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(71) Applicant: **LG Electronics Inc.**
Seoul (KR)

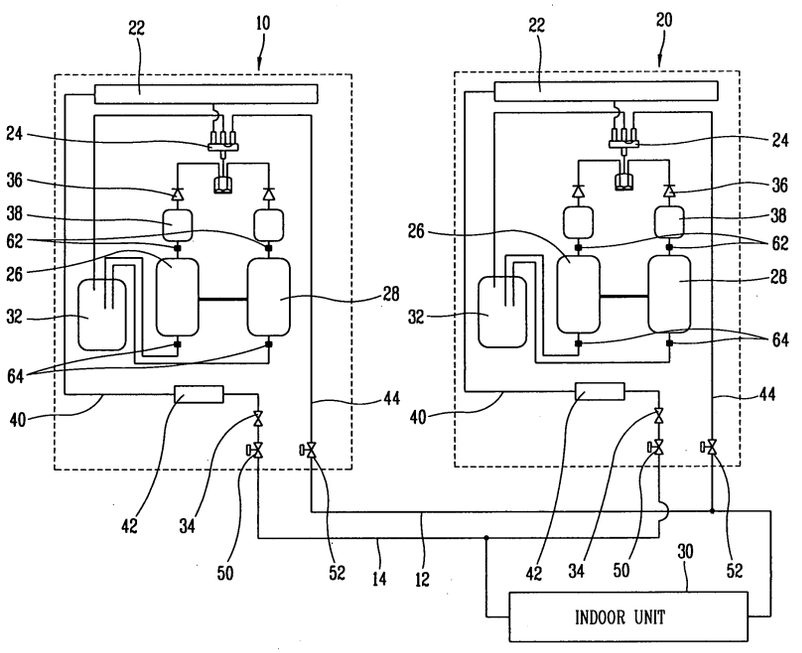
(72) Inventors:
- **Song, Jin-Seob**
  Gunpo Gyeonggi-Do (KR)
- **Jang, Sae-Dong**
  Gwangmyeong Gyeonggi-Do (KR)
- **Hwang, Il-Nahm**
  Ansan Gyeonggi-Do (KR)
- **Chung, Balk-Young**
  213-2, Yongjong-Dong Gyeyang-Gu
  Incheon (KR)

(74) Representative: **Schippan, Ralph, Dr.-Ing.**
COHAUSZ & FLORACK
Patent- und Rechtsanwälte
Bleichstrasse 14
40211 Düsseldorf (DE)

(54) air conditioner having multiple outdoor units and control method thereof

(57) The present invention discloses an air conditioner having multiple outdoor units, including a plurality of outdoor units disposed outdoors, at least one indoor unit connected to the plurality of outdoor units through refrigerant tubes, for exchanging heat with indoor air, and when part of the outdoor units are operated, a control unit for storing refrigerants in non-operated outdoor units, so that a proper amount of refrigerants can be supplied to the operated outdoor units. The air conditioner having the multiple outdoor units can improve performance and durability by preventing the refrigerants from being excessively concentrated on the operated outdoor units.

FIG. 2



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an air conditioner having multiple outdoor units and a control method thereof, and more particularly to, an air conditioner having multiple outdoor units which can improve performance by preventing refrigerants from being concentrated on operated outdoor units, when part of the outdoor units are operated, and a control method thereof.

2. Description of the Background Art

[0002] In general, a heat-pump type air conditioner can perform both cooling and heating. That is, the heat-pump type air conditioner provided with an indoor heat exchanger and an outdoor heat exchanger can be used as a cooling apparatus, and also used as a heating apparatus by inversing a flow of refrigerants of a refrigeration cycle.

[0003] Fig. 1 is a structure diagram illustrating a conventional heat-pump type air conditioner.

[0004] The conventional air conditioner includes a plurality of outdoor units 110 and 120 disposed outdoors and connected in parallel to each other, and at least one indoor unit 130 connected to the outdoor units 110 and 120 through refrigerant tubes 112 and 114, and disposed indoors, for exchanging heat with indoor air.

[0005] The outdoor units 110 and 120 each respectively includes an outdoor heat exchanger 116 for exchanging heat with outdoor air, a four-way valve 118 for switching a flow of refrigerants in the forward or backward direction, an expansion valve 122 for changing a refrigerant gas supplied to the indoor unit 130 into low temperature low pressure, compressors 124 and 126 for compressing the refrigerants into high temperature high pressure, and an accumulator 128 for separating the refrigerants into gas and liquid, and supplying gas phase refrigerants to each compressor 124 and 126.

