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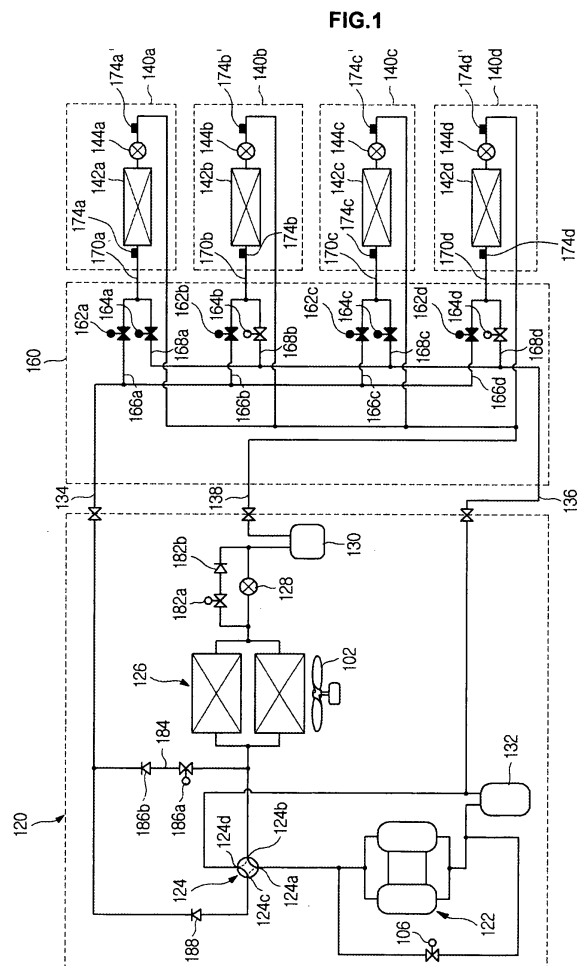
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(54) **Air conditioner inspection method**

(57) Disclosed herein is air conditioner inspection method that is capable of reducing inspection time and increasing inspection efficiency. The air conditioner inspection method is applied to an air conditioner including a plurality of indoor units (140a-140d) having cooling and heating valves and a plurality of mode change units (160) connected to the indoor units, via pipes, to control refrigerant flow to the indoor units such that cooling operation mode and heating operation mode of the respective indoor units are controlled. The air conditioner inspection method comprises operating all the indoor units in one of the cooling operation mode and heating operation mode for a predetermined period of time and, if all the indoor units are normally operated in the selected operation mode, determining that all the valves corresponding to the selected operation mode among the cooling and heating valves of the indoor units are normally operated.



Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 2005-0066882, filed on July 22, 2005 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 inspection method, and, more particularly, to a method of inspecting a multi air conditioner comprising at least one outdoor unit and a plurality of indoor units connected to the at least one outdoor unit via a mode change unit (hereinafter, referred to as "MCU").

2. Description of the Related Art

[0003] Generally, a multi air conditioner includes at least one outdoor unit, a plurality of indoor units connected in parallel to the outdoor unit, communication cables, power cables, and refrigerant pipes connected between the outdoor unit and the indoor units, and electronic valves.

[0004] When such a conventional multi air conditioner is installed, an installer connects the outdoor unit and the indoor units via the communication cables, the power cables, and the refrigerant pipes, and uses input devices (for example, rotary switches) provided for the respective indoor units to input numbers of the refrigerant pipes connected to the respective indoor units so that an outdoor unit microcomputer or indoor unit microcomputers recognize the numbers of the refrigerant pipes connected to the indoor units. However, the number of the refrigerant pipes and the indoor units, to which the refrigerant pipes are connected, is large, and therefore, much time is used to confirm whether the refrigerant pipes are normally (correctly, in other words) connected to the indoor units according to the numbers of the refrigerant pipes inputted through the input device by the installer.

SUMMARY OF THE INVENTION

[0005] Therefore, it is an aspect of the invention to provide an air conditioner inspection method that is capable of reducing inspection time and increasing inspection efficiency.

[0006] In accordance with one aspect, the present invention provides a method of inspecting an air conditioner including a plurality of indoor units having cooling and heating valves and a plurality of mode change units connected to the indoor units, via pipes, to control refrigerant flow to the indoor units such that cooling operation mode and heating operation mode of the respective indoor units

are controlled, the method comprising: operating all the indoor units in one of the cooling operation mode and heating operation mode for a predetermined period of time; and, when all the indoor units are normally operated in the selected operation mode, determining that all the valves corresponding to the selected operation mode among the cooling and heating valves of the indoor units are normally operated.

[0007] The air conditioner inspection method further comprises: when outdoor temperature is low, and therefore, the heating operation is more effective than the cooling operation for inspection of the installation state of the air conditioner, operating all the indoor units in the heating operation mode to raise temperatures of indoor spaces where the indoor units are installed such that the indoor units can be operated in the cooling operation mode; and, when the outdoor temperature is high, and therefore, the cooling operation is more effective than the heating operation for inspection of the installation state of the air conditioner, operating all the indoor units in the cooling operation mode to lower temperatures of indoor spaces where the indoor units are installed such that the indoor units can be operated in the heating operation mode.

[0008] In accordance with another aspect, the present invention provides a method of inspecting an air conditioner including a plurality of indoor units and a plurality of mode change units connected to the indoor units, via pipes, to control refrigerant flow to the indoor units such that cooling operation mode and heating operation mode of the respective indoor units are controlled, the method comprising: sequentially selecting the mode change units one by one; operating the indoor units connected to the selected mode change unit in one of the cooling operation mode and heating operation mode; and, when at least one of the indoor units connected to the selected mode change unit is not operated in the selected operation mode, determining that piping between the selected mode change unit and the unselected mode change units is abnormal.

[0009] The air conditioner inspection method further comprises: when outdoor temperature is low, and therefore, the heating operation is more effective than the cooling operation for inspection of the installation state of the air conditioner, operating the indoor units connected to the selected mode change unit in the heating operation mode; and, when the outdoor temperature is high, and therefore, the cooling operation is more effective than the heating operation for inspection of the installation state of the air conditioner, operating the indoor units connected to the selected mode change unit in the cooling operation mode.

[0010] In accordance with another aspect, the present invention provides a method of inspecting an air conditioner including a plurality of indoor units and a plurality of mode change units connected to the indoor units, via pipes, to control refrigerant flow to the indoor units such that cooling operation mode and heating operation mode of the respective indoor units are controlled, the method

comprising: sequentially selecting the indoor units one by one for each of the mode change units to operate the selected indoor units, wherein the selected indoor units connected to the respective mode change units are simultaneously operated to inspect the pipe connection between the indoor units and the mode change units in batch mode.

[0011] The air conditioner inspection method further comprises: when outdoor temperature is low, and therefore, the heating operation is more effective than the cooling operation for inspection of the installation state of the air conditioner, operating the selected indoor units in blowing operation mode and operating the unselected indoor units in the heating operation mode; and, when the selected indoor units are normally operated in the blowing operation mode, determining that the pipe connection of the selected indoor units is normal.

[0012] The indoor units have heating valves and electronic expansion valves, and the air conditioner inspection method further comprises: after closing the heating valves and the electronic expansion valves of the selected indoor units, operating the selected indoor units in the blowing operation mode; and, when the difference between inlet temperatures and outlet temperatures of heat exchangers of the selected indoor units is less than a predetermined level, determining that the pipe connection of the selected indoor units is normal.

[0013] The air conditioner inspection method further comprises: when outdoor temperature is high, and therefore, the cooling operation is more effective than the heating operation for inspection of the installation state of the air conditioner, operating the selected indoor units in the cooling operation mode and operating the unselected indoor units in blowing operation mode; and, when the selected indoor units are normally operated in the cooling operation mode, determining that the pipe connection of the selected indoor units is normal.

[0014] The air conditioner inspection method further comprises: operating the selected indoor units in the cooling operation mode; and, when the difference between inlet temperatures and outlet temperatures of heat exchangers of the selected indoor units is greater than a predetermined level, determining that the pipe connection of the selected indoor units is normal.

[0015] The indoor units have cooling valves and electronic expansion valves, and the air conditioner inspection method further comprises: after closing the cooling valves and the electronic expansion valves of the unselected indoor units, operating the unselected indoor units in the blowing operation mode.

