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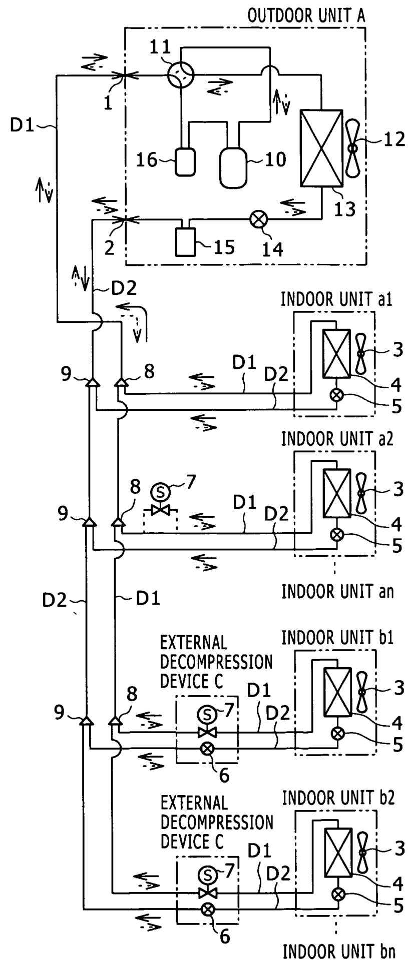
(54) Air conditioner and method for controlling the same

(57) There is disclosed an air conditioner having an outdoor unit (A) and plural indoor units (a,b) connected by refrigerant pipes. The plural indoor units (a,b) include a first unit having an expansion valve (5) and a heat exchanger (4) incorporated therein, and a second indoor unit having a heat exchanger (4) incorporated therein. A decompression device including an expansion valve (6) and an on-off valve (7) is connected at the middle of the outward and inward refrigerant pipes connecting the second indoor unit (b) with the outdoor unit (A). This makes it possible to connect different types of indoor units, namely, the first indoor units (a) having the decompression device (5) incorporated therein and the second indoor units having no decompression device incorporated therein.

FIG. 1



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Description

Background of the Invention

[0001] The present invention relates to a multi-type air conditioner having plural indoor units combined with a single outdoor unit, and to a method for controlling such an air conditioner.

[0002] In known multi-type air conditioners having plural indoor units connected to a single outdoor unit, the operation states of indoor units as well as the load states of corresponding rooms are different. For this reason, it is necessary to finely adjust the amount of refrigerant (heating medium) by a compressor in each indoor unit, in order to prevent an imbalance from occurring in the refrigerant flowing into each indoor unit. In the conventional technology, it has been difficult to achieve coexistence of indoor units having a decompression device incorporated therein (package air conditioners), and indoor units having no decompression device incorporated therein (room air conditioners) that are not capable of adjusting the amount of refrigerant flowing therein.

[0003] Japanese Patent No. 2925694 discloses a multi-type air conditioner having plural indoor units connected to a single outdoor unit, in which one of the indoor units has a decompression valve and heat exchanger incorporated therein, and the other indoor unit has only a heat exchanger incorporated therein with a decompression valve provided in a refrigerant pipe connected to the other indoor unit. In this air conditioner, the other indoor unit has no decompression valve, but instead the decompression valve connected to the refrigerant pipe adjusts the amount of refrigerant. This allows coexistence of different types of indoor units such as package air conditioners and room air conditioners.

[0004] In Japanese Patent No. 2925694, different types of indoor units can coexist. However, assuming that all the indoor units are simultaneously operated, the number of indoor units to be connected is limited so that the total capacity of all the indoor units does not exceed the capacity of a single indoor unit.

[0005] This is because, even if plural indoor units are not typically operated at a time, but if all the indoor units are simultaneously operated on site, the heat exchange capacity of the indoor units is excessive relative to the heat exchange capacity of the outdoor unit. The cycle balance is lost, resulting in lack of refrigerant in the cooling-heating cycle. The lack of refrigerant in the cooling cycle or heating cycle (cooling-heating cycle) has negative effects, such as degradation of insulation due to insufficient cooling in a compressor motor, degradation of freezer oil and refrigerant due to increase of discharge gas temperature, and degradation of air conditioning performance due to reduction of refrigerant circulation amount. The lack of refrigerant in the cooling-heating cycle is solved by adding an appropriate amount of refrigerant. However, the amount of refrigerant is excessive relative to the capacity of a compressor as well as the capacity of a refrigerant receiver tank and its accessories, causing a phenomenon that excess liquid refrigerant not evaporated in an evaporator returns to the compressor, or liquid-back operation. This has led to lower reliability associated with lower viscosity of freezer oil, bearing friction due to lack of lubrication in the compressor, and compressor failure.

Brief Summary of the Invention

[0006] The present invention aims at providing an air conditioner designed to increase flexibility in installation of indoor units, by allowing connection of a predetermined number or more of indoor units to a single outdoor unit, or connection of indoor units whose total capacity exceeds the capacity of an outdoor unit, and providing a method for controlling such an air conditioner.

[0007] The present invention is an air conditioner having an outdoor unit and plural indoor units connected by refrigerant pipes. In the air conditioner, an expansion valve is provided in one of plural refrigerant pipes connecting an arbitrary one of the indoor units with the outdoor unit, and an on-off valve is provided in another refrigerant pipe.

[0008] Further, the present invention is an air conditioner having an outdoor unit and plural indoor units connected by refrigerant pipes. In the air conditioner, the plural indoor units include a first indoor unit having an expansion valve and heat exchanger incorporated therein, and a second indoor unit having a heat exchanger but no expansion valve incorporated therein. Further, an expansion valve is provided in one of plural refrigerant pipes connecting the second indoor unit with the outdoor unit, and an on-off valve is provided in another refrigerant pipe.

[0009] Further, the present invention is an air conditioner having an outdoor unit and plural indoor units connected by refrigerant pipes. In the air conditioner, the plural indoor units include a first indoor unit having an expansion valve and a heat exchanger incorporated therein, and a second indoor unit having a heat exchanger but no expansion valve incorporated therein. Further, an on-off valve is connected to one of plural refrigerant pipes connecting the outdoor unit with the first indoor unit, which is other than the refrigerant pipe in which the expansion valve of the first indoor unit is provided.

