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(72) Inventor: **Jung, Gyoo Ha**
Jangan-gu, Suwon-si
Gyeonggi-do (KR)

(74) Representative: **Grünecker, Kinkeldey, Stockmair & Schwanhäusser**
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

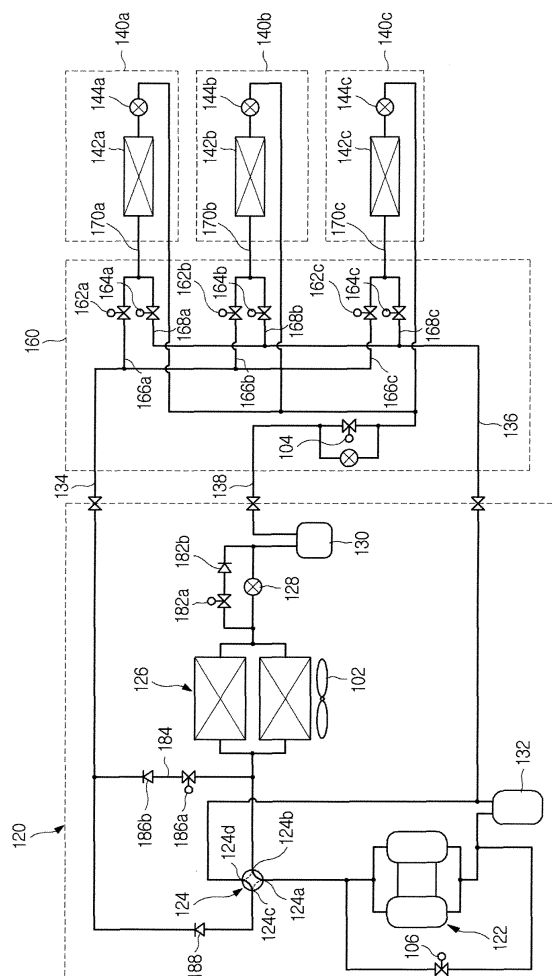
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(71) Applicant: **Samsung Electronics Co., Ltd.**
Suwon-si, Gyeonggi-Do (KR)

(54) **Air conditioner and method of controlling the same**

(57) Disclosed herein are a simultaneous cooling and heating type multi-system air conditioner and a method of controlling the same that can minimize noise generated when operation mode of each indoor unit is changed. The air conditioner includes a compressor, at least one indoor unit, a mode change unit having a cooling valve openable to perform a cooling operation of the indoor unit and a heating valve openable to perform a heating operation of the indoor unit, a refrigerant cycle to connect the compressor, the mode change unit, and the indoor unit, a hot gas bypass valve disposed between inlet and outlet sides of the compressor, and a controller to control the cooling valve to be turned off for a first predetermined time around the point of time when the hot gas bypass valve is turned on, when operation mode of the indoor unit is changed from cooling mode to heating mode, so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of an outlet side of the indoor unit.

Fig.1



Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 2006-2278, filed on January 9, 2006 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to an air conditioner and a method of controlling the same, and, more particularly, to a simultaneous cooling and heating type multi-system air conditioner that includes a plurality of indoor units and that is capable of performing simultaneous cooling and heating, and a method of controlling the same.

2. Description of the Related Art

[0003] A simultaneous cooling and heating type multi-system air conditioner is constructed in a structure in which a plurality of indoor units are connected in parallel with at least one outdoor unit. The indoor units are electrically connected to the at least one outdoor unit via a communication line and a power line. The indoor units and the at least one outdoor unit includes a plurality of refrigerant pipes and valves to control the flow and the amount of refrigerant.

[0004] Simultaneous cooling and heating means that a cooling or heating operation is selectively performed in each indoor unit. In performing such simultaneous cooling and heating, cooling or heating is selectively performed in each indoor unit depending upon the need of a user or indoor environment. A cooling valve and a heating valve are used to perform one of the cooling and heating operations. Specifically, when the cooling valve is opened, the corresponding indoor unit performs the cooling operation. When the heating valve is opened, the corresponding indoor unit performs the heating operation.

[0005] In this way, the cooling operation or the heating operation is performed in each indoor unit. To this end, each indoor unit needs necessary cooling capacity or heating capacity from the at least one outdoor unit. When the total cooling capacity needed by the indoor units is greater than the total heating capacity, a main cooling operation is performed in the at least one outdoor unit. On the other hand, when the total heating capacity needed by the indoor units is greater than the total cooling capacity, a main heating operation is performed in the at least one outdoor unit. When there is switch between the main cooling operation and the main heating operation in the at least one outdoor unit, the flow direction of refrigerant discharged from a compressor is also changed.

At this time, a four-way valve is used.

[0006] During the operation of the at least one outdoor unit, when the cooling valve is closed and, at the same time, the heating valve is opened such that the operation mode is changed from the cooling mode to the heating mode in the indoor units, or when the heating valve is closed and, at the same time, the cooling valve is opened such that the operation mode is changed from the heating mode to the cooling mode in the indoor units, high-pressure refrigerant discharged from the compressor flows abruptly through the opened valve, and therefore, refrigerant flow noise is generated.

[0007] Furthermore, in the simultaneous cooling and heating type multi-system air conditioner, the valve opening and closing operations for switching between the cooling and heating operations in the respective indoor units are more frequently performed as the number of the indoor units is increased. As a result, discomfort of a user due to abrupt refrigerant flow noise is further increased.

SUMMARY OF THE INVENTION

[0008] Therefore, it is an aspect of the invention to minimize noise generated when operation mode of each indoor unit is changed in a simultaneous cooling and heating type multi-system air conditioner.

[0009] In accordance with one aspect, the present invention provides an air conditioner comprising: a compressor; at least one indoor unit; a mode change unit including a cooling valve openable to perform a cooling operation of the indoor unit and a heating valve openable to perform a heating operation of the indoor unit; a refrigerant cycle to connect the compressor, the mode change unit, and the indoor unit; a hot gas bypass valve disposed between inlet and outlet sides of the compressor; and a controller to control the cooling valve to be turned off for a first predetermined time around the point of time when the hot gas bypass valve is turned on, when operation mode of the indoor unit is changed from cooling mode to heating mode, so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of an outlet side of the indoor unit.

[0010] Preferably, the controller controls the compressor to be turned off around the point of time when the hot gas bypass valve is turned on.

[0011] Preferably, the controller controls the compressor to be turned on and the cooling valve to be turned off when a second predetermined time has elapsed after the cooling valve and the heating valve are turned on.

[0012] Preferably, the controller controls the hot gas bypass valve to be turned off when a third predetermined time has elapsed after the compressor is turned on.

[0013] Preferably, the controller controls the cooling valve and the heating valve to be turned on after the first predetermined time has elapsed.

[0014] Preferably, the cooling valve and the heating valve are normally closed type valves, which are turned

on to make refrigerant forcibly flow in a predetermined direction.

[0015] Preferably, the at least one indoor unit comprises a plurality of indoor units, and, when the total heating capacity needed in the indoor units is greater than the total cooling capacity, the controller controls the cooling valve to be turned off so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of outlet sides of the indoor units.

[0016] Preferably, the controller controls the cooling valve to be turned off for the first predetermined time such that the pressure of the high-pressure section of the refrigerant cycle and the pressure of the outlet side of the indoor unit can be increased in unison to a middle pressure, which is between a low pressure and a high pressure.

