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(71) Applicant: **LG ELECTRONICS INC.**  
**Seoul 150-010 (KR)**

(72) Inventors:  
• **Park, Jong Han**  
**Kwangmyong-shi, Kyonggi-do (KR)**

• **Park, Young Min**  
**Namdong-gu, Inchon-kwangyok-shi (KR)**  
• **Lee, Chang Seon**  
**Gumchon-gu, Seoul (KR)**  
• **Choi, Sung Oh**  
**Kwangmyong-shi, Kyonggi-do (KR)**

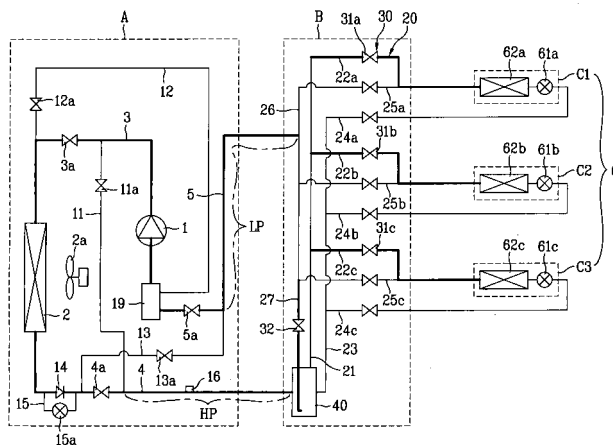
(74) Representative: **Schorr, Frank, Dr. et al**  
**Diehl Glaeser Hiltl & Partner,**  
**Augustenstrasse 46**  
**80333 München (DE)**

(54) **Multi-unit air conditioner and method for controlling operation of outdoor unit fan thereof**

(57) Multi-unit air conditioner for independent cooling/heating of each room including an outdoor unit (A), a distributor (B) and a plurality of indoor units (C1,C2,C3), wherein the outdoor unit (A) and the distributor (B) are connected with two piping specifically defined as a high pressure section and a low pressure section. The outdoor unit (A) includes an outdoor unit piping for connecting different elements, a bypass piping (11,12,13) for bypassing refrigerant depending on operation a condition, and a plurality of refrigerant flow control valves (3a,4a,5a,11a,12a,13a) for controlling a refrigerant flow. The distributor (B) includes a gas-liquid separator (40) for separating the refrigerant into gas re-

frigerant and liquid refrigerant, for selectively leading refrigerant from the outdoor unit (A) to a plurality of indoor units (C1,C2,C3) according to different operation conditions for independent cooling and heating of each room. Method for controlling operation of an outdoor unit fan (2a) in a multi-unit air conditioner includes the steps of measuring a temperature of gas-liquid mixture refrigerant from an outdoor unit heat exchanger (2), comparing a measured refrigerant temperature and a preset refrigerant temperature, to detect a gas-refrigerant mixture ratio of the refrigerant, and varying a rotational speed of an outdoor unit fan (2a) so that a detected gas-liquid mixture ratio is identical to a preset gas-liquid mixture ratio required for an intended operation condition.

FIG. 1



## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

[0001] The present invention relates to a multi-unit air conditioner.

#### Background of the Related Art

[0002] In general, the air conditioner is an appliance for cooling or heating spaces, such as living spaces, restaurants, and offices. At present, for effective cooling or heating of a space partitioned into many rooms, it is a trend that there has been ceaseless development of multi-unit air conditioner. The multi-unit air conditioner is in general provided with one outdoor unit and a plurality of indoor units each connected to the outdoor unit and installed in a room, for cooling or heating the room while operating in one of cooling or heating mode.

[0003] However, the multi-unit air conditioner is operative only one mode of cooling or heating uniformly even if one room requires heating, and the other room requires cooling among the many rooms within the partitioned space, the multi-unit air conditioner has a limit in that the requirement can not be dealt with, appropriately.

[0004] For an example, even in a building, there are rooms having a temperature difference depending on locations of the room or time, such as while a north side room requires heating, a south side room requires cooling owing to the sun light, which can not be dealt with a related art multi-unit air conditioner that is operative in a single mode.

[0005] Moreover, even though a building equipped with a computer room requires cooling not only in summer, but also in winter for resolving the problem of heat load of the computer related equipment, the related art multi-unit air conditioner can not deal with such a requirement, appropriately.

[0006] In conclusion, the requirement demands development of multi-unit air conditioner of concurrent cooling/heating type, for air conditioning rooms individually, i.e., the indoor unit installed in a room requiring heating is operative in a heating mode, and, at the same time, the indoor unit installed in a room requiring cooling is operative in a cooling mode.

### SUMMARY OF THE INVENTION

[0007] Accordingly, the present invention is directed to multi-unit air conditioner that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0008] An object of the present invention is to provide a multi-unit air conditioner which can carry out heating and cooling at the same time individually suitable for each room.

[0009] Another object of the present invention is to provide a multi-unit air conditioner, in which a piping connecting a distributor and an outdoor unit is reduced for convenience of installation.

5 [0010] Further object of the present invention is to provide a method for controlling operation of a multi-unit air conditioner which can improve an efficiency of air conditioning by optimizing a gas-liquid mixture ratio of refrigerant introduced into a gas-liquid separator in operations of cooling all rooms, or cooling a major number of the rooms while heating a minor number of rooms.

10 [0011] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

15 [0012] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, the multi-unit air conditioner includes an outdoor unit including an accumulator, a compressor, and an outdoor heat exchanger connected in series with an outdoor unit piping, an outdoor unit electric expansion valve in parallel to the outdoor unit piping on an outlet side of the outdoor unit heat exchanger, a bypass piping for bypassing refrigerant from the compressor to outside of the outdoor unit, refrigerant from an outside of the outdoor unit toward the outdoor unit electric expansion valve, and refrigerant introduced into an outlet side of the compressor to an inlet side of the compressor, and a plurality of refrigerant flow control valves on the outdoor unit piping and the bypass piping for controlling flow of the refrigerant, an indoor unit in each of rooms each including an indoor unit heat exchanger and an indoor unit electric expansion valve, and a distributor including a gas-liquid separator for separating refrigerant from the outdoor unit into gas refrigerant and liquid refrigerant, for leading the gas refrigerant to the indoor unit heat exchanger of the indoor unit which heats the room, the liquid refrigerant to the indoor unit electric expansion valve of the indoor unit which cools the room, and the refrigerant passed through the indoor units to the outdoor unit, wherein, if cooling and heating are carried out for each rooms individually, the refrigerant liquefied as the refrigerant passes through the indoor unit which heats the room is made to be re-introduced into the electric expansion valve of the indoor unit which cools the room before leading to the outdoor unit.

20 [0013] The multi-unit air conditioner further includes controlling means for controlling a rotational speed of the outdoor unit fan so that a gas-liquid mixture ratio of the refrigerant introduced into the gas-liquid separator through the outdoor unit heat exchanger is regulated suitable for different operation conditions. The controlling means includes a temperature sensor provided on

the outdoor unit piping on a side of the outdoor unit heat exchanger for measuring a temperature of the refrigerant from the outdoor unit heat exchanger, and a micro-computer for comparing a refrigerant temperature measured at the temperature sensor and a preset refrigerant temperature to detect a refrigerant mixture ratio in the piping, and controlling a rotational speed of the outdoor fan for making the detected mixture ratio to be identical to a preset mixture ratio required for an intended operation condition.

**[0014]** The outdoor unit piping includes a discharge pipe connected between an outlet of the compressor and an inlet of the outdoor unit heat exchanger, an outflow pipe connected between an outlet of the outdoor unit heat exchanger and an inlet of the gas-liquid separator, and a suction pipe connected between an outlet of the distributor and an inlet of the compressor.

**[0015]** The bypass piping includes a first bypass pipe connected between the discharge pipe and the outflow pipe, a second bypass pipe connected between a part of the discharge pipe between the first bypass pipe and the outdoor unit heat exchanger and the suction pipe, and a third bypass pipe connected between a part of the outflow pipe between the outdoor unit heat exchanger and the first bypass pipe and a part of the suction pipe between the second bypass pipe and an outlet of the distributor.

**[0016]** The refrigerant flow control valves include a first on/off solenoid valve on the discharge pipe between the first bypass pipe and the second bypass pipe, a second on/off solenoid valve on the suction pipe between the second bypass pipe and the third bypass pipe, a third on/off solenoid valve on the outflow pipe between the first bypass pipe and the third bypass pipe, a fourth on/off solenoid valve on the first bypass pipe, a fifth on/off solenoid valve on the second bypass pipe, a sixth on/off solenoid valve on the third bypass pipe, and a check valve on the outflow pipe between the third bypass pipe and the outdoor unit heat exchanger for prevention of refrigerant flow in a direction from the third bypass pipe to an outlet of the outdoor unit heat exchanger.

**[0017]** The first, second, and third on/off solenoid valves are opened in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and closed in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled, and the fourth, fifth, and sixth on/off solenoid valves are closed in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and opened in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

**[0018]** The refrigerant flow control valves include a first three way valve provided on a point the discharge pipe and the first bypass pipe join, a second three way valve provided on a point the suction pipe and the third

bypass pipe join, a seventh on/off solenoid valve provided on a part of the outflow pipe between the first bypass pipe and the third bypass pipe, an eighth on/off solenoid valve provided on a second bypass pipe, and a check valve on the outflow pipe between the third bypass pipe and the outdoor unit heat exchanger for prevention of refrigerant flow in a direction from the third bypass pipe to an outlet of the outdoor unit heat exchanger.

**[0019]** The first three way valve is controlled such that refrigerant is lead to the outdoor unit heat exchanger in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and lead to the first bypass pipe in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled. The second three way valve is controlled such that refrigerant is lead to the compressor in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and lead to the third bypass pipe in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled. The seventh on/off solenoid valve is opened in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and closed in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled. The eighth on/off solenoid valve is closed in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and opened in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

**[0020]** The outdoor unit electric expansion valve is provided on the parallel pipe provided on the outflow pipe in parallel to the check valve. The outdoor unit electric expansion valve is closed in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and opened in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled. The accumulator is provided to a part of the suction pipe between the second bypass pipe and the compressor.

**[0021]** The distributor includes a gas-liquid separator having the outflow pipe in the outdoor unit heat exchanger connected thereto, a distributor piping for guiding gas or liquid refrigerant separated at the gas-liquid separator toward a side of the indoor units, and the refrigerant passed through the indoor units to the outdoor unit again, and a valve part for controlling refrigerant flow in the distributor piping according to a desired operation condition.

