

Description

[0001] The present invention relates to an air conditioning system comprising at least one compressor, an outdoor unit including an outdoor heat exchanger and a plurality of indoor units, each including an indoor heat exchanger and a control unit and a method of controlling an air conditioning system having at least one compressor, an outdoor unit including an outdoor heat exchanger and a plurality of indoor units each including an indoor heat exchanger comprising the steps of turning the air conditioning system on from an off state, and performing a start-up operation.

[0002] Generally, known air conditioning systems comprise a single outdoor unit and a plurality of indoor units distributed within a building each connected to the outdoor unit. The outdoor unit includes a compressor, an outdoor heat exchanger, an outdoor fan, and a motor-operated outdoor valve. Each of the indoor units includes an indoor heat exchanger, an indoor fan, and a motor-operated indoor valve.

[0003] The temperature requirements in different parts of a building may vary according to a multitude of factors and so the operating mode, i.e. heating or cooling mode applied to each indoor unit may not necessarily be the same. That is, the operating modes may all be of a single mode, in which all of the indoor units operate in the same mode, i.e. either all heating or all cooling or a complex mode, in which some of the indoor units are operating in a heating mode, and the rest of the indoor units are simultaneously operating in a cooling mode. The complex mode can be divided into a 'general cooling mode' in which the majority of the indoor units are operating in a cooling mode and the remainder of the indoor units are operating in the heating mode and a 'general heating mode' in which the majority of the indoor units are operating in the heating mode and the remainder of the indoor units are operating in the cooling mode.

[0004] When a conventional air conditioning system starts up in a general cooling mode, an initial 'starting operation' is performed, in which refrigerant is discharged from the compressor through the outdoor heat exchanger and is supplied to only those indoor units that have been selected to be operating in the cooling mode. After passing through these indoor units, the refrigerant is returned to the compressor. After this 'starting operation' is finished, the air conditioning system, performs a 'main operation', i.e. the normal running operation for the system in which the refrigerant discharged from the compressor is also supplied to those indoor units that have been selected to operate in the heating mode, thus allowing the air conditioning system to simultaneously operate the cooling and heating modes. Since the indoor units set to operate in the heating mode do not perform a heating operation during the starting operation, the conventional air conditioning system has the disadvantage that the heating operation is delayed.

[0005] The differences in operational characteristics of the starting operation commencing from when the system is switched off and operational characteristics of the main operation commencing from a time when the system has been stabilized by the starting operation should be considered. However, in known air conditioning systems, the control applied to the starting operation and the control applied to the main operation are almost identical resulting in the operating efficiency being reduced. That is, the air conditioning system fluctuates extremely during the starting operation and the resulting instability increases the length of time taken to stabilize the system. In addition, since the conventional air conditioning systems are mainly designed to operate in a cooling mode, they have the disadvantage that the cooling capacity is comparatively good, but the heating capacity is poor.

[0006] Therefore, it is an object of the invention to provide an air conditioning system and method of controlling the same which substantially alleviates or overcomes the problems mentioned above.

[0007] The air conditioning system of the present invention is characterised in that the control unit is operable to control the air conditioning system to separately supply a refrigerant from the at least one compressor to at least one of the indoor units operating in a heating mode and supply refrigerant from the at least one compressor to the remaining indoor unit(s) operating in a cooling mode simultaneously and immediately upon start-up of the system.

[0008] The method of controlling an air conditioning system of the present invention is characterised by the steps of simultaneously supplying a quantity of refrigerant from the at least one compressor to at least one indoor unit operating in a heating mode and simultaneously supplying a quantity of refrigerant from the at least one compressor to the remaining indoor unit(s) operating in a cooling mode.

[0009] In accordance with another aspect, the present invention provides an air conditioning system comprising an outdoor unit including at least one compressor and at least one outdoor heat exchanger, a plurality of indoor units connected to the outdoor unit, a refrigerant guide unit to guide a refrigerant discharged from the at least one compressor to the indoor units through first and/or second routes, and a control unit to simultaneously control a first quantity of the refrigerant discharged from the at least one compressor to at least one of the indoor units operating in a cooling mode through the first route, and a second quantity of the refrigerant discharged from the at least one compressor to a remainder of the indoor units operating in a heating mode through the second route.

[0010] The control unit may divisionally supply the refrigerant discharged from the at least one compressor through the first and second routes in a general cooling mode in which a majority of the indoor units are operating in the cooling mode and the remainder of the indoor

units are operating in the heating mode.

[0011] The control unit may include indoor control units to control the indoor units, and an outdoor control unit connected to the indoor control units, wherein the outdoor control unit sets the general cooling mode in response to a total cooling capacity of the indoor units operating in the cooling mode being larger than a total heating capacity of the indoor units operating in the heating mode.

[0012] The at least one outdoor heat exchanger may be installed on the first route, and an on-off valve to guide the second quantity of the refrigerant discharged from the at least one compressor to the indoor units operating in the heating mode without passing through the at least one outdoor heat exchanger may be provided on the second route.

[0013] In accordance with another aspect, the present invention provides a method of controlling an air conditioning system which simultaneously performs cooling and heating operations by connecting a plurality of indoor units to an outdoor unit having at least one outdoor heat exchanger, the method comprising setting an operating mode of the system, determining whether the set operating mode is a general cooling mode in which a majority of the indoor units are operating in a cooling mode and a remainder of the indoor units are operating in a heating mode, determining whether the system is operating in a starting mode, which results from the system starting from a stopped state, in response to the determining that the set operating mode is the general cooling mode, and supplying a first quantity of refrigerant discharged from at least one compressor to the indoor units operating in the cooling mode through a first route, and simultaneously supplying a second quantity of the refrigerant to the indoor units operating in the heating mode through a second route, in response to the determining that the system is operating in the starting mode.

[0014] The general cooling mode may be set in response to a total cooling capacity of the indoor units operating in the cooling mode being larger than a total heating capacity of the indoor units operating in the heating mode.