[0016] In accordance with yet another aspect, the present invention provides a method of inspecting an air conditioner including a plurality of indoor units having cooling and heating valves and a plurality of mode change units connected to the indoor units, via pipes, to control refrigerant flow to the indoor units such that cooling operation mode and heating operation mode of the respective indoor units are controlled, the method com-

prising: operating all the indoor units in one of the cooling operation mode and heating operation mode for a predetermined period of time to inspect whether the cooling and heating valves of the indoor units are normally operated; sequentially selecting the mode change units one by one, and operating all the indoor units connected to the selected mode change unit in one of the cooling operation mode and heating operation mode to inspect abnormal pipe connection between the selected mode change unit and the unselected mode change units; and sequentially selecting the indoor units one by one for each of the mode change units to operate the selected indoor units, wherein the selected indoor units connected to the respective mode change units are simultaneously operated to inspect the pipe connection between the indoor units and the mode change units in batch mode.

[0017] The air conditioner inspection method further comprises: when all the indoor units are normally operated in the selected operation mode, determining that all the valves corresponding to the selected operation mode among the cooling and heating valves of the indoor units are normally operated.

[0018] The air conditioner inspection method further comprises: when at least one of the indoor units connected to the selected mode change unit is not operated in the selected operation mode, determining that piping between the selected mode change unit and the unselected mode change units is abnormal.

[0019] The air conditioner inspection method further comprises: when outdoor temperature is low, and therefore, the heating operation is more effective than the cooling operation for inspection of the installation state of the air conditioner, operating the selected indoor units in blowing operation mode and operating the unselected indoor units in the heating operation mode; and, when the selected indoor units are normally operated in the blowing operation mode, determining that the pipe connection of the selected indoor units is normal.

[0020] The indoor units further have electronic expansion valves, and the air conditioner inspection method further comprises: after closing the heating valves and the electronic expansion valves of the selected indoor units, operating the selected indoor units in the blowing operation mode; and, when the difference between inlet temperatures and outlet temperatures of heat exchangers of the selected indoor units is less than a predetermined level, determining that the pipe connection of the selected indoor units is normal.

[0021] The air conditioner inspection method further comprises: when outdoor temperature is high, and therefore, the cooling operation is more effective than the heating operation for inspection of the installation state of the air conditioner, operating the selected indoor units in the cooling operation mode and operating the unselected indoor units in blowing operation mode; and, when the selected indoor units are normally operated in the cooling operation mode, determining that the pipe connection of the selected indoor units is normal.

[0022] The air conditioner inspection method further comprises: operating the selected indoor units in the cooling operation mode; and, when the difference between inlet temperatures and outlet temperatures of heat exchangers of the selected indoor units is greater than a predetermined level, determining that the pipe connection of the selected indoor units is normal.

[0023] The indoor units further have electronic expansion valves, and the air conditioner inspection method further comprises: after closing the cooling valves and the electronic expansion valves of the unselected indoor units, operating the unselected indoor units in the blowing operation mode.

[0024] 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

[0025] 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 multi air conditioner according to 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 an air conditioner inspection method according to the present invention;

FIG. 4 is a view illustrating installation errors inspected by the air conditioner inspection method of FIG. 3; FIGS. 5A and 5B are a flow chart illustrating an installation state inspecting process through a heating operation of the air conditioner inspection method of FIG. 3; and

FIGS. 6A and 6B are a flow chart illustrating an installation state inspecting process through a cooling operation of the air conditioner inspection method of FIG. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] Reference will now be made in detail to the embodiment of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiment is described below to explain the present invention by referring to the figures.

[0027] FIG. 1 is a view illustrating a multi air conditioner according to the present invention. The multi air conditioner is an air conditioner comprising a plurality of indoor units and at least one outdoor unit to perform cooling or heating through the indoor units.

[0028] As shown in FIG. 1, the multi air conditioner comprises an outdoor unit 120, first to fourth indoor units 140a to 140d, and a mode change unit (MCU) 160.

[0029] In the outdoor unit 120, a four-way valve 124 changes the flow direction of refrigerant discharged from a compressor 122. Specifically, the four-way valve 124 changes the flow direction of high-temperature and high-pressure refrigerant such that the refrigerant discharged from a compressor flows to a main cooling-purpose electronic valve 186a and an outdoor heat exchanger 126 at the time of a main cooling operation and such that the refrigerant flows to the first to fourth indoor units 140a to 140d via a check valve 188 and the MCU 160 at the time of a main heating operation, through selective opening and closing of four 124a, 124b, 124c, and 124d. The outdoor heat exchanger 126 performs heat exchange between outdoor air introduced into the outdoor unit 120 through an outdoor fan 102 and the refrigerant. In the outdoor unit 120 are also mounted an outdoor electronic expansion valve 128 to expand the refrigerant, a liquid receiver to separate liquid-state refrigerant from the refrigerant, and an accumulator 132. The refrigerant flow between the first to fourth indoor units 140a to 140d and the outdoor unit 120 is achieved through a high-pressure gas pipe 134, a low-pressure gas pipe 136, and a high-pressure liquid pipe 138.

[0030] The low-pressure gas pipe 136 is connected to the inlet side of the compressor 122 via the accumulator 132, and the high-pressure liquid pipe 138 is connected to the outdoor electronic expansion valve 128 via the liquid receiver 130. Between the inlet and outlet sides of the compressor 122 is connected a hot gas bypass valve 106 via an additional refrigerant pipe. A bypass 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. Consequently, some of the liquid refrigerant discharged from the outdoor heat exchanger 126 flows through the bypass valve 182a and the check valve 182b, i.e., the refrigerant bypasses the outdoor electronic expansion valve 128. The bypass valve 182a and the check valve 182b are 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 main cooling-purpose 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 mounted another check valve 188 to prevent backward-flow of the refrigerant.

[0032] The first to fourth indoor units 140a to 140d are connected in parallel to the outdoor unit 120. The first to fourth indoor units 140a to 140d include first to fourth

indoor heat exchangers 142a to 142d, first to fourth indoor electronic expansion valve 144a to 144d, and first to fourth temperature sensor pairs 174a-174a' to 174d-174d', respectively. The first to fourth temperature sensor pairs 174a-174a' to 174d-174d' serve to detect the difference between the inlet temperatures and outlet temperatures of the first to fourth indoor heat exchangers 142a to 142d, respectively.

[0033] The MCU 160 serves to switch between the cooling and heating operations of the first to fourth indoor units 140a to 140d. The MCU 160 includes first to fourth high-pressure gas branch pipes 166a to 166d, which diverge from the high-pressure gas pipe 134. First to fourth heating-purpose electronic valves 162a to 162d are mounted on the first to fourth high-pressure gas branch pipes 166a to 166d, respectively. The MCU 160 further includes first to fourth low-pressure gas branch pipes 168a to 168d, which diverge from the low-pressure gas pipe 136. First to fourth cooling-purpose electronic valves 164a to 164d are mounted on the first to fourth low-pressure gas branch pipes 168a to 168d, respectively. The first heating-purpose electronic valve 162a and the first cooling-purpose electronic valve 164a are connected to a first refrigerant pipe 170a, which is connected to the first indoor heat exchanger 142a. The second to fourth heating-purpose electronic valves 162b to 162d and the second to fourth cooling-purpose electronic valves 164b to 164d are connected to second to fourth refrigerant pipes 170b to 170d in consecutive order.

[0034] 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 the components of the outdoor unit 120. The first to fourth indoor units 140a to 140d further include first to fourth indoor unit microcomputers 206a to 206d to control components of the first to fourth indoor units 140a to 140d, respectively. The MCU 160 further includes a MCU microcomputer 204 to control the first to fourth cooling-purpose electronic valves 164a to 164d and the first to fourth heating-purpose electronic valves 162a to 162d.

[0035] FIG. 3 is a flow chart illustrating an air conditioner inspection method according to the present invention. As shown in FIG. 3, a multi air conditioner, which comprises at least one outdoor unit, a plurality of MCUs connected to the outdoor unit, and a plurality of indoor units connected to the respective MCUs, is installed first (300), and the indoor units are manually matched with the valves of the MCUs, respectively (301). In this state, it is determined whether the outdoor temperature is lower than the heating allowance temperature, and therefore, the heating operation is possible (302). If the outdoor temperature is lower than the heating allowance temperature, and therefore, the heating operation is possible, an inspection through the heating operation is performed (304). If the outdoor temperature is higher than the heating allowance temperature, and therefore, the heating operation is not possible, an inspection through the cool-

ing operation is performed (306). That is, when the temperature (i.e., the outdoor air) at the time of installing and inspecting the air conditioner is low, and therefore, the heating operation is more effective than the cooling operation for inspection of the installation state of the air conditioner, the installation state of the air conditioner is inspected through the heating operation (for example, in winter). When the temperature (i.e., the outdoor air) at the time of installing and inspecting the air conditioner is high, and therefore, the cooling operation is more effective than the heating operation for inspection of the installation state of the air conditioner, the installation state of the air conditioner is inspected through the cooling operation (for example, in summer).

