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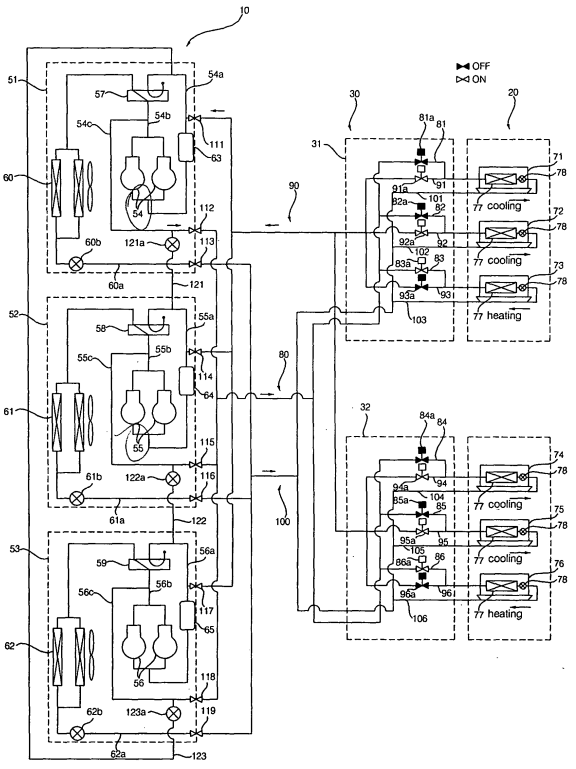
(54) Multi-type air conditioner

(57) According to the multi-type air conditioner for simultaneous heating and cooling use and the method for withdrawing refrigerant therefrom, the refrigerant withdrawing device (121,122,123) is provided between the plural outdoor units (51,52,53), refrigerant in the malfunctioning outdoor unit is withdrawn to the other outdoor units and the other outdoor units are normally operated while the compressor unit of the malfunctioning outdoor unit among the plural outdoor units is replaced. Thus, the compressor unit is replaced and/or the outdoor unit is repaired without cessation of heating and/or cooling.

FIG. 1



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Description

[0001] The present invention relates to an air conditioner.

[0002] Generally, an air conditioner is a device for cooling or heating in order to provide a comfortable indoor climate, which draws in indoor air, heats or cools the indoor air, and discharges the heated or cooled air to a confined space.

[0003] Recently, in order to achieve a heating or cooling capacity corresponding to the number of operating indoor units, multi-type air conditioners, which include a plurality of compressors or a plurality of outdoor units connected to each other in parallel, have been developed.

[0004] A conventional multi-type air conditioner includes a plurality of compressors, a plurality of indoor units, and refrigerant tubes for connecting the outdoor units to the indoor units.

[0005] Each of the plural outdoor units includes a compressor for compressing low-temperature/low-pressure gas refrigerant into high-pressure gas refrigerant, an outdoor heat exchanger for performing heat exchange between circulated refrigerant and outdoor air, and a four-way valve for switching the direction of the refrigerant flow according which of the heating mode and the cooling mode is being used.

[0006] Each of the indoor units includes an expansion device and an indoor heat exchanger for performing heat exchange between the circulated refrigerant and indoor air.

[0007] In the conventional air conditioner as described above, the refrigerant compressed by the compressor is fed to the outdoor units by the four-way valve in the cooling mode. The refrigerant passing through the outdoor heat exchangers is condensed due to heat exchange between the refrigerant and ambient air and is fed to the expansion device.

[0008] The refrigerant expanded by the expansion device enters the indoor units and is evaporated by absorbing heat from indoor air, thereby cooling the indoor air.

[0009] In the heating mode, the four-way valve switches the refrigerant path configuration so that the refrigerant discharged from the compressor passes through the four-way valve, the indoor units, the expansion device, the outdoor units, and the four-way valve to heat a confined space.

[0010] However, in the conventional multi-type air conditioner, when any one of the compressors installed in the plural outdoor units malfunctions, the conventional multi-type air conditioner can only be re-operated after all of the refrigerant circulating through the multi-type air conditioner has been discharged, the malfunctioning compressor replaced, vacuum applied to the multi-type air conditioner, and the multi-type air conditioner refilled with refrigerant. Thus, all heating and cooling operations must be stopped and replacement of the malfunctioning compressor is considerably time consuming and expensive.

[0011] Therefore, the present invention has been made in view of the above and/or other problems, and it is an object of embodiments of the present invention to provide a multi-type air conditioner for simultaneous heating and cooling use in which a compressor can be replaced without stopping heating and cooling operations when the compressor malfunctions so that it is convenient to use and costs can be reduce.