**[0022]** The distributor piping includes a gas refrigerant pipe for guiding gas refrigerant separated at the gas-liquid separator, gas refrigerant branch pipes each branched from the gas refrigerant pipe and connected

to the indoor unit heat exchanger of each indoor unit, a liquid refrigerant pipe for guiding liquid refrigerant separated at the gas-liquid separator, liquid refrigerant branch pipes each branched from the liquid refrigerant pipe and connected to the indoor unit electric expansion valve on each indoor unit, return branch pipes each branched from the gas refrigerant branch pipe, a return pipe having the return branch pipes joined together and connected to the suction pipe, and a distributor bypass pipe connected between a lower part of the gas-liquid separator and the return pipe.

**[0023]** The valve part includes a plurality of on/off control valve provided on the gas refrigerant branch pipes, the liquid refrigerant branch pipes, and the return branch pipes and controlled, and a ninth on/off solenoid valve provided on the distributor bypass pipe and controlled. The distributor valve part is controlled such that the on/off control valve provided on the refrigerant connection pipe on a side of the indoor unit which heats the room and the on/off solenoid valve provided on the gas refrigerant branch pipe on a side of the indoor unit which cools the room, are only closed.

**[0024]** In another aspect of the present invention, there is provided a method for controlling operation of an outdoor unit fan in a multi-unit air conditioner including the steps of measuring a temperature of gas-liquid mixture refrigerant from an outdoor unit heat exchanger, comparing a measured refrigerant temperature and a preset refrigerant temperature, to detect a gas-refrigerant mixture ratio of the refrigerant, and varying a rotational speed of an outdoor unit fan so that a detected gas-liquid mixture ratio is identical to a preset gas-liquid mixture ratio required for an intended operation condition.

**[0025]** It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0026]** 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:

**[0027]** In the drawings:

FIG. 1 illustrates a circuit diagram showing multi-unit air conditioner in accordance with a first preferred embodiment of the present invention;

FIG. 2A illustrates a circuit diagram showing an operation state of the multi-unit air conditioner in FIG. 1 when all rooms are cooled;

FIG. 2B illustrates a circuit diagram showing an operation state of the multi-unit air conditioner in FIG. 1 when all rooms are heated;

FIG. 3A illustrates a circuit diagram showing an operation state of the multi-unit air conditioner in FIG. 1 when a major number of rooms are cooled and a minor number of rooms are heated;

FIG. 3B illustrates a circuit diagram showing an operation state of the multi-unit air conditioner in FIG. 1 when a major number of rooms are heated and a minor number of rooms are cooled; and

FIG. 4 illustrates a circuit diagram showing a multi-unit air conditioner in accordance with a second preferred embodiment of the present invention;

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

**[0028]** Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. In describing the embodiments of the present invention, same parts will be given the same names and reference symbols, and iterative description of which will be omitted.

**[0029]** Referring to FIG. 1, the air conditioner in accordance with a preferred embodiment of the present invention includes an outdoor unit 'A', a distributor 'B', and a plurality of indoor units 'C'; 'C1', 'C2', and 'C3', wherein the air conditioner has a system in which rooms the indoor units 'C'; 'C1', 'C2', and 'C3' are installed therein respectively are cooled or heated independently depending on different operation conditions of cooling all rooms, heating all rooms, cooling a major number of the rooms and heating a minor number of rooms, and heating a major number of the rooms and cooling a minor number of rooms, detail of which will be described with reference to FIG. 1.

**[0030]** For convenience of description, the following drawing reference symbols 22 represents 22a, 22b, and 22c, 24 represents 24a, 24b, and 24c, 25 represents 25a, 25b, and 25c, 31 represents 31a, 31b, and 31c, 61 represents 61a, 61b, and 61c, 62 represents 62a, 62b, and 62c, and C represents C1, C2, and C3. Of course, a number of the indoor units 'C' and numbers of elements related to the indoor units are varied with a number of rooms, and for convenience of description, the specification describes assuming a case when there are three rooms.

**[0031]** The outdoor unit 'A' includes a compressor 1, an outdoor unit heat exchanger 2 and an outdoor unit fan 2a, a gas-liquid separator 3, an outdoor unit electric expansion valve 13a, an accumulator 19, outdoor unit piping, bypass piping, and a plurality of flow control valves on the outdoor unit piping and the bypass piping, of which detailed system will be described, with reference to FIG. 1.

**[0032]** Referring to FIG. 1, the compressor 1 and the outdoor unit heat exchanger 2 are connected with a discharge pipe 3. The outdoor unit fan 2a is provided to blow air toward the outdoor unit heat exchanger 2 for

cooling down the outdoor heat exchanger 2. The compressor 1 has a suction pipe 5 connected to a suction side thereof, with an accumulator 19 on the suction pipe 5.

**[0033]** There are an outflow pipe 4 connected to an outlet of the outdoor unit heat exchanger 2, and a parallel pipe 15 branched from one point of the outflow pipe 4 and joined to the other point of the outflow pipe 4 for form a bypass path. There is an outdoor unit electric expansion valve 15a on the parallel pipe 15, so that the outdoor unit electric expansion valve 13a is closed in operations all rooms are cooled, and a major number of the room are cooled and a minor number of rooms are heated, and operative in operations all rooms are heated, and a major number of the room are heated and a minor number of rooms are cooled.

**[0034]** There is a check valve 14 on the outflow pipe 4 between one point and the other point the parallel pipe 15 is connected thereto. The check valve 14 permits a refrigerant flow from the outdoor unit heat exchanger 2 to the distributor 'B', and blocks a refrigerant flow in the opposite direction.

**[0035]** There is a first bypass pipe 11 connected between one point of the outflow pipe 4 and one point of the discharge pipe 4. There is a fourth solenoid valve 11a on the first bypass pipe 11. The second bypass pipe 12 is provided and connected such that the accumulator 19 is positioned between the compressor 1 and the second bypass pipe 12. There is a fifth solenoid valve 12a provided on the second bypass pipe 12.

**[0036]** There is a first solenoid valve 3a provided on the discharge pipe 3 between one point the first bypass pipe 11 is connected thereto and the other point the second bypass pipe 12 is connected thereto.

**[0037]** A part of the outflow pipe 4 between the outdoor unit heat exchanger 2 and the first bypass pipe 11 and a part of the suction pipe 5 between the second bypass pipe 12 and the outlet of the distributor 'B' are connected with a third bypass pipe 13. The third bypass pipe 13 is provided and connected such that the check valve 14 and the parallel pipe 15 are positioned between the third bypass pipe 13 itself and the outdoor unit heat exchanger 2. There is a sixth solenoid valve 13a provided on the third bypass pipe 13.

**[0038]** There is a third solenoid valve 4a on the outflow pipe 4 between one point the first bypass pipe 11 is connected thereto and the other point the third bypass pipe 13 is connected thereto, and there is a second solenoid valve 5a provided on the suction pipe 5 between one point the third bypass pipe 13 is connected thereto and the other point the second bypass pipe 12 is connected thereto.

**[0039]** The flow control valves having six solenoid valves are controlled such that the first, second, and third solenoid valves 3a, 5a and 4a are opened in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of room are heated, closed in operations all rooms are heated, and a ma-

major number of rooms are heated and a minor number of room are cooled, and the fourth, fifth, and sixth solenoid valves 11a, 12a, and 13a closed in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of room are heated, opened in operations all rooms are heated, and a major number of rooms are heated and a minor number of room are cooled.

**[0040]** Next, referring to FIG. 1, the distributor 'B' includes a gas-liquid separator 40, a distributor piping 20 and a valve part 30.

**[0041]** The gas-liquid separator 40 has one inlet and three outlets, wherein the inlet is connected to the outflow pipe in the outdoor unit 'A', and the three outlets are connected to a liquid refrigerant pipe 23, a gas refrigerant pipe 21 and a distributor bypass pipe 27 in the distributor piping 20, respectively. The gas-liquid separator 40 separates two phased refrigerant received through the outflow pipe 4 into liquid refrigerant and gas refrigerant, and discharge to the liquid refrigerant pipe 23 and the gas refrigerant pipe 21, respectively. Of course, if the gas-liquid separator 40 receives one phased refrigerant of a gas phase or liquid phase through the outflow pipe 4, the one phased refrigerant is discharged either to the gas refrigerant pipe 21 or to the liquid refrigerant pipe 23, directly.

**[0042]** In the meantime, the distributor piping 20 guides the gas or liquid refrigerant from the gas-liquid separator 40 toward the indoor units 'C', the refrigerant from the indoor units 'C' toward the outdoor unit 'A'. The distributor piping 20 includes a gas refrigerant pipe 21, gas refrigerant branch pipes 22, a liquid refrigerant pipe 23, liquid refrigerant branch pipes 24, a return pipe 26, and a distributor bypass pipe 27, of which detailed connected is as follows.

**[0043]** The liquid refrigerant pipe 23 and the distributor bypass pipe 27 are connected to outlets of the gas-liquid separator 40 in a lower part thereof, and the gas refrigerant pipe 21 is connected to an outlet in an upper part of the gas-liquid separator 40.

**[0044]** Referring to FIG. 1, a plurality of the liquid refrigerant branch pipes 22 are branched from the gas refrigerant pipe 21 and connected to the indoor heat exchangers 62 of the indoor units 'C' respectively, and a plurality of the liquid refrigerant branch pipes 24 are branched from the liquid refrigerant pipe 23 and connected to the indoor unit electric expansion valves 61 in the indoor units 'C'.

**[0045]** Referring to FIG. 1, the return branch pipes 25 are branched from respective gas refrigerant branch pipes 22, and the return pipe 26 joins the return branch pipes 25 branched from the gas refrigerant branch pipes 22 into one and connects to the suction pipe 5 in the outdoor unit 'A'.

**[0046]** Referring to FIG. 1, the distributor bypass pipe 27 is provided such that the low part of the gas-liquid separator 40 and the return pipe 26 are connected, and there is a ninth solenoid valve 32 on the distributor by-

pass pipe 27.

**[0047]** The valve part 30 serves to control refrigerant flow in the distributor piping 20 such that gas or liquid refrigerant is introduced into the indoor units 'C' selectively depending on different operation conditions of cooling all rooms, heating all rooms, a major number of rooms are cooled and a minor number of rooms are heated, a major number of rooms are heated and a minor number of rooms are cooled, and the gas or liquid refrigerant passed through the indoor units 'C' is re-introduced into the outdoor unit 'A'.

