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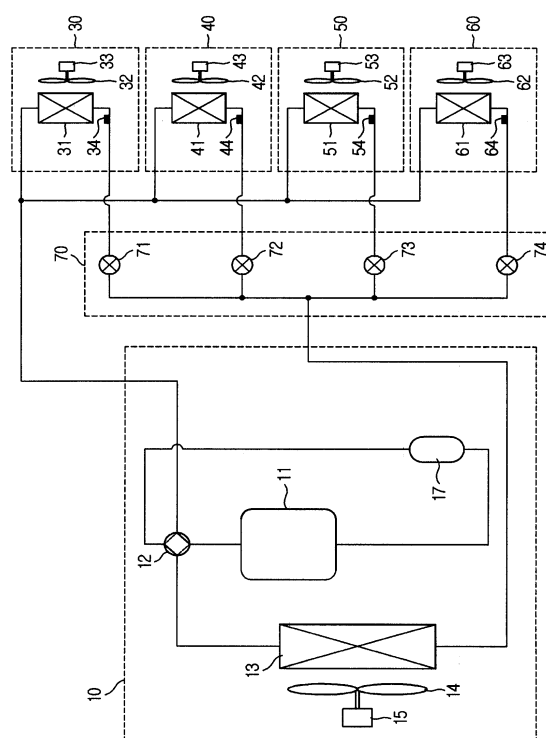
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(54) **Method of determining the configuration of an air conditioning system**

(57) Disclosed herein is a pipe connection searching method of a multi air conditioner system comprising an outdoor unit, a plurality of indoor units connected to the outdoor unit, a plurality of refrigerant pipes connected between the outdoor unit and the respective indoor units, and a plurality of refrigerant control valves mounted on the respective refrigerant pipes. The pipe connection searching method comprises measuring outdoor temperature, and selecting operation mode of the multi air conditioner system based on the outdoor temperature and performing a pipe connection searching operation.

Fig 1



Description

[0001] The present invention relates to a method of determining the refrigerant conduit connections between indoor units and control valves in a multi air conditioner system comprising an outdoor unit, a plurality of indoor units, a plurality of refrigerant paths between the indoor units to the outdoor unit and refrigerant control valves in respective ones of said refrigerant paths, the method comprising:

closing one of the refrigerant control valves;
operating the air conditioner system; and
determining the indoor unit controlled by the closed refrigerant control valve by detecting a change in temperature at an indoor unit substantially coincident with the closing of the closed refrigerant control valve.

[0002] Generally, a conventional multi air conditioner system comprises an outdoor unit, a plurality of indoor units connected in parallel to the outdoor unit, communication lines connected between the outdoor unit and the respective indoor units, power cables and refrigerant pipes. The outdoor unit comprises a compressor, an outdoor heat exchanger and a plurality of motor-operated valves mounted in the refrigerant pipes. An example of the conventional multi air conditioner system is disclosed in KR-A-1998-025714.

[0003] When initially installing a conventional multi air conditioner system, as described above, an engineer connects the indoor units to the outdoor unit by the communication lines, the power cables and the refrigerant pipes. After that, the engineer measures the difference in temperature between the indoor units while opening and closing the motor-operated valves during cooling operation in order to determine which indoor units are connected to which respective refrigerant pipes (or the motor-operated valves).

[0004] In the conventional multi air conditioner system, cooling operation is carried out for determining how the indoor units are connected. This can result in the system becoming damaged. Specifically, the amount of refrigerant condensed in the outdoor heat exchanger is increased when the pipe connection determination is being performed in this way when the outdoor temperature is low.

[0005] When the outdoor temperature is low, the condensed refrigerant may not be sufficiently evaporated by the indoor heat exchangers and, therefore, the refrigerant is introduced into the compressor in a liquid state, which is harmful to the compressor.

[0006] A method, according to the present invention, is characterised by selecting heating or cooling for said operation of the air conditioner system in dependence of the ambient temperature at the outdoor unit.