[0012] The present invention id defined in the accompanying independent claims. Some preferred features are recited in the dependent claims.

[0013] A multi-type air conditioner for simultaneous heating and cooling use is disclosed in which refrigerant in a malfunctioning outdoor unit of plural outdoor units is withdrawn to other outdoor units such that the other outdoor units work normally, whereby a compressor can be replaced and/or the malfunctioning outdoor unit can be repaired without stopping heating and cooling operations.

[0014] In accordance with embodiments of the present invention, the above and other aspects can be accomplished by the provision of a multi-type air conditioner for simultaneous heating and cooling use including: a plurality of outdoor units respectively including a compressor unit, a four-way valve, and an outdoor heat exchanger; a plurality of indoor units respectively including an indoor heat exchanger and an electronic expansion valve; a distributor installed between the plural outdoor units and the plural indoor units to selectively guide refrigerant to the plural indoor units according to operation conditions of a cooling mode, a heating mode, and a cooling and heating mode; and a refrigerant withdrawing device installed between the plural outdoor units to withdraw the refrigerant from a malfunctioning outdoor unit to the other outdoor units when a compressor unit in the malfunctioning outdoor unit among the plural outdoor units is replaced.

[0015] Preferably, the refrigerant withdrawing device includes refrigerant withdrawing tubes for withdrawing the refrigerant discharged from the compressor unit of the malfunctioning outdoor unit among the plural outdoor units to the other outdoor unit, and opening and closing valves for opening and closing the refrigerant withdrawing tubes.

[0016] The compressor unit may include one side to which a compressor suction tube, through which the refrigerant is sucked from the indoor units, is connected, and another side to which a bypass for bypassing the discharged refrigerant such that the refrigerant does not pass through the outdoor heat exchangers is connected.

[0017] The refrigerant withdrawing tubes may connect the bypass of the malfunctioning outdoor unit to the compressor suction tube of the other outdoor units.

[0018] The distributor may include a high-pressure refrigerant tube for guiding high-pressure gas refrigerant discharged from the compressor unit to the indoor unit for performing the heating operation, a low-pressure refrigerant tube for guiding refrigerant passing through the

first, second, third, fourth, fifth, and sixth indoor units to a suction port of the compressor, a liquid refrigerant tube for guiding liquid refrigerant discharged from the outdoor heat exchangers to the indoor units for performing cooling operation, and a valve device for selectively opening and closing the high-pressure refrigerant tube and the low-pressure refrigerant tub.

[0019] The outdoor unit may further include an outdoor discharge tube for guiding the liquid refrigerant discharged from the outdoor heat exchangers.

[0020] The compressor suction tubes, the bypasses, and the outdoor heat exchanger discharge tubes may be respectively connected to the low-pressure refrigerant tube, the high-pressure refrigerant tube, and the liquid refrigerant tube by service valves.

[0021] In accordance with embodiments of the present invention, the above and other aspects can be accomplished by the provision of a method for withdrawing refrigerant of a multi-type air conditioner for simultaneous heating and cooling use, including: a first step of blocking the refrigerant flow to indoor units by closing a service valve installed in a malfunctioning outdoor unit among a plurality of outdoor units when one of the plural outdoor units malfunctions; a second step of opening an opening and closing valve installed in a refrigerant withdrawing tube of the malfunctioned outdoor unit; a third step of operating compressor units of the other outdoor units to pump down to withdraw the refrigerant in the malfunctioning outdoor unit to the other outdoor units; a fourth step of closing the opening and closing valve once all of the refrigerant in the malfunctioning outdoor unit is withdrawn; and a fifth step of replacing a compressor unit of the malfunctioning outdoor unit and normally operating the other outdoor units.

[0022] Preferably, the first step further comprises the sub-step of closing a service valve for connecting compressor suction tubes of the other outdoor units to the distributor.

[0023] The fourth step may further include the sub-step of opening a service valve of the other outdoor units.

[0024] These and/or other aspects and advantages of the present invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a systemic view illustrating a multi-type air conditioner for simultaneous heating and cooling use according to a preferred embodiment of the present invention;

Fig. 2 is a view illustrating withdrawal of refrigerant from a malfunctioning first outdoor unit of the multi-type air conditioner for simultaneous heating and cooling use according to the preferred embodiment of the present invention; and

Fig. 3 is a flowchart illustrating a method for withdrawing refrigerant from the multi-type air conditioner for simultaneous heating and cooling use according to the preferred embodiment of the present invention.

