanger intermediate temperature detector 335 of the outdoor unit 330 stopped at the time of the cooling operation is denoted by stopped heat exchanger intermediate temperature T21, the heat exchanger outlet temperature detected by the outdoor heat exchanger outlet temperature detector 336 of the stopped outdoor unit 330 is denoted by stopped heat exchanger outlet temperature T22, and the temperature detected before starting the cooling operation by the outdoor heat exchanger intermediate temperature detector 335 or the outdoor heat exchanger outlet temperature detector 336 in the outdoor unit 330 that is stopped at the time of the cooling operation is denoted by air temperature T23.

[Eq. 3]

$$\varepsilon = (T21 - T22) / (T21 - T23)$$

(3)

[0175] That is to say, in the embodiment 3, the calculation value ε is a ratio of a difference between the stopped heat exchanger intermediate temperature T21 and the stopped heat exchanger outlet temperature T22 to a difference between the stopped heat exchanger intermediate temperature T21 and the air temperature T23.

[0176] Fig. 16 is a flowchart indicating operation of the multiple-type air conditioner 300 of the embodiment 3.

[0177] First, the controller 350 refers to operating information stored in the memory (not shown) so as to check operation or stop of the first outdoor unit 330A, the second outdoor unit 330B, the first indoor unit 310A, the second indoor unit 310B, and the Xth indoor unit 310X (S50). Here, it is assumed that the first outdoor unit 330A is in an operating state and the second outdoor unit 330B is in a stopped state.

[0178] Next, the controller 350 detects the outside air temperature through the indoor heat exchanger intermediate temperature detector 335 or the outdoor heat exchanger outlet temperature detector 336 of an outdoor unit 330 (S51). Here, although any one of the detectors of the operating first outdoor unit 330A and the stopped second outdoor unit 330B can be used, it is favorable to use the detector of the stopped second outdoor unit 330B. If an outside air temperature detector (not shown) is added, an air temperature obtained from the outside air temperature detector can be used.

[0179] Next, the controller 350 makes the compressor 331 of the outdoor unit 330 in the operating state operate (S52). Here, the first compressor 331A of the first outdoor unit 330A in the operating state is operated. By operating the first compressor 331A, cooling operation is started.

[0180] Further, the controller 350 sets a predetermined initial value (for example, $\varepsilon = 0.8$) as the target value to be compared with the calculation value ε (S53).

[0181] Further, the controller 350 controls the indoor expansion valve 340 and the outdoor expansion valve 341 to have predetermined opening degrees (S54). In particular, the controller 350 controls the outdoor expansion valve 341 corresponding to the outdoor unit 330 in the operating state to have an opening degree appropriate to the load applied to the outdoor unit 330 in the operating state. Here, the controller 350 sets the opening degree of the first outdoor expansion valve 341A corresponding to the first outdoor unit 330A in the operating state to a predetermined value.

[0182] Next, the controller 350 obtains the heat exchanger intermediate temperatures and the heat exchanger outlet temperatures, from the outdoor heat exchanger intermediate temperature detector 335 and the outdoor heat exchanger outlet temperature detector 336 of the outdoor unit 330 in the operating state, and the outdoor heat exchanger intermediate temperature detector 335 and the outdoor heat exchanger outlet temperature detector 336 of the outdoor unit 330 in the stopped state (S55). For example, the controller 350 obtains the temperatures from the first outdoor heat exchanger intermediate temperature detector 335A, the second outdoor heat exchanger intermediate temperature detector 335B, the first outdoor heat exchanger outlet temperature detector 336A, and the second outdoor heat exchanger outlet temperature detector 336B.

[0183] Next, the controller 350 calculates the calculation value ε by using the air temperature obtained in step S51, and the heat exchanger intermediate temperature and the heat exchanger outlet temperature of the outdoor unit 330 in the stopped state among the temperatures obtained in step S55 (S55). Here, the heat exchanger intermediate temperature and the heat exchanger outlet temperature of the second outdoor unit 330B are used.

[0184] Next, the controller 350 judges whether the calculation value ε calculated in step S55 is less than or equal to the target value (S57). If the calculation value ε is greater than the target value (No in S57), the processing proceeds to step S58; or if the calculation value ε is less than or equal to the target value (Yes in S57), the processing proceeds to step S59.

[0185] In step S58, since the refrigerant stagnation amount is large in the outdoor unit 330 in the stopped state and there is a high possibility that the refrigerant becomes insufficient in the indoor unit 310 in the operating state, the controller 350 increases the opening degree of the outdoor expansion valve 341 corresponding to the outdoor unit 330

in the stopped state so as to open that outdoor expansion valve 341. Here, the controller 350 increases the opening degree of the second outdoor expansion valve 341B corresponding to the second outdoor unit 330B in the stopped state. Then, the processing returns to step S55.

[0186] In step S59, the controller 350 judges whether the calculation value ε calculated in step S56 is greater than or equal to the target value. If the calculation value ε is less than the target value (No in S59), the processing proceeds to step S60; or if the calculation value ε is greater than or equal to the target value (Yes in S59), the processing proceeds to step S61.

[0187] In step S60, since the refrigerant stagnation amount is small in the outdoor unit 330 in the stopped state, the refrigerant circulation amount is large, and there is a high possibility that the capacity shortage of the outdoor unit 310 in the operating state occurs, the controller 350 reduces the opening degree of the outdoor expansion valve 341 corresponding to the outdoor unit 330 in the stopped state so as to throttle that outdoor expansion valve 341. Here, the controller 350 reduces the opening degree of the second outdoor expansion valve 341B corresponding to the second outdoor unit 330B in the stopped state. Then, the processing returns to step S55.

[0188] In step S61, the controller 350 judges whether a temperature difference between the heat exchanger intermediate temperature and the heat exchanger outlet temperature of the outdoor unit 330 in the operating state among the temperatures obtained in step S55 is greater than or equal to "0", or whether the supercooling degree is greater than or equal to "0". Here, the controller 350 judges whether a temperature difference between the heat exchanger intermediate temperature and the heat exchanger outlet temperature of the first outdoor unit 330A in the operating state is greater than or equal to "0". If the temperature difference is greater than or equal to "0" (Yes in S61), the processing is ended, and the controller 350 continues the cooling operation. If the temperature difference is less than "0" (No in S61), the processing proceeds to step S62.

[0189] In step S62, the controller 350 changes the target value so that the supercooling degree of the outdoor unit 330 in the operating state may become greater than or equal to "0". Here, the controller 350 reduces the target value. For example, the controller 350 subtracts a predetermined value (for example, a value greater than "0" and less than or equal to "0.1") from the current target value. Then, the processing returns to step S55. By subtracting such a value, it is possible to perform the cooling operation without unnecessarily circulating the refrigerant in the outdoor unit 330 in the stopped state.

[0190] Since the multiple-type air conditioner 300 of the embodiment 3 is constructed as described above, it is possible, regardless of unit type and the number of connected units, to minimize the opening degree of the expansion valve as far as possible while allowing cooling operation without causing capacity shortage and refrigerant insufficiency of the operating indoor unit 310, by controlling, at the time of the cooling operation, the opening degree of the outdoor expansion valve 341 corresponding to the stopped outdoor unit 330 so that the calculation value ε calculated from the values of the temperature detectors 335, 336 provided in the stopped outdoor unit 330 may become the set target value.

[0191] Further, the multiple-type air conditioner 300 changes the target value so that a temperature difference (supercooling degree) between the heat exchanger intermediate temperature obtained from the outdoor heat exchanger intermediate temperature detector 335 of the operating outdoor unit 330 and the heat exchanger outlet temperature obtained from the outdoor heat exchanger outlet temperature detector 336 of that outdoor unit 330 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 300 controls the opening degree of the outdoor expansion valve 341 corresponding to the stopped outdoor unit 330 so that the changed target value may be achieved, thereby minimizing the expansion valve's opening degree regardless of unit type and the number of the outdoor units 310.

[0192] Further, the multiple-type air conditioner 300 changes the target value so that the temperature difference (supercooling degree) between the heat exchanger intermediate temperature obtained from the outdoor heat exchanger intermediate temperature detector 335 of the operating outdoor unit 330 and the heat exchanger outlet temperature obtained from the outdoor heat exchanger outlet temperature detector 336 of that outdoor unit 330 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 300 controls the opening degree of the outdoor expansion valve 341 corresponding to the stopped outdoor unit 330 so that the changed target value may be achieved, thereby preventing the operating outdoor unit 310 from falling into capacity shortage regardless of unit type and the number of the indoor units 210.

