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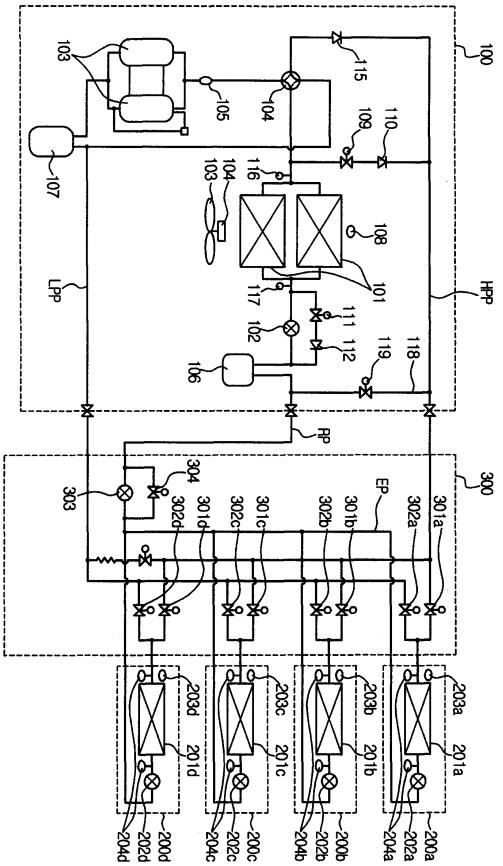
(54) Multi-unit air conditioning system

(57) A multi-chamber type air conditioning system for simultaneously operating a plurality of indoor units in heating and cooling modes, and a method for controlling the system. The multi-chamber type air conditioning system includes a bypass circuit connected between a high-pressure gas pipe, connected between an outlet of a compressor and the indoor units, and a liquid pipe, connected between the outdoor heat exchanger and the indoor units; and a control unit for controlling the quantity of the refrigerant flowing into the indoor units, operated in a cooling mode, using the bypass circuit based on operating conditions. The multi-chamber type air conditioning system increases the quantity of a refrigerant flowing into the indoor units, operated in the cooling mode, so as not to deteriorate the cooling capacities of the indoor units, operated in the cooling mode, thereby increasing performances of the indoor units, operated in the cooling mode, when the system is operating in a main heating mode. Further, the multi-chamber type air conditioning system controls the opening degree of an outdoor electric valve such that the pressure of the refrigerant at an outlet of a compressor is in a proper range, thereby being stabilized in a short period of time.

FIG.1



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Description

[0001] The present invention relates to a multi-chamber type air conditioning system comprising an outdoor unit, a plurality of indoor units individually operable in cooling and heating modes, a high pressure refrigerant supply pipe from the outdoor unit, a liquid refrigerant supply pipe from the outdoor unit to a first port of each indoor unit, a low pressure refrigerant return pipe to the outdoor unit, indoor unit flow control valves for selectively connecting a second port of each indoor unit to either the high pressure refrigerant supply pipe or the low pressure refrigerant return pipe and control means for controlling said valves.

[0002] Generally, a multi-chamber type air conditioning system performs air conditioning operations in indoor spaces using a plurality of indoor units connected to one outdoor unit.

[0003] The air conditioning requirements of the indoor spaces, in which each of the indoor units is installed, may be uniformly set or varied according to the surrounding environments of the indoor spaces. Since inhabitants in the indoor spaces have different temperatures requirements, some indoor units can be operated in a heating mode while other indoor units are being operated in a cooling mode.

[0004] In order to simultaneously operate different indoor units in the cooling and heating modes, a refrigerant distributor is installed between the outdoor unit and the indoor units for controlling the flow of refrigerant and the refrigerant, which flows from the outdoor units through the refrigerant distributor, is suitably supplied to the indoor units required to be operated in the heating mode and the indoor units required to be operated in the cooling mode.

[0005] When different indoor units are simultaneously operated in the cooling and heating modes, in the case that the heating load on the indoor units, operated in the heating mode, is higher than the cooling load on the indoor units, operated in the cooling mode, the multi-chamber type air conditioning system is operated in a mainly heating mode.

[0006] In the mainly heating mode, a sufficient quantity of the refrigerant is supplied to the indoor units, operated in the heating mode, but an insufficient quantity of the refrigerant is supplied to the indoor units, operated in the cooling mode, thereby deteriorating their cooling capacities. Accordingly, the multi-chamber type air conditioning system requires a satisfactory indoor unit cooling capacity at the same time as a satisfactory indoor unit heating capacity.

[0007] When the pressure of a compressor is high, the heating capacity of the indoor units, operated in the heating mode, is increased and the high pressure of the refrigerant at an outlet of the compressor in the mainly heating mode is maintained. When the pressure of the refrigerant at the outlet of the compressor is excessively increased, the capacity of the compressor is forcibly lowered so as to protect the compressor, thereby steeply decreasing the pressure of the refrigerant at the outlet of the compressor. Accordingly, when the conventional multi-chamber type air conditioning system is operated in the mainly heating mode, the pressure of the compressor is excessively increased and is then suddenly decreased. Thus, unstable operation of the compressor is maintained, thereby lengthening the time taken to stabilizing the multi-chamber type air conditioning system.

[0008] Therefore, an aspect of the invention is to provide a multi-chamber type air conditioning system, which has a satisfactory heating capacity of indoor units, operated in a heating mode, and a satisfactory cooling capacity of indoor units, operated in a cooling mode, when the indoor units are simultaneously operated in the heating and cooling modes based on a mainly heating mode, and a method for controlling the multi-chamber type air conditioning system.

[0009] Another aspect of the present invention is to provide a multi-chamber type air conditioning system, which controls the pressure of a refrigerant at an outlet of a compressor using an outdoor electric valve in a mainly heating mode so that the system is rapidly stabilized, and a method for controlling the multi-chamber type air conditioning system.

[0010] In accordance with one aspect, the present invention provides a multi-chamber type air conditioning system, which is provided with a refrigerant distributor connected between an outdoor unit and a plurality of indoor units for controlling the flow of a refrigerant, and simultaneously performs cooling and heating operations: a compressor; an outdoor heat exchanger; a high-pressure gas pipe connected between an outlet of the compressor and the indoor units; a liquid pipe connected between the outdoor heat exchanger and the indoor units; a bypass circuit connected between the high-pressure gas pipe and the liquid pipe; and a control unit for controlling the quantity of the refrigerant flowing into the indoor units, operated in a cooling mode, using the bypass circuit based on operating conditions.

[0011] The control unit may increase the quantity of the refrigerant flowing into the indoor units, operated in the cooling mode, in case that the sum total of heating capacities of the indoor units, operated in a heating mode, is higher than the sum total of cooling capacities of the indoor units, operated in the cooling mode, and a heating percentage is in a predetermined range.

[0012] The bypass circuit may include a bypass channel provided with one end connected to the high-pressure gas pipe and the other end connected to the liquid pipe, and a valve installed on the bypass channel for controlling the pressure of the liquid pipe; and the control unit may open the valve to increase the quantity of the refrigerant flowing into the indoor units, operated in the cooling mode.