[0007] Preferably, cooling is performed when said ambient temperature is higher than a threshold but other-

wise heating is performed.

[0008] A method of determining refrigerant conduit connections may comprise a method according to the present invention repeated for all or all but one of said refrigerant control valves.

[0009] Optional and preferred features of the present invention are set forth in claims 4 to 13 appended hereto.

[0010] An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows the refrigerant circuit of a multi air conditioner system according to the present invention;

Figure 2 is a block diagram showing the structure of the multi air conditioner system shown in Figure 1; Figure 3 is a graph showing the opening and closing of indoor motor-operated valves when performing the pipe connection determination operation of the multi air conditioner system shown in Figure 1; and Figure 4 is a flowchart illustrating the pipe connection determination operation of the multi air conditioner system shown in Figure 1.

[0011] Referring to Figures 1 and 2, a multi air conditioner system comprises an outdoor unit 10, first to fourth indoor units 30, 40, 50, 60, connected to the outdoor unit 10, and a distributor 70 having first to fourth motor-operated valves 71, 72, 73, 74.

[0012] The outdoor unit 10 comprises a compressor 11 for compressing refrigerant, a four-way valve 12 for guiding the refrigerant flow, discharged from the compressor 11, an outdoor heat exchanger 13 which receives compressed refrigerant from the compressor 11, an outdoor fan 14 for forcibly blowing air across or through the outdoor heat exchanger 13 and an outdoor fan motor 15.

[0013] The outdoor unit 10 further comprises an outdoor temperature sensor 16 for measuring the outdoor temperature, an accumulator 17 for delivering gaseous refrigerant to the compressor 11, an outdoor unit microcomputer 18 for controlling the various components of the outdoor unit 10 and performing data communication with indoor unit microcomputers 36, 46, 56, 66, which are described below in detail; and a display part 19 for displaying the state of the multi air conditioner system.

[0014] The first to fourth indoor units 30, 40, 50, 60 comprise first to fourth indoor heat exchangers 31, 41, 51, 61 for performing heat exchange with introduced indoor air; first to fourth indoor fans 32, 42, 52, 62 for introducing indoor air into the first to fourth indoor units 30, 40, 50, 60, guiding the introduced air through the first to fourth indoor heat exchangers 31, 41, 51, 61 and discharging the air out of the first to fourth indoor units 30, 40, 50, 60, and first to fourth indoor fan motors 33, 43, 53, 63 for rotating the first to fourth indoor fans 32, 42, 52, 62.

[0015] The first to fourth indoor units 30, 40, 50, 60 further comprise first to fourth inlet temperature sensors

34, 44, 54, 64 mounted to pipes connected to the first to fourth indoor heat exchangers 31, 41, 51, 61, through which refrigerant is introduced (when performing a cooling operation), and first to fourth indoor unit microcomputers 36, 46, 56, 66 for controlling the respective components of the first to fourth indoor units 30, 40, 50, 60 and performing data communication with the outdoor unit microcomputer 18.

[0016] The first to fourth motor-operated valves 71, 72, 73, 74, mounted in the distributor 70, are connected to the first to fourth indoor units 30, 40, 50, 60 via refrigerant pipes to control the refrigerant flow rate into the first to fourth indoor units 30, 40, 50, 60.

[0017] A pipe connection determination method for the above-described multi air conditioner will be described with reference to Figures 3 and 4.

[0018] When an engineer connects the motor-operated valves 71, 72, 73, 74 of the distributor 70 to respective indoor units 30, 40, 50, 60 and inputs a pipe connection determination command, using a test switch (not shown), the outdoor temperature sensor 16 measures outdoor temperature (80) to determine whether the measured outdoor temperature is higher than or equal to a reference temperature (82). If the outdoor temperature is higher than or equal to the reference temperature, cooling is performed (84). If the outdoor temperature is lower than the reference temperature, heating is performed (85). The operating levels of the compressor 11, the outdoor fan 15 and the first to fourth indoor fans 32, 42, 52, 62 are appropriately controlled, according to operation modes, and the first to fourth motor-operated valves 71, 72, 73, 74 are maintained open at predetermined initial levels (86).