**[0048]** Referring to FIG. 1, the valve part 30 includes the gas refrigerant branch pipes 22, the liquid refrigerant branch pipes 24, and a plurality of on/off control valves 31; 31a, 31b and 31c provided to the return pipes 25. Of the plurality of on/off control valves 31, the on/off control valve on the return branch pipe 25 on an indoor unit side which heats the room and the on/off control valve on the liquid refrigerant branch pipe 22 on an indoor unit side which heat the room only are controlled to be closed, of which detailed control depending on different operation conditions will be described, later.

**[0049]** Next, the indoor unit 'C' is installed in each room, and includes the indoor unit heat exchanger 62, the indoor unit electric expansion valve 61, and an indoor unit fan (not shown).

**[0050]** The indoor unit heat exchangers 62 are respectively connected to the gas refrigerant branch pipes 22 in the distributor 'B', and the indoor unit electric expansion valves 61 are respectively connected to the liquid refrigerant branch pipes 24 in the distributor. The indoor unit heat exchangers 62 and the indoor unit electric expansion valves 61 are respectively connected with refrigerant pipes.

**[0051]** The indoor unit fan respectively blow air to the indoor unit heat exchangers 62.

**[0052]** In the meantime, referring to FIG. 4, the multi-unit air conditioner of the present invention may have a different flow control valve system provided to the indoor unit 'A'. Another preferred embodiment of the present invention will be described with reference to FIG. 4 focused on the flow control valve. For reference, parts identical to the first embodiment of the present invention described with reference to FIG. 1 will be given the same names.

**[0053]** Referring to FIG. 4, the flow control valve for controlling refrigerant flow in the outdoor unit 'A' includes two three way valves 17a and 17b and two solenoid valves 17c and 17d.

**[0054]** The first three way valve 17a is provided to a point the discharge pipe 3 and the first bypass pipe 11 meet, and the second three way valve 17b is provided to a point the suction pipe 5 and the third bypass pipe 13 meet.

**[0055]** The seventh solenoid valve 17c is provided on the outflow pipe 4 between a point the first bypass pipe 11 is connected, and a point the third bypass pipe 13 is connected, and the eighth solenoid valve 17d is provided

ed on the second bypass pipe 12.

**[0056]** The two three way valves 17a and 17b and the two solenoid valves 17c and 17d are controlled as follows.

**[0057]** The first three way valve 17a is controlled such that the refrigerant is lead toward the outdoor unit heat exchanger 2 in the operations all the rooms are cooled, and a major number of rooms are cooled, and a minor number of rooms are heated, and toward the first bypass pipe 11 in the operations all the rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled. The second three way valve 17d is controlled such that the refrigerant is lead toward the compressor 1 in the operations all the rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and toward the third bypass pipe 13 in the operations all the rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled. The seventh solenoid valve 17c is controlled such that the seventh solenoid valve 17c is opened in the operations all the rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and closed in the operations all the rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled. The eighth solenoid valve 17d is controlled such that the eighth solenoid valve 17d is closed in the operations all the rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and opened in the operations all the rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

**[0058]** In the meantime, the multi-unit air conditioner of the present invention may further includes control means for controlling a rotational speed of the outdoor unit fan 2a.

**[0059]** The control means includes a temperature sensor 16 and a microcomputer (not shown), for controlling to vary the rotational speed of the outdoor unit fan 2a such that a gas-liquid mixture ratio of the refrigerant lead to the gas-liquid separator 40 through the outdoor heat exchanger 2 is appropriate to the different operation conditions.

**[0060]** Referring to FIG. 1, the temperature sensor 16 is provided on the outflow pipe 4, for measuring a temperature of refrigerant flowing in the outflow pipe 4 after being discharged from the outdoor unit heat exchanger 2.

**[0061]** The microcomputer compares a refrigerant temperature measured at the temperature sensor 16 and a preset refrigerant temperature to detect the gas-liquid mixture ratio of the refrigerant flowing inside of the outflow pipe 4, and controls to vary the rotational speed of the outdoor unit fan 2a such that the detected gas-liquid mixture ratio is the same with the preset gas-liquid mixture ratio required for different operation conditions.

**[0062]** The foregoing multi-unit air conditioner is op-

erative such that, after the gas refrigerant discharged from the compressor 1 is lead to the distributor 'B' directly through the first bypass pipe 11, or lead to the gas-liquid separator 40 in the distributor 'B' via the outdoor unit heat exchanger 2 depending on the different operation conditions, and the liquid refrigerant separated at, and discharged from the gas-liquid separator 40 is lead to the compressor 1 after passed through indoor unit electric expansion valve and the indoor unit heat exchanger of the indoor unit, which cools the room, and the distributor 'B', and the gas refrigerant separated at, and discharged from the gas-liquid separator 40 is lead to the compressor 1 through the second bypass pipe 12 after passed through the indoor unit heat exchanger and the indoor unit electric expansion valve of the indoor unit, which heats the room, the gas-liquid separator 40 in the distributor 'B', and the outdoor unit electric expansion valve 15a and the outdoor unit heat exchanger 2 in the outdoor unit 'A', of which detailed operation will be described for the different operation conditions. For convenience of description, it is assumed that two indoor units C1 and C2 cool the rooms and the third one C3 heats the room in the operation a major number of rooms are cooled and a minor number of rooms are heated, and two indoor units C1 and C2 heat the rooms and the third one C3 cools the room in the operation a major number of rooms are heated and a minor number of rooms are cooled.

**[0063]** FIG. 2A illustrates a circuit diagram showing an operation state of the multi-unit air conditioner in FIG. 1 when all rooms are cooled, wherein the operation condition of cooling all rooms has a circulation path in which the entire refrigerant discharged from the compressor 1 is lead to the compressor 1 after passed through the outdoor unit heat exchanger 2, the distributor 'B', the indoor unit electric expansion valve 61, the indoor unit heat exchanger 62, and the distributor 'B' in succession, of which details are as follows. HHHH

**[0064]** Referring to FIG. 2A, the gas refrigerant discharged from the compressor 1 is lead into the outdoor unit heat exchanger 2 through the discharge pipe 3. In this instance, for guiding the gas refrigerant toward the outdoor unit heat exchanger 2, the first solenoid valve 3a is opened, and the fourth solenoid valve 11a on the first bypass pipe 11 and the fifth solenoid valve 12a on the second bypass pipe 12 are closed.

**[0065]** The refrigerant lead to the outdoor unit heat exchanger 2 makes heat exchange with external air blown from the outdoor unit fan 2a controlled by the control means, until supercooled into a liquid state, passes through the check valve 14 as it flows through the outflow pipe 4, and lead to the gas-liquid separator 40. In this instance, the outdoor unit heat exchanger 2 serves as a condenser, and the outdoor unit electric expansion valve on the parallel pipe 13 is closed, fully.

**[0066]** The high pressure liquid refrigerant introduced into the gas-liquid separator 40 in the distributor passes through the liquid refrigerant pipe 23 and divided and

introduced into the liquid refrigerant branch pipes 24. The liquid refrigerant introduced into the liquid refrigerant branch pipes 24 is introduced into the indoor units 'C' after passed through the on/off control valves on the liquid refrigerant branch pipes 24, respectively.

**[0067]** The liquid refrigerant introduced into the indoor unit 'C' is expanded at the expansion valve 61, cools down the room as the refrigerant vaporizes at the indoor unit heat exchanger 62 and makes heat exchange with room air, and introduced into the gas refrigerant branch pipe 22. In this instance, the indoor unit heat exchanger 62 serves as a vaporizer.

**[0068]** The gas refrigerant introduced into the gas refrigerant branch pipe 22 is introduced into the return pipe 26 through the return branch pipe 25. In this instance, for guiding the gas refrigerant toward the return branch pipe 25, the on/off control valve on the gas refrigerant branch pipe 22 is closed. The gas refrigerant introduced into the return pipe 26 is introduced into the compressor 1 via the suction pipe 5 and the accumulator 19. In this instance, for guiding the refrigerant introduced into the suction pipe 5 toward the accumulator 19, the sixth solenoid valve 13a on the third bypass pipe 13 is closed.

**[0069]** FIG. 2B illustrates a circuit diagram showing an operation state of the multi-unit air conditioner when all rooms are heated, wherein the operation condition of heating all rooms has a circulation path in which entire refrigerant discharged from the compressor 1 is introduced into the compressor 1 through the second bypass pipe 12 after passing through the first bypass pipe 11, the distributor 'B', the indoor unit heat exchanger 62, the indoor unit electric expansion valve 61, the distributor 'B', the bypass pipe 13, the outdoor unit electric expansion valve 15a, and the outdoor unit heat exchanger 2 in succession, of which detail is as follows.

**[0070]** Referring to FIG. 2B, the gas refrigerant discharged from the compressor 1 moves through the discharge pipe 4 toward the outflow pipe 4 through the first bypass pipe 11 as the first solenoid valve 3a is closed. In this instance, the fourth solenoid valve 11a is opened.

**[0071]** The gas refrigerant introduced into the outflow pipe 4 moves toward the gas-liquid separator 40 in the distributor 'B' as flow toward the outdoor unit heat exchanger 2 is blocked with the closed third solenoid valve 4a.

**[0072]** The gas refrigerant introduced into the gas-liquid separator 40 is introduced into the gas refrigerant branch pipes 22 via the gas refrigerant pipe 21, and, therefrom to the indoor unit heat exchangers 62 in the indoor unit 'C' as the on/off control valves on the return branch pipes 25 are closed.

**[0073]** The gas refrigerant introduced into the indoor unit heat exchanger 62 makes heat exchange with the air blown from the indoor unit fan, to discharge condensing heat and heat the room, when the indoor unit heat exchanger 62 serves as a condenser.

**[0074]** The liquid refrigerant supercooled and condensed at the indoor unit heat exchanger 62 passes

through the electric expansion valve 61 opened fully, and is introduced into the gas-liquid separator 40 in the outdoor unit 'B' through the liquid refrigerant branch pipe 24, and the liquid refrigerant pipe 23.

**[0075]** The liquid refrigerant introduced into the gas-liquid separator 40 is discharged to the distributor bypass pipe 27, and introduced into the suction pipe 5 in the outdoor unit 'A' via the return pipe 26. Of course, in this instance, for guiding the refrigerant, the ninth solenoid valve 32 is opened, and all the on/off control valves 31 on respective return branch pipes 25 are closed as shown in FIG. 2B.

**[0076]** The refrigerant introduced into the suction pipe 5 is guided to the third bypass pipe 13 by the second solenoid valve 5a, guided to the parallel pipe 15 by the check valve 14, expanded at the outdoor unit electric expansion valve 15a, and makes heat exchange and vaporizes at the outdoor unit heat exchanger 2. In this instance, the outdoor unit heat exchanger 2 serves as an evaporator.