[0017] In accordance with another aspect, the present invention provides a method of controlling an air conditioner comprising a compressor, at least one indoor unit, a mode change unit including a cooling valve openable to perform a cooling operation of the indoor unit and a heating valve openable to perform a heating operation of the indoor unit, a refrigerant cycle to connect the compressor, the mode change unit, and the indoor unit, and a hot gas bypass valve disposed between inlet and outlet sides of the compressor, wherein the method comprises controlling the cooling valve to be turned off for a first predetermined time around the point of time when the hot gas bypass valve is turned on, when operation mode of the indoor unit is changed from cooling mode to heating mode, so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of an outlet side of the indoor unit.

[0018] Preferably, the method further comprises: controlling the compressor to be turned off around the point of time when the hot gas bypass valve is turned on.

[0019] Preferably, the method further comprises: controlling the compressor to be turned on and the cooling valve to be turned off when a second predetermined time has elapsed after the cooling valve and the heating valve are turned on.

[0020] Preferably, the method further comprises: controlling the hot gas bypass valve to be turned off when a third predetermined time has elapsed after the compressor is turned on.

[0021] Preferably, the method further comprises: controlling the cooling valve and the heating valve to be turned on after the first predetermined time has elapsed.

[0022] Preferably, the cooling valve and the heating valve are normally closed type valves, which are turned on to make refrigerant forcibly flow in a predetermined direction.

[0023] Preferably, the at least one indoor unit comprises a plurality of indoor units, and the method further comprises: when the total heating capacity needed in the indoor units is greater than the total cooling capacity, controlling the cooling valve to be turned off so as to minimize

the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of outlet sides of the indoor units.

[0024] Preferably, the method further comprises: controlling the cooling valve to be turned off for the first predetermined time such that the pressure of the high-pressure section of the refrigerant cycle and the pressure of the outlet side of the indoor unit can be increased in unison to a middle pressure, which is between a low pressure and a high pressure.

[0025] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings, of which:

FIG. 1 is a view illustrating a refrigerant cycle of an air conditioner according to an embodiment of the present invention;

FIG. 2 is a view illustrating a control system of the air conditioner shown in FIG. 1;

FIG. 3 is a flow chart illustrating a method of controlling an air conditioner according to an embodiment of the present invention;

FIG. 4 is a flow chart illustrating a control method when operation mode is changed from main cooling mode to heating mode in the method of controlling the air conditioner shown in FIG. 3;

FIG. 5 is a timing chart illustrating the operation and pressure characteristics of respective components in the control method shown in FIG. 4;

FIG. 6 is a flow chart illustrating a control method when operation mode is changed from main cooling mode to main heating mode in the method of controlling the air conditioner shown in FIG. 3; and

FIG. 7 is a timing chart illustrating the operation and pressure characteristics of respective components in the control method shown in FIG. 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Reference will now be made in detail to the embodiment of the present invention, examples of which are illustrated in the accompanying drawings. The embodiment is described below to explain the present invention by referring to the figures.

[0028] FIG. 1 is a view illustrating a refrigerant cycle of an air conditioner according to an embodiment of the present invention. As shown in FIG. 1, the air conditioner includes an outdoor unit 120, first to third indoor units

140a, 140b, and 140c, and a mode change unit (MCU) 160.

[0029] In the outdoor unit 120 is provided a four-way valve 124, which decides the flow direction of refrigerant discharged from a compressor 122. Specifically, the four-way valve 124 is constructed in a structure in which its refrigerant channel is changed such that high-temperature and high-pressure refrigerant discharged from the compressor 122 flows to a high-pressure gas pipe electronic valve 186a and an outdoor heat exchanger 126 during a main cooling operation, and its refrigerant channel is changed such that refrigerant is supplied to the first to third indoor units 140a, 140b, and 140c through a check valve 188 and the mode change unit 160 during a main heating operation. The outdoor heat exchanger 126 performs heat exchange between outdoor air introduced into the outdoor unit 120 through an outdoor unit fan 102 and the refrigerant. In the outdoor unit 120 is also provided an outdoor electronic expansion valve 128 to expand refrigerant, a liquid receiver 130 to separate liquid-state refrigerant from gas-state refrigerant, and an accumulator 132. The refrigerant flow between the first to third indoor units 140a, 140b, and 140c and the outdoor unit 120 is achieved through a high-pressure gas pipe 134 and a low-pressure gas pipe 136.

[0030] The piping and the valve location in the outdoor unit 120 are as follows. The low-pressure gas pipe 136 is connected to the inlet side of the compressor 122 via the accumulator 132, and a high-pressure liquid pipe 138 is connected to the outdoor electronic expansion valve 128 via the liquid receiver 130. An outdoor electronic valve 182a and a check valve 182b, which are connected in parallel to the outdoor electronic expansion valve 128, are opened during the cooling operation. As a result, the liquid refrigerant discharged from the outdoor heat exchanger 126 flows through the outdoor electronic valve 182a and the check valve 182b, i.e., the refrigerant bypasses the outdoor electronic expansion valve 128. Consequently, the refrigerant is supplied to the MCU 160 without loss of pressure. On the other hand, the outdoor electronic valve 182a is fully closed during the heating operation. Consequently, the refrigerant flows through the outdoor electronic expansion valve 128 such that the refrigerant is expanded.

[0031] Between the four-way valve 124 and the inlet of the outdoor heat exchanger 126 is connected a high-pressure branch pipe 184, which diverges from the high-pressure gas pipe 134. On the high-pressure branch pipe 184 are mounted the high-pressure gas pipe electronic valve 186a, which is an opening and closing valve, and a check valve 186b to prevent backward-flow of the refrigerant from the high-pressure gas pipe 134. Between the four-way valve 124 and the high-pressure liquid pipe 138 is also mounted another check valve 188 to prevent backward-flow of the refrigerant.

[0032] The first to third indoor units 140a, 140b, and 140c are connected in parallel to the outdoor unit 120. The first to third indoor units 140a, 140b, and 140c include

first to third indoor heat exchangers 142a, 142b, and 142c, and first to third indoor electronic expansion valves 144a, 144b, and 144c, respectively.

[0033] The MCU 160 serves to switch between the cooling and heating operations of the first to third indoor units 140a, 140b, and 140c. The MCU 160 includes first to third high-pressure gas branch pipes 166a, 166b, and 166c, which diverge from the high-pressure gas pipe 134. First to third heating valves 162a, 162b, and 162c are mounted on the first to third high-pressure gas branch pipes 166a, 166b, and 166c, respectively. The MCU 160 further includes first to third low-pressure gas branch pipes 168a, 168b, and 168c, which diverge from the low-pressure gas pipe 136. First to third cooling valves 164a, 164b, and 164c are mounted on the first to third low-pressure gas branch pipes 168a, 168b, and 168c, respectively.

[0034] The first heating valve 162a and the first cooling valve 164a are connected to a first refrigerant pipe 170a, which is connected to the first indoor heat exchanger 142a. The second and third heating valves 162b and 162c and the second and third cooling valves 164b and 164c are connected to second and third refrigerant pipes 170b and 170c in consecutive order. An MCU electronic valve 104 is mounted on the refrigerant pipe between the respective first to third indoor electronic expansion valves 144a, 144b, and 144c and the liquid receiver 130 of the outdoor unit 120. The MCU electronic valve 104 is opened, when the number of the indoor units performing the cooling operation is greater than the number of the indoor units performing the heating operation, to control the refrigerant discharged from the indoor unit performing the cooling operation not to be excessively supplied to the indoor unit performing the heating operation.

