(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 010 952 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.06.2000 Bulletin 2000/25

(51) Int. Cl.[7]: **F24F 11/00**

(21) Application number: **99124106.8**

(22) Date of filing: **02.12.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **14.12.1998 JP 35419598**

(71) Applicant:
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.
Kadoma-shi, Osaka-fu (JP)

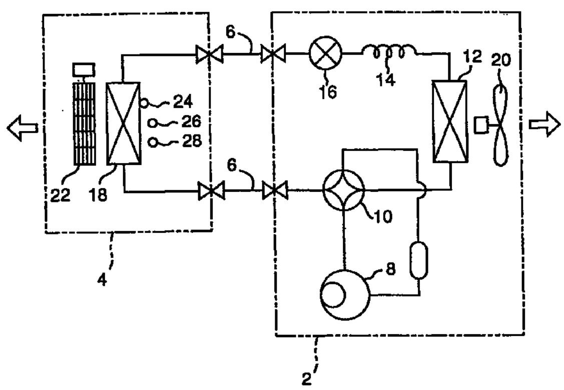
(72) Inventors:
- **Nishihara, Yoshikazu**
  Kouka-gun, Shiga 529-1851 (JP)
- **Ishikawa, Norimasa**
  Kusatsu-shi, Shiga 525-0057 (JP)
- **Ao, Takahiko**
  Otsu-shi, Shiga 520-2141 (JP)
- **Uchiyama, Kuniyasu**
  Kasatsu-shi, Shiga 525-0045 (JP)
- **Takahara, Tsutomo**
  Shiga 524-0022 (JP)
- **Unida, Hiroyuki**
  Kusatsu-shi, Shiga 525-0045 (JP)

(74) Representative:
Eisenführ, Speiser & Partner
Martinistrasse 24
28195 Bremen (DE)

(54) **Air direction control method for an air conditioner**

(57) In an air conditioner including an outdoor unit and an indoor unit connected with each other, an air direction changing blade pivotally mounted on the indoor unit for selectively opening and closing an outlet opening of the indoor unit is set to a closed position, at which the outlet opening is closed, or a position adjacent thereto during dehumidifying mode operation.

Fig. 1



EP 1 010 952 A2

Description

BACKGROUND OF THE INVENTION

(Field of the Invention)

[0001] The present invention relates generally to control of an air conditioner and, in particular but not exclusively, to an air direction control method for controlling the air direction or the air flow during dehumidifying mode operation to increase the degree of dehumidification or to improve a feeling of coolness.

(Description of the Related Art)

[0002] During dehumidifying mode operation of a conventional air conditioner, dehumidified air is introduced indoors through an air direction changing blade directed downwards that is mounted on an indoor unit.

[0003] However, when the air direction changing blade is set downwards, cool air directly impinges on a resident or residents inside the room and makes them chilly or uncomfortable. In order not to make the cool air impinge on the residents, setting the air direction changing blade horizontally has been proposed (see, for example, Japanese Laid-Open Patent Publication No. 10-61999).

[0004] Although in this air conditioner the cool air does not directly impinge on the residents, the cool air that flows on the upper side of the room drops thereafter and makes them somewhat chilly.

[0005] Recently, an air conditioner employing a short-circuit system has been proposed wherein cool air emitted from an air outlet of an indoor unit is directly drawn into an air inlet by setting the air direction changing blade upwards. This air conditioner aims to achieve comfortable dehumidification without any feeling of chilliness by causing the cool air not to directly impinge on the residents (see, for example, Japanese Laid-Open Patent Publication No. 9-72599).

[0006] Although this air conditioner almost eliminates the feeling of chilliness during dehumidifying mode operation, the amount of moisture that is removed thereby is relatively little and the dehumidifying efficiency thereof is low, resulting in a relatively high ultimate humidity.

SUMMARY OF THE INVENTION

[0007] The present invention has been developed to overcome the above-described disadvantages.

[0008] It is accordingly an objective of the present invention to provide an air direction control method for an air conditioner capable of enhancing the dehumidifying performance and minimizing a feeling of air flow or a feeling of chilliness.

[0009] In accomplishing the above and other objectives, the air conditioner according to the present invention includes an outdoor unit having a variable capacity compressor, a four-way valve, an outdoor heat exchanger, and an expansion valve, and an indoor unit having an indoor heat exchanger and connected with the outdoor unit. The indoor unit also has an air direction changing blade pivotally mounted thereon for selectively opening and closing an outlet opening defined therein. The air direction changing blade is set to a closed position, at which the outlet opening is closed, or a position adjacent thereto during dehumidifying mode operation.

[0010] By this construction, because any cold or chilly air does not directly impinge on a person or persons inside the room, a feeling of chilliness is eliminated and the dehumidifying performance can be enhanced at a low cost.

[0011] It is preferred that an indoor fan mounted in the indoor unit be set to a medium air flow or below when the air direction changing blade is set to the closed position or the position adjacent thereto, making it possible to eliminate the feeling of chilliness.

[0012] Advantageously, before the air direction changing blade is set to the closed position or the position adjacent thereto, the indoor fan is set to a minimum air flow and is turned on and off. By so doing, no drops of dew are created around an outlet opening of the indoor unit during dehumidification.

[0013] Again advantageously, when the air direction changing blade is set to the closed position or the position adjacent thereto, the variable capacity compressor is reduced in frequency, resulting in a reduction in input.

[0014] Conveniently, before the air direction changing blade is set to the closed position or the position adjacent thereto, when the detected intake temperature is greater than the temperature setting, cooling mode operation is performed, thereby accomplishing effective dehumidification and preventing drops of dew from being created around the outlet opening when it is closed. Furthermore, the use of both the cooling mode operation and the dehumidifying mode operation enlarges the range of use, making it possible to efficiently operate the air conditioner.

[0015] Preferably, before the air direction changing blade is set to the closed position or the position adjacent thereto, when the detected intake temperature is greater than the temperature setting, the indoor fan is reduced in air flow and the variable capacity compressor is increased in frequency. By so doing, effective dehumidification is accomplished prior to closure of the outlet opening, thus avoiding creation of drops of dew around the outlet opening during the closure thereof.

[0016] Again preferably, when the detected humidity is less than the humidity setting, the air direction changing blade is set to the closed position or the position adjacent thereto. In this case, it is unlikely that drops of dew adhere to the indoor unit in the vicinity of the outlet opening and subsequently fall to the floor, thus making it possible to desirably perform the dehumidifying mode operation during closure of the outlet opening.

[0017] The humidity setting is changed according to at least one of the intake temperature and the pipe temperature.

[0018] When the detected pipe temperature is greater than a predetermined temperature, the air direction changing blade is set to the closed position or the position adjacent thereto, thereby avoiding creation of drops of dew around the outlet opening.

[0019] The predetermined temperature is changed according to the intake temperature.

[0020] Immediately after the air direction changing blade has been set to the closed position or the position adjacent thereto, the angle of inclination of the air direction changing blade is held for a predetermined time, thereby avoiding chattering of the air direction changing blade.

[0021] Though the pipe temperature varies due to clogging of the indoor unit with dust, the amount of refrigerant, or the total length of pipes, the indoor unit can be stably controlled by determining a target pipe temperature according to the detected intake temperature and the detected humidity.

