

(19)



(11)

EP 1 635 129 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
21.11.2018 Bulletin 2018/47

(51) Int Cl.:
F25B 13/00 ^(2006.01)

(21) Application number: **05019588.2**

(22) Date of filing: **08.09.2005**

(54) **Air conditioner**

Klimaanlage

Climatiseur

(84) Designated Contracting States:
DE ES GB

(30) Priority: **08.09.2004 JP 2004260403**

(43) Date of publication of application:
15.03.2006 Bulletin 2006/11

(73) Proprietor: **Hitachi-Johnson Controls Air
Conditioning, Inc.
Tokyo 105-0022 (JP)**

(72) Inventors:
• **Ishigami, Tatsuya,
c/o Shimizu Works
Shimizu-ku,
Shizuoka-shi,
Shizuoka (JP)**

- **Yoshida, Yasutaka,
c/o Shimizu Works
Shimizu-ku,
Shizuoka-shi,
Shizuoka (JP)**
- **Yamada, Noriyoshi,
c/o Shimizu Works
Shimizu-ku,
Shizuoka-shi,
Shizuoka (JP)**

(74) Representative: **MERH-IP Matias Erny Reichl
Hoffmann
Patentanwälte PartG mbB
Paul-Heyse-Strasse 29
80336 München (DE)**

(56) References cited:
**EP-A1- 1 394 476 EP-A2- 1 443 287
GB-A- 2 261 964 JP-A- H0 526 532
JP-A- H0 599 525 US-A- 5 009 077**

EP 1 635 129 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

Background of the Invention

5 **[0001]** The present invention relates to an air conditioner including a first interior heat exchanger for heating an air with a refrigerant, a second interior heat exchanger for cooling the air with the refrigerant, and an exterior heat exchanger for required one of taking a heat energy into the refrigerant and radiating the heat energy from the refrigerant as occasion demands.

10 **[0002]** In a prior art air conditioner as disclosed by JP-A-2003-130492, a gaseous refrigerant pressurized by a compressor is fed to an interior heat exchanger for heating a room air so that the gaseous refrigerant is condensed to change to a liquid refrigerant, and a gaseous refrigerant pressurized by another compressor is fed to an exterior heat exchanger to be condensed and subsequently fed to another interior heat exchanger for cooling the room air so that the refrigerant condensed to be liquefied by the exterior heat exchanger is evaporated in the another interior heat exchanger.

15 **[0003]** In another prior art air conditioner as disclosed by EP1394476 A1 in which heating and cooling operations are performed at the same time, a number of connection pipes connecting an outdoor unit A and a distributor B is simplified to three to flow a specific pressure and phase refrigerant through each connection pipe regardless of operation condition. The air conditioner includes the outdoor unit A installed at an outdoor location, and having therein a compressor and an outdoor heat exchanger, a plurality of indoor units C respectively installed at indoor rooms, each of the indoor units C having therein an electronic expansion valve and an indoor heat exchanger, the distributor B provided between the outdoor unit A and the plurality of indoor units C, for selectively guiding a refrigerant introduced from the outdoor unit A to the plurality of indoor units C according to an operation condition, a four-way valve provided on an outlet side of the compressor, for selectively switching a flow direction of the refrigerant flowing through the outdoor heat exchanger, a first connection pipe branched from a pipe connecting an inlet side of the compressor with the four-way valve, for connecting the distributor B to guide the refrigerant, a second connection pipe for connecting the outdoor heat exchanger with the distributor B to guide the refrigerant, and a selective expansion apparatus provided on the third connection pipe and including a heating electronic expansion unit for selectively expanding the refrigerant

Brief Summary of the Invention

30 **[0004]** An object of the present invention is to provide an air conditioner by which an operating efficiency is improved with preventing or restraining an excessive cooling capacity or performance of the first interior heat exchanger and an insufficient heating capacity or performance of the second interior heat exchanger when a temperature of an exterior air is deemed to be not more than a predetermined temperature to cause an excessive heating performance for the exterior air of the exterior heat exchanger with decreasing the heating capacity or performance of the second interior heat exchanger.

35 **[0005]** According to the invention defined in claim 1, in an air conditioner comprising, an exterior heat exchanger capable of performing a heat exchange between a refrigerant and an exterior air and including an adjustable valve whose opening area (for passing the refrigerant through the adjustable valve) is variable so that the adjustable valve is usable as desired (or selected) one of an expansion valve for the refrigerant to use the exterior heat exchanger as an evaporator and a passage for the refrigerant to use the exterior heat exchanger as a condenser, a first interior heat exchanger capable of performing a heat exchange between the refrigerant and an interior air to be cooled (in such a manner that a difference between an actual temperature of the interior air to be cooled and a desirable temperature of the interior air to be cooled is automatically or manually decreased, minimized or kept within a desirable range, with a change of a rate of heat exchange energy amount for cooling with respect to a time proceeding, that is, a change of the heat exchange energy amount for cooling per every unit time in accordance with the difference between the actual temperature of the interior air to be cooled and the desirable temperature of the interior air to be cooled so that the greater the difference between the actual temperature of the interior air to be cooled and the desirable temperature of the interior air to be cooled is, the greater the rate of heat exchange energy amount for cooling with respect to the time proceeding or the heat exchange energy amount for cooling per every unit time is) and including another expansion valve for the refrigerant enabling the first interior heat exchanger to be used as another evaporator, a second interior heat exchanger capable of performing as another condenser a heat exchange between the refrigerant and an interior air to be heated (in such a manner that a difference between an actual temperature of the interior air to be heated and a desirable temperature of the interior air to be heated is automatically or manually decreased, minimized or kept within a desirable range, with a change of the rate of heat exchange energy amount for heating with respect to the time proceeding, that is, a change of the heat exchange energy amount for heating per every unit time in accordance with the difference between the actual temperature of the interior air to be heated and the desirable temperature of the interior air to be heated so that the greater the difference between the actual temperature of the interior air to be heated and the desirable temperature of the interior air to be heated is, the greater the rate of heat exchange energy amount for heating with respect to the time

proceeding or the heat exchange energy amount for heating per every unit time is), and a compressor for pressurizing the refrigerant,

since a valve means is capable of changing a flow course of the refrigerant between a cooling main course in which the pressurized refrigerant discharged from the compressor flows into each of the second interior heat exchanger (as the another condenser) and the exterior heat exchanger including the adjustable valve used as the passage to use the exterior heat exchanger as the condenser, subsequently the condensed refrigerant discharged from each of the second interior heat exchanger and the exterior heat exchanger flows into the first interior heat exchanger (as the another evaporator), and finally the evaporated refrigerant discharged from the first interior heat exchanger returns to the compressor, and a heating main course in which the pressurized refrigerant discharged from the compressor flows into the second interior heat exchanger (as the another condenser), subsequently the condensed refrigerant discharged from the second interior heat exchanger flows into each of the first interior heat exchanger (as the another evaporator) and the exterior heat exchanger including the adjustable valve used as the expansion valve to use the exterior heat exchanger as the evaporator, and finally the evaporated refrigerant discharged from each of the first interior heat exchanger and the exterior heat exchanger returns to the compressor, and the valve means changes the flow course of the refrigerant from the cooling main course to the heating main course when a temperature of the exterior air is not more than a predetermined temperature, and a difference in absolute value between a desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger and a desirable amount in absolute value of thermal energy per unit time to be exchanged by the second interior heat exchanger is not more than a predetermined value,

an operating efficiency is improved when a temperature of an exterior air is deemed to be not more than a predetermined temperature causing an excessive cooling capacity of the first interior heat exchanger.

[0006] The below mentioned various controls does not need necessarily to be performed with calculation in the absolute values(s), and may be performed when the physical conditions or situations defined with using the absolute values(s) are actually satisfied or fulfilled, irrespective of whether or not the calculation in the absolute values(s) is performed. That is, the absolute values(s) is used to definitely clarify the physical conditions or situations on which the control is performed, but is not used to restrict the scopes of the below mentioned various controls to respective calculating manners with using the absolute values(s).

[0007] It is preferable for improving an operating efficiency of the air conditioner with preventing or restraining an excessive cooling capacity or performance of the first interior heat exchanger and an insufficient heating capacity or performance of the second interior heat exchanger that the valve means changes the flow course of the refrigerant from the cooling main course to the heating main course

when a difference in absolute value between a desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger and a desirable amount in absolute value of heat energy per unit time to be exchanged by the second interior heat exchanger is not more than a predetermined value,

and a difference in absolute value between an amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger and an amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger is more than a predetermined reference value.

[0008] It is preferable for easily and appropriately estimating the desirable amount in absolute value of thermal energy per unit time to be exchanged by each of the first and second interior heat exchangers that a difference in absolute value between an actual temperature of the interior air to be cooled by the first interior heat exchanger and a desirable temperature of the interior air to be cooled by the first interior heat exchanger lower than the actual temperature of the interior air to be cooled by the first interior heat exchanger is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger, and a difference in absolute value between a desirable temperature of the interior air to be heated by the second interior heat exchanger and an actual temperature of the interior air to be heated by the second interior heat exchanger lower than the desirable temperature of the interior air to be heated by the second interior heat exchanger is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the second interior heat exchanger.

[0009] It is preferable for easily and appropriately estimating the desirable amount in absolute value of thermal energy per unit time to be exchanged by each of the first and second interior heat exchangers that a product of a flow rate of the interior air flowing through the first interior heat exchanger and a difference in absolute value between an actual temperature of the interior air to be cooled by the first interior heat exchanger and a desirable temperature of the interior air to be cooled by the first interior heat exchanger lower than the actual temperature of the interior air to be cooled by the first interior heat exchanger is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger, and a product of a flow rate of the interior air flowing through the second interior heat exchanger and a difference in absolute value between an actual temperature of the interior air to be heated by the second interior heat exchanger and a desirable temperature of the interior air to be heated by the second interior heat exchanger higher than the actual temperature of the interior air to be heated by the second

interior heat exchanger is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the second interior heat exchanger.

[0010] When at least one of the first and second interior heat exchangers has a plurality of interior sub-heat exchangers connected fluidly in parallel to each other, the desirable amount in absolute value of thermal energy per unit time to be exchanged by the at least one of the first and second interior heat exchangers is a total amount of desirable amounts in absolute value of thermal energy per unit time to be exchanged by the interior sub-heat exchangers respectively.

[0011] For easily and appropriately judging the condition or situation on which the control of the air conditioner is performed, it is deemed when a difference in absolute value in temperature between the interior air to be taken into the first interior heat exchanger and the interior air discharged from the first interior heat exchanger is more than a first reference degree and a difference in absolute value in temperature between the interior air to be taken into the second interior heat exchanger and the interior air discharged from the second interior heat exchanger is less than a second reference degree, that the difference in absolute value between the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger and the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger is more than the predetermined reference value.

[0012] For easily and appropriately judging the condition or situation on which the control of the air conditioner is performed, it is deemed when a pressure of the refrigerant evaporated by the first interior heat exchanger is less than a first comparison value and a pressure of the refrigerant condensed by the second interior heat exchanger is less than a second comparison value, that the difference in absolute value between the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger and the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger is more than the predetermined reference value.

[0013] For easily and appropriately judging the condition or situation on which the control of the air conditioner is performed, it is deemed when a difference in absolute value in temperature between the interior air to be taken into the first interior heat exchanger and the interior air discharged from the first interior heat exchanger / a difference in absolute value in temperature between the interior air to be taken into the second interior heat exchanger and the interior air discharged from the second interior heat exchanger is more than a reference degree, that the difference in absolute value between the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger and the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger is more than the predetermined reference value.

[0014] For correctly and easily detecting the excessive cooling performance of the first interior heat exchanger, it is preferable that when the first interior heat exchanger has a plurality of first interior sub-heat exchangers connected fluidly in parallel to each other, the difference in absolute value in temperature between the interior air to be taken into the first interior heat exchanger and the interior air discharged from the first interior heat exchanger is the smallest one of differences in absolute value in temperature between the interior airs to be taken into the respective first interior sub-heat exchangers and the interior airs discharged from the respective first interior sub-heat exchangers.

[0015] For correctly and easily detecting the insufficient heating performance of the second interior heat exchanger, it is preferable that when the second interior heat exchanger has a plurality of second interior sub-heat exchangers connected in parallel to each other, and the difference in absolute value in temperature between the interior air to be taken into the second interior heat exchanger and the interior air discharged from the second interior heat exchanger is the greatest one of differences in absolute value in temperature between the interior airs to be taken into the respective second interior sub-heat exchangers and the interior airs discharged from the respective second interior sub-heat exchangers.

