



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
18.06.2003 Bulletin 2003/25

(51) Int Cl.7: **F24F 11/02, F24F 6/00**

(21) Application number: **01967718.6**

(86) International application number:
PCT/JP01/08092

(22) Date of filing: **18.09.2001**

(87) International publication number:
WO 02/025183 (28.03.2002 Gazette 2002/12)

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**

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(30) Priority: **21.09.2000 JP 2000287158**

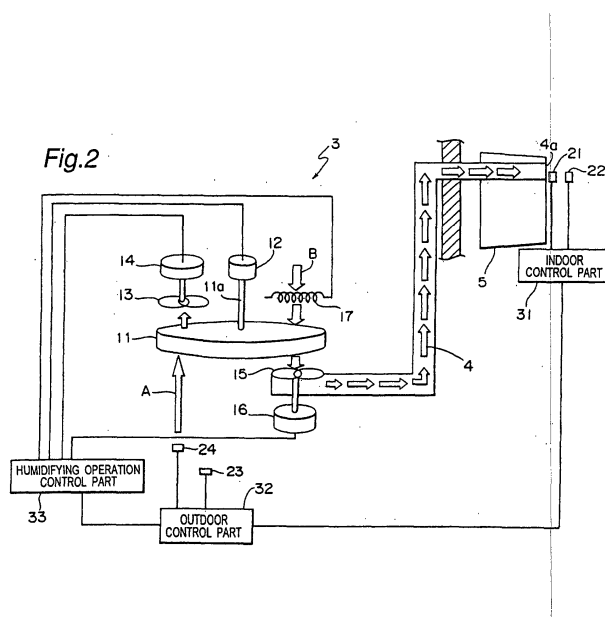
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(54) **HUMIDIFIER AND AIR CONDITIONER USING THE HUMIDIFIER**

(57) In a humidifier and an air conditioner using the humidifier, when a temperature of outside air detected by an outside air temperature sensor (24) is higher than an indoor temperature detected by an indoor temperature sensor (22) and when a humidity of the outside air is 90% or less so that the inside of the humidifying hose 4 can be dried, a drying operation is conducted. On the other hand, when a humidity of the outside air detected by an outside air humidity sensor (23) is higher than 90%, the drying operation is not conducted because the

inside of the humidifying hose (4) cannot be sufficiently dried even though the outside air is blown thereinto, namely, the drying efficiency is low. When the humidity of the outside air detected by the outside air humidity sensor (23) is 60% or more not allowing the inside of the humidifying hose (4) to be dried efficiently, the outside air to be blown into the humidifying hose 4 is heated with a heater (17). Thus, moisture condensation inside the humidifying hose (4) is prevented from occurring even when a humidifying operation is not conducted.



Description

TECHNICAL FIELD

[0001] The present invention relates to a humidifier which supplies a humidified air into a room, and an air conditioner using the humidifier.

BACKGROUND ART

[0002] A humidifier supplying a humidified air into a room from outside of the room is known. In the humidifier, moisture in the outside air is adsorbed onto an outdoor humidifying rotor and then desorbed from the humidifying rotor to humidify the air. The thus obtained humidified air is supplied to the interior of the room through a humidifying hose. By doing so, it is possible to adjust the relative humidity inside the room and improve the comfortableness inside the room. However, the humidifier has a problem that dewdrops inside the humidifying hose stay.

[0003] Accordingly, the present applicant proposed a humidifier capable of preventing the stay of dewdrops inside the humidifying hose by repeatedly alternating a humidifying operation of supplying a humidified air to the interior of a room from outdoors through the humidifying hose with a drying operation of blowing a dry air into the humidifying hose. The humidifier is here described to facilitate understanding of the present invention, although it is not a known art nor a prior art.

[0004] However, the humidifier has a problem that in summer when the humidifying operation is not required, hot and humid outside air flows into the humidifying hose, so that when the indoor temperature is lower than the outside air temperature, or the temperature of the outside air, owing to cooling of the room, moisture condenses to form dew inside the humidifying hose at its indoor side and dewdrops stay there.

DISCLOSURE OF THE INVENTION

[0005] Therefore, it is an object of the present invention to provide a humidifier and an air conditioner using the humidifier, the humidifier being capable of preventing moisture condensation inside a humidifying hose even when a humidifying operation is not conducted.