[0036] After the inspection through the heating operation (304) or the inspection through the cooling operation (306) is completed, it is determined whether the installation states of the valves and pipes are normal. If it is determined that the installation states of the valves and pipes are all normal, the inspection is completed ('yes' at Operation 308). If it is determined that the installation states of the valves and pipes are abnormal, installation errors are displayed to inform an inspector that the installation states of the valves and pipes are abnormal (310).

[0037] FIG. 4 is a view illustrating installation errors inspected by the air conditioner inspection method of FIG. 3. As shown in FIG. 4, a plurality of MCUs #10 to #40 are connected to an outdoor unit #1, and a plurality of indoor units #11 - #14 to #41 - #44 are connected to the MCUs #10 to #40, respectively. The constructions of the outdoor unit #1, the MCUs #10 to #40, and the indoor units #11 - #14 to #41 - #44 are identical to those of the outdoor unit, the MCU, and the indoor units shown in FIGS. 1 and 2. The MCUs #10 to #40 control operation mode (the cooling or heating operation) of the indoor units connected thereto, respectively.

[0038] An installation error 402 shown in FIG. 4 indicates abnormal pipe connection between the MCUs #10 and #20. The indoor unit #14, which is to be connected to the MCU #10, is connected to the MCU #20, and the indoor unit #21, which is to be connected to the MCU #20, is connected to the MCU #10. In this case, when the MCU #10 controls the operation of the indoor unit #14, the indoor unit #21 is operated. Similarly, when the MCU #20 controls the operation of the indoor unit #21, the indoor unit #14 is operated.

[0039] Another installation error 404 shown in FIG. 4 indicates abnormal pipe connection in the MCU #30. The two indoor units #32 and #33 among the indoor units #31 to #34 controlled by the MCU #30 are abnormally connected to the MCU #30. In this case, when the MCU #30 controls the operation of the indoor unit #32, the indoor unit #33 is operated. Similarly, when the MCU #30 controls the operation of the indoor unit #33, the indoor unit #32 is operated.

[0040] In FIG. 4, the indoor units #41 - #44 is normally (correctly, in other words) connected to the MCU #40.

[0041] FIGS. 5A and 5B are a flow chart illustrating an installation state inspecting process through the heating operation among the air conditioner inspection method of FIG. 3. When the outdoor temperature is low, and therefore, the installation state inspecting process through the heating operation is performed, as shown in FIG. 5A, it is determined whether the outdoor temperature is higher than the cooling allowance temperature, even though the outdoor temperature is low, and therefore, the cooling operation is possible (502). If the outdoor temperature is lower than or equal to the cooling allowance temperature ('no' at Operation 502), all the indoor units are operated in heating operation mode for a predetermined period of time (504). When the outdoor temperature is too low, and therefore, the cooling operation is not possible, the heating operation is performed to raise the indoor temperature such that the cooling operation is possible, and then the installation states of the valves and pipes related to the cooling operation are inspected through the cooling operation. If the installation state of the air conditioner is inspected through the heating operation when the temperature is low, i.e., in winter, the installation states of the valves and pipes related to the heating operation can be inspected. However, the installation states of the valves and pipes related to the cooling operation cannot be inspected. For this reason, although the installation state of the air conditioner is inspected through the heating operation, the cooling operation is performed for the predetermined period of time such that the cooling operation is possible. Consequently, the installation states of the valves and pipes related to the cooling operation can be inspected.

[0042] If the outdoor temperature is higher than the cooling allowance temperature ('yes' at Operation 502) or the cooling operation becomes possible through the heating operation (504), all the indoor units are operated in cooling operation mode for a predetermined period of time (506). If the cooling operations of some of the indoor units are not normally performed ('no' at Operation 508), it is determined that the installation or operation states of the cooling valves are not normal, and therefore, flow of the refrigerant for the cooling operation is not smooth, and registration of cooling valve errors is performed (510). If the cooling operations of all the indoor units are normally performed ('yes' at Operation 508), it is determined that the installation and operation states of the cooling valves are normal (512). In this way, the installation errors of the cooling valves can be inspected even when the inspection through the heating operation is performed.

[0043] After the installation and operation states of the cooling valves are inspected, the respective MCUs are sequentially selected (514), and all the indoor units connected to the selected MCU are operated in heating operation mode, to inspect abnormal pipe connection between the MCUs (516). If some or all of the indoor units connected to the selected MCU are not normally operated in heating operation mode ('no' at Operation 518), it

is determined that piping between two or more MCUs is abnormal, and registration of abnormal pipe connection between MCUs is performed (520). The abnormal pipe connection between the MCUs means that the indoor units, which are to be connected to one MCU, are connected to another MCU, as indicated by the installation error 402 shown in FIG. 4, and therefore, when the heating operation is attempted for all the indoor units connected to the one MCU, some or all of the indoor units are not operated in the heating operation mode. The inspection of abnormal pipe connection between the MCUs is continuously performed until the inspection is completed for all the MCUs ('no' at Operation 522).

[0044] After the inspection of abnormal pipe connection between the MCUs is completed for all the MCUs ('yes' at Operation 522), as shown in FIG. 5B, the inspection of abnormal pipe connection in the respective MCUs is performed. In order to inspect abnormal pipe connection in the respective MCUs, one indoor unit is selected for each of the MCUs (552). The selected indoor units are operated in blowing operation mode while the heating valves and electronic expansion valves of the selected indoor units are closed (554), and the unselected indoor units are operated in heating operation mode (556). For example, the indoor unit #11 is selected for the MCU #10, the indoor unit #21 for the MCU #20, the indoor unit #31 for the MCU #30, and the indoor unit #41 for the MCU #40. In this way, one indoor unit is selected for each of the MCUs such that the abnormal pipe connection inspections for the respective MCUs are simultaneously performed in batch mode. If only one MCU is selected from the plurality of MCUs to inspect the abnormal pipe connection, much time may be used for inspection depending on the number of MCUs and the number of indoor units connected to the respective MCUs. According to the present invention, however, all the MCUs are simultaneously inspected in batch mode, and therefore, inspection time is reduced.

[0045] If the selected indoor units are not normally operated in the blowing operation mode, or the unselected indoor units are not normally operated in the heating operation mode ('no' at Operation 558), it is determined that the piping between the currently selected MCU and the indoor unit is abnormal, and registration of abnormal pipe connection in the selected MCU is performed (560). When the selected indoor units are normally operated in the blowing operation mode, there is little difference between the inlet temperatures and outlet temperatures of heat exchangers of the selected indoor units. Consequently, if the difference between the inlet and outlet temperatures of the heat exchangers of the selected indoor units is less than a predetermined level, it is determined that the indoor units are normally operated in the blowing operation mode, and the pipe connection is also normal. However, if the selected indoor unit is operated in the heating operation mode, not in the blowing operation mode (in this case, the difference between the inlet temperature and outlet temperature of the heat exchanger

is greater than the predetermined level), and one of the unselected indoor units is operated in the blowing operation mode, it is determined that the pipe connection between the two indoor units is abnormal. The piping inspection of the indoor units connected to the respective MCUs is continuously performed until the piping inspection is completed for all the indoor units ('no' at Operation 562). If the piping inspection is not completed for all the indoor units, the next one indoor unit is selected for each of the MCUs, and abnormal pipe connection inspection is performed through the blowing and heating operations (564). For example, the indoor unit #12 is selected for the MCU #10, the indoor unit #22 for the MCU #20, the indoor unit #32 for the MCU #30, and the indoor unit #42 for the MCU #40.

[0046] FIGS. 6A and 6B are a flow chart illustrating an installation state inspecting process through the cooling operation among the air conditioner inspection method of FIG. 3. When the outdoor temperature is high, and therefore, the installation state inspecting process through the cooling operation is performed, as shown in FIG. 6A, it is determined whether the outdoor temperature is lower than the heating allowance temperature, even though the outdoor temperature is high, and therefore, the heating operation is possible (602). If the outdoor temperature is higher than or equal to the heating allowance temperature ('no' at Operation 602), all the indoor units are operated in cooling operation mode for a predetermined period of time (604). When the outdoor temperature is too high, and therefore, the heating operation is not possible, the cooling operation is performed to lower the indoor temperature such that the heating operation is possible, and then the installation states of the valves and pipes related to the heating operation are inspected through the heating operation. If the installation state of the air conditioner is inspected through the cooling operation when the temperature is high, i.e., in summer, the installation states of the valves and pipes related to the cooling operation can be inspected. However, the installation states of the valves and pipes related to the heating operation cannot be inspected. For this reason, although the installation state of the air conditioner is inspected through the cooling operation, the heating operation is performed for the predetermined period of time such that the heating operation is possible. Consequently, the installation states of the valves and pipes related to the heating operation can be inspected.