[0006] Here, check valves 132 for preventing an inverse flow of the refrigerants and oil separators 134 for separating oil are installed at the discharge sides of the compressors 124 and 126, respectively.

[0007] Receivers 138 for preventing oil from being accumulated in the indoor unit 130 by separating oil contained in the refrigerants supplied to the indoor unit 130 are installed at discharge tubes 136 of the outdoor units 110 and 120.

[0008] The discharge tubes 136 of the outdoor units 110 and 120 are connected in parallel to the refrigerant tube 114, and the suction tubes 140 of the outdoor units 110 and 120 are connected in parallel to the refrigerant tube 112. The refrigerant tubes 112 and 114 are connected to the suction and discharge sides of the indoor unit 130, respectively.

[0009] In the conventional air conditioner, part of the outdoor units 110 and 120 are operated according to load of the indoor unit 130 or indoor and outdoor environment, and a number of the outdoor units in operation are controlled according to load variations.

[0010] However, when part of the outdoor units are operated, the refrigerants flow toward the operated outdoor units and finally exceed a proper refrigerant amount of the operated outdoor units. As a result, performance and durability of the conventional air conditioner are deteriorated.

SUMMARY OF THE INVENTION

[0011] Therefore, an object of the present invention is to provide an air conditioner having multiple outdoor units which can improve performance and durability by preventing refrigerants from being excessively concentrated on operated outdoor units by compressing and storing the refrigerants in non-operated outdoor units, when part of the outdoor units are operated, and a control method thereof.

[0012] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided an air conditioner having multiple outdoor units, including: a plurality of outdoor units disposed outdoors; at least one indoor unit connected to the plurality of outdoor units through refrigerant tubes, for exchanging heat with indoor air; and when part of the outdoor units are operated, a control unit for storing refrigerants in non-operated outdoor units, so that a proper amount of refrigerants can be supplied to the operated outdoor units.

[0013] Preferably, the outdoor units each respectively includes: an outdoor heat exchanger for exchanging heat with outdoor air; a four-way valve for switching a flow of the refrigerants in the forward or backward direction; compressors for changing the refrigerants into high temperature high pressure by compression; and a plurality of accumulators for separating the refrigerants supplied to the compressors into gas and liquid.

[0014] Preferably, first valves for opening or closing discharge tubes of the outdoor units are mounted on the discharge tubes, and second valves for opening or closing suction tubes of the outdoor units are mounted on the suction tubes.

[0015] Preferably, the control unit includes: a sensing unit for sensing an amount of refrigerants supplied to the operated outdoor units; and a controller for compressing and storing the refrigerants in the non-operated outdoor units, by controlling the first open/close valves and the second open/close valves installed at the suction and discharge tubes of the non-operated outdoor units according to the signal from the sensing unit.

[0016] According to another aspect of the present invention, a control method of an air conditioner having multiple outdoor units includes: in a partial load opera-

tion in which part of the outdoor units are operated, a first step for measuring an amount of refrigerants supplied to the operated outdoor units; when the amount of the refrigerants supplied to the operated outdoor units exceeds a set amount in the first step, a second step for compressing and storing the refrigerants in non-operated outdoor units, by closing discharge tubes of the non-operated outdoor units; and when the refrigerants are compressed and stored in the non-operated outdoor units and the amount of the refrigerants supplied to the operated outdoor units reaches the set amount in the second step, a third step for closing suction tubes of the non-operated outdoor units.

[0017] Preferably, the first step includes the sub-steps of: sensing load of an indoor unit; when the indoor unit has a partial load state, driving part of the outdoor units; and sensing refrigerant pressures in the operated outdoor units.

[0018] Preferably, the second step includes the sub-steps of: comparing refrigerant pressures in the high and low pressure sides of the operated outdoor units with a set pressure; when the refrigerant pressures of the operated outdoor units are higher than the set pressure, converting the non-operated outdoor units into a cooling mode; and storing the refrigerants sucked into the non-operated outdoor units in the non-operated outdoor units, by preventing discharge of the refrigerants by closing the discharge tubes of the non-operated outdoor units.