[0006] In order to accomplish the object, the present invention provides a humidifier performing a humidifying operation to supply a humidified air into a room from outside of the room through a humidifying hose, comprising an outside air temperature sensor detecting a temperature of outside air; an indoor temperature sensor detecting an indoor temperature; and a control part for executing a drying operation of blowing the outside air into the humidifying hose when the temperature of the outside air detected by the outside air temperature sensor is higher than the indoor temperature detected by the indoor temperature sensor and when a predetermined

condition is satisfied.

[0007] According to the humidifier having the above construction, when the temperature of the outside air detected by the outside air temperature sensor is higher than the indoor temperature detected by the indoor temperature sensor and when the predetermined condition (such as a relative humidity of the outside air at which moisture tends to condense inside the humidifying hose, a difference between the indoor temperature and the outside air temperature, or the like) is satisfied, the control part executes the drying operation of blowing the outside air into the humidifying hose. Thereby in a cooling operation in which the humidifying operation is not performed, moisture condensation inside the humidifying hose is prevented. Thus, reliability improves.

[0008] In one embodiment, the humidifier further comprises an outside air humidity sensor detecting a relative humidity of the outside air, and the control part executes the drying operation, based on the relative humidity of the outside air detected by the outside air humidity sensor.

[0009] According to the humidifier of the embodiment, when the relative humidity of the outside air is too high to dry the interior of the humidifying hose even though the outside air is blown into the humidifying hose, the control part does not conduct the drying operation. On the other hand, when the relative humidity of the outside air is appropriate for allowing the interior of the humidifying hose to be dried, the control part conducts the drying operation. Therefore, by referring to the relative humidity of the outside air detected by the outside air humidity sensor, the control part is capable of executing the drying operation appropriately.

[0010] In one embodiment, the control part executes the drying operation when the relative humidity of the outside air detected by the outside air humidity sensor is 90% or less.

[0011] According to the humidifier of the embodiment, when the humidity of the outside air is more than 90%, the inside of the humidifying hose cannot be sufficiently dried even though the outside air is blown into the humidifying hose and thus the efficiency is low. Thus the drying operation is not conducted. On the other hand, when the blowoff humidity is 90% or less so that the inside of the humidifying hose can be dried, the control part conducts the drying operation. Thus the drying operation can be accomplished efficiently based on the relative humidity of the outside air.

[0012] In one embodiment, the humidifier comprises a heater for heating outside air to be blown into the humidifying hose, and the control part controls the heater to heat the outside air to be blown into the humidifying hose in the drying operation, based on the relative humidity of the outside air detected by the outside air humidity sensor.

[0013] According to the humidifier of the embodiment, when the relative humidity of the outside air detected by the outside air humidity sensor is too high for drying the

interior of the humidifying hose, the control part is capable of accomplishing the drying operation efficiently by controlling the heater to heat the outside air to be blown into the humidifying hose in the drying operation.

[0014] In one embodiment, when the relative humidity of the outside air detected by the outside air humidity sensor is 60% or more, the control part controls the heater to heat the outside air to be blown into the humidifying hose in the drying operation.

[0015] According to the humidifier of the embodiment, when the relative humidity of the outside air detected by the outside air humidity sensor is 60% or more so that the inside of the humidifying hose cannot be dried efficiently, with the control part controlling the heater to heat the outside air to be blown into the humidifying hose in the drying operation based on the relative humidity of the outside air, the drying operation is performed efficiently and reliably.

[0016] In one embodiment, the humidifier comprises a blowoff humidity sensor detecting a relative humidity of air blown out from an outlet of the humidifying hose, and the control part executes the drying operation, based on the relative humidity of the blown air detected by the blowoff humidity sensor.

[0017] According to the humidifier of the embodiment, the drying performance and the degree of dryness in the humidifying hose can be estimated from values and variations of the relative humidity of air blown out from the outlet of the humidifying hose detected by the blowoff humidity sensor. Thus the control part is capable of accomplishing the drying operation efficiently.

[0018] In one embodiment, the control part controls the heater to heat the outside air to be blown into the humidifying hose in the drying operation, based on the temperature of the outside air detected by the outside air temperature sensor and the indoor temperature detected by the indoor temperature sensor.