[0193] Further, the multiple-type air conditioner 300 changes the target value so that the temperature difference (supercooling degree) between the heat exchanger intermediate temperature obtained from the outdoor heat exchanger intermediate temperature detector 335 of the operating outdoor unit 330 and the heat exchanger outlet temperature obtained from the outdoor heat exchanger outlet temperature detector 336 of that outdoor unit 330 may become greater than or equal to 0 °C. Then, the multiple-type air conditioner 300 controls the opening degree of the outdoor expansion valve 341 corresponding to the stopped outdoor unit 330 so that the changed target value may be achieved, thereby ensuring that the refrigerant is a liquid refrigerant on the outlet side of the outdoor heat exchanger 334.

[0194] Further, by minimizing the expansion valve's opening degree as far as possible without causing capacity shortage and refrigerant insufficiency of the operating indoor unit 310, it is possible to make the outdoor heat exchanger 334 of the stopped outdoor unit 330 hold surplus refrigerant.

DESCRIPTION OF REFERENCE CHARACTERS

[0195] 100, 100#1, 100#2, 200, 200#1, 200#2, 300: multiple-type air conditioner; 110A, 210A, 310A: first indoor unit; 111A, 311A: first indoor heat exchanger; 112A: first heat exchanger intermediate temperature detector; 113A: first heat exchanger outlet temperature detector; 214A: first pressure detector; 110B, 210B, 310B: second indoor unit; 111B: second indoor heat exchanger; 112B: second heat exchanger intermediate temperature detector; 113B: second heat exchanger outlet temperature detector; 214B: second pressure detector; 310X: Xth indoor unit; 113X: Xth heat exchanger outlet temperature detector; 130, 130#1: outdoor unit; 131: compressor; 132: four-way valve; 133: liquid reservoir; 134: outdoor heat exchanger; 330A: first outdoor unit; 331A: first compressor; 332A: first four-way valve; 333A: first liquid reservoir; 334A: first outdoor heat exchanger; 335A: first outdoor heat exchanger intermediate temperature detector; 336A: first outdoor heat exchanger outlet temperature detector; 330B: second outdoor unit; 331B: second compressor; 332B: second four-way valve; 333B: second liquid reservoir; 334B: second outdoor heat exchanger; 335B: second outdoor heat exchanger intermediate temperature detector; 336B: second outdoor heat exchanger outlet temperature detector; 140A, 340A: first indoor expansion valve; 140B, 340B: second indoor expansion valve; 340X: Xth indoor expansion valve; 140C: auxiliary expansion valve; and 150, 250, 350: controller.

Claims

1. A multiple-type air conditioner comprising:

a first device that includes a first heat exchanger;
 a first detector to detect a temperature of a refrigerant in the first heat exchanger;
 a second detector to detect a temperature of the refrigerant flowing out of the first heat exchanger;
 a third detector to detect an air temperature outside the first device;
 an expansion valve for the refrigerant in the first device;
 a second device that includes a second heat exchanger, and operates and stops separately from the first device;
 and
 a control unit to increase an opening degree of the expansion valve if a ratio of a difference between the temperature detected by the first detector and the temperature detected by the second detector to a difference between the temperature detected by the first detector and the air temperature detected by the third detector is greater than a target value, and to reduce the opening degree of the expansion valve if the ratio is less than the target value, when the first device is stopped and the second device is operating with the second heat exchanger functioning as a condenser.

2. The multiple-type air conditioner of Claim 1, wherein
 the target value is a value determined so that a supercooling degree in the second device becomes greater than or equal to 0.

3. The multiple-type air conditioner of Claim 1 or 2, further comprising:

a fourth detector to detect a temperature of the refrigerant in the second heat exchanger; and
 a fifth detector to detect a temperature of the refrigerant flowing out of the second heat exchanger; wherein
 the control unit reduces the target value when a value obtained by subtracting the temperature detected by the fifth detector from the temperature detected by the fourth detector is less than 0.

4. The multiple-type air conditioner of any one of Claims 1 - 3, wherein
 the first detector is attached to a part of a path from an inlet to an outlet of the first heat exchanger for the refrigerant, and detects a temperature of the refrigerant passing the part to which the first detector is attached.

5. The multiple-type air conditioner of Claim 4, wherein
 in a case where there are a plurality of the paths, the first detector is attached to a path having a part in which the refrigerant flows in a direction against gravity.

6. The multiple-type air conditioner of any one of Claims 1 - 5, wherein
 the control unit makes the first detector or the second detector function as the third detector, by using as the air temperature, the temperature detected before starting operation of the second device by the first detector or the second detector.

7. A multiple-type air conditioner comprising:

a compressor;
 a first device that includes a first heat exchanger;
 a first expansion valve for a refrigerant in the first device;
 a first detector to detect a pressure of the refrigerant between the compressor and the first expansion valve;
 a second detector to detect a temperature of the refrigerant flowing out of the first heat exchanger;
 a third detector to detect an air temperature outside the first device;
 a second device that includes a second heat exchanger, and operates and stops separately from the first device;
 and
 a control unit to increase an opening degree of the first expansion valve if a ratio of a difference between a saturated liquid temperature corresponding to the pressure detected by the first detector and the temperature detected by the second detector to a difference between the saturated liquid temperature and the air temperature detected by the third detector is greater than a target value, and to reduce the opening degree of the first expansion valve if the ratio is less than the target value, when the first device is stopped and the second device is operating with the second heat exchanger functioning as a condenser.

8. The multiple-type air conditioner of Claim 7, wherein
 the target value is a value determined so that a supercooling degree in the second device becomes greater than or equal to 0.

9. The multiple-type air conditioner of Claim 7 or 8, further comprising:

a fourth detector to detect a pressure of the refrigerant between the compressor and the second expansion valve; and
 a fifth detector to detect a temperature of the refrigerant flowing out of the second heat exchanger; wherein
 the control unit reduces the target value when a value obtained by subtracting the temperature detected by the fifth detector from a saturated liquid temperature corresponding to the pressure detected by the fourth detector is less than 0.

10. A multiple-type air conditioner of any one of Claims 7 - 9, wherein
 the control unit makes the second detector function as the third detector, by using as the air temperature the temperature detected before starting operation of the second device by the second detector.