[0025] The multi-type air conditioner for simultaneous heating and cooling use according to one preferred embodiment of the present invention, as shown in Fig. 1, includes a plurality of outdoor units 10, a plurality of indoor units 20, a distributor 30, disposed between the plural outdoor units 10 and the plural indoor units 20, to selectively guide refrigerant to the plural indoor units 20 according to the operating mode, i.e. a cooling mode, a heating mode, or a cooling and heating mode, and a refrigerant withdrawing device for withdrawing the refrigerant from a malfunctioning outdoor unit among the plural outdoor units 10 to other outdoor units when replacing a part of the malfunctioning outdoor unit.

[0026] Here, the plural outdoor units 10 include three outdoor units, i.e. first, second, and third outdoor units 51, 52, and 53. Only the plural outdoor units 10 including the three outdoor units 51, 52, and 53 are described.

[0027] The first, second, and third outdoor units 51, 52, and 53 respectively include first, second, and third compressor units 54, 55, and 56, first, second, and third four-way valves 57, 58, and 59, and first, second, and third heat exchangers 60, 61, and 62.

[0028] Each of the first, second, and third compressor units 54, 55, and 56 includes two compressors. Only one of these compressor units having two compressors is described.

[0029] The first compressors pair 54 are connected to each other via a common accumulator 63. The second compressor pair 55 are connected to each other via a second common accumulator 64. The third compressor pair 56 are connected to each other via a third common accumulator 65.

[0030] One side of each of the first, second, and third compressor units 54, 55 and 56 is connected to respective first, second and third compressor suction tubes 54a, 55a and 56a into which refrigerant is drawn from the first, second, third, fourth, fifth and sixth indoor units 71, 72, 73, 74, 75 and 76. The other side of each of the first, second and third compressor units 54, 55 and 56 is connected to respective first, second, and third compressor discharge tubes 54b, 55b and 56b for guiding refrigerant discharged from the first, second and third compressor units 54, 55, and 56 to the respective first, second and third four-way valves 57, 58 and 59.

[0031] The first, second and third compressor discharge tubes 54b, 55b and 56b are respectively connected to first, second, and third bypasses 54c, 55c and 56c for allowing refrigerant to bypass the first, second, and third outdoor heat exchangers 60, 61, and 62.

[0032] The high-pressure refrigerant compressed by the first, second and third compressor units 54, 55 and 56 is fed to one or more indoor units for performing a heating operation among the plural indoor units 20 through the first, second and third bypasses 54c, 55c and 56c.

[0033] Discharging parts of the first, second, and third outdoor heat exchangers 60, 61, and 62 are respectively connected to first, second and third outdoor heat exchanger discharge tubes 60a, 61a and 62a for guiding liquid refrigerant discharged from the first, second and third outdoor heat exchangers 60, 61 and 62.

[0034] First, second and third outdoor heat exchanger discharge valves 60b, 61b and 62 are respectively installed in the first, second and third outdoor heat exchanger discharge tubes 60a, 61a and 62a.

[0035] Only the plural indoor units 20 including the first, second, third, fourth, fifth and sixth indoor units 71, 72, 73, 74, 75, and 76 will be described.

[0036] Each of the first, second, third, fourth, fifth and sixth indoor units 71, 72, 73, 74, 75 and 76 includes an indoor heat exchanger 77 and an electronic expansion valve 78.

[0037] Moreover, the distributor 30 includes a first distributor 31 connected to the first, second and third indoor units 71, 72 and 73, and a second distributor 32 connected to fourth, fifth and sixth indoor units 74, 75 and 76.

[0038] Each of the first and second distributors 31 and 32 includes a high-pressure refrigerant tube 80 for guiding high-pressure gaseous refrigerant discharged from the first, second and third compressor units 54, 55, and 56 to one or more indoor units for performing the heating operation. A low-pressure refrigerant tube 90 guides refrigerant passing through the first, second, third, fourth, fifth and sixth indoor units 71, 72, 73, 74, 75 and 76 to the outdoor units. A liquid refrigerant tube 100 guides liquid refrigerant discharged from the first, second and third outdoor heat exchangers 60, 61 and 62 to one or more indoor units for performing the cooling operation. A valve means selectively open and close the high-pressure refrigerant tube 80 and the low-pressure refrigerant tube 90.

[0039] The high-pressure refrigerant tube 80 is divided into first, second, third, fourth, fifth and sixth high-pressure refrigerant tubes 81, 82, 83, 84, 85 and 86 which are respectively connected to the indoor heat exchangers 77 of the first, second, third, fourth, fifth and sixth indoor units 71, 72, 73, 74, 75 and 76. The other side is branched and connected to the first, second and third bypasses 54c, 55c and 56c.