[0015] In accordance with still another aspect, the present invention provides an air conditioning system comprising an outdoor unit including at least one compressor, at least one outdoor heat exchanger, an outdoor fan, and a motor-operated outdoor valve, a plurality of indoor units connected to the outdoor unit, a plurality of indoor heat exchangers respectively provided to the indoor units, a refrigerant guide unit to simultaneously guide a refrigerant discharged from the at least one compressor to the indoor units operating in a cooling mode through a first route and to the indoor units operating in a heating mode through a second route, and a control unit to sequentially perform a starting operation in response to the system being started from a stopped state and a main operation in response to the system

being stabilized by the starting operation, and to control the at least one compressor, the outdoor fan, and the motor-operated outdoor valve according to operational characteristics of the starting and main operations.

[0016] The control unit may perform the starting and main operations in response to a total cooling capacity of the indoor units operating in the cooling mode being larger than a total heating capacity of the indoor units operating in the heating mode.

[0017] In accordance with yet another aspect, the present invention provides a method of controlling an air conditioning system which simultaneously performs cooling and heating operations by connecting a plurality of indoor units to an outdoor unit including at least one outdoor heat exchanger, the method comprising setting an operating mode of the system, determining whether the set operating mode is a general cooling mode in which a majority of the indoor units are operating in a cooling mode and a remainder of the indoor units are operating in a heating mode, sequentially performing a starting operation in response to the system being started from a stopped state and a main operation in response to the system being stabilized by the starting operation, and controlling at least one compressor, an outdoor fan and a motor-operated outdoor valve of the outdoor unit according to operational characteristics of the starting and main operations.

[0018] In the starting operation, an operating capacity of the at least one compressor may be set to approximately 50~80% of a total cooling capacity of the indoor units operating in the cooling mode.

[0019] In the starting operation, an opening degree of the motor-operated outdoor valve may be set according to a total cooling capacity of the indoor units operating in the cooling mode.

[0020] In the starting operation, an operating capacity of the outdoor fan may be set according to a difference between a total cooling capacity of the indoor units operating in the cooling mode and a total heating capacity of the indoor units operating the heating mode, and according to an outdoor temperature.

[0021] During the sequentially performing of the starting and main operation, a pressure sensed by a pressure sensor installed at an outlet of the at least one compressor may be compared to a predetermined pressure to determine whether the starting operation is terminated.

[0022] In the main operation, an operating capacity of the at least one compressor may be set according to a total cooling capacity of the indoor units operating in the cooling mode.

[0023] In the main operation, an opening degree of the motor-operated outdoor valve may be set according to a ratio of a total heating capacity of the indoor units operating in the heating mode to a total operating capacity obtained by adding a total cooling capacity of the indoor units operating in the cooling mode and the total heating capacity of the indoor units operating in the

heating mode.

[0024] The total heating capacity may be inversely proportional to the opening degree of the motor-operated outdoor valve.

[0025] A pressure sensor to sense a pressure of refrigerant discharged from the compressors may be provided, and, in the main operation, an operating capacity of the outdoor fan may be set such that the pressure of the refrigerant sensed by the pressure sensor and supplied to the indoor units operating in the heating mode reaches a set standard pressure.

[0026] A preferred embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of an air conditioning system in accordance with an embodiment of the present invention;

Figure 2 is a block diagram of the air conditioning system of Figure 1;

Figure 3 is a schematic view of the air conditioning system of Figure 1 in which three indoor units are operating in a cooling mode and one indoor unit is operating in a heating mode; and

Figures 4A and 4B are flow charts of a method of controlling the air conditioning system in accordance with the embodiment of the present invention shown in Figure 3.

[0027] The air conditioning system comprises a plurality of indoor units connected to an indoor unit. As shown in Figure 1, the air conditioning system comprises an outdoor unit 100, four indoor units 200a, 200b, 200c and 200d and a directional conversion circuit 300 interposed between the outdoor unit 100 and the indoor units 200a, 200b, 200c and 200d to selectively direct the flow of a refrigerant therebetween.

[0028] The outdoor unit 100 comprises outdoor heat exchangers 101a and 101b, a motor-operated valve 102 connected to outlets of the outdoor heat exchangers 101a and 101b and an on-off valve 111 and a check valve 112 connected to the motor-operated outdoor valve 102. An outdoor fan 113 connected to an outdoor fan motor 114 is disposed adjacent the outdoor heat exchangers 101a, 101b. The outdoor unit 100 further includes variable capacity compressors 103a and 103b, a four-way valve 104, a receiver 106, and an accumulator 107. An on-off valve 109 and a check valve 110 are provided to supply refrigerant discharged from the compressors 103a and 103b to the indoor units operating in a heating mode, without it having to pass through the outdoor heat exchangers 101a and 101b. The outdoor unit 100 also includes an outdoor temperature sensor 108 and a pressure sensor 105 to detect the pressure of the refrigerant discharged from the compressors 103a and 103b.

[0029] The indoor units 200a, 200b, 200c, 200d, respectively include indoor heat exchangers 201 a, 201 b,

201c and 201d, motor-operated indoor valves 202a, 202b, 202c, 202d and indoor temperature sensors 203a, 203b, 203c, 203d. They also respectively include pipe temperature sensors 204a, 204b, 204c, 204d to detect the temperatures at inlets and outlets of the indoor heat exchangers 201a, 201b, 201c, 201 d. The indoor units 200a, 200b, 200c, 200d respectively further include indoor fans (not shown) and indoor fan motors (not shown).