FIG. 1

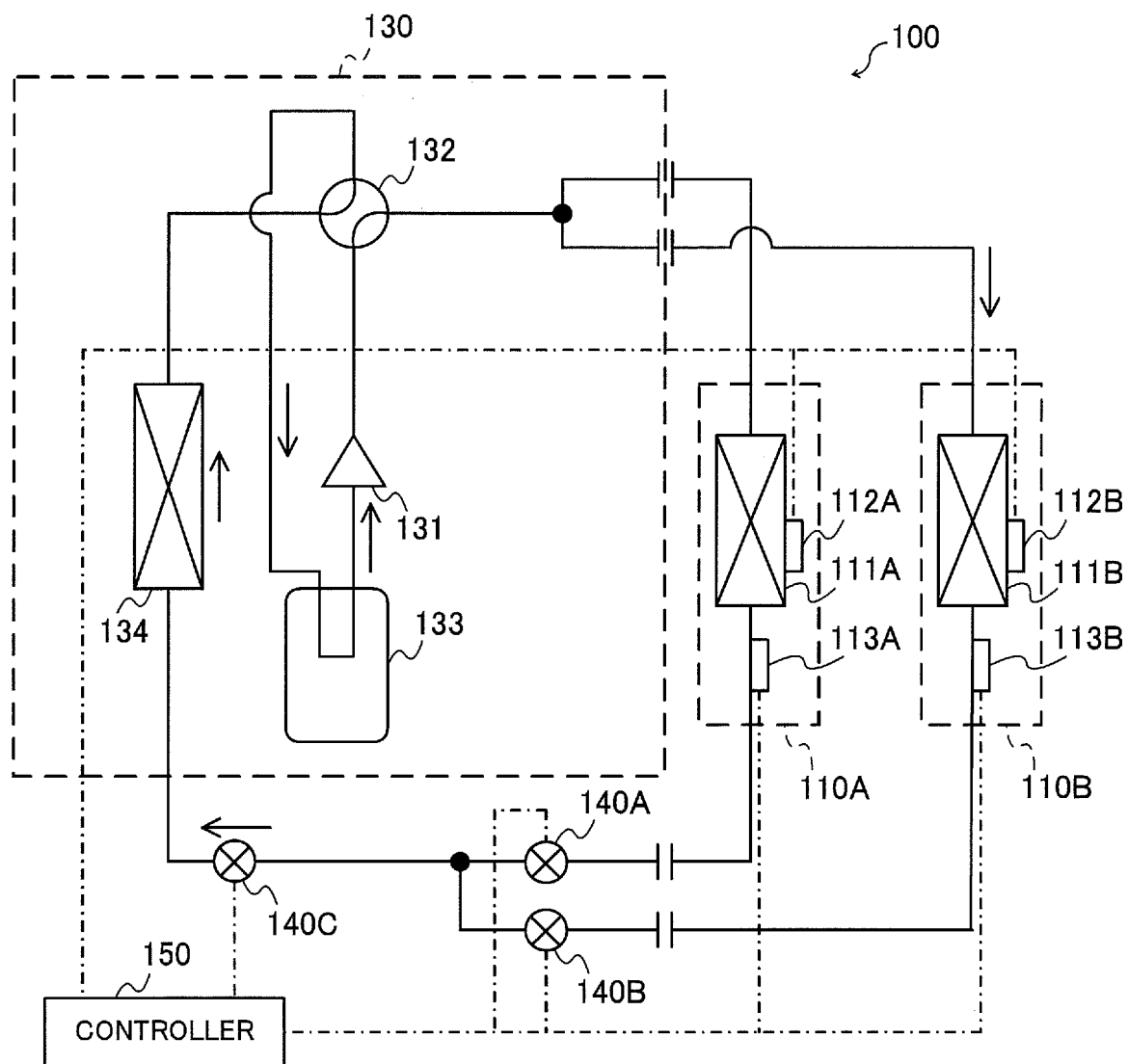


FIG. 2

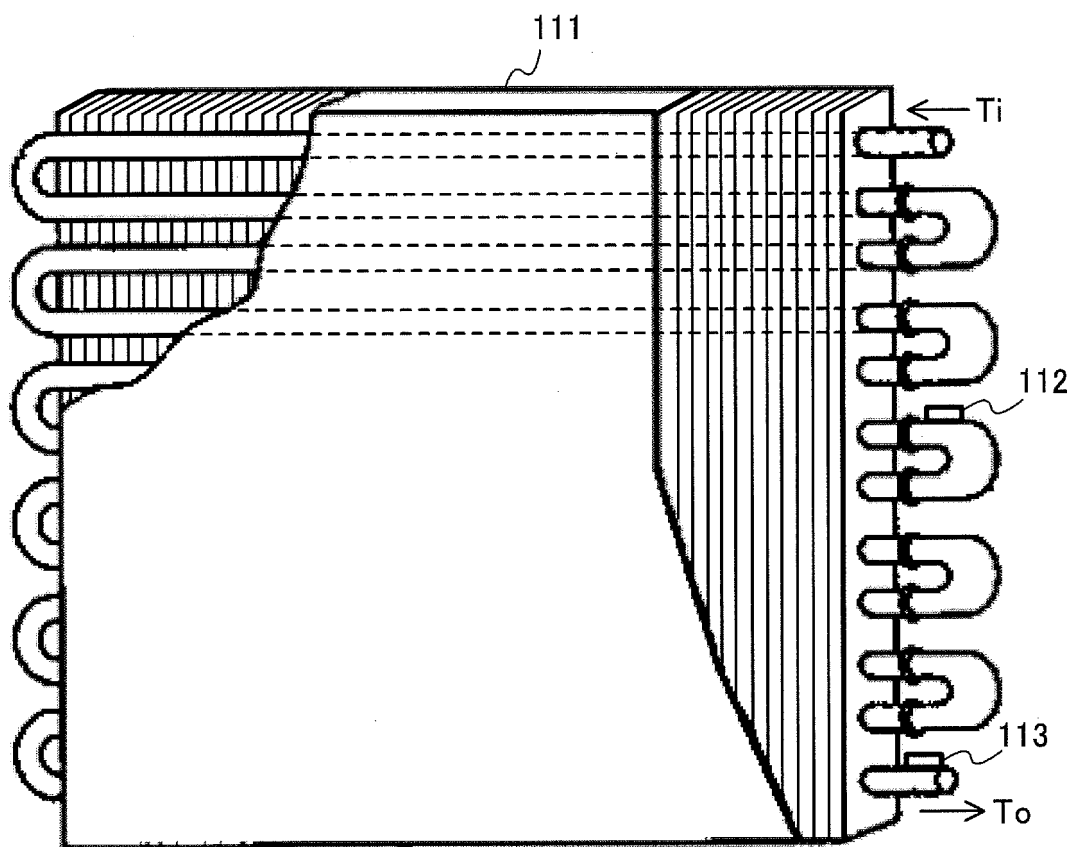


FIG. 3

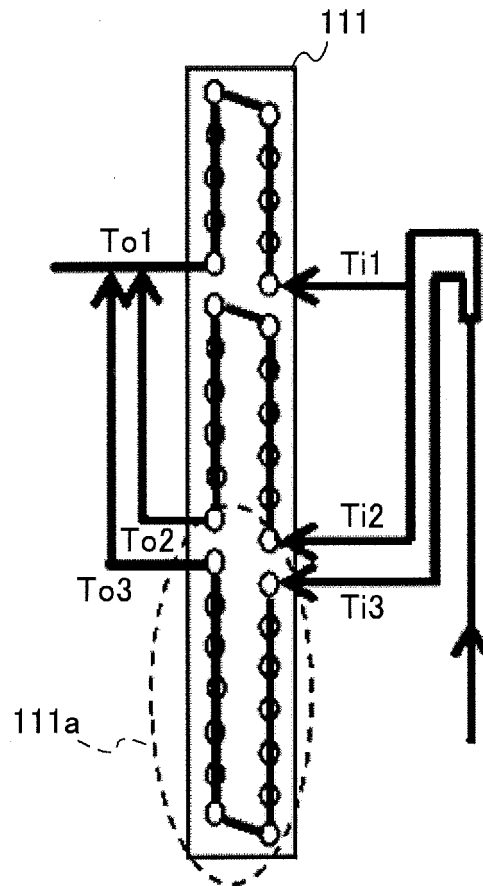


FIG. 4

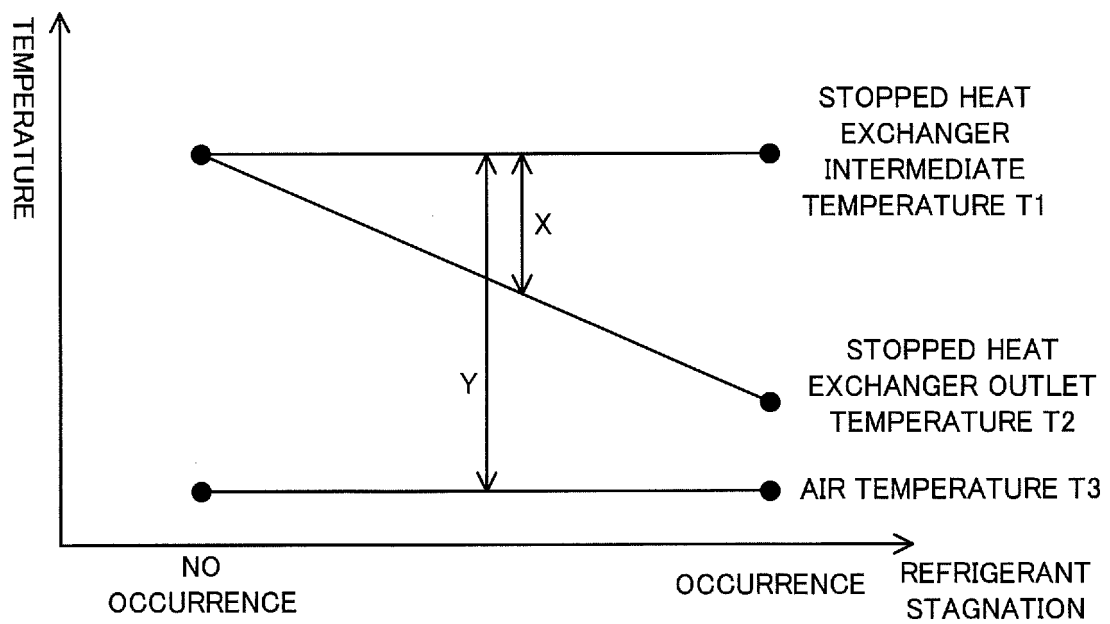


FIG. 5