[0022] Advantageously, when the detected pipe temperature is greater than the target pipe temperature, the opening of the expansion valve is reduced, or the frequency of the variable capacity compressor is increased. In contrast, when the detected pipe temperature is less than the target pipe temperature, the opening of the expansion valve is increased, or the frequency of the variable capacity compressor is reduced. By so doing, the dehumidifying mode operation is efficiently performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The above and other objectives and features of the present invention will become more apparent from the following description of preferred embodiments thereof with reference to the accompanying drawings, throughout which like parts are designated by like reference numerals, and wherein:

Fig. 1 is a circuit diagram showing a refrigeration cycle of an air conditioner in which an air direction control method according to the present invention is employed;
Fig. 2 is a block diagram of a control circuit in the air conditioner of Fig. 1 whereby the compressor frequency and the expansion valve opening are controlled;
Fig. 3 is a schematic vertical sectional view of an indoor unit;
Fig. 4 is a flowchart indicating control during dehumidifying mode operation;
Fig. 5 is a schematic view showing movements of an air direction changing blade in a cooling region during the dehumidifying mode operation;
Fig. 6 is a schematic view showing movements of the air direction changing blade in a drying region during the dehumidifying mode operation;
Fig. 7 is a flowchart indicating control when any one of the conditions for performing "Breezeless and Dry" operation in the drying region has been satisfied;
Fig. 8 is a flowchart indicating control of a motor-driven expansion valve when any one of the conditions for performing "Breezeless and Dry" operation has been satisfied;
Fig. 9 is a flowchart indicating control of the compressor frequency when any one of the conditions for performing "Breezeless and Dry" operation has been satisfied;
Fig. 10 is a timing chart when the air direction control method according to the present invention has been employed;
Fig. 11A is a schematic view showing a cool air flow in "Drying Region 1" when "Air Direction-Auto" has been set during the dehumidifying mode operation;
Fig. 11B is a view similar to Fig. 11A, showing a cool air flow in "Drying Region 2" when an indoor fan is turned on and off during the dehumidifying mode operation; and
Fig. 11C is a view similar to Fig. 11A, showing a cool air flow in "Drying Region 2" during "Breezeless and Dry" operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] This application is based on an application No. 10-354195 filed December 14, 1998 in Japan, the content of which is incorporated hereinto by reference.

[0025] Fig. 1 shows a refrigeration cycle of an air conditioner employing an air direction control method according to the present invention. This air conditioner includes an outdoor unit 2 and an indoor unit 4 connected to each other via connecting pipes 6.

[0026] As shown in Fig. 1, the outdoor unit 2 includes an inverter-driven, variable capacity (frequency) compressor 8, a four-way valve 10 for heating and cooling mode selection, an outdoor heat exchanger 12, an auxiliary throttle 14, and a motor-driven expansion valve 16, while the indoor unit 4 includes an indoor heat exchanger 18. In this figure, reference numerals 20 and 22 denote an outdoor fan and an indoor fan, respectively, and reference numerals 24, 26 and 28 denote a pipe temperature sensor, an intake air temperature sensor, and a humidity sensor, respectively, all of which are mounted in the indoor unit 4.

[0027] With the refrigeration cycle configured as shown in Fig. 1, refrigerant from the compressor 8 during cooling or dehumidifying mode operation flows through the four-way valve 10 and reaches the outdoor heat exchanger 12, in which heat is exchanged with the outdoor air and the refrigerant is condensed. The condensed refrigerant then passes the auxiliary throttle 14 whereby the refrigerant pressure is reduced and the refrigerant is converted to an easily evaporable state. The condensed, low pressure refrigerant then passes the motor-driven expansion valve 16 whereby the refrigerant pressure is further reduced. The opening of the motor-driven expansion valve 16 is pulse-controlled by, for example, a stepping-motor according to the load of the room to be cooled or dehumidified, and the low pressure refrigerant thus flows to the indoor unit 4 via the connecting pipe 6 at a flow rate proportional to the load of the room. The refrigerant then evaporates in the indoor heat exchanger 18, and the gasified refrigerant thus passes back through the connecting pipe 6, through the four-way valve 10, and re-enters the compressor 8.

[0028] A method of controlling the compressor frequency and the opening of the motor-driven expansion valve is described next with reference to Fig. 2, a block diagram of the corresponding control circuit. Note that differential temperature ΔT is the room temperature Tr minus the temperature setting Ts.

[0029] In the indoor unit 4, an output (room temperature) from the intake air temperature sensor 26 is first inputted into a room temperature detection circuit 40, which in turn outputs a temperature signal (Tr) to a differential temperature calculator 42. Substantially concurrently, a setting discriminator 44 determines the temperature (Ts) and operating mode set by an operation setting circuit 38, and supplies this information to the differential temperature calculator 42. The differential temperature calculator 42 thus calculates the differential temperature ΔT (= Tr - Ts), and outputs a differential temperature signal to a signal transmission circuit 50.

[0030] An ON/OFF discriminator 46 determines whether the indoor unit 4 has been turned on or off. The rated capacity of the indoor unit 4 is stored in a rated capacity memory 48.

[0031] A rated capacity signal from the rated capacity memory 48, the differential temperature signal from the differential temperature calculator 42, and an operating mode signal and on/off status signal from the ON/OFF discriminator 46 are passed by the signal transmission circuit 50 of the indoor unit 4 to a signal reception circuit 52 of the outdoor unit 2. The signals received by the signal reception circuit 52 are sent to a compressor frequency calculator 54 and to a valve opening calculator 56.

[0032] Based on the rated capacity signal, differential temperature signal, operating mode signal, and on/off status signal from the indoor unit 4, the compressor frequency calculator 54 performs a predetermined operation to calculate the frequency value (No.) (for example, an integer from 0 to 8).

[0033] Based on the rated capacity signal, differential temperature signal, operating mode signal, and on/off status signal from the indoor unit 4, the valve opening calculator 56 similarly performs another predetermined operation to determine the opening of the motor-driven expansion valve 16.

[0034] The result of the operation performed by the compressor frequency calculator 54 and that of the operation performed by the valve opening calculator 56 are applied as a frequency signal and a valve opening signal to a compressor drive circuit (not shown) and to a valve drive circuit (not shown), respectively, to control the frequency of the compressor 8 and the opening of the motor-driven expansion valve 16.

[0035] Since then, the frequency No. of the compressor 8 and the valve opening of the motor-driven expansion valve 16 are calculated for each predetermined cycle, based on the rated capacity signal, differential temperature signal, operating mode signal, and on/off status signal so that the frequency of the compressor 8 and the opening of the motor-driven expansion valve 16 may be appropriately controlled.

[0036] A heating mode operation is not a principal objective of the present invention and, hence, the description thereof is omitted.

[0037] Fig. 3 depicts the indoor unit 4, in which a plurality of intake openings 30 are formed at an upper portion and a front portion of the main body, while an outlet opening 32 is formed at a lower portion of the main body.