[0035] FIG. 2 is a view illustrating a control system of the air conditioner shown in FIG. 1. As shown in FIG. 2, the outdoor unit 120 further includes an outdoor unit microcomputer 202 to control components of the outdoor unit 120. The first to third indoor units 140a, 140b, and 140c further include first to third indoor unit microcomputers 206a, 206b, and 206c to control components of the first to third indoor units, respectively. The MCU 160 further includes a MCU microcomputer 204 to control the first to third cooling valves 164a, 164b, and 164c and the first to third heating valves 162a, 162b, and 162c.

[0036] The outdoor unit 120 is operated in any one of "cooling mode," "heating mode," "main cooling mode," and "main heating mode" depending upon the ratio of cooling capacity to heating capacity needed by the indoor units 140a, 140b, and 140c. The "cooling mode" is an operation mode performed when only the cooling capacity is needed by the indoor units 140a, 140b, and 140c, but the heating capacity is not needed by the indoor units 140a, 140b, and 140c. The "heating mode" is an operation mode performed when only the heating capacity is needed by the indoor units 140a, 140b, and 140c, but the cooling capacity is not needed by the indoor units 140a, 140b, and 140c. The "main cooling mode" is an

operation mode performed when the cooling capacity needed by the indoor units 140a, 140b, and 140c is greater than the heating capacity needed by the indoor units 140a, 140b, and 140c. The "main heating mode" is an operation mode performed when the heating capacity needed by the indoor units 140a, 140b, and 140c is greater than the cooling capacity needed by the indoor units 140a, 140b, and 140c.

[0037] FIG. 3 is a flow chart illustrating a method of controlling an air conditioner according to an embodiment of the present invention. As shown in FIG. 3, indoor air temperature and outdoor air temperature are measured, and user-set temperatures set for the respective indoor units 140a, 140b, and 140c are determined (302). Based on the indoor air temperature, the outdoor air temperature, and the user-set temperatures for the indoor units, necessary cooling capacity and heating capacity are calculated (304). FIG. 3 shows that the operation is initiated in the "main cooling mode," and the operation mode is changed to the "heating mode" and the "main heating mode."

[0038] Specifically, when the cooling operation is needed in the first indoor unit 140a and the second indoor unit 140b, the heating operation is needed in the third indoor unit 140c, and the total cooling capacity needed by the first indoor unit 140a and the second indoor unit 140b is greater than the heating capacity needed by the third indoor unit 140c, as a result of the calculation of necessary cooling capacity and heating capacity, the air conditioner is operated in the "main cooling mode" (306). At this time, the cooling operation is performed in the first indoor unit 140a and the second indoor unit 140b, and the heating operation is performed in the third indoor unit 140c.

[0039] When the heating operation is needed in the first indoor unit 140a ('yes' of 308), and the heating operation is needed in the second indoor unit 140b ('yes' of 310) during the operation in the "main cooling mode," the operation mode is changed from the "main cooling mode" to the "heating mode" (312). At this time, the heating operation is performed in all the indoor units 140a, 140b, and 140c.

[0040] On the other hand, when the heating operation is needed in the first indoor unit 140a, which is in the cooling operation ('no' of 310), or the heating operation is needed in the second indoor unit 140b ('yes' of 314), the operation mode is changed from the "main cooling mode" to the "main heating mode" (316). At this time, the cooling operation is performed in one of the first and second indoor units 140a and 140b, and the heating operation is performed in the other indoor units.

[0041] When the cooling operation is continuously performed in the first indoor unit 140a and the second indoor unit 140b ('no' of 314), the air conditioner is continuously operated in the "main cooling mode" without changing the operation mode (318).

[0042] The cooling valves 164a, 164b, and 164c and the heating valves 162a, 162b, and 162c are normally

closed type valves, which use power only when the valves are opened, thereby reducing power consumption. When the normally closed type valves are turned on (opened), refrigerant forcibly flows in a predetermined direction. When the normally closed type valves are turned off, however, the refrigerant may flow backward from the high-pressure side to the low-pressure side irrespective of the predetermined direction. Due to the backward-flow of the refrigerant, chattering noise is generated from the valves.

[0043] In the embodiment of the present invention, a control method, which will be described below in detail with reference to FIGS. 4 to 7, is performed to reduce the chattering noise generated when the operation mode is changed from the "main cooling mode" to the "heating mode" or the "main heating mode" (312 and 316 of FIG. 3).

[0044] FIG. 4 is a flow chart illustrating a control method when the operation mode is changed from the "main cooling mode" to the "heating mode" in the method of controlling the air conditioner shown in FIG. 3. As shown in FIG. 4, the compressor 122 is turned off (stopped), a hot gas bypass valve 106 is turned on (opened), and the first and second cooling valves 164a and 164b are turned off (closed) so as to change the operation mode from the "main cooling mode" to the "heating mode" (402). In this state, when a first predetermined time t1 (for example, approximately 1 minute) has elapsed ('yes' of 404), all of the cooling valves and the heating valves of the indoor units performing the operation are turned on (406). In this embodiment, the first to third cooling valves 162a, 162b, and 162c and the first and second heating valves 164a and 164b are turned on (opened) except for the third heating valve 164c of the third indoor unit 140c, which has already been turned on.

[0045] In this state, when a second predetermined time t2 (for example, approximately 2 minutes) has elapsed ('yes' of 408), the compressor 122 is turned on such that the operation is performed in the "heating mode," and the first to third cooling valves 164a, 164b, and 164c are all turned off (410). At this time, the first to third heating valves 162a, 162b, and 162c remain off. The hot gas bypass valve 106 remains on for a third predetermined time t3 (for example, approximately 1 minute) even after the compressor 122 has been turned on. When the third predetermined time has elapsed ('yes' of 412), the hot gas bypass valve 106 is turned off (414). The reason why there is a gap between the point of time when the compressor 122 is turned on and the point of time when the hot gas bypass valve 106 is turned off is to smoothly operate the compressor 122. As the hot gas bypass valve 106 is turned off while the compressor 122 is on, the low-pressure section of the refrigerant cycle is maintained at low pressure, the high-pressure section of the refrigerant cycle is maintained at high pressure, and the needed heating operation is performed in the respective indoor units (416).

[0046] FIG. 5 is a timing chart illustrating the operation

and pressure characteristics of the respective components in the control method shown in FIG. 4. As shown in FIG. 5, when the cooling valves 164a and 164b of the first and second indoor units 140a and 140b, which need to be changed from the cooling operation to the heating operation, are turned off at the point of time when the compressor 122 is turned off and around the point of time when the hot gas bypass valve 106 is turned on (preferably, at the same time), the pressure of the low-pressure section of the refrigerant cycle (for example, approximately 5 kg/cm²) is gradually increased to a middle pressure (for example, approximately 10 kg/cm²). As a result, the outlet-side pressure of the first and second indoor units 140a and 140b, which have performed the cooling operation, is also gradually increased from the low pressure (approximately 5 kg/cm²) to the middle pressure (approximately 10 kg/cm²).