[0019] Subsequently, the temperatures at the inlets of the indoor units are measured by the first to fourth inlet temperature sensors 34, 44, 54, 64 respectively and the measured temperatures are stored (88). At this time, the temperatures at the inlets of the indoor units are temperate at the inlets of the respective indoor heat exchangers (based on the cooling operation).

[0020] After the temperatures at the inlets of the respective indoor units are measured, as shown in A of Figure 3, the first motor-operated valve 71 is closed, while the other motor-operated valves 72, 73 and 74 remain open by an unchanged amount (90 and 92). After a predetermined period of time, the temperatures at the inlets of the indoor units are measured again (94). Preferably, the predetermined period of time is set so that a change in temperature, resulting from the closing of the first motor-operated valve 25, is apparent.

[0021] Subsequently, the differences between temperatures at the inlets of the indoor units before closing the first motor-operated valve 71 and temperatures at the inlets of the indoor units after closing the first motor-operated valve 71 are calculated to determine whether there is an indoor unit where the temperature difference is more than a reference value (96). Such determination is made in order to prevent the temperature

change at an indoor unit, where the inlet temperature has changed due to other causes than closing of the first motor-operated valve 71, from being incorrectly regarded as the indoor unit connected to the first motor-operated valve 71.

[0022] The reference value may be changed according to the system. During heating operation, high-temperature refrigerant is not supplied to the indoor heat exchanger as the motor-operated valve is closed and, therefore, the temperature at the inlet of the indoor unit gradually decreases. During cooling operation, low-temperature refrigerant is not supplied to the indoor heat exchanger as the motor-operated valve is closed and, therefore, the temperature at the inlet of the indoor unit gradually increases. Consequently, determination of whether the temperature at the inlet of the indoor unit has decreased more than the reference value, when the motor-operated valve is closed, is made when performing the pipe connection determination operation during heating operation, and determination as to whether the temperature at the inlet of the indoor unit has been increased more than the reference value as the motor-operated valve is closed is made when performing a pipe connection searching operation during the cooling operation.

[0023] If it is determined in Operation 96 that there are no indoor units where the inlet temperatures before closing and after the first motor-operated valve 71 differ by more than the reference value, it is determined that the pipe connection between the first motor-operated valve 71 and the corresponding indoor unit is abnormal and, therefore, abnormal pipe connection is displayed on the display part 19 (106). When it is determined in Operation 96 that there is an indoor unit where the difference between temperatures at the inlet of the indoor unit before and after closing the first motor-operated valve 71 is more than the reference value, on the other hand, it is determined whether the temperature at the inlet of the indoor unit is the highest or lowest among the temperatures at the inlets of all the indoor units (it is determined whether the temperature at the inlet of the indoor unit is the lowest among the temperatures at the inlets of all the indoor units in the heating operation, and it is determined whether the temperature at the inlet of the indoor unit is the highest among the temperatures at the inlets of all the indoor units in the cooling operation) (98).

[0024] If the condition in Operation 98 is satisfied, it is determined that the indoor unit is connected to the first motor-operated valve 71 (100). If the condition in Operation 98 is not satisfied, Operation 106 is performed.

[0025] Subsequently, it is determined whether the pipe connection determining operation for all the motor-operated valves 71, 72, 73, 74 has been completed (102). If it is determined that the pipe connection determining operation of all the motor-operated valves 71, 72, 73, 74 has been completed, Operation 104 is performed to successively close the second to fourth motor-operated valves and carry out the pipe connection searching operation, as shown in B, C and D of Figure 3.