[0010] Further, the present invention is a method for controlling an air conditioner having an outdoor unit and plural indoor units connected by refrigerant pipes. In the air conditioner, an expansion valve is provided in one of plural refrigerant pipes connecting an arbitrary one of the indoor units with the outdoor unit, and an on-off valve is provided in another refrigerant pipe. The method includes the steps of: closing, when stopping the arbitrary indoor unit, the valve provided in one of the plural refrigerant pipes, which is assigned to the outward flow, while opening the valve provided in the other refrigerant pipe; operating the arbitrary indoor unit for a predetermined period of time in such a state; and collecting the refrigerant from the arbitrary indoor unit into the outdoor unit via the open valve. In this case, the open valve provided in the other refrigerant pipe is closed after the operation for collecting the refrigerant from the indoor unit into the outdoor unit is performed for a predetermined period of time.

[0011] Further, the present invention is a method for controlling an air conditioner having an outdoor unit and plural indoor units connected by refrigerant pipes. In the air conditioner, the plurality indoor units include a first indoor unit hiving an expansion valve and a heart exchanger incorporated therein, and a second indoor unit having a heart exchanger but not expansion valve incorporated therein. Further, an expansion valve is provided in one of plural refrigerant pipes connecting the second indoor unit with the outdoor unit, and an on-off valve is provided in another refrigerant pipe. The method includes the steps of: opening the valve provided in one of the plural refrigerant pipes connected to the second unit, which is assigned to the outward flow, while closing the valve provided in the other refrigerant pipe; operating the second indoor unit for a predetermined time in such a state; and collecting the refrigerant from the second indoor unit into the outdoor unit via the open valve. In this case, the valve provided in the other refrigerant pipe is closed after the refrigerant in the second indoor unit is collected in the outdoor unit.

[0012] Further, the present invention is a method for controlling an air conditioner having an outdoor unit and plural indoor units connected by refrigerant pipes. In the air conditioner, the plurality indoor units include a first indoor unit hiving an expansion valve and a heart exchanger incorporated therein, and a second indoor unit having a heart exchanger but not expansion valve incorporated therein. Further, an on-off valve is connected to one of plural refrigerant pipes connecting the first indoor unit with the outdoor unit, which is other than the refrigerant pipe in which the expansion valve of the first indoor unit is provided. The method includes the steps of: closing the expansion valve of the first indoor unit while opening the on-off valve; operating the first indoor unit for a predetermined period of time in such a state; and collecting the refrigerant from the first indoor unit into the outdoor unit via the open on-off valve. In this case, the on-off valve is closed after the refrigerant in the first indoor unit is collected in the outdoor unit.

[0013] According to the present invention, it is possible to provide an air conditioner designed to increase flexibility in installation of indoor units, by allowing connection of a predetermined number or more of indoor units to a single outdoor unit, or connection of indoor units whose total capacity exceeds the capacity of an outdoor unit, without suffering from a lack of refrigerant in the cooling-heating cycle.

Brief Description of the Several View of the Drawing

[0014]

Fig. 1 is a configuration diagram of a refrigeration cycle according to an embodiment of the present invention;

Fig. 2 is a control block diagram according to an embodiment of the present invention;

Fig. 3 is a control system diagram according to an embodiment of the present invention; and

Fig. 4 is a control flowchart according to an embodiment of the present invention.

Detailed Description of the Invention

[0015] Fig. 1 is a configuration diagram of a cooling-heating cycle of a multi-air conditioner (a multi-type air conditioner) according to an embodiment of the present invention.

[0016] The multi-air conditioner includes an outdoor unit A, plural indoor units a (a1, a2, and an) and b (b1, b2, and bn), and refrigerant pipes D1 D2 for connecting each of the units. The refrigerant pipes D1 D2 are branched and connected with a gas-side branch pipe 8 and a liquid-side branch pipe 9, respectively, to distribute and supply refrigerant to the indoor units a and b. The refrigerant pipe D1 is connected to a gas side stop valve 1 of the outdoor unit A, and the refrigerant pipe D2 is connected to a liquid side stop valve 2 thereof. In this way, a cooling-heating cycle system is formed.

[0017] The indoor unit a is an indoor unit having a decompression device (indoor expansion valve 5) incorporated therein, and including an indoor fan 3 and an indoor heat exchanger 4. The indoor unit b is an indoor unit having no decompression device (indoor expansion valve 5) incorporated therein, and including the indoor fan 3 and the indoor heat exchanger 4. The indoor unit b is connected with an external decompression device C at the middle of the refrigerant pipes D2, D1 which are respectively connected to the liquid side branch pipe 9 and the gas side branch pipe 8. The external decompression device C has an expansion valve 6 externally connected to the refrigerant pipe D2, and an electromagnetic valve (on-off valve) 7 externally connected to the refrigerant pipe D1. In this embodiment, the indoor unit a is referred to as a first indoor unit, and the indoor unit b as a second indoor unit.

[0018] In the outdoor unit A, reference numeral 10 denotes a compressor, 11 denotes a four-way valve, 12 denotes an outdoor fan, 13 denotes an outdoor heat exchanger, 14 denotes an outdoor expansion valve, 15 denotes a refrigerant tank, and 16 denotes an accumulator. The arrows indicate the directions of the refrigerant flowing through the refrigerant pipes. More specifically, the solid arrows indicate the flow in cooling operation, and the dotted arrows in the opposite direction indicate the flow in heating operation. The refrigerant flow direction is determined by switching of the four-way valve 11 in the outdoor unit A.

[0019] Fig. 2 is a control block diagram according to an embodiment of the present invention. Reference numeral 17 denotes a remote control for providing operation instructions (such as operation, stop, operation mode, air volume/direction setting, and temperature setting) to the indoor units a, b. Reference numeral 18 denotes a remote control line. Reference numeral 20 denotes a central control unit for controlling the entire operation of the multi-air conditioner. Reference numeral 23 denotes a controller of the outdoor unit A. Reference numeral 24 denotes a controller of the indoor unit a. Reference numeral 25 denotes a controller of the indoor unit b. Reference numeral 21 denotes a central control transmission line for connecting the central control unit 20 and the controller 23. Reference numeral 19 denotes an indoor-outdoor transmission line for connecting the outdoor unit A and the indoor units a, b. Reference numeral 22 denotes an external decompression device transmission line for connecting the controller 25 and the external decompression device C.