[0013] The multi-chamber type air conditioning system may further comprise an outdoor electric valve connected to a compressor sensor, for sensing the pressure of the

refrigerant at the outlet of the compressor, and the outdoor heat exchanger; and the control unit may control the opening degree of the outdoor electric valve based on the pressure of the refrigerant at the outlet of the compressor, in case that the opening degree of the outdoor electric valve, set by the sum total of heating capacities of the indoor units, operated in a heating mode, and the sum total of cooling capacities of the indoor units, operated in the cooling mode, is in a predetermined range.

[0014] The control unit may increase the opening degree of the outdoor electric valve in case that the pressure of the refrigerant at the outlet of the compressor is higher than the predetermined range, and decrease the opening degree of the outdoor electric valve in case that the pressure of the refrigerant at the outlet of the compressor is lower than the predetermined range.

[0015] The control unit may compare an average pressure, obtained by averaging the pressure of the refrigerant at the outlet of the compressor for a predetermined time, with the predetermined range.

[0016] In accordance with another aspect, the present invention provides a method for controlling a multi-chamber type air conditioning system for allowing a plurality of indoor units connected to an outdoor unit to simultaneously perform cooling and heating operations, comprising: setting an operating mode according to the sum total of heating capacities of the indoor units, operated in a heating mode, and the sum total of cooling capacities of the indoor units, operated in a cooling mode; and allowing a part of a refrigerant, to be supplied to the indoor units, operated in the heating mode, to flow into the indoor units, operated in the cooling mode, when a heating percentage, set by the sum total of the heating capacities and the sum total of the cooling capacities, is in a predetermined range in case that set operating mode is a mainly heating mode in which a larger number of the indoor units are operated in the heating mode and a smaller number of the indoor units are operated in the cooling mode.

[0017] The predetermined range may be higher than 50% and lower than 82%.

[0018] The pressure of the refrigerant at an outlet of a compressor may be sensed and the opening degree of an outdoor electric valve connected to an outdoor heat exchanger may be controlled based on the sensed pressure of the refrigerant, during the operation in the mainly heating mode.

[0019] The opening degree of the outdoor electric valve may be increased in case that the pressure of the refrigerant at the outlet of the compressor is higher than the predetermined range, and the opening degree of the outdoor electric valve may be decreased in case that the pressure of the refrigerant at the outlet of the compressor is lower than the predetermined range.

[0020] An average pressure, obtained by averaging the pressure of the refrigerant at the outlet of the compressor, may be compared with the predetermined range.

[0021] In another aspect, a multi-chamber air conditioning system, according to the present invention, is characterised by a controlled valve for controlling the flow of refrigerant between the high pressure refrigerant supply pipe and the liquid refrigerant supply pipe and the control means being configured to control the state of the controlled valve in dependence on the current operating conditions of the indoor units.

[0022] An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a multi-chamber type air conditioning system in accordance with the present invention;

Figure 2 is a block diagram of the multi-chamber type air conditioning system of Figure 1;

Figure 3 is a schematic view illustrating the flow of refrigerant, when the multi-chamber type air conditioning system of Figure 1 is being operated in its mainly heating mode;

Figure 4 is a flowchart illustrating a process for controlling the quantity of the refrigerant flowing into indoor units operating in cooling mode using a pressure-control valve provided in a bypass circuit, when the multi-chamber type air conditioning system of Figure 1 is being operated in its mainly heating mode; and

Figure 5 is a flowchart illustrating a process for controlling the pressure of a compressor using an outdoor electric valve, when the multi-chamber type air conditioning system of Figure 1 is being operated in its mainly heating mode.

[0023] A multi-chamber type air conditioning system in accordance with the present invention, as shown in Figure 1, comprises an outdoor unit 100, a plurality of indoor units 200a, 200b, 200c, 200d, and a refrigerant distributor 300 connected between the outdoor unit 100 and the indoor units 200a, 200b, 200c, 200d for controlling the flow of a refrigerant.

[0024] The outdoor unit 100 includes an outdoor heat exchanger 101, an outdoor fan 113, an outdoor fan motor 114, an outdoor electric valve 102 connected to an outlet of the outdoor heat exchanger 101, a switch valve 111 and a check valve 112 connected in parallel with the outdoor electric valve 102, a check valve 115, a compressor 103, a four-way valve 104, a receiver 106, an accumulator 107, and a switch valve 109 and a check valve 110 for causing the refrigerant, discharged from the compressor 103, to go around the outdoor heat exchanger 101 and be supplied to the indoor units, which are operating in heating mode.

[0025] The outdoor unit 100 further includes an outdoor temperature sensor 108 for sensing the outdoor temperature, a pressure sensor 105 for sensing the pressure of the refrigerant discharged from the compressor 103 and pipe temperature sensors 116, 117 for sensing

the inlet and outlet temperatures respectively of the outdoor heat exchanger 101.

[0026] A liquid pipe RP is installed between the outdoor heat exchanger 101 of the outdoor unit 100 and the refrigerant distributor 300 and the outdoor electric valve 102 is installed in the liquid pipe RP. The switch valve 111, connected in parallel with the outdoor electric valve 102, is a flow rate control valve.

[0027] The outdoor unit 100 further comprises a bypass channel 118, connected between a high-pressure gas pipe HPP and the liquid pipe RP, and a pressure-control switch valve 119, installed in the bypass channel 118. When the switch valve 119 is opened in the mainly heating mode, some of the refrigerant, flowing through the high-pressure gas pipe HPP, passes through the bypass channel 118 and joins the refrigerant flowing through the liquid pipe RP, thereby increasing the refrigerant pressure in the liquid pipe RP. The above operation of the switch valve 119 is achieved under the control of an outdoor control unit, which is described below.

[0028] In the mainly heating mode, the pressure of the refrigerant at the outlet of the compressor 103 is maintained high. Accordingly, the opening degree of the outdoor electric valve 102 is controlled such that the correct refrigerant pressure is maintained at the outlet of the compressor 103, thereby stabilizing the system. The opening degree of the outdoor electric valve 102 is controlled by the outdoor control unit, which is described below.

[0029] The indoor units 200a, 200b, 200c, 200d each include an indoor heat exchanger 201a, 201b, 201c, 201d, an indoor electric valve 202a, 202b, 202c, 202d, an indoor temperature sensor 203a, 203b, 203c, 203d for sensing the local indoor temperature, and a pipe temperature sensor 204a, 204b, 204c, 204d for sensing the inlet and outlet temperatures of the indoor unit's indoor heat exchanger 201a, 201b, 201c, 201 d. The indoor units 200a, 200b, 200c, 200d further include respective indoor fans (not shown) and respective indoor fan motors (not shown).

[0030] The refrigerant distributor 300 includes high-pressure gas valves 301a, 301b, 301c, 301d connected between the high-pressure gas pipe HPP and respective indoor units 200a, 200b, 200c, 200d, low-pressure gas valves 302a, 302b, 302c, 302d connected between a low-pressure gas pipe LPP and respective indoor units 200a, 200b, 200c, 200d, and an electric valve 303 and a switch valve 304 connected in parallel between the liquid pipe RP and the indoor units 200a, 200b, 200c, 200d. The operation of the above valves of the refrigerant distributor 300 is achieved under the control of the outdoor control unit, which is described below.