[0047] If the outdoor temperature is lower than the cooling allowance temperature ('yes' at Operation 602) or the heating operation becomes possible through the cooling operation (604), all the indoor units are operated in heating operation mode for a predetermined period of time (606). If the heating operations of some of the indoor units are not normally performed ('no' at Operation 608), it is determined that the installation or operation states of the heating valves are not normal, and therefore, flow of the refrigerant for the heating operation is not smooth, and registration of heating valve errors is performed

(610). If the heating operations of all the indoor units are normally performed ('yes' at Operation 608), it is determined that the installation and operation states of the heating valves are normal (612). In this way, the installation errors of the heating valves can be inspected even when the inspection through the cooling operation is performed.

[0048] After the installation and operation states of the heating valves are inspected, the respective MCUs are sequentially selected (614), and all the indoor units connected to the selected MCU are operated in cooling operation mode, to inspect abnormal pipe connection between the MCUs (616). If some or all of the indoor units connected to the selected MCU are not normally operated in cooling operation mode ('no' at Operation 618), it is determined that piping between two or more MCUs is abnormal, and registration of abnormal pipe connection between MCUs is performed (620). The abnormal pipe connection between the MCUs means that the indoor units, which are to be connected to one MCU, are connected to another MCU, as indicated by the installation error 402 shown in FIG. 4, and therefore, when the cooling operation is attempted for all the indoor units connected to the one MCU, some or all of the indoor units are not operated in the cooling operation mode. The inspection of abnormal pipe connection between the MCUs is continuously performed until the inspection is completed for all the MCUs ('no' at Operation 622).

[0049] After the inspection of abnormal pipe connection between the MCUs is completed for all the MCUs ('yes' at Operation 622), as shown in FIG. 5B, the inspection of abnormal pipe connection in the respective MCUs is performed. In order to inspect abnormal pipe connection in the respective MCUs, one indoor unit is selected for each of the MCUs (652). The selected indoor units are operated in cooling operation mode (654), and the unselected indoor units are operated in blowing operation mode while the heating valves and electronic expansion valves of the selected indoor units are closed (656). For example, the indoor unit #11 is selected for the MCU #10, the indoor unit #21 for the MCU #20, the indoor unit #31 for the MCU #30, and the indoor unit #41 for the MCU #40. In this way, one indoor unit is selected for each of the MCUs such that the piping inspections for the respective MCUs are simultaneously performed in batch mode. If only one MCU is selected from the plurality of MCUs to inspect the abnormal pipe connection, much time may be used for inspection depending on the number of MCUs and the number of indoor units connected to the respective MCUs. According to the present invention, however, all the MCUs are simultaneously inspected in batch mode, and therefore, inspection time is reduced.

[0050] If the selected indoor units are not normally operated in the cooling operation mode, or the unselected indoor units are not normally operated in the blowing operation mode ('no' at Operation 658), it is determined that the piping between the currently selected MCU and the indoor unit is abnormal, and registration of abnormal pipe

connection in the selected MCU is performed (660). When the unselected indoor units are normally operated in the blowing operation mode, there is little difference between the inlet temperatures and outlet temperatures of heat exchangers of the unselected indoor units. Consequently, if the difference between the inlet temperatures and outlet temperatures of the heat exchangers of the selected indoor units is less than a predetermined level, it is determined that the indoor units are normally operated in the blowing operation mode, and the pipe connection is also normal.

[0051] However, if one of the unselected indoor units is operated in the cooling operation mode, not in the blowing operation mode (in this case, the difference between the inlet temperatures and outlet temperatures of the heat exchanger is greater than the predetermined level), and the selected indoor unit is operated in the blowing operation mode, it is determined that the pipe connection between the two indoor units is abnormal. The piping inspection of the indoor units connected to the respective MCUs is continuously performed until the piping inspection is completed for all the indoor units ('no' at Operation 662). If the piping inspection is not completed for all the indoor units, the next one indoor unit is selected for each of the MCUs, and abnormal pipe connection inspection is performed through the cooling and blowing operations (664). For example, the indoor unit #12 is selected for the MCU #10, the indoor unit #22 for the MCU #20, the indoor unit #32 for the MCU #30, and the indoor unit #42 for the MCU #40.

[0052] When errors are found at any one of the inspecting operations while the installation state inspecting process of the FIGS. 5A, 5B, 6A, and 6B is performed, the errors may be immediately informed to the installer or the administrator, and the other inspecting operations may be omitted.

[0053] As apparent from the above description, abnormal pipe connection of the indoor units is simultaneously inspected for the respective MCUs. Consequently, time necessary to inspect the installation state of the air conditioner is reduced although the air conditioner includes a great number of MCUs.

[0054] Furthermore, the cooling valve error inspection is performed through the cooling operation while the abnormal pipe connection inspecting is performed through the heating operation in winter, and the heating valve error inspection is performed through the cooling operation while the abnormal pipe connection inspecting is performed through the cooling operation in summer. Consequently, the present invention has the effect of improving inspection efficiency.

[0055] In addition, the inspection of abnormal pipe connection between the MCUs and the inspection of incorrect piping in the respective MCUs are performed in batch mode. Consequently, the present invention has the effect of improving inspection efficiency.

[0056] Although a few embodiments of the present invention have been shown and described, it would be ap-

preciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Claims

1. A method of inspecting an air conditioner including a plurality of indoor units having cooling and heating valves and a plurality of mode change units connected to the indoor units, via pipes, to control refrigerant flow to the indoor units such that cooling operation mode and heating operation mode of the respective indoor units are controlled, the method comprising:

operating all the indoor units in one of the cooling operation mode and heating operation mode for a predetermined period of time; and
when all the indoor units are normally operated in the selected operation mode, determining that all the valves corresponding to the selected operation mode among the cooling and heating valves of the indoor units are normally operated.

2. The method according to claim 1, further comprising:

when outdoor temperature is low, and therefore, the heating operation is more effective than the cooling operation for inspection of the installation state of the air conditioner, operating all the indoor units in the heating operation mode to raise temperatures of indoor spaces where the indoor units are installed such that the indoor units can be operated in the cooling operation mode; and

when the outdoor temperature is high, and therefore, the cooling operation is more effective than the heating operation for inspection of the installation state of the air conditioner, operating all the indoor units in the cooling operation mode to lower temperatures of indoor spaces where the indoor units are installed such that the indoor units can be operated in the heating operation mode.

3. A method of inspecting an air conditioner including a plurality of indoor units and a plurality of mode change units connected to the indoor units, via pipes, to control refrigerant flow to the indoor units such that cooling operation mode and heating operation mode of the respective indoor units are controlled, the method comprising:

sequentially selecting the mode change units one by one;
operating the indoor units connected to the selected mode change unit in one of the cooling

- operation mode and heating operation mode;
and
when at least one of the indoor units connected
to the selected mode change unit is not operated
in the selected operation mode, determining that
pipe connection between the selected mode
change unit and the unselected mode change
units is abnormal. 5
4. The method according to claim 3, further comprising: 10
- when outdoor temperature is low, and therefore,
the heating operation is more effective than the
cooling operation for inspection of the installa-
tion state of the air conditioner, operating the
indoor units connected to the selected mode
change unit in the heating operation mode; and
when the outdoor air is high, and therefore, the
cooling operation is more effective than the heat-
ing operation for inspection of the installation
state of the air conditioner, operating the indoor
units connected to the selected mode change
unit in the cooling operation mode. 15
5. A method of inspecting an air conditioner including
a plurality of indoor units and a plurality of mode
change units connected to the indoor units, via pipes,
to control refrigerant flow to the indoor units such
that cooling operation mode and heating operation
mode of the respective indoor units are controlled,
the method comprising: 20
- sequentially selecting the indoor units one by
one for each of the mode change units to operate
the selected indoor units, wherein the selected
indoor units connected to the respective mode
change units are simultaneously operated to in-
spect the pipe connection between the indoor
units and the mode change units in batch mode. 25
6. The method according to claim 5, further comprising: 30
- when outdoor temperature is low, and therefore,
the heating operation is more effective than the
cooling operation for inspection of the installa-
tion state of the air conditioner, operating the
selected indoor units in blowing operation mode
and operating the unselected indoor units in the
heating operation mode; and
when the selected indoor units are normally op-
erated in the blowing operation mode, determin-
ing that the pipe connection of the selected in-
door units is normal. 35
7. The method according to claim 6, wherein the indoor
units have heating valves and electronic expansion
valves, and the method further comprises: 40
- after closing the heating valves and the electron-
ic expansion valves of the selected indoor units,
operating the selected indoor units in the blow-
ing operation mode; and
when the difference between inlet temperatures
and outlet temperatures of heat exchangers of
the selected indoor units is less than a prede-
termined level, determining that the pipe con-
nection of the selected indoor units is normal. 45
8. The method according to claim 5, further comprising:
- when outdoor temperature is high, and there-
fore, the cooling operation is more effective than
the heating operation for inspection of the instal-
lation state of the air conditioner, operating the
selected indoor units in the cooling operation
mode and operating the unselected indoor units
in blowing operation mode; and
when the selected indoor units are normally op-
erated in the cooling operation mode, determin-
ing that the pipe connection of the selected in-
door units is normal. 50
9. The method according to claim 8, further comprising:
- operating the selected indoor units in the cooling
operation mode; and
when the difference between inlet temperatures
and outlet temperatures of heat exchangers of
the selected indoor units is greater than a pre-
determined level, determining that the pipe con-
nection of the selected indoor units is normal. 55
10. The method according to claim 8, wherein the indoor
units have cooling valves and electronic expansion
valves, and the method further comprises:
- after closing the cooling valves and the electron-
ic expansion valves of the unselected indoor
units, operating the unselected indoor units in
the blowing operation mode. 60
11. A method of inspecting an air conditioner including
a plurality of indoor units having cooling and heating
valves and a plurality of mode change units connect-
ed to the indoor units, via pipes, to control refrigerant
flow to the indoor units such that cooling operation
mode and heating operation mode of the respective
indoor units are controlled, the method comprising:
- operating all the indoor units in one of the cooling
operation mode and heating operation mode for
a predetermined period of time to inspect wheth-
er the cooling valves and heating valves of the
indoor units are normally operated;
sequentially selecting the mode change units
one by one, and operating all the indoor units