**[0077]** The liquid refrigerant supercooled and condensed at the outdoor unit heat exchanger 2 is guided to the second bypass pipe 12 through the discharge pipe 4 as the first solenoid valve 3a is closed, and introduced into the compressor 1 via the second bypass pipe 12, the suction pipe 5 and the accumulator 19.

**[0078]** FIG. 3A illustrates a circuit diagram showing an operation state of the multi-unit air conditioner in FIG. 1 when a major number of the rooms are cooled and a minor number of rooms are heated, wherein the operation condition of cooling a major number of rooms and heating a minor number of rooms has a circulation path in which entire refrigerant discharged from the compressor 1 is introduced into the outdoor unit heat exchanger 2 and the gas-liquid separator 40 in the distributor 'B', wherefrom the liquid refrigerant separated at the gas-liquid separator 40 is introduced into the compressor 1 after passed through the indoor unit electric expansion valves 61a and 61b, the indoor unit heat exchangers 62a and 62b in the indoor units C1 and C2 which cool the room, the distributor 'B', suction pipe 5 in succession, and gas refrigerant separated at the gas-liquid separator 40 is introduced into the compressor 1 through the indoor unit heat exchanger 62c and the electric expansion valve 61c in the indoor unit C3 which heats the room, joined with the liquid refrigerant in the distributor 'B', and passed through the electric expansion valves 61a and 61b, and the indoor unit-heat exchangers 62a and 62b which cool the rooms, the distributor 'B', and the suction pipe 5, of which detail is as follows.

**[0079]** Referring to FIG. 3A, the gas refrigerant discharged from the compressor 1 is introduced into the outdoor unit heat exchanger 2 through the discharge pipe 3, when, for guidance of the gas refrigerant, the first solenoid valve 3a is opened, and the fourth solenoid valve 11a on the first bypass pipe 11 and the fifth solenoid valve 12a on the second bypass pipe 12 are closed.

**[0080]** In the meantime, the gas refrigerant introduced into the outdoor unit heat exchanger 2 makes heat exchange with external air blown from the outdoor unit fan 2a, to have a gas-liquid mixture ratio suitable for operation for cooling a major number of the rooms and heating a minor number of rooms. That is, if a large amount of external air is blown to the outdoor unit heat exchanger 2 owing to a high rotational speed of the outdoor unit fan 2a, a liquid ratio in the refrigerant becomes high, and if a small amount of external air is blown to the outdoor unit heat exchanger 2 owing to a low rotational speed of the outdoor unit fan 2a, a gas ratio in the refrigerant becomes high. The present invention suggests to control the rotational speed of the outdoor unit fan 2a by control means, for obtaining an optimal gas-liquid mixture ratio required for an operation for cooling a major number of the rooms and heating a minor number of rooms.

**[0081]** A method for controlling operation of an outdoor unit fan in an air conditioner of the present invention for obtaining the optimal gas-liquid mixture ratio is as follows.

**[0082]** A temperature of the gas-liquid mixture refrigerant discharged from the outdoor unit heat exchanger 2 is measured at the temperature sensor 16 on the out-flow pipe 4.

**[0083]** Then, a refrigerant temperature measured at the temperature sensor 16 and a preset refrigerant temperature are compared, to detect the gas-liquid mixture ratio of the refrigerant.

**[0084]** Next, the rotational speed of the outdoor unit fan 2a is changed such that the detected gas-liquid mixture ratio of the refrigerant is identical to the preset mixture ratio required for the intended operation condition; cooling a major number of rooms and heating a minor number of rooms.

**[0085]** Once the control means changes the rotational speed of the outdoor unit fan 2a by above method, the multi-unit air conditioner of the present invention can optimize the gas-liquid mixture ratio of the refrigerant under all conditions, thereby improving cooling/heating efficiencies.

**[0086]** When the control means controls the outdoor unit fan 2a by above method, the refrigerant mixture ratios set at the microcomputer of the control means are experimental values fixed from tests under different load conditions, such as suitable to the two cooling side indoor units C1 and C2 which require liquid refrigerant and the one heating indoor unit C3 which requires gas refrigerant, or suitable to a flow rate of the liquid refrigerant introduced into the two cooling side indoor units C1 and C2 through the one heating indoor unit C3, or the like.

**[0087]** The control of the outdoor unit fan 2a carried out thus is applicable to operation conditions for cooling all rooms, and heating a major number of rooms and cooling a minor number of rooms.

**[0088]** In the meantime, the two phased refrigerant mixed at an optimal gas-liquid mixture ratio at the out-

door unit heat exchanger 2 is introduced into the gas-liquid separator 3 in the distributor 'B' through the outflow pipe 4. For guiding the refrigerant thus, the outdoor unit electric expansion valve 15a on the parallel pipe 13 is closed fully, and the third solenoid valve 4a is opened.

[0089] The high pressure two phased refrigerant introduced into the gas-liquid separator 40 is separated into liquid refrigerant and gas refrigerant, wherein the liquid refrigerant is introduced into the liquid refrigerant pipe 23 and the gas refrigerant is introduced into the gas refrigerant pipe 21.

[0090] The liquid refrigerant introduced into the liquid refrigerant pipe 23 is divided into the first liquid refrigerant branch pipe 24a and the second liquid refrigerant branch pipe 24b, expanded as the liquid refrigerant passes through the first indoor unit electric expansion valve 61a and the second indoor unit electric expansion valve 61b, and makes heat exchange as the refrigerant passes through the first indoor unit heat exchanger 62a and the second indoor unit heat exchanger 62b, to cool down the rooms.

[0091] The gas refrigerant, vaporized at the first indoor unit heat exchanger 62a and the second indoor unit heat exchanger 62b while cooling down the rooms, is introduced into the return pipe 26 through the first gas refrigerant branch pipe 22a and the second gas refrigerant branch pipe 22b, and the first return branch pipe 25a and the second return branch pipe 25b. In this instance, for guiding the gas refrigerant, the on/off control valves 31a and 31b on the first gas refrigerant branch pipe 22a and the second gas refrigerant branch pipe 22b and the on/off control valve on the third connection branch pipe 25c on the third indoor unit C3 are closed. The gas refrigerant introduced into the return pipe 26 is introduced into the compressor 1 through the suction pipe 5 and the accumulator 19. In this instance, for guiding the refrigerant, the sixth solenoid valve 13a on the third bypass pipe 13 are closed.

[0092] In the meantime, entire gas refrigerant, separated at the gas-liquid separator 40 and introduced into the gas refrigerant pipes 21, is introduced into the third gas refrigerant branch pipe 22c on an indoor unit C3 side as the on/off control valves 31a and 31b on the first gas refrigerant branch pipe 22a and the second gas refrigerant branch pipe 22b are closed.

[0093] The gas refrigerant introduced into the third gas refrigerant branch pipe 22c is introduced into the third indoor unit heat exchanger 62c, and makes heat exchange to discharge heat as the gas refrigerant is condensed, to heat the room as the on/off control valve on the third return branch pipe 25c is closed, then introduced into the third liquid refrigerant branch pipe 24c through the third electric expansion valve 61c, and joined with the liquid refrigerant flowing in the liquid refrigerant pipe 23. After the joining, the refrigerant is introduced into the indoor units C1 and C2, which cool the rooms, cool respective rooms, and introduced into the compressor 1.

[0094] In this instance, the liquid refrigerant introduced into the liquid refrigerant pipe 23 is introduced, not to the third indoor unit C3 side, but only to the sides of the first indoor unit C1 and the second indoor unit C2 owing to a pressure difference of the refrigerant. That is, it is because a pressure of the refrigerant from the third liquid refrigerant branch pipe 24c is higher than a pressure of the refrigerant flowing toward the first liquid refrigerant branch pipe 24a and the second refrigerant branch pipe 24b.

[0095] FIG. 3B illustrates a circuit diagram showing an operation state of the multi-unit air conditioner when a major number of rooms are heated and a minor number of rooms are cooled, wherein the operation condition of heating a major number of rooms and cooling a minor number of rooms has a circulation path in which entire refrigerant discharged from the compressor 1 is introduced into the distributor 'B' through the first bypass pipe 11, and, therefrom, re-introduced into the distributor 'B' via the indoor unit heat exchangers 62a and 62b and the indoor unit electric expansion valves 61a and 61b in the indoor units C1 and C2, which heat the rooms, and a portion of which refrigerant is introduced into the compressor 1 via the indoor unit electric expansion valve 61c and the indoor unit heat exchanger 62c of the indoor unit C3, which cools the room, and the distributor 'B', and the other portion of which refrigerant is introduced into the compressor 1 via the gas-liquid separator 40, the distributor bypass pipe 27, the return pipe 26, the suction pipe 5, the third bypass pipe 13, the outdoor unit electric expansion valve 15a, and the outdoor unit heat exchanger 2, and through the second bypass pipe 12, of which detail is as follows.

[0096] Referring to FIG. 3B, the gas refrigerant discharged from the compressor 1 is guided to the first bypass pipe 11 by the closed first solenoid valve 3a through the discharge pipe 3, and introduced into the outflow pipe 4.

[0097] The gas refrigerant introduced into the outflow pipe 4 is introduced into the gas-liquid separator 40 in the distributor 'B' by blocking of the third solenoid valve 4a, introduced into and condensed at the first indoor unit heat exchanger 62a and the second indoor unit heat exchanger 62b through the first gas refrigerant branch pipe 22a and the second gas refrigerant branch pipe 22b, and introduced into the first liquid refrigerant branch pipe 24a and the second refrigerant branch pipe 24b via the first indoor unit electric expansion valve 61a and the second indoor unit electric expansion valve 61b. In this instance, the first indoor unit electric expansion valve 61a and the second indoor unit electric expansion valve 61b are fully opened.

[0098] The liquid refrigerant introduced into the first liquid refrigerant branch pipe 24a and the second refrigerant branch pipe 24b is introduced into the liquid refrigerant connection pipe 23, and a portion of the liquid refrigerant is branched toward the gas-liquid separator 40, and the other portion thereof is branched toward the

third liquid refrigerant branch pipe 24c.

**[0099]** In this instance, the portion of liquid refrigerant branched to, and flowing in the gas-liquid separator 40 is introduced into the suction pipe 5 via the third bypass pipe 13 and the return pipe 26. The refrigerant introduced into the suction pipe 5 is introduced into the third bypass pipe 13 by the guide of the closed second solenoid valve 5a, and expands as it passes through the outdoor unit electric expansion valve 15a on the parallel pipe 15 by the blocking of flow of the check valve 14 and the third solenoid valve 4a, and introduced into the compressor 1 through the outdoor heat exchanger 2, the second bypass pipe 12, and the suction pipe 5.