[0040] The low-pressure refrigerant tube 90 is divided into first, second, third, fourth, fifth and sixth low-pressure refrigerant tubes 91, 92, 93, 94, 95 and 96 respectively connected to the indoor heat exchangers 77 of the first, second, third, fourth, fifth and sixth indoor units 71, 72, 73, 74, 75 and 76. The other side is branched and connected to the first, second, and third compressor suction tubes 54a, 55a, and 56a.

[0041] The liquid refrigerant tube 100 includes is divided into first, second, third, fourth, fifth and sixth liquid refrigerant tubes 101, 102, 103, 104, 105 and 106 respectively connected to the electronic expansion valves 78 of the first, second, third, fourth, fifth and sixth indoor units 71, 72, 73, 74, 75 and 76. The other side is branched and connected to the first, second and third outdoor heat exchangers 60a, 61a and 62a.

[0042] In the first outdoor unit 51, the first bypass 54c is connected to the high-pressure refrigerant tube 80 by a first service valve 111. The first compressor suction tube 54a is connected to the low-pressure refrigerant tube 90 by a second service valve 112. The first outdoor heat exchanger discharge tube 60a is connected to the liquid refrigerant tube 100 by a third service valve 113.

[0043] In the second outdoor unit 52, the second bypass 55c is connected to the high-pressure refrigerant tube 80 by a fourth service valve 114. The second compressor suction tube 55a is connected to the low-pressure refrigerant tube 90 by a fifth service valve 115. The second outdoor heat exchanger discharge tube 61a is connected to the liquid refrigerant tube 100 by a sixth service valve 116.

[0044] In the third outdoor unit 53, the third bypass 56c is connected to the high-pressure refrigerant tube 80 by a seventh service valve 117. The third compressor suction tube 56a is connected to the low-pressure refrigerant tube 90 by an eighth service valve 118. The third outdoor heat exchanger discharge tube 62a is connected to the liquid refrigerant tube 100 by a ninth service valve 119.

[0045] The valve device includes first, second, third, fourth, fifth and sixth high-pressure valves 81a, 82a, 83a, 84a, 85a, and 86a, which are respectively installed in the first, second, third, fourth, fifth and sixth high-pressure refrigerant tubes 81, 82, 83, 84, 85 and 86. These valves are open in the heating mode and closed in the cooling mode. First, second, third, fourth, fifth, and sixth low-pressure valves 91a, 92a, 93a, 94a, 95a and 96a are respectively installed in the first, second, third, fourth, fifth and sixth low-pressure refrigerant tubes 91, 92, 93, 94, 95 and 96. These are open in the cooling mode and closed in the heating mode.

[0046] The refrigerant withdrawing device includes a refrigerant withdrawing tubing for withdrawing refrigerant discharged from a compressor unit of a malfunctioning outdoor unit among the plural outdoor units 10 to the other outdoor units, and an opening and closing valve means for opening and closing the refrigerant withdrawing tube.

[0047] The refrigerant withdrawing tubing includes a first refrigerant withdrawing tube 121 for connecting the first outdoor unit 51 to the second outdoor unit 52, a second refrigerant withdrawing tube 122 for connecting the second outdoor unit 52 to the third outdoor unit 53, and a third refrigerant withdrawing tube 123 for connecting the third outdoor unit 53 to the first outdoor unit 51.

[0048] The first refrigerant withdrawing tube 121 connects the first bypass 54c to the second compressor suction tube 55a. The second refrigerant withdrawing tube 122 connects the second bypass 55c to the third compressor suction tube 56a. The third refrigerant withdrawing tube 123 connects the third bypass 56c to the first compressor suction tube 54a.

[0049] The opening and closing valve means include

a first opening and closing valve 121a installed in the first refrigerant withdrawing tube 121, a second opening and closing valve 122a installed in the second refrigerant withdrawing tube 121, and a third opening and closing valve 123a installed in the third refrigerant withdrawing tube 123.

[0050] The multi-type air conditioner according to this embodiment of the present invention is operated as follows.

[0051] First, assuming that the first compressor 54 of the first outdoor unit 51 malfunctions, as a first step (S1), the first, second and third service valves 111, 112, and 113 are closed to block refrigerant flow between the first outdoor unit 51 and the indoor units 20.

[0052] Then, the fourth service valve 114 installed in the second outdoor unit 52 is closed to prevent refrigerant from entering the second outdoor unit 42.