[0016] It is preferable for easily and appropriately estimating the amount in absolute value of thermal energy per unit time actually exchanged by each of the first and second interior heat exchangers that a difference in temperature in absolute value between the interior air to be taken into the first interior heat exchanger and the interior air discharged from the first interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger, and a difference in temperature in absolute value between the interior air to be taken into the second interior heat exchanger and the interior air discharged from the second interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger.

[0017] It is preferable for easily and appropriately estimating the amount in absolute value of thermal energy per unit time actually exchanged by each of the first and second interior heat exchangers that a product of a flow rate of the interior air flowing through the first interior heat exchanger and a difference in temperature in absolute value between the interior air to be taken into the first interior heat exchanger and the interior air discharged from the first interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by

the first interior heat exchanger, and a product of a flow rate of the interior air flowing through the second interior heat exchanger and a difference in temperature in absolute value between the interior air to be taken into the second interior heat exchanger and the interior air discharged from the second interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger.

[0018] It is preferable for easily and appropriately estimating the amount in absolute value of thermal energy per unit time actually exchanged by each of the first and second interior heat exchangers that a difference in temperature in absolute value between the refrigerant taken into the first interior heat exchanger and the refrigerant discharged from the first interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger, and a difference in temperature in absolute value between the refrigerant taken into the second interior heat exchanger and the refrigerant discharged from the second interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger.

[0019] It is preferable for easily and appropriately estimating the amount in absolute value of thermal energy per unit time actually exchanged by each of the first and second interior heat exchangers that a product of a mass flow rate of the refrigerant flowing through the first interior heat exchanger and a difference in temperature in absolute value between the refrigerant taken into the first interior heat exchanger and the refrigerant discharged from the first interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger, and a product of a mass flow rate of the refrigerant flowing through the second interior heat exchanger and a difference in temperature in absolute value between the refrigerant taken into the second interior heat exchanger and the refrigerant discharged from the second interior heat exchanger is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger.

[0020] It is preferable for correctly and stably detecting at least one of actual and desirable amounts of heat energy exchanged by each of the first and second interior heat exchanger that at least one of actual and desirable amounts of heat energy exchanged by each of the first and second interior heat exchanger is detected by the air conditioner after at least a predetermined time period elapse from a change between the cooling main course and heating main course.

[0021] For easily and appropriately judging the condition or situation on which the control of the air conditioner is performed when the valve means has a four-way valve (3a, 3b), it is preferable that at which the four-way valve is set ON condition or OFF condition is detected from a value of electric current applied to the four-way valve, the exterior heat exchanger has a thermistor for measuring a temperature of the refrigerant in the exterior heat exchanger, and at which the exterior heat exchanger is used the evaporator condition or condenser condition is detected from the temperature of the refrigerant measured by the thermistor so that when the measured temperature of the refrigerant is lower than a predetermined temperature, the exterior heat exchanger is deemed to be used as the evaporator, and when the measured temperature of the refrigerant is not lower than the predetermined temperature, the exterior heat exchanger is deemed to be used as the condenser. It is preferable that the detected conditions of the four-way valve and exterior heat exchanger are indicated on at least one of a remote controller for controlling the air conditioner and the exterior heat exchanger.

[0022] An air conditioner may comprise an exterior unit having a compressor (1), a plurality of four-way valves (3a, 3b) connected to the compressor to change a flow direction of a refrigerant, a plurality of exterior heat exchangers (2a, 2b), and exterior electronic expansion valves (4a, 4b) connected to the exterior heat exchangers respectively, and a plurality of interior units having respective interior heat exchangers, respective interior electronic expansion valves and respective shut-off valves and connected to the exterior heat exchangers through a pipe for refrigerant of gas state and a pipe for refrigerant of liquid state wherein a refrigerant cycle having one of the interior units operable to cool an interior air and the other one of the interior units operable to heat the interior air is formed, and an operation of the air conditioner is changed to a cooling main mode with using the exterior heat exchanger as a condenser when a cooling load is greater than a heating load, and to a heating main mode with using the exterior heat exchanger as an evaporator when the heating load is greater than the cooling load, wherein the operation of the air conditioner is changed from the cooling main mode to the heating main mode when a temperature of an exterior air is not more than a predetermined temperature, and a difference between the cooling load and the heating load is not more than a predetermined value.

[0023] Other objects, features and advantages of the invention will become apparent from the following description of the embodiments of the invention taken in conjunction with the accompanying drawings.

Brief Description of the Several Views of the Drawings

[0024]

Fig. 1 is a block diagram showing a refrigerating cycle as an embodiment capable of simultaneously heating an air and cooling the air.

Fig. 2 is a block diagram showing a flow route of a refrigerant and operations of elements in the refrigerating cycle

in various operating modes.

Fig. 3 is a flow chart for changing the operating mode from a cooling main mode to a heating main mode.

Fig. 4 includes diagrams showing relationships between a capacity (thermal energy) and a refrigerant pressure in cooling main mode and heating main mode.

Fig. 5 includes diagrams showing relationships between the capacity (thermal energy) and an ambient temperature in cooling main mode and heating main mode.

Fig. 6 is a diagram showing a relationship between the cooling and heating capacities and the ambient temperature in cooling main mode and heating main mode.

Detailed Description of the Invention

[0025] Hereafter, an air conditioner as an embodiment of the invention will be described with making reference to the drawings.

[0026] Figs. 1 and 2 show a refrigerating cycle capable of simultaneously heating and cooling, an upper drawing of fig. 1 shows a full cooling mode, a lower drawing thereof shows a cooling main mode during simultaneous heating and cooling operations, an upper drawing of fig. 2 shows a heating main mode during simultaneous heating and cooling operations, a lower drawing thereof shows a full heating mode, and an arrow mark shows a flow of a refrigerant.

[0027] The refrigerating cycle is constituted by a compressor 1, a plurality of exterior heat exchangers 2a and 2b, exterior electronically controlled expansion valves 4a and 4b attached to the exterior heat exchangers 2a and 2b, a check valve 5, an exterior unit including four-way valves 3a and 3b for changing a refrigerant flowing route, and at least two, for example, k interior units which are connected to the exterior unit through gas and liquid pipes and include respective interior heat exchangers 6a and 6b with respective interior electronically controlled expansion valves 7a and 7b and respective pairs of valves 8a and 9a and valves 8b and 9b (one filled with black is closed, and one filled with white is opened).

[0028] Next, the cooling main mode and heating main mode will be described in detail.

[0029] In the cooling main mode (during simultaneously heating and cooling), the gas refrigerant discharged from the compressor 1 is fed to the exterior heat exchanger 2b and interior heat exchanger 6b as condensers so that it is changed to the liquid refrigerant through the heat exchange, and subsequently the liquid refrigerant is fed to the interior heat exchanger 6a as an evaporator. The liquid refrigerant is vaporized in the interior heat exchanger 6a, and the vaporized refrigerant is recovered into the compressor 1. When a heat energy amount of absolute value exchanged through the interior heat exchanger 6b as the condenser is smaller than a heat energy amount of absolute value exchanged through the interior heat exchanger 6a as the evaporator, a difference therebetween is radiated from the exterior heat exchanger 2b as the condenser.

[0030] In the heating main mode (during simultaneously heating and cooling), the refrigerant discharged from the compressor 1 flows into the interior heat exchanger 6b as the condenser to perform the heat exchange, and the liquefied refrigerant is fed to the exterior heat exchanger 2a and interior heat exchanger 6a as the evaporator, and the refrigerant vaporized by the heat exchange by them returns to the compressor 1. A heat exchange energy amount thermally exchanged by the interior heat exchanger 6b as the condenser is balanced with a heat exchange energy amount thermally exchanged by the interior heat exchanger 6a and exterior heat exchanger 2a as the evaporator.

[0031] As mentioned above, in the air conditioner for simultaneously heating and cooling, an intended purpose and/or capacity of the exterior heat exchanger is changed to drive both the interior room heater and interior room cooler, and a difference in amount of exchanged thermal energy between the interior cooling and the interior heating is compensated by the exterior heat exchanger to form the refrigerating cycle. Incidentally, when an interior cooling load Q_{ei} and an interior heating load Q_{ci} are substantially equal to each other, an exterior heat exchange amount Q_o for other than a thermal input from the compressor is not necessary, and may be zero, so that if the exterior heat exchange amount Q_o by the exterior heat exchanger is more than zero as performed in the prior art, the heat exchange amount Q_{ci} of the interior heat exchanger as the condenser is decreased by the heat exchange amount Q_{co} of the exterior heat exchanger as the condenser when the cooling main mode. Further, in the heating main mode, the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator is decreased by the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator. When the exterior temperature is significantly low or high to increase the heat exchange amount by the exterior heat exchanger, an effect thereby increases.

[0032] In the cooling main mode and the heating main mode, it is difficult for the cooling capacity to be sufficient and it is easy for the heating capacity to be sufficient when the ambient temperature is high, it is easy for the cooling capacity to be sufficient and it is difficult for the heating capacity to be sufficient when the ambient temperature is low, and these relationships during simultaneously heating and cooling will be explained in detail with making reference to fig. 4 showing a relationship in the refrigerating cycle (a diagram whose ordinate corresponds to the pressure and whose abscissa corresponds to the capacity (thermal energy amount)) and fig. 5 showing a relationship between the ambient (exterior) temperature and the capacity (thermal energy amount) of each part.

(in cooling main mode)

[0033] When the heat exchange amount of the interior heat exchanger for cooling the room air and the heat exchange amount of the interior heat exchanger for heating the room air are balanced with each other except for the power P_c applied by the compressor to the refrigerant, an enthalpy necessary for the required cooling capacity is supplied from the interior heat exchanger 6b for heating the room air. However, if the refrigerant flows through the exterior unit, the high pressure and high temperature gas refrigerant flows through the exterior heat exchanger 2b to generate the heat exchange amount Q_{co} radiated from the exterior heat exchanger as the condenser. Therefore, when the heat exchange amount Q_t of the heat energy absorbing side in the refrigerating cycle is kept unchanged, since the enthalpy necessary for the required cooling capacity is a total amount of the heat exchange amount Q_{co} of the exterior heat exchanger as the condenser and the heat exchange amount Q_{ci} of the interior heat exchanger as the condenser, the heat exchange amount Q_{ci} of the interior heat exchanger as the condenser is smaller than the heat exchange amount Q_t of the heat energy absorbing side by the heat exchange amount Q_{co} of the exterior heat exchanger as the condenser.

[0034] Therefore, the greater the heat exchange amount Q_{co} of the exterior heat exchanger as the condenser is, the smaller the heat exchange amount Q_{ci} of the interior heat exchanger as the condenser (that is, the capacity of the heat exchanger for heating the room air) is. This situation occurs when the ambient temperature is low to accelerate the heat radiation of the exterior heat exchanger 2b as the condenser. Therefore, an efficiency of operation for simultaneous heating and cooling is low.

[0035] On the contrary, when the ambient temperature is high to decelerate the heat exchange amount Q_{co} of the exterior heat exchanger 2b as the condenser, the heat exchange amount Q_{ci} of the interior heat exchanger as the condenser becomes great. Regarding the input power P_c from the compressor, when Q_t is kept unchanged, the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator and the input power P_c from the compressor change inversely with respect to each other, so that the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator is decreased by the input power P_c from the compressor.

(in heating main mode)

[0036] When the heat exchange amount of the interior heat exchanger for cooling the room air and the heat exchange amount of the interior heat exchanger for heating the room air are balanced with each other in the heating main mode, an enthalpy necessary for the required heating capacity is supplied from the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator and the input power P_c from the compressor. However, if the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator exists and the heat exchange amount Q_t of the heat energy emitting side in the refrigerating cycle is kept unchanged, since the enthalpy difference necessary for the required heating capacity is a total amount of the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator, the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator and the input power P_c from the compressor, the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator is smaller than the heat exchange amount Q_t of the heat energy emitting side by the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator.

[0037] Therefore, the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator and the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator change inversely with respect to each other, so that the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator is decreased by the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator. This situation occurs when the ambient temperature is high to accelerate the heat absorption of the exterior heat exchanger as the evaporator, and increase the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator, the heat exchange amount Q_{ei} of the interior heat exchanger as the evaporator is decreased. Therefore, an efficiency of operation for simultaneous heating and cooling is low.