[0031] One port of the four-way valve 104 of the outdoor unit 100 is connected to the high-pressure gas valves 301a, 301b, 301c, 301d of the refrigerant distributor 300 through the high-pressure gas pipe HPP. The accumulator 107 of the outdoor unit 100 is connected to the low-pressure gas valves 302a, 302b, 302c, 302d of the refrigerant distributor 300 through the low-pressure gas pipe LPP.

[0032] The liquid pipe RP is connected a branch pipe EP. The branch pipe EP is branched toward the indoor units 200a, 200b, 200c, 200d and connected to the indoor electric valves 202a, 202b, 202c, 202d.

[0033] The air conditioning system of the present invention, as shown in Figure 2, comprises an outdoor control unit 120 for controlling the outdoor unit 100, first to fourth indoor control units 210a, 210b, 210c, 210d for controlling the indoor units 200a, 200b, 200c, 200d and a connection unit 122 connected between the outdoor control unit 120 and the indoor control units 210a, 210b, 210c, 210d for the bidirectional communication of data for the operation of the air conditioning system.

[0034] The pressure sensor 105, the outdoor temperature sensor 108 and the pipe temperature sensors 116, 117 are connected to input terminals of the outdoor control unit 120.

[0035] A compressor-operating unit 124 for operating the compressor 103, a four-way valve-operating unit 126 for operating the four-way valve 104, an outdoor fan-operating unit 128 for operating the outdoor fan 105, an outdoor electric valve-operating unit 130 for operating the outdoor electric valve 102 and a switch valve-operating unit 132 for operating the switch valves 109, 111, 119 are connected to output terminals of the outdoor control unit 120.

[0036] The indoor control units 210a, 210b, 210c, 210d respectively supply indoor temperatures, sensed by the indoor temperature sensors 203a, 203b, 203c, 203d, target temperatures and operating modes, set by the user using function keys or a remote controller, and data, regarding the capacities of the indoor units 200a, 200b, 200c, 200d, to the outdoor control unit 120.

[0037] The indoor control units 210a, 210b, 210c, 210d, in cooperation with the outdoor control unit 120, control the indoor electric valves 202a, 202b, 202c, 202d and the indoor fan motors (not shown).

[0038] Figure 3 illustrates the flow of refrigerant, when the multi-chamber type air conditioning system of the present invention is operated in the mainly heating mode, in which three indoor units 200a, 200b, 200c are operating in heating mode and the remaining indoor unit 200d is operating in cooling mode.

[0039] In the case that the multi-chamber type air conditioning initially operates in the mainly heating mode, the outdoor control unit 120 operates the compressor 103, controls the outdoor electric valve 102 to have an initial opening degree and opens the switch valve 109. The outdoor control unit 120 opens the high-pressure gas valves 301a, 301b, 301c of the indoor units 200a, 200b, 200c, which are operating in heating mode, and closes the high-pressure gas valve 301d of the indoor unit 200d, which is operating in cooling mode. Furthermore, the outdoor control unit 120 closes the low-pressure gas valves 302a, 302b, 302c of the indoor units 200a, 200b, 200c, which are operating in heating mode, and opens the low-pressure gas valve 302d of the indoor

unit 200d, which is operating in cooling mode.

[0040] Most of the refrigerant discharged from the compressor 103, as indicated by the solid line arrows, passes through the switch valve 109 and the check valve 110, and is the supplied to the indoor units 200a, 200b, 200c, which are operating in the heating mode. The remainder of the refrigerant discharged from the compressor 103, as indicated by dotted line arrows, passes through the outdoor heat exchanger 101 and the outdoor electric valve 102.

[0041] In the mainly heating mode, the sum total (HQ) of heating capacities is higher than the sum total (CQ) of cooling capacities, but the heating percentage varies according to the operating conditions of the indoor units 200a, 200b, 200c, 200d. In the case that the heating percentage in the mainly heating mode is in the range of 50~82%, in order to prevent the cooling capacity of the indoor unit 200d from deteriorating, the outdoor control unit 120 opens the switch valve 119 so that high pressure refrigerant flows into the liquid pipe RP through the bypass channel 118, increasing the refrigerant pressure in the liquid pipe RP.

[0042] The high pressure refrigerant, which has flown into the liquid pipe RP, joins the refrigerant, which has passed through the outdoor electric valve 102, and then flows, as indicated by the one-dot chain arrows. The refrigerant passing through the liquid pipe RP joins the refrigerant, which has passed through the indoor units 200a, 200b, 200c, which are operating in the heating mode, and is then supplied to the indoor unit 200d, which is operating in cooling mode, as indicated by the two-dot chain arrows, thereby increasing the quantity of refrigerant flowing into the indoor unit 200d, which is operating in the cooling mode, and thus increasing the cooling capacity. The refrigerant, which has flown into the indoor unit 200d, passes through the indoor electric valve 202d and the indoor heat exchanger 201 d of the indoor unit 200d, which is operating in the cooling mode, and is then returned to the compressor 103 through the low-pressure gas pipe LPP. The refrigerant is circulated by the above procedure.

[0043] In the mainly heating mode, the outlet of the compressor 103 maintains a high pressure state. During the operation, the outdoor control unit 120 controls the opening degree of the outdoor electric valve 102 so that the proper pressure of the refrigerant at the outlet of the compressor 103 is maintained.

[0044] A method of controlling the above-described multi-chamber type air conditioning system will now be described in detail.

[0045] As shown in Figure 4, when power is supplied to the multi-chamber type air conditioning system, the outdoor control unit 120 performs initialization (S401). The initialization is automatically achieved based on a predetermined control program in order to perform an air conditioning operation.

[0046] After the initialization is completed, the individual indoor control units 210a, 210b, 210c, 210d supply operating mode signals for setting the heating and cooling modes of the indoor units 200a, 200b, 200c, 200d, set capacities of the indoor heat exchangers 201a, 201b, 201c, and 201d of the indoor units 200a, 200b, 200c, 200d, set temperatures, and indoor temperatures to the outdoor control unit 120 through the connection unit 122. Furthermore, the outdoor temperature sensor 108 supplies an outdoor temperature to the outdoor control unit 120 (S403).

[0047] The outdoor control unit 120 calculates the heating capacity (heating load) and the cooling capacity (cooling load) on the basis on the above supplied data. The outdoor control unit 120 calculates the sum total (HQ) of the heating capacities of the indoor units, which are set to heating mode, and the sum total (CQ) of the cooling capacities of the indoor units, which are set to cooling mode (S405).

[0048] The outdoor control unit 120 compares the sum total (CQ) of the cooling capacities with the sum total (HQ) of the heating capacities, thereby determining whether or not the multi-chamber type air conditioning system is operating in the mainly heating mode (S407). If the results of the above comparison of step S407 indicate that the multi-chamber type air conditioning system is not operating in the mainly heating mode, the outdoor control unit 120 operates the multi-chamber type air conditioning system in a corresponding operating mode (i.e. a single mode, such as a cooling or heating mode, or a mainly cooling mode) (S408).

[0049] If the results of the above comparison of step S407 indicate that the sum total (HQ) of the heating capacities is higher than the sum total (CQ) of the cooling capacities, the operating mode of the multi-chamber type air conditioning system is set to the mainly heating mode and it is determined whether or not the heating percentage in the mainly heating mode is in the predetermined range of 50%~Hr (S409). Here, the heating percentage denotes the percentage of the sum total of the heating capacities relative to the total capacities, obtained by adding the sum total of the cooling capacities to the sum total of the heating capacities. Preferably, Hr is set to 82%.