[0053] After that, as a second step (S2), the first opening and closing valve 121a installed in the first refrigerant withdrawing tube 121 is opened to open the first refrigerant withdrawing tube 121.

[0054] In a third step (S3), the second compressor unit 55 of the second outdoor unit 52 is operated to pump down such that refrigerant in the first outdoor unit 51 is withdrawn to the second outdoor unit 52.

[0055] Therefore, all of the refrigerant in the first outdoor unit 51 is withdrawn to the second outdoor unit 52 through the first refrigerant withdrawing tube 121.

[0056] When all of the refrigerant in the first outdoor unit 51 has been withdrawn, in a fourth step (S4) the first opening and closing valve 121a is closed to seal the first refrigerant withdrawing tube 121.

[0057] The fourth service valve 114 is then opened such that refrigerant can flow between the second outdoor unit 52 and the indoor unit 20 (step S5).

[0058] Afterwards, in a sixth step (S6), the first compressor unit 54 of the first outdoor unit 51 is replaced while the second and third outdoor units 52 and 53 can continue to be operated normally.

[0059] After the replacement of the compressor unit of the first outdoor unit 51, vacuum is applied to the first outdoor unit 51 and the first, second and third service valves 111, 112, and 113 are opened to normally operate the first outdoor unit 51.

[0060] Meanwhile, since the withdrawal of refrigerant when the second outdoor unit 52 or the third outdoor unit 53 malfunctions is similar to the withdrawal of refrigerant from the first outdoor unit 51, a description thereof will be omitted.

[0061] Since, when one of the plural outdoor units 10 malfunctions, heating and/or cooling can be performed by continuing to drive the remainder of the plural outdoor units, the malfunctioning compressor unit can be replaced without interruption of heating and/or cooling.

[0062] The multi-type air conditioner for simultaneous heating and cooling use and the method for withdrawing refrigerant therefrom has the following advantages.

[0063] According to the disclosed multi-type air conditioner for simultaneous heating and cooling use and the method for withdrawing refrigerant therefrom, the refrigerant withdrawing device is provided between the plural outdoor units, refrigerant in a malfunctioning outdoor unit is withdrawn to the other outdoor units and the other outdoor units are normally operated while the compressor unit of the malfunctioning outdoor unit among the plural outdoor units is replaced. Thus, the compressor can be replaced, and/or the outdoor unit repaired, without interruption of heating and/or cooling.

[0064] Moreover, since there is no need to remove the entirety of the refrigerant from the system, time spent replacing the compressor is reduced and the replacement of the compressor is made more convenient. Thus, since loss of refrigerant is minimized, costs can be reduced.

[0065] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the accompanying claims.

Claims

1. An air conditioner comprising:

   a plurality of outdoor units (10) each including a compressor unit, a multi-way valve, and an outdoor heat exchanger;
   a plurality of indoor units (20) each including an indoor heat exchanger and an electronic expansion valve;
   a distributor (30) installed between the plural outdoor units (10) and the plural indoor units (20) to selectively guide refrigerant to the plural indoor units (20) according to operation of the air conditioner; and
   a refrigerant withdrawing means installed between the plural outdoor units (10) to enable withdrawal of refrigerant from one outdoor unit to the other outdoor units).

2. The air conditioner as set forth in claim 1, wherein the refrigerant withdrawing device comprises:

   refrigerant withdrawing tubes (121, 122, and 123) for withdrawing the refrigerant discharged from the compressor unit of the one outdoor unit to the other outdoor unit(s); and
   opening and closing valves (121a, 122a, and 123a) for opening and closing the refrigerant withdrawing tubes (121, 122, and 123).

3. The air conditioner as set forth in claim 2, wherein the compressor unit includes:

one side to which a compressor suction tube (54a, 55a, and 56a), through which the refrigerant is drawn from the indoor units, is connected; and

another side to which a bypass (54c, 55c, and 56c) for bypassing the discharged refrigerant such that the refrigerant does not pass through the outdoor heat exchangers is connected.

4. The air conditioner as set forth in claim 3, wherein the refrigerant withdrawing tubes (121, 122, and 123) connect the bypass of the malfunctioning outdoor unit to the compressor suction tube of the other outdoor units.