[0038] The intake openings 30 and the outlet opening 32 communicate with each other through an air passage 34, in which the indoor heat exchanger 18 and the indoor fan 22 are disposed. An air direction changing blade 36 is pivotally mounted on the main body at a lower portion thereof so as to selectively open and close the outlet opening 32. The pipe temperature sensor 24 is mounted on and held in contact with a lowermost one of a plurality of heat exchanger blocks of the indoor heat exchanger 18, while the intake air temperature sensor 26 and the humidity sensor 28 are juxtaposed with each other at a front portion of the main body.

[0039] The air direction control method according to the present invention during dehumidifying mode operation is discussed hereinafter.

[0040] Fig. 4 depicts the control method during the dehumidifying mode operation. At step S1, the differential temperature △ T between the room temperature detected by the intake air temperature sensor 26 and the temperature setting Ts set by the user is first calculated, and the compressor frequency and the valve opening are then determined on the basis of the differential temperature ΔT, as described above. At step S2, the differential temperature △T is compared with t1 (for example, +0.5°C). If the differential temperature △T is greater than t1, a cooling mode operation is performed at step S3, and if the differential temperature △T is less than or equal to t1, the procedure advances to step S4, at which the differential temperature △T is compared with t2 (for example, -0.5°C). If the differential temperature △T is greater than t2, an operation for "Drying Region 1" is performed at step S5. In contrast, if the differential temperature △T is less than or equal to t2, the procedure advances to step S6, at which the differential temperature △T is compared with t3 (for example, -2.5°C). If the differential temperature △T is greater than t3, an operation for "Drying Region 2" is performed at step S7, and if the differential temperature △T is less than or equal to t3, the compressor 8 is stopped at step S8. A determination is then made at step S9 whether or not a predetermined time t4 (for example, about three minutes) has elapsed after the compressor 8 has been stopped. If the decision at step S9 is YES, the differential temperature △T is again compared with T3 at step S10. If the differential temperature △T is greater than t3, the compressor 8 is started again at step S11.

[0041] It is to be noted that the sampling of the intake air temperature is carried out for each predetermined cycle (for example, about one second), and the operating conditions are determined by repeatedly calculating the differential temperature △T.

[0042] During a cooling operation in the dehumidification mode, when the user sets "Air Direction-Auto" using a remote controller (not shown), the air direction changing blade 36 swings between the upper limit position and the lower limit position, as shown in Fig. 5, except when the indoor fan 22 is at a standstill. It is also possible for the user to set the angle of inclination of the air direction changing blade 36 to one of five different angles with the use of the remote controller. In a region in the vicinity of "Drying Region 1", when the intake air temperature detected by the intake air temperature sensor 26 approaches the temperature setting, The compressor frequency is extremely reduced (the Frequency No. is, for example, 1), while the indoor fan 22 is set to an air flow ranging from "Hi (high speed)" to "Lo (low speed)".

[0043] In "Drying Region 1", in view of a reduction in absolute humidity, the frequency No. of the compressor 8 is set to, for example, 3, while the indoor fan 22 is set to a medium air flow or "Super Breeze" lower than "Lo". If "Air Direction-Auto" is set, the air direction changing blade 36 is directed generally horizontally, as shown in Fig. 6, to reduce the feeling of chilliness. On the other hand, if "Air Direction Setting" is selected, it is possible for the user to select one of five different angles of inclination of the air direction changing blade 36 using the remote controller, as in the cooling operation in the dehumidification mode.

[0044] In "Drying Region 2", in view of a reduction in relative humidity, the frequency No. of the compressor 8 is set to, for example, 2, while either a "Super Breeze and Dry" operation or a "Breezeless and Dry " operation is set depending on the operating conditions, as discussed later.

[0045] As shown in Fig. 6, during the "Super Breeze and Dry" operation, the indoor fan 22 creates a light or gentle breeze to provide an extremely low air flow and is turned on and off. When "Air Direction-Auto" is selected, the air direction changing blade 36 is set to a position (this position is hereinafter referred to as the downwards directed position) directed further downwards from the lower limit position in the operation for "Drying Region 1", thus causing cold or chilly air not to directly impinge on the resident or residents. If the "Air Direction Selling" is selected, it is possible for the user to set the air direction changing blade 36 to one of five different positions between the upper limit position and the downwards directed position using the remote controller. The ON/OFF operation of the indoor fan 22 is, for example, such that the indoor fan 22 is turned on and off to repeat a 15-minute operation and a 10-minute stop alternately.

[0046] On the other hand, during the "Breezeless and Dry" operation, the indoor fan 22 creates a light or gentle breeze to provide an extremely low air flow, and in any one of "Air Direction-Auto" and "Air Direction Setting", the air direction changing blade 36 is set to a position (reset position) to close the outlet opening 32 or another position in the vicinity thereof. The "Breezeless and Dry" operation has the following features.

(1) To provide comfort without imparting a feeling of chilliness to the resident or residents (a feeling of no air flow).
(2) To reduce heat exchange to reduce the temperature of the pipes, thereby enhancing the dehumidifying capacity (high power dehumidification).
(3) To minimize the cooling capacity to restrain a reduction in room temperature to a minimum (continued dehumidifying performance).

[0047] The "Breezeless and Dry" operation is carried out when the decision at step S6 is YES and when any one of the conditions shown in Table 1 is continued for, for example, more than five minutes in "Drying Region 2" (step S7).

Table 1

Intake Air Temp.	Relative Humidity	Pipe Temp.
	impossible	
28℃	less than 50%	more than 11℃
27℃	less than 60%	more than 9℃
25℃	less than 70%	more than 8℃
23℃	less than 70%	more than 7℃
21℃	less than 70%	more than 6℃

[0048] When about ten minutes have elapsed after none of the above conditions has been satisfied, a determination is made whether or not any one of them is satisfied.

[0049] The conditions to release the "Breezeless and Dry" operation are discussed hereinafter with reference to a flowchart shown in Fig. 7.

[0050] After any one of the "Breezeless" conditions has been satisfied and after the air direction changing blade 36 has been held at the reset position or a position in the vicinity thereof for a predetermined time (for example, about five minutes), a determination is made at step S21 whether or not the pipe temperature detected by the pipe temperature sensor 24 is less than (the target pipe temperature (A) minus three). If the decision at step S21 is YES, the "Breezeless and Dry" operation is immediately terminated at step S22, and if the decision at step S21 is No, the procedure advances to step S23, at which a determination is made whether or not the pipe temperature is less than (the target pipe temperature (A) minus two). If the decision at step S23 is YES, the "Breezeless and Dry" operation is continued for thirty minutes and stopped thereafter at step S24. In contrast, if the decision at step S23 is NO, the procedure advances to step S25, at which the "Breezeless and Dry" operation is continued for sixty minutes and stopped thereafter.

[0051] The target pipe temperature (A) is determined based on Table 2 below using the intake air temperature detected by the intake air temperature sensor 26 and the relative humidity detected by the humidity sensor 28.

Table 2

Intake Air Temp. (℃) / Rela. Humi. (%)	t<21	21≤t<23	23≤t<25	25≤t<27	27≤t<28	28≤t
Rh≥70	immediate termination					
70>Rh≥60	11	12	13	15	17	
60>Rh≥50	8	9	10	11	13	
50>Rh	4	5	6	7	9	

[0052] In the course of the "Breezeless and Dry" operation, if the condition for determining the target pipe temperature (A) has changed and if a certain condition has been held for, for example, about two minutes, such condition is used to determine the target pipe temperature (A).