[0047] On the other hand, when the cooling valves 164a and 164b of the first and second indoor units 140a and 140b, which have performed the cooling operation, are not turned off at the point of time when the compressor 122 is turned off and around the point of time when the hot gas bypass valve 106 is turned on, but, as indicated by an arrow 502 of FIG. 5, the cooling valves 164a and 164b are turned off later than the point of time when the compressor 122 is turned off and the point of time when the hot gas bypass valve 106 is turned on, the outlet-side pressure of the first and second indoor units 140a and 140b, which have performed the cooling operation, has a pressure characteristic 504 as indicated by a dotted line of FIG. 5(I). Specifically, the outlet-side pressure of the first and second indoor units 140a and 140b, which have performed the cooling operation, is maintained at the low pressure (approximately 5 kg/cm²) until the point of time when the cooling valves 140a and 140b are turned off is reached. On the other hand, the pressure of the low-pressure section (i.e., the low-pressure gas pipe 136) is increased to the middle pressure (approximately 10 kg/cm²) by the pressure equilibrium between the low-pressure section and the high-pressure section due to the turn-on of the hot gas bypass valve 106. When the cooling valves 164a and 164b of the first and second indoor units 140a and 140b, which have performed the cooling operation, are turned off, while the outlet-side pressure of the first and second indoor units 140a and 140b, which have performed the cooling operation, is the lower pressure (approximately 5 kg/cm²), the pressure of the low-pressure section is the middle pressure (approximately 10 kg/cm²), and therefore, the pressure difference is great, as described above, the pressure difference between opposite ends of the respective first and second cooling valves 164a and 164b is increased to approximately 5 kg/cm². Due to this pressure difference, refrigerant flows backward from the low-pressure section of the refrigerant cycle to the first and second indoor units 140a and 140b through the first and second cooling valves 164a and 164b. This backward-flow of the refrigerant generates chattering noise from the first and sec-

ond cooling valves 164a and 164b.

[0048] Consequently, as shown in FIGS. 4 and 5, when the cooling valves 164a and 164b of the first and second indoor units 140a and 140b, which need to be changed from the cooling mode to the heating mode, are turned off at the point of time when the compressor 122 is turned off and around the point of time when the hot gas bypass valve 106 is turned on (preferably, at the same time), the pressure of the low-pressure section of the refrigerant cycle and the outlet-side pressure of the first and second indoor units 140a and 140b are gradually increased in unison from the low pressure (approximately 5 kg/cm²) to the middle pressure (approximately 10 kg/cm²). As a result, the backward-flow of the refrigerant due to the pressure difference does not occur, and therefore, the chattering noise due to the backward-flow of the refrigerant is hardly generated.

[0049] FIG. 6 is a flow chart illustrating a control method when the operation mode is changed from the "main cooling mode" to the "main heating mode" in the method of controlling the air conditioner shown in FIG. 3. As shown in FIG. 6, the compressor 122 is turned off (stopped), the hot gas bypass valve 106 is turned on (opened), and the first cooling valve 164a of the first indoor unit 140a, which needs to be changed from the cooling mode to the heating mode, are turned off (closed) so as to change the operation mode from the "main cooling mode" to the "main heating mode" (602). In this state, when the first predetermined time t1 (for example, approximately 1 minute) has elapsed ('yes' of 604), all of the cooling valves and the heating valves of the indoor units performing the operation are turned on (606). In this embodiment, the first cooling valve 164a, the first heating valve 162a, the second heating valve 162b, and the third cooling valve 164 are turned on (opened).

[0050] In this state, when the second predetermined time t2 (for example, approximately 2 minutes) has elapsed ('yes' of 608), the compressor 122 is turned on such that the operation is performed in the "main heating mode," the first and third cooling valves 164a and 164c and the second heating valve 162b are turned off, the first and third heating valves 162a and 162c and the second cooling valve 164b remain on (610). The hot gas bypass valve 106 remains on for the third predetermined time t3 (for example, approximately 1 minute) even after the compressor 122 has been turned on. When the third predetermined time has elapsed ('yes' of 612), the hot gas bypass valve 106 is turned off (614). As the hot gas bypass valve 106 is turned off while the compressor 122 is on, the low-pressure section of the refrigerant cycle is maintained at low pressure, the high-pressure section of the refrigerant cycle is maintained at high pressure, and the needed heating operation is selectively performed in the respective indoor units (616).

[0051] FIG. 7 is a timing chart illustrating the operation and pressure characteristics of the respective components in the control method shown in FIG. 6. As shown in FIG. 7, when the first cooling valve 164a of the first

indoor unit 140a, which needs to be changed from the cooling operation to the heating operation, is turned off at the point of time when the compressor 122 is turned off and around the point of time when the hot gas bypass valve 106 is turned on (preferably, at the same time), the pressure of the low-pressure section of the refrigerant cycle (approximately 5 kg/cm²) is gradually increased to the middle pressure (approximately 10 kg/cm²). As a result, the outlet-side pressure of the first indoor unit 140a, which has performed the cooling operation, is also gradually increased from the low pressure (approximately 5 kg/cm²) to the middle pressure (approximately 10 kg/cm²) as in the low-pressure section.

[0052] On the other hand, when the first cooling valve 164a of the first indoor unit 140a, which has performed the cooling operation, is not turned off at the point of time when the compressor 122 is turned off and around the point of time when the hot gas bypass valve 106 is turned on, but, as indicated by an arrow 702 of FIG. 7, the first cooling valve 164a is turned off later than the point of time when the compressor 122 is turned off and the point of time when the hot gas bypass valve 106 is turned on, the outlet-side pressure of the first indoor unit 140a, which has performed the cooling operation, has a pressure characteristic 704 as indicated by a dotted line of FIG. 7 (I). As a result, chattering noise is generated as previously described with reference to FIG. 5.

[0053] Consequently, as shown in FIG. 7, when the first cooling valve 164a of the first indoor unit 140a, which needs to be changed from the cooling mode to the heating mode, is turned off at the point of time when the compressor 122 is turned off and around the point of time when the hot gas bypass valve 106 is turned on (preferably, at the same time), the pressure of the low-pressure section of the refrigerant cycle and the outlet-side pressure of the first indoor unit 140a are gradually increased in unison from the low pressure (approximately 5 kg/cm²) to the middle pressure (approximately 10 kg/cm²). As a result, the backward-flow of the refrigerant due to the pressure difference does not occur, and therefore, the chattering noise due to the backward-flow of the refrigerant is not generated.

[0054] As apparent from the above description, the cooling valves of the indoor units, which need to be changed from the cooling mode to the heating mode, are turned off at the point of time when the compressor is turned off and around the point of time when the hot gas bypass valve is turned on. Consequently, the preset invention has the effect of reducing the pressure difference between the high-pressure and low-pressure sections of the refrigerant cycle, greatly reducing the chattering noise generated due to the backward-flow of the refrigerant in the cooling valves, and therefore, greatly improving satisfaction of users (consumers).

[0055] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the prin-

ciples and spirit of the invention, the scope of which is defined in the claims and their equivalents.

5 Claims

1. An air conditioner comprising:

a compressor;
at least one indoor unit;
a mode change unit including a cooling valve openable to perform a cooling operation of the indoor unit and a heating valve openable to perform a heating operation of the indoor unit;
a refrigerant cycle to connect the compressor, the mode change unit, and the indoor unit;
a hot gas bypass valve disposed between inlet and outlet sides of the compressor; and
a controller to control the cooling valve to be turned off for a first predetermined time around the point of time when the hot gas bypass valve is turned on, when operation mode of the indoor unit is changed from cooling mode to heating mode, so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of an outlet side of the indoor unit.

2. The air conditioner according to claim 1, wherein the controller controls the compressor to be turned off around the point of time when the hot gas bypass valve is turned on.

3. The air conditioner according to claim 2, wherein the controller controls the compressor to be turned on and the cooling valve to be turned off when a second predetermined time has elapsed after the cooling valve and the heating valve are turned on.

4. The air conditioner according to claim 3, wherein the controller controls the hot gas bypass valve to be turned off when a third predetermined time has elapsed after the compressor is turned on.