5. The air conditioner as set forth in claim 4, wherein the distributor (30) comprises:

a high-pressure refrigerant tube (80) for guiding high-pressure gas refrigerant discharged from the compressor unit to the indoor unit for performing a heating operation;

a low-pressure refrigerant tube (90) for guiding refrigerant passing through the first, second, third, fourth, fifth and sixth indoor units (20) to a suction port of the compressor;

a liquid refrigerant tube (100) for guiding liquid refrigerant discharged from the outdoor heat exchangers to the indoor units for performing cooling operation; and

a valve device for selectively opening and closing the high-pressure refrigerant tube (80) and the low-pressure refrigerant tub (90).

6. The air conditioner as set forth in claim 5, wherein the outdoor unit (10) further comprises outdoor discharge tube (60a, 61a, and 62a) for guiding the liquid refrigerant discharged from the outdoor heat exchangers.

7. The air conditioner as set forth in claim 6, wherein the compressor suction tubes (54a, 55a, and 56a), the bypasses (54c, 55c, and 56c), and the outdoor heat exchanger discharge tubes (60a, 61a, and 62a) are respectively connected to the low-pressure refrigerant tube (90), the high-pressure refrigerant tube (80), and the liquid refrigerant tube (100) by service valves (111, 112, 113, 114, 115, 116, 117, 118 and 119).

8. The air conditioner of claim 1 constructed and arranged as a multi-type air conditioner for simultaneous heating and cooling.

9. A method for withdrawing refrigerant from a unit of an air conditioner, comprising:

a first step of blocking the refrigerant flow to indoor units by closing a service valve installed in one outdoor unit among a plurality of outdoor units (10);

a second step of opening an opening and closing valve installed in a refrigerant withdrawing tube of the one outdoor unit;

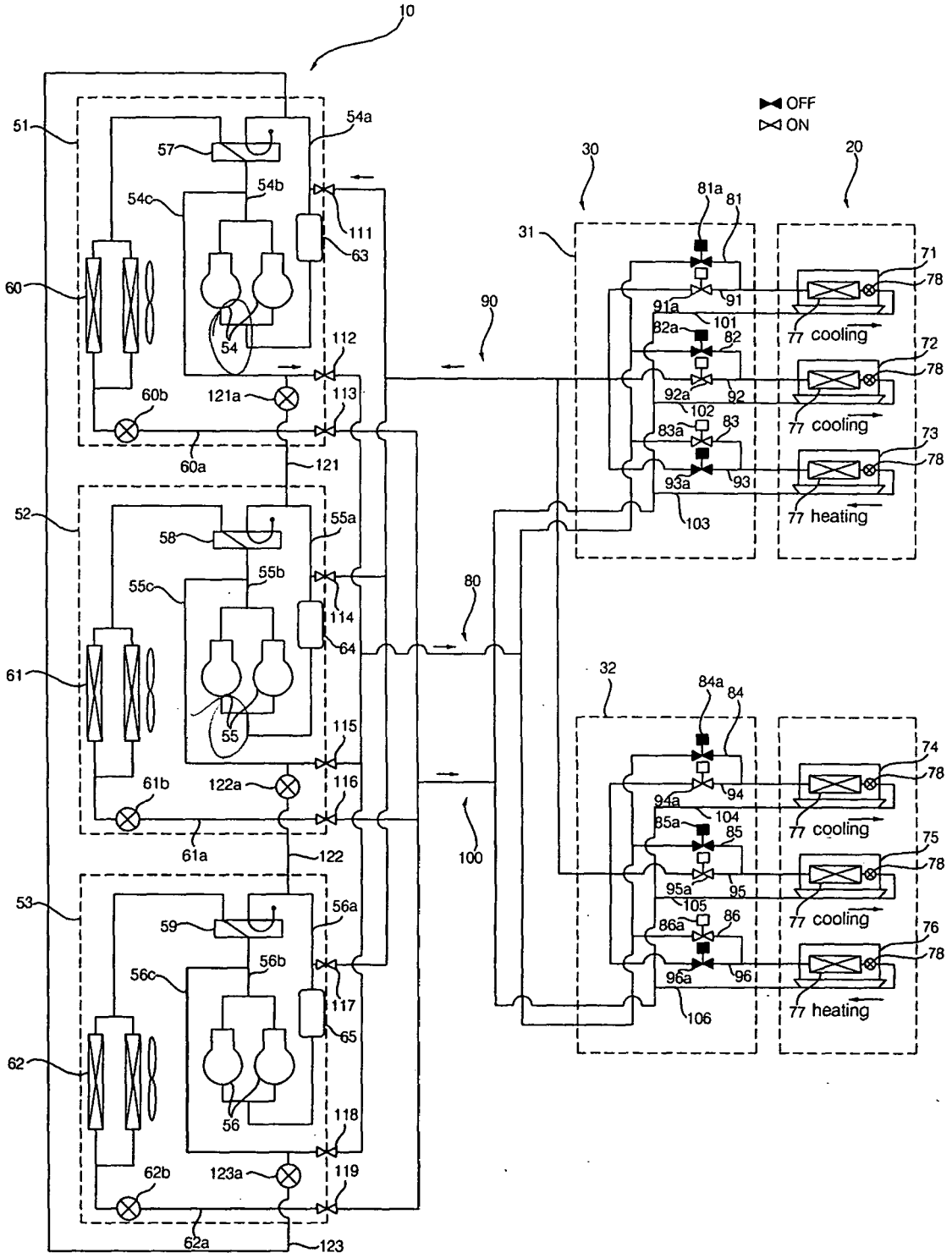
a third step of operating compressor units of the other outdoor units to pump down to withdraw the refrigerant from the one outdoor unit to the other outdoor units; and