**[0100]** The other portion of the liquid refrigerant branch to, and flowing in the third liquid refrigerant branch pipe 24c passes and expands through the third indoor unit electric expansion valve 61c, makes heat exchange at the third indoor unit heat exchanger 62c and cools down the room. The gas refrigerant vaporized as the refrigerant cools the room passes the third gas refrigerant branch pipe 22c and the third return branch pipe 25c, joins with the return pipe 26 through the third gas refrigerant branch pipe 22c and the third return branch pipe 25c, and introduced into the compressor 1 through the suction pipe 5.

**[0101]** As described, the present invention, not only simply connects the outdoor unit 'A' and the distributor 'B' with only two line of piping, but also specifically defines the two line of piping as a high pressure section HP in which the high pressure refrigerant flows and a low pressure section LP in which the low pressure refrigerant flows regardless of operation condition owing to the unique connection of the outdoor unit piping and the bypass piping. The high pressure section in which a high pressure is always maintained regardless of the operation condition is specifically defined as a section between the first bypass pipe 11 and the gas-liquid separator 40 of the outflow pipe 4 as shown in FIGS. 1 ~ 4, and the low pressure section in which a low pressure is always maintained regardless of the operation condition is specifically defined as a section between the distributor 'B' and the third bypass pipe 13 of the suction pipe 5.

**[0102]** The foregoing description of operation of the multi-unit air conditioner of the present invention is on one preferred embodiment of the present invention of which flow control valves include six solenoid valves 3a, 5a, 4a, 11a, 12a, and 13a shown in FIG. 1. However, as shown in FIG. 4, the present invention can be embodied as another embodiment of which flow control valves include two three way valves 17a and 17b and two solenoid valves 17c and 17d. Only the operation of the flow control valves when the another embodiment of the present invention shown in FIG. 4 is operated will be described hereafter because the another embodiment of the present invention shown in FIG. 4 is identical to the one preferred embodiment of the present invention shown in FIG. 1 except the system of the flow control

valves.

**[0103]** In the operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, the first three way valve 17a is controlled such that entire refrigerant from the compressor 1 is introduced into the outdoor unit heat exchanger 2 through the discharge pipe 3. The second three way valve 17b is controlled such that entire refrigerant from the distributor 'B' to the suction pipe 5 is introduced into the compressor 1. Along with this, the seventh solenoid valve 17c is opened, and the eighth solenoid valve 17d is closed.

**[0104]** In the operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled, the first three way valve 17a is controlled such that entire refrigerant from the compressor 1 is introduced into the first bypass pipe 11. The second three way valve 17b is controlled such that entire refrigerant from the distributor 'B' to the suction pipe 5 is introduced into the third bypass pipe 13. Along with this, the seventh solenoid valve 17c is closed, and the eighth solenoid valve 17d is opened.

**[0105]** Meanwhile, the foregoing another embodiment of the present invention has a reduced number of components and, therefore, is easy to fabricate.

**[0106]** The present invention having the foregoing system and operative thus has the following advantages.

**[0107]** First, optimal dealing with individual room environments are made available by the multi-unit air conditioner of the present invention. That is, not only the all room heating operation and the all room cooling operation, but also an operation a major number of rooms are heated and a minor number of rooms are cooled, and an operation a major number of rooms are cooled and a minor number of rooms are heated, when the rooms are selectively heated or cooled, are made available, thereby permitting to deal with individual room environments.

**[0108]** Second, the specifically defined two line of piping between the distributor and the outdoor unit as the high pressure section in which only high pressure refrigerant flows and the low pressure section in which only low pressure refrigerant flows regardless of operation conditions permits to reduce variation of a specific volume of refrigerant, that improves an efficiency of air conditioning.

**[0109]** Third, the only two line of piping between the distributor and the outdoor unit permits an easy installation at site.

**[0110]** Fourth, the optimization of the mixture ratio of the refrigerant introduced into the gas-liquid separator in the operations of cooling all rooms, and cooling a major number of rooms and heating a minor number of rooms improves an air conditioning efficiency.

**[0111]** Fifth, the product cost is reduced because the distributor is provided with many inexpensive and simple on/off valves.

[0112] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

[0113] Summarized, the present invention provides a multi-unit air conditioner for independent cooling/heating of each room including an outdoor unit, a distributor and a plurality of indoor units, wherein the outdoor unit and the distributor are connected with two piping specifically defined as a high pressure section and a low pressure section. The outdoor unit includes an outdoor unit piping for connecting different elements, a bypass piping for bypassing refrigerant depending on operation a condition, and a plurality of refrigerant flow control valves for controlling a refrigerant flow. The distributor includes a gas-liquid separator for separating the refrigerant into gas refrigerant and liquid refrigerant, for selectively leading refrigerant from the outdoor unit to a plurality of indoor units according to different operation conditions for independent cooling and heating of each room. Method for controlling operation of an outdoor unit fan in a multi-unit air conditioner includes the steps of measuring a temperature of gas-liquid mixture refrigerant from an outdoor unit heat exchanger, comparing a measured refrigerant temperature and a preset refrigerant temperature, to detect a gas-refrigerant mixture ratio of the refrigerant, and varying a rotational speed of an outdoor unit fan so that a detected gas-liquid mixture ratio is identical to a preset gas-liquid mixture ratio required for an intended operation condition.

## Claims

### 1. A multi-unit air conditioner comprising:

an outdoor unit (A) including:

an accumulator (19), a compressor (1), and an outdoor heat exchanger (2) connected in series with an outdoor unit piping;

an outdoor unit electric expansion valve (15a) in parallel to the outdoor unit piping on an outlet side of the outdoor unit heat exchanger (2);

a bypass piping (11,12,13) for bypassing refrigerant from the compressor (1) to outside of the outdoor unit (A), refrigerant from an outside of the outdoor unit (A) toward the outdoor unit electric expansion valve (15a), and refrigerant introduced into an outlet side of the compressor (1) to an inlet side of the compressor (1); and

a plurality of refrigerant flow control valves (3a;4a;5a;11a;12a;13a;17a;17b;17c;17d) on the outdoor unit piping and the bypass piping for controlling flow of the refrigerant;

an indoor unit (C1,C2,C3) in each of rooms each including an indoor unit heat exchanger (62) and an indoor unit electric expansion valve (61); and

a distributor including a gas-liquid separator (40) for separating refrigerant from the outdoor unit (A) into gas refrigerant and liquid refrigerant, for leading the gas refrigerant to the indoor unit heat exchanger (62) of the indoor unit (C) which heats the room, the liquid refrigerant to the indoor unit electric expansion valve (61) of the indoor unit (C) which cools the room, and the refrigerant passed through the indoor units (C) to the outdoor unit (A), wherein, if cooling and heating are carried out for each rooms individually, the refrigerant liquefied as the refrigerant passes through the indoor unit (C) which heats the room is made to be re-introduced into the electric expansion valve (61) of the indoor unit (C) which cools the room before leading to the outdoor unit (A).

2. The multi-unit air conditioner as claimed in claim 1, further comprising controlling means for controlling a rotational speed of an outdoor unit fan (2a) so that a gas-liquid mixture ratio of the refrigerant introduced into the gas-liquid separator (40) through the outdoor unit heat exchanger (2) is regulated suitable for different operation conditions.

3. The multi-unit air conditioner as claimed in claim 2, wherein the controlling means includes; a temperature sensor (16) provided on the outdoor unit piping on a side of the outdoor unit heat exchanger (2) for measuring a temperature of the refrigerant from the outdoor unit heat exchanger; and a microcomputer for comparing a refrigerant temperature measured at the temperature sensor (16) and a preset refrigerant temperature to detect a refrigerant mixture ratio in the piping, and controlling a rotational speed of the outdoor fan (2a) for making the detected mixture ratio to be identical to a preset mixture ratio required for an intended operation condition.

4. The multi-unit air conditioner as claimed in one of claims 1 to 3, wherein the outdoor unit piping includes:

a discharge pipe (3) connected between an out-

let of the compressor (1) and an inlet of the outdoor unit heat exchanger (2);

an outflow pipe (4) connected between an outlet of the outdoor unit heat exchanger (2) and an inlet of the gas-liquid separator (40); and

a suction pipe (5) connected between an outlet of the distributor (40) and an inlet of the compressor (1).

5. The multi-unit air conditioner as claimed in claim 4, wherein the bypass piping includes:

a first bypass pipe (11) connected between the discharge pipe (3) and the outflow pipe (4);

a second bypass pipe (12) connected between a part of the discharge pipe (3) between the first bypass pipe (11) and the outdoor unit heat exchanger (2) and the suction pipe (5); and

a third bypass pipe (13) connected between a part of the outflow pipe (4) between the outdoor unit heat exchanger (2) and the first bypass pipe (11) and a part of the suction pipe (5) between the second bypass pipe (12) and an outlet of the distributor (40).

6. The multi-unit air conditioner as claimed in claim 4 or 5, wherein the refrigerant flow control valves (3a; 4a; 5a; 11a; 12a; 13a) include:

a first on/off solenoid valve (3a) on the discharge pipe (3) between the first bypass pipe (12) and the second bypass pipe (13);

a second on/off solenoid valve (5a) on the suction pipe (5) between the second bypass pipe (11) and the third bypass pipe (12);

a third on/off solenoid valve (4a) on the outflow pipe (4) between the first bypass pipe (11) and the third bypass pipe (13);

a fourth on/off solenoid valve (11a) on the first bypass pipe (11);

a fifth on/off solenoid valve (12a) on the second bypass pipe (12);

a sixth on/off solenoid valve (13a) on the third bypass pipe (13); and

a check valve (14) on the outflow pipe (4) between the third bypass pipe (13) and the outdoor unit heat exchanger (2) for prevention of refrigerant flow in a direction from the third by-

pass pipe (13) to an outlet of the outdoor unit heat exchanger (2).