[0019] Preferably, the third step includes the sub-steps of: deciding whether the refrigerant pressures in the high and low pressure sides of the operated outdoor units reach the set pressure; and when the refrigerant pressures of the operated outdoor units reach the set pressure, compressing and storing the refrigerants in the non-operated outdoor units, by blocking suction lines of the non-operated outdoor units.

[0020] The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0022] In the drawings:

Fig. 1 is a structure diagram illustrating a conventional air conditioner;

Fig. 2 is a structure diagram illustrating an air conditioner in accordance with a preferred embodiment of the present invention;

Fig. 3 is a block diagram illustrating a control unit of the air conditioner in accordance with the preferred embodiment of the present invention; and

Fig. 4 is a flowchart showing sequential steps of a control method of an air conditioner in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0024] Fig. 2 is a structure diagram illustrating an air conditioner in accordance with the preferred embodiment of the present invention.

[0025] The air conditioner includes a plurality of outdoor units 10 and 20 disposed outdoors, at least one indoor unit 30 connected to the plurality of outdoor units 10 and 20 through refrigerant tubes 12 and 14, and disposed indoors, for exchanging heat with indoor air, and when part of the outdoor units 10 and 20 are operated according to load of the indoor unit 30, a control unit for controlling a proper amount of refrigerants to be supplied to the operated outdoor units.

[0026] The outdoor units 10 and 20 each respectively includes an outdoor heat exchanger 22 for exchanging heat with outdoor air, a four-way valve 24 for switching a flow of the refrigerants in the forward or backward direction, compressors 26 and 28 for changing the refrigerants into high temperature high pressure by compression, a plurality of accumulators 32 for separating the refrigerants supplied to the compressors 26 and 28 into gas and liquid, and an expansion valve 34 for changing the refrigerants supplied to the indoor unit 30 into low temperature low pressure.

[0027] Check valves 36 for preventing an inverse flow of the refrigerants and oil separators 38 for separating oil contained in the refrigerants discharged from the compressors 26 and 28 are installed at the discharge sides of the compressors 26 and 28, respectively.

[0028] Receivers 42 for preventing oil from being accumulated in the indoor unit 30 by separating oil contained in the refrigerants supplied to the indoor unit 30 are installed at discharge tubes 40 of the outdoor units 10 and 20.

[0029] In the outdoor units 10 and 20, the discharge tubes 40 for discharging the refrigerants to the indoor unit 30 and the suction tubes 44 for sucking the refrigerants from the indoor unit 30 are connected respectively. Here, each of the discharge tubes 40 is connected in parallel to the first refrigerant tube 14, and the first refrigerant tube 14 is connected to the suction side of the indoor unit 30. In addition, each of the suction tubes 44 is connected in parallel to the second refrigerant tube 12, and the second refrigerant tube 12 is connected to the discharge side of the indoor unit 30.

[0030] First valves 50 are installed at the discharge tubes 40, respectively, for opening or closing the discharge tubes 40 for discharging the refrigerants from the outdoor units 10 and 20, and second valves 52 are installed at the suction tubes 44, respectively, for opening or closing the suction tubes 44 for sucking the refrigerants into the outdoor units 10 and 20.

[0031] Referring to Fig. 3, the control unit includes a load sensor 60 for sensing load of the indoor unit 30, sensors 62 and 64 for sensing an amount of refrigerants supplied to each outdoor unit 10 and 20, and a controller 70 for controlling driving of the compressors 26 and 28 according to the signals from the load sensor 60 and the sensors 62 and 64, and also controlling a proper amount of refrigerants to be supplied to the operated outdoor units, by adjusting the first valves 50 and the second valves 52.

[0032] Preferably, the first and second valves 50 and 52 are solenoid valves for opening or closing the discharge tubes 40 and the suction tubes 44 according to the signals from the controller 70.

[0033] When the load sensor 60 senses the load of the indoor unit 30 and applies the sensed load to the controller 70, the controller 70 wholly or partially operates the plurality of outdoor units 10 and 20 according to the load of the indoor unit 30.

[0034] The first sensor 62 is a high pressure side pressure sensor installed at the refrigerant tube for discharging the refrigerants compressed in the compressors 26 and 28, for sensing a pressure of the compressed refrigerants.

[0035] The second sensor 64 is a low pressure side pressure sensor installed at the refrigerant tube for supplying the refrigerants to the compressors 26 and 28, for sensing a pressure of the refrigerants before compression.

[0036] The operation of the air conditioner having the multiple outdoor units in accordance with the present invention will now be described.