[0030] The directional conversion circuit 300 includes high-pressure gas valves 301a, 301b, 301c, 301d respectively installed in high-pressure gas pipes (HPPs) located between the outdoor unit 100 and the indoor units 200a, 200b, 200c, 200d. The direction conversion circuit 300 also includes low-pressure gas valves 302a, 302b, 302c, 302d respectively installed in low-pressure gas pipes (LPPs). A motor-operated valve 303 is installed in a common pipe (RP) which connects the outdoor unit 100 to the indoor units 200a, 200b, 200c, 200d. The above mentioned high-pressure gas valves 301a, 301b, 301 c, 301 d and low-pressure gas valves 302a, 302b, 302c, 302d are operated under the control of an outdoor control unit which will be described later.

[0031] One end 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 directional conversion circuit 300 through the high-pressure gas pipes (HPPs). The accumulator 107 of the outdoor unit 100 is connected to the low-pressure gas valves 302a, 302b, 302c, 302d of the directional conversion circuit 300 through the low-pressure gas pipes (LPPs).

[0032] The common pipe (RP) is installed between the outdoor heat exchangers 101a and 101b and the directional conversion circuit 300 and the motor-operated outdoor valve 102 is installed in the common pipe (RP). The on-off valve 111, connected in parallel to the motor-operated outdoor valve 102, serves as a flow control valve.

[0033] Pipes EP1, EP2, EP3 and EP4 of the indoor heat exchangers 201 a, 201 b, 201 c and 201d are connected to the common pipe (RP).

[0034] Referring now to Figure 2, the air conditioning system shown in Figure 1 comprises an outdoor control unit 120 to control the outdoor unit 100, first to fourth indoor control units 210a, 210b, 210c, 210d to respectively control the indoor units 200a, 200b, 200c, 200d and a connection unit 122 interposed between the outdoor control unit 120 and the first to fourth indoor control units 210a, 210b, 210c, 210d to communicate information therebetween to operate the air conditioning system.

[0035] The pressure sensor 105 and the outdoor temperature sensor 108 are connected to an input terminal of the outdoor control unit 120.

[0036] A compressor operating unit 124 to operate the compressors 103a and 103b, a four-way valve operating unit 126 to operate the four-way valve 104, an outdoor fan operating unit 128 to operate the outdoor fan

105, a motor-operated outdoor valve operating unit 130 to operate the motor-operated outdoor valve 102, and an on-off valve operating unit 132 to operate the on-off valves 109 and 111 are all connected to an output terminal of the outdoor control unit 120.

[0037] The first to fourth indoor control units 210a, 210b, 210c, 210d respectively provide indoor temperatures sensed by the indoor temperature sensors 203a, 203b, 203c, 203d, a pre-set temperature value and an operating mode set by a user using a function key and a remote control unit and information regarding capacities of the indoor heat exchangers 201a, 201b, 201c, 201d to the outdoor control unit 120.

[0038] The first to fourth indoor control units 210a, 210b, 210c, 210d in connection with the outdoor control unit 120 respectively control the motor-operated indoor valves 202a, 202b, 202c, 202d and the indoor fans (not shown).

[0039] Figure 3 illustrates the air conditioning system of Figure 1 in which one indoor unit (i.e. the indoor unit 200a) is set to operate in a heating mode and the remaining three indoor units (i.e. the indoor units 200b, 200c and 200d) are set to operate in a cooling mode.

[0040] In this 'general cooling mode' of the air conditioning system, the outdoor control unit 120 operates the compressors 103a and 103b, opens the motor-operated outdoor valve 102 to an initial degree, and opens the on-off valve 109. The outdoor control unit 120 opens the high-pressure gas valve 301a of the one indoor unit 200a operating in the heating mode, and closes the high-pressure gas valves 301b, 301c, 301d of the remaining indoor units 200b, 200c, 200d operating in the cooling mode. The outdoor control unit 120 also closes the low-pressure gas valve 302a of the one indoor unit 200a operating in the heating mode, and opens the low-pressure gas valves 302b, 302c, 302d of the remaining indoor units 200b, 200c, 200d operating in the cooling mode.

[0041] Some of the refrigerant discharged from the compressors 103a and 103b passes through the on-off valve 109 and the check valve 110 and is then supplied to the one indoor unit 200a operating in the heating mode, as shown by arrows represented by a solid line. The remainder of the refrigerant discharged from the compressors 103a and 103b passes through the outdoor heat exchangers 101a and 101b and the motor-operated outdoor valve 102 and is then combined with the refrigerant that has passed through the indoor unit 200a as shown by arrows represented by a dotted line. The combined refrigerant sequentially passes through the motor-operated indoor valves 202b, 202c, 202d and the indoor heat exchangers 201b, 201c, 201d of the remaining indoor units 200b, 200c, 200d operating in the cooling mode, and is then returned to the compressors 103a and 103b through the low-pressure gas pipes (LPPs). The refrigerant then continues to circulate through the air conditioning system in the above described cycle.

[0042] If the total combined cooling capacity of the indoor units 200b, 200c, 200d operating in the cooling mode is larger than the heating capacity of the indoor unit 200a operating in the heating mode, the outdoor control unit 120 sets a 'general cooling mode' and controls the operation of the air conditioning system accordingly. During the start operation of the general cooling mode, the refrigerant discharged from the compressors 103a and 103b is divided into two flow paths as shown in Figure 3, thus allowing the indoor unit 200a, which is operating in the heating mode, to achieve rapid heating. Furthermore, the outdoor control unit 120 sets the capacities of the compressors 103a and 103b and a speed of the outdoor fan 113 so as to satisfy characteristics of the start operation of the air conditioning system, and controls the degree to which the motor-operated outdoor valve 102 opens, thus maximising the operating efficiency of the air conditioning system.

[0043] The operation of the air conditioning system shown in Figure 3 will now be described in detail with references to Figures 4A and 4B.

[0044] When the air conditioning system is first switched on, the outdoor control unit 120 performs an automatic initialisation procedure (400) according to a predetermined control program.

[0045] After the initialisation, the indoor control units 210a, 210b, 210c, 210d provide operating mode signals to the outdoor control unit 120 through the connection unit 122 to distinguish between heating and cooling modes set to the corresponding indoor units 200a, 200b, 200c, 200d, capacities of the respective indoor heat exchangers 201a, 201b, 201c, 201d, a set temperature and an indoor temperature. The outdoor control unit 120 receives an outdoor temperature from the outdoor temperature sensor 108 (410).