7. The multi-unit air conditioner as claimed in claim 6, wherein the first (3a), second (5a), and third (4a) on/off solenoid valves are opened in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and closed in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

8. The multi-unit air conditioner as claimed in claim 6 or 7, wherein the fourth (11a), fifth (12a), and sixth (13a) on/off solenoid valves are closed in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and opened in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

9. The multi-unit air conditioner as claimed in claim 5, wherein the refrigerant flow control valves include:

a first three way valve (17a) provided on a point the discharge pipe (3) and the first bypass pipe (11) join;

a second three way valve (17b) provided on a point the suction pipe (5) and the third bypass pipe (13) join;

a seventh on/off solenoid valve (17c) provided on a part of the outflow pipe (4) between the first bypass pipe (11) and the third bypass pipe (13);

an eighth on/off solenoid valve (17d) provided on a second bypass pipe (12); and

a check valve (14) on the outflow pipe (4) between the third bypass pipe (13) and the outdoor unit heat exchanger (2) for prevention of refrigerant flow in a direction from the third bypass pipe (13) to an outlet of the outdoor unit heat exchanger (2).

10. The multi-unit air conditioner as claimed in claim 9, wherein the first three way valve (17a) is controlled such that refrigerant is led to the outdoor unit heat exchanger (2) in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and led to the first bypass pipe (11) in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

11. The multi-unit air conditioner as claimed in claim 9

or 10, wherein the second three way valve (17b) is controlled such that refrigerant is led to the compressor (1) in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and led to the third bypass pipe (13) in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

12. The multi-unit air conditioner as claimed in one of claims 9 to 11, wherein the seventh on/off solenoid valve (17c) is opened in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and closed in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

13. The multi-unit air conditioner as claimed in one of claims 9 to 12, wherein the eighth on/off solenoid valve (17d) is closed in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and opened in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

14. The multi-unit air conditioner as claimed in one of claims 5 to 13, wherein the outdoor unit electric expansion valve (13a) is provided on the parallel pipe (15) provided on the outflow pipe (4) in parallel to the check valve (14).

15. The multi-unit air conditioner as claimed in claim 14, wherein the outdoor unit electric expansion valve (13a) is closed in operations all rooms are cooled, and a major number of rooms are cooled and a minor number of rooms are heated, and opened in operations all rooms are heated, and a major number of rooms are heated and a minor number of rooms are cooled.

16. The multi-unit air conditioner as claimed in one of claims 5 to 15, wherein the accumulator (19) is provided to a part of the suction pipe (5) between the second bypass pipe (12) and the compressor (1).

17. The multi-unit air conditioner as claimed in one of claims 5 to 16, wherein the distributor includes:

a gas-liquid separator (40) having the outflow pipe in the outdoor unit heat exchanger connected thereto;

a distributor piping (20) for guiding gas or liquid refrigerant separated at the gas-liquid separator (40) toward a side of the indoor units, and the refrigerant passed through the indoor units

to the outdoor unit again; and

a valve part (30) for controlling refrigerant flow in the distributor piping (20) according to a desired operation condition.

18. The multi-unit air conditioner as claimed in claim 17, wherein the distributor piping (20) includes:

a gas refrigerant pipe (21) for guiding gas refrigerant separated at the gas-liquid separator (40);

gas refrigerant branch pipes (22) each branched from the gas refrigerant pipe (21) and connected to the indoor unit heat exchanger (62a;62b;62c) of each indoor unit;

a liquid refrigerant pipe (23) for guiding liquid refrigerant separated at the gas-liquid separator (40);

liquid refrigerant branch pipes (24;24a;24b;24c) each branched from the liquid refrigerant pipe (23) and connected to the indoor unit electric expansion valve (61) on each indoor unit;

return branch pipes (25;25a;25b;25c) each branched from the gas refrigerant branch pipe (22);

a return pipe (26) having the return branch pipes (25;25a;25b;25c) joined together and connected to the suction pipe (5); and

a distributor bypass pipe (27) connected between a lower part of the gas-liquid separator (40) and the return pipe (26).

19. The multi-unit air conditioner as claimed in claim 17 or 18, wherein the valve part includes:

a plurality of on/off control valves (31;31a;31b) provided on the gas refrigerant branch pipes (22), the liquid refrigerant branch pipes (24;24a;24b;24c), and the return branch pipes (25;25a;25b;25c) and controlled; and

a ninth on/off solenoid valve (32) provided on the distributor bypass pipe (27) and controlled.

20. The multi-unit air conditioner as claimed in claim 19, wherein the distributor valve part is controlled such that the on/off control valve (32) provided on the refrigerant connection pipe (27) on a side of the indoor unit (C1,C2,C3) which heats the room and the on/off solenoid valve provided on the gas refrigerant branch pipe (22) on a side of the indoor unit

(C1,C2,C3) which cools the room, are only closed.

- 21.** A method for controlling operation of an outdoor unit fan (2a) in a multi-unit air conditioner comprising the steps of:

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measuring a temperature of gas-liquid mixture refrigerant from an outdoor unit heat exchanger (2);

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comparing a measured refrigerant temperature and a preset refrigerant temperature, to detect a gas-refrigerant mixture ratio of the refrigerant; and

15

varying a rotational speed of an outdoor unit fan (2a) so that a detected gas-liquid mixture ratio is identical to a preset gas-liquid mixture ratio required for an intended operation condition.