[0037] Fig. 4 is a flowchart showing sequential steps of the control method of the air conditioner in accordance with the preferred embodiment of the present invention.

[0038] Decided is whether the indoor unit 30 performs the partial load operation (S10).

[0039] That is, the load sensor 60 senses the load of the indoor unit 30, and applies the sensed load to the controller 70. The controller 70 decides the number of the operated outdoor units 10 and 20 according to the signal from the load sensor 60.

[0040] If the indoor unit 30 performs the partial load operation, the amount of the refrigerants supplied to the operated outdoor unit 10 is sensed, and whether the amount of the refrigerants supplied to the operated outdoor unit 10 is larger than a set amount is decided (S20) (It is presumed that the outdoor unit 10 is the operated outdoor unit 10 and the outdoor unit 20 is the non-operated outdoor unit).

[0041] That is, the first sensor 62 installed at the operated outdoor unit 10 senses a pressure of the refrigerants compressed and discharged from the compressors 26 and 28 in the high pressure side, and the second sensor 64 senses a pressure of the refrigerants in the low pressure side before the refrigerants are supplied to the compressors 26 and 28. Whether a proper amount of refrigerants are supplied to the operated outdoor unit 10 is decided by comparing the sensed pressures with a set pressure.

[0042] If the amount of the refrigerants supplied to the operated outdoor unit 10 is larger than the set amount, the refrigerants are compressed and stored in the non-operated outdoor unit 20, and thus not concentrated on the operated outdoor unit 10.

[0043] That is, the controller 70 switches the non-operated outdoor unit 20 into a cooling mode, by driving the four-way valve 24 of the non-operated outdoor unit 20, and closes the discharge tube 40 of the non-operated outdoor unit 20 by closing the first valve 50 mounted on the non-operated outdoor unit 20 (S30). Therefore, the refrigerants are not discharged from the non-operated outdoor unit 20 to the indoor unit 30.

[0044] Here, the outdoor unit 10 is operated, and the refrigerants discharged from the outdoor unit 10 are supplied to the indoor unit 30, pass through the indoor unit 30 and exchange heat with indoor air. The refrigerants discharged from the indoor unit 30 are supplied to the suction tube 44 of the non-operated outdoor unit 20 as well as the suction tube 44 of the operated outdoor unit 10 through the first refrigerant tube 12.

[0045] The refrigerants sucked into the non-operated outdoor unit 20 are supplied to each element of the non-operated outdoor unit 20, namely, the accumulator 32, the compressors 26 and 28 and the receiver 42. Since the discharge tube 40 of the non-operated outdoor unit 20 is closed by the first valve 50, the refrigerants supplied to the non-operated outdoor unit 20 are compressed and stored in each element of the non-operated outdoor unit 20.

[0046] If the amount of the refrigerants supplied to the operated outdoor unit 10 reaches the set amount, a predetermined amount of refrigerants are stored in the non-operated outdoor unit 20 by closing the suction tube 44 of the non-operated outdoor unit 20, and a proper amount of refrigerants are supplied to the operated outdoor unit 10 (S40 and S50).

[0047] That is, when the controller 70 decides that the refrigerant pressures in the high and low pressure sides of the operated outdoor unit 10 reach the set pressure according to the signals from the first and second sensors 62 and 64 mounted on the operated outdoor unit 10, the controller 70 closes the suction tube 44 of the non-operated outdoor unit 20 by operating the second valve 52 mounted on the suction tube 44. Accordingly, the predetermined amount of refrigerants are compressed and stored in the non-operated outdoor unit 20. In addition, the proper amount of refrigerants are sup-

plied to the operated outdoor unit 10, so that the air conditioner can be efficiently driven.

[0048] As discussed earlier, in accordance with the present invention, the air conditioner having the multiple outdoor units can improve performance and durability by preventing the refrigerants from being concentrated on the operated outdoor units by compressing and storing some refrigerants in the non-operated outdoor units in the partial load operation in which part of the outdoor units are operated.

[0049] As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.

Claims

1. An air conditioner having multiple outdoor units, comprising:

a plurality of outdoor units disposed outdoors;
at least one indoor unit connected to the plurality of outdoor units through refrigerant tubes, for exchanging heat with indoor air; and
when part of the outdoor units are operated, a control unit for storing refrigerants in non-operated outdoor units, so that a proper amount of refrigerants can be supplied to the operated outdoor units.