[0020] Fig. 3 is a control system diagram according to an embodiment of the present invention. In the control block diagram of Fig. 2, the remote control 17 first issues an operation instruction to the indoor unit a. Then, the controller 24 transmits the information about the state of the indoor unit a as well as the instruction of the remote control 17, to the outdoor unit A. Based on this transmission, the controller 23 of the outdoor unit A transmits the information of the outdoor unit A, the information of the indoor unit a, and the information (instruction) of the remote control 17, to the central control unit 20.

[0021] Upon receiving such information, the central control unit 20 transmits an instruction (such as operation, stop, operation mode, air volume/direction setting, temperature setting, or remote control permission/prohibition), to the controller 23 in order to collectively manage the indoor units based on a control program stored in advance. The controller 23 transmits the instruction from the indoor unit A to the controller 24, based on the instruction of the central control unit 20. The controller 24 transmits the information of the indoor unit a as well as the information of the outdoor unit A, to the remote control 17. At the same time, the controller 24 transmits an instruction for controlling the opening degree of the expansion valve, to the expansion valve 5 of the indoor unit a.

[0022] When the remote control 17 issues an operation instruction to the indoor unit b, the controller 25 transmits the information about the state of the indoor unit b as well as the instruction of the remote control 17, to the outdoor unit A in a similar way as described above. Based on this transmission, the controller 23 transmits the information of the outdoor unit A, the information of the indoor unit b, and the information (instruction) of the remote control 17, to the central control unit 20.

[0023] Upon receiving such information, the central control unit 20 transmits an instruction (such as operation, stop, operation mode, air volume/direction setting, temperature setting, or remote control permission/prohibition) to the controller 23 in order to collectively manage the indoor units, based on a control program stored in advance. The controller 23 transmits the instruction from the indoor unit A to the controller 25 of the indoor unit b, based on the instruction of the central control unit 20. The controller 25 transmits the information of the indoor unit b as well as the information of the outdoor unit A, to the remote control 17. At the same time, the controller 25 transmits an instruction for controlling the opening degree of the expansion valve, to the expansion valve 6 of the external decompression device C. Further, the controller 25 transmits an instruction for controlling on/off of the electromagnetic valve, to the electromagnetic valve 7 of the external decompression device C. In addition, through the central control unit 20 and the outdoor unit A in this control system, the remote control information is exchanged between the remote controls 17, and the indoor unit information is exchanged between the indoor units 24 and 25.

[0024] As described above, air conditioning operation of the control system is started by an operation instruction from the remote control 17 or from the central control unit 20. The air conditioning operation is continued with the entire system monitored by the central control unit 20.

[0025] Next, the operation will be described based on the control flowchart shown in Fig. 4 according to an embodiment of the present invention. In this embodiment, it is assumed that the total capacity of the plural indoor units a (a1, a2, and an) and b (b1, b2, and bn) exceeds the capacity of the single outdoor unit A.

[0026] In the control block diagram of Fig. 2 and in the control system diagram of Fig. 3, the remote control 1 or the central control unit 20 first issues an operation instruction, and the operation is finally started in step 101 based on the instruction of the central control unit 20. Next, it is determined whether there is a (stopped) indoor unit to which the operation instruction is not issued from the central control unit 20 in step 102. This determination is made by the central control unit 20 by collecting information of the indoor units a, b from the controllers 24, 25.

[0027] When the determination result is NO, all the indoor units a, b will be operated, namely, the single outdoor unit A will be operated exceeding its capacity. In order to prevent this, in step 120, all the indoor units are stopped from starting operation, and a warning is issued. When YES in step 102, the process proceeds to step 103 to determine whether the total capacity of the indoor units to be operated exceeds the capacity of the outdoor unit A.

[0028] When the determination result is NO in step 103, the total capacity does not exceed the capacity of the outdoor unit A, so that it is possible to operate the indoor units to be operated. Thus, normal operation is started in step 121. When YES in step 103, the total capacity of the indoor units to be operated will exceed the capacity of the outdoor unit A, resulting in lack of refrigerant in the cooling-heating cycle. Thus, in order to ensure the necessary amount of refrigerant, a refrigerant collection operation control is started in step 104 to collect the refrigerant in (stopped) indoor units to which no operation instruction is issued from the central control unit

20. Then, the process proceeds to step 105.

[0029] In step 105, the connection state of the external decompression device of each stopped indoor unit from which the refrigerant is to be collected, is confirmed. In other words, it is determined whether the external decompression device C including the expansion valve 6 and the electromagnetic on-off valve 7 is connected to each of the corresponding indoor units. This determination is made by the central control unit 20, based on the information of the indoor unit a or based on the information of the indoor unit b in the system diagram of Fig. 3. The indoor units from which the refrigerant is to be collected, correspond to the stopped indoor units whose total amount of refrigerant calculated by the central control unit 20 reaches the amount to be collected.

[0030] When the determination result is both YES and NO in step 105, the process proceeds to step 106 and step 115 to start operations of the corresponding indoor units from which the refrigerant is to be collected. When YES in step 105, the process moves from step 106 to step 107 to determine whether the operation mode is cooling. When the cooling operation mode is determined (YES), the expansion valve 6 of the decompression device C is closed in step 108. Then, the cooling operation is continued for a predetermined period of time in step 109. In the case of YES in step 105, the corresponding indoor unit is connected with the external decompression device C, namely, any of the indoor units b1, b2 and bn in Fig. 1.

[0031] The cooling operation will be described taking an example in which the refrigerant is collected from the indoor unit b1 in Fig. 1. In this cooling operation, the refrigerant pipe D2 is assigned to the outward flow and the refrigerant pipe D1 is assigned to the inward flow.

[0032] In step 108, the expansion valve 6 is closed, but the electromagnetic valve 7 is opened because the cooling operation is performed. When the cooling operation is continued in this state, the refrigerant flows into the outdoor unit A in the direction of the solid arrow, through the refrigerant pipe D1 via the electromagnetic valve 7. On the other hand, the refrigerant in the refrigerant pipe D2 is stopped from flowing by the expansion valve 6. In this way, the refrigerant in the indoor unit b1 is collected in the refrigerant tank 15 of the outdoor unit A from the heat exchanger 4 and from the refrigerant pipe connected thereto.