[0053] The control of the opening of the motor-driven expansion valve 16 is discussed hereinafter with reference to a flowchart shown in Fig. 8.

[0054] Upon a lapse of a predetermined time after the receipt of a signal indicating that the condition for controlling the "Breezeless and Dry" operation has been satisfied at step S31, a determination is made at step S32 whether or not the pipe temperature detected by the pipe temperature sensor 24 is greater than (the target pipe temperature (A) plus one). If the detected pipe temperature is greater than (the target pipe temperature (A) plus one), the motor-driven expansion valve 16 is controlled to be closed by, for example, four pulses at step S33, and a determination of the valve opening is made at step S34. At this moment, if the valve opening is greater than or equal to the set minimum pulses (for example, 60 pulses), the procedure returns to step S32, and if the valve opening is less than the set minimum pulses, it is set to the set minimum pulses at step S35. On the other hand, if the detected pipe temperature is less than or equal to (the target pipe temperature (A) plus one) at step S32, a determination is made at step S36 whether or not the detected pipe temperature is greater than (the target pipe temperature (A) minus one). If the detected pipe temperature is less than or equal to (the target pipe temperature (A) minus one), the motor-driven expansion valve 16 is controlled to be opened by, for example, eight pulses at step S37. In contrast, if the detected pipe temperature is greater than (the target pipe temperature (A) minus one), the motor-driven expansion valve 16 is locked to the present opening at step S38.

[0055] The control of the frequency of the compressor 8 is discussed hereinafter with reference to a flowchart shown in Fig. 9.

[0056] Upon a lapse of a predetermined time after the receipt of a signal indicating that the condition for controlling the "Breezeless and Dry" operation has been satisfied at step S41, a determination is made at step S42 whether or not the pipe temperature detected by the pipe temperature sensor 24 is greater than (the target pipe temperature (A) plus one). If the detected pipe temperature is greater than (the target pipe temperature (A) plus one), the frequency of the compressor 8 is increased by 1Hz at step S43, and a determination is made at step S44 whether or not an increment in compressor frequency is less than 5Hz. If the increment in compressor frequency is less than 5Hz, the procedure returns to step S42 after a predetermined time (for example, about three minutes) has elapsed, and if the increment is greater than or equal to 5Hz, the procedure advances to step S48 at which the frequency 8 is locked to the present frequency. On the other hand, if the detected pipe temperature is less than or equal to (the target pipe temperature (A) plus one) at step S42, a determination is made at step S45 whether or not the detected pipe temperature is greater than (the target pipe temperature (A) minus one). If the detected pipe temperature is less than or equal to (the target pipe temperature (A) minus one), the frequency of the compressor 8 is reduced by 1Hz at step S46, and the procedure advances to step S47 at which a determination is made whether or not a decrement in compressor frequency is less than 5Hz. If the decrement in compressor frequency is less than 5Hz, the procedure returns to step S45 after a predetermined time (for example, about three minutes) has elapsed. In contrast, if the decrement is greater than or equal to 5Hz, the compressor 8 is locked to the present frequency at step S48. On the other hand, if the detected pipe temperature is greater than (the target pipe temperature (A) minus one) at step S45, the procedure advances to step S48 at which the compressor 8 is similarly locked to the present frequency.

[0057] Fig. 10 depicts one example of timing charts when the air direction control method according to the present invention has been employed.

[0058] Figs. 11A, 11B and 11C depict cool air flows during dehumidifying mode operation when the air direction control method according to the present invention has been employed. In particular, Fig. 11A depicts the cool air flow in "Drying Region 1" when "Air Direction-Auto" has been set, Fig. 11B the cool air flow in "Drying Region 2" when the indoor fan is turned on and off, Fig. 11C the cool air flow in "Drying Region 2" during "Breezeless and Dry" operation.

[0059] In "Drying Region 1", though relatively much moisture is removed, cool or chilly air flows horizontally on the upper side within the room, as shown in Fig. 11. Accordingly, the resident feels chilly from above, but the feeling of chilliness is considerably suppressed. When the indoor fan is turned on and off in "Drying Region 2", the resident feels chilly from below to some extent, but there is little chilly air flow. During "Breezeless and Dry" operation, the resident does not have any feeling of chilliness from below.

[0060] Although the present invention has been described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims, unless they depart therefrom.

Claims

1. An air conditioner comprising:

an outdoor unit having a variable capacity compressor, a four-way valve, an outdoor heat exchanger, and an expansion valve;

an indoor unit having an indoor heat exchanger and connected with said outdoor unit, said indoor unit also having an air direction changing blade pivotally mounted thereon for selectively opening and closing an outlet opening defined therein; and

said air direction changing blade being set to a closed position, at which said outlet opening is closed, or a position adjacent thereto during dehumidifying mode operation.

2. The air conditioner according to claim 1, further comprising an indoor fan mounted in said indoor unit, wherein said indoor fan is set to a medium air flow or below when said air direction changing blade is set to the closed position or the position adjacent thereto.

3. The air conditioner according to claim 1, further comprising an indoor fan mounted in said indoor unit, wherein before said air direction changing blade is set to the closed position or the position adjacent thereto, said indoor fan is set to a minimum air flow and is turned on and off.

4. The air conditioner according to claim 1, further comprising an indoor fan mounted in said indoor unit, wherein said variable capacity compressor is reduced in frequency when said air direction changing blade is set to the closed position or the position adjacent thereto.

5. The air conditioner according to claim 1, wherein before said air direction changing blade is set to the closed position or the position adjacent thereto, when a detected intake temperature is greater than a temperature setting, cooling mode operation is performed.

6. The air conditioner according to claim 1, further comprising an indoor fan mounted in said indoor unit, wherein before said air direction changing blade is set to the closed position or the position adjacent thereto, when a detected intake temperature is greater than a temperature setting, said indoor fan is reduced in air flow and said variable capacity compressor is increased in frequency.

7. The air conditioner according to claim 1, wherein when a detected humidity is less than a humidity setting, said air direction changing blade is set to the closed position or the position adjacent thereto.

8. The air conditioner according to claim 7, wherein the humidity setting is changed according to at least one of an intake temperature and a pipe temperature.

9. The air conditioner according to claim 1, wherein when a detected pipe temperature is greater than a predetermined temperature, said air direction changing blade is set to the closed position or the position adjacent thereto.

10. The air conditioner according to claim 9, wherein the predetermined temperature is changed according to an intake temperature.

11. The air conditioner according to claim 1, wherein immediately after said air direction changing blade has been set to the closed position or the position adjacent thereto, an angle of inclination of said air direction changing blade is held for a predetermined time.

12. The air conditioner according to claim 1, wherein a target pipe temperature is determined according to a detected intake temperature and a detected humidity.

13. The air conditioner according to claim 1, wherein when a detected pipe temperature is greater than a target pipe temperature, an opening of said expansion valve is reduced, and when the detected pipe temperature is less than the target pipe temperature, the opening of said expansion valve is increased.