a fourth step of closing the opening and closing valve once all of the refrigerant in the one outdoor unit is withdrawn, whereby the other outdoor units can be operated normally after refrigerant is withdrawn from the one outdoor unit.

10. The method as set forth in claim 9, wherein the first step further comprises the sub-step of closing a service valve for connecting compressor suction tubes of the other outdoor units to the distributor (30).

11. The method as set forth in claim 9, wherein the fourth step further comprises the sub-step of opening a service valve of the other outdoor units.

FIG. 1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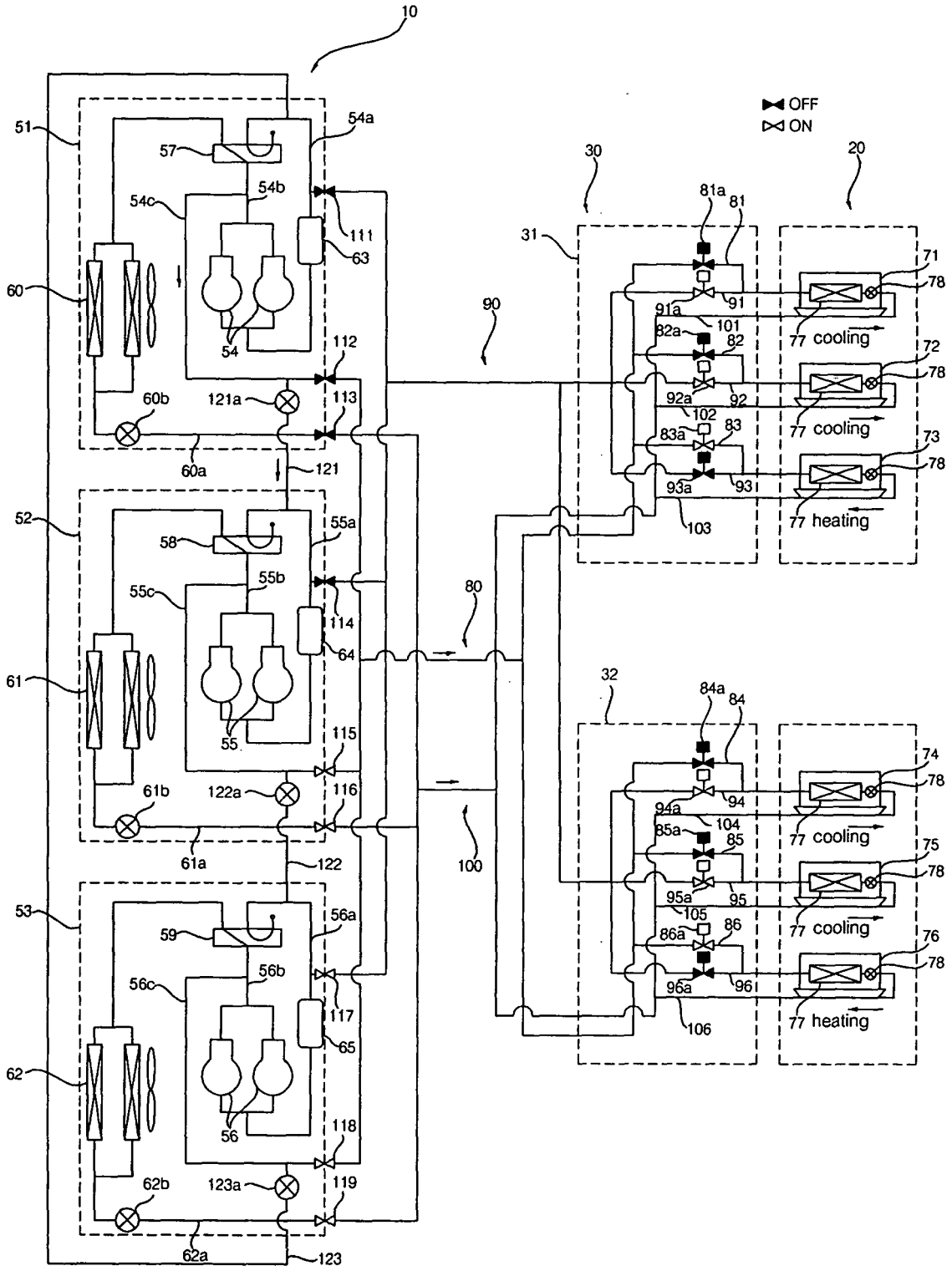
77 cooling
77 heating