[0019] According to the humidifier of the embodiment, when the difference between the temperature of the outside air and the indoor temperature is large, judging that moisture tends to condense, the control part controls the heater to heat the outside air to be blown into the humidifying hose in the drying operation. On the other hand, when the difference between the temperature of the outside air and the indoor temperature is small, the drying operation can be accomplished efficiently by turning off the heater.

[0020] The present invention also provides a humidifier performing a humidifying operation to supply a humidified air into a room from outside of the room through a humidifying hose, comprising a control part for executing a drying operation of blowing outside air into the humidifying hose when an associated refrigeration system operates in a cooling mode and when a predetermined condition is satisfied.

[0021] According to the humidifier having the construction, when the associated refrigeration system operates in the cooling mode and when the predetermined

condition (such as a relative humidity of outside air at which moisture tends to condense inside the humidifying hose, a difference between the indoor temperature and the outside air temperature, or the like) is satisfied, the control part executes the drying operation of blowing the outside air into the humidifying hose. Thereby even in the cooling operation time in which the humidifying operation is not performed, it is possible to prevent dew formation inside the humidifying hose and improve the reliability of the humidifier.

[0022] Also, the present invention provides an air conditioner using the humidifier described above.

[0023] According to the air conditioner, it is possible to realize the reliable air conditioner capable of preventing dew formation inside the humidifying hose even in the cooling operation in which the humidifying operation is not performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

Fig. 1 is a schematic block diagram showing an air conditioner using a humidifier of an embodiment of the present invention;

Fig. 2 is a block diagram showing essential parts of the air conditioner using the humidifier.

Fig. 3 is a flowchart showing processing of a drying operation of the humidifier; and

Fig. 4 is a flowchart subsequent to the flowchart of Fig. 3, showing processing of the drying operation of the humidifier.

BEST MODE FOR CARRYING OUT THE INVENTION

[0025] The humidifier and the air conditioner using it according to the present invention will be described in detail below by way of examples.

[0026] Fig. 1 is a schematic block diagram showing an air conditioner using a humidifier of an embodiment of the present invention. Reference numeral 1 denotes an indoor unit. Reference numeral 2 denotes an outdoor unit. Reference numeral 3 denotes a humidifier disposed above the outdoor unit 2. Reference numeral 4 denotes a humidifying hose connecting the indoor unit 1 and the humidifier 3 to each other. In the air conditioner using the humidifier, in a heating operation, a humidified air is supplied from the humidifier 3 to the indoor unit 1 through the humidifying hose 4 to humidify the interior of a room.

[0027] Fig. 2 is a block diagram showing essential parts of the air conditioner using the humidifier shown in Fig. 1. The humidifier 3 has a disk-shaped humidifying rotor 11 disposed inside a casing (not shown) thereof. The humidifying rotor 11 is formed by molding an adsorbent such as silica gel, zeolite, and alumina into a honeycomb configuration or a porous and grained configuration. The humidifying rotor 11 is rotated around an

axis 11a by a motor 12 therefor. The inside of the casing is partitioned with a partitioning plate (not shown) to form a moisture pickup passage A and a humidifying passage B both passing through each portion of the humidifying rotor 11.

[0028] At a downstream side of the moisture pickup passage A with respect to the humidifying rotor 11, a moisture-absorbing fan 13 and a motor 14 for driving the moisture-absorbing fan 13 are provided. The humidifying rotor 11 picks up moisture (adsorbs moisture) from air flowing through the moisture pickup passage A in a direction shown with an arrow. On the other hand, at a downstream side of the humidifying passage B with respect to the humidifying rotor 11, a humidifying fan 15 and a motor 16 for driving the humidifying fan 15 are provided to suck air and flow it in a direction shown with arrows. A heater 17 is provided on the humidifying passage B upstream of the humidifying rotor 11. While air heated by the heater 17 passes through the humidifying rotor 11, the air is humidified (moisture is desorbed from the humidifying rotor 11) by the humidifying rotor 11. In this way, the moisture the humidifying rotor 11 has picked up from the air flowing along the moisture pickup passage A is desorbed therefrom by the air heated by the heater 17, and the air is humidified. The thus humidified air is sent to the humidifying hose 4 by the humidifying fan 15.