5. The air conditioner according to claim 1, wherein the controller controls the cooling valve and the heating valve to be turned on after the first predetermined time has elapsed.

6. The air conditioner according to claim 1, wherein the cooling valve and the heating valve are normally closed type valves, which are turned on to make refrigerant forcibly flow in a predetermined direction.

7. The air conditioner according to claim 1, wherein, the at least one indoor unit comprises a plurality of indoor units, and, when the total heating capacity needed in the indoor units is greater than the total

cooling capacity, the controller controls the cooling valve to be turned off so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of outlet sides of the indoor units.

8. The air conditioner according to claim 1, wherein the controller controls the cooling valve to be turned off for the first predetermined time such that the pressure of the high-pressure section of the refrigerant cycle and the pressure of the outlet side of the indoor unit can be increased in unison to a middle pressure, which is between a low pressure and a high pressure.
9. A method of controlling an air conditioner comprising a compressor, at least one indoor unit, a mode change unit including a cooling valve openable to perform a cooling operation of the indoor unit and a heating valve openable to perform a heating operation of the indoor unit, a refrigerant cycle to connect the compressor, the mode change unit, and the indoor unit, and a hot gas bypass valve disposed between inlet and outlet sides of the compressor, wherein the method comprises
controlling the cooling valve to be turned off for a first predetermined time around the point of time when the hot gas bypass valve is turned on, when operation mode of the indoor unit is changed from cooling mode to heating mode, so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of an outlet side of the indoor unit.
10. The method according to claim 9, further comprising:
controlling the compressor to be turned off around the point of time when the hot gas bypass valve is turned on.
11. The method according to claim 10, further comprising:
controlling the compressor to be turned on and the cooling valve to be turned off when a second predetermined time has elapsed after the cooling valve and the heating valve are turned on.
12. The method according to claim 11, further comprising:
controlling the hot gas bypass valve to be turned off when a third predetermined time has elapsed after the compressor is turned on.
13. The method according to claim 9, further comprising:
controlling the cooling valve and the heating valve to be turned on after the first predeter-

mined time has elapsed.

14. The method according to claim 9, wherein the cooling valve and the heating valve are normally closed type valves, which are turned on to make refrigerant forcibly flow in a predetermined direction.
15. The method according to claim 9, wherein the at least one indoor unit comprises a plurality of indoor units, and the method further comprises:
when the total heating capacity needed in the indoor units is greater than the total cooling capacity, controlling the cooling valve to be turned off so as to minimize the difference between the pressure of a high-pressure section of the refrigerant cycle and the pressure of outlet sides of the indoor units.
16. The method according to claim 9, further comprising:
controlling the cooling valve to be turned off for the first predetermined time such that the pressure of the high-pressure section of the refrigerant cycle and the pressure of the outlet side of the indoor unit can be increased in unison to a middle pressure, which is between a low pressure and a high pressure.