[0033] The cooling operation is performed for a predetermined period of time in step 109, and then the electromagnetic valve 7 is closed in step 110. The cooling operation of the indoor unit b1 is stopped in step 111, and the refrigerant collection operation control is completed. In this case, the electromagnetic valve 7 is closed to prevent unwanted penetration of refrigerant into the heat exchanger 4 and the like in the indoor unit b1 during normal air conditioning operation.

[0034] When NO (heating operation mode) in step 107, the electromagnetic valve 7 of the decompression device C is closed in step 112. Then, the heating operation is continued for a predetermined period of time in step 113. In this heating operation, the refrigerant pipe D1 is assigned to the outward flow and the refrigerant D2 is assigned to the inward flow.

[0035] The heating operation will be described taking an example in which the refrigerant is collected from the indoor unit b1 in Fig. 1. The electromagnetic valve 7 is closed in step 112, but the expansion valve 6 is opened because the heating operation is performed. When the heating operation is continued in this state, the refrigerant flows into the outdoor unit A in the dotted arrow direction through the refrigerant pipe D2 via the expansion valve 6. On the other hand, the refrigerant in the refrigerant pipe D1 is stopped from flowing by the electromagnetic valve 7. In this way, the refrigerant in the indoor unit b1, namely, the refrigerant contained in the heat exchanger 4 and in the refrigerant pipe connected thereto, is collected in the refrigerant tank 15 of the outdoor unit A.

[0036] The heat operation is performed for a predetermined period of time in step 113, and then the expansion valve 6 is closed in step 114. The heating operation of the indoor unit b1 is stopped in step 111, and the refrigerant collection operation control is completed. In this case, the expansion valve 6 is closed to prevent unwanted penetration of refrigerant into the heat exchanger 4 and the like in the indoor unit b1 during normal air conditioning operation.

[0037] Returning back to step 105 and when the answer is NO, the operation of the corresponding indoor unit is started in step 115. Then, it is determined whether the operation mode is cooling in step 116. When the cooling operation mode is determined (YES), the expansion valve 5 is closed in step 117, and the cooling operation is continued for a predetermined period of time in step 118. In the case of NO in step 105, the indoor unit is not connected with the external decompression device C, namely, any of the indoor units a1, a2, and an in Fig. 1.

[0038] The cooling operation will be described taking an example in which the refrigerant is collected from the indoor unit a2 in Fig. 1. When the cooling operation is performed with the expansion valve 5 closed, the refrigerant flows into the outdoor unit A in the solid arrow direction through the refrigerant pipe D1 from the indoor unit a2. On the other hand, the refrigerant in the refrigerant pipe D2 is stopped from flowing by the expansion valve 5. In this way, the refrigerant in the indoor unit a2, namely, the refrigerant contained in the indoor heat exchanger 4 and in the refrigerant pipe D1 connected thereto, is collected in the refrigerant tank 15 of the outdoor unit A.

[0039] The cooling operation is performed for a predetermined period of time in step 118, and then the cooling operation of the indoor unit a2 is stopped in step 111. The refrigerant collection operation control is completed in a state in which the refrigerant pipe D1 on the side opposite to the expansion valve 5 is opened. Thus, there is a possibility that the refrigerant flows into the indoor heat exchanger 4 of the indoor unit a2 through the refrigerant pipe D1 during normal air conditioning operation. In order to surely prevent this, the electromagnetic valve 7 is additionally connected to the refrigerant pipe D1 of the indoor unit a2, as shown by the dotted line in Fig. 1, so that the electromagnetic valve 7 is closed in step 122.

[0040] When NO in step 116, the indoor unit a2 is in the heating operation and the refrigerant flows in the dotted arrow direction. Because the refrigerant pipe D1 has no electromagnetic valve 7 to stop the flow, the refrigerant can flow through the refrigerant pipe D1 via the open expansion valve 5 without being collected from the indoor unit a2. For this reason, the operation of the indoor unit a2 is stopped in step 119, and a warning is issued.

[0041] In order to collect the refrigerant in the indoor unit a2 during the heating operation, the electromagnetic valve 7 is additionally connected to the refrigerant pipe D1, as shown by the dotted line in Fig. 1. The electromagnetic valve 7 is closed in step 123, instead of proceeding to step 119, and the heating operation is continued for a predetermined period of time in step 124. When the heating operation is performed with the electromagnetic valve 7 closed and the expansion valve 5 opened, the refrigerant flows in the dotted arrow direction through the refrigerant pipe D2 via the expansion valve 5. Because the flow in the refrigerant pipe D1 is stopped by the electromagnetic valve 7, the refrigerant in the indoor unit a1, namely, the refrigerant contained in the heat exchanger 4 and in the refrigerant pipe D2 connected thereto, is collected in the refrigerant tank 15 of the outdoor unit A.

[0042] The heating operation is performed for a predetermined period of time in step 124, and then the expansion valve 5 is closed in step 125. The heating operation of the indoor unit a2 is stopped in step 111, and the refrigerant collection operation control is completed. In this case, the expansion valve 5 is closed to prevent unwanted penetration of refrigerant into the indoor unit a2 during normal air conditioning operation.

[0043] The above described refrigerant collection operation can be performed for plural corresponding indoor units at a time, and completed by closing the necessary valve when the collected refrigerant reaches the necessary amount. However, the refrigerant collection operation may also be performed on a one-by-one basis in order to surely collect the refrigerant from each of the corresponding indoor units.

[0044] After the refrigerant is collected as described above, the normal operation of the air conditioner is started in step 121. In this operation, the refrigerant does not flow into the stopped indoor units from which the refrigerant has been collected. Thus, there is no shortage of refrigerant circulating during the operation, thereby preventing lack of refrigerant in the cooling-heating cycle.

[0045] In the above describe embodiment, the external decompression device C including the expansion valve 6 and the electromagnetic valve 7, is connected at the middle of the refrigerant pipes D2 connected to the indoor unit b having no decompression device incorporated therein. With this configuration, it is possible to adjust the amount of refrigerant flowing into the indoor unit b by the expansion valve 6 of the external decompression device C, even in the case in which the operation state of each indoor unit b as well as the load state and the like of each room are different. This allows connection of different types of indoor units, namely, the indoor units b having no decompression device incorporated therein and the indoor units a having the decompression device incorporated therein.

[0046] Further, this also allows connection of a predetermined number or more of indoor units to a single outdoor unit, or connection of indoor units whose total capacity exceeds the predetermined amount of capacity.