[0029] In Fig. 2, reference numeral 21 denotes a blow-off humidity sensor 21 disposed in the vicinity of an outlet 4a of the humidifying hose 4 inside a body 5 of the indoor unit for detecting a relative humidity of blowoff air (hereinafter referred to as "blowoff humidity"). Reference numeral 22 denotes an indoor temperature sensor detecting an indoor temperature. Reference numeral 23 denotes an outside air humidity sensor detecting a relative humidity of outside air (hereinafter referred to as "outside air humidity"). Reference numeral 24 denotes an outside air temperature sensor detecting the temperature of outside air. Reference numeral 31 denotes an indoor control part 31 controlling an indoor fan (not shown) and other parts upon receipt of signals from the blowoff humidity sensor 21 and the indoor temperature sensor 22. Reference numeral 32 denotes an outdoor control part controlling a compressor (not shown) and other parts upon receipt of signals from the outside air humidity sensor 23 and the outside air temperature sensor 24. Reference numeral 33 denotes a humidifying operation control part controlling the humidifying operation upon receipt of a signal from the outdoor control part 32. The humidifying operation control part 33 controls the motor 12 for the humidifying rotor, the motor 14 for the moisture-absorbing fan, the motor 16 for the humidifying fan, and the heater 17.

[0030] In a heating operation in winter, the air conditioner using the humidifier 3 repeatedly alternates the humidifying operation of blowing the humidified air into the room through the humidifying hose 4 with a drying operation of blowing a dry air heated by the heater 17

into the humidifying hose 4 to dry the inside of the humidifying hose 4 to thereby prevent moisture condensation inside the humidifying hose 4 and the stay of dewdrops therein.

[0031] On the other hand, in a cooling operation in summer, the humidifying fan 15 is operated at predetermined time intervals, with the humidifying rotor 11 stopped, to perform the drying operation of blowing outside air into the humidifying hose 4, whereby a hot and humid outside air is prevented from flowing into the humidifying hose 4, which in turn prevents moisture condensation inside the humidifying hose 4 at its indoor side and stay of dewdrops therein from occurrence.

[0032] Figs. 3 and 4 are flowcharts showing the drying operation processing at the cooling operation time not accompanied with the humidifying operation of the humidifier 3.

[0033] Initially, when the cooling operation starts, it is determined at step S1 whether twenty minutes have elapsed since the processing started. If it is determined that twenty minutes have not elapsed, the processing at step S1 is repeated. If it is determined that twenty minutes have elapsed, the program goes to step S2.

[0034] Then it is determined at step S2 whether the temperature of the outside air is higher than the indoor temperature. If it is determined that the temperature of the outside air is higher than the indoor temperature, the program goes to step S3. On the other hand, if it is determined that the temperature of the outside air is equal to or lower than the indoor temperature, the processing at step S2 is repeated. That an outside air temperature is higher than the temperature of an indoor heat exchanger by a predetermined temperature or more may be set as the condition at step S2.

[0035] Thereafter at step S3, the humidifying fan 15 is operated to blow the outside air into the humidifying hose 4.

[0036] Thereafter the program goes to step S4 at which a timer T1 is started. Thereafter the program goes to step S5 at which a timer T2 is started. The timer T1 clocks a minimum drying operation time period. The timer T2 clocks a maximum drying operation time period.

[0037] Thereafter it is determined whether a blowoff humidity detected by the blowoff humidity sensor 21 is 80% or more. If it is determined that the blowoff humidity is 80% or more, the program goes to step S8 at which the heater 17 is turned on. On the other hand, if it is determined at step S6 that the blowoff humidity is less than 80%, the program goes to step S7 at which the heater 17 is turned off. That is, if the blowoff humidity of the humidifying hose 4 at a time immediately after the humidifying fan 15 starts is 80% or more, it is determined that the drying capability is insufficient and the heater 17 is turned on.

[0038] Then the program goes to step S9 at which it is determined whether the counting of the timer T1 has terminated. If it is determined that the counting of the timer T1 has not terminated, the program returns to step

S6. If it is determined that the counting of the timer T1 has terminated, the program goes to step S10 shown in Fig. 4.

[0039] Thereafter it is determined at step S10 shown in Fig. 4 whether the blowoff humidity detected by the blowoff humidity sensor 21 is 60% or less. If it is determined that the blowoff humidity is 60% or less, the program goes to step S11. On the other hand, if it is determined at step S6 that the blowoff humidity is over 60%, the program goes to step S12.