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FIG. 1

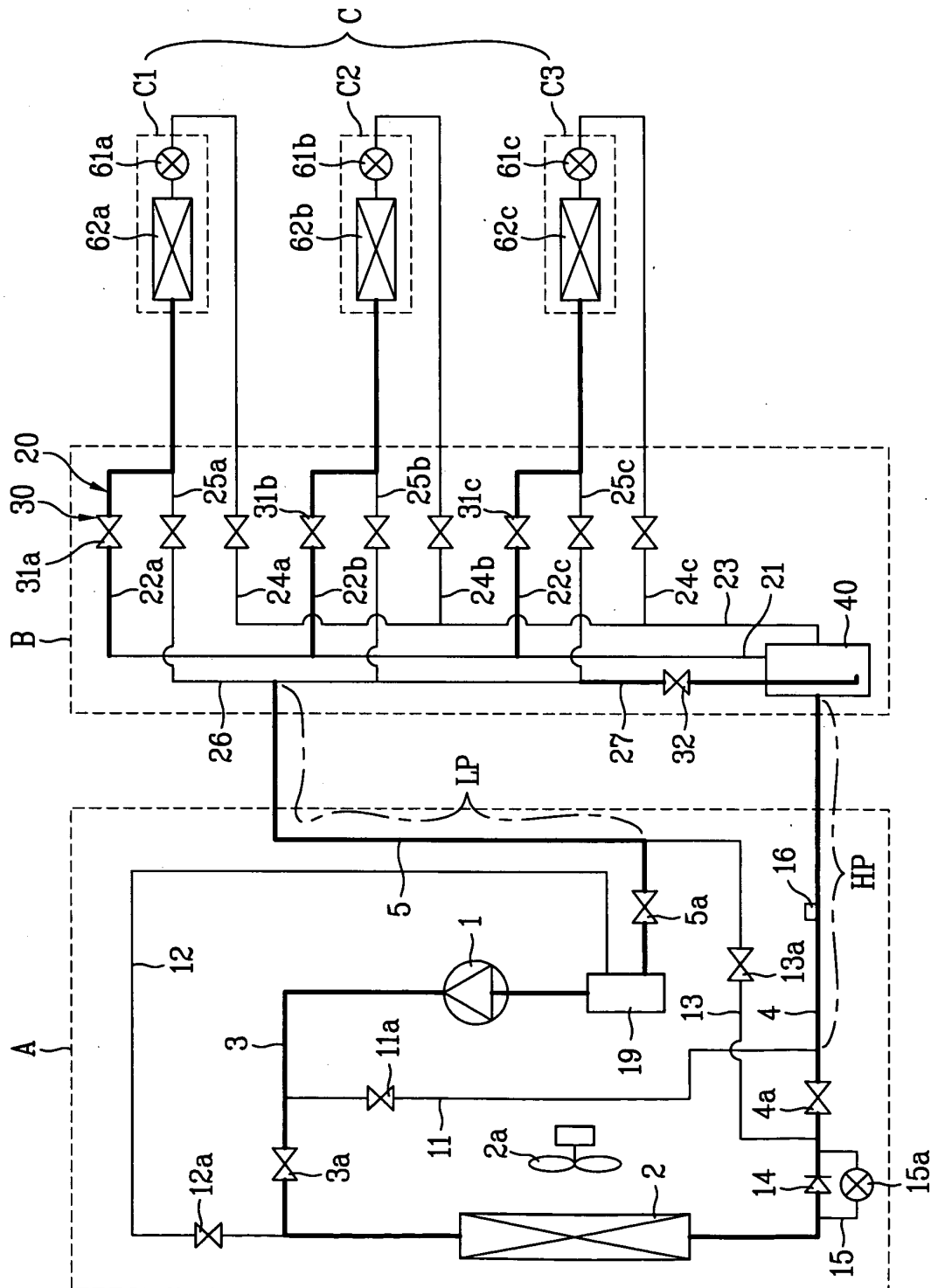


FIG. 2A

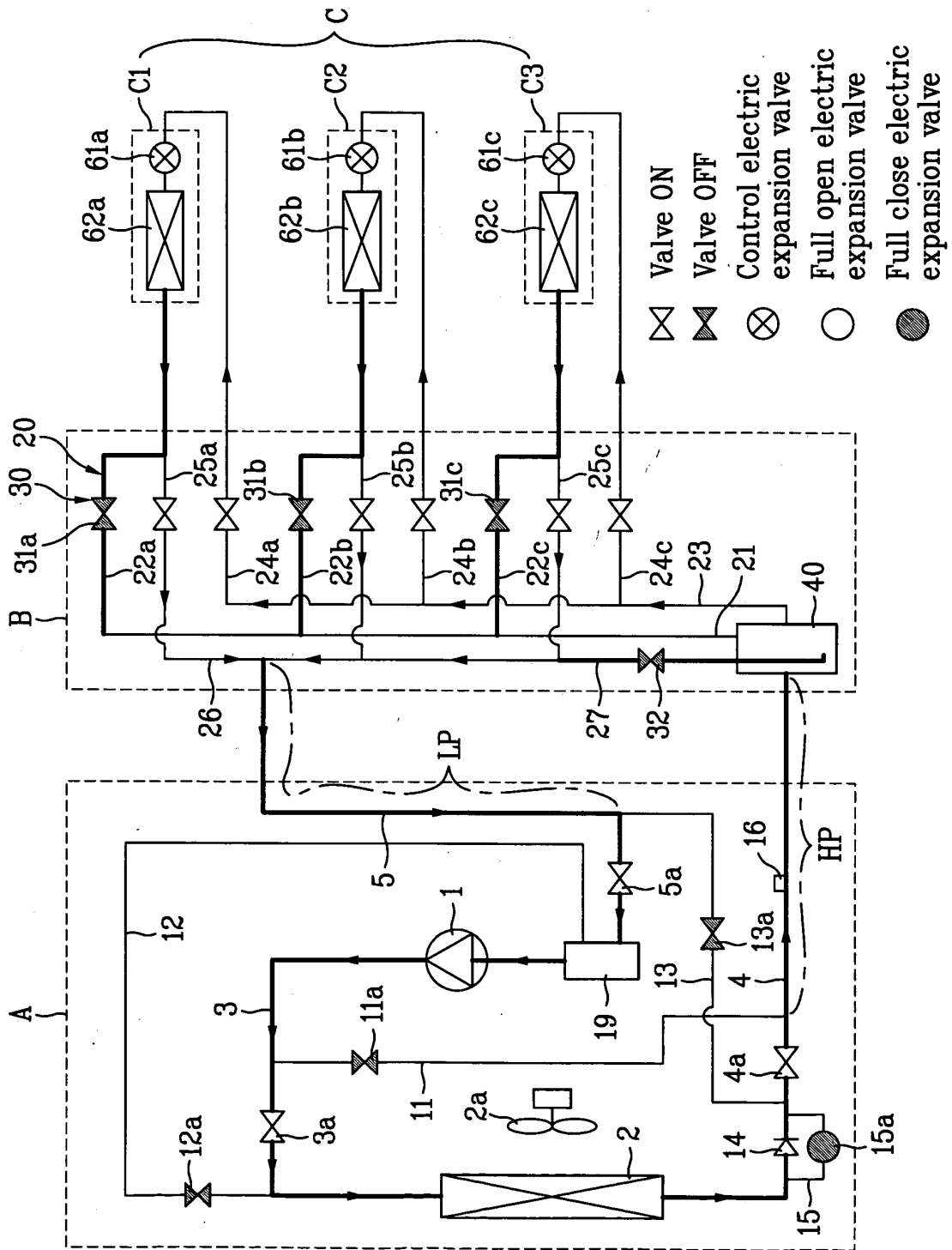


FIG. 2B

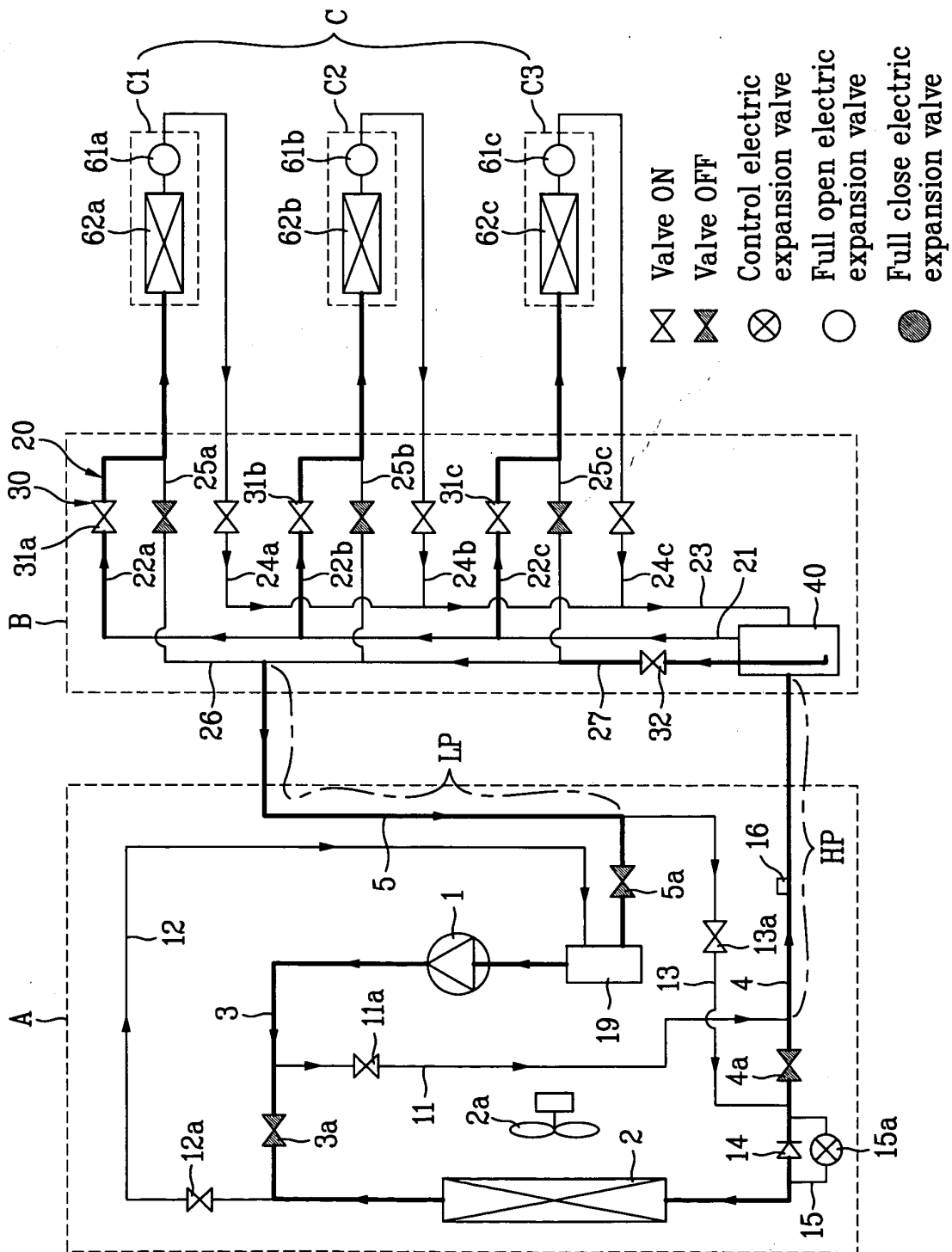


FIG. 3A

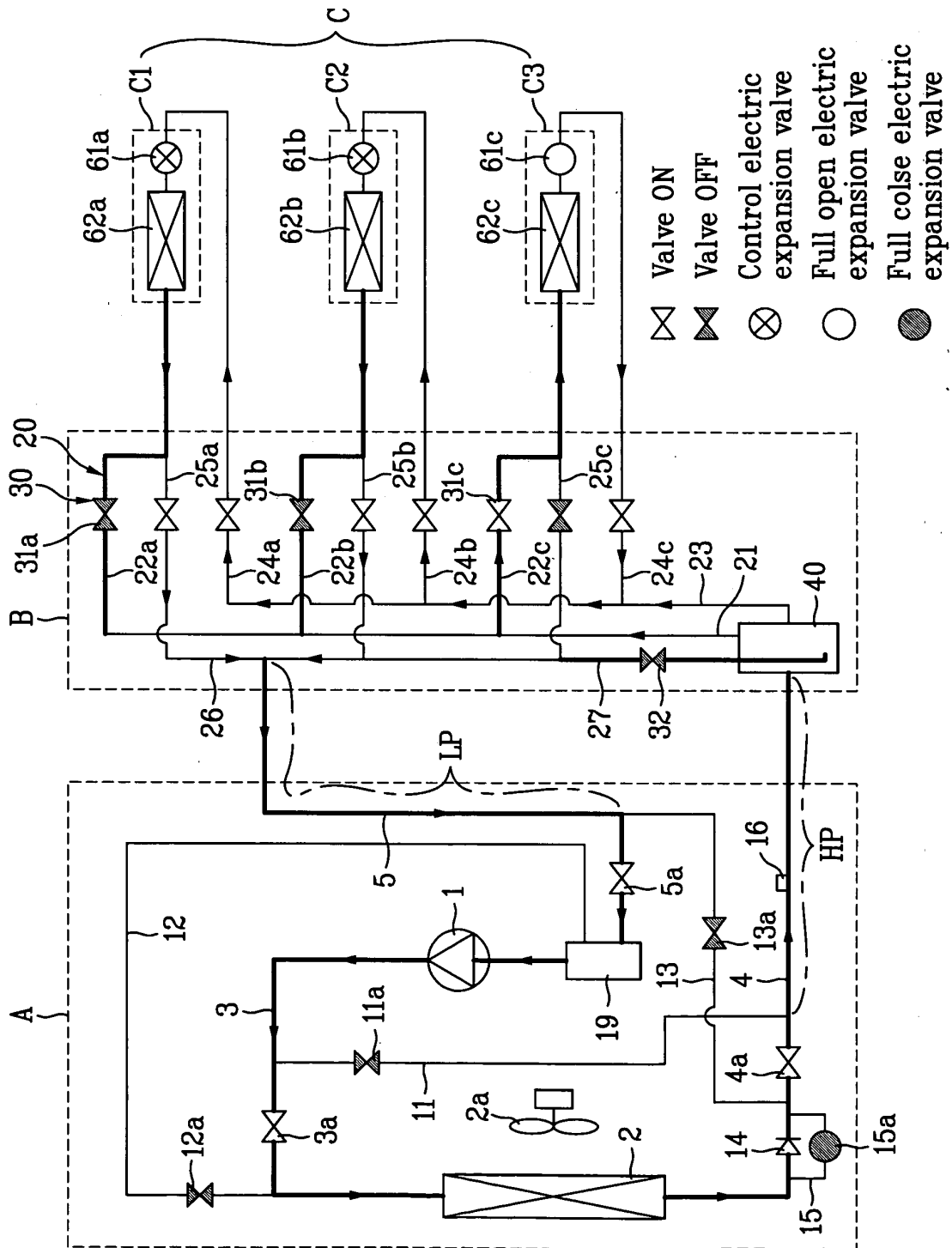


FIG. 3B

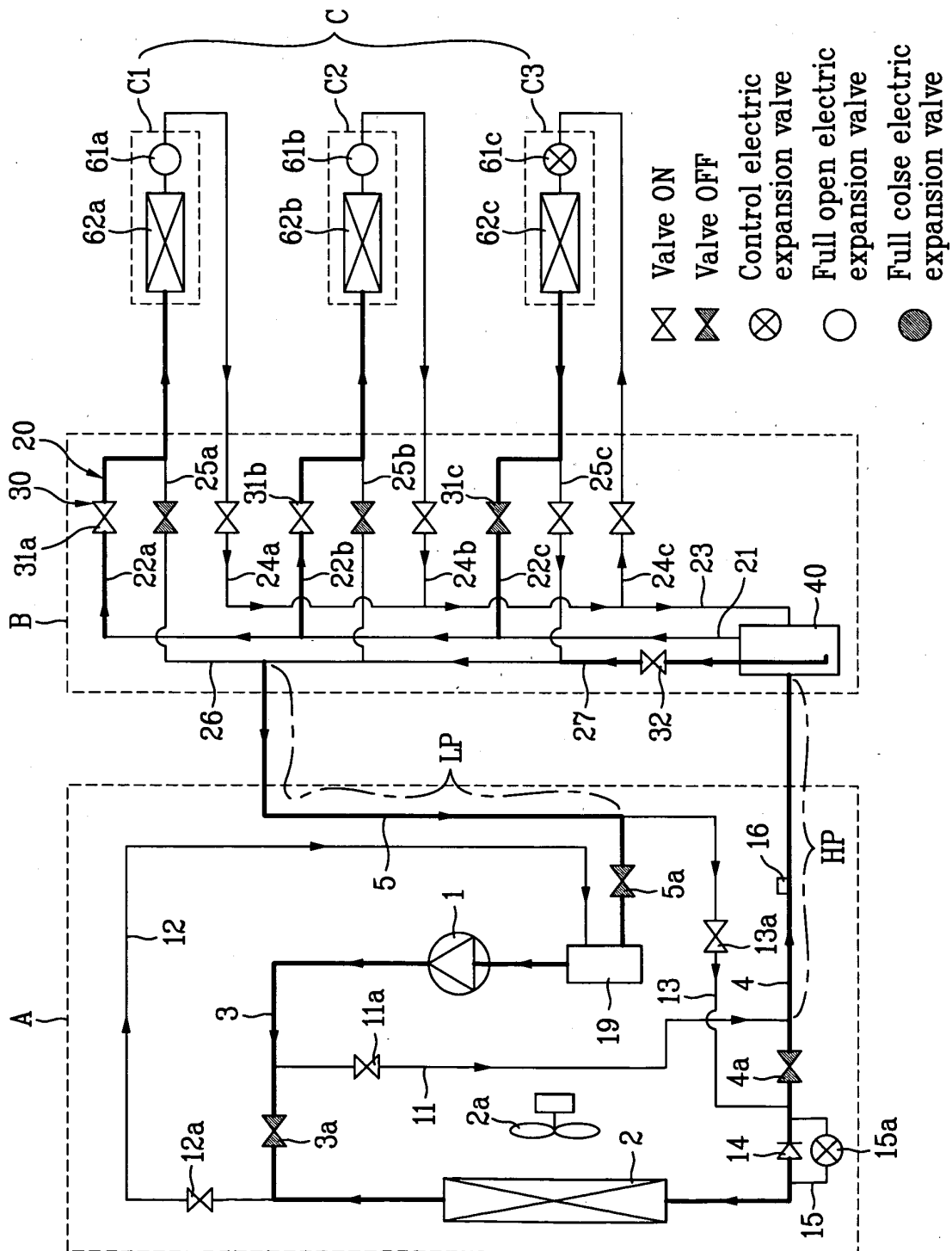
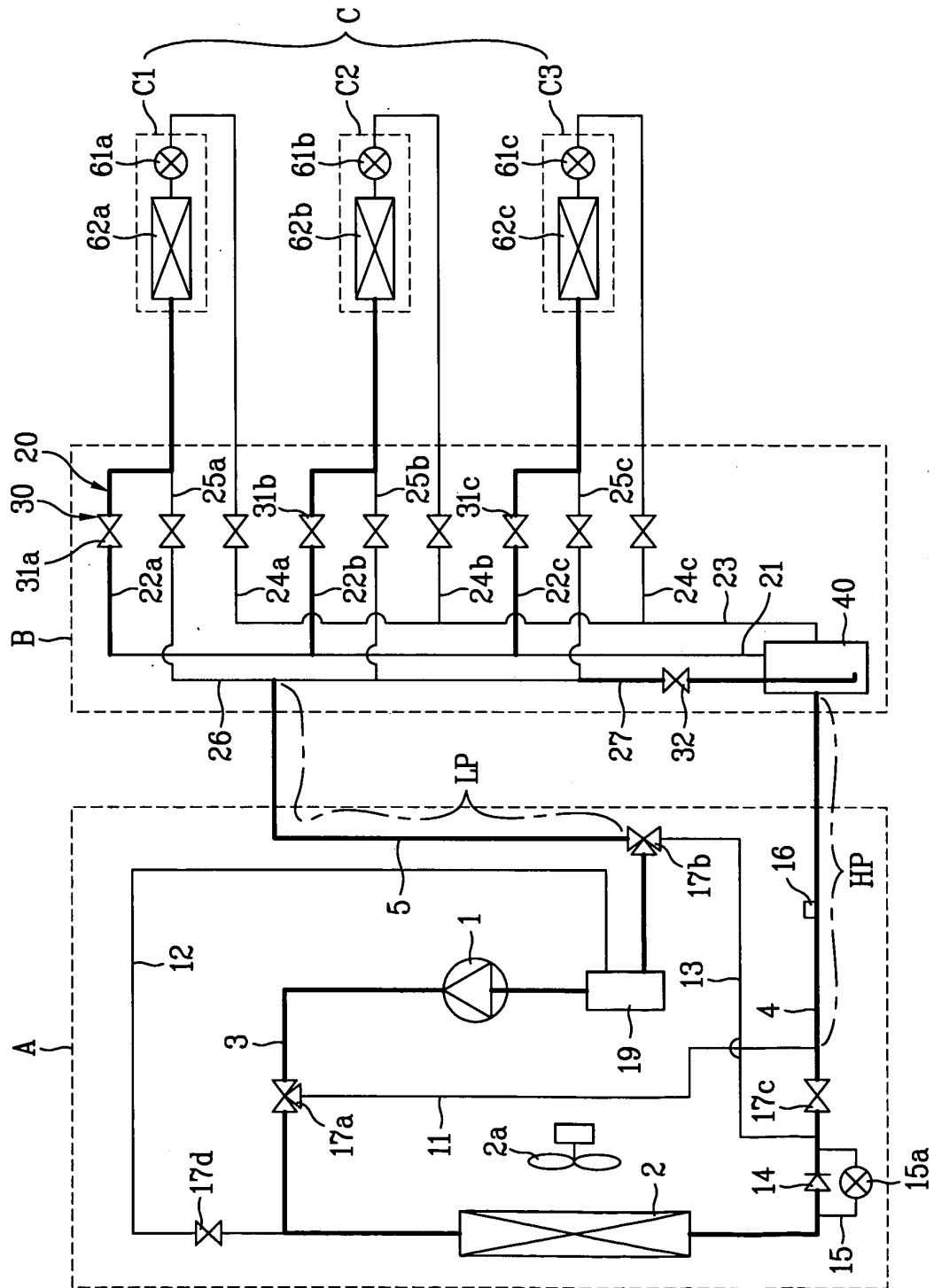


FIG. 4





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Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 03 00 7968

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                            |                                                     |                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                                                                                              | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION (Int.Cl.7)    |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 5 568 732 A (KAGEYAMA YASUHIRO ET AL)<br>29 October 1996 (1996-10-29)<br>* claim 19 *                                                                                                   | 21                                                  | F24F3/06<br>F24F11/00<br>F25B13/00<br>F25B41/04 |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ---<br>PATENT ABSTRACTS OF JAPAN<br>vol. 015, no. 142 (M-1101),<br>10 April 1991 (1991-04-10)<br>& JP 03 020574 A (SANYO ELECTRIC CO LTD),<br>29 January 1991 (1991-01-29)<br>* abstract * | 1-21                                                |                                                 |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ---<br>EP 0 496 505 A (MITSUBISHI ELECTRIC CORP)<br>29 July 1992 (1992-07-29)<br>* the whole document *                                                                                    | 1-21                                                |                                                 |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ---<br>EP 0 692 683 A (TOKYO SHIBAURA ELECTRIC CO)<br>17 January 1996 (1996-01-17)<br>* the whole document *                                                                               | 1-21                                                |                                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -----                                                                                                                                                                                      |                                                     |                                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                            |                                                     | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.7)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                            |                                                     | F24F<br>F25B                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                            |                                                     |                                                 |
| Place of search<br>MUNICH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                            | Date of completion of the search<br>23 October 2003 | Examiner<br>Valenza, D                          |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                                                            |                                                     |                                                 |

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 00 7968

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-10-2003