[0047] Incidentally, the external decompression device C including the expansion valve 6 and the electromagnetic valve 7, may be connected at the middle of the refrigerant pipes D1, D2 connecting the outdoor unit A and the indoor unit a having the decompression device incorporated therein. With this configuration, it is possible to eliminate the refrigerant flow noise and vibration from the indoor expansion valve 5, by using the expansion valve 6 of the external decompression device C instead of the indoor expansion valve 5 of the indoor unit a. As a result, it is possible to improve quietness and comfort in the use of the air conditioner. Incidentally, the expansion valve 6 of the decompression device C is connected to the refrigerant pipe D1, D2 of the indoor unit b, so that there is no refrigerant flow noise and vibration in the indoor unit b.

Claims

1. An air conditioner having an outdoor unit and a plurality of indoor units connected by refrigerant pipes, wherein an expansion valve is provided in one of a plurality of refrigerant pipes connecting an arbitrary one of the indoor units with the outdoor unit, and an on-off valve is provided in another refrigerant pipe.

2. An air conditioner having an outdoor unit and a plurality of indoor units connected by refrigerant pipes, wherein the plurality of indoor units include a first indoor unit having an expansion valve and heat exchanger incorporated therein, and a second indoor unit having a heat exchanger but no expansion valve incorporated therein,
wherein an expansion valve is provided in one of a plurality of refrigerant pipes connecting the second indoor unit with the outdoor unit, and an on-off valve is provided in another refrigerant pipe.

3. An air conditioner having an outdoor unit and a plurality of indoor units connected by refrigerant pipes, wherein the plurality of indoor units include a first indoor unit having an expansion valve and a heat exchanger incorporated therein, and a second in-

door unit having a heat exchanger but no expansion valve incorporated therein,
wherein an on-off valve is connected to one of a plurality of refrigerant pipes connecting the first indoor unit with the outdoor unit, which is other than the refrigerant pipe in which the expansion valve of the first indoor unit is provided.

4. A method for controlling an air conditioner having an outdoor unit and a plurality of indoor units connected by refrigerant pipes, wherein an expansion valve is provided in one of a plurality of refrigerant pipes connecting an arbitrary one of the indoor units with the outdoor unit, and an on-off valve is provided in another refrigerant pipe,
the method comprising the steps of:

closing, when stopping the arbitrary indoor unit, the valve provided in an outward pipe of the plurality of refrigerant pipes, while opening the valve provided in the other refrigerant pipe;
operating the arbitrary indoor unit for a predetermined period of time in such a state; and
collecting the refrigerant from the arbitrary indoor unit into the outdoor unit via the open valve.

5. The method for controlling the air conditioner according to claim 4, the method further comprising the step of closing the open valve provided in the other refrigerant pipe, after performing the operation of collecting the refrigerant from the indoor unit into the outdoor unit for a predetermined period of time.

6. A method for controlling an air conditioner having an outdoor unit and a plurality of indoor units connected by refrigerant pipes, wherein the plurality of indoor units include a first indoor unit having an expansion valve and a heat exchanger incorporated therein, and a second indoor unit having a heat exchanger but no expansion valve incorporated therein, an expansion valve is provided in one of a plurality of refrigerant pipes connecting the second indoor unit with the outdoor unit, and an on-off valve is provided in another refrigerant pipe,
the method comprising the steps of:

closing the valve provided in one of the plurality of refrigerant pipes connected to the second indoor unit, which is assigned to the outward flow, while opening the valve provided in the other refrigerant pipe;
operating the second indoor unit for a predetermined period of time in such a state; and
collecting the refrigerant from the second indoor unit into the outdoor unit via the open valve.

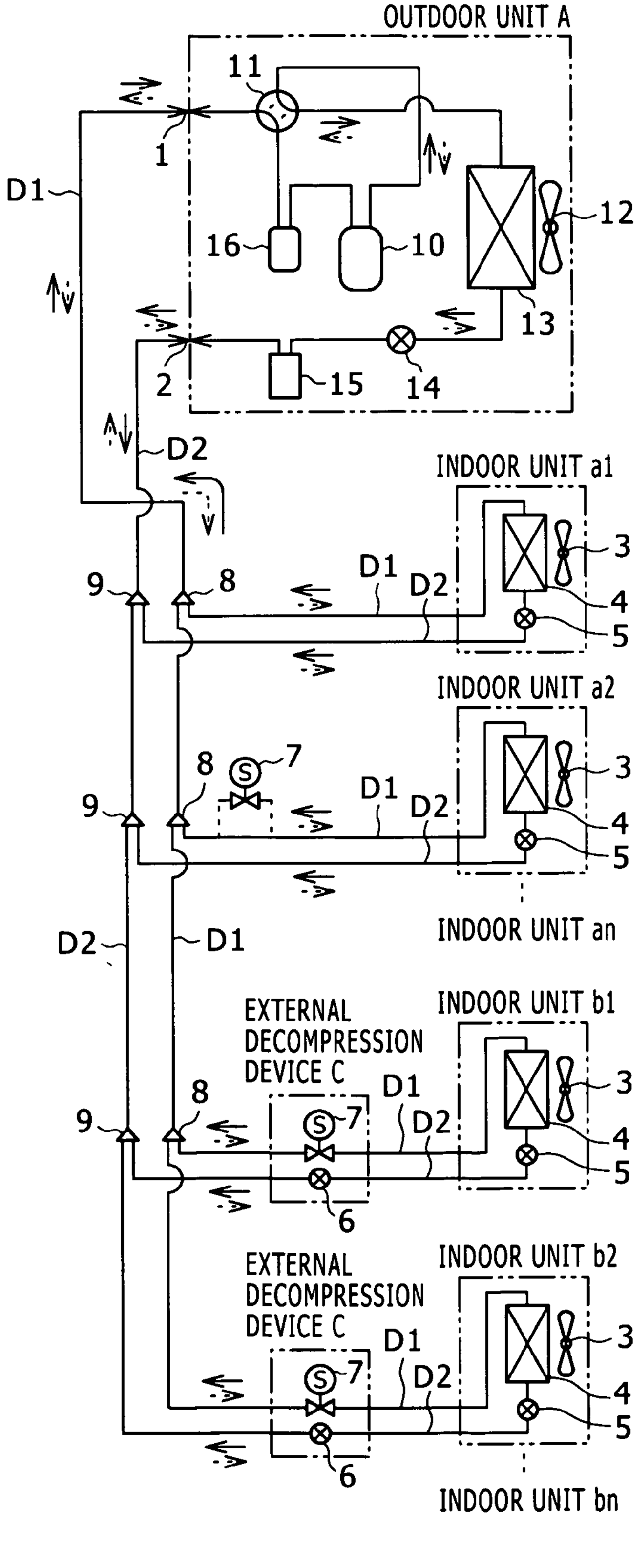
7. The method for controlling the air conditioner according to claim 6, the method further comprising the step of closing the valve provided in the other refrigerant pipe after collecting the refrigerant from the second indoor unit into the outdoor unit.