[0038] As mentioned above, the heating capacity is insufficient at the low ambient temperature in the cooling main mode, and cooling capacity is insufficient at the high ambient temperature in the heating main mode, so that an input power for the compressor needs to be increased to compensate this insufficiency of the capacity, and an operating efficiency during simultaneous heating and cooling is decreased.

[0039] In the embodiment, the operating mode is changed between the heating main mode and cooling main mode in accordance with a detection of insufficiency of the heating or cooling capacity on the basis of a decision value for each of the capacity of the interior heat exchanger for cooling the room air and the capacity of the interior heat exchanger for heating the room air, in addition to a judgment on the basis of a rate between the cooling load and heating load.

[0040] That is, when the load of cooling the room air and the load of heating the room air are substantially equal to each other, and the ambient temperature is low, the insufficiency of the heating capacity is detected so that the cooling main mode is replaced by the heating main mode in which the exterior heat exchanger is used as the evaporator forming the refrigerating cycle. Whereby, the heat exchange amount of the exterior heat exchanger is decreased to prevent the condensing pressure from decreasing, so that the capacity for heating the room air is maintained, and an excessive

decrease of the evaporating pressure is prevented. Therefore, the cooling capacity is restrained from becoming excessive when the ambient temperature is low, and the efficiency for simultaneous heating and cooling is increased.

[0041] In the cooling main mode, when the heat exchange amount Q_{co} of the exterior heat exchanger as the condenser is zero, the heat exchange is performed only by the interior heat exchanger as the evaporator and the interior heat exchanger as the condenser, so that the heat radiation or heat absorption added by the exterior heat exchanger does not exist and the whole of the heat energy circulates between the interior heat exchangers to increase the operating efficiency. As an indicator showing the operating efficiency in simultaneous heating and cooling, the operating efficiency in simultaneous heating and cooling is indicated by $COP^{(s)}$ calculated by formula 1, and the heat exchange amounts in the modes are calculated by formula 2 and 3 respectively.

operating efficiency:

$$COP^{(s)} = \frac{Q_{ci} + Q_{ei}}{P_c} \quad (\text{formula 1})$$

cooling main mode : $Q_{co} + Q_{ci} = Q_{ei} + P_c$ (formula 2)

heating main mode : $Q_{ci} = Q_{eo} + Q_{ei} + P_c$ (formula 3)

operating efficiency (cooling main) :

$$COP^{(s)} = \frac{(Q_{ei} + P_c - Q_{co}) + Q_{ei}}{P_c} = \frac{2Q_{ei} + P_c - Q_{co}}{P_c} \quad (\text{formula 4})$$

operating efficiency (heating main) :

$$COP^{(s)} = \frac{Q_{ci} + (Q_{ci} - Q_{eo} - P_c)}{P_c} = \frac{2Q_{ci} - P_c - Q_{eo}}{P_c} \quad (\text{formula 5})$$

[0042] Therefore, the operating efficiency (the cooling main mode) and the operating efficiency (the heating main mode) are calculated along the formulas 4 and 5.

[0043] As mentioned above, when $Q_{ei} + P_c = \text{constant} = Q_t$ (in the cooling main mode) or $Q_{ci} = Q_t$ (in the heating main mode), the smaller the heat exchange amount Q_{co} of the exterior heat exchanger as the condenser is or the smaller the heat exchange amount Q_{eo} of the exterior heat exchanger as the evaporator is, the higher COP for simultaneous heating and cooling is.

[0044] Incidentally, in fig. 6, the cooling and heating capacities in the cooling main mode as shown in fig. 5 and the cooling and heating capacities in the heating main mode overlap with each other, the cooling capacity Q_{ei} is excessive while the heating capacity Q_{ci} is insufficient during the cooling main mode in the ambient temperature shown in fig. 6, and a condition shown by $\bigcirc$ mark is changed to a condition shown by $\star$ mark by changing to the heating main mode so that the balancing situation is obtained for the high operating efficiency of simultaneous heating and cooling.

[0045] A change from the cooling main mode to the heating main mode is brought about in the following condition.

condition (c1): $L_H > 0$ and a number of interior heat exchanger(s) in cooling operation = 0, or

condition (c2): a number of interior heat exchanger(s) in heating operation > 0 and $L_H > 1.25 L_R$ and at least one minute elapse after increase of the number of the interior heat exchanger(s),

or

condition (c3): a number of interior heat exchanger(s) in heating operation > 0 and $L_H > 0.9 L_R$ and $\Delta T_{hm} - \Delta T_{cm} \leq 1$ and at least one minute elapse after increase of the number of the interior heat exchanger(s).

[0046] A change from the heating main mode to the cooling main mode is brought about in the following condition.

condition (c4): a number of interior heat exchanger(s) in heating operation = 0,

or

condition (c5): a number of interior heat exchanger(s) in cooling operation > 0 and $L_R > 1.25 L_H$ and at least one minute elapse after increase of the number of the interior heat exchanger(s),

or

condition (c6): a number of interior heat exchanger(s) in cooling operation > 0 and $L_R > 0.9 L_H$ and $\Delta T_{hm} - \Delta T_{cm} \leq 1$ and at least one minute elapse after increase of the number of the interior heat exchanger(s).

[0047] Here, the notes are as follows.

$$L_R = \sum_k l_R \quad (\text{formula 6})$$

$$l_R = \frac{hp^{(R)}}{HP} \cdot V \cdot \left\{ \frac{1}{2} + \frac{\Delta T_c}{8} \right\} \cdot K$$

$$\Delta T_c = T_i - T_s$$

$$L_H = \sum_k l_H \quad (\text{formula 7})$$

$$l_H = \frac{hp^{(H)}}{HP} \cdot V \cdot \left\{ \frac{1}{2} + \frac{\Delta T_h}{8} \right\} \cdot K$$

$$\Delta T_h = T_s - T_i$$

L_R : a total amount of heating loads of interior heat exchanger(s) for heating, L_H : a total amount of cooling loads of interior heat exchanger(s) for cooling, T_s : set temperature, T_i : air temperature in room, ΔT_c : a difference between the air temperature in room and the set temperature for cooling operation, ΔT_h : a difference between the air temperature in room and the set temperature for heating operation, $hp^{(R)}$: capacity of interior heat exchanger for cooling, $hp^{(H)}$: capacity of interior heat exchanger for heating, HP : capacity of exterior heat exchanger,

ΔT_{hm} : a maximum value of ΔT_h , ΔT_{cm} : a maximum value of ΔT_c ,

K : correction coefficient has a value of 1.0 when thermo on, a value of 0.1 when thermo off, and a value of 0 when stopping,

V : correction coefficient has a value of 1.0 when an air flow is high, a value of 7/8 when the air flow is medium, and has a value 3/4 when the air flow is low.

[0048] In these conditions (c1)-(c6) for changing the operating mode, since only a rate between the heating and cooling loads is considered, at least one of the following conditions (C7-1), (C7-2) and (C7-3) is considered for change from the cooling main mode to the heating main mode when the ambient temperature is low to increase the capacity of the heat exchanger for cooling the room air.

condition (C7-1)

[0049] $\Delta T_{cm} > a$ and $\Delta T_{hmax} < b$ (and at least four minutes elapse after changing the operating mode) and preferably $a = 12$ with $b = 15$

ΔT_{cm} is a minimum value of $(T_i - T_{io})$, ΔT_{hmax} is a maximum value of $(T_{io} - T_i)$, and T_{io} is a temperature of the air after passing through the interior heat exchanger. That is, during the cooling main mode, when the minimum one ΔT_c of the differences in temperature between the airs taken into and flowing out of the respective interior heat exchangers for cooling the air is more than a while the maximum one ΔT_h of the differences in temperature between the airs taken into and flowing out of the respective interior heat exchangers for heating the air is less than b , the operating mode is changed to the heating main mode.

condition (C7-2)

[0050]

$$P_s \leq P_{so} - \gamma (\gamma = 0.17) \quad \text{and} \quad P_d \leq P_{do} - \xi \quad (\xi = 0.15) \quad (\text{and preferably } P_d / (P_s + 0.13) \leq \varepsilon (\varepsilon = 2.4))$$

P_s : refrigerant pressure at low pressure side (evaporating pressure), P_d : refrigerant pressure at high pressure side

(condensing pressure), P_{so} : desired evaporating pressure for cooling, P_{do} : desired condensing pressure for heating. That is, at least during the cooling main mode, when the detected evaporating pressure in the interior heat exchanger for cooling the room air is smaller than (the desired evaporating pressure - the predetermined value γ) and the detected condensing pressure in the interior heat exchanger for heating the room air is smaller than (the desired condensing pressure - the predetermined value ξ), the operating mode is changed to the heating main mode.

(condition C7-3)

[0051] $\Delta T_{cmin} / \Delta T_{hmax} > 2.3$ (and preferably at least four minute elapse after changing the operating mode)

Whereby when the cooling capacitance is excessive and the heating capacitance is insufficient, the operating mode is changed from the cooling main mode to the heating main mode to improve a margin or spare operating capacity, an amenity and the operating efficiency. On the other hand, when the cooling capacitance is insufficient and the heating capacitance is excessive, the operating mode is changed from the heating main mode to the cooling main mode.

[0052] Fig. 3 shows a control flow chart for change from the cooling main mode to the heating main mode on the basis of the condition (C7-1), and at first, during the cooling main mode, a number of the interior heat exchanger(s) being operating to cool the air is detected, and when the number of the interior heat exchanger(s) being operating to cool the air is zero, the operating mode is changed to the heating main mode. When the number of the interior heat exchanger(s) being operating to cool the air is not zero and the number of the interior heat exchanger(s) being operating to heat the air is zero, the load for cooling the room air and the load for heating the room air are measured. On the other hand, when the number of the interior heat exchanger(s) being operating to heat the air is more than zero, after one minute elapse for making the refrigerating cycle stable from an increase of the number of the operated interior heat exchanger(s), the load for cooling the room air and the load for heating the room air are measured, and subsequently when the load for cooling the room air is smaller the load for heating the room air, that is, L_H (the total amount of the heat exchange amounts of the cooling loads of the interior heat exchanger(s) for cooling the air) - L_R (the total amount of the heat exchange amounts of the heating loads of the interior heat exchanger(s) for heating the air) is smaller than a predetermined value B, the operating mode is changed to the heating main mode.

[0053] When the number of the interior heat exchanger(s) being operating to heat the air is more than zero, and one minute has not elapsed from the increase of the number of the operated interior heat exchanger(s), the load for cooling the room air and the load for heating the room air are measured, and when the the load for cooling the room air and the load for heating the room air are substantially equal to each other and $\Delta T_{cmin} > 12$ and $\Delta T_{hmax} < 15$, the operating mode is changed from the cooling main mode to the heating main mode.

[0054] By switching the operating mode as described above, the operating efficiency for simultaneous heating and cooling is improved, and the performed operating mode is indicated on a remote controller for controlling the exterior heat exchanger and/or the interior heat exchangers. A detection of the operating mode to be indicated is performed from conditions of the four-way valves 3a and 3b and the exterior heat exchangers (evaporators or condensers) 2a and 2b. Regarding the four-way valves 3a and 3b, ON/OFF situations thereof are detected from electric currents of the four-way valve coils, and regarding the exterior heat exchangers 2a and 2b, the refrigerant temperatures are measured by thermistors attached to inlets of the exterior heat exchangers, so that when the temperature is high, they are deemed to be the condensers and when the temperature is low, they are deemed to be the evaporators. From a combination of the using purposes of these four-way valves and the exterior heat exchangers, which operating mode is selected is detected.

[0055] As mentioned above, the efficiency of simultaneous heating and cooling is increased to improve an yearly power consumption efficiency such as an year-round power consumption efficiency determined along JIS C 9612 and JRA4055 so that CO_2 discharge is decreased and an amount of the refrigerant used in the air conditioner is decreased.

[0056] It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without departing from the scope of the appended claims.