2. The air conditioner of claim 1, wherein the outdoor units each respectively comprises:

an outdoor heat exchanger for exchanging heat with outdoor air;
a four-way valve for switching a flow of the refrigerants in the forward or backward direction;
compressors for changing the refrigerants into high temperature high pressure by compression; and
a plurality of accumulators for separating the refrigerants supplied to the compressors into gas and liquid.

3. The air conditioner of claim 1, wherein first valves for opening or closing discharge tubes of the outdoor units are mounted on the discharge tubes, and second valves for opening or closing suction tubes of the outdoor units are mounted on the suction tubes.

4. The air conditioner of claim 3, wherein the first and second valves are solenoid valves operated when power is applied thereto.

5. The air conditioner of claim 3, wherein the control unit comprises:

a sensing unit for sensing an amount of refrigerants supplied to the operated outdoor units; and
a controller for compressing and storing the refrigerants in the non-operated outdoor units, by controlling the first open/close valves and the second open/close valves installed at the suction and discharge tubes of the non-operated outdoor units according to the signal from the sensing unit.

6. The air conditioner of claim 5, wherein the control unit further comprises a load sensor for sensing load of the indoor unit.

7. The air conditioner of claim 5, wherein the sensing unit comprises:

a first pressure sensor installed at the refrigerant tubes for discharging the refrigerants from the compressors, for sensing a pressure of the refrigerants passing through the compressors; and
a second pressure sensor installed at the refrigerant tubes for sucking the refrigerants into the compressors, for sensing a pressure of the refrigerants supplied to the compressors.

8. A control method of an air conditioner having multiple outdoor units, comprising:

in a partial load operation in which part of the outdoor units are operated, a first step for measuring an amount of refrigerants supplied to the operated outdoor units;
when the amount of the refrigerants supplied to the operated outdoor units exceeds a set amount in the first step, a second step for compressing and storing the refrigerants in non-operated outdoor units, by closing discharge tubes of the non-operated outdoor units; and
when the refrigerants are compressed and stored in the non-operated outdoor units and the amount of the refrigerants supplied to the operated outdoor units reaches the set amount in the second step, a third step for closing suction tubes of the non-operated outdoor units.

9. The method of claim 8, wherein the first step comprises the sub-steps of:

sensing load of an indoor unit;
when the indoor unit has a partial load state, driving part of the outdoor units; and
sensing refrigerant pressures in the operated outdoor units.

10. The method of claim 9, wherein the step for sensing the refrigerant pressures senses the pressure of the refrigerants supplied to the compressors of the operated outdoor units in the low pressure sides and the pressure of the refrigerants compressed in the compressors in the high pressure sides, respectively.

11. The method of claim 8, wherein the second step comprises the sub-steps of:

comparing refrigerant pressures in the high and low pressure sides of the operated outdoor units with a set pressure;
when the refrigerant pressures of the operated outdoor units are higher than the set pressure, converting the non-operated outdoor units into a cooling mode; and
storing the refrigerants sucked into the non-operated outdoor units in the non-operated outdoor units, by preventing discharge of the refrigerants by closing the discharge tubes of the non-operated outdoor units.

12. The method of claim 11, wherein first valves are installed at the discharge tubes, for closing the discharge tubes according to the signal from the controller.

13. The method of claim 8, wherein the third step comprises the sub-steps of:

deciding whether the refrigerant pressures in the high and low pressure sides of the operated outdoor units reach the set pressure; and
when the refrigerant pressures of the operated outdoor units reach the set pressure, compressing and storing the refrigerants in the non-operated outdoor units, by blocking suction lines of the non-operated outdoor units.

14. The method of claim 13, wherein second valves are installed at the suction lines of the non-operated outdoor units, for blocking the suction lines according to the signal from the controller.