[0046] The outdoor control unit 120 calculates heating capacities (heating loads) and cooling capacities (cooling loads) based on the capacities of the indoor heat exchangers 201a, 201b, 201c, 201d provided from the indoor units 200a, 200b, 200c, 200d. In this example in Figure 3, the capacities of the indoor heat exchangers 201b, 201c, 201d of the three indoor units 200b, 200c, 200d which are set to operate in the cooling mode, are summed to obtain a total cooling capacity (CQ) and a capacity of the indoor heat exchanger 201a of the one indoor unit 200a, which is set to operate in the heating mode, serves as a total heating capacity (HQ) (420).

[0047] The outdoor control unit 120 determines whether the total cooling capacity (CQ) is larger than the total heating capacity (HQ) (430). If it is determined that the total cooling capacity (CQ) is less than the total heating capacity (HQ), the operating mode of the air conditioning system is set to an appropriate operating mode such as a cooling mode, a heating mode, and a general heating mode, in which the majority of the indoor units operate in the heating mode and the remainder of the indoor units operate in the cooling mode (431).

[0048] Conversely, if it is determined that the total

cooling capacity (CQ) is larger than the total heating capacity (HQ), the operating mode of the air conditioning system is set to a general cooling mode (440).

[0049] The outdoor control unit 120 determines whether the general cooling mode of the air conditioning system is to perform the start operation (450) and if so, the outdoor control unit 120 controls the four-way valve operating unit 126 to direct the flow path of the four-way valve 104, and the on-off valve operating unit 132 to open the on-off valve 109, such that the refrigerant flow corresponds to the general cooling mode (460).

[0050] The outdoor control unit 120 controls the compressor operating unit 124 to operate the compressors 103a and 103b according to the initial operating capacity of the compressors 103a and 103b. Here, the initial operating capacity of the compressors 103a and 103b is set to approximately 50~80% of the total cooling capacity (CQ) calculated in operation 420, thus preventing the air conditioning system from being overloaded (470).

[0051] The outdoor control unit 120 controls the motor-operated outdoor valve operating unit 130 to operate the motor-operated outdoor valve 102 to an initial opening degree, this opening degree being set according to the total cooling capacity (CQ), thus preventing the air conditioning system from being overloaded (480).

[0052] The outdoor control unit 120 sets the operating capacity/speed of the outdoor fan 113 based on a difference (CQ-HQ) between the total cooling capacity (CQ) and the total heating capacity (HQ) and an outdoor temperature (490), and controls the outdoor fan operating unit 128 to operate the outdoor fan 113 based on the set operating capacity of the outdoor fan 113 (500).

[0053] Some of the refrigerant discharged from the compressors 103a and 103b passes through the outdoor heat exchangers 101 a and 101 b and the motor-operated outdoor valve 102, and is then supplied to those indoor units 200b, 200c, 200d, which are operating in the cooling mode. Simultaneously, the rest of the refrigerant discharged from the compressors 103a and 103b passes through the on-off valve 109 and the check valve 110, without passing through the outdoor heat exchangers 101a and 101b and is then supplied to the one indoor unit 200a, which is operating in the heating mode.

[0054] During the start operation, the pressure sensor 105 senses the pressure of the discharged refrigerant, and then supplies the sensed pressure value to the outdoor control unit 120 (510). The outdoor control unit 120 compares the supplied refrigerant pressure value to a set pressure value set at which the starting operation is to finish, and determines whether the starting operation is finished (520).

[0055] If it is determined that the starting operation is not finished, the operation of the air conditioning system is returned to operation 460 to perform the start operation. However, if it is determined that the start operation has finished, or as a result of operation 450, it is determined that the air conditioning system is already stabilized due to the starting operation, the outdoor control

unit 120 sets the operating capacity of the compressors 103a and 103b based on the total cooling capacity (CQ) (530) and then controls the compressor operating unit 124 to operate the compressors 103a and 103b according to the said operating capacity (540).

[0056] The outdoor control unit 120 sets an opening degree of the motor-operated outdoor valve 102 based on the ratio of the total heating capacity (HQ) to the total operating capacity (CQ+HQ) (550), and controls the motor-operated outdoor valve operating unit 130 to operate the motor-operated outdoor valve 102 based on the set opening degree. Here, the larger the heating capacity of the indoor unit 200a operating in the heating mode is, the smaller the opening degree of the motor-operated outdoor valve 102 is, thus causing an amount of the refrigerant supplied to the indoor unit 200a operating in the heating mode to be increased (560).

[0057] The outdoor control unit 120 sets the operating capacity of the outdoor fan 113 such that the pressure of the refrigerant discharged from the compressors 103a and 103b and supplied to the indoor unit 200a operating in the heating mode reaches a standard pressure (570).

[0058] In order to achieve the desired heating performance using the refrigerant supplied to the indoor unit 200a operating in the heating mode, it is necessary for the temperature of the refrigerant discharged from the compressors 103a and 103b to be greater than a predetermined temperature. In an embodiment of the present invention, the pressure of the discharged refrigerant sensed by the pressure sensor 105, corresponding to the temperature of the refrigerant discharged from the compressors 103a and 103b, is maintained to be more than a predetermined pressure. The pressure of the refrigerant discharged from the compressors 103a and 103b varies according to the variation in the operating capacity (speed) of the outdoor fan 113, such that when the operating capacity of the outdoor fan 113 is increased, the heat exchanging efficiency of the outdoor heat exchangers 101a and 101b is increased, and the discharge pressure of the compressors 103a and 103b is decreased. Conversely, when the operating capacity of the outdoor fan 105 is decreased, the heat exchanging efficiency of the outdoor heat exchangers 101a and 101b is decreased, and the discharge pressure of the compressors 103a and 103b is increased. The outdoor control unit 120 controls the outdoor fan operating unit 128 to operate the outdoor fan 113 based on the set operating capacity of the outdoor fan 113 (580).