14. The air conditioner according to claim 1, wherein when a detected pipe temperature is greater than a target pipe temperature, a frequency of said variable capacity compressor is increased, and when the detected pipe temperature is less than the target pipe temperature, the frequency of said variable capacity compressor is reduced.

Fig.1

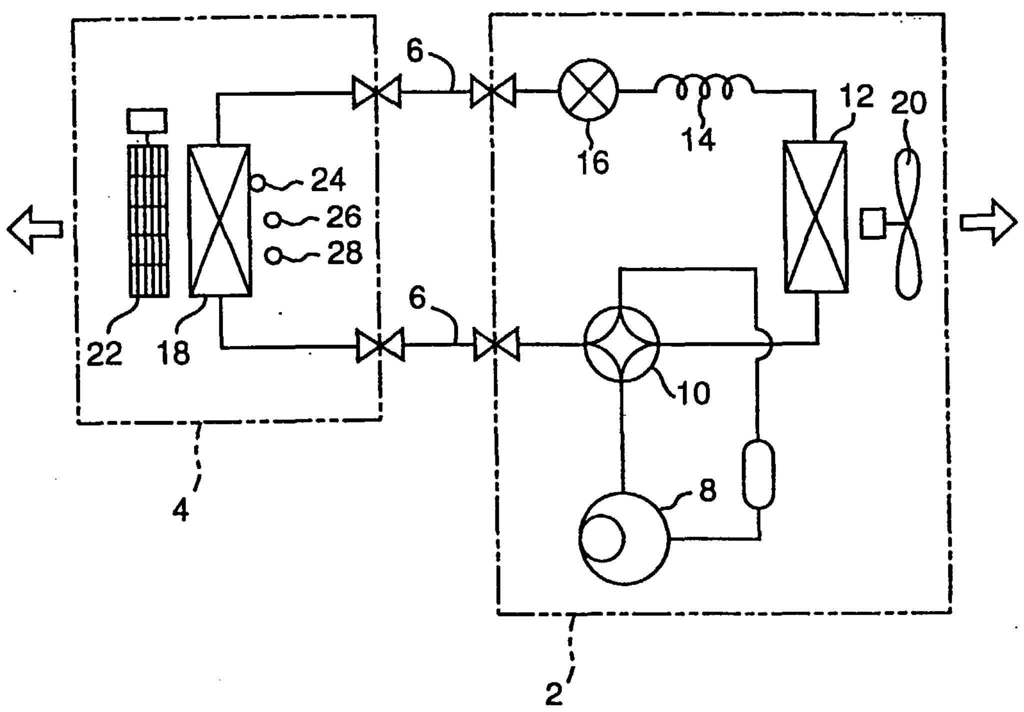


Fig.3

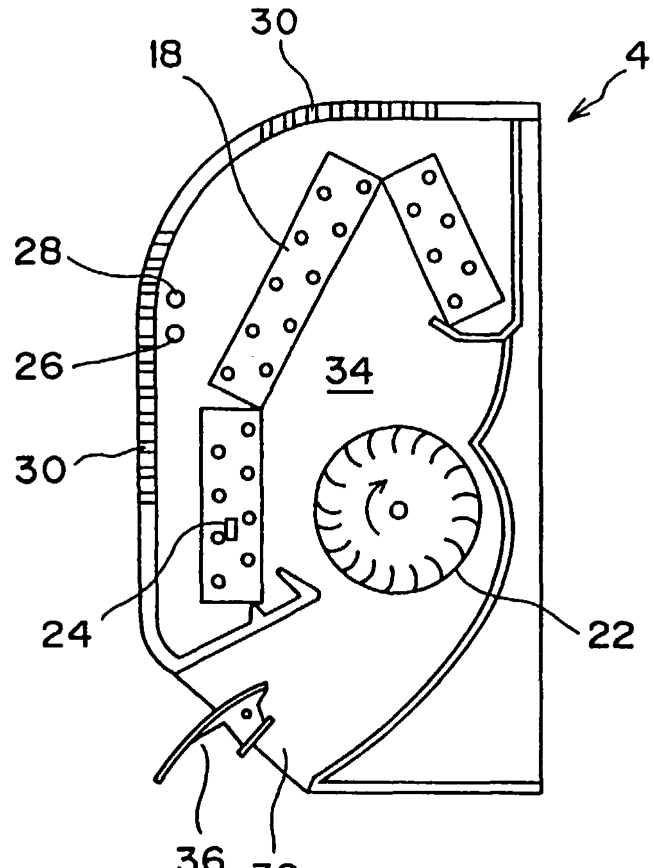


Fig.2

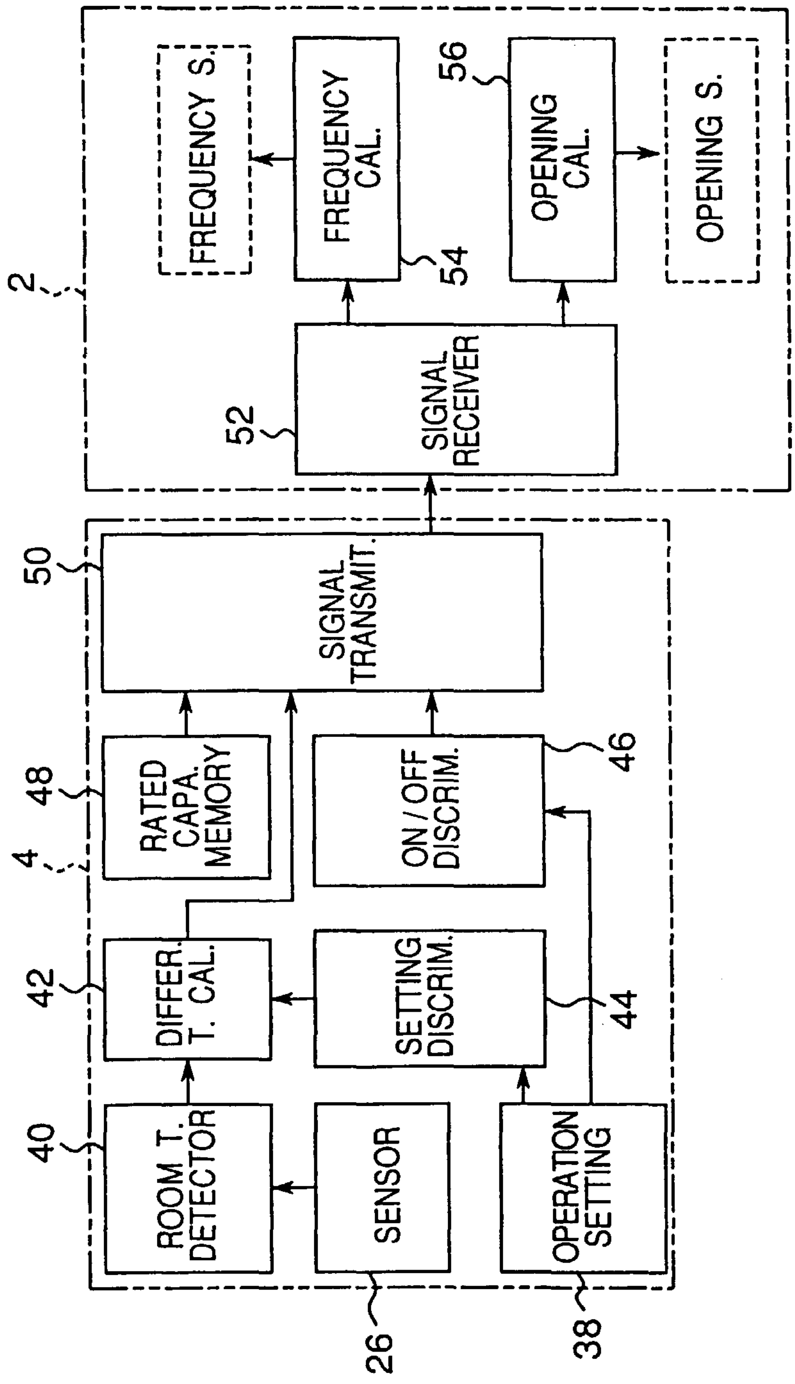

2
FREQUENCY S.
FREQUENCY CAL.
54
56
OPENING CAL.
OPENING S.
52
SIGNAL RECEIVER
50
SIGNAL TRANSMIT.
48
RATED CAPA. MEMORY
4
ON / OFF DISCRIM.
46
42
DIFFER. T. CAL.
SETTING DISCRIM.
44
40
ROOM T. DETECTOR
SENSOR
OPERATION SETTING
26
38

Fig.4

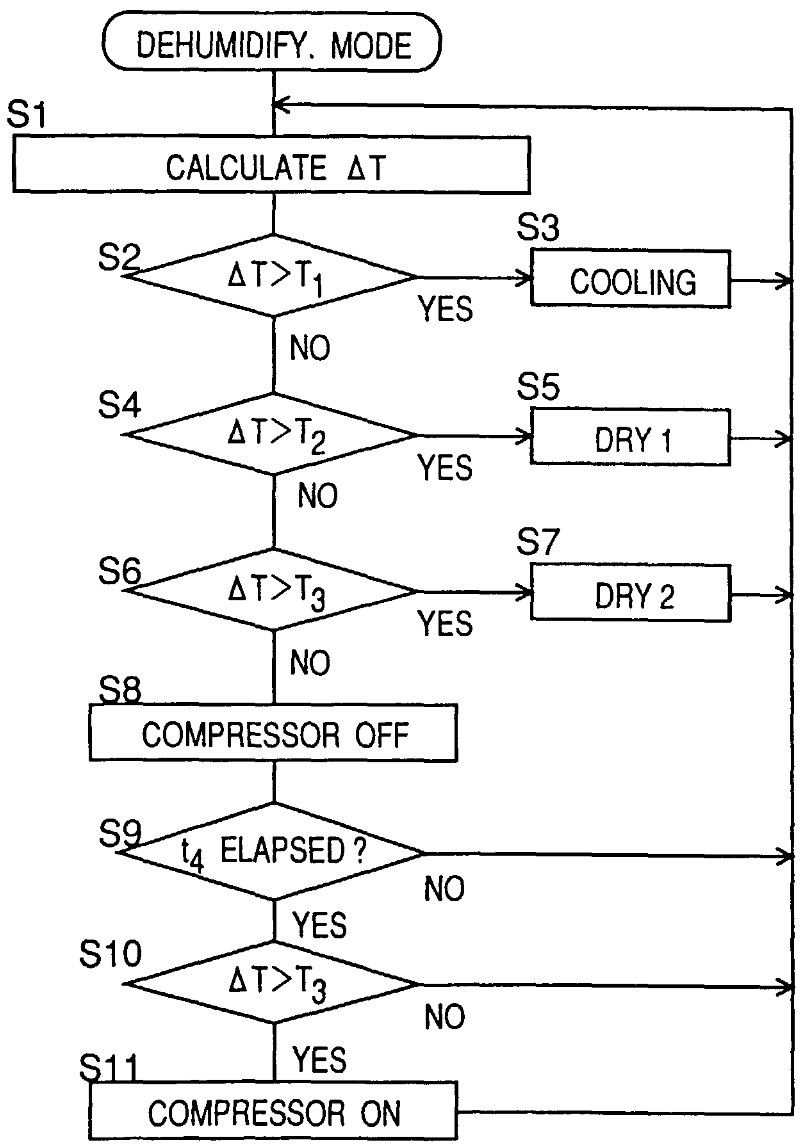

DEHUMIDIFY. MODE