FIG. 1

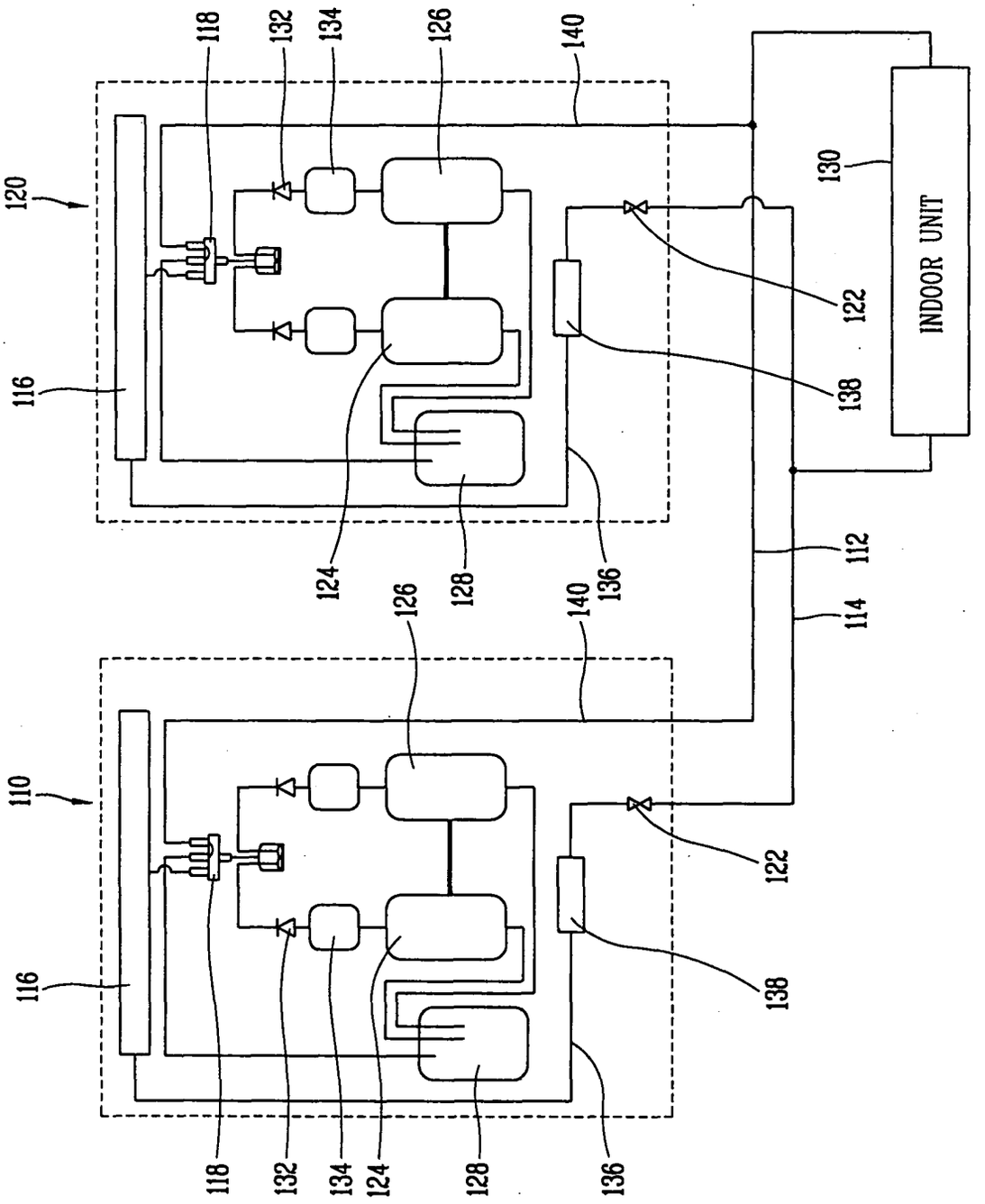
INDOOR UNIT
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FIG. 2