connected to the selected mode change unit in one of the cooling operation mode and heating operation mode to inspect abnormal pipe connection between the selected mode change unit and the unselected mode change units; and sequentially selecting the indoor units one by one for each of the mode change units to operate the selected indoor units, wherein the selected indoor units connected to the respective mode change units are simultaneously operated to inspect the pipe connection between the indoor units and the mode change units in batch mode.

12. The method according to claim 11, further comprising:

when all the indoor units are normally operated in the selected operation mode, determining that all the valves corresponding to the selected operation mode among the cooling valves and heating valves of the indoor units are normally operated.

13. The method according to claim 11, further comprising:

when at least one of the indoor units connected to the selected mode change unit is not operated in the selected operation mode, determining that pipe connection between the selected mode change unit and the unselected mode change units is abnormal.

14. The method according to claim 11, further comprising:

when outdoor temperature is low, and therefore, the heating operation is more effective than the cooling operation for inspection of the installation state of the air conditioner, operating the selected indoor units in blowing operation mode and operating the unselected indoor units in the heating operation mode; and
when the selected indoor units are normally operated in the blowing operation mode, determining that the pipe connection of the selected indoor units is normal.

15. The method according to claim 14, wherein the indoor units further have electronic expansion valves, and the method further comprises:

after closing the heating valves and the electronic expansion valves of the selected indoor units, operating the selected indoor units in the blowing operation mode; and
when the difference between inlet temperature and outlet temperatures of heat exchangers of

the selected indoor units is less than a predetermined level, determining that the pipe connection of the selected indoor units is normal.

16. The method according to claim 11, further comprising:

when outdoor temperature is high, and therefore, the cooling operation is more effective than the heating operation inspection of the installation state of the air conditioner, operating the selected indoor units in the cooling operation mode and operating the unselected indoor units in blowing operation mode; and
when the selected indoor units are normally operated in the cooling operation mode, determining that the pipe connection of the selected indoor units is normal.

17. The method according to claim 16, further comprising:

operating the selected indoor units in the cooling operation mode; and
when the difference between inlet temperature and outlet temperatures of heat exchangers of the selected indoor units is greater than a predetermined level, determining that the pipe connection of the selected indoor units is normal.

18. The method according to claim 16, wherein the indoor units further have electronic expansion valves, and the method further comprises:

after closing the cooling valves and the electronic expansion valves of the unselected indoor units, operating the unselected indoor units in the blowing operation mode.