Claims

1. An air conditioner comprising,
an exterior heat exchanger (2a, 2b) capable of performing a heat exchange between a refrigerant and an exterior air and including an adjustable valve (4a, 4b) whose opening area is variable so that the adjustable valve is usable as desired one of an expansion valve for the refrigerant to use the exterior heat exchanger as an evaporator and a passage for the refrigerant to use the exterior heat exchanger as a condenser,
a first interior heat exchanger (6a) capable of performing a heat exchange between the refrigerant and an interior air to be cooled and including another expansion valve (7a) for the refrigerant enabling the first interior heat exchanger to be used as another evaporator,

a second interior heat exchanger (6b) capable of performing as another condenser a heat exchange between the refrigerant and an interior air to be heated, and
 a compressor (1) for pressurizing the refrigerant, **characterized in that** a valve means (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) is capable of changing a flow course of the refrigerant between:

a cooling main course in which the pressurized refrigerant discharged from the compressor (1) flows into each of the second interior heat exchanger (6b) and the exterior heat exchanger (2a, 2b) including the adjustable valve used as the passage to use the exterior heat exchanger (2a, 2b) as the condenser, subsequently the condensed refrigerant discharged from each of the second interior heat exchanger (6b) and the exterior heat exchanger (2a, 2b) flows into the first interior heat exchanger (6a), and finally the evaporated refrigerant discharged from the first interior heat exchanger (6a) returns to the compressor (1), and
 a heating main course in which the pressurized refrigerant discharged from the compressor (1) flows into the second interior heat exchanger (6b), subsequently the condensed refrigerant discharged from the second interior heat exchanger (6b) flows into each of the first interior heat exchanger (6a) and the exterior heat exchanger (2a, 2b) including the adjustable valve used as the expansion valve to use the exterior heat exchanger (2a, 2b) as the evaporator, and finally the evaporated refrigerant discharged from each of the first interior heat exchanger (6a) and the exterior heat exchanger (2a, 2b) returns to the compressor (1);

wherein the valve means (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) is to change the flow course of the refrigerant from the cooling main course to the heating main course when a temperature of the exterior air is not more than a predetermined temperature, and a difference in absolute value between a desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger (6a) and a desirable amount in absolute value of thermal energy per unit time to be exchanged by the second interior heat exchanger (6b) is not more than a predetermined value.

2. An air conditioner according to claim 1, wherein the valve means (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) is to change the flow course of the refrigerant from the cooling main course to the heating main course when a difference in absolute value between a desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger (6a) and a desirable amount in absolute value of heat energy per unit time to be exchanged by the second interior heat exchanger (6b) is not more than a predetermined value, and a difference in absolute value between an amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) and an amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b) less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) is more than a predetermined reference value.
3. An air conditioner according to any one of claims 1-2, wherein, for estimating the desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger (6a), a difference in absolute value between an actual temperature of the interior air to be cooled by the first interior heat exchanger (6a) and a desirable temperature of the interior air to be cooled by the first interior heat exchanger (6a) lower than the actual temperature of the interior air to be cooled by the first interior heat exchanger (6a) is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger (6a), and, for estimating the desirable amount in absolute value of thermal energy per unit time to be exchanged by the second interior heat exchanger (6b), a difference in absolute value between a desirable temperature of the interior air to be heated by the second interior heat exchanger (6b), and an actual temperature of the interior air to be heated by the second interior heat exchanger (6a) lower than the desirable temperature of the interior air to be heated by the second interior heat exchanger (6b) is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the second interior heat exchanger (6b).
4. An air conditioner according to any one of claims 1-3, wherein, for estimating the desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger (6a), a product of a flow rate of the interior air flowing through the first interior heat exchanger (6a) and a difference in absolute value between an actual temperature of the interior air to be cooled by the first interior heat exchanger (6a) and a desirable temperature of the interior air to be cooled by the first interior heat exchanger (6a) lower than the actual temperature of the interior air to be cooled by the first interior heat exchanger (6a) is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the first interior heat exchanger (6a), and a product of a flow rate of the interior air flowing through the second interior heat exchanger (6b) and a difference in absolute value between an actual temperature of the interior air to be heated by the second interior heat exchanger (6b) and, for estimating the desirable amount in absolute value of thermal energy per unit time to be exchanged by the second

interior heat exchanger (6b), a desirable temperature of the interior air to be heated by the second interior heat exchanger (6b) higher than the actual temperature of the interior air to be heated by the second interior heat exchanger (6b) is a value corresponding to the desirable amount in absolute value of thermal energy per unit time to be exchanged by the second interior heat exchanger (6b).

- 5 5. An air conditioner according to any one of claims 1-4, wherein at least one of the first and second interior heat exchangers (6a, 6b) has a plurality of interior sub-heat exchangers connected fluidly in parallel to each other so that the desirable amount in absolute value of thermal energy per unit time to be exchanged by the at least one of the first and second interior heat exchangers (6a, 6b) is a total amount of desirable amounts in absolute value of thermal energy per unit time to be exchanged by the interior sub-heat exchangers respectively.
- 10 6. An air conditioner according to claim 2, wherein it is deemed when a difference in absolute value in temperature between the interior air to be taken into the first interior heat exchanger (6a) and the interior air discharged from the first interior heat exchanger (6a) is more than a first reference degree and a difference in absolute value in temperature between the interior air to be taken into the second interior heat exchanger (6b) and the interior air discharged from the second interior heat exchanger (6b) is less than a second reference degree, that the difference in absolute value between the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) and the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b) less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) is more than the predetermined reference value.
- 15 7. An air conditioner according to claim 2, wherein it is deemed when a pressure of the refrigerant evaporated by the first interior heat exchanger (6a) is less than a first comparison value and a pressure of the refrigerant condensed by the second interior heat exchanger (6b) is less than a second comparison value, that the difference in absolute value between the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) and the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b) less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) is more than the predetermined reference value.
- 20 25 8. An air conditioner according to claim 2, wherein it is deemed when a difference in absolute value in temperature between the interior air to be taken into the first interior heat exchanger (6a) and the interior air discharged from the first interior heat exchanger (6a) / a difference in absolute value in temperature between the interior air to be taken into the second interior heat exchanger (6b) and the interior air discharged from the second interior heat exchanger (6b) is more than a reference degree, that the difference in absolute value between the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) and the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b) less than the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a) is more than the predetermined reference value.
- 30 35 9. An air conditioner according to claim 6 or 8, wherein the first interior heat exchanger has a plurality of first interior sub-heat exchangers connected fluidly in parallel to each other, and the difference in absolute value in temperature between the interior air to be taken into the first interior heat exchanger (6a) and the interior air discharged from the first interior heat exchanger (6a) is the smallest one of differences in absolute value in temperature between the interior airs to be taken into the respective first interior sub-heat exchangers and the interior airs discharged from the respective first interior sub-heat exchangers.
- 40 45 10. An air conditioner according to any one of claims 6, 8 and 9, wherein the second interior heat exchanger (6b) has a plurality of second interior sub-heat exchangers connected in parallel to each other, and the difference in absolute value in temperature between the interior air to be taken into the second interior heat exchanger (6b) and the interior air discharged from the second interior heat exchanger (6b) is the greatest one of differences in absolute value in temperature between the interior airs to be taken into the respective second interior sub-heat exchangers and the interior airs discharged from the respective second interior sub-heat exchangers.
- 50 55 11. An air conditioner according to any one of claims 2-10, wherein a difference in temperature in absolute value between the interior air to be taken into the first interior heat exchanger (6a) and the interior air discharged from the first interior heat exchanger (6a) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a), and a difference in temperature in absolute value between the interior air to be taken into the second interior heat exchanger (6b) and the interior air discharged from

the second interior heat exchanger (6b) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b).

12. An air conditioner according to any one of claims 2-10, wherein, for estimating the amount in absolute value of thermal energy per unit time actually exchanged by the first interior heat exchanger (6a), a product of a flow rate of the interior air flowing through the first interior heat exchanger (6a) and a difference in temperature in absolute value between the interior air to be taken into the first interior heat exchanger (6a) and the interior air discharged from the first interior heat exchanger (6a) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a), and, for estimating the amount in absolute value of thermal energy per unit time actually exchanged by the second interior heat exchanger (6b), a product of a flow rate of the interior air flowing through the second interior heat exchanger (6b) and a difference in temperature in absolute value between the interior air to be taken into the second interior heat exchanger (6b) and the interior air discharged from the second interior heat exchanger (6b) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b).
13. An air conditioner according to any one of claims 2-10, wherein, for estimating the amount in absolute value of thermal energy per unit time actually exchanged by the first interior heat exchanger (6a), a difference in temperature in absolute value between the refrigerant taken into the first interior heat exchanger (6a) and the refrigerant discharged from the first interior heat exchanger (6a) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a), and a difference in temperature in absolute value between the refrigerant taken into the second interior heat exchanger (6b) and, for estimating the amount in absolute value of thermal energy per unit time actually exchanged by the second interior heat exchanger (6b), the refrigerant discharged from the second interior heat exchanger (6b) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b).
14. An air conditioner according to any one of claims 2-10, wherein, for estimating the amount in absolute value of thermal energy per unit time actually exchanged by the first interior heat exchanger (6a), a product of a mass flow rate of the refrigerant flowing through the first interior heat exchanger and a difference in temperature in absolute value between the refrigerant taken into the first interior heat exchanger (6a) and the refrigerant discharged from the first interior heat exchanger (6a) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the first interior heat exchanger (6a), and, for estimating the amount in absolute value of thermal energy per unit time actually exchanged by the second interior heat exchanger (6b), a product of a mass flow rate of the refrigerant flowing through the second interior heat exchanger (6b) and a difference in temperature in absolute value between the refrigerant taken into the second interior heat exchanger (6b) and the refrigerant discharged from the second interior heat exchanger (6b) is a value corresponding to the amount in absolute value of heat energy per unit time actually exchanged by the second interior heat exchanger (6b).
15. An air conditioner according to any one of claims 1-14, wherein at least one of actual and desirable amounts of heat energy exchanged by each of the first and second interior heat exchanger (6a, 6b) is detected by the air conditioner after at least a predetermined time period elapse from a change between the cooling main course and heating main course.
16. An air conditioner according to any one of claims 1-15, wherein the valve means (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) has a four-way valve (3a, 3b) and whether the four-way valve (3a, 3b) is set to an ON condition or to an OFF condition is detected from a value of electric current applied to the four-way valve (3a, 3b), the exterior heat exchanger (2a, 2b) has a thermistor for measuring a temperature of the refrigerant in the exterior heat exchanger (2a, 2b), and whether the exterior heat exchanger (2a, 2b) is used in the evaporator condition or in the condenser condition is detected from the temperature of the refrigerant measured by the thermistor so that when the measured temperature of the refrigerant is lower than a predetermined temperature, the exterior heat exchanger is deemed to be used as the evaporator, and when the measured temperature of the refrigerant is not lower than the predetermined temperature, the exterior heat exchanger (2a, 2b) is deemed to be used as the condenser.
17. An air conditioner according to claim 16, wherein the detected conditions of the four-way valve (3a, 3b) and exterior heat exchanger (2a, 2b) are indicated on at least one of a remote controller for controlling the air conditioner and the exterior heat exchanger (2a, 2b).

Patentansprüche

1. Klimaanlage, die Folgendes umfasst:

5 einen Außenwärmetauscher (2a, 2b), der einen Wärmeaustausch zwischen einem Kältemittel und einer Außenluft durchführen kann und ein einstellbares Ventil (4a, 4b), dessen Öffnungsbereich derart veränderbar ist, dass das einstellbare Ventil nach Bedarf entweder als ein Expansionsventil für das Kältemittel, um den Außenwärmetauscher als einen Verdampfer zu verwenden, oder als ein Kanal für das Kältemittel, um den Außenwärmetauscher als einen Verflüssiger zu verwenden, verwendbar ist, enthält,
 10 einen ersten Innenwärmetauscher (6a), der einen Wärmeaustausch zwischen dem Kältemittel und einer Innenluft, die gekühlt werden soll, durchführen kann und ein weiteres Expansionsventil (7a) für das Kältemittel, das ermöglicht, dass der erste Innenwärmetauscher als ein weiterer Verdampfer verwendet werden kann, enthält, einen zweiten Innenwärmetauscher (6b), der als ein weiterer Verflüssiger einen Wärmeaustausch zwischen dem Kältemittel und einer Innenluft, die erwärmt werden soll, durchführen kann, und
 15 einen Kompressor (1), um das Kältemittel unter Druck zu setzen,
dadurch gekennzeichnet, dass
 ein Ventilmittel (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) einen Strömungsverlauf des Kältemittels zwischen Folgendem ändern kann:

20 einem Kühlhauptverlauf, in dem das druckbeaufschlagte Kältemittel, das vom Kompressor (1) ausgestoßen wird, sowohl in den zweiten Innenwärmetauscher (6b) als auch in den Außenwärmetauscher (2a, 2b), der das einstellbare Ventil, das als der Durchgang verwendet wird, um den Außenwärmetauscher (2a, 2b) als den Verflüssiger zu verwenden, enthält, strömt, anschließend das verflüssigte Kältemittel, das sowohl vom zweiten Innenwärmetauscher (6b) als auch vom Außenwärmetauscher (2a, 2b) ausgestoßen wird, in den
 25 ersten Innenwärmetauscher (6a) strömt und schließlich das verdampfte Kältemittel, das vom ersten Innenwärmetauscher (6a) ausgestoßen wird, zum Kompressor (1) zurückkehrt, und
 einem Heizhauptverlauf, in dem das druckbeaufschlagte Kältemittel, das vom Kompressor (1) ausgestoßen wird, in den zweiten Innenwärmetauscher (6b) strömt, anschließend das verflüssigte Kältemittel, das vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, sowohl in den ersten Innenwärmetauscher (6a) als
 30 auch den Außenwärmetauscher (2a, 2b), der das einstellbare Ventil, das als das Expansionsventil verwendet wird, um den Außenwärmetauscher (2a, 2b) als den Verdampfer zu verwenden, enthält, strömt und schließlich das verdampfte Kältemittel, das sowohl vom ersten Innenwärmetauscher (6a) als auch vom Außenwärmetauscher (2a, 2b) ausgestoßen wird, zum Kompressor (1) zurückkehrt; wobei

35 wobei das Ventilmittel (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) ausgelegt ist, den Strömungsverlauf des Kältemittels vom Kühlhauptverlauf zum Heizhauptverlauf zu ändern, wenn eine Temperatur der Außenluft nicht mehr als eine vorgegebene Temperatur ist und eine Betragsdifferenz zwischen einer gewünschten Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den ersten Innenwärmetauscher (6a) getauscht werden soll, und einer gewünschten Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den zweiten Innenwärmetauscher (6b) getauscht werden soll, nicht mehr als ein vorgegebener Wert ist.