[0026] As apparent from the above description, the operation mode of the system is properly set depending on outdoor temperature when performing the pipe connection searching operation. Consequently, the present invention has the effect of preventing the pipe connection searching operation from being performed in improper operation modes, and therefore, preventing the system from being damaged.

Claims

1. A method of determining the refrigerant conduit connections between indoor units (30, 40, 50, 60) and control valves (71, 72, 73, 74) in a multi air conditioner system comprising an outdoor unit (10), a plurality of indoor unit (30, 40, 50, 60), a plurality of refrigerant paths between the indoor units (30, 40, 50, 60) to the outdoor unit (10) and refrigerant control valves (71, 72, 73, 74) in respective ones of said refrigerant paths, the method comprising:

closing one of the refrigerant control valves (71, 72, 73, 74);
operating the air conditioner system; and
determining the indoor unit (30, 40, 50, 60) controlled by the closed refrigerant control valve (71, 72, 73, 74) by detecting a change in temperature at an indoor unit (30, 40, 50, 60) substantially coincident with the closing of the closed refrigerant control valve (71, 72, 73, 74),

characterised by

selecting heating or cooling for said operation of the air conditioner system in dependence of the ambient temperature at the outdoor unit (10).

2. A method according to claim 1, wherein cooling is performed when said ambient temperature is higher than a threshold but otherwise heating is performed.
3. A method of determining refrigerant conduit connections comprising a method according to claim 1 or 2 repeated for all or all but one of said refrigerant control valves (71, 72, 73, 74).
4. A pipe connection searching method of a multi air conditioner system comprising an outdoor unit, a plurality of indoor units connected to the outdoor unit, a plurality of refrigerant pipes connected between the outdoor unit and the respective indoor units, and a plurality of refrigerant control valves mounted on the respective refrigerant pipes, wherein the method comprises:

measuring outdoor temperature; and
selecting operation mode of the multi air conditioner system based on the outdoor temperature and performing a pipe connection searching op-

eration.

5. The method according to claim 4, wherein the operation mode is selected to perform a cooling operation when the outdoor temperature is higher than a reference temperature and to perform a heating operation when the outdoor temperature is lower than the reference temperature.
6. The method according to claim 5, wherein the pipe connection searching operation comprises:

operating the multi air conditioner system while the refrigerant control valves are opened, and closing one of the refrigerant control valves; measuring temperature change patterns of the respective indoor units; and determining which indoor unit shows the temperature change patterns related to the closed refrigerant control valve to search the indoor unit connected to the refrigerant control valve.

7. The method according to claim 6, wherein the indoor unit showing the temperature change patterns related to the closed refrigerant control valve is the indoor unit whose temperature is changed more than a reference value by closing the refrigerant control valve.

8. The method according to claim 7, wherein the indoor unit showing the temperature change patterns related to the closed refrigerant control valve is the indoor unit whose temperature is changed more than the reference value, is the lowest among the indoor units in the heating operation, and is the highest among the indoor units in the cooling operation.

9. The method according to claim 4, wherein the pipe connection searching operation is repetitively performed while successively closing the refrigerant control valves until the whole inspection is completed.

10. A pipe connection searching method of a multi air conditioner system comprising an outdoor unit, a plurality of indoor units connected to the outdoor unit, a plurality of refrigerant pipes connected between the outdoor unit and the respective indoor units, and a plurality of refrigerant control valves mounted on the respective refrigerant pipes, wherein the method comprises:

measuring outdoor temperature, and selecting operation mode of the multi air conditioner system based on the outdoor temperature;
operating the multi air conditioner system while the refrigerant control valves are opened, and closing one of the refrigerant control valves; measuring the difference in temperature of the

respective indoor units; and
determining which indoor unit is the indoor unit
whose difference in temperature is more than a
reference value to set as the indoor unit con-
nected to the closed refrigerant control valve. 5

11. The method according to claim 10, wherein it is de-
termined that connection between the refrigerant
control valve and the indoor unit is abnormal when
there is no indoor unit whose difference in tempera- 10
ture is more than the reference value.