[0059] The indoor control units 210b, 210c, 210d operating in the cooling mode receive temperatures at inlets and outlets of their respective indoor heat exchangers 201b, 201 c, 201 d through the pipe temperature sensors 204b, 204c, 204d calculate degrees of super-heat based on corresponding differences between the temperatures at the inlets and outlets, and control the opening degrees of the respective motor-operated indoor valves 202b, 202c, 202d such that the calculated

degrees of superheat reach a set degree of superheat (590).

[0060] The indoor control unit 210a operating in the heating mode fully opens the motor-operated indoor valve 202a (600).

[0061] The outdoor control unit 120 determines whether the operation of the air conditioning system is to be terminated (610). If it is determined that the operation is not to be terminated, the operating process of the air conditioning system is returned to operation 430 to continue performing the operation. However, if it is determined that the operation of the air conditioning system is terminated, the outdoor control unit 120 stops the operations of the compressors 103a and 103b, the outdoor fan 113, and the motor-operated outdoor valve 102, thus stopping the operation of the air conditioning system (620).

[0062] As is apparent from the above description, the present invention provides an air conditioning system, in which a refrigerant discharged from compressors is supplied to indoor units, operating in a heating mode during the starting operation in a general cooling mode, and a method of controlling the air conditioning system to rapidly perform the heating mode. Since the compressors, an outdoor fan, and a motor-operated outdoor valve are controlled in consideration of operational characteristics required by the starting operation and operational characteristics required by the main operation in a general cooling mode, the air conditioning system is rapidly stabilized without being overloaded during the starting operation. The air conditioning system also operates in the general cooling mode once the system is stabilized in consideration of cooling and heating capacities, thus significantly improving cooling and heating efficiency over that of known air conditioning systems.

[0063] 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 these embodiments without departing from the principles of the invention, the scope of which is defined in the claims hereafter.

Claims

1. An air conditioning system comprising at least one compressor, an outdoor unit including an outdoor heat exchanger, and a plurality of indoor units, each including an indoor heat exchanger, and a control unit **characterised in that** the control unit is operable to control the air conditioning system to separately supply a refrigerant from the at least one compressor to at least one of the indoor units operating in a heating mode, and supply refrigerant from the at least one compressor to the remaining indoor unit (s) operating in a cooling mode, simultaneously and immediately upon start-up of the system.

2. A method of controlling an air conditioning system having at least one compressor, an outdoor unit including an outdoor heat exchanger and a plurality of indoor units, each including an indoor heat exchanger, comprising the steps of turning the air conditioning system on from an off state and performing a start up operation **characterised by** the steps of simultaneously supplying a quantity of refrigerant from the at least one compressor to at least one indoor unit operating in a heating mode and simultaneously supplying a quantity of refrigerant from the at least one compressor to the remaining indoor unit (s) operating in a cooling mode.

3. An air conditioning system comprising an outdoor unit comprising at least one compressor and at least one outdoor heat exchanger, a plurality of indoor units connected to the outdoor unit, a refrigerant guide unit to guide a refrigerant discharged from the at least one compressor to the indoor units through first and/or second routes, and a control unit to simultaneously control a first quantity of the refrigerant discharged from the at least one compressor to at least one of the indoor units operating in a cooling mode through the first route, and a second quantity of the refrigerant discharged from the at least one compressor to a remainder of the indoor units operating in a heating mode through the second route.

4. The air conditioning system according to claim 3 wherein the control unit divisionally supplies the refrigerant discharged from the at least one compressor through the first and second routes in a general cooling mode in which a majority of the indoor units are operating in the cooling mode and the remainder of the indoor units are operating in the heating mode.

5. The air conditioning system according to claim 4 wherein the control unit comprises indoor control units to control the indoor units and an outdoor control unit connected to the indoor control units, wherein the outdoor control unit sets the general cooling mode in response to a total cooling capacity of the indoor units operating in the cooling mode being larger than a total heating capacity of the indoor units operating in the heating mode.

6. The air conditioning system according to claim 3 further comprising an on-off valve provided in the second route wherein the at least one outdoor heat exchanger is installed on the first route, and the on-off valve guides the second quantity of the refrigerant discharged from the at least one compressor to the indoor units operating in the heating mode without passing through the at least one outdoor heat exchanger.