2. Klimaanlage nach Anspruch 1, wobei das Ventilmittel (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) ausgelegt ist, den Strömungsverlauf des Kältemittels vom Kühlhauptverlauf zum Heizhauptverlauf zu ändern, wenn eine Betragsdifferenz zwischen einer gewünschten Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den ersten Innenwärmetauscher (6a) getauscht werden soll, und einer gewünschten Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den zweiten Innenwärmetauscher (6b) getauscht werden soll, nicht mehr als ein vorgegebener Wert ist und eine Betragsdifferenz zwischen einer Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, und einer Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, die weniger als die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, ist, mehr als ein vorgegebener Bezugswert ist.

3. Klimaanlage nach einem der Ansprüche 1-2, wobei, um die gewünschte Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den ersten Innenwärmetauscher (6a) getauscht werden soll, zu schätzen, eine Betragsdifferenz zwischen einer tatsächlichen Temperatur der Innenluft, die durch den ersten Innenwärmetauscher (6a) gekühlt werden soll, und einer gewünschten Temperatur der Innenluft, die durch den ersten Innenwärmetauscher (6a) gekühlt werden soll, die geringer als die tatsächliche Temperatur der Innenluft, die durch den ersten Innenwärmetauscher (6a) gekühlt werden soll, ist, ein Wert ist, der der gewünschten Betragsmenge von Wärmeenergie pro

Einheitszeit, die durch den ersten Innenwärmetauscher (6a) getauscht werden soll, entspricht, und, um die gewünschte Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den zweiten Innenwärmetauscher (6b) getauscht werden soll, zu schätzen, eine Betragsdifferenz zwischen einer tatsächlichen Temperatur der Innenluft, die durch den zweiten Innenwärmetauscher (6b) erwärmt werden soll, und einer tatsächlichen Temperatur der Innenluft, die durch den zweiten Innenwärmetauscher (6a) erwärmt werden soll, die geringer als die gewünschte Temperatur der Innenluft, die durch den zweiten Innenwärmetauscher (6b) erwärmt werden soll, ist, ein Wert ist, der der gewünschten Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den zweiten Innenwärmetauscher (6b) getauscht werden soll, entspricht.

4. Klimaanlage nach einem der Ansprüche 1-3, wobei, um die gewünschte Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den ersten Innenwärmetauscher (6a) getauscht werden soll, zu schätzen, ein Produkt einer Durchflussmenge der Innenluft, die durch den ersten Innenwärmetauscher (6a) strömt, und einer Betragsdifferenz zwischen einer tatsächlichen Temperatur der Innenluft, die durch den ersten Innenwärmetauscher (6a) gekühlt werden soll, und einer gewünschten Temperatur der Innenluft, die durch den ersten Innenwärmetauscher (6a) gekühlt werden soll, die geringer als die tatsächliche Temperatur der Innenluft, die durch den ersten Innenwärmetauscher (6a) gekühlt werden soll, ist, ein Wert ist, der der gewünschten Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den ersten Innenwärmetauscher (6a) getauscht werden soll, entspricht, und ein Produkt einer Durchflussmenge der Innenluft, die durch den zweiten Innenwärmetauscher (6b) strömt, und einer Betragsdifferenz zwischen einer tatsächlichen Temperatur der Innenluft, die durch den zweiten Innenwärmetauscher (6b) erwärmt werden soll, und, um die gewünschte Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den zweiten Innenwärmetauscher (6b) getauscht wird soll, zu schätzen, einer gewünschten Temperatur der Innenluft, die durch den zweiten Innenwärmetauscher (6b) erwärmt werden soll, die höher als die tatsächliche Temperatur der Innenluft, die durch den zweiten Innenwärmetauscher (6b) erwärmt werden soll, ist, ein Wert ist, der der gewünschten Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den zweiten Innenwärmetauscher (6b) getauscht werden soll, entspricht.

5. Klimaanlage nach einem der Ansprüche 1-4, wobei der erste und/oder der zweite Innenwärmetauscher (6a, 6b) mehrere Innenunterwärmetauscher, die fluidtechnisch parallelgeschaltet sind, besitzen, derart, dass die gewünschte Betragsmenge von Wärmeenergie pro Einheitszeit, die durch den ersten und/oder den zweiten Innenwärmetauscher (6a, 6b) getauscht werden soll, eine Gesamtmenge von gewünschten Beträgen von Wärmeenergie pro Einheitszeit, die durch die Innenunterwärmetauscher jeweils getauscht werden soll, ist.

6. Klimaanlage nach Anspruch 2, wobei davon ausgegangen wird, dass dann, wenn eine Betragsdifferenz der Temperatur zwischen der Innenluft, die in den ersten Innenwärmetauscher (6a) aufgenommen werden soll, und der Innenluft, die vom ersten Innenwärmetauscher (6a) ausgestoßen werden soll, mehr als ein erstes Bezugsmaß ist und eine Betragsdifferenz der Temperatur zwischen der Innenluft, die in den zweiten Innenwärmetauscher (6b) aufgenommen werden soll, und der Innenluft, die vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, weniger als ein zweites Bezugsmaß ist, die Betragsdifferenz zwischen der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, und der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, die geringer als die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, ist, mehr als ein vorgegebener Bezugswert ist.

7. Klimaanlage nach Anspruch 2, wobei davon ausgegangen wird, dass dann, wenn ein Druck des Kältemittels, das durch den ersten Innenwärmetauscher (6a) verdampft wird, geringer als ein erster Vergleichswert ist und ein Druck des Kältemittels, das durch den zweiten Innenwärmetauscher (6b) verflüssigt wird, geringer als ein zweiter Vergleichswert ist, die Betragsdifferenz zwischen der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, und der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, die geringer als die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, ist, mehr als der vorgegebene Bezugswert ist.

8. Klimaanlage nach Anspruch 2, wobei davon ausgegangen wird, dass dann, wenn eine Betragsdifferenz der Temperatur zwischen der Innenluft, die in den ersten Innenwärmetauscher (6a) aufgenommen werden soll, und der Innenluft, die vom ersten Innenwärmetauscher (6a) ausgestoßen wird, / eine Betragsdifferenz der Temperatur zwischen der Innenluft, die in den zweiten Innenwärmetauscher (6b) aufgenommen werden soll, und der Innenluft, die vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, mehr als ein Bezugsmaß ist, die Betragsdifferenz zwischen der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetaus-

scher (6a) getauscht wird, und der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, die geringer als die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, ist, mehr als der vorgegebene Bezugswert ist.

9. Klimaanlage nach Anspruch 6 oder 8, wobei der erste Innenwärmetauscher mehrere erste Innenunterwärmetauscher, die fluidtechnisch zueinander parallelgeschaltet sind, besitzt und die Betragsdifferenz der Temperatur zwischen der Innenluft, die in den ersten Innenwärmetauscher (6a) aufgenommen werden soll, und der Innenluft, die vom ersten Innenwärmetauscher (6a) ausgestoßen wird, die kleinste von Betragsdifferenzen der Temperatur zwischen den Innenluftanteilen, die von den entsprechenden ersten Innenunterwärmetauschern aufgenommen werden sollen, und den Innenluftanteilen, die von den entsprechenden ersten Innenunterwärmetauschern ausgestoßen werden, ist.

10. Klimaanlage nach einem der Ansprüche 6, 8 und 9, wobei der zweite Innenwärmetauscher (6b) mehrere zweite Innenunterwärmetauscher, die fluidtechnisch zueinander parallelgeschaltet sind, besitzt und die Betragsdifferenz der Temperatur zwischen der Innenluft, die in den zweiten Innenwärmetauscher (6b) aufgenommen werden soll, und der Innenluft, die vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, die größte von Betragsdifferenzen der Temperatur zwischen den Innenluftanteilen, die von den entsprechenden zweiten Innenunterwärmetauschern aufgenommen werden sollen, und den Innenluftanteilen, die von den entsprechenden zweiten Innenunterwärmetauschern ausgestoßen werden, ist.

11. Klimaanlage nach einem der Ansprüche 2-10, wobei eine Betragsdifferenz der Temperatur zwischen der Innenluft, die in den ersten Innenwärmetauscher (6a) aufgenommen werden soll, und der Innenluft, die vom ersten Innenwärmetauscher (6a) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, entspricht, und eine Betragsdifferenz der Temperatur zwischen der Innenluft, die in den zweiten Innenwärmetauscher (6b) aufgenommen werden soll, und der Innenluft, die vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, entspricht.

12. Klimaanlage nach einem der Ansprüche 2-10, wobei, um die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, zu schätzen, ein Produkt einer Durchflussmenge der Innenluft, die durch den ersten Innenwärmetauscher (6a) strömt, und einer Betragsdifferenz der Temperatur zwischen der Innenluft, die in den ersten Innenwärmetauscher (6a) aufgenommen werden soll, und der Innenluft, die vom ersten Innenwärmetauscher (6a) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, entspricht, und, um die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, zu schätzen, ein Produkt einer Durchflussmenge der Innenluft, die durch den zweiten Innenwärmetauscher (6b) strömt, und einer Betragsdifferenz der Temperatur zwischen der Innenluft, die in den zweiten Innenwärmetauscher (6b) aufgenommen werden soll, und der Innenluft, die vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, entspricht.

13. Klimaanlage nach einem der Ansprüche 2-10, wobei, um die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, zu schätzen, eine Betragsdifferenz der Temperatur zwischen dem Kältemittel, das in den ersten Innenwärmetauscher (6a) aufgenommen wird, und dem Kältemittel, das vom ersten Innenwärmetauscher (6a) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, entspricht, und, eine Betragsdifferenz der Temperatur zwischen dem Kältemittel, das in den zweiten Innenwärmetauscher (6b) aufgenommen wird und, um die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, zu schätzen, dem Kältemittel, das vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, entspricht.

14. Klimaanlage nach einem der Ansprüche 2-10, wobei, um die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, zu schätzen, ein Produkt einer Massendurchflussmenge des Kältemittels, das durch den ersten Innenwärmetauscher (6a) strömt, und einer Betragsdifferenz der Temperatur zwischen dem Kältemittel, das in den ersten Innenwärmetauscher (6a) aufgenommen wird,

und dem Kältemittel, das vom ersten Innenwärmetauscher (6a) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den ersten Innenwärmetauscher (6a) getauscht wird, entspricht, und, um die Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, zu schätzen, ein Produkt einer Massendurchflussmenge des Kältemittels, das durch den zweiten Innenwärmetauscher (6b) strömt, und einer Betragsdifferenz der Temperatur zwischen dem Kältemittel, das in den zweiten Innenwärmetauscher (6b) aufgenommen wird und dem Kältemittel, das vom zweiten Innenwärmetauscher (6b) ausgestoßen wird, ein Wert ist, der der Betragsmenge von Wärmeenergie pro Einheitszeit, die tatsächlich durch den zweiten Innenwärmetauscher (6b) getauscht wird, entspricht.