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---|---------------------|----------------------------|---------------------|
| US 5568732                                | A | 29-10-1996          | JP 7280327 A               | 27-10-1995          |
|                                           |   |                     | CN 1116292 A               | 07-02-1996          |
|                                           |   |                     | GB 2289124 A ,B            | 08-11-1995          |
|                                           |   |                     | KR 150812 B1               | 02-11-1998          |
| JP 03020574                               | A | 29-01-1991          | JP 2760577 B2              | 04-06-1998          |
| EP 0496505                                | A | 29-07-1992          | AU 634111 B2               | 11-02-1993          |
|                                           |   |                     | AU 1004792 A               | 23-07-1992          |
|                                           |   |                     | AU 656064 B2               | 19-01-1995          |
|                                           |   |                     | AU 3680893 A               | 24-06-1993          |
|                                           |   |                     | AU 656063 B2               | 19-01-1995          |
|                                           |   |                     | AU 3680993 A               | 24-06-1993          |
|                                           |   |                     | DE 69201968 D1             | 18-05-1995          |
|                                           |   |                     | DE 69201968 T2             | 23-11-1995          |
|                                           |   |                     | EP 0496505 A2              | 29-07-1992          |
|                                           |   |                     | ES 2074817 T3              | 16-09-1995          |
|                                           |   |                     | JP 2944507 B2              | 06-09-1999          |
|                                           |   |                     | JP 8291951 A               | 05-11-1996          |
|                                           |   |                     | JP 2875507 B2              | 31-03-1999          |
|                                           |   |                     | JP 8291952 A               | 05-11-1996          |
|                                           |   |                     | JP 2875665 B2              | 31-03-1999          |
|                                           |   |                     | JP 5231749 A               | 07-09-1993          |
|                                           |   |                     | US 5309733 A               | 10-05-1994          |
|                                           |   |                     | US 5388422 A               | 14-02-1995          |
|                                           |   |                     | US 5237833 A               | 24-08-1993          |
| EP 0692683                                | A | 17-01-1996          | JP 3290306 B2              | 10-06-2002          |
|                                           |   |                     | JP 8028985 A               | 02-02-1996          |
|                                           |   |                     | CN 1128340 A ,B            | 07-08-1996          |
|                                           |   |                     | EP 0692683 A2              | 17-01-1996          |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82