S1
CALCULATE ΔT
S2
ΔT>T1
YES
NO
S3
COOLING
S4
ΔT>T2
YES
NO
S5
DRY 1
S6
ΔT>T3
YES
NO
S7
DRY 2
S8
COMPRESSOR OFF
S9
t4 ELAPSED ?
NO
YES
S10
ΔT>T3
NO
YES
S11
COMPRESSOR ON

Fig. 5

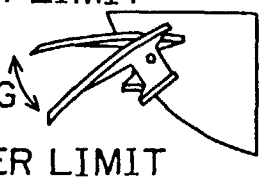
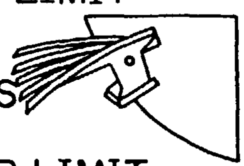
CONDITION		ORDINARY
COOL·DRY (COOL.REGION)	AIR DIREC. -AUTO	UPPER LIMIT  SWING LOWER LIMIT
	AIR DIREC. SETTING	UPPER LIMIT  5STEPS LOWER LIMIT

Fig.6

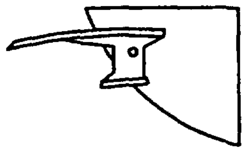
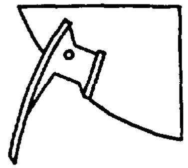
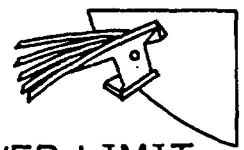
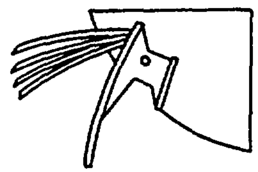
CONDITION		DRY 1	DRY 2	DRY2 (BREEZELESS)
DRY	AIR DIREC. -AUTO	HORIZON. 	 DOWNWARD	 CLOSE
	AIR DIREC. SETTING	UPPER LIMIT  LOWER LIMIT	 DOWNWARD	
AIR FLOW		EXTREMELY LOW	EXTREMELY LOW	EXTREMELY LOW