15. Klimaanlage nach einem der Ansprüche 1-14, wobei die tatsächliche und/oder die gewünschte Menge von Wärmeenergie, die durch den ersten und den zweiten Innenwärmetauscher (6a, 6b) jeweils getauscht werden, durch die Klimaanlage detektiert wird, nachdem mindestens ein vorgegebener Zeitraum von einer Änderung zwischen dem Kühlgangverlauf und dem Heizgangverlauf verstrichen ist.

16. Klimaanlage nach einem der Ansprüche 1-15, wobei das Ventilmittel (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) ein Vierwegeventil (3a, 3b) besitzt und aus einem Wert des elektrischen Stromes, der an das Vierwegeventil (3a, 3b) angelegt ist, detektiert wird, ob das Vierwegeventil (3a, 3b) in einen eingeschalteten Zustand oder in einen ausgeschalteten Zustand eingestellt ist, der Außenwärmetauscher (2a, 2b) einen Thermistor besitzt, um eine Temperatur des Kältemittels im Außenwärmetauscher (2a, 2b) zu messen, und aus der Temperatur des Kältemittels, die durch den Thermistor gemessen wird, detektiert wird, ob der Außenwärmetauscher (2a, 2b) im Verdampferzustand oder im Verflüssigerzustand verwendet wird, derart, dass dann, wenn die gemessene Temperatur des Kältemittels geringer als eine vorgegebene Temperatur ist, davon ausgegangen wird, dass der Außenwärmetauscher als der Verdampfer verwendet wird, und dann, wenn die gemessene Temperatur des Kältemittels nicht geringer als die vorgegebene Temperatur ist, davon ausgegangen wird, dass der Außenwärmetauscher (2a, 2b) als der Verflüssiger verwendet wird.

17. Klimaanlage nach Anspruch 16, wobei die detektierten Zustände des Vierwegeventils (3a, 3b) und des Außenwärmetauschers (2a, 2b) an einer Fernsteuerung, um die Klimaanlage zu steuern, und/oder dem Außenwärmetauscher (2a, 2b) angezeigt werden.

Revendications

1. Appareil de conditionnement d'air comprenant

un échangeur de chaleur extérieur (2a, 2b) capable d'effectuer un échange de chaleur entre un réfrigérant et un air extérieur, et incluant une vanne ajustable (4a, 4b), dont la surface d'ouverture est variable de sorte que la vanne ajustable peut être utilisée de manière désirée soit comme une vanne d'expansion pour que le réfrigérant utilise l'échangeur de chaleur extérieur comme un évaporateur, soit comme un passage pour que le réfrigérant utilise l'échangeur de chaleur comme un condenseur,

un premier échangeur de chaleur intérieur (6a) capable d'effectuer un échange de chaleur entre le réfrigérant et un air intérieur qu'il s'agit de refroidir, et incluant une autre vanne d'expansion (7a) pour que le réfrigérant permette au premier échangeur de chaleur intérieur d'être utilisé comme un autre évaporateur,

un deuxième échangeur de chaleur intérieur (6b) capable d'effectuer, en tant qu'autre condenseur, un échange de chaleur entre le réfrigérant et un air intérieur qu'il s'agit de réchauffer, et

un compresseur (1) pour pressuriser le réfrigérant,

caractérisé en ce que

un moyen de vanne (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) est capable de changer une course d'écoulement du réfrigérant entre :

une course principale de refroidissement dans laquelle le réfrigérant pressurisé évacué depuis le compresseur (1) s'écoule jusque dans chaque échangeur parmi le deuxième échangeur de chaleur intérieur (6b) et l'échangeur de chaleur extérieur (2a, 2b) incluant la vanne ajustable utilisée comme le passage pour utiliser l'échangeur de chaleur extérieur (2a, 2b) comme le condenseur, puis le réfrigérant condensé évacué depuis chaque échangeur parmi le deuxième échangeur de chaleur intérieur (6b) et l'échangeur de chaleur extérieur (2a, 2b) s'écoule jusque dans le premier échangeur de chaleur intérieur (6a), et enfin le réfrigérant évaporé évacué depuis le premier échangeur de chaleur intérieur (6a) retourne vers le compresseur (1), et

une course principale de chauffage dans laquelle le réfrigérant pressurisé évacué depuis le compresseur (1) s'écoule jusque dans le deuxième échangeur de chaleur intérieur (6b), puis le réfrigérant condensé évacué

depuis le deuxième échangeur de chaleur intérieur (6b) s'écoule jusque dans chaque échangeur parmi le premier échangeur de chaleur intérieur (6a) et l'échangeur de chaleur extérieur (2a, 2b) incluant la vanne ajustable utilisée comme la vanne d'expansion pour utiliser l'échangeur de chaleur extérieur (2a, 2b,) comme l'évaporateur, et enfin le réfrigérant évaporé évacué depuis chaque échangeur parmi le premier échangeur de chaleur intérieur (6a) et l'échangeur de chaleur extérieur (2a, 2b) retourne vers le compresseur (1) ; dans lequel le moyen de vanne (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) doit changer la course d'écoulement du réfrigérant depuis la course principale de refroidissement vers la course principale de chauffage quand une température de l'air extérieur n'est pas supérieure à une température prédéterminée, et une différence en valeur absolue entre une quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le premier échangeur de chaleur intérieur (6a) et une quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le deuxième échangeur de chaleur intérieur (6b) n'est pas supérieure à une valeur prédéterminée.

2. Appareil de conditionnement d'air selon la revendication 1, dans lequel le moyen de vanne (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) est prévu pour changer la course d'écoulement du réfrigérant depuis la course principale de refroidissement vers la course principale de chauffage quand une différence en valeur absolue entre une quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le premier échangeur de chaleur intérieur (6a) et une quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le deuxième échangeur de chaleur intérieur (6b) n'est pas supérieure à une valeur prédéterminée, et une différence en valeur absolue entre une quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a) et une quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b), inférieure à la quantité en valeur absolue d'énergie thermique par unité de temps réellement échangée par le premier échangeur de chaleur intérieur (6a), est supérieure à une valeur de référence prédéterminée.

3. Appareil de conditionnement d'air selon l'une quelconque des revendications 1 ou 2, dans lequel, pour estimer la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le premier échangeur de chaleur intérieur (6a), une différence en valeur absolue entre une température réelle de l'air intérieur devant être refroidi par le premier échangeur de chaleur intérieur (6a) et une température désirée de l'air intérieur devant être refroidi par le premier échangeur de chaleur intérieur (6a), inférieure à la température réelle de l'air intérieur devant être refroidi par le premier échangeur de chaleur intérieur (6a), est une valeur correspondant à la quantité désirée en valeur absolue de l'énergie thermique par temps unitaire devant être échangée par le premier échangeur de chaleur intérieur (6a), et, pour estimer la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le deuxième échangeur de chaleur intérieur (6b), une différence en valeur absolue entre une température désirée de l'air intérieur devant être réchauffé par le deuxième échangeur de chaleur intérieur (6b) et une température réelle de l'air intérieur devant être réchauffé par le deuxième échangeur de chaleur intérieur (6b), inférieure à la température désirée de l'air intérieur devant être réchauffé par le deuxième échangeur de chaleur intérieur (6b), est une valeur correspondant à la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le deuxième échangeur de chaleur intérieur (6b).

4. Appareil de conditionnement d'air selon l'une quelconque des revendications 1 à 3, dans lequel, pour estimer la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le premier échangeur de chaleur intérieur (6a), un produit d'un débit de l'air intérieur circulant à travers le premier échangeur de chaleur intérieur (6a) et d'une différence en valeur absolue entre une température réelle de l'air intérieur devant être refroidi par le premier échangeur de chaleur intérieur (6a) et une température désirée de l'air intérieur devant être refroidi par le premier échangeur de chaleur intérieur (6a), inférieure à la température réelle de l'air intérieur devant être refroidi par le premier échangeur de chaleur intérieur (6a) est une valeur correspondant à la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le premier échangeur de chaleur intérieur (6a), et un produit d'un débit de l'air intérieur circulant à travers le deuxième échangeur de chaleur intérieur (6b) et d'une différence en valeur absolue entre une température réelle de l'air intérieur devant être réchauffé par le deuxième échangeur de chaleur intérieur (6b) et, pour estimer la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le deuxième échangeur de chaleur intérieur (6b), une température désirée de l'air intérieur devant être réchauffé par le deuxième échangeur de chaleur intérieur (6b), supérieure à la température réelle de l'air intérieur devant être réchauffé par le deuxième échangeur de chaleur intérieur (6b), est une valeur correspondant à la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par le deuxième échangeur de chaleur intérieur (6b).

5. Appareil de conditionnement d'air selon l'une quelconque des revendications 1 à 4, dans lequel au moins un échan-

geur parmi le premier échangeur de chaleur intérieur et le deuxième échangeur de chaleur intérieur (6a, 6b) a une pluralité de sous-échangeurs de chaleur intérieurs reliés en communication fluïdique en parallèle les uns aux autres, de sorte que la quantité désirée en valeur absolue d'énergie thermique par temps unitaire devant être échangée par ledit au moins un parmi le premier et le deuxième échangeur de chaleur intérieur (6a, 6b) est une quantité totale des quantités désirées en valeur absolue d'énergie thermique par temps unitaire devant être échangées par les sous-échangeurs de chaleur intérieurs respectivement.

6. Appareil de conditionnement d'air selon la revendication 2, dans lequel il est jugé, quand une différence en valeur absolue de température entre l'air intérieur devant être admis jusque dans le premier échangeur de chaleur intérieur (6a) et l'air intérieur évacué depuis le premier échangeur de chaleur intérieur (6a) est supérieure à un premier degré de référence, et qu'une différence en valeur absolue de température entre l'air intérieur devant être admis jusque dans le deuxième échangeur de chaleur intérieur (6b) et l'air intérieur évacué depuis le deuxième échangeur de chaleur intérieur (6b) est inférieure à un deuxième degré de référence, que la différence en valeur absolue entre la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a) et la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b), inférieure à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a) est supérieure à la valeur de référence prédéterminée.
7. Appareil de conditionnement d'air selon la revendication 2, dans lequel il est jugé, quand une pression du réfrigérant évaporé par le premier échangeur de chaleur intérieur (6a) est inférieure à une première valeur de comparaison et qu'une pression du réfrigérant condensé par le deuxième échangeur de chaleur intérieur (6b) est inférieure à une deuxième valeur de comparaison, que la différence en valeur absolue entre la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a) et la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b), inférieure à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), est supérieure à la valeur de référence prédéterminée.
8. Appareil de conditionnement d'air selon la revendication 2, dans lequel il est jugé, quand une différence en valeur absolue de température entre l'air intérieur devant être admis jusque dans le premier échangeur de chaleur intérieur (6a) et l'air intérieur évacué depuis le premier échangeur de chaleur intérieur (6a) / une différence en valeur absolue de température entre l'air intérieur devant être admis jusque dans le deuxième échangeur de chaleur intérieur (6b) et l'air intérieur évacué depuis le deuxième échangeur de chaleur intérieur (6b) est supérieure à un degré de référence, que la différence en valeur absolue entre la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a) et la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b), inférieure à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), est supérieure à la valeur de référence prédéterminée.
9. Appareil de conditionnement d'air selon la revendication 6 ou 8, dans lequel le premier échangeur de chaleur intérieur a une pluralité de premiers sous-échangeurs de chaleur intérieurs reliés en communication fluïdique en parallèle les uns aux autres, et la différence en valeur absolue de température entre l'air intérieur devant être admis jusque dans le premier échangeur de chaleur intérieur (6a) et l'air intérieur évacué depuis le premier échangeur de chaleur intérieur (6a) est la plus petite des différences en valeur absolue de température entre les airs intérieurs devant être admis jusque dans les premiers sous-échangeurs de chaleur intérieurs respectifs et les airs intérieurs évacués depuis les premiers sous-échangeurs de chaleur intérieurs respectifs.
10. Appareil de conditionnement d'air selon l'une quelconque des revendications 6, 8 et 9, dans lequel le deuxième échangeur de chaleur intérieur (6b) a une pluralité de deuxièmes sous-échangeurs de chaleur intérieurs reliés en communication fluïdique en parallèle les uns aux autres, et la différence en valeur absolue de température entre l'air intérieur devant être admis jusque dans le deuxième échangeur de chaleur intérieur (6b) et l'air intérieur évacué depuis le deuxième échangeur de chaleur intérieur (6b) est la plus grande des différences en valeur absolue de température entre les airs intérieurs devant être admis jusque dans les deuxièmes sous-échangeurs de chaleur

intérieurs respectifs et les airs intérieurs évacués depuis les deuxièmes sous-échangeurs de chaleur intérieurs respectifs.