7. A method of controlling an air conditioning system which simultaneously performs cooling and heating operations by connecting a plurality of indoor units to an outdoor unit having at least one outdoor heat exchanger, the method comprising setting an operating mode of the system, determining whether the set operating mode is a general cooling mode in which a majority of the indoor units are operating in a cooling mode and a remainder of the indoor units are operating in a heating mode, determining whether the system is operating in a starting mode, which results from the system starting from a stopped state, in response to the determining that the set operating mode is the general cooling mode and supplying a first quantity of refrigerant discharged from at least one compressor to the indoor units operating in the cooling mode through a first route, and simultaneously supplying a second quantity of the refrigerant to the indoor units operating in the heating mode through a second route, in response to determining that the system is operating in the starting mode.
 8. The method according to claim 7 wherein the general cooling mode is set in response to a total cooling capacity of the indoor units operating in the cooling mode being larger than a total heating capacity of the indoor units operating in the heating mode.
 9. An air conditioning system comprising an outdoor unit comprising at least one compressor, at least one outdoor heat exchanger, an outdoor fan and a motor-operated outdoor valve, a plurality of indoor units connected to the outdoor unit, a plurality of indoor heat exchangers respectively provided to the indoor units, a refrigerant guide unit to simultaneously guide a refrigerant discharged from the at least one compressor to the indoor units operating in a cooling mode through a first route and to the indoor units operating in a heating mode through a second route, and a control unit to sequentially perform a starting operation in response to the system being started from a stopped state and a main operation in response to the system being stabilized by the starting operation, and to control the at least one compressor, the outdoor fan, and the motor-operated outdoor valve according to operational characteristics of the starting and main operations.
 10. The air conditioning system according to claim 9 wherein the control unit performs the starting and main operations in response to a total cooling capacity of the indoor units operating in the cooling mode being larger than a total heating capacity of the indoor units operating in the heating mode.
 11. A method of controlling an air conditioning system which simultaneously performs cooling and heating operations by connecting a plurality of indoor units to an outdoor unit having at least one outdoor heat exchanger, the method comprising setting an operating mode of the system, determining whether the set operating mode is a general cooling mode in which a majority of the indoor units are operating in a cooling mode and a remainder of the indoor units are operating in a heating mode, sequentially performing a starting operation in response to the system being started from a stopped state and a main operation in response to the system being stabilized by the starting operation and controlling at least one compressor, an outdoor fan, and a motor-operated outdoor valve of the outdoor unit according to operational characteristics of the starting and main operations.
 12. The method according to claim 11 wherein in the starting operation, an operating capacity of the at least one compressor is set to approximately 50~80% of a total cooling capacity of the indoor units operating in the cooling mode.
 13. The method according to claim 11 wherein in the starting operation, an opening degree of the motor-operated outdoor valve is set according to a total cooling capacity of the indoor units operating in the cooling mode.
 14. The method according to claim 11 wherein in the starting operation, an operating capacity of the outdoor fan is set according to a difference between a total cooling capacity of the indoor units operating in the cooling mode and a total heating capacity of the indoor units operating in the heating mode, and according to an outdoor temperature.
 15. The method according to claim 11 wherein during the sequentially performing the starting and main operation, a pressure sensed by a pressure sensor installed at an outlet of the at least one compressor is compared to a predetermined pressure to determine whether the starting operation is terminated.
 16. The method according to claim 11 wherein in the main operation, an operating capacity of the at least one compressor is set according to a total cooling capacity of the indoor units operating in the cooling mode.
 17. The method according to claim 11 wherein in the main operation, an opening degree of the motor-operated outdoor valve is set according to a ratio of a total heating capacity of the indoor units operating in the heating mode to a total operating capacity obtained by adding a total cooling capacity of the indoor units operating in the cooling mode and the total heating capacity of the indoor units operating

in the heating mode.

18. The method according to claim 17 wherein the total heating capacity is inversely proportional to the opening degree of the motor-operated outdoor valve. 5
19. The method according to claim 11 wherein a pressure sensor to sense a pressure of refrigerant discharged from the compressors is provided, and, in the main operation, an operating capacity of the outdoor fan is set such that the pressure of the refrigerant sensed by the pressure sensor and supplied to the indoor units operating in the heating mode reaches a set standard pressure. 10 15
20. An air conditioning system comprising an outdoor unit having at least one compressor, and a plurality of indoor units connected to the outdoor unit, wherein at least one of the indoor units receives refrigerant from the at least one compressor through a first route to operate in a heating mode, and a remainder of the indoor units receive the refrigerant from the at least one compressor through a second route to operate in a cooling mode, the refrigerant being simultaneously supplied through both routes from a start-up point of the system. 20 25
21. A method of controlling an air conditioning system which simultaneously performs cooling and heating operations in a plurality of indoor units connected to an outdoor unit having at least one compressor, the method comprising performing a starting operation in which refrigerant is simultaneously provided from the at least one compressor to at least one of the indoor units operating in a heating mode and a remainder of the indoor units operating in a cooling mode wherein a first quantity of the refrigerant is provided through a first path to the at least one of the indoor units operating in the heating mode, and a second quantity of the refrigerant is provided through a second path to remainder of the indoor units operating in the cooling mode. 30 35 40