[0050] In the case that the heating percentage is in the predetermined range, the outdoor control unit 120 controls the switch valve-operating unit 132 such that the switch valve 119 is opened (S411), increasing the pressure in the liquid pipe RP and thus allowing a larger quantity of the refrigerant to flow into the indoor units, which are operating in cooling mode.

[0051] If the results of the above determination of step S409 indicate that the heating percentage is not in the predetermined range, i.e. in the case that the heating percentage is more than 82%, the outdoor control unit 120 closes the switch valve 119 (S413). The closing of the switch valve 119 relatively increases the heating percentage, so that the sum total of the heating capacities is much higher than the sum total of the cooling capacities, and decreases the quantity of refrigerant required

by the indoor units, which are operating in cooling mode, so that the cooling capacities of the indoor units, which are operating in the cooling mode, are not sufficient.

[0052] The control unit 120 controls the opening degree of the outdoor electric valve 102 based on the pressure of the refrigerant at the outlet of the compressor 103 supplied from the temperature sensor 105. Hereinafter, with reference to Figure 5, the control of the opening degree of the outdoor electric valve 102 by the control unit 120 will be described.

[0053] The outdoor control unit 120 performs initialization (S501).

[0054] After the initialization is completed, the individual indoor control units 210a, 210b, 210c, 210d supply operating mode signals for setting the heating and cooling modes of the indoor units 200a, 200b, 200c, 200d, set capacities of the indoor heat exchangers 201a, 201b, 201c, 201d of the indoor units 200a, 200b, 200c, 200d, set temperatures and indoor temperatures to the outdoor control unit 120 through the connection unit 122. Furthermore, the outdoor temperature sensor 108 supplies an outdoor temperature to the outdoor control unit 120 (S503).

[0055] The outdoor control unit 120 calculates the sum total (HQ) of the heating capacities of the indoor units, which are set to the heating mode, and the sum total (CQ) of the cooling capacities of the indoor units, which are set to the cooling mode, based on the above supplied data (S505).

[0056] The outdoor control unit 120 compares the sum total (CQ) of the cooling capacities with the sum total (HQ) of the heating capacities, thereby determining whether or not the multi-chamber type air conditioning system is operating in the mainly heating mode (S507). If the results of the above comparison of step S507 indicate that the multi-chamber type air conditioning system is not operated in the mainly heating mode, the outdoor control unit 120 operates the multi-chamber type air conditioning system in a corresponding operating mode (S508).

[0057] If the results of the above comparison of step S507 indicate that the sum total (HQ) of the heating capacities is higher than the sum total (CQ) of the cooling capacities, the operating mode of the multi-chamber type air conditioning system is set to the mainly heating mode and the opening degree of the outdoor electric valve 102 is set according to the heating percentage in the mainly heating mode (S509). Here, the heating percentage denotes the percentage of the sum total of the heating capacities to the total capacities, obtained by adding the sum total of the cooling capacities to the sum total of the heating capacities.

[0058] The outdoor control unit 120 determines whether or not the set opening degree of the outdoor electric valve 102 is lower than a first reference value K1 (S511). Here, the first reference value K1 denotes an opening degree of 20% of the outdoor electric valve 102 and corresponds to 400 steps when the variable range of the outdoor electric valve 102 is 0 steps (completely closed) ~ 2,000 steps (completely opened).

[0059] In the case that the opening degree of the outdoor electric valve 102 set in step S511 is not lower than the first reference valve K1, the outdoor control unit 120 controls the opening degree of the outdoor electric valve 102 according to the overheating degree of the outdoor heat exchanger 101, calculated on the basis of the inlet temperature and the outlet temperature, input from the pipe temperature sensors 116, 117 (S512). Thereafter, step S507 is performed.

[0060] In the case that the opening degree of the outdoor electric valve 102 set in step S511 is lower than the first reference valve K1, the outdoor control unit 120 determines whether or not the set opening degree of the outdoor electric valve 102 is higher than a second reference value K2 (S513). Here, the second reference value K2 is lower than the first reference value K1 and corresponds to 250 steps when the variable range of the outdoor electric valve 102 is 0 steps (completely closed) ~ 2,000 steps (completely opened). In the case that the opening degree of the outdoor electric valve is set to 250 steps, the quantity of the refrigerant passing through the outdoor electric valve 102 is excessively small and the flow of the refrigerant is weak.

[0061] In the case that the opening degree of the outdoor electric valve 102 set in step S513 is higher than the second reference valve K2, the outdoor control unit 120 averages the pressure of the refrigerant at the outlet of the compressor 103, sensed by the pressure sensor 105, over a predetermined time T1 (S515). Preferably, the predetermined time T1 is 20 seconds.

[0062] Thereafter, it is determined whether or not the average pressure of the refrigerant at the outlet of the compressor 103, obtained in step S515, is higher than a predetermined value set for controlling the compressor 103 (S517). Here, the predetermined value is obtained by adding a designated value (A) to a target pressure (Pt).

[0063] In the case that the average pressure of the refrigerant at the outlet of the compressor 103 is higher than the predetermined value (Pt+A), the outdoor control unit 120 increases the opening degree of the outdoor electric valve 102 by a designated amount, for example, by 5 steps (S519). Thereby, the quantity of the refrigerant passing through the outdoor unit 101 and the outdoor electric valve 102 is increased and the pressure at the compressor 103 is decreased. Thereafter, step S507 is performed.

[0064] In the case that the average pressure of the refrigerant at the outlet of the compressor 103 is not higher than the predetermined value (Pt+A), it is determined whether or not the pressure of the refrigerant at the outlet of the compressor 103 is lower than the target pressure (Pt) for a predetermined time (2 minutes) and the average pressure of the refrigerant at the outlet of the compressor 103 for the final 20 seconds out of the predetermined time (2 minutes) is lower than the target pressure (Pt) (S521). As the results of the above determination, in case

that the average pressure is lower than the target pressure (Pt), the outdoor control unit 120 decreases the opening degree of the outdoor electric valve 102 by a designated amount, for example, by 5 steps (S523). Thereby, the quantity of the refrigerant passing through the outdoor unit 101 and the outdoor electric valve 102 is deceased and the pressure at the compressor 103 is increased. Thereafter, step S507 is performed.

[0065] In the case that the opening degree of the outdoor electric valve 102 set in step S513 is not higher than the second reference valve K2, i.e. in the case that the opening degree of the outdoor electric valve 102 is less than 250 steps, the quantity of the refrigerant passing through the outdoor electric valve 102 is excessively small and the flow of the refrigerant is weak. Accordingly, the outdoor control unit 120 sets the opening degree of the outdoor electric valve 102 to the first reference value K1 and maintains the first reference value K1 for a predetermined time T2 (S514). Preferably, the predetermined time T2 is 2 minutes. Thereafter, step S507 is performed.