Fig.7

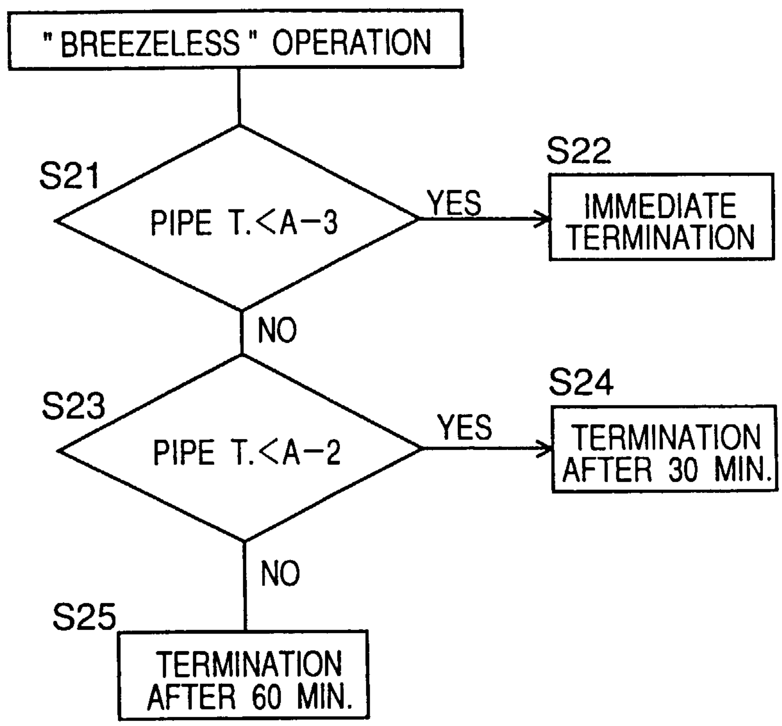

"BREEZELESS" OPERATION
S21
PIPE T.<A−3
YES
S22
IMMEDIATE TERMINATION
NO
S23
PIPE T.<A−2
YES
S24
TERMINATION AFTER 30 MIN.
NO
S25
TERMINATION AFTER 60 MIN.

Fig.8

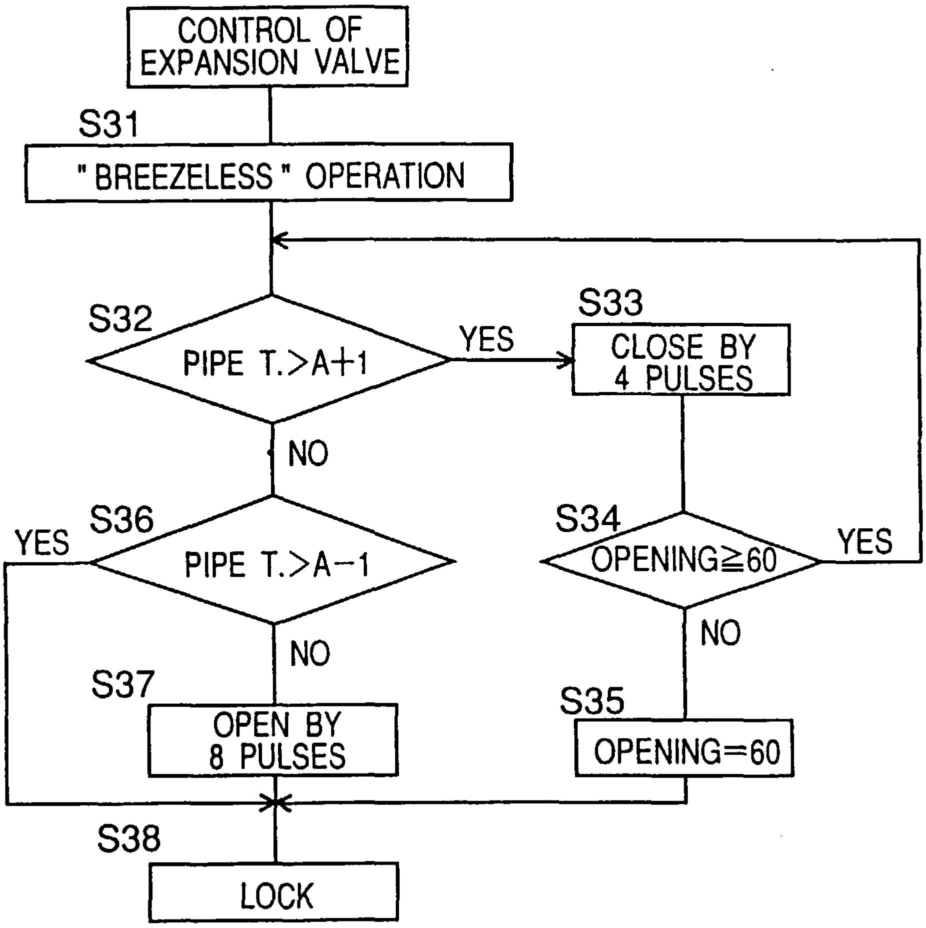

CONTROL OF
EXPANSION VALVE
S31
"BREEZELESS" OPERATION
S32
PIPE T.>A+1
YES
S33
CLOSE BY
4 PULSES
NO
S36
YES
PIPE T.>A−1
S34
OPENING≧60
YES
NO
NO
S37
OPEN BY
8 PULSES
S35
OPENING=60
S38
LOCK