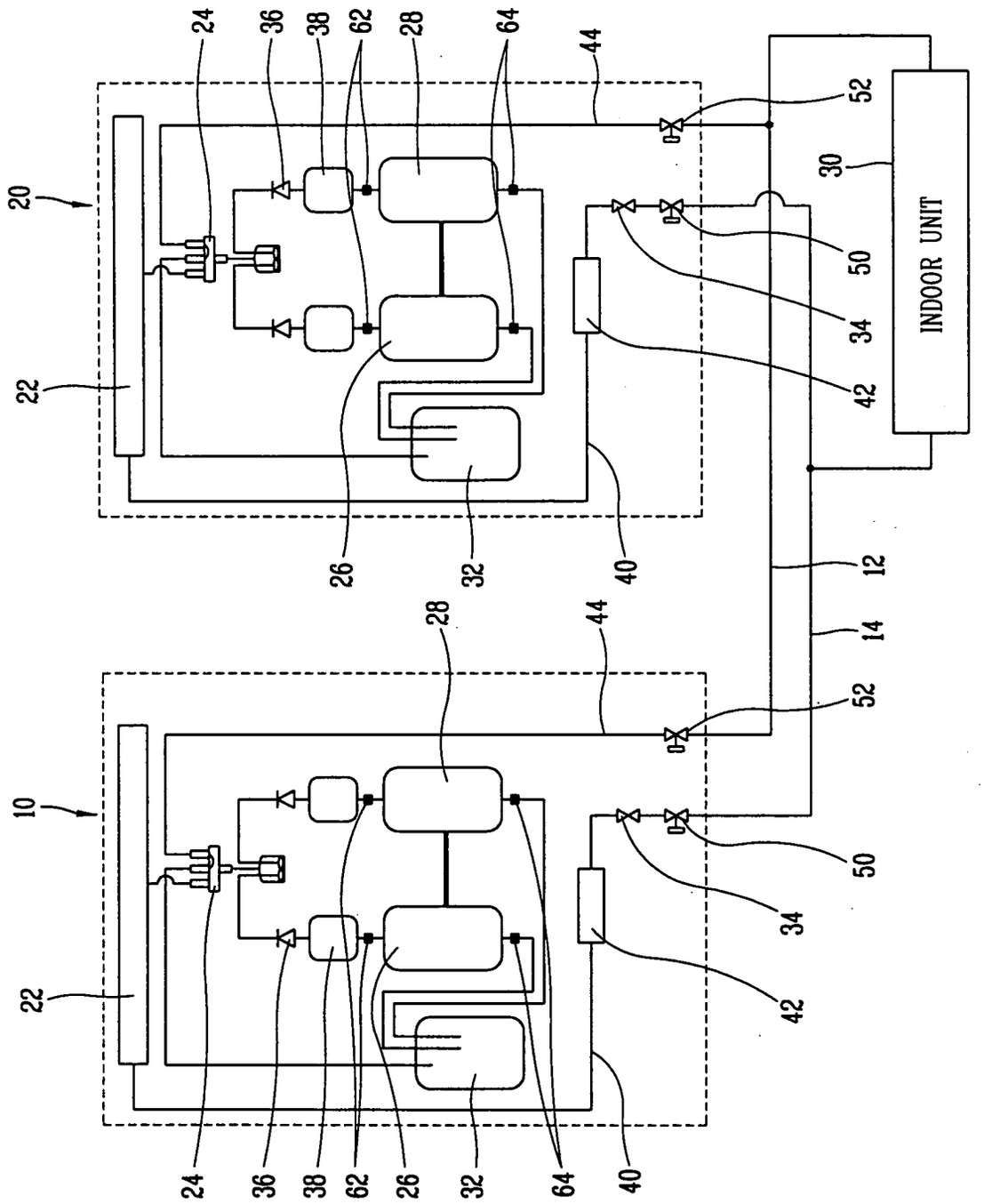
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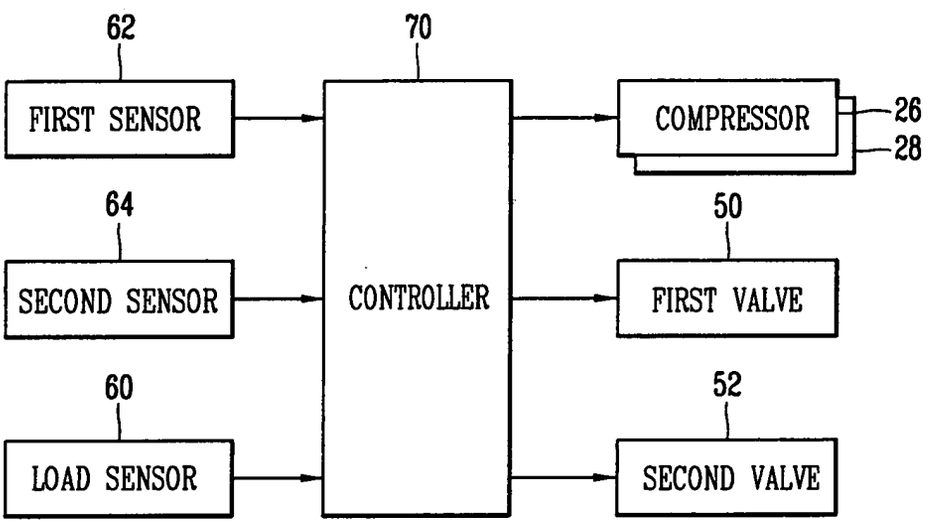
FIG. 3