FIG.1

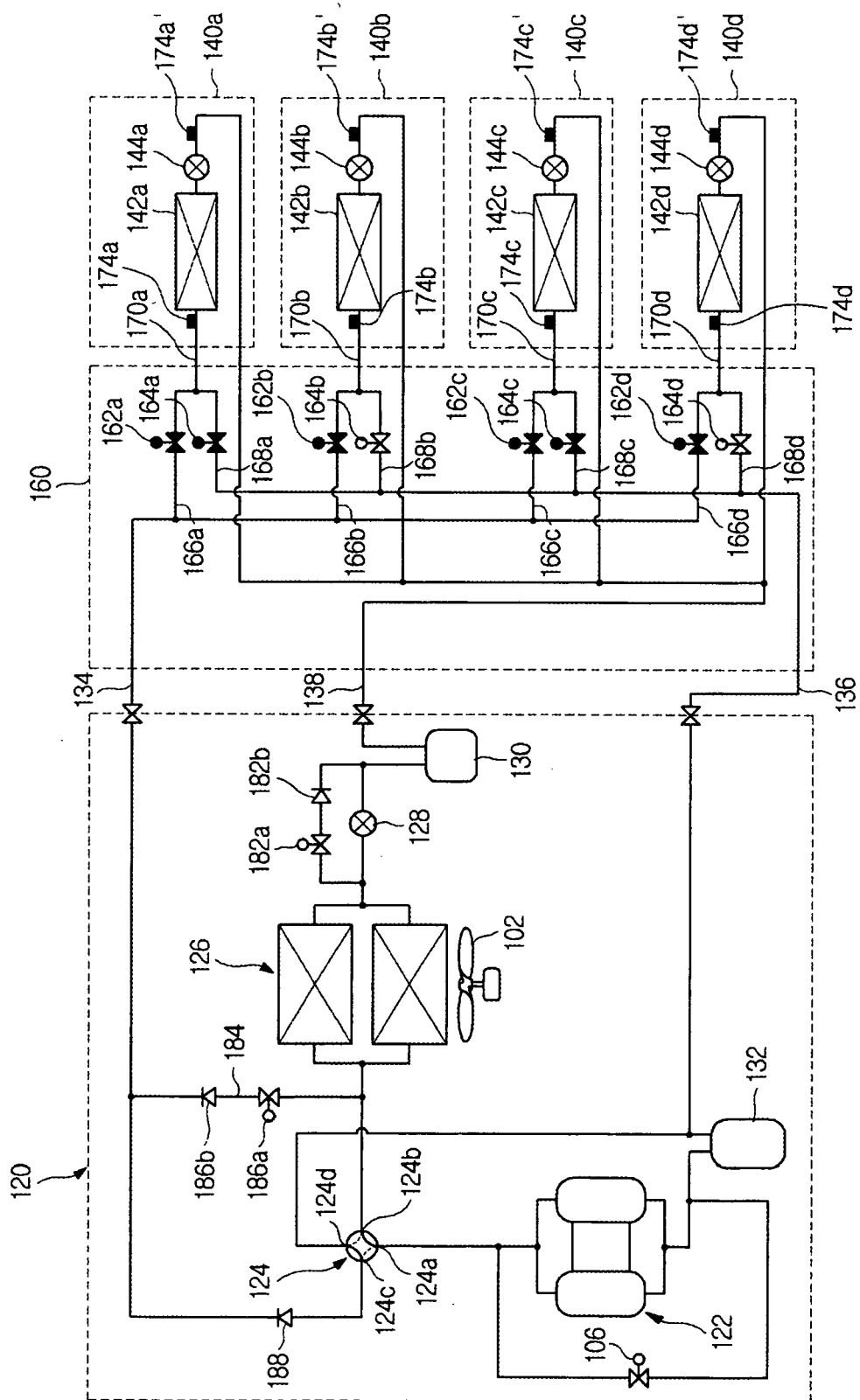


FIG. 2

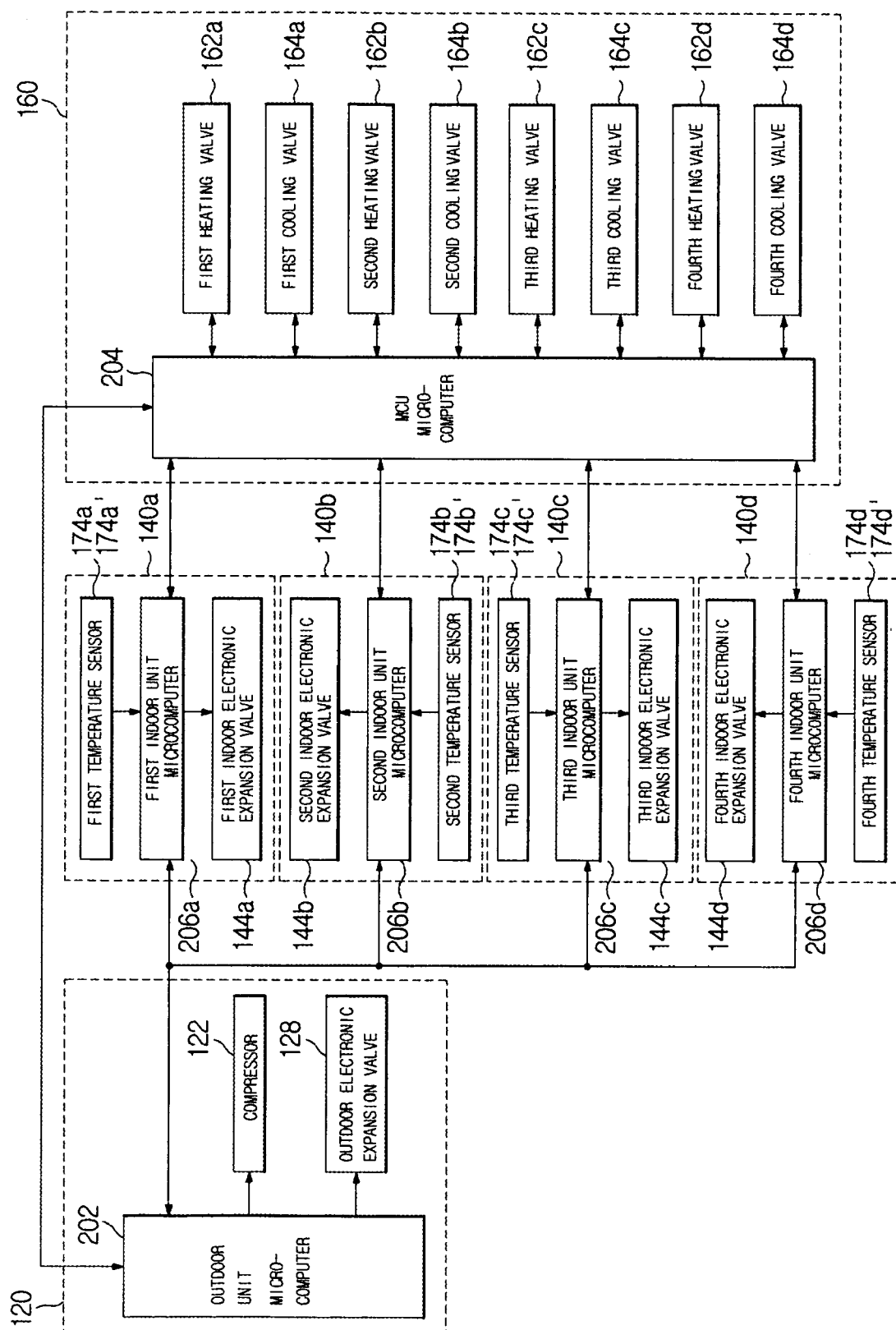


FIG.3

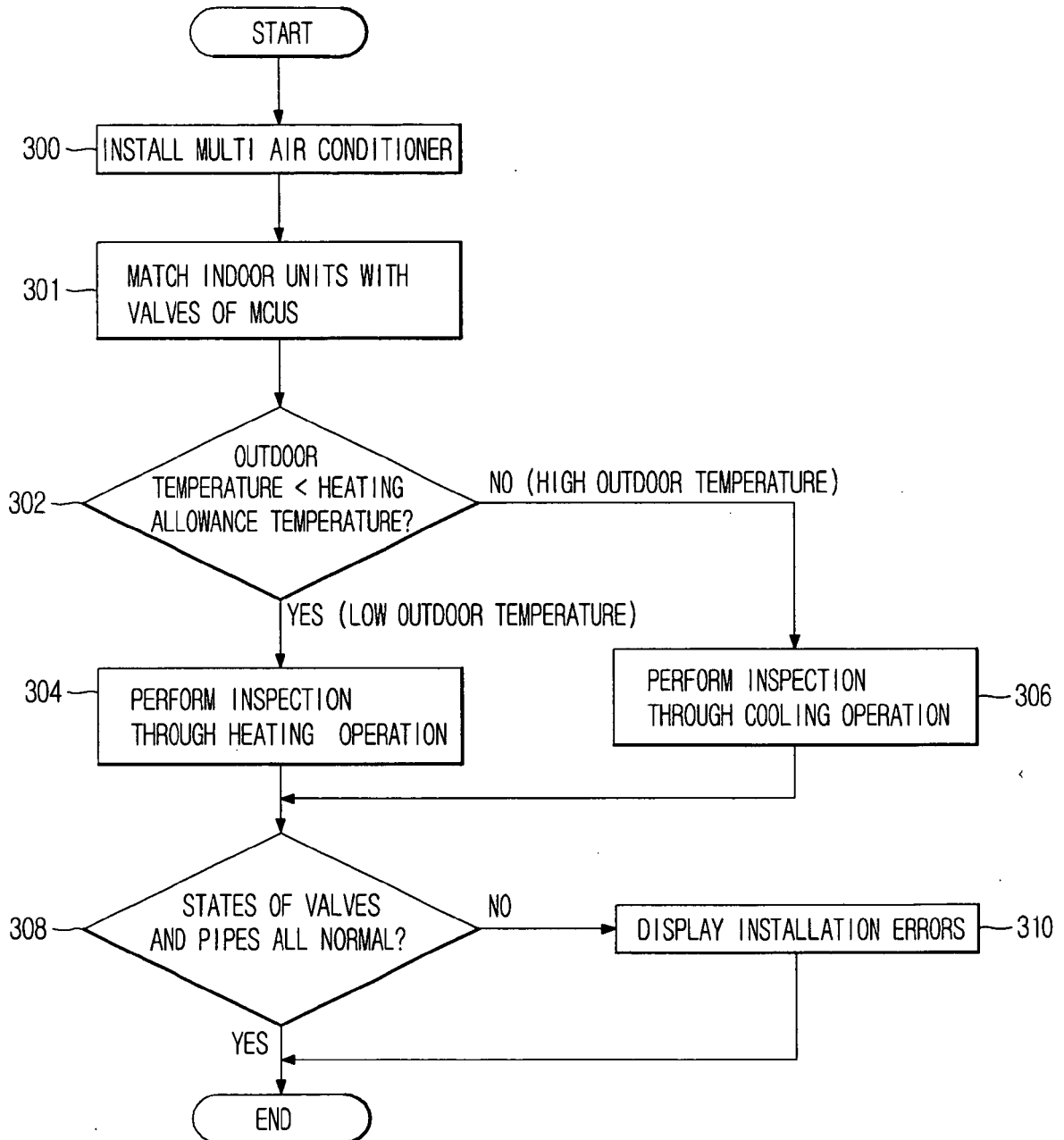


FIG.4