FIG. 2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84a
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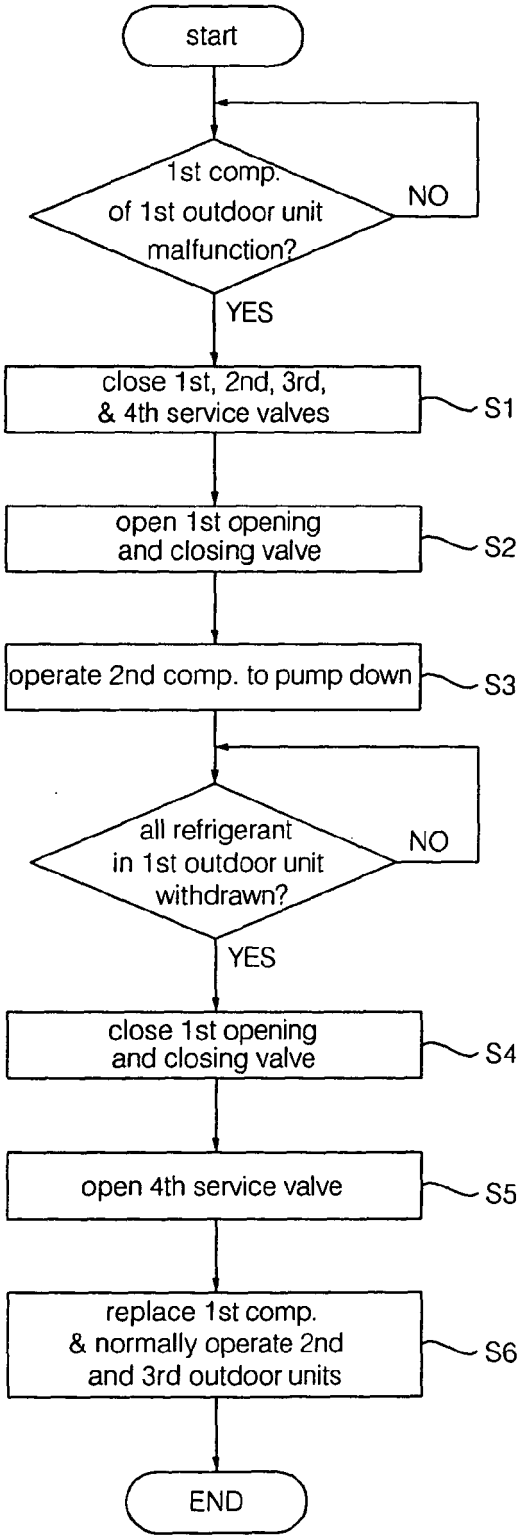
FIG. 3


start
1st comp. of 1st outdoor unit malfunction?
NO
YES
close 1st, 2nd, 3rd, & 4th service valves
S1
open 1st opening and closing valve
S2
operate 2nd comp. to pump down
S3
all refrigerant in 1st outdoor unit withdrawn?
NO
YES
close 1st opening and closing valve
S4
open 4th service valve
S5
replace 1st comp. & normally operate 2nd and 3rd outdoor units
S6
END

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 8097

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 08, 6 October 2000 (2000-10-06) -& JP 2000 146345 A (DAIKIN IND LTD), 26 May 2000 (2000-05-26) * abstract; figures 1,4 * -----	1-11	INV. F25B13/00
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X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 08, 30 June 1999 (1999-06-30) & JP 11 063711 A (MITSUBISHI ELECTRIC CORP), 5 March 1999 (1999-03-05) * abstract * -----	1,2	TECHNICAL FIELDS SEARCHED (IPC) F25B F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 April 2006	Yousufi, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 25 8097

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