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FIG. 1

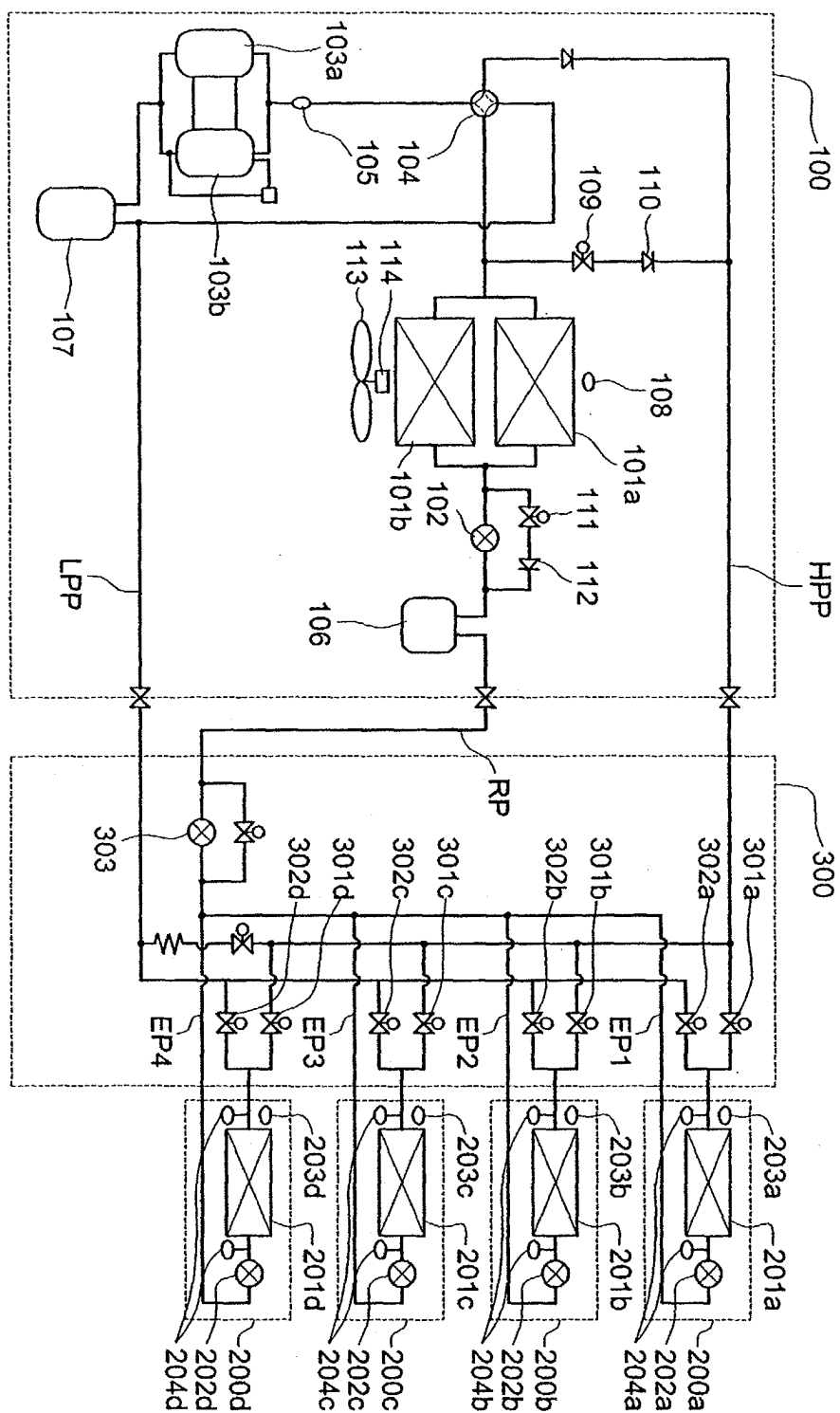


FIG. 2

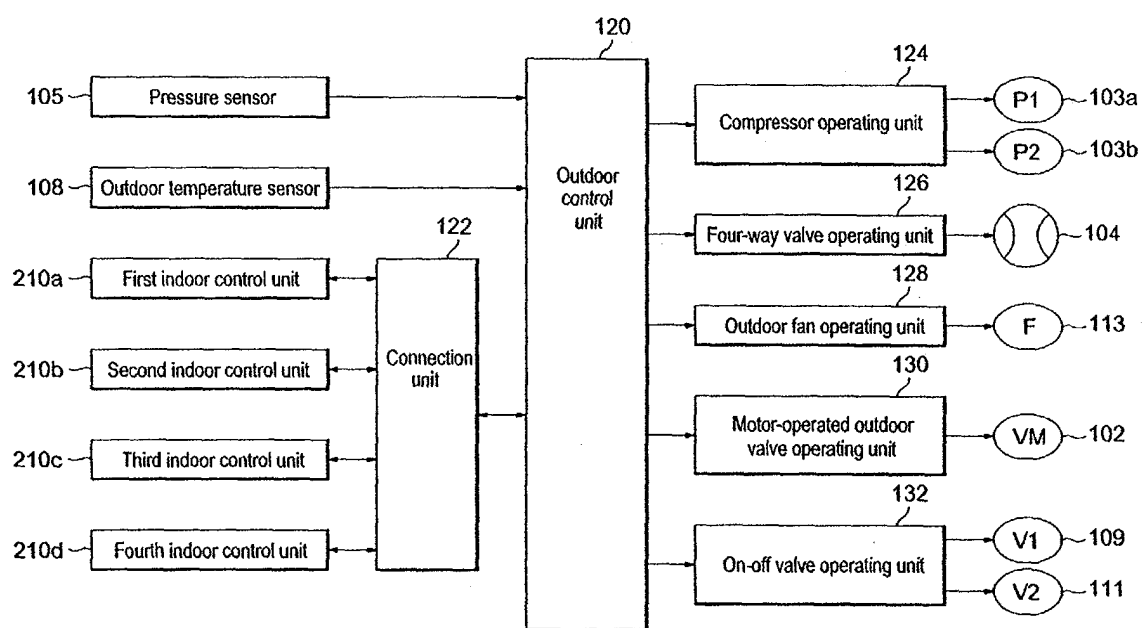