Fig.1

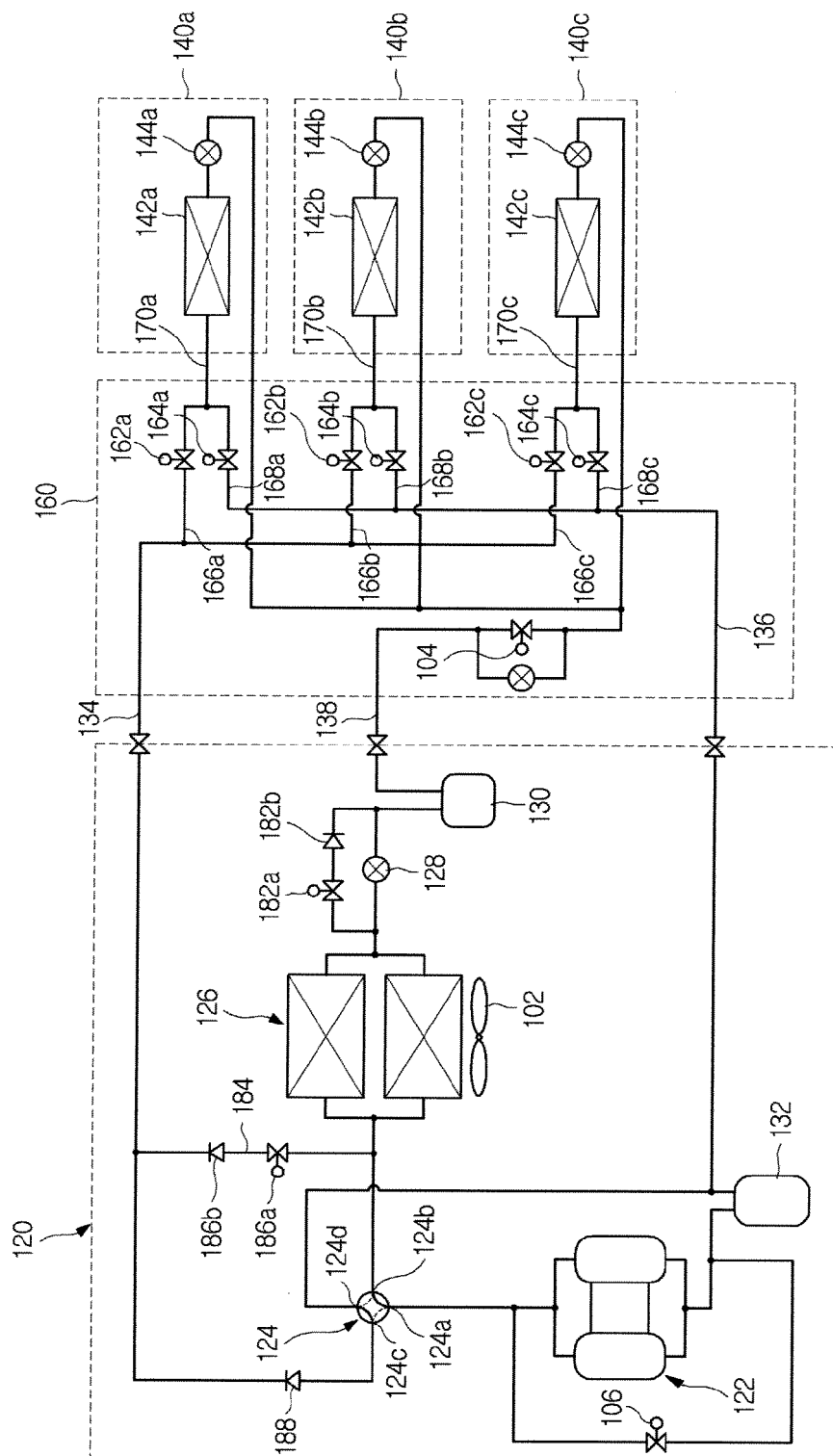


Fig.2

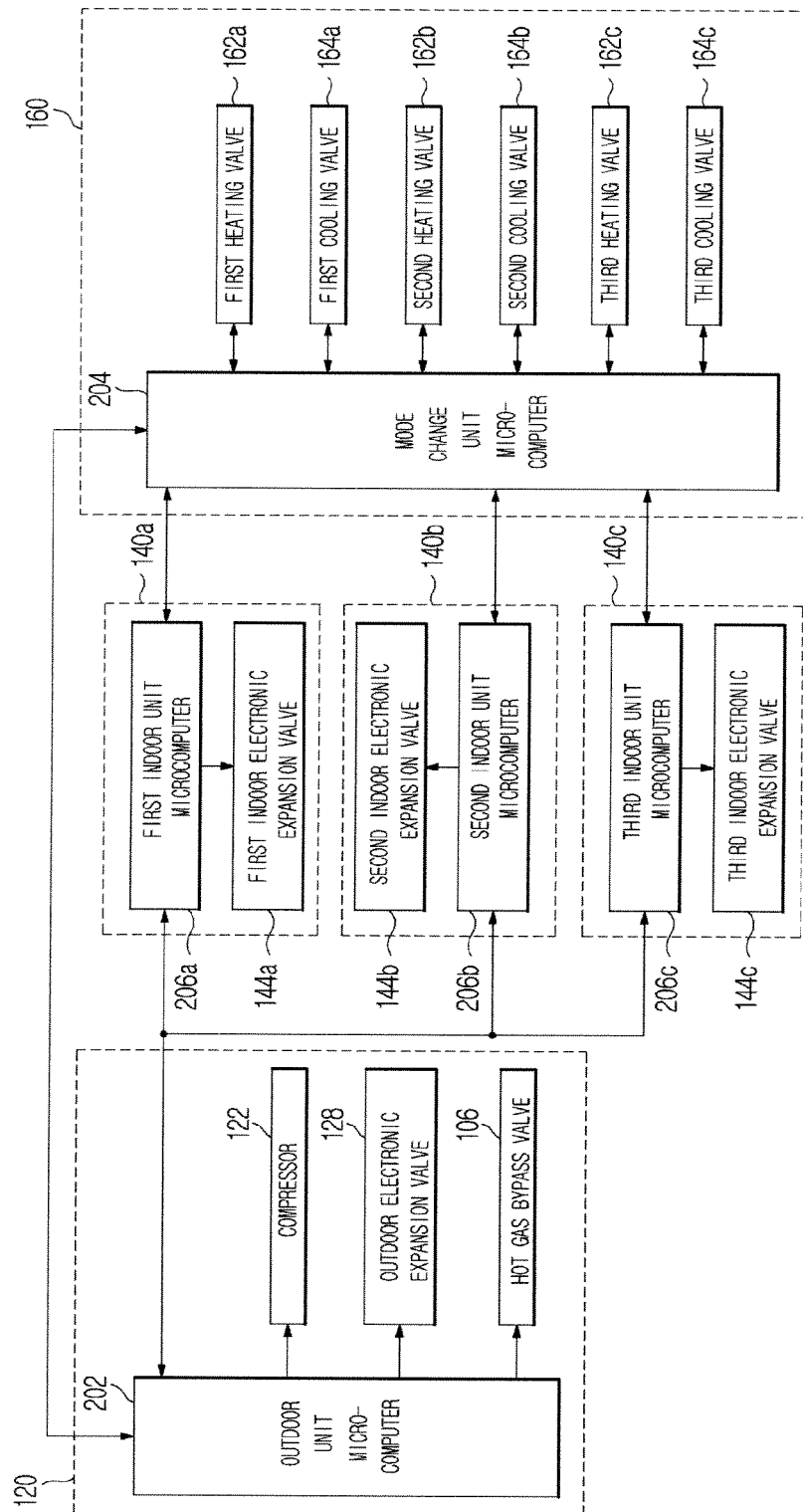


Fig.3

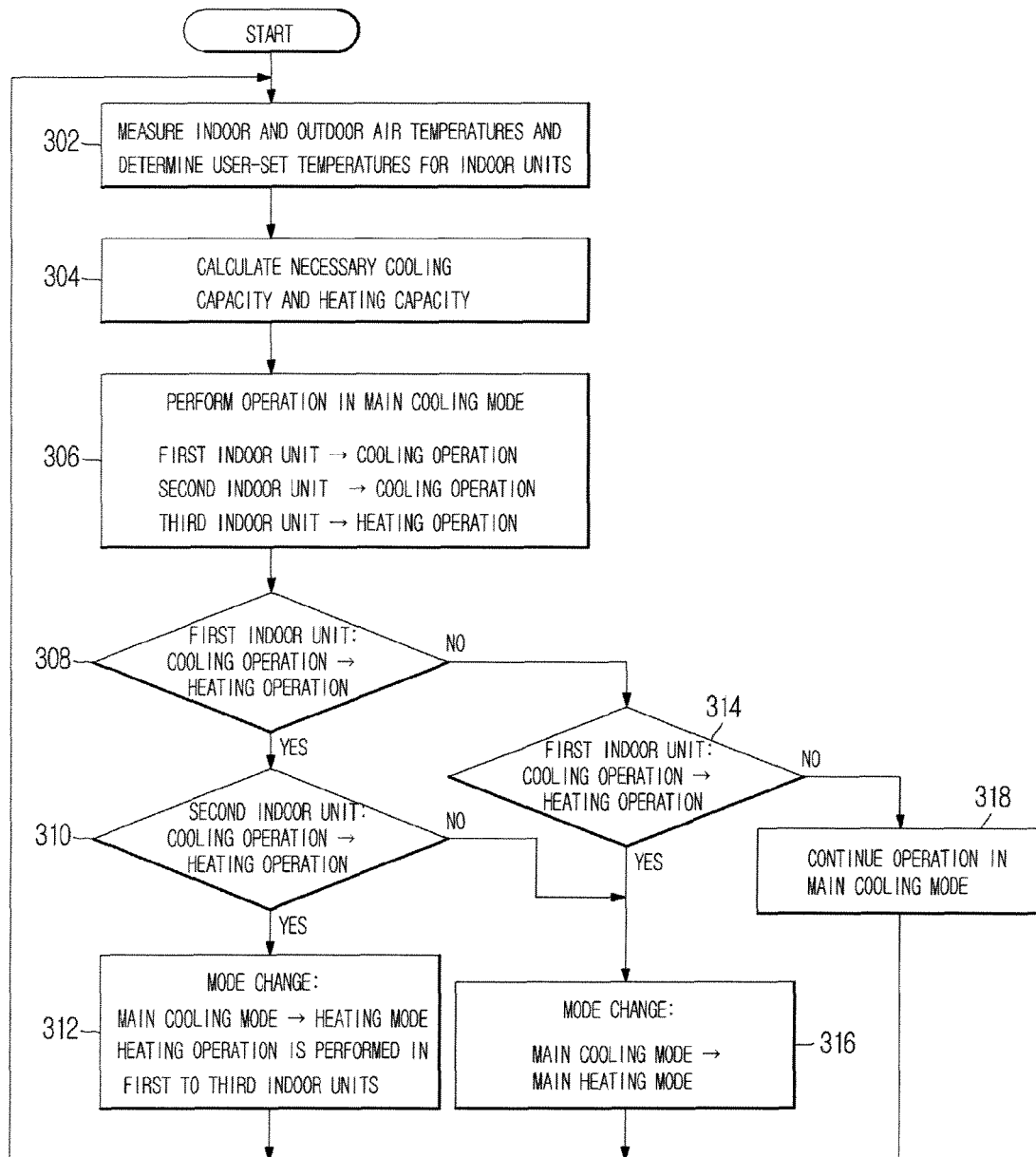


Fig.4

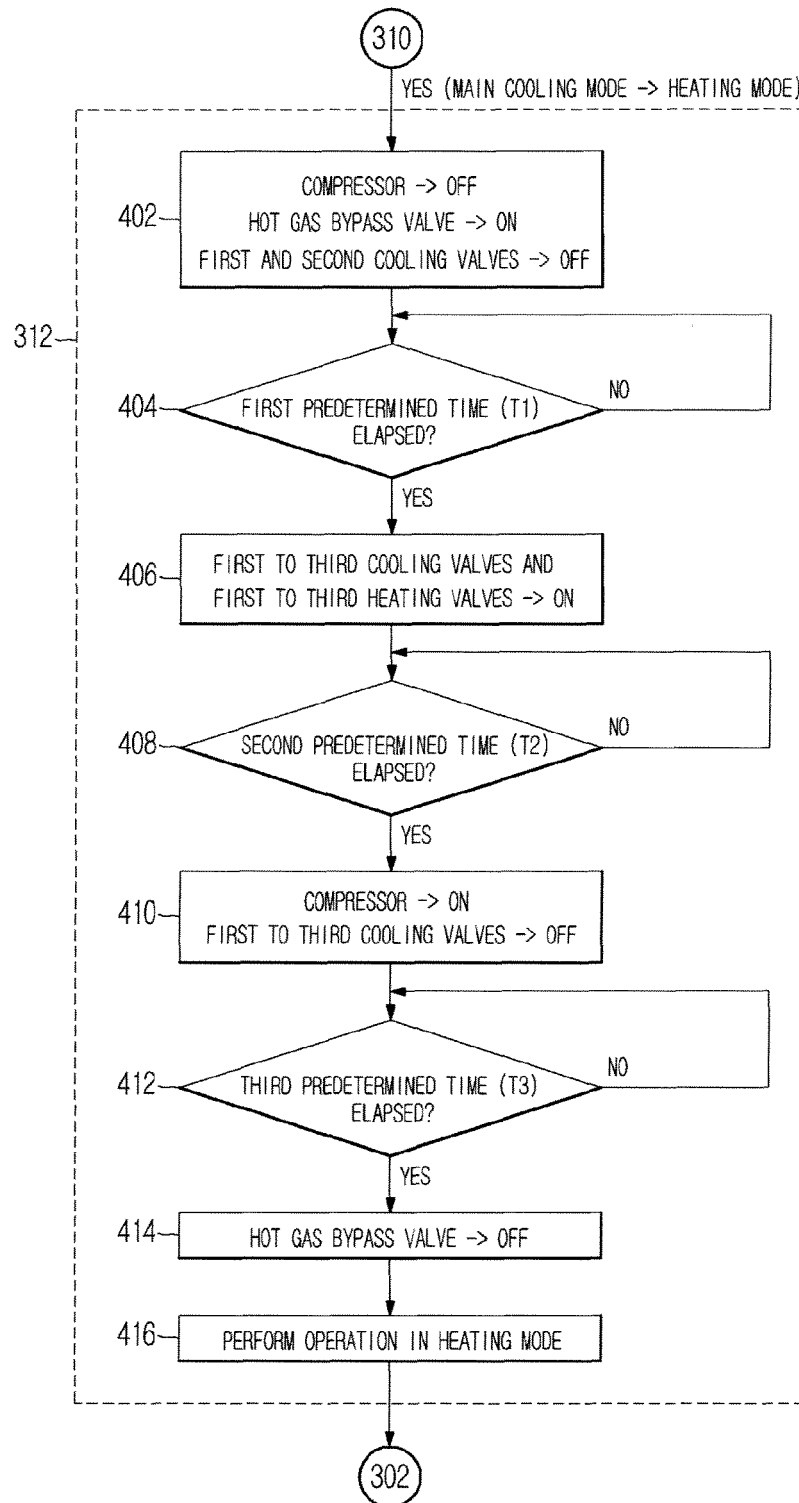