[0040] Thereafter it is determined at step S11 whether the gradient of the blowoff humidity is down. If it is determined that the gradient of the blowoff humidity is down, the program goes to step S12. On the other hand, if it is determined that the gradient of the blowoff humidity is not down, the program goes to step S13. That is, when the gradient of the blowoff humidity is not down, it is determined that there are no dewdrops left inside the humidifying hose 4. In this way, time to terminate the drying operation is determined.

[0041] It is determined at step S12 whether the counting of the timer T2 has terminated. If it is determined that the counting of the timer T2 has not terminated, the program returns to step S10. On the other hand, if it is determined that the counting of the timer T2 has terminated, the program goes to step S13.

[0042] Thereafter at step S13, the heater 17 is turned off. At step S14, the humidifying fan 15 is stopped.

[0043] Thereafter the program goes to step S15 at which the blowoff humidity is monitored. Thereafter the program goes to step S16 at which it is determined whether or not the monitored blowoff humidity is 90% or more. If it is determined at step S16 that the blowoff humidity is 90% or more, the program goes to step S17. On the other hand, if it is determined that the blowoff humidity is less than 90%, the program returns to step S15. That is, when the blowoff humidity of the humidifying hose 4 is as high as 90% or more even after the humidifying fan 15 has stopped, it is determined that the drying operation is required, and the program goes to the next drying operation.

[0044] Thereafter an interval timer T3 is started. Then the program goes to step S18 at which it is determined whether the counting of the interval timer T3 has terminated. If it is determined at step S18 that the counting of the interval timer T3 has terminated, the program returns to step S2 shown in Fig. 3. On the other hand, if it is determined that the counting of the interval timer T3 has not terminated, the processing at step S18 is repeated.

[0045] As described above, in the air conditioner using the humidifier 3, when the temperature of the outside air detected by the outside air temperature sensor 24 is higher than the indoor temperature detected by the indoor temperature sensor 22 and when a predetermined condition is satisfied, the drying operation of blowing the outside air into the humidifying hose 4 is performed. Thereby, even when the humidifying operation is not

performed, such as during a cooling operation, moisture condensation, i.e. dew formation inside the humidifying hose 4 can be prevented.

[0046] Further the drying performance and the degree of dryness in the humidifying hose 4 can be estimated from a value and variation of the blowoff humidity detected by the blowoff humidity sensor 21. Thus an efficient drying operation can be accomplished.

[0047] According to the humidifier of the present invention, it is possible to realize a reliable air conditioner capable of preventing moisture condensation inside the humidifying hose even in the cooling operation time in which the humidifying operation is not performed.

[0048] In the above-described embodiment, the drying operation of blowing the outside air into the humidifying hose 4 is performed when the temperature of the outside air detected by the outside air temperature sensor 24 is higher than the indoor temperature detected by the indoor temperature sensor 22 and at the same time when the predetermined condition is satisfied. Alternatively, the drying operation of blowing the outside air into the humidifying hose may be performed when a refrigerating apparatus, which is an air conditioner, operates in a cooling mode and when the predetermined condition is satisfied. Then, the moisture condensation inside the humidifying hose can be prevented even when the cooling operation involving no humidifying operation is performed.

[0049] In the above-described embodiment, when the blowoff humidity of the humidifying hose 4 is 90% or more, the drying operation is again executed. Alternatively, the drying operation may be controlled based on the humidity of the outside air. For example, when the humidity of the outside air detected by the outside air humidity sensor 23 is 90% or more, the drying operation is not carried out. This is because blowing of the outside air into the humidifying hose 4 cannot dry the inside of the humidifying hose 4 sufficiently, meaning that the efficiency is low. On the other hand, when the humidity of the outside air is less than 90% so that the inside of the humidifying hose 4 can be dried, the drying operation is made. Thus an efficient drying operation can be accomplished.

[0050] Also, in the above-described embodiment, the heater 17 is turned on when the blowoff humidity of the humidifying hose 4 is 80% or more. Alternatively, on and off of the heater may be controlled based on the humidity of the outside air. For example, when the humidity of the outside air detected by the outside air humidity sensor 23 is 60% or more so that the inside of the humidifying hose 4 may not be dried efficiently, heating the outside air to be blown into the humidifying hose 4 by the heater 17 allows an efficient drying operation to be reliably accomplished.