FIG. 3

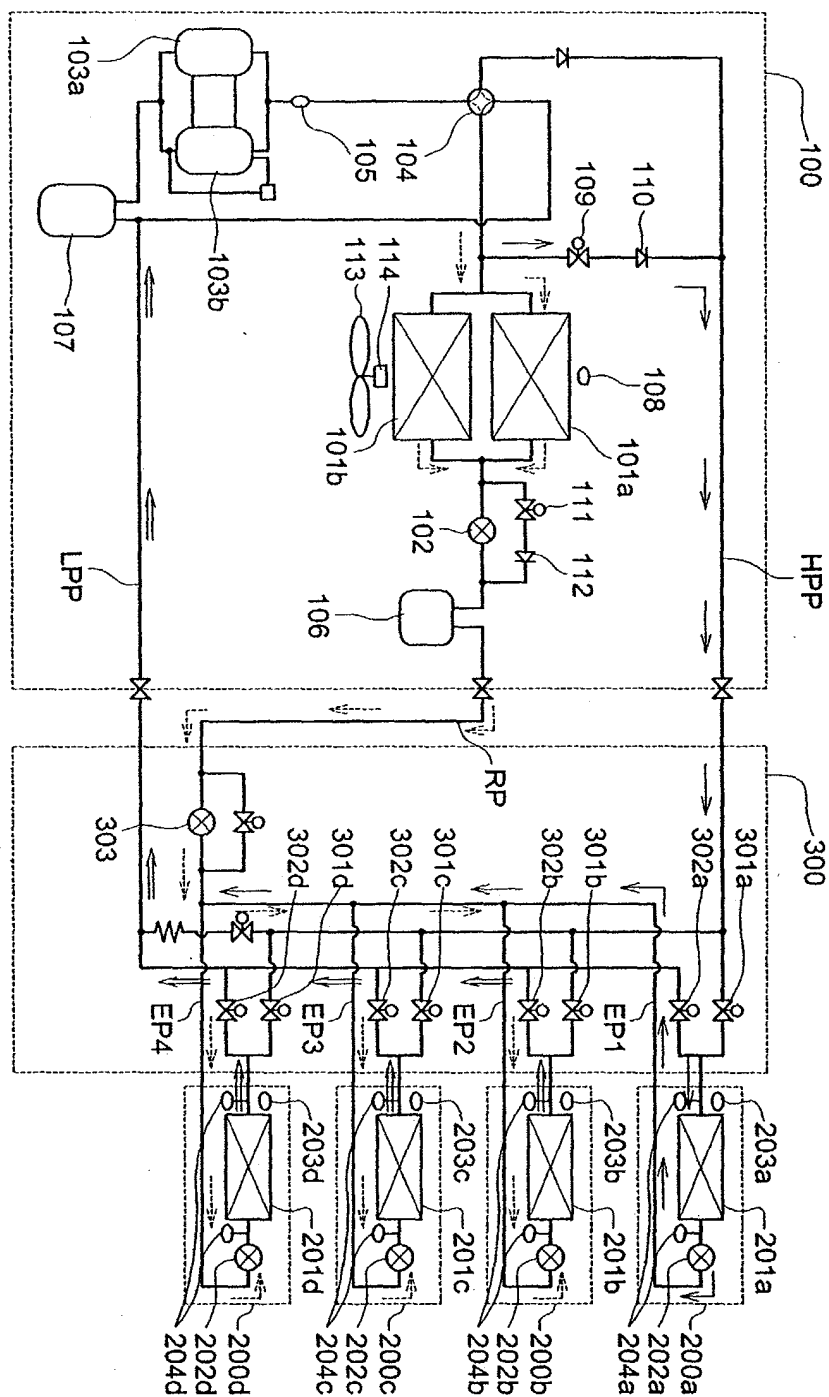


FIG. 4A

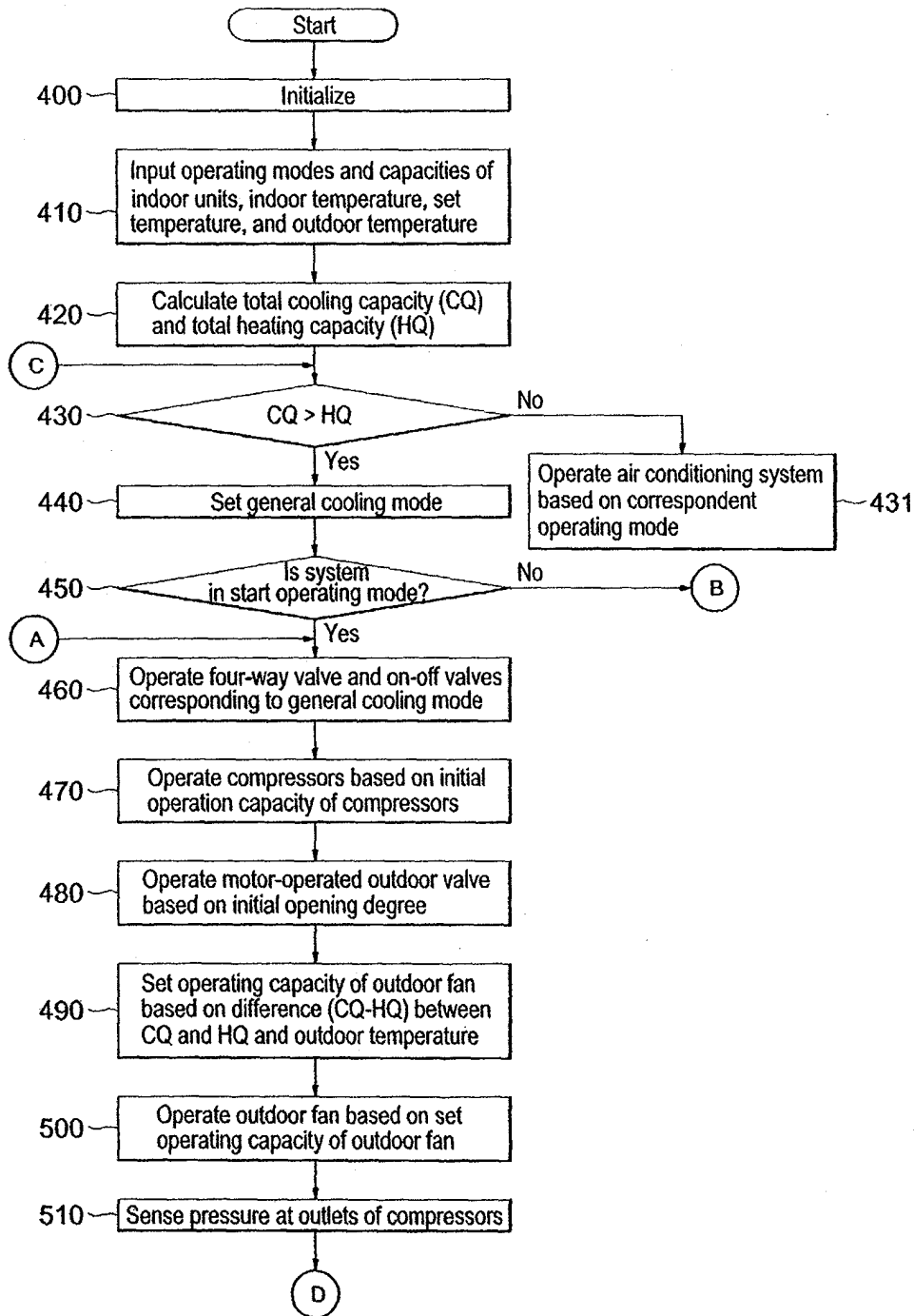


FIG. 4B