Fig.5

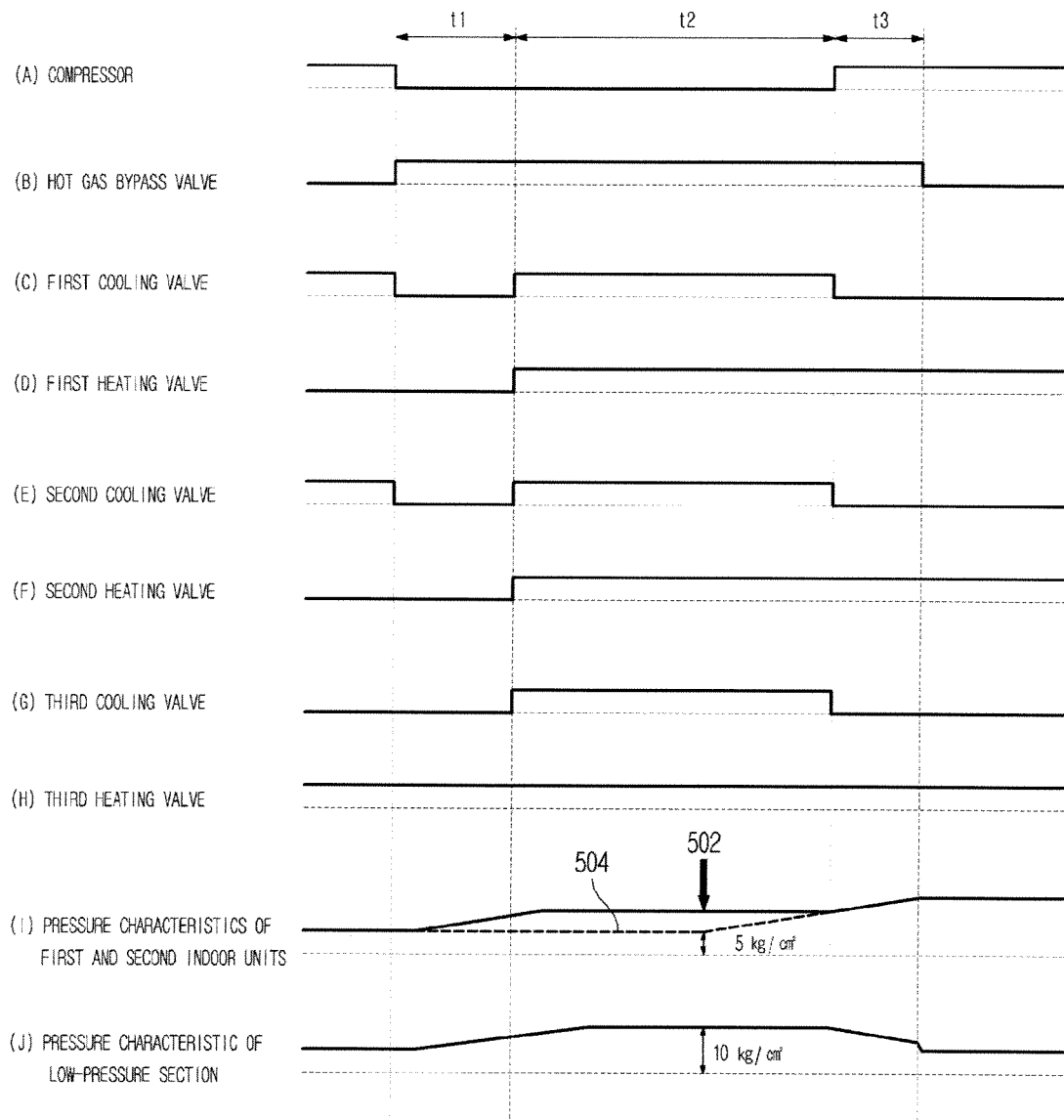


Fig.6

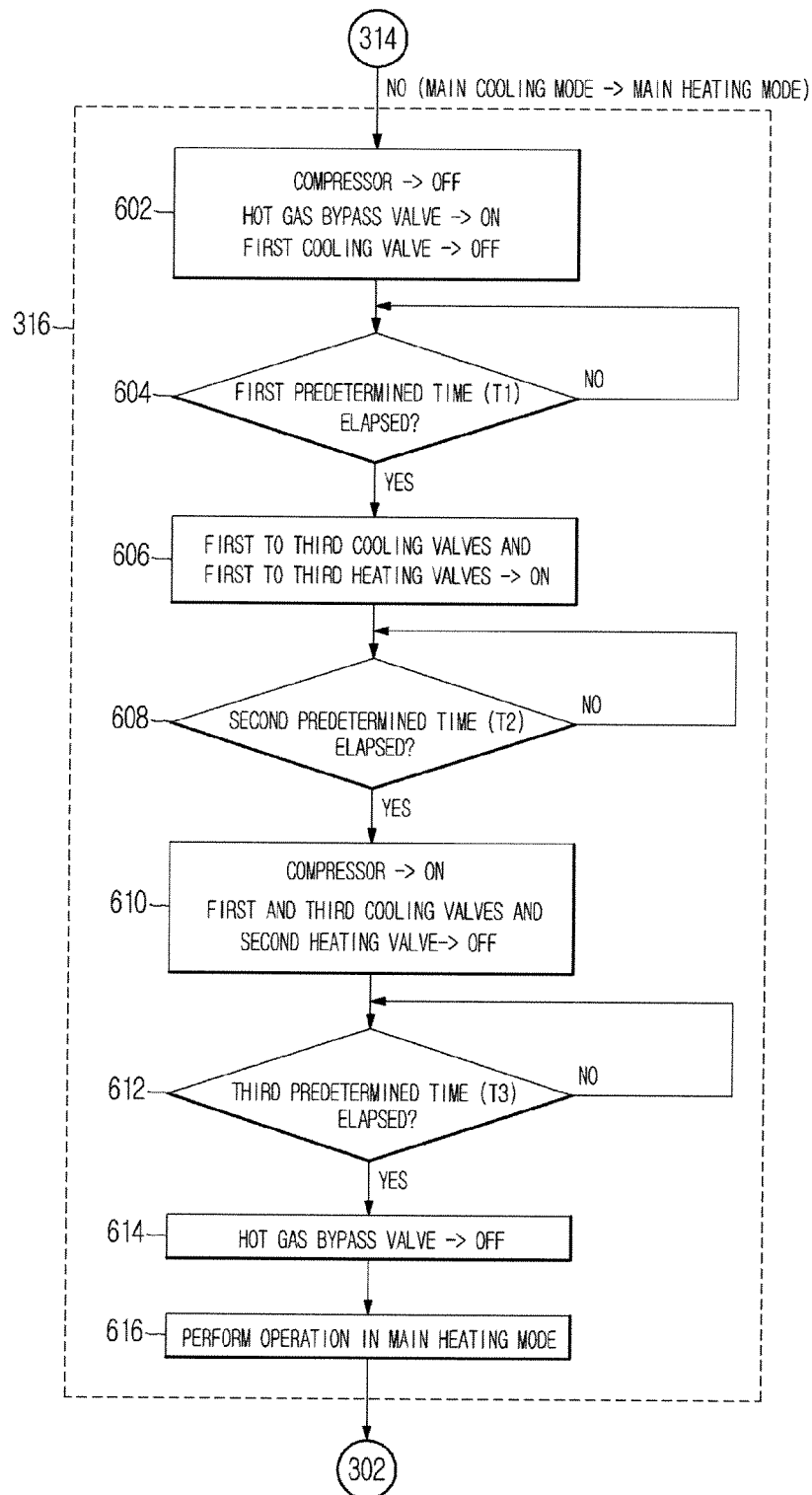
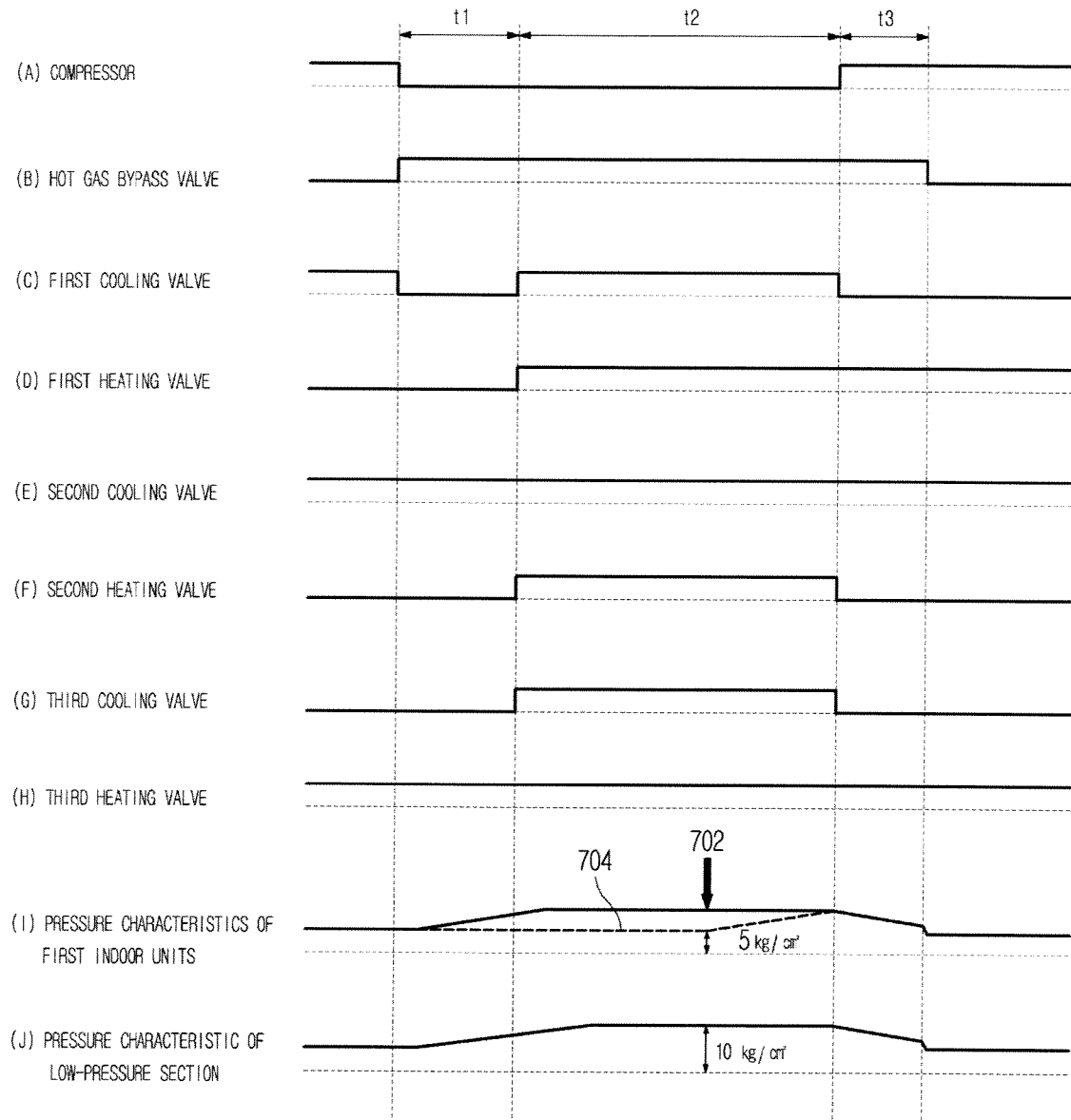


Fig.7





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			F25B F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 April 2007	Examiner Valenza, Davide
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