8. A method for controlling an air conditioner having an outdoor unit and a plurality of indoor units connected by refrigerant pipes, wherein the plurality of indoor units include a first indoor unit having an expansion valve and a heat exchanger incorporated therein, and a second indoor unit having a heat exchanger but no expansion valve incorporated therein, wherein an on-off valve is connected to one of a plurality of refrigerant pipes connecting the first indoor unit with the outdoor unit, which is other than the refrigerant pipe in which the expansion valve of the first indoor unit is provided,
the method comprising the steps of:

closing the expansion valve of the first indoor unit while opening the on-off valve;
operating the first indoor unit for a predetermined period of time in such a state; and
collecting the refrigerant from the first indoor unit into the outdoor unit via the open on-off valve.

9. The method for controlling the air conditioner according to claim 8, the method further comprising the step of closing the on-off valve after collecting the refrigerant from the first unit into the outdoor unit.

FIG. 1



OUTDOOR UNIT A
11
1
D1
12
16
10
13
2
15
14
D2
INDOOR UNIT a1
3
9
8
D1
D2
4
5
INDOOR UNIT a2
7
8
D1
D2
3
9
4
5
INDOOR UNIT an
D2
D1
EXTERNAL DECOMPRESSION DEVICE C
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D1
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D2
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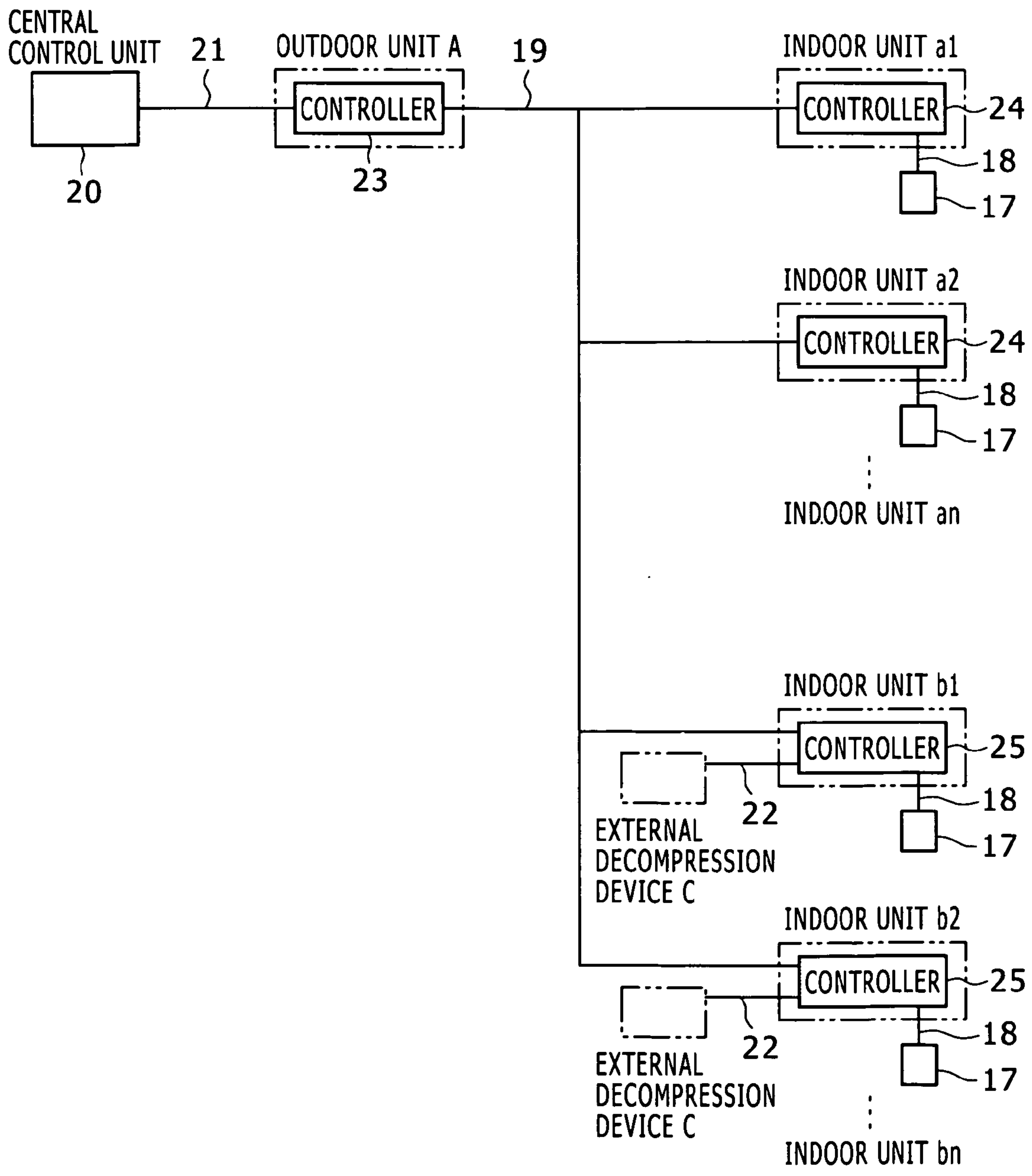
FIG. 2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17
INDOOR UNIT an
INDOOR UNIT b1
CONTROLLER
25
22
18
17
EXTERNAL
DECOMPRESSION
DEVICE C
INDOOR UNIT b2
CONTROLLER
25
22
18
17
EXTERNAL
DECOMPRESSION
DEVICE C
INDOOR UNIT bn