- 5 11. Appareil de conditionnement d'air selon l'une quelconque des revendications 2 à 10, dans lequel une différence de température en valeur absolue entre l'air intérieur devant être admis jusque dans le premier échangeur de chaleur intérieur (6a) et l'air intérieur évacué depuis le premier échangeur de chaleur intérieur (6a) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), et une différence de température en valeur absolue entre l'air intérieur devant être admis jusque dans le deuxième échangeur de chaleur intérieur (6b) et l'air intérieur évacué depuis le deuxième échangeur de chaleur intérieur (6b) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b).
10
12. Appareil de conditionnement d'air selon l'une quelconque des revendications 2 à 10, dans lequel, pour estimer la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), un produit d'un débit de l'air intérieur s'écoulant à travers le premier échangeur de chaleur intérieur (6a) et d'une différence de température en valeur absolue entre l'air intérieur devant être admis jusque dans le premier échangeur de chaleur intérieur (6a) et l'air intérieur évacué depuis le premier échangeur de chaleur intérieur (6a) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), et, pour estimer la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b), un produit d'un débit de l'air intérieur s'écoulant à travers le deuxième échangeur de chaleur intérieur (6b) et d'une différence de température en valeur absolue entre l'air intérieur devant être admis jusque dans le deuxième échangeur de chaleur intérieur (6b) et l'air intérieur évacué depuis le deuxième échangeur de chaleur intérieur (6b) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b).
15
20
25
13. Appareil de conditionnement d'air selon l'une quelconque des revendications 2 à 10, dans lequel, pour estimer la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), une différence de température en valeur absolue entre le réfrigérant admis jusque dans le premier échangeur de chaleur intérieur (6a) et le réfrigérant évacué depuis le premier échangeur de chaleur intérieur (6a) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), et une différence de température en valeur absolue entre le réfrigérant admis jusque dans le deuxième échangeur de chaleur intérieur (6b) et, pour estimer la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b), le réfrigérant évacué depuis le deuxième échangeur de chaleur intérieur (6b) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b).
30
35
14. Appareil de conditionnement d'air selon l'une quelconque des revendications 2 à 10, dans lequel, pour estimer la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), un produit d'un débit massique du réfrigérant s'écoulant à travers le premier échangeur de chaleur intérieur et d'une différence de température en valeur absolue entre le réfrigérant admis jusque dans le premier échangeur de chaleur intérieur (6a) et le réfrigérant évacué depuis le premier échangeur de chaleur intérieur (6a) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le premier échangeur de chaleur intérieur (6a), et, pour estimer la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b), un produit d'un débit massique du réfrigérant s'écoulant à travers le deuxième échangeur de chaleur intérieur (6b) et d'une différence de température en valeur absolue entre le réfrigérant admis jusque dans le deuxième échangeur de chaleur intérieur (6b) et le réfrigérant évacué depuis le deuxième échangeur de chaleur intérieur (6b) est une valeur correspondant à la quantité en valeur absolue d'énergie thermique par temps unitaire réellement échangée par le deuxième échangeur de chaleur intérieur (6b).
40
45
50
15. Appareil de conditionnement d'air selon l'une quelconque des revendications 1 à 14, dans lequel au moins une quantité parmi les quantités réelles et désirées d'énergie thermique échangées par chacun du premier et du deuxième échangeur de chaleur intérieur (6a, 6b) est détectée par l'appareil de conditionnement d'air après qu'au moins une période temporelle prédéterminée s'écoule depuis un changement entre la course principale de refroidissement et la course principale de chauffage.
55

16. Appareil de conditionnement d'air selon l'une quelconque des revendications 1 à 15, dans lequel le moyen de vanne (3a, 3b, 4a, 4b, 5, 8a, 8b, 9a, 9b) a une vanne à quatre voies (3a, 3b) et, si la vanne à quatre voies (3a, 3b) est établie dans une condition ON ou dans une condition OFF et que cette condition est détectée à partir d'une valeur de courant électrique appliqué à la vanne à quatre voies (3a, 3b), l'échangeur de chaleur extérieur (2a, 2b) a une thermistance pour mesurer une température du réfrigérant dans l'échangeur de chaleur extérieur (2a, 2b), et si l'échangeur de chaleur extérieur (2a, 2b) est utilisé dans la condition comme évaporateur ou dans la condition comme condenseur et que cette condition est détectée à partir de la température du réfrigérant mesurée par la thermistance de sorte que, quand la température mesurée du réfrigérant est inférieure à une température prédéterminée, l'échangeur de chaleur extérieur est jugé comme devant être utilisé comme évaporateur, et quand la température mesurée du réfrigérant n'est pas inférieure à la température prédéterminée, l'échangeur de chaleur extérieur (2a, 2b) est jugé comme devant être utilisé comme condenseur.

17. Appareil de conditionnement d'air selon la revendication 16, dans lequel les conditions détectées de la vanne à quatre voies (3a, 3b) et de l'échangeur de chaleur extérieur (2a, 2b) sont indiquées sur au moins un élément parmi un contrôleur à distance pour commander le climatiseur, et l'échangeur de chaleur extérieur (2a, 2b).