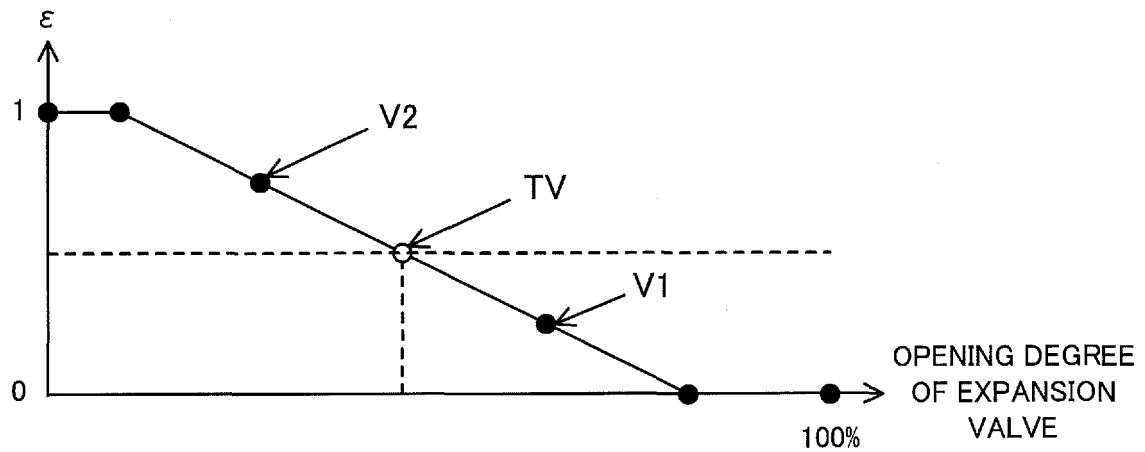


FIG. 6

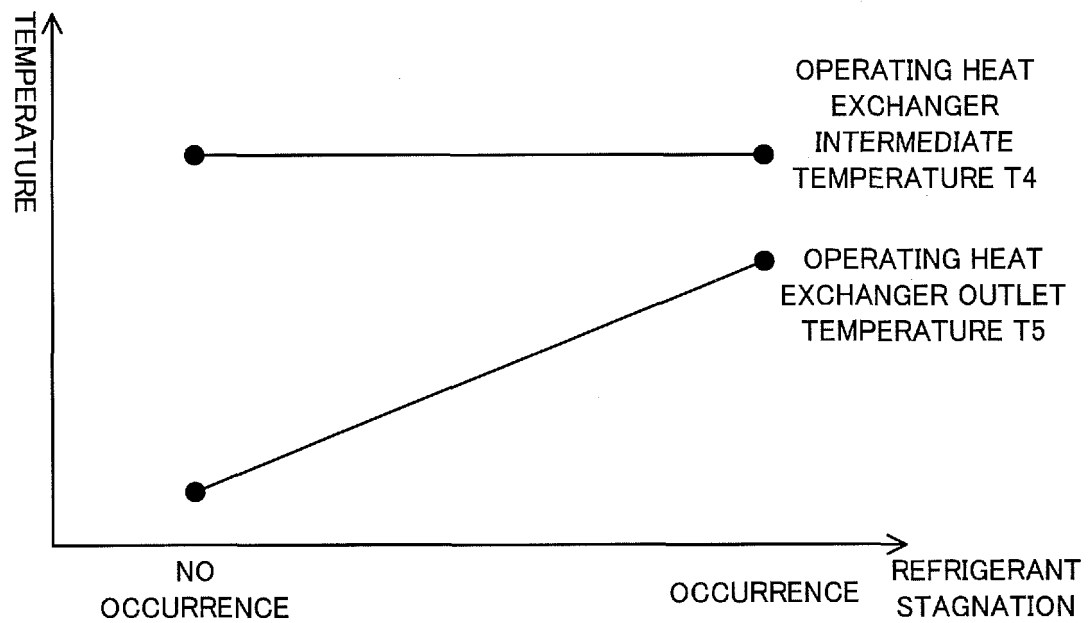


FIG. 7.

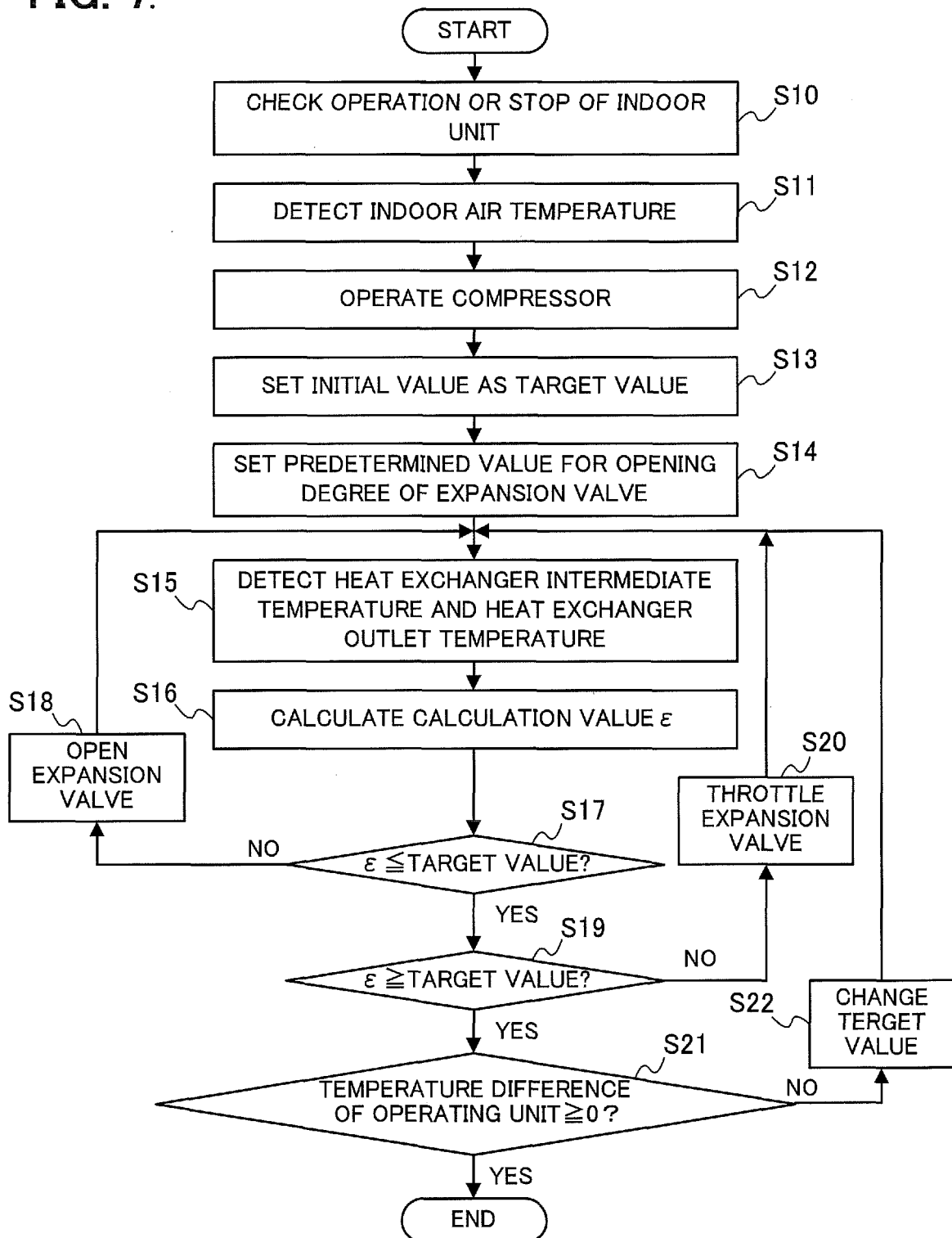


FIG. 8(A)

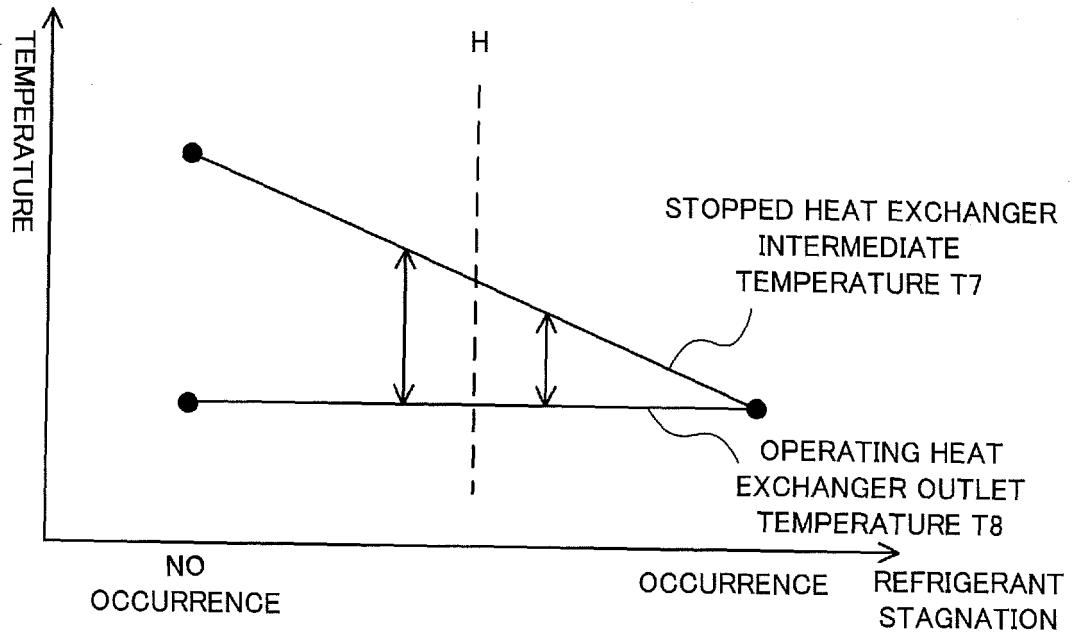


FIG. 8(B)