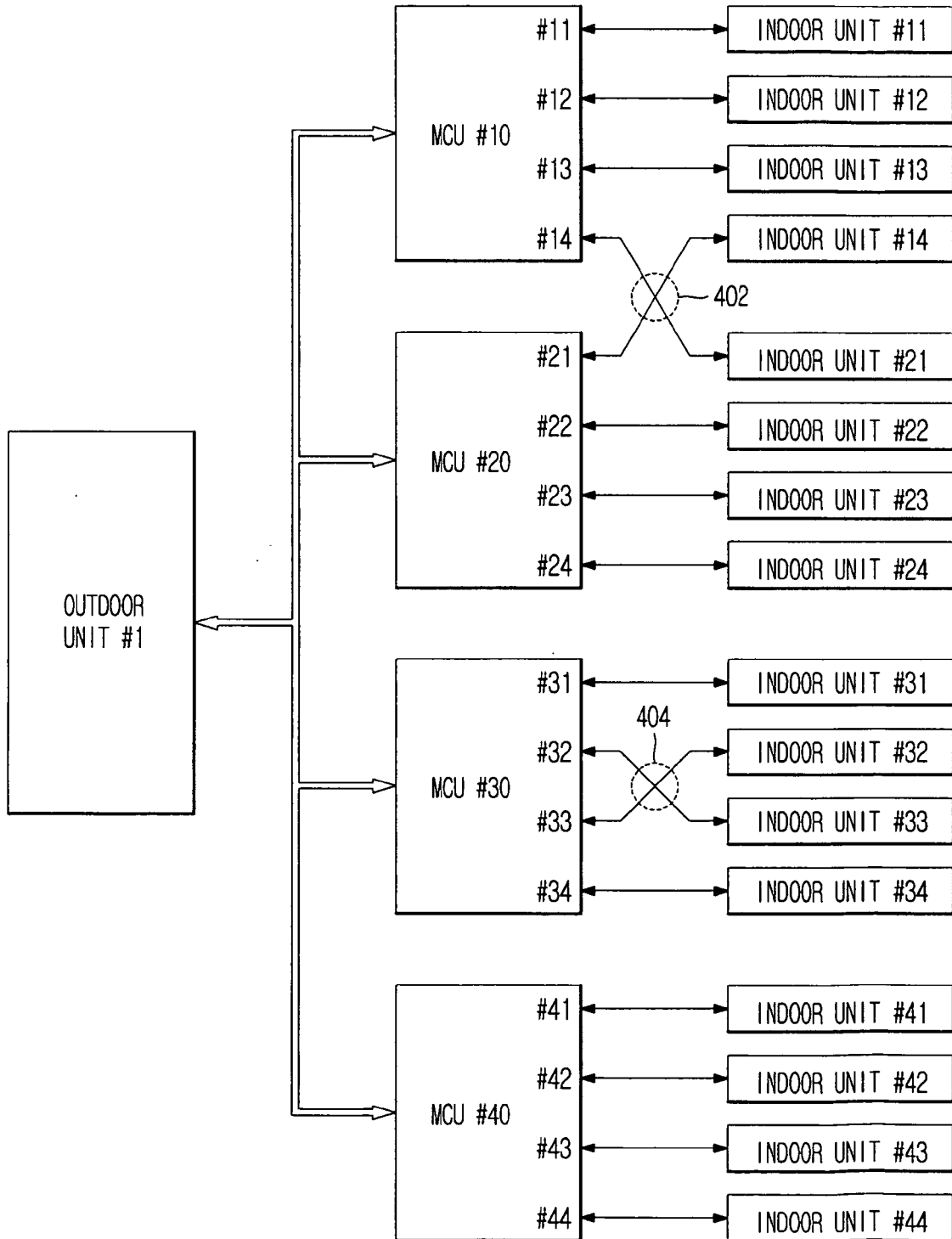


FIG.5A

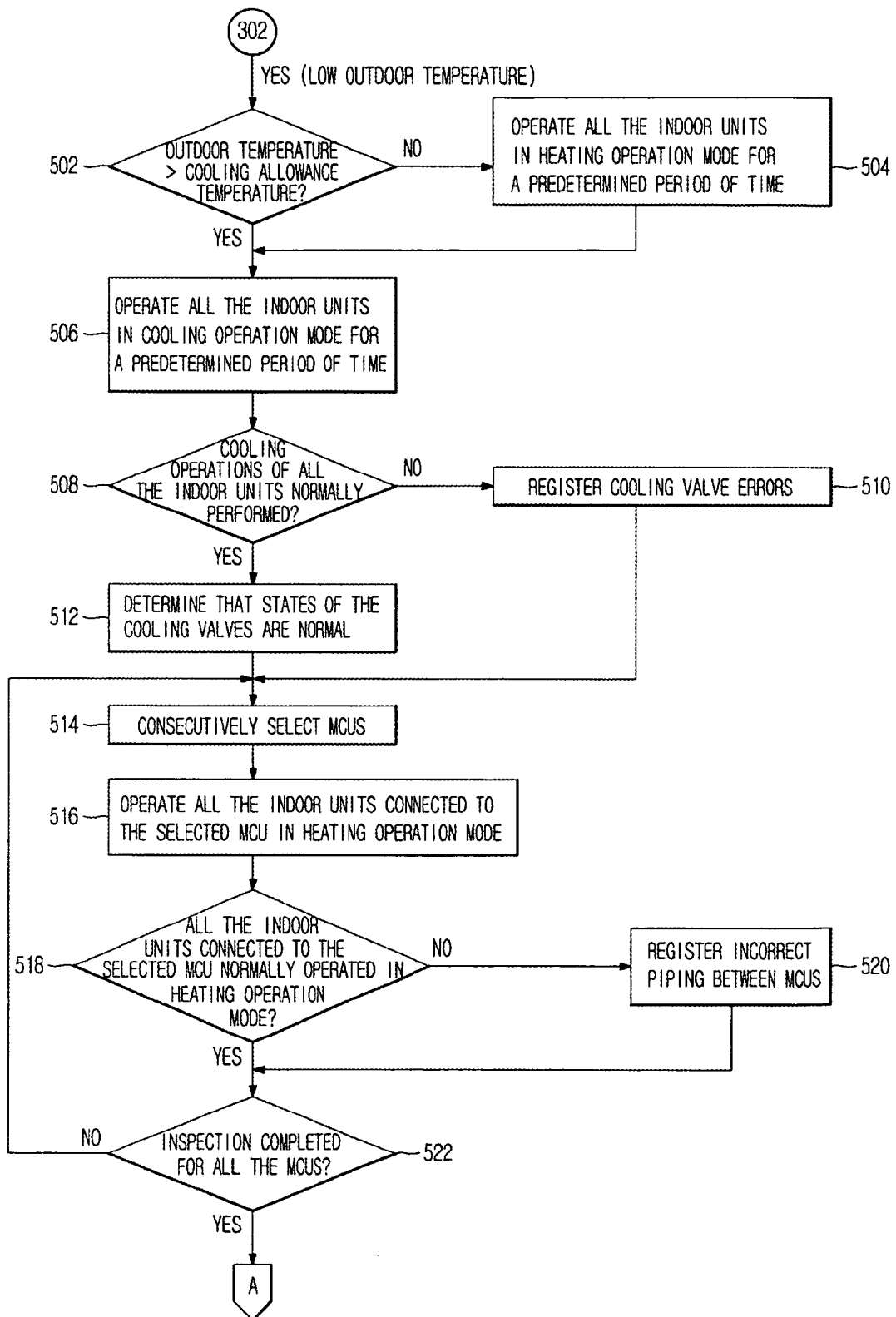


FIG.5B

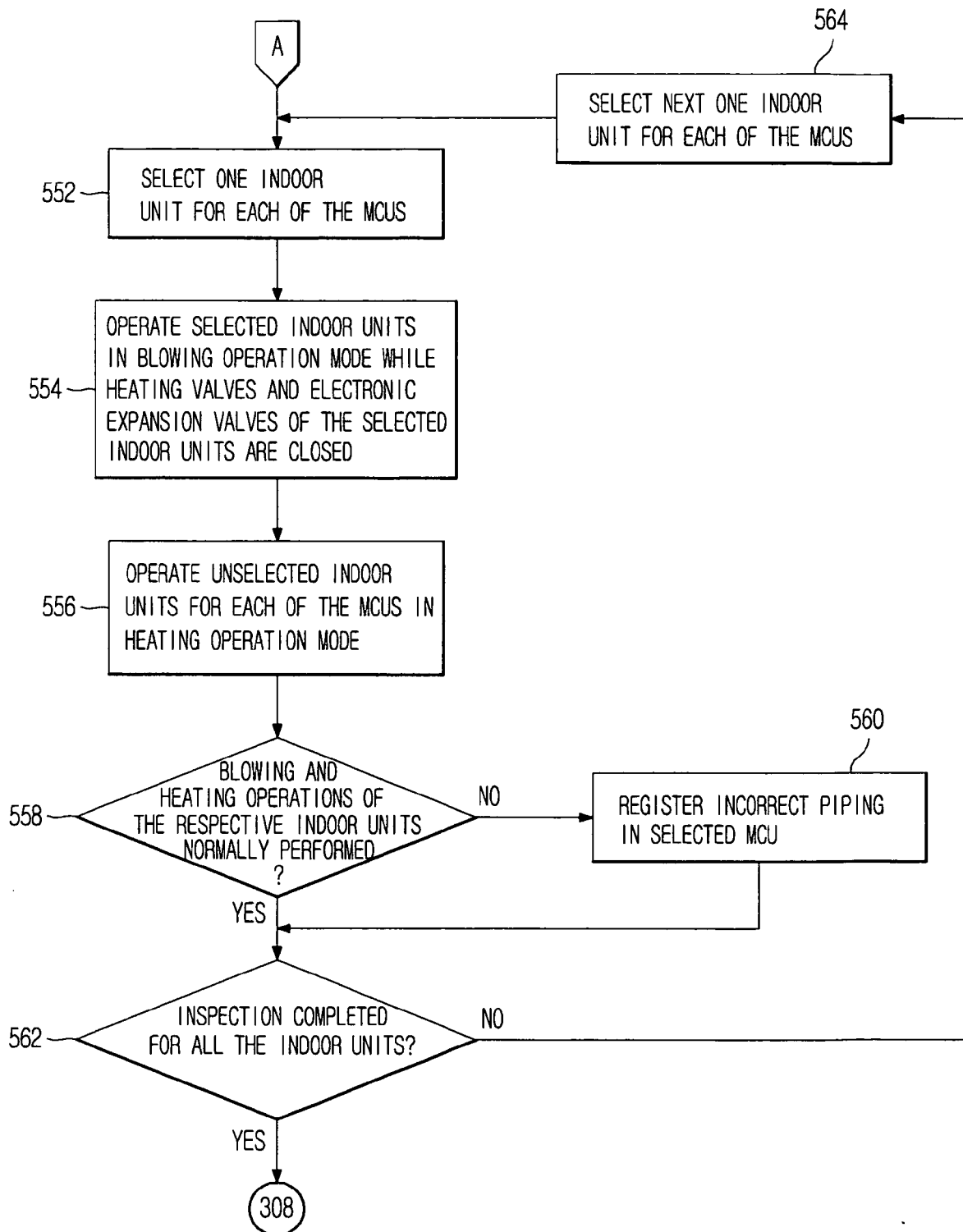


FIG.6A

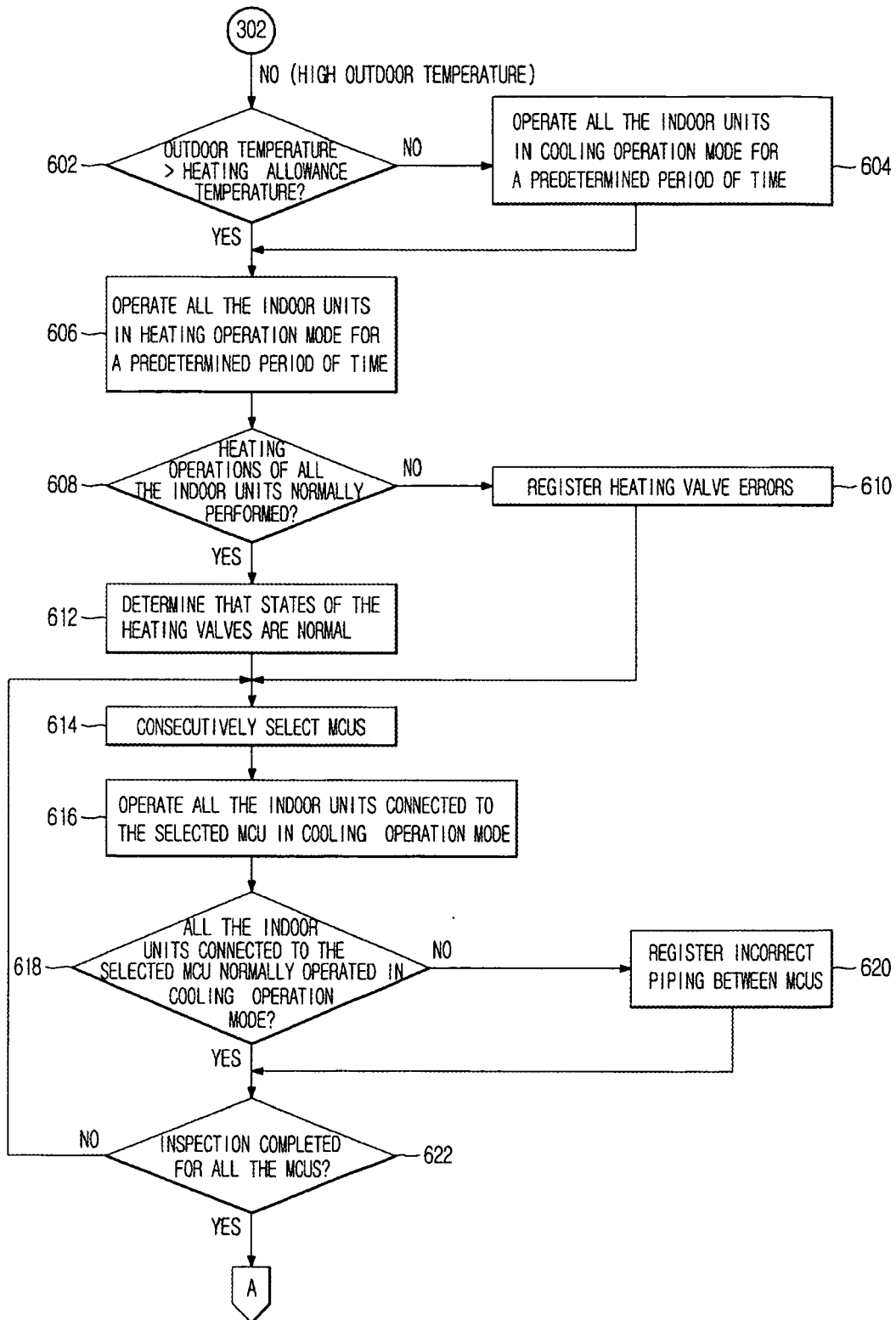