FIG. 3

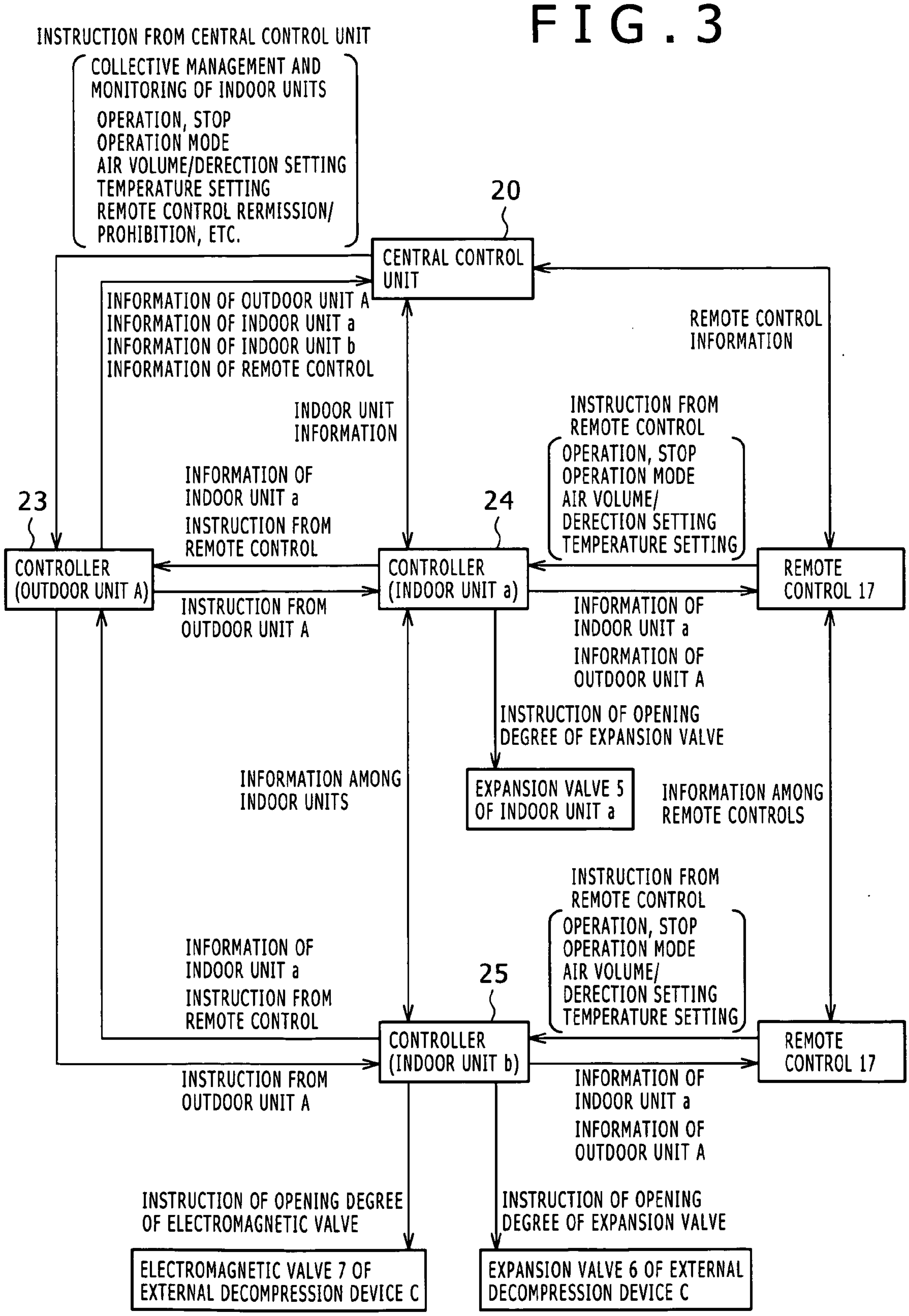
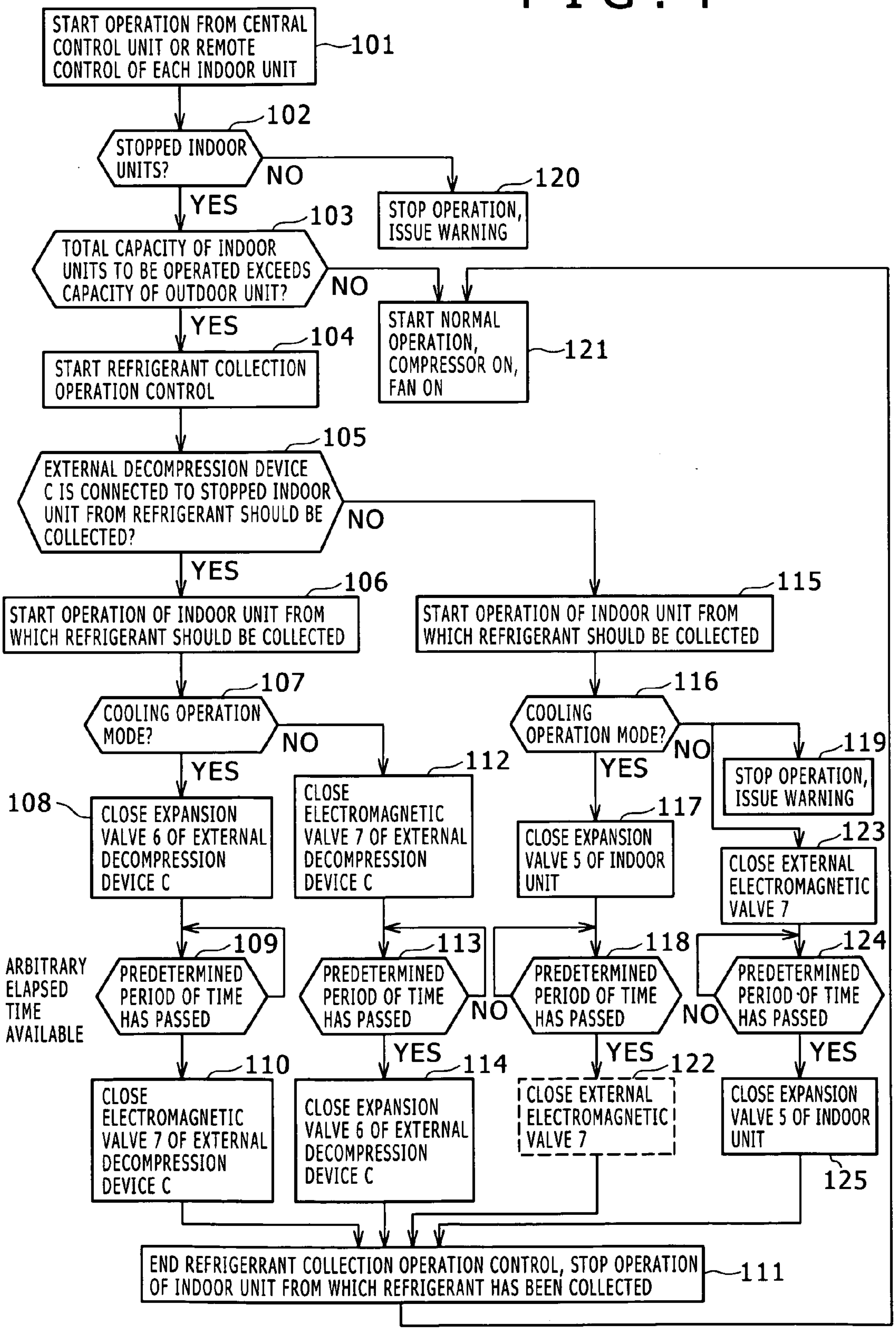