[0066] As apparent from the above description, the present invention provides a multi-chamber type air conditioning system, in which a bypass channel is installed between a high-pressure gas pipe and a liquid pipe so that the pressure in the liquid pipe increases and the quantity of a refrigerant flowing into indoor units operated in a cooling mode increases so as not to deteriorate the cooling capacities of the indoor units operated in the cooling mode, and a method for controlling the system, thereby increasing performances of the indoor units operated in the cooling mode when the system is operating in a mainly heating mode.

[0067] Further, the opening degree of an outdoor electric valve of an outdoor unit of the multi-chamber type air conditioning system is controlled such that the pressure of the refrigerant at an outlet of a compressor is in a proper range when the opening degree of the outdoor electric valve set according to a heating percentage in the mainly heating mode is lower than a predetermined value, thereby allowing the system to be stabilized in a short period of time.

Claims

1. A multi-chamber type air conditioning system, which is provided with a refrigerant distributor connected between an outdoor unit and a plurality of indoor units for controlling the flow of a refrigerant, and simultaneously performs cooling and heating operations:

   a compressor;
   an outdoor heat exchanger;
   a high-pressure gas pipe connected between an outlet of the compressor and the indoor units;
   a liquid pipe connected between the outdoor heat exchanger and the indoor units;
   a bypass circuit connected between the high-pressure gas pipe and the liquid pipe; and
   a control unit for controlling the quantity of the refrigerant flowing into the indoor units, operated in a cooling mode, using the bypass circuit based on operating conditions.

2. The multi-chamber type air conditioning system as set forth in claim 1, wherein the control unit increases the quantity of the refrigerant flowing into the indoor units, operated in the cooling mode, in case that the sum total of heating capacities of the indoor units, operated in a heating mode, is higher than the sum total of cooling capacities of the indoor units, operated in the cooling mode, and a heating percentage is in a predetermined range.

3. The multi-chamber type air conditioning system as set forth in claim 1, wherein:

   the bypass circuit includes a bypass channel provided with one end connected to the high-pressure gas pipe and the other end connected to the liquid pipe, and a valve installed on the bypass channel for controlling the pressure of the liquid pipe; and
   the control unit opens the valve to increase the quantity of the refrigerant flowing into the indoor units, operated in the cooling mode.

4. The multi-chamber type air conditioning system as set forth in claim 1, further comprising an outdoor electric valve connected to a compressor sensor, for sensing the pressure of the refrigerant at the outlet of the compressor, and the outdoor heat exchanger, wherein the control unit controls the opening degree of the outdoor electric valve based on the pressure of the refrigerant at the outlet of the compressor, in case that the opening degree of the outdoor electric valve, set by the sum total of heating capacities of the indoor units, operated in a heating mode, and the sum total of cooling capacities of the indoor units, operated in the cooling mode, is in a predetermined range.

5. The multi-chamber type air conditioning system as set forth in claim 4,
   wherein the control unit increases the opening degree of the outdoor electric valve in case that the pressure of the refrigerant at the outlet of the compressor is higher than the predetermined range, and decreases the opening degree of the outdoor electric valve in case that the pressure of the refrigerant at the outlet of the compressor is lower than the predetermined range.

6. The multi-chamber type air conditioning system as set forth in claim 5,

wherein the control unit compares an average pressure, obtained by averaging the pressure of the refrigerant at the outlet of the compressor for a predetermined time, with the predetermined range.

7. A method for controlling a multi-chamber type air conditioning system for allowing a plurality of indoor units connected to an outdoor unit to simultaneously perform cooling and heating operations, comprising:

setting an operating mode according to on the sum total of heating capacities of the indoor units, operated in a heating mode, and the sum total of cooling capacities of the indoor units, operated in a cooling mode; and
allowing a part of a refrigerant, to be supplied to the indoor units, operated in the heating mode, to flow into the indoor units, operated in the cooling mode, when a heating percentage, set by the sum total of the heating capacities and the sum total of the cooling capacities, is in a predetermined range in case that set operating mode is a main heating mode in which a larger number of the indoor units are operated in the heating mode and a smaller number of the indoor units are operated in the cooling mode.

8. The method as set forth in claim 7, wherein the predetermined range is higher than 50% and lower than 82%.

9. The method as set forth in claim 7, wherein the pressure of the refrigerant at an outlet of a compressor is sensed, and the opening degree of an outdoor electric valve connected to an outdoor heat exchanger is controlled based on the sensed pressure of the refrigerant, during the operation in the main heating mode.

10. The method as set forth in claim 9, wherein the opening degree of the outdoor electric valve is increased in case that the pressure of the refrigerant at the outlet of the compressor is higher than the predetermined range, and the opening degree of the outdoor electric valve is decreased in case that the pressure of the refrigerant at the outlet of the compressor is lower than the predetermined range.

11. The method as set forth in claim 10, wherein an average pressure, obtained by averaging the pressure of the refrigerant at the outlet of the compressor, is compared with the predetermined range.

12. A multi-chamber type air conditioning system comprising:

an outdoor unit (100);
a plurality of indoor units (200a, ..., 200d) individually operable in cooling and heating modes;
a high pressure refrigerant supply pipe (HPP) from the outdoor unit (100);
a liquid refrigerant supply pipe (RP) from the outdoor unit to a first port of each indoor unit (200a, ..., 200d);
a low pressure refrigerant return pipe (LPP) to the outdoor unit (100);
indoor unit flow control valves (301a, ..., 301d, 302a, ..., 302b) for selectively connecting a second port of each indoor unit (200a, ..., 200d) to either the high pressure refrigerant supply pipe (HPP) or the low pressure refrigerant return pipe (LPP); and
control means (120) for controlling said valves, **characterised by** a controlled valve (119) for controlling the flow of refrigerant between the high pressure refrigerant supply pipe (HPP) and the liquid refrigerant supply pipe (RP) and the control means (120) being configured to control the state of the controlled valve (119) in dependence on the current operating conditions of the indoor units (200a, ..., 200d).