62
70
FIRST SENSOR
COMPRESSOR
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64
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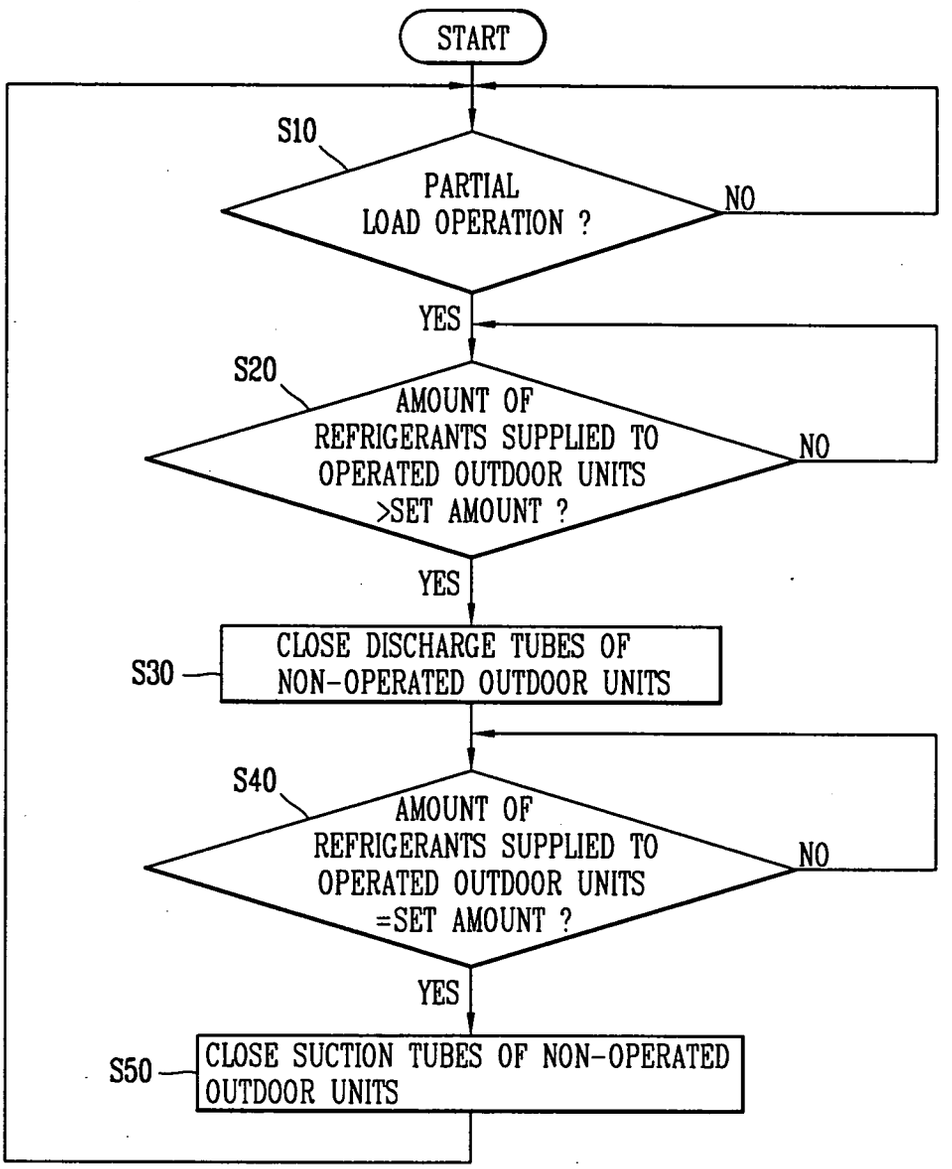
SECOND SENSOR
CONTROLLER
FIRST VALVE
60
52
LOAD SENSOR
SECOND VALVE

FIG. 4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YES
S20
AMOUNT OF REFRIGERANTS SUPPLIED TO OPERATED OUTDOOR UNITS >SET AMOUNT ?
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YES
S30
CLOSE DISCHARGE TUBES OF NON-OPERATED OUTDOOR UNITS
S40
AMOUNT OF REFRIGERANTS SUPPLIED TO OPERATED OUTDOOR UNITS =SET AMOUNT ?
NO
YES
S50
CLOSE SUCTION TUBES OF NON-OPERATED OUTDOOR UNITS

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 4799

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F24F
F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 February 2005	Valenza, D

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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