[0051] Further, the heater 17 heating the outside air to be blown into the humidifying hose 4 in the drying operation may be turned on and off based on both the temperature of the outside air detected by the outside air

temperature sensor 24 and the indoor temperature detected by the indoor temperature sensor 22. In this case, when the difference between the outside air temperature and the indoor temperature is larger than a predetermined temperature, the heater 17 may be turned on. On the other hand, when the difference between the outside air temperature and the indoor temperature is smaller than the predetermined temperature, the heater 17 may be turned off. Thereby an efficient drying operation can be accomplished.

[0052] In the above-described embodiment, the blow-off humidity is detected by the blowoff humidity sensor 21 disposed in the vicinity of the outlet 4a of the humidifying hose 4 at the body 5 of the indoor unit. Alternatively, a humidity sensor detecting the humidity of air blown into the humidifying hose 4 may be disposed at the inlet of the humidifying hose at the humidifier so that the heater 17, which heats the outside air to be blown into the humidifying hose 4 in the drying operation time, is turned on and off based on the detected humidity of the blown air.

[0053] Further a temperature sensor detecting the temperature of the outside air to be blown into the humidifying hose 4 may be disposed at the inlet of the humidifying hose 4 so that the heater 17 is turned on and off based on the temperature of the outside air detected by the temperature sensor.

Claims

1. A humidifier performing a humidifying operation to supply a humidified air into a room from outside of the room through a humidifying hose (4), comprising:

an outside air temperature sensor (24) detecting a temperature of outside air;
an indoor temperature sensor (22) detecting an indoor temperature; and
a control part (32) for executing a drying operation of blowing the outside air into the humidifying hose (4) when the temperature of the outside air detected by the outside air temperature sensor (24) is higher than the indoor temperature detected by the indoor temperature sensor (22) and when a predetermined condition is satisfied.

2. A humidifier according to claim 1, comprising an outside air humidity sensor (23) detecting a relative humidity of the outside air,
wherein the control part (32) executes the drying operation, based on the relative humidity of the outside air detected by the outside air humidity sensor (23).

3. A humidifier according to claim 2, wherein when the

relative humidity of the outside air detected by the outside air humidity sensor (23) is equal to or less than 90%, the control part (32) executes the drying operation.

4. A humidifier according to claim 2, comprising a heater (17) for heating outside air to be blown into the humidifying hose (4),

wherein the control part (32) controls the heater (17) to heat the outside air to be blown into the humidifying hose (4) in the drying operation, based on the relative humidity of the outside air detected by the outside air humidity sensor (23).

5. A humidifier according to claim 4, wherein when the relative humidity of the outside air detected by the outside air humidity sensor (23) is 60% or more, the control part (32) controls the heater (17) to heat the outside air to be blown into the humidifying hose (4) in the drying operation.

6. A humidifier according to claim 1, comprising a blowoff humidity sensor (21) detecting a relative humidity of air blown out from an outlet of the humidifying hose (4),

wherein the control part executes the drying operation, based on the relative humidity of the blown air detected by the blowoff humidity sensor (21).

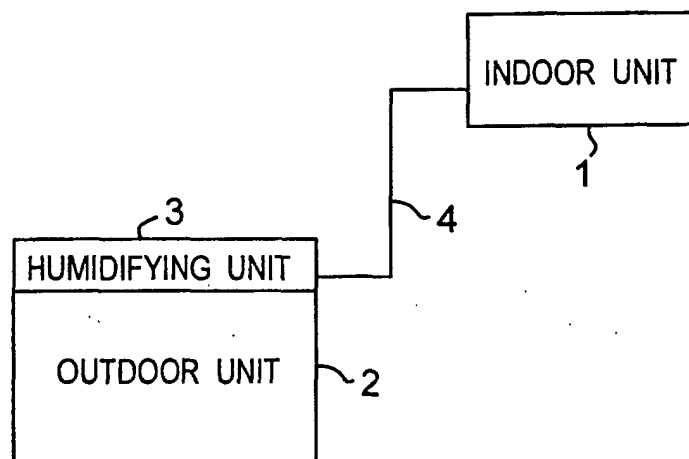
7. A humidifier according to claim 1, wherein the control part (32) controls the heater (17) to heat the outside air to be blown into the humidifying hose (4) in the drying operation, based on the temperature of the outside air detected by the outside air temperature sensor (24) and the indoor temperature detected by the indoor temperature sensor (22).