FIG.1

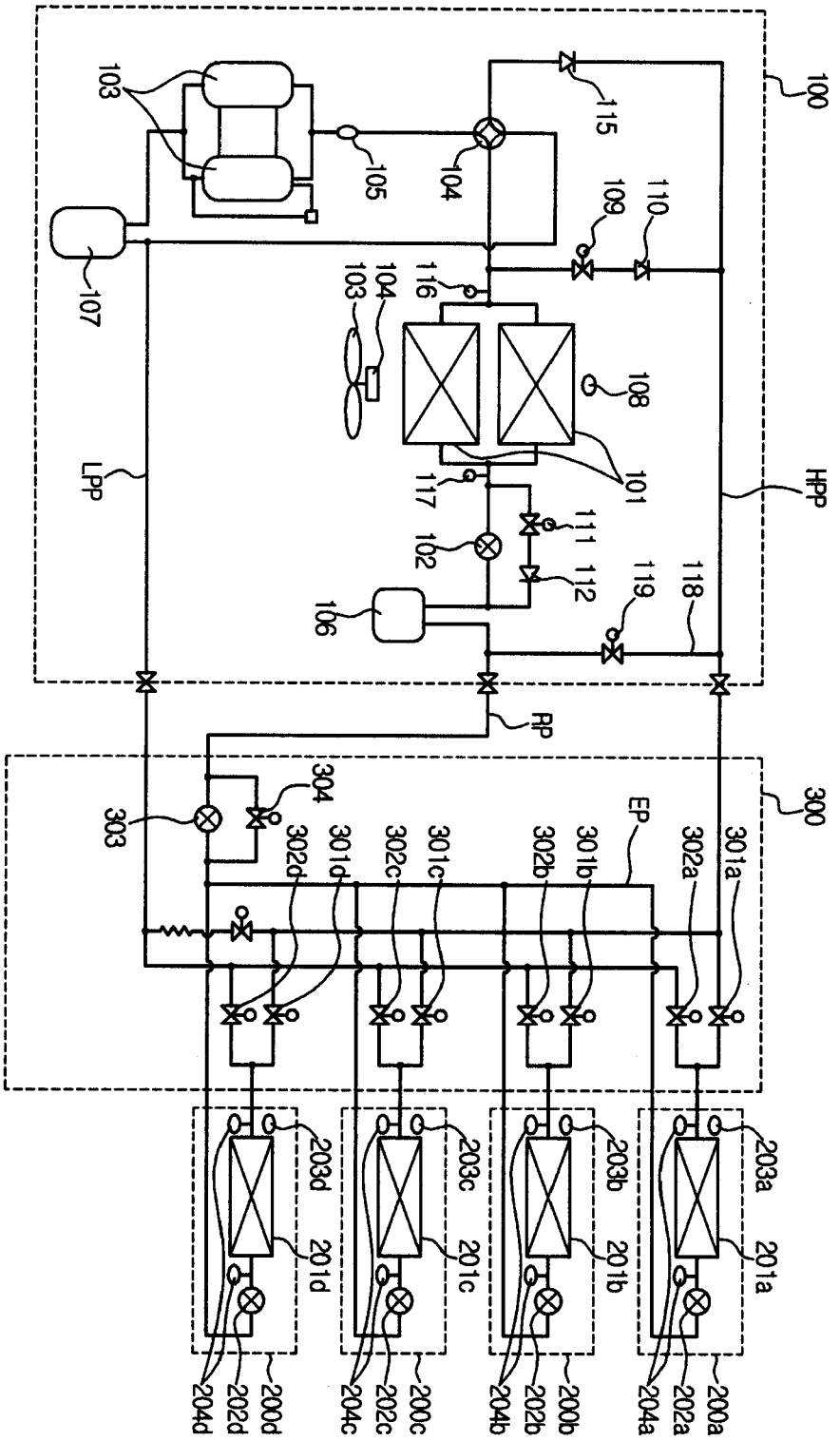

100
103
105
104
115
109
110
107
116
103
104
108
101
LPP
HPP
117
102
111
112
119
118
106
RP
300
303
304
302d
301d
302c
301c
302b
301b
EP
302a
301a