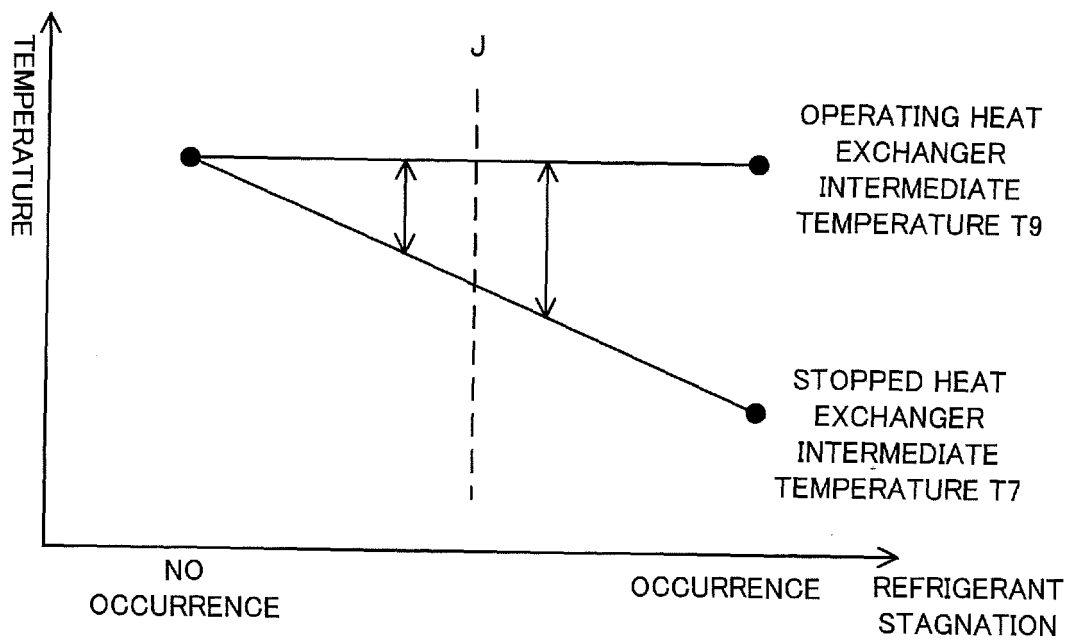


FIG. 9

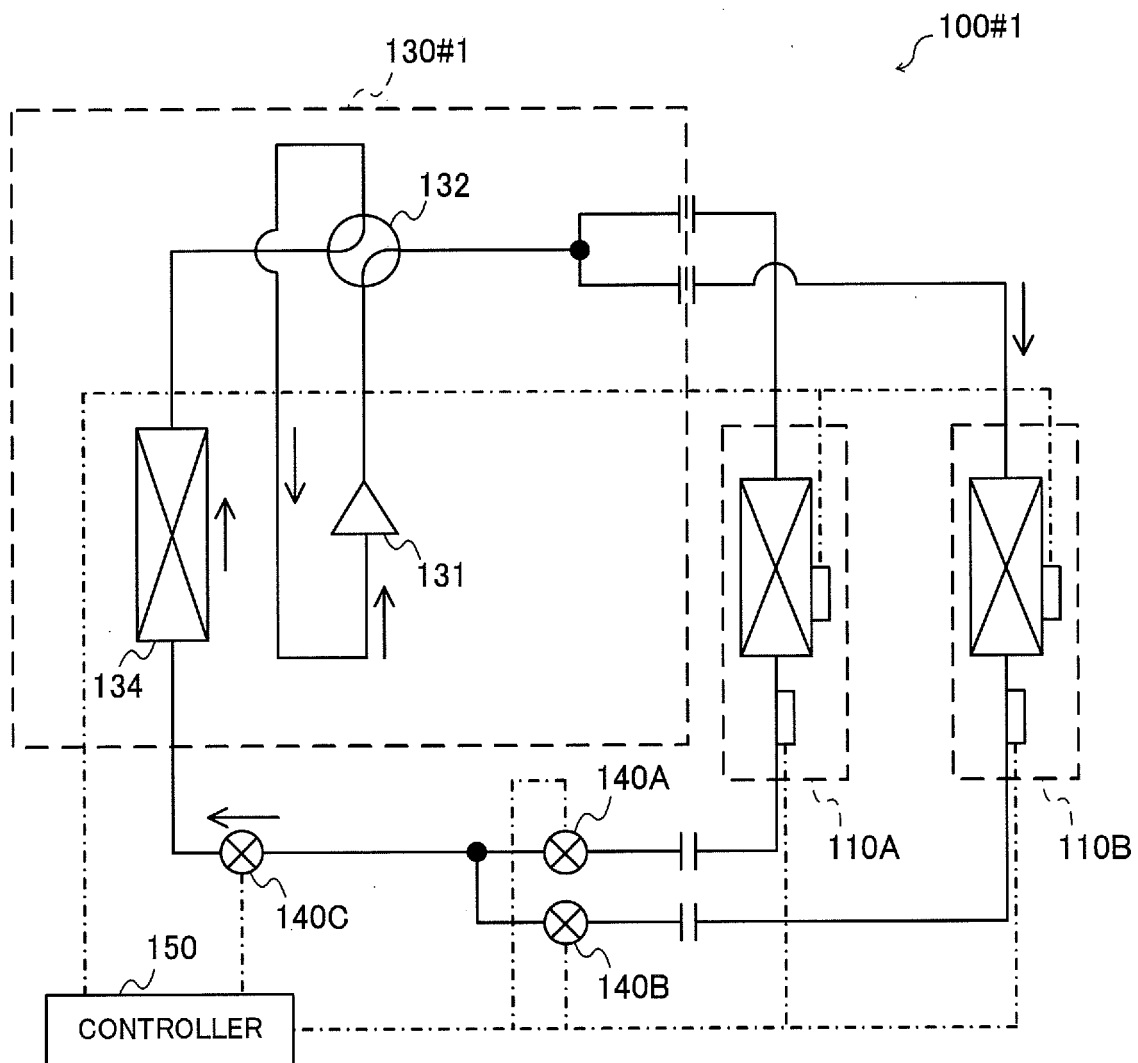


FIG. 10

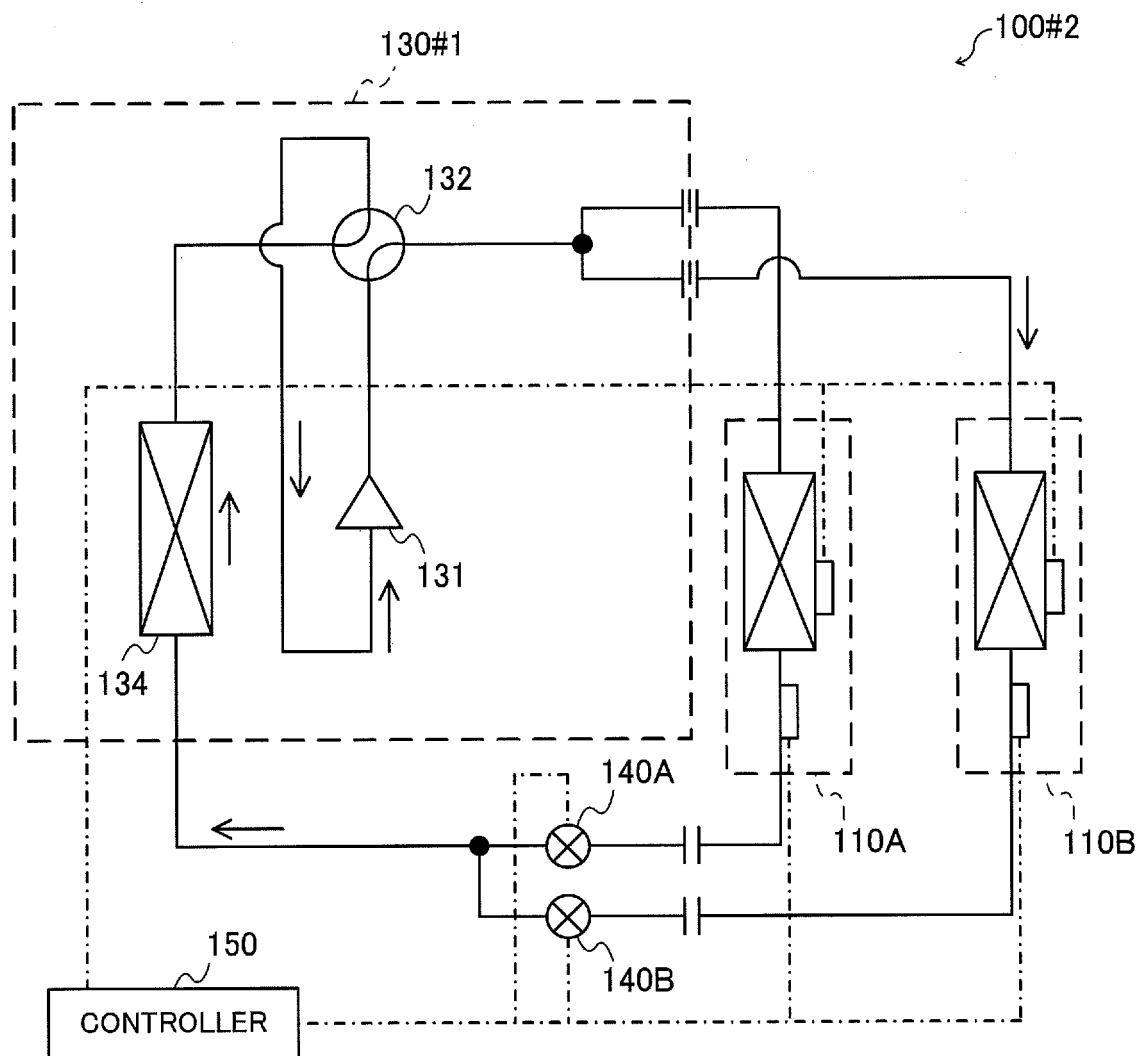


FIG. 11

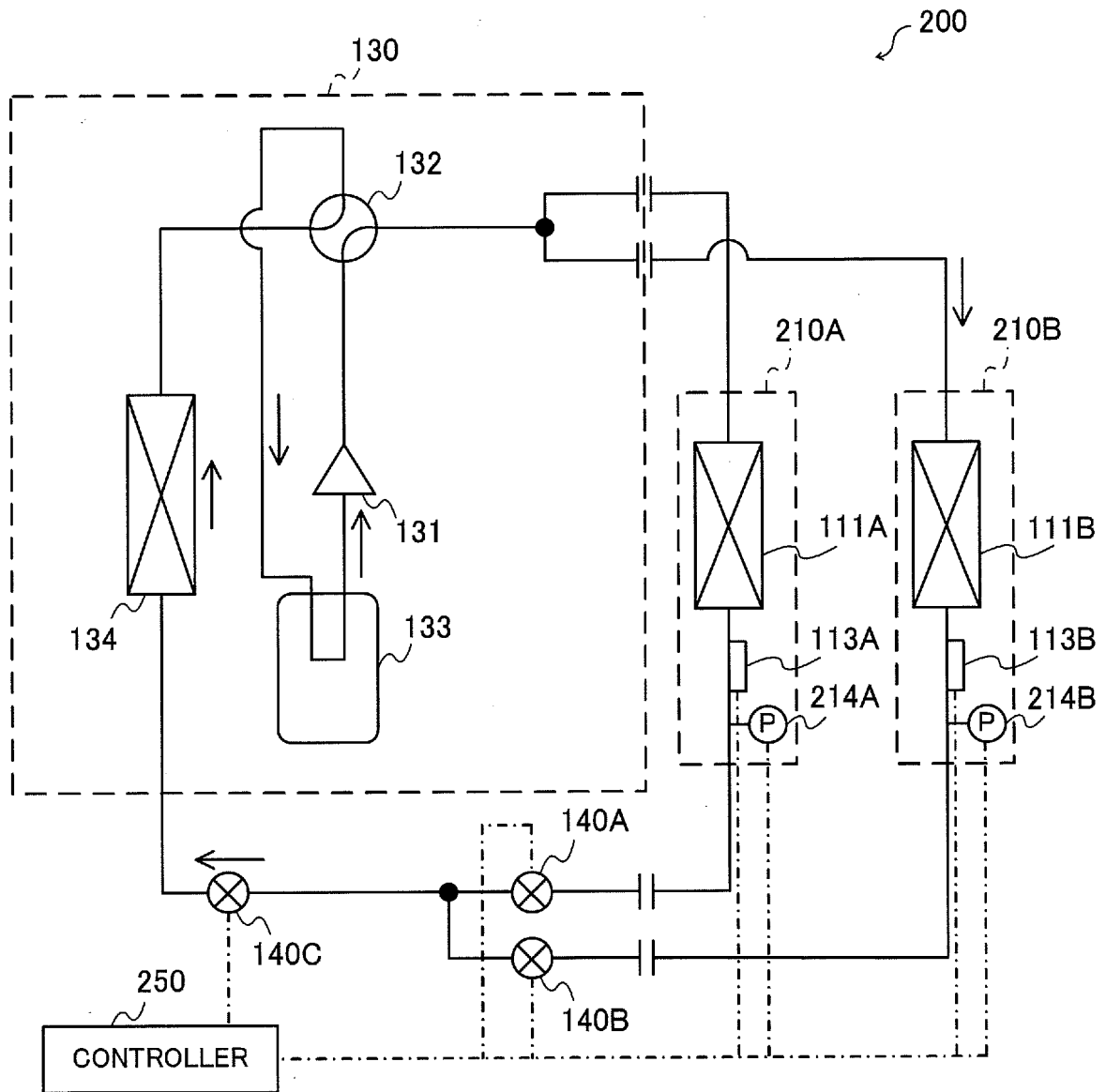


FIG. 12

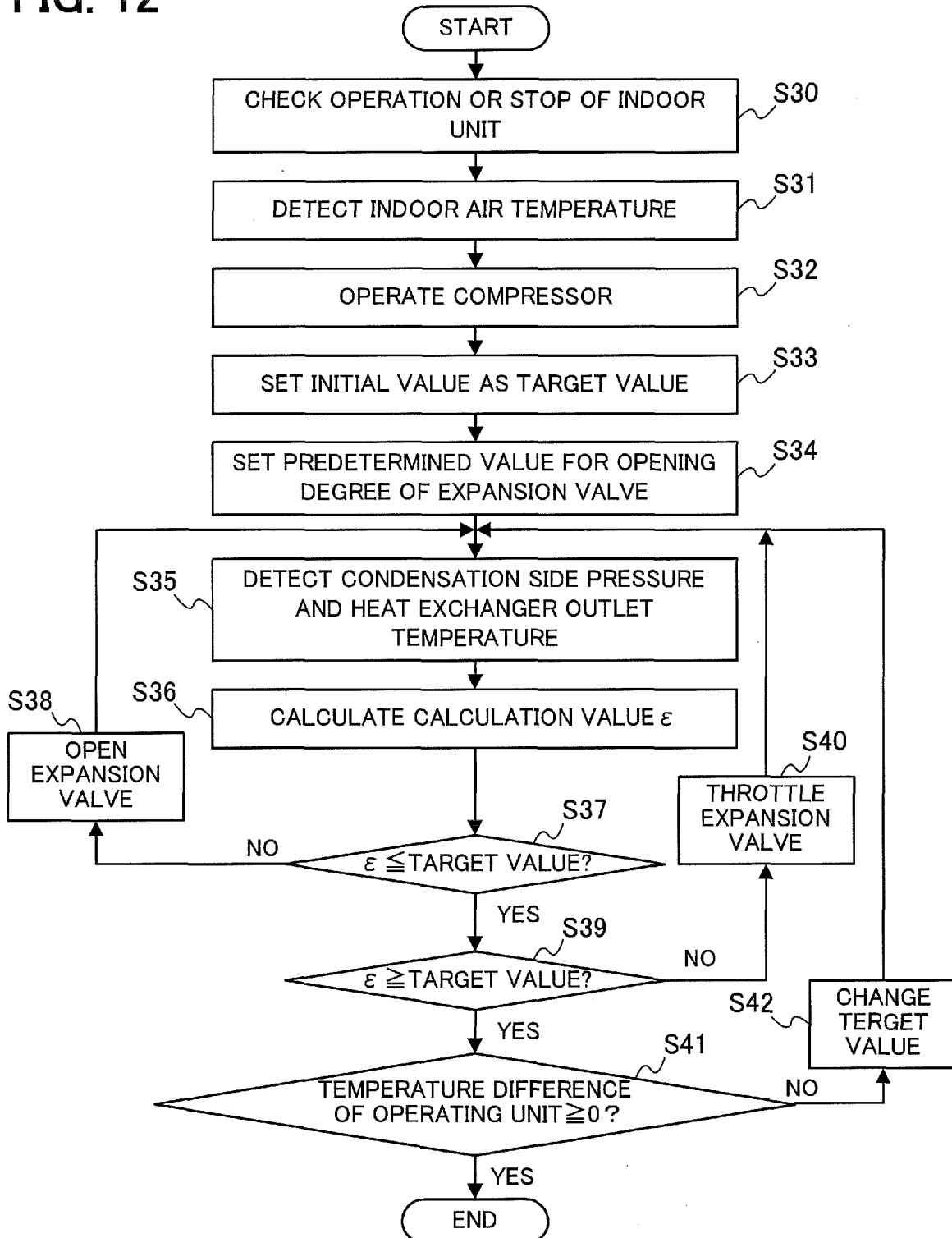


FIG. 13

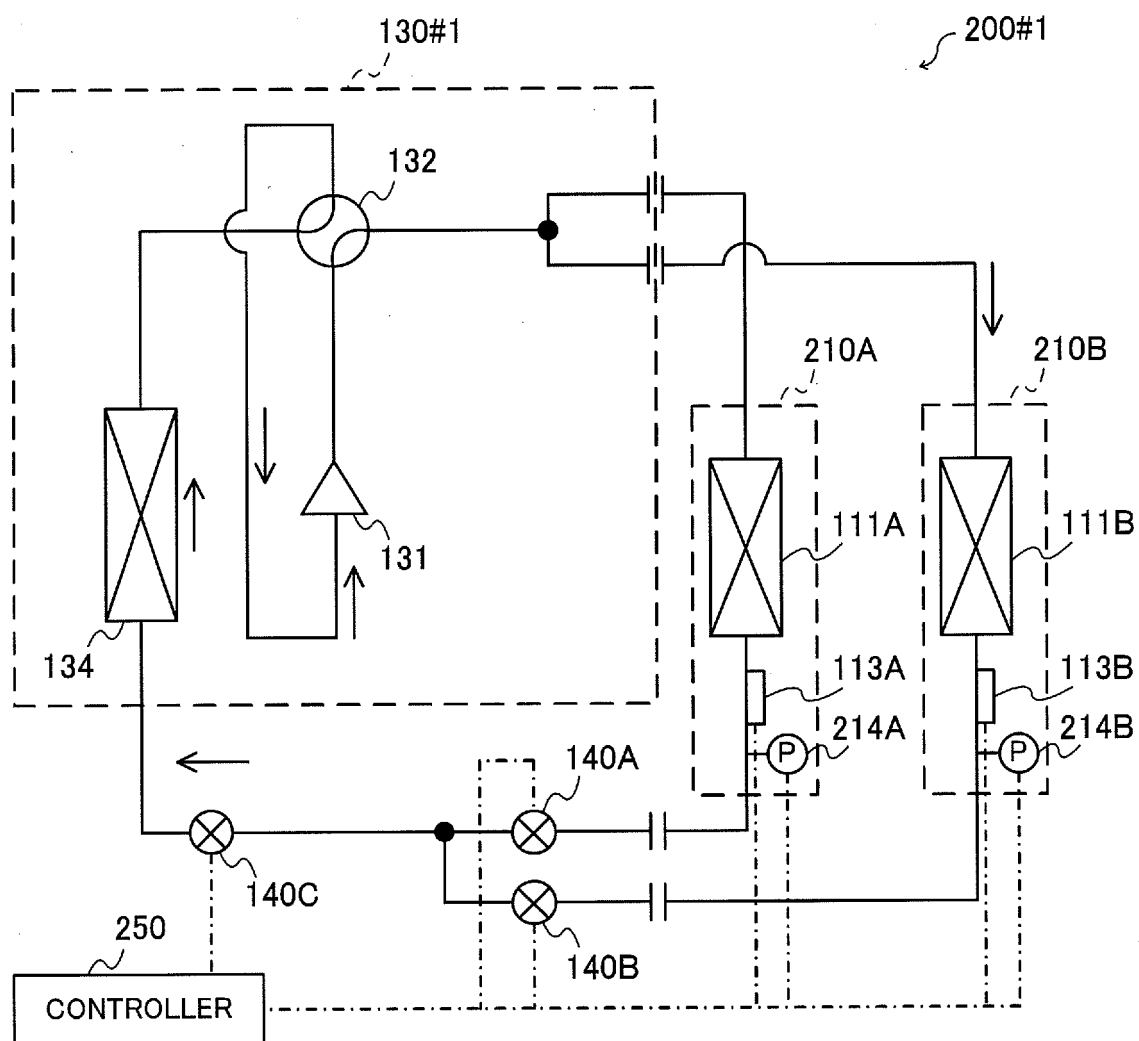


FIG. 14

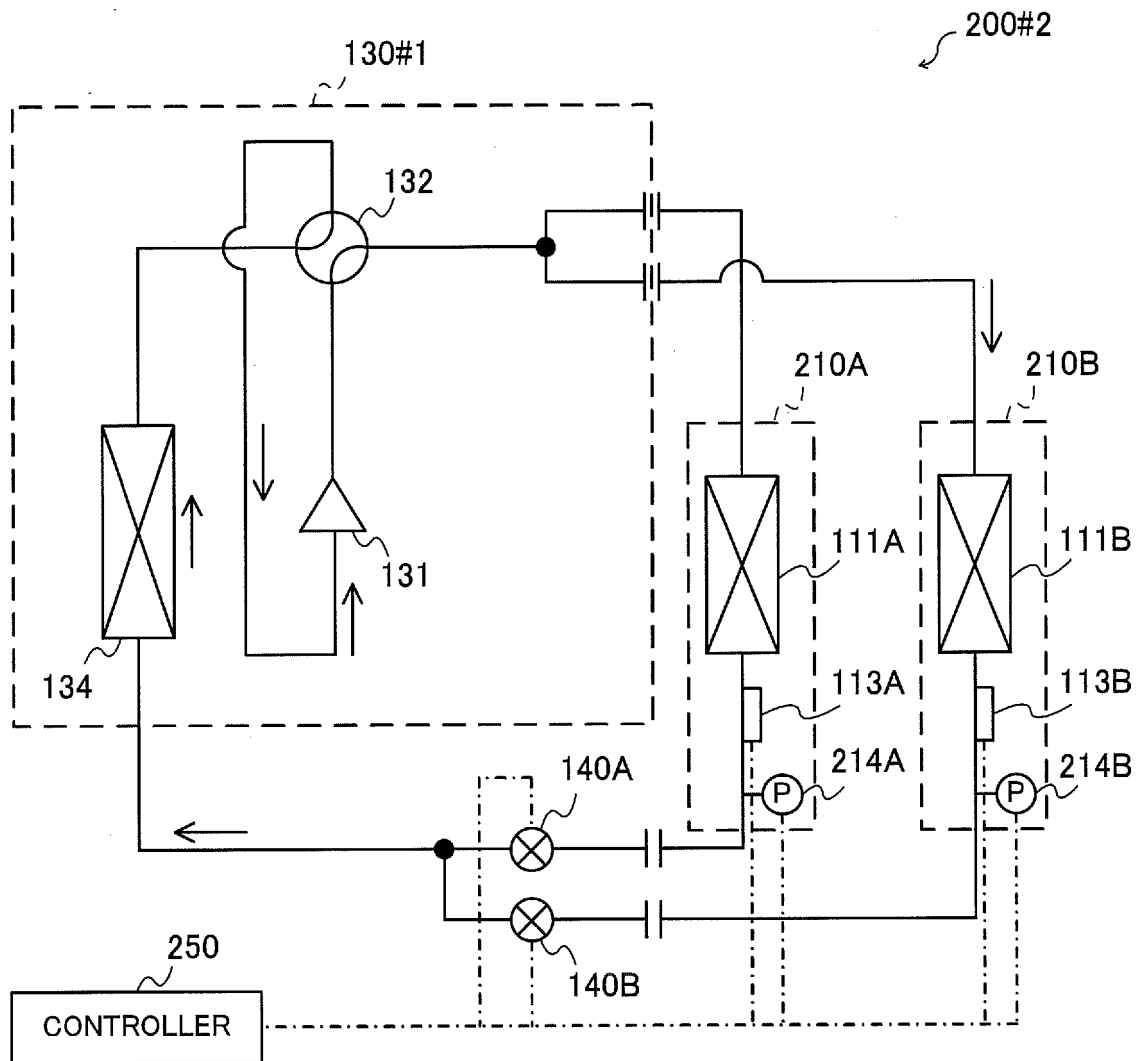


FIG. 15