12. The method according to claim 11, wherein the re-
frigerant control valve is displayed on the display part
when it is determined that the connection between 15
the refrigerant control valve and the indoor unit is
abnormal.

13. A multi air conditioner system comprising: 20
a plurality of indoor units connected to an out-
door unit;
a plurality of refrigerant pipes connected be-
tween the outdoor unit and the respective indoor
units; 25
an outdoor temperature sensor mounted at the
outdoor unit;
a plurality of refrigerant control valves mounted
on the respective refrigerant pipes; and
a controller to perform a control operation to se- 30
lect operation mode of the multi air conditioner
system based on outdoor temperature meas-
ured by the outdoor temperature sensor and
search pipe connection. 35

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Fig 1

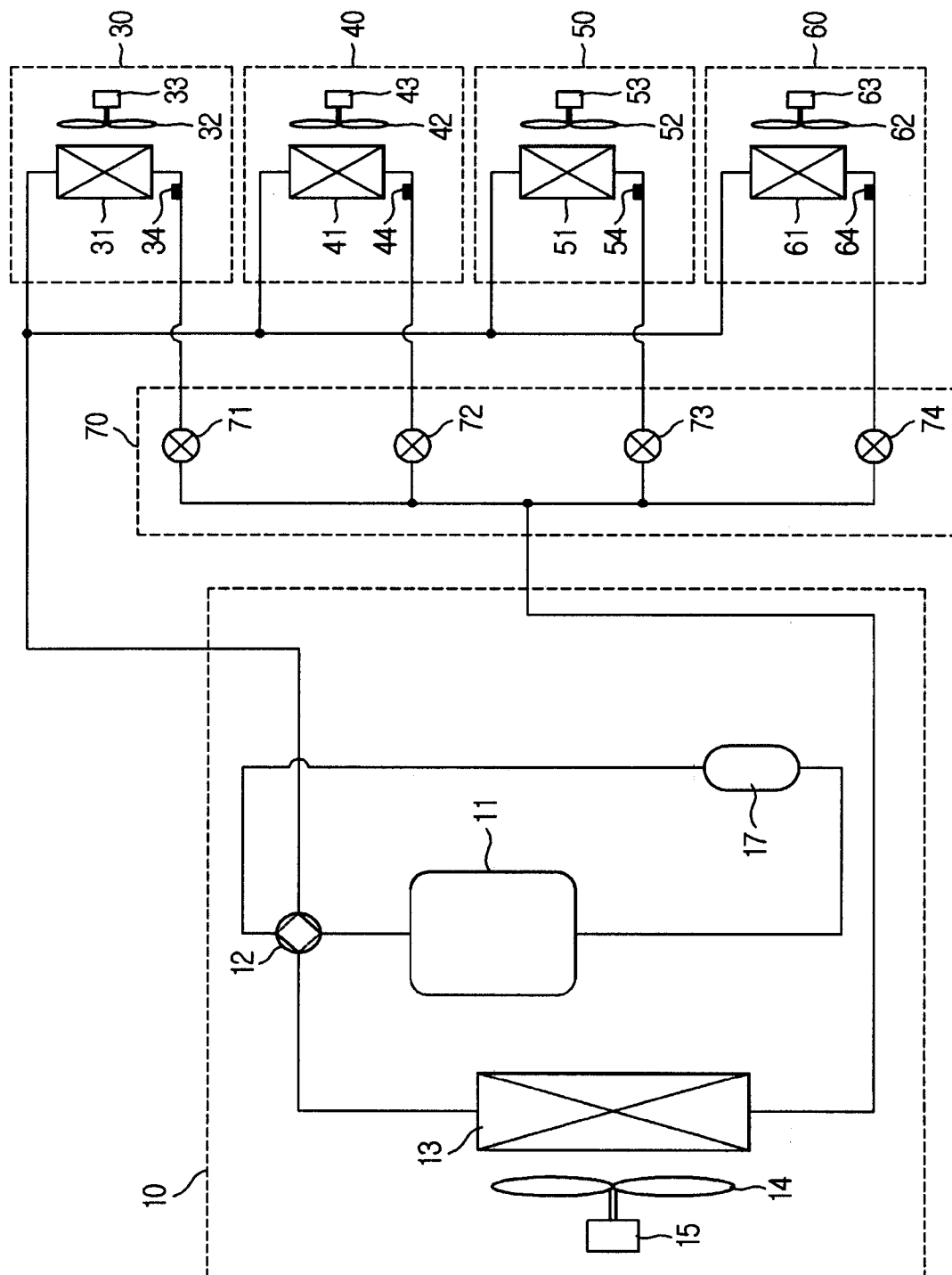


Fig 2

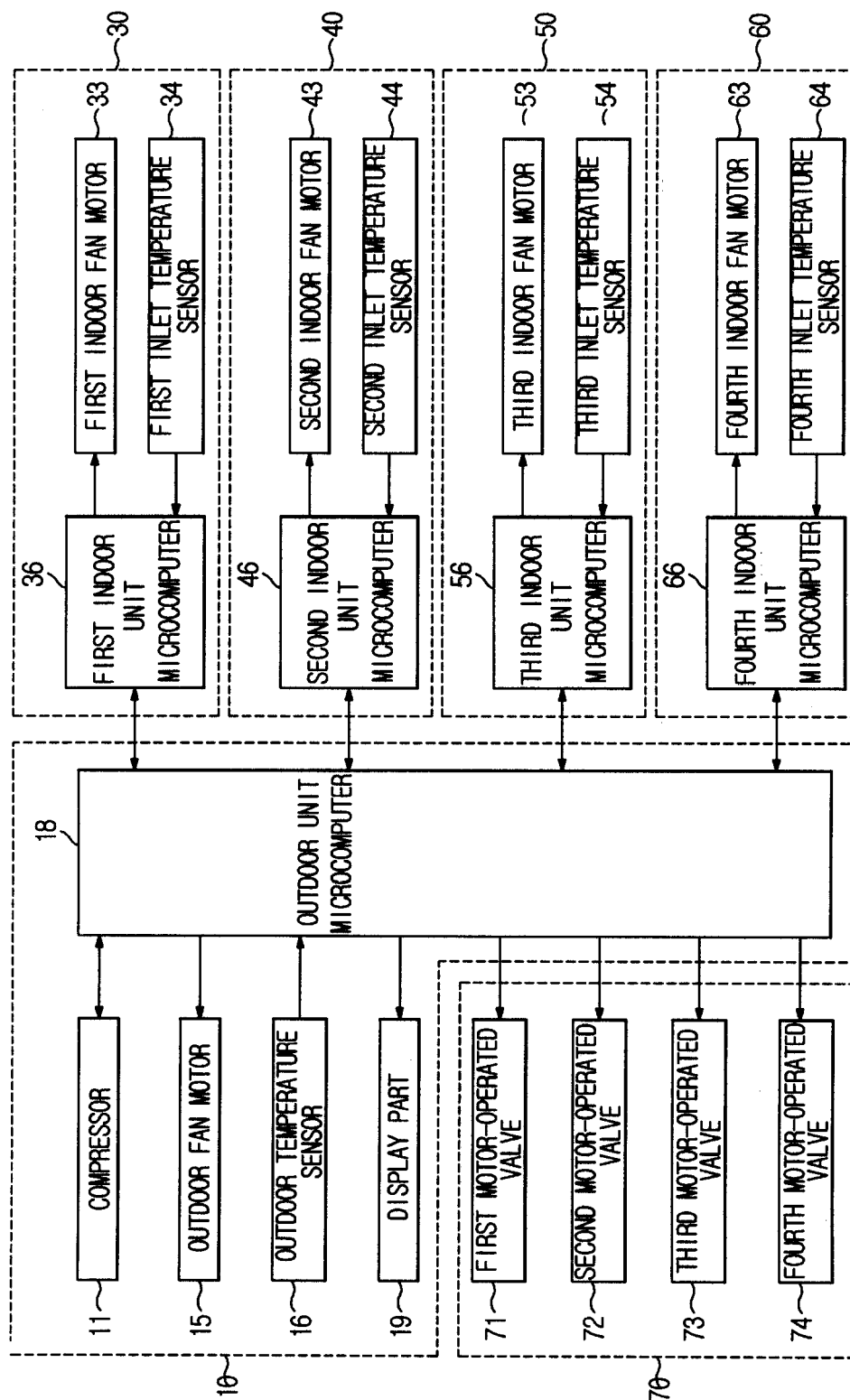


Fig 3

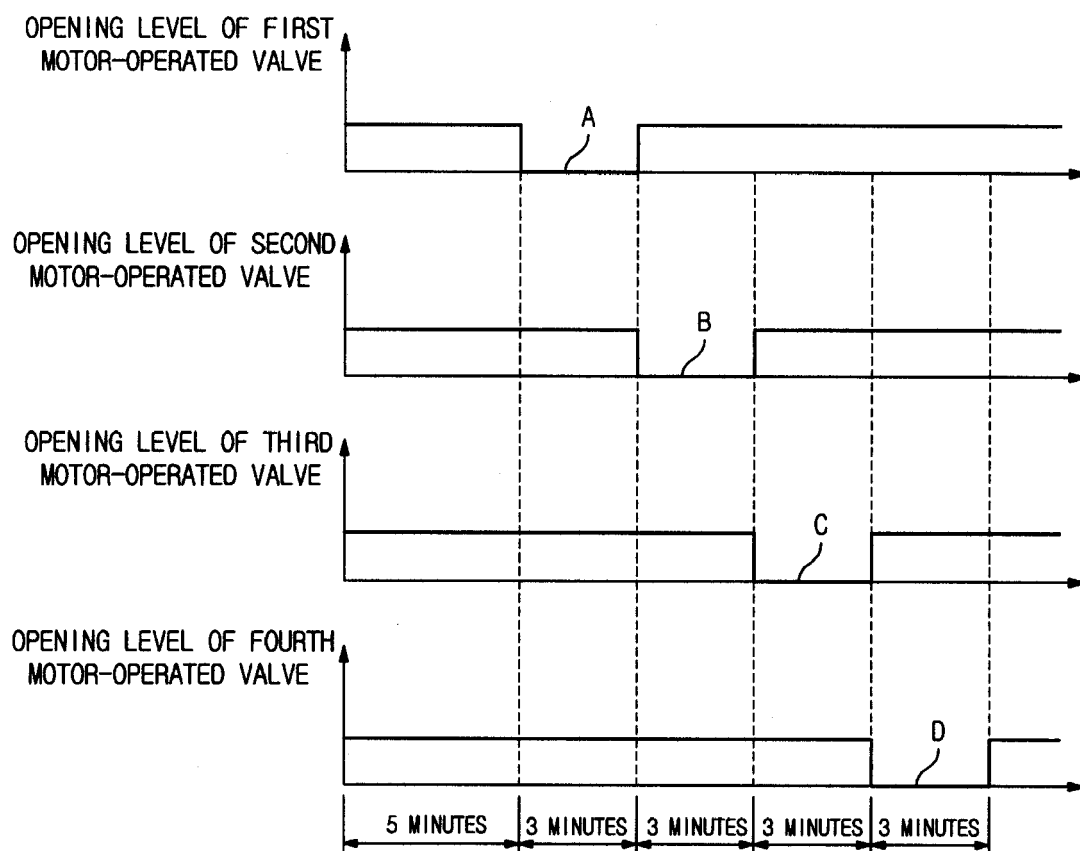


Fig 4