203d
201d
203c
201c
203b
201b
203a
201a
204d
202d
200d
204c
202c
200c
204b
202b
200b
204a
202a
200a

FIG.2

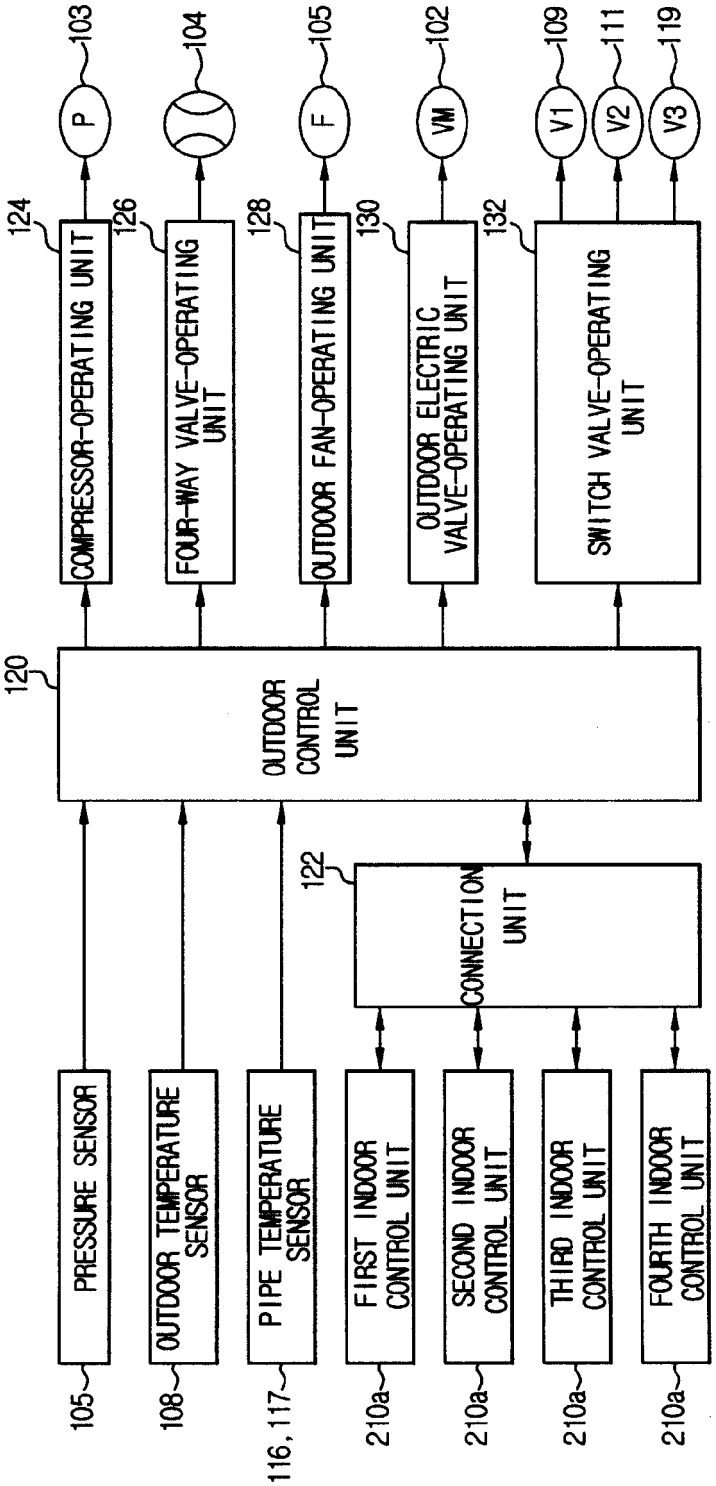
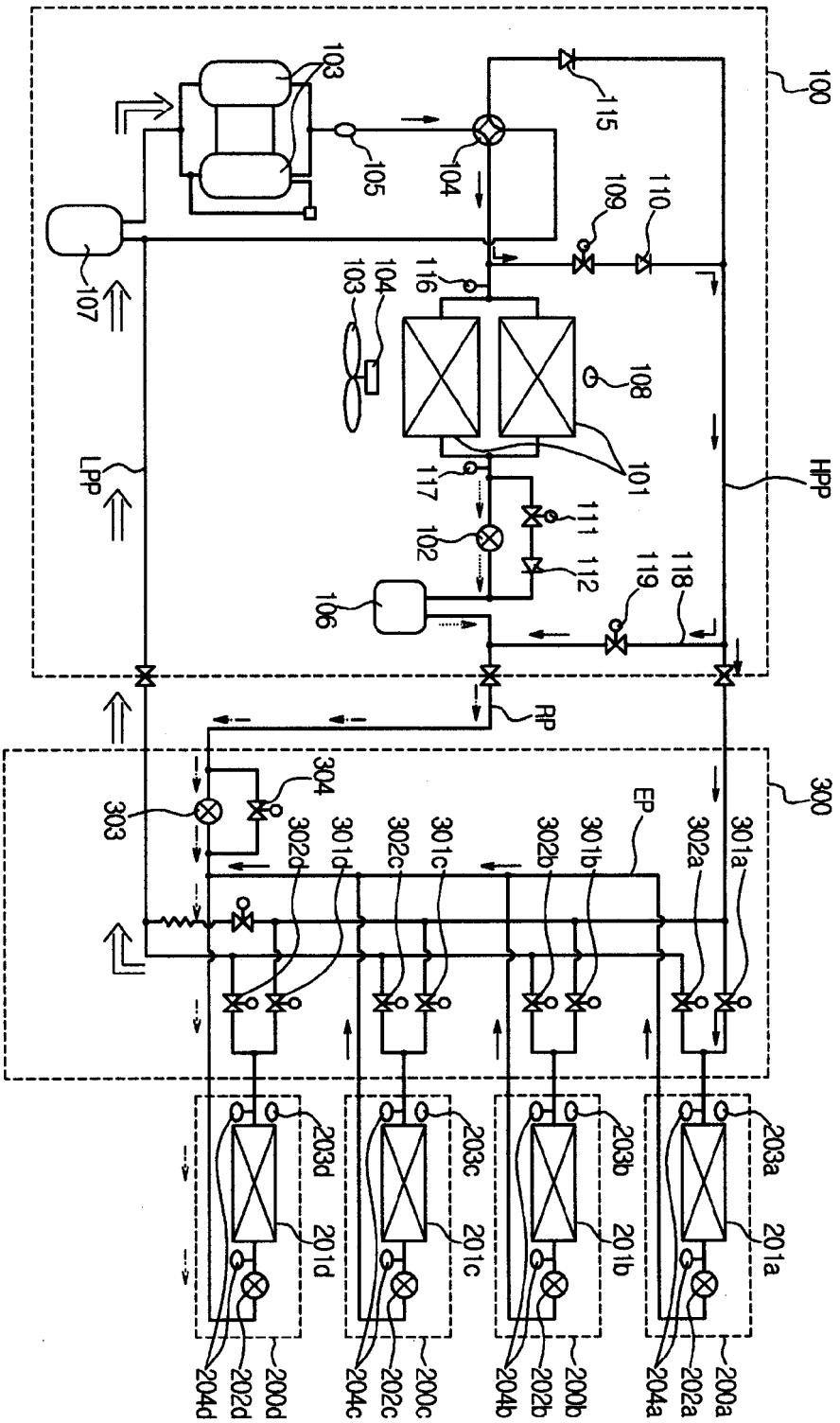