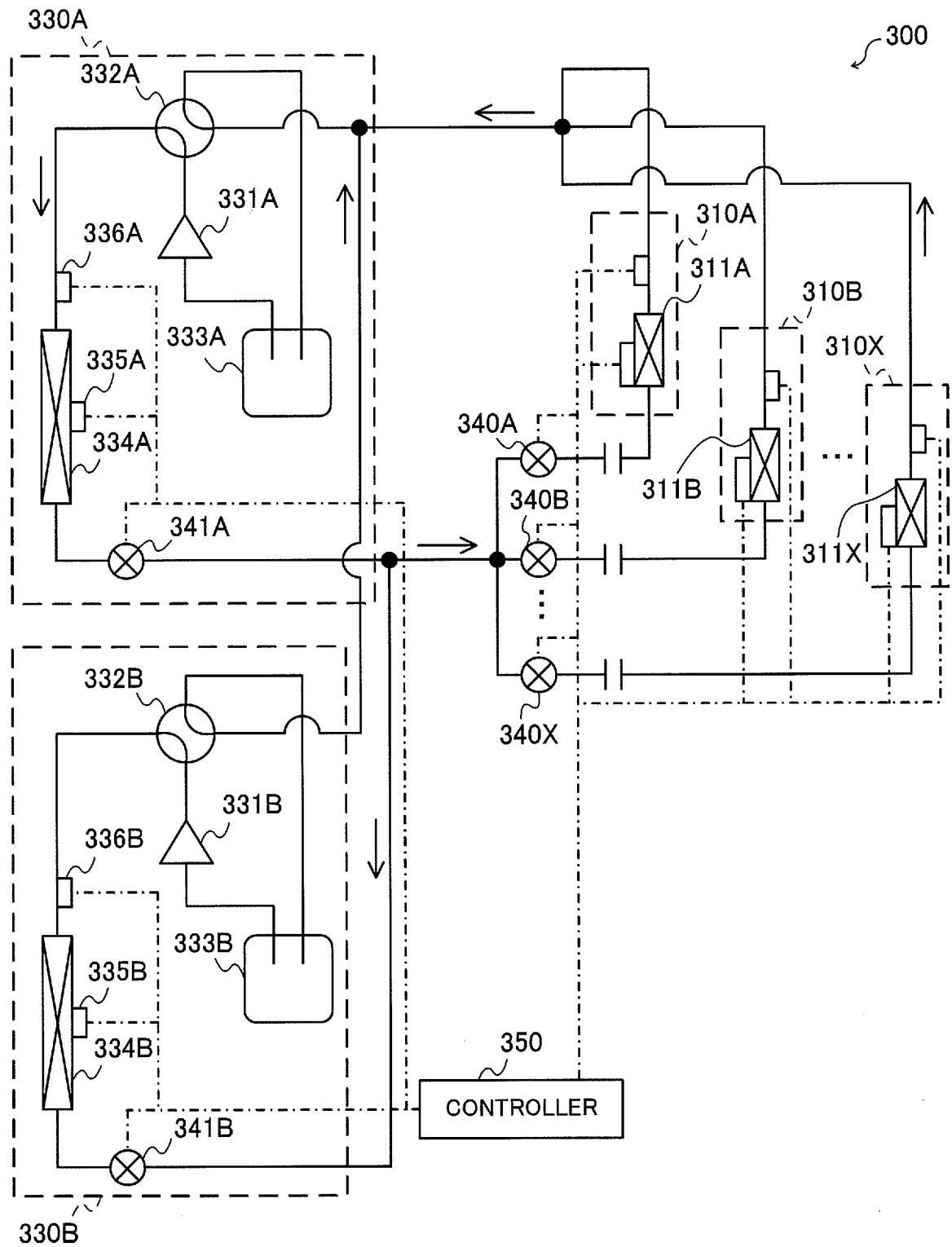
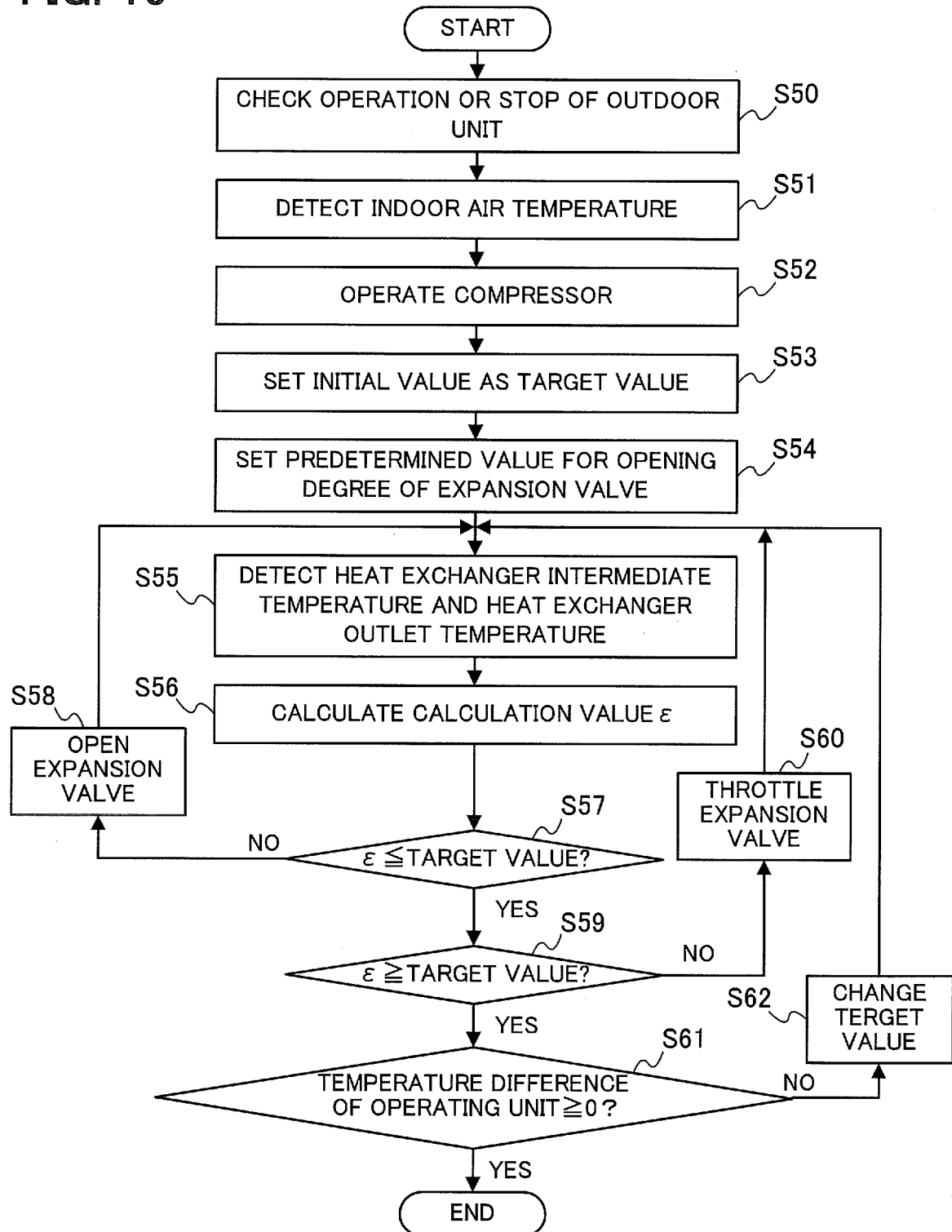


FIG. 16



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/072935

A. CLASSIFICATION OF SUBJECT MATTER

F25B1/00(2006.01)i, F24F11/02(2006.01)i, F25B6/02(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B1/00, F24F11/02, F25B6/02

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 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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.
A	JP 7-158989 A (Daikin Industries, Ltd.), 20 June 1995 (20.06.1995), entire text; all drawings (Family: none)	1-10
A	JP 2005-207722 A (LG Electronics Inc.), 04 August 2005 (04.08.2005), entire text; all drawings & US 2005/0155368 A1 & EP 1555492 A2 & KR 10-2005-0076080 A & CN 1645007 A	1-10
A	JP 2004-60956 A (Sanyo Electric Co., Ltd.), 26 February 2004 (26.02.2004), entire text; all drawings (Family: none)	1-10

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
17 October 2016 (17.10.16)Date of mailing of the international search report
25 October 2016 (25.10.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H07158989 B [0003]