INSTRUCTION FROM CENTRAL CONTROL UNIT
COLLECTIVE MANAGEMENT AND MONITORING OF INDOOR UNITS
OPERATION, STOP
OPERATION MODE
AIR VOLUME/DERECTION SETTING
TEMPERATURE SETTING
REMOTE CONTROL RERMISSION/ PROHIBITION, ETC.
20
CENTRAL CONTROL UNIT
INFORMATION OF OUTDOOR UNIT A
INFORMATION OF INDOOR UNIT a
INFORMATION OF INDOOR UNIT b
INFORMATION OF REMOTE CONTROL
REMOTE CONTROL INFORMATION
INDOOR UNIT INFORMATION
INSTRUCTION FROM REMOTE CONTROL
OPERATION, STOP
OPERATION MODE
AIR VOLUME/ DERECTION SETTING
TEMPERATURE SETTING
INFORMATION OF INDOOR UNIT a
INSTRUCTION FROM REMOTE CONTROL
23
24
CONTROLLER (OUTDOOR UNIT A)
CONTROLLER (INDOOR UNIT a)
REMOTE CONTROL 17
INSTRUCTION FROM OUTDOOR UNIT A
INFORMATION OF INDOOR UNIT a
INFORMATION OF OUTDOOR UNIT A
INSTRUCTION OF OPENING DEGREE OF EXPANSION VALVE
INFORMATION AMONG INDOOR UNITS
EXPANSION VALVE 5 OF INDOOR UNIT a
INFORMATION AMONG REMOTE CONTROLS
INSTRUCTION FROM REMOTE CONTROL
OPERATION, STOP
OPERATION MODE
AIR VOLUME/ DERECTION SETTING
TEMPERATURE SETTING
INFORMATION OF INDOOR UNIT a
INSTRUCTION FROM REMOTE CONTROL
25
CONTROLLER (INDOOR UNIT b)
REMOTE CONTROL 17
INSTRUCTION FROM OUTDOOR UNIT A
INFORMATION OF INDOOR UNIT a
INFORMATION OF OUTDOOR UNIT A
INSTRUCTION OF OPENING DEGREE OF ELECTROMAGNETIC VALVE
INSTRUCTION OF OPENING DEGREE OF EXPANSION VALVE
ELECTROMAGNETIC VALVE 7 OF EXTERNAL DECOMPRESSION DEVICE C
EXPANSION VALVE 6 OF EXTERNAL DECOMPRESSION DEVICE C

FIG. 4


START OPERATION FROM CENTRAL CONTROL UNIT OR REMOTE CONTROL OF EACH INDOOR UNIT
101
STOPPED INDOOR UNITS?
102
NO
YES
STOP OPERATION, ISSUE WARNING
120
TOTAL CAPACITY OF INDOOR UNITS TO BE OPERATED EXCEEDS CAPACITY OF OUTDOOR UNIT?
103
NO
YES
START NORMAL OPERATION, COMPRESSOR ON, FAN ON
121
START REFRIGERANT COLLECTION OPERATION CONTROL
104
EXTERNAL DECOMPRESSION DEVICE C IS CONNECTED TO STOPPED INDOOR UNIT FROM REFRIGERANT SHOULD BE COLLECTED?
105
NO
YES
START OPERATION OF INDOOR UNIT FROM WHICH REFRIGERANT SHOULD BE COLLECTED
106
START OPERATION OF INDOOR UNIT FROM WHICH REFRIGERANT SHOULD BE COLLECTED
115
COOLING OPERATION MODE?
107
NO
YES
COOLING OPERATION MODE?
116
NO
YES
STOP OPERATION, ISSUE WARNING
119
108
CLOSE EXPANSION VALVE 6 OF EXTERNAL DECOMPRESSION DEVICE C
CLOSE ELECTROMAGNETIC VALVE 7 OF EXTERNAL DECOMPRESSION DEVICE C
112
CLOSE EXPANSION VALVE 5 OF INDOOR UNIT
117
CLOSE EXTERNAL ELECTROMAGNETIC VALVE 7
123
ARBITRARY ELAPSED TIME AVAILABLE
PREDETERMINED PERIOD OF TIME HAS PASSED
109
PREDETERMINED PERIOD OF TIME HAS PASSED
113
NO
YES
PREDETERMINED PERIOD OF TIME HAS PASSED
118
NO
YES
PREDETERMINED PERIOD OF TIME HAS PASSED
124
NO
YES
CLOSE ELECTROMAGNETIC VALVE 7 OF EXTERNAL DECOMPRESSION DEVICE C
110
CLOSE EXPANSION VALVE 6 OF EXTERNAL DECOMPRESSION DEVICE C
114
CLOSE EXTERNAL ELECTROMAGNETIC VALVE 7
122
CLOSE EXPANSION VALVE 5 OF INDOOR UNIT
125
END REFRIGERRANT COLLECTION OPERATION CONTROL, STOP OPERATION OF INDOOR UNIT FROM WHICH REFRIGERANT HAS BEEN COLLECTED
111

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2925694 B **[0003] [0004]**