103
P
104
105
F
102
VM
109
V1
111
V2
119
V3
124
126
128
130
132
COMPRESSOR-OPERATING UNIT
FOUR-WAY VALVE-OPERATING UNIT
OUTDOOR FAN-OPERATING UNIT
OUTDOOR ELECTRIC VALVE-OPERATING UNIT
SWITCH VALVE-OPERATING UNIT
120
OUTDOOR CONTROL UNIT
122
CONNECTION UNIT
PRESSURE SENSOR
OUTDOOR TEMPERATURE SENSOR
PIPE TEMPERATURE SENSOR
FIRST INDOOR CONTROL UNIT
SECOND INDOOR CONTROL UNIT
THIRD INDOOR CONTROL UNIT
FOURTH INDOOR CONTROL UNIT
105
108
116, 117
210a
210a
210a
210a

FIG.3


100
103
115
105
104
109
110
107
116
103
104
108
101
HPP
LPP
117
111
102
112
119
118
106
RP
300
304
303
EP
302d
301d
302c
301c
302b
301b
302a
301a
203d
203c
203b
203a
201d
201c
201b
201a
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202d
200d
204c
202c
200c
204b
202b
200b
204a
202a
200a

FIG.4

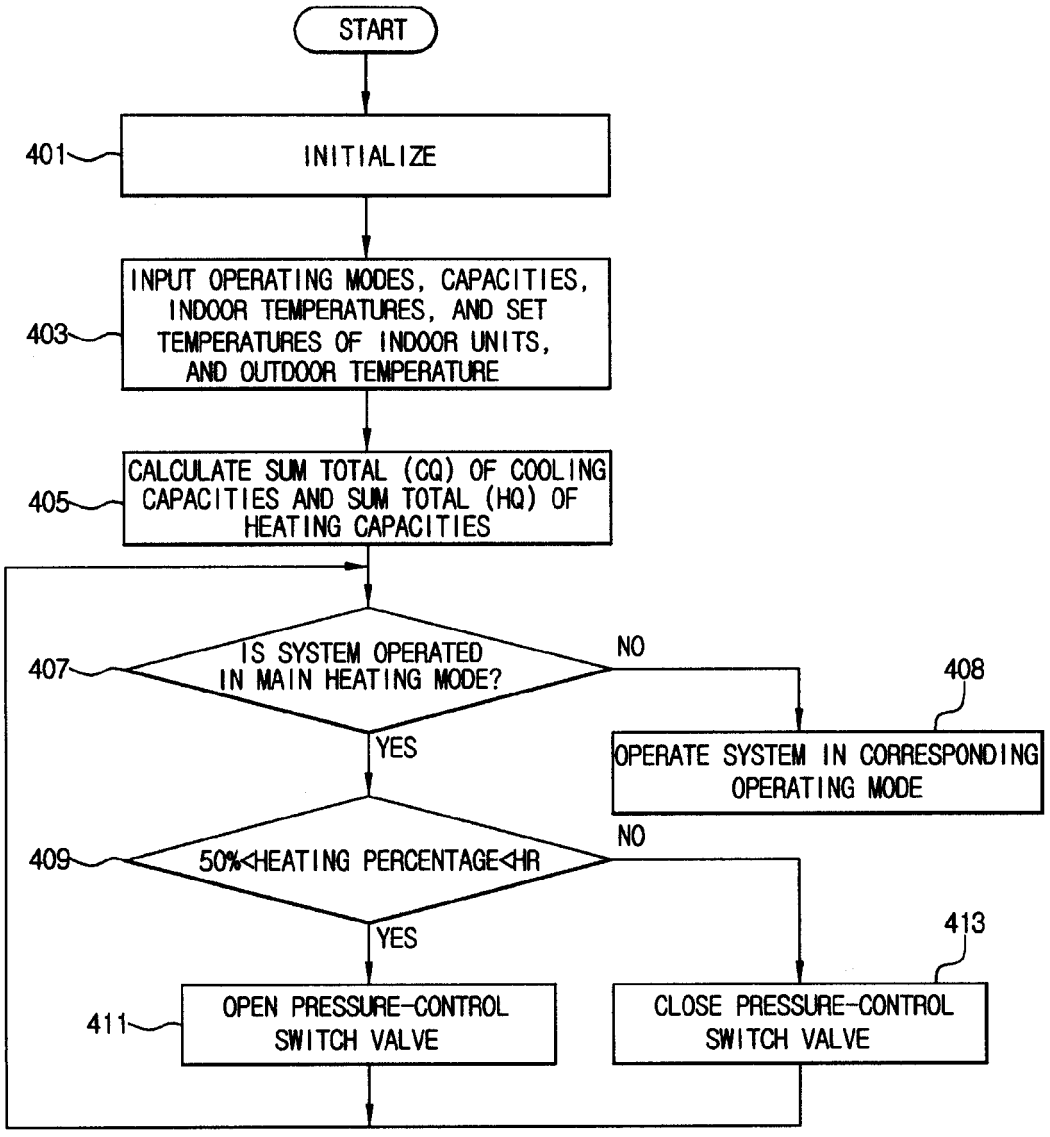
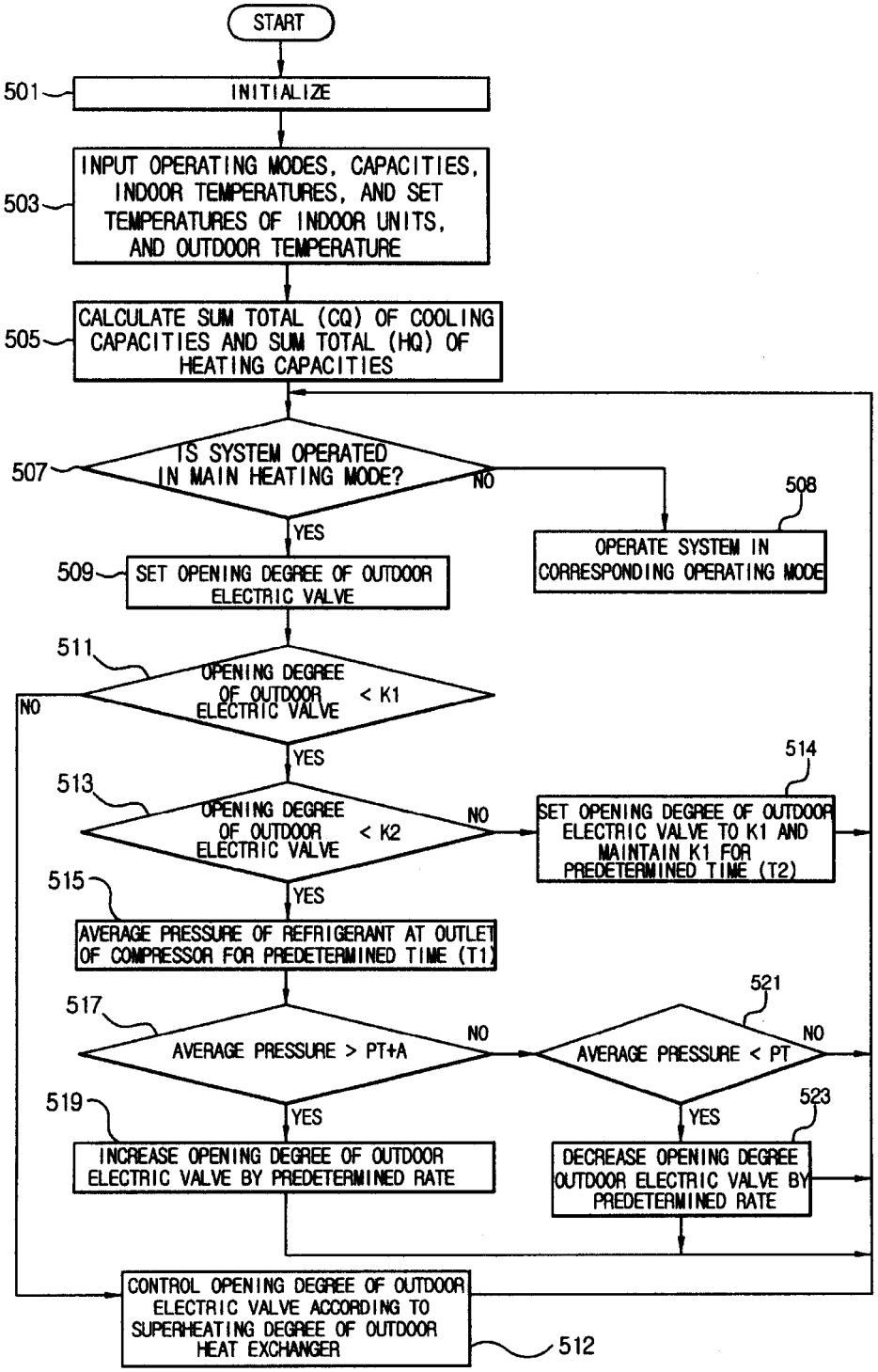

START
401
INITIALIZE
403
INPUT OPERATING MODES, CAPACITIES, INDOOR TEMPERATURES, AND SET TEMPERATURES OF INDOOR UNITS, AND OUTDOOR TEMPERATURE
405
CALCULATE SUM TOTAL (CQ) OF COOLING CAPACITIES AND SUM TOTAL (HQ) OF HEATING CAPACITIES
407
IS SYSTEM OPERATED IN MAIN HEATING MODE?
NO
408
OPERATE SYSTEM IN CORRESPONDING OPERATING MODE
YES
409
50%<HEATING PERCENTAGE<HR
NO
413
YES
411
OPEN PRESSURE-CONTROL SWITCH VALVE
CLOSE PRESSURE-CONTROL SWITCH VALVE

FIG.5


START
501
INITIALIZE
503
INPUT OPERATING MODES, CAPACITIES, INDOOR TEMPERATURES, AND SET TEMPERATURES OF INDOOR UNITS, AND OUTDOOR TEMPERATURE
505
CALCULATE SUM TOTAL (CQ) OF COOLING CAPACITIES AND SUM TOTAL (HQ) OF HEATING CAPACITIES
507
IS SYSTEM OPERATED IN MAIN HEATING MODE?
NO
YES
508
OPERATE SYSTEM IN CORRESPONDING OPERATING MODE
509
SET OPENING DEGREE OF OUTDOOR ELECTRIC VALVE
511
OPENING DEGREE OF OUTDOOR ELECTRIC VALVE < K1
NO
YES
513
OPENING DEGREE OF OUTDOOR ELECTRIC VALVE < K2
NO
514
SET OPENING DEGREE OF OUTDOOR ELECTRIC VALVE TO K1 AND MAINTAIN K1 FOR PREDETERMINED TIME (T2)
YES
515
AVERAGE PRESSURE OF REFRIGERANT AT OUTLET OF COMPRESSOR FOR PREDETERMINED TIME (T1)
517
AVERAGE PRESSURE > PT+A
NO
521
AVERAGE PRESSURE < PT
NO
YES
519
INCREASE OPENING DEGREE OF OUTDOOR ELECTRIC VALVE BY PREDETERMINED RATE
YES
523
DECREASE OPENING DEGREE OUTDOOR ELECTRIC VALVE BY PREDETERMINED RATE
CONTROL OPENING DEGREE OF OUTDOOR ELECTRIC VALVE ACCORDING TO SUPERHEATING DEGREE OF OUTDOOR HEAT EXCHANGER
512