Fig.9

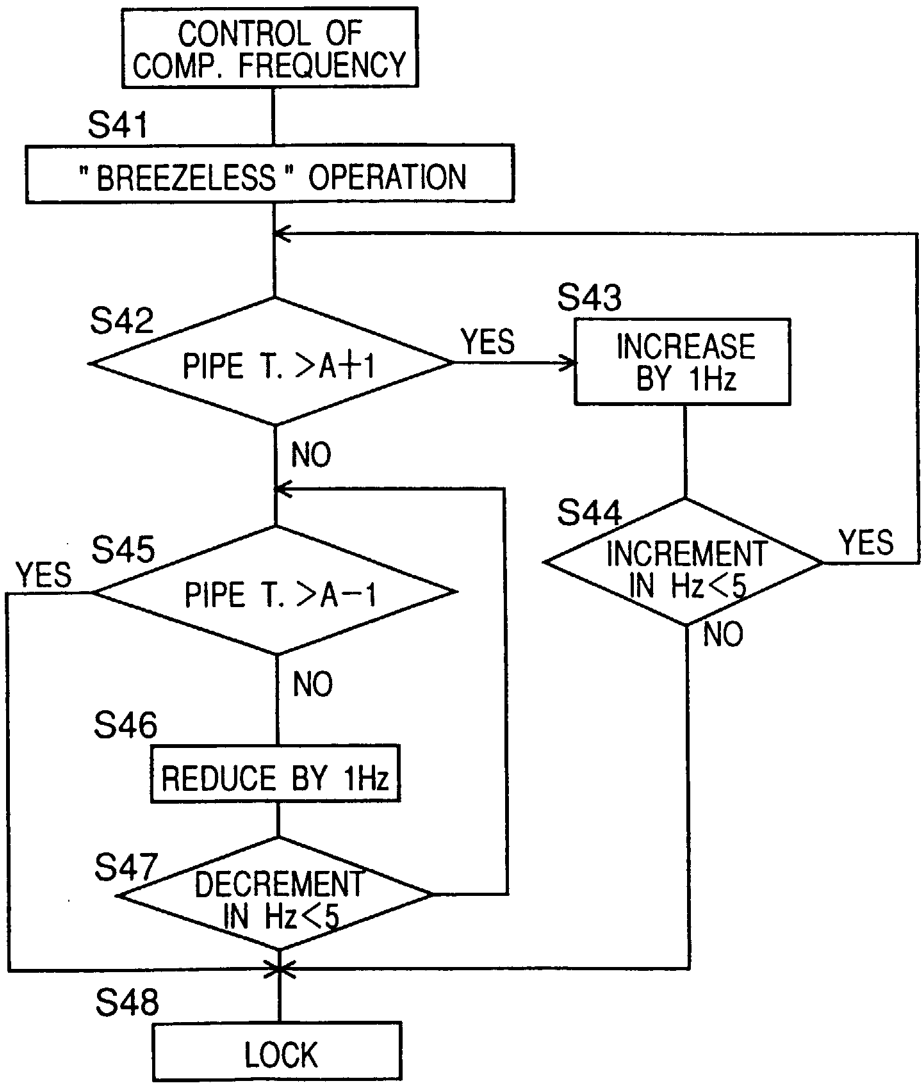

CONTROL OF
COMP. FREQUENCY
S41
" BREEZELESS " OPERATION
S42
PIPE T. >A+1
YES
S43
INCREASE
BY 1Hz
NO
S44
INCREMENT
IN Hz<5
YES
NO
S45
YES
PIPE T. >A−1
NO
S46
REDUCE BY 1Hz
S47
DECREMENT
IN Hz<5
S48
LOCK

Fig. 10

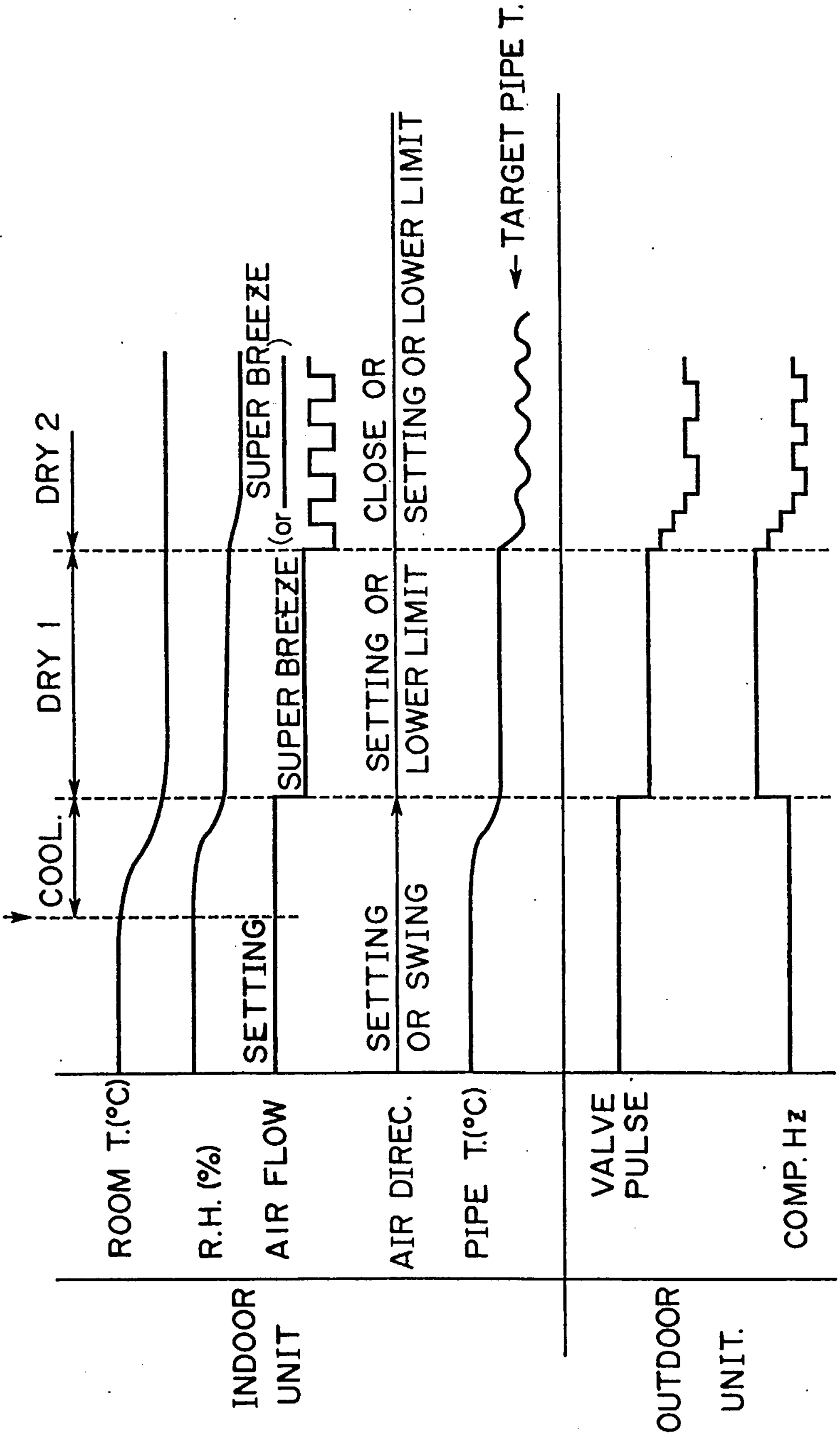

DRY MODE ON
COOL.
DRY 1
DRY 2
INDOOR UNIT
ROOM T.(°C)
R.H. (%)
AIR FLOW
SETTING
SUPER BREEZE
SUPER BREEZE (or SUPER BREEZE)
AIR DIREC.
SETTING OR SWING
SETTING OR LOWER LIMIT
CLOSE OR SETTING OR LOWER LIMIT
PIPE T.(°C)
TARGET PIPE T.
OUTDOOR UNIT.
VALVE PULSE
COMP. Hz

Fig. 11A

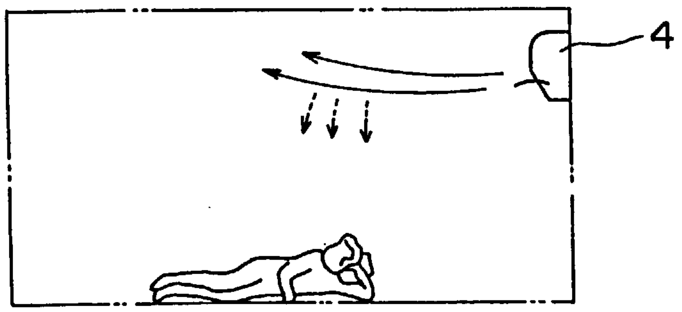


Fig. 11B

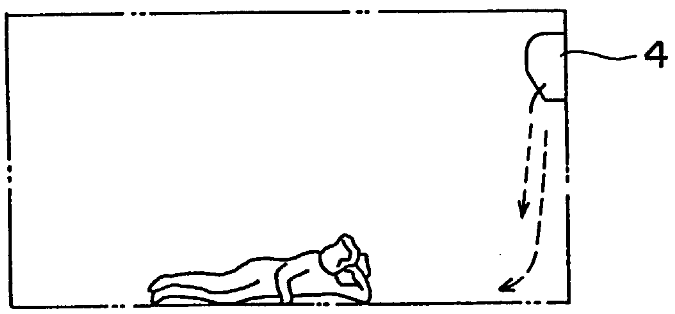


Fig. 11C