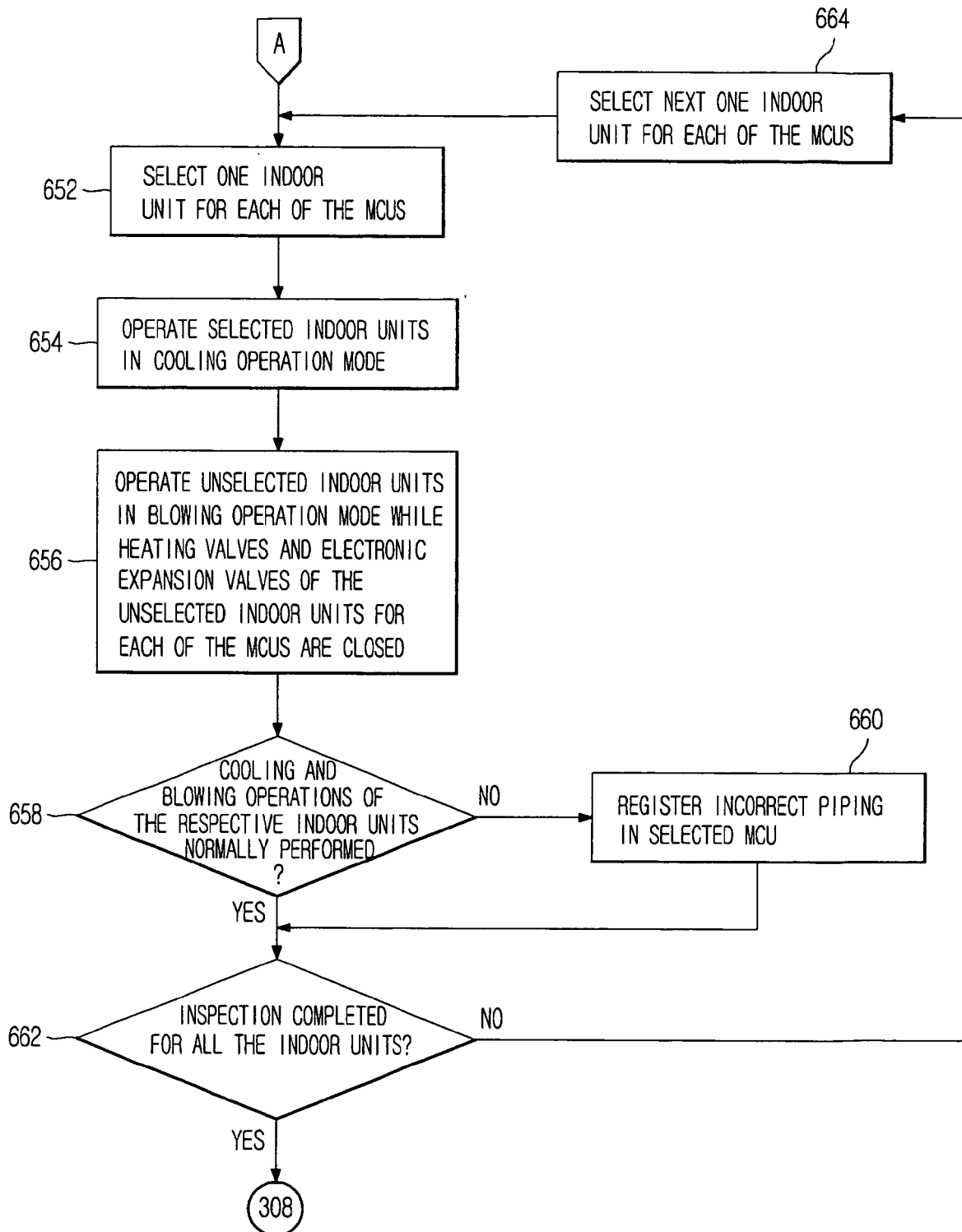


FIG.6B



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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