8. A humidifier performing a humidifying operation to supply a humidified air into a room from outside of the room through a humidifying hose (4), comprising:

a control part (32) for executing a drying operation of blowing outside air into the humidifying hose (4) when an associated refrigeration system operates in a cooling mode and when a predetermined condition is satisfied.

9. An air conditioner using the humidifier according to claim 1 or 8.

Fig.1



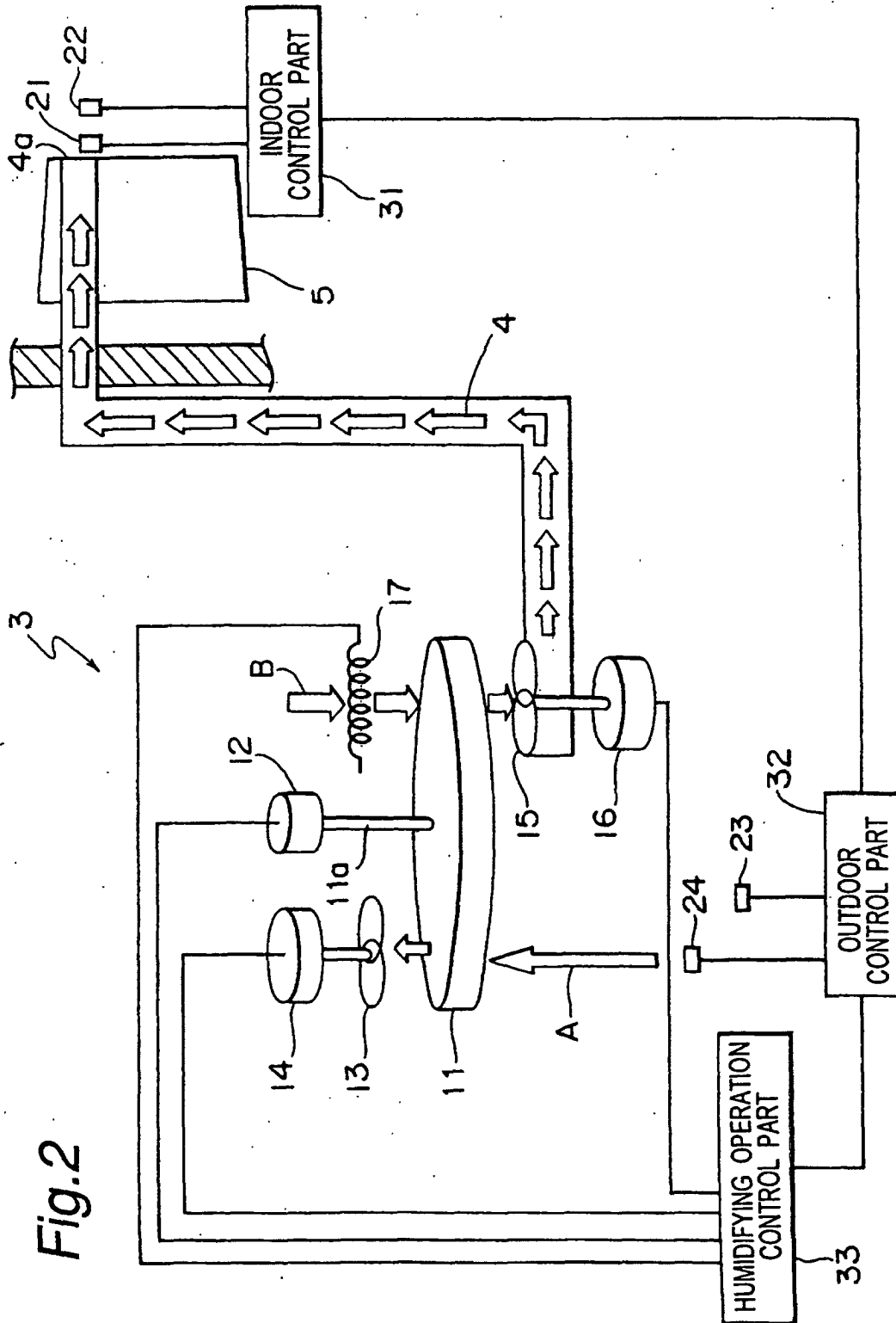


Fig. 2

Fig.3

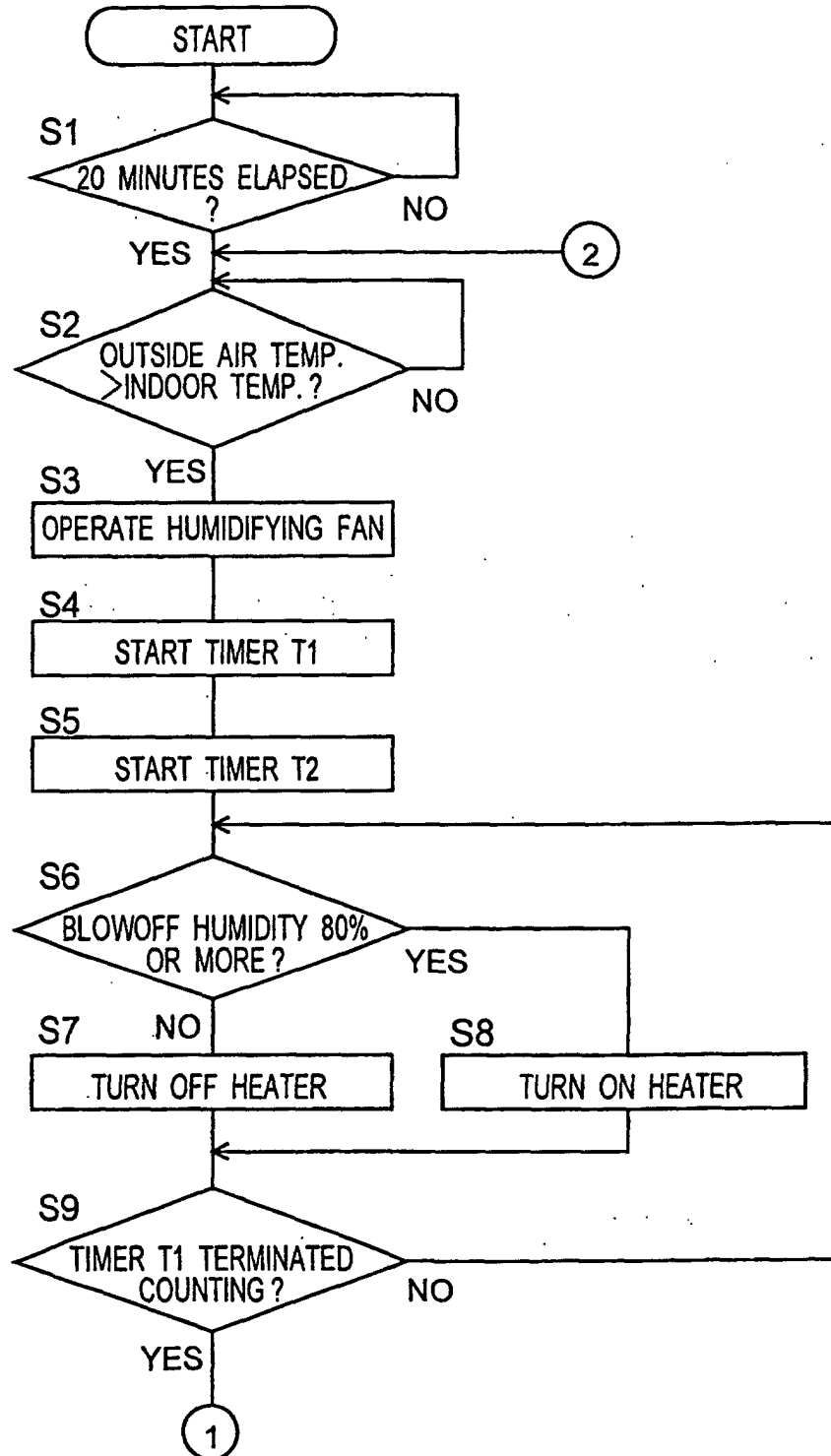