FIG. 1

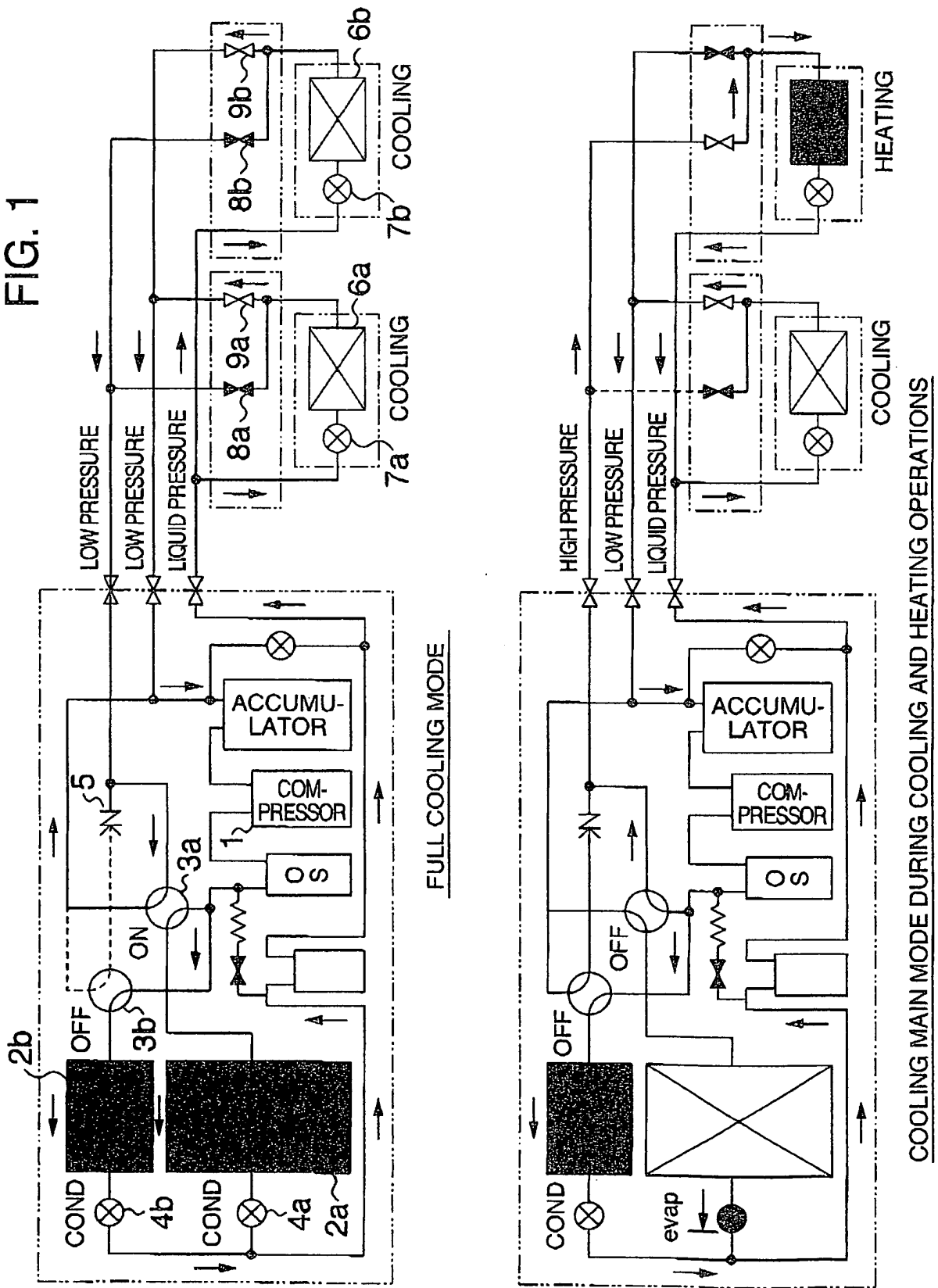


FIG. 2

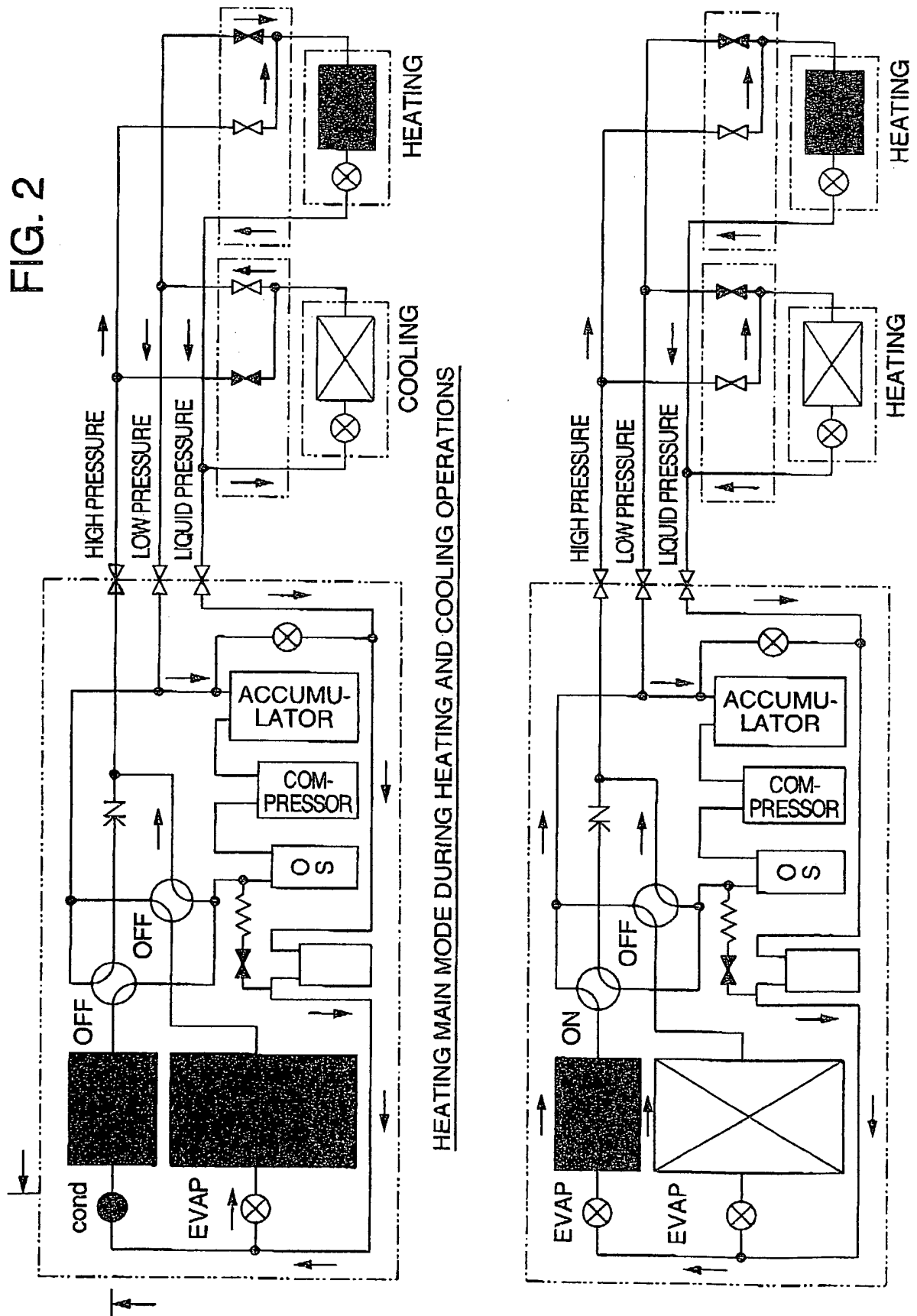


FIG. 3

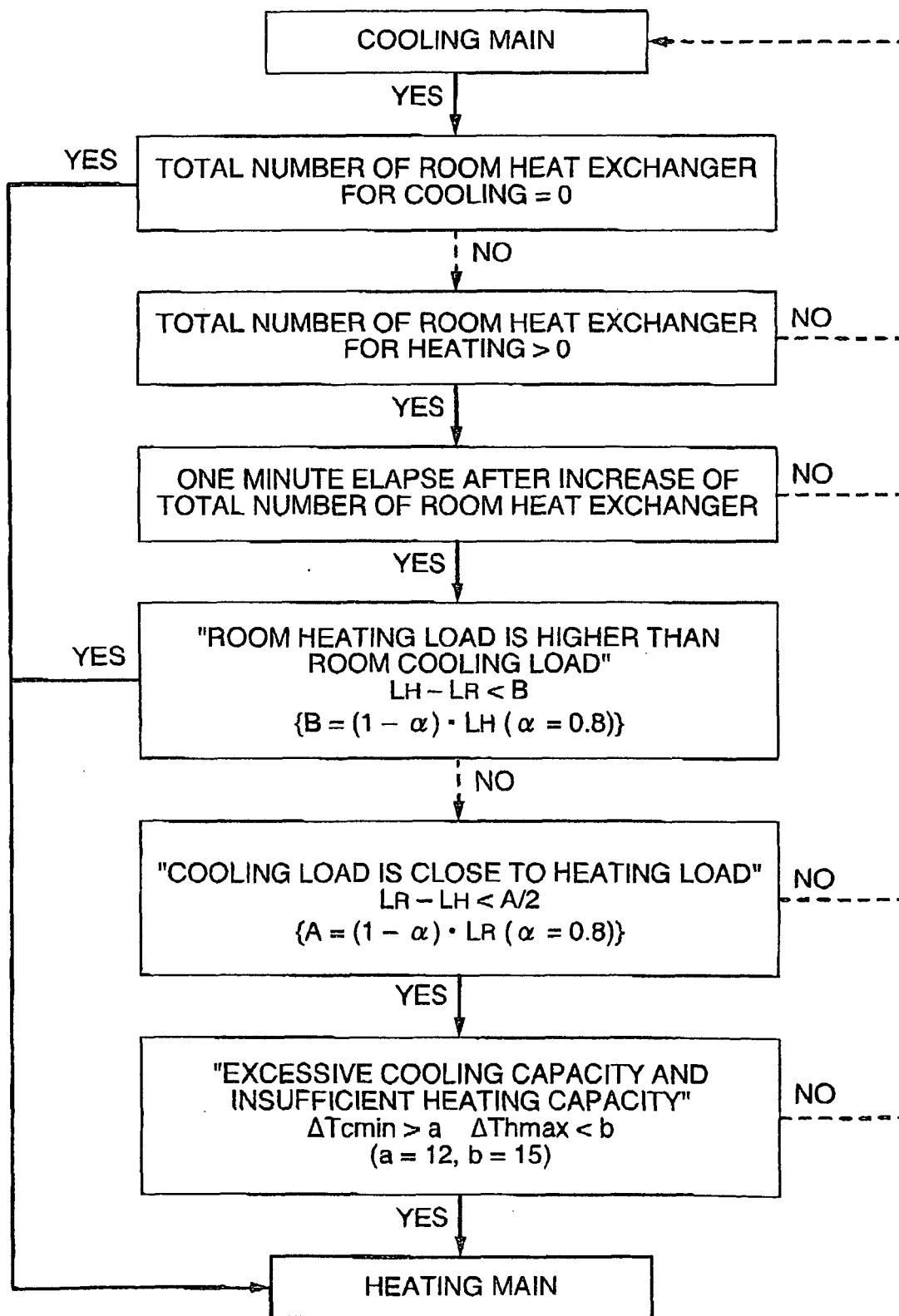


FIG. 4

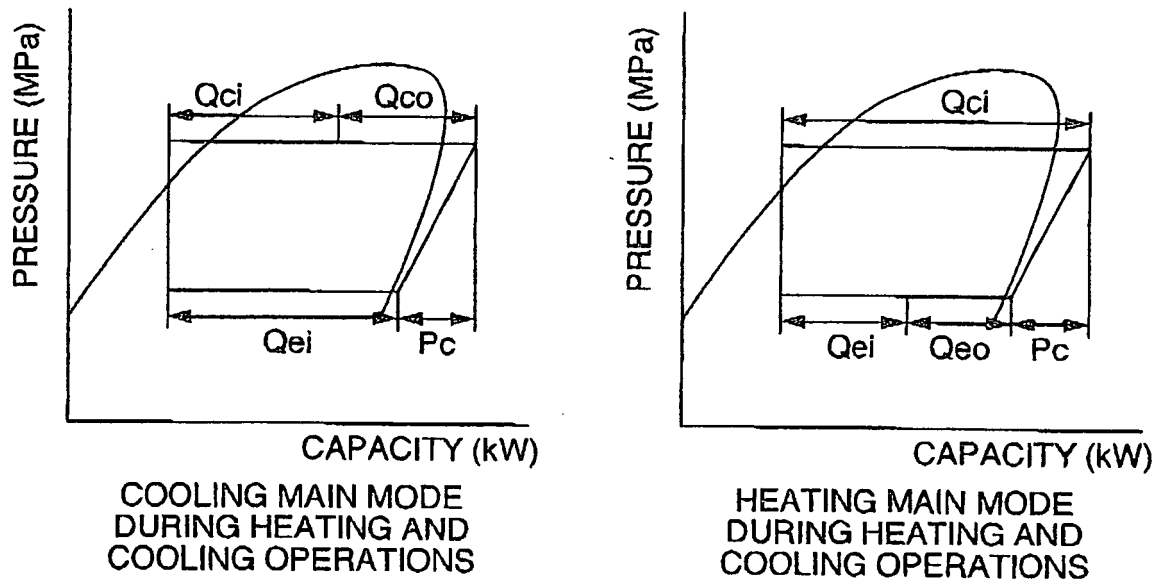


FIG. 6

EFFECT BY AMBIENT TEMPERATURE

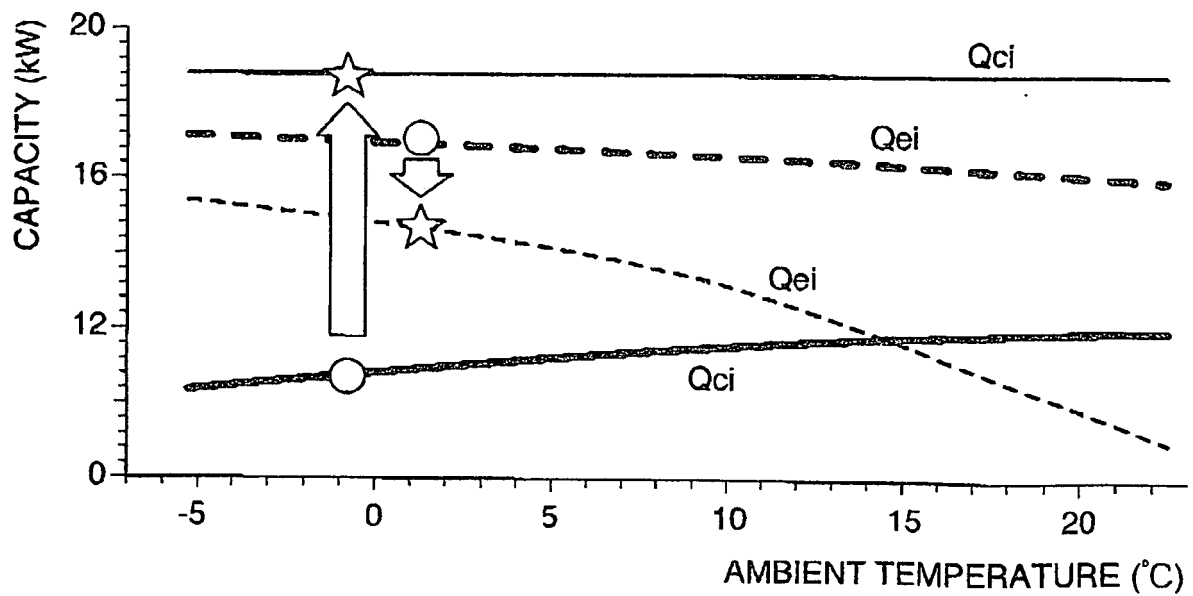
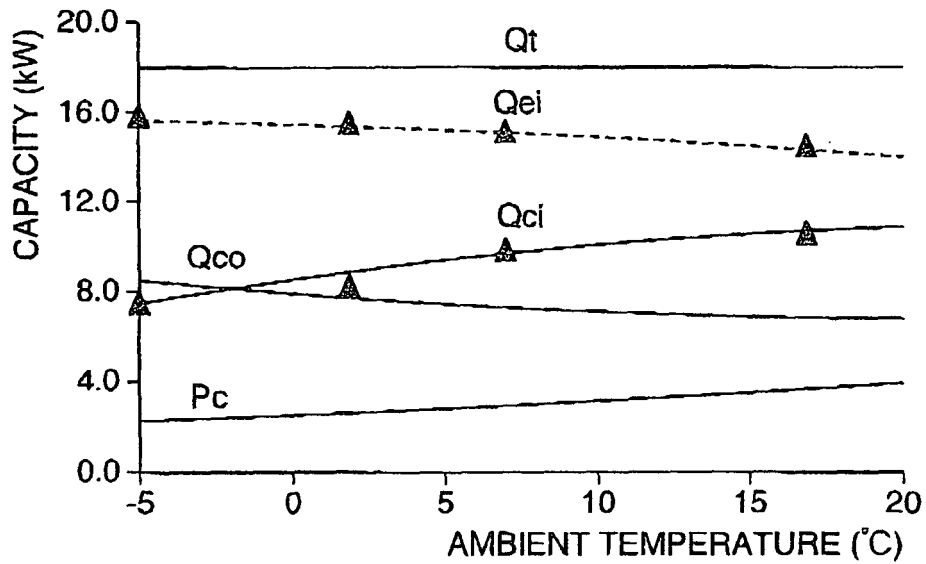
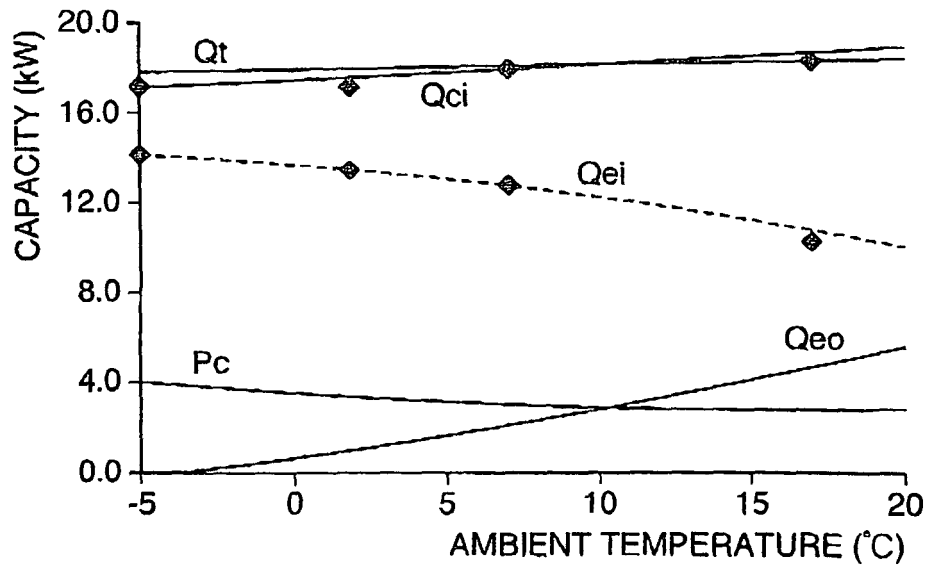


FIG. 5

EFFECT BY AMBIENT TEMPERATURE
(COOLING MAIN)EFFECT BY AMBIENT TEMPERATURE
(HEATING MAIN)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2003130492 A [0002]
- EP 1394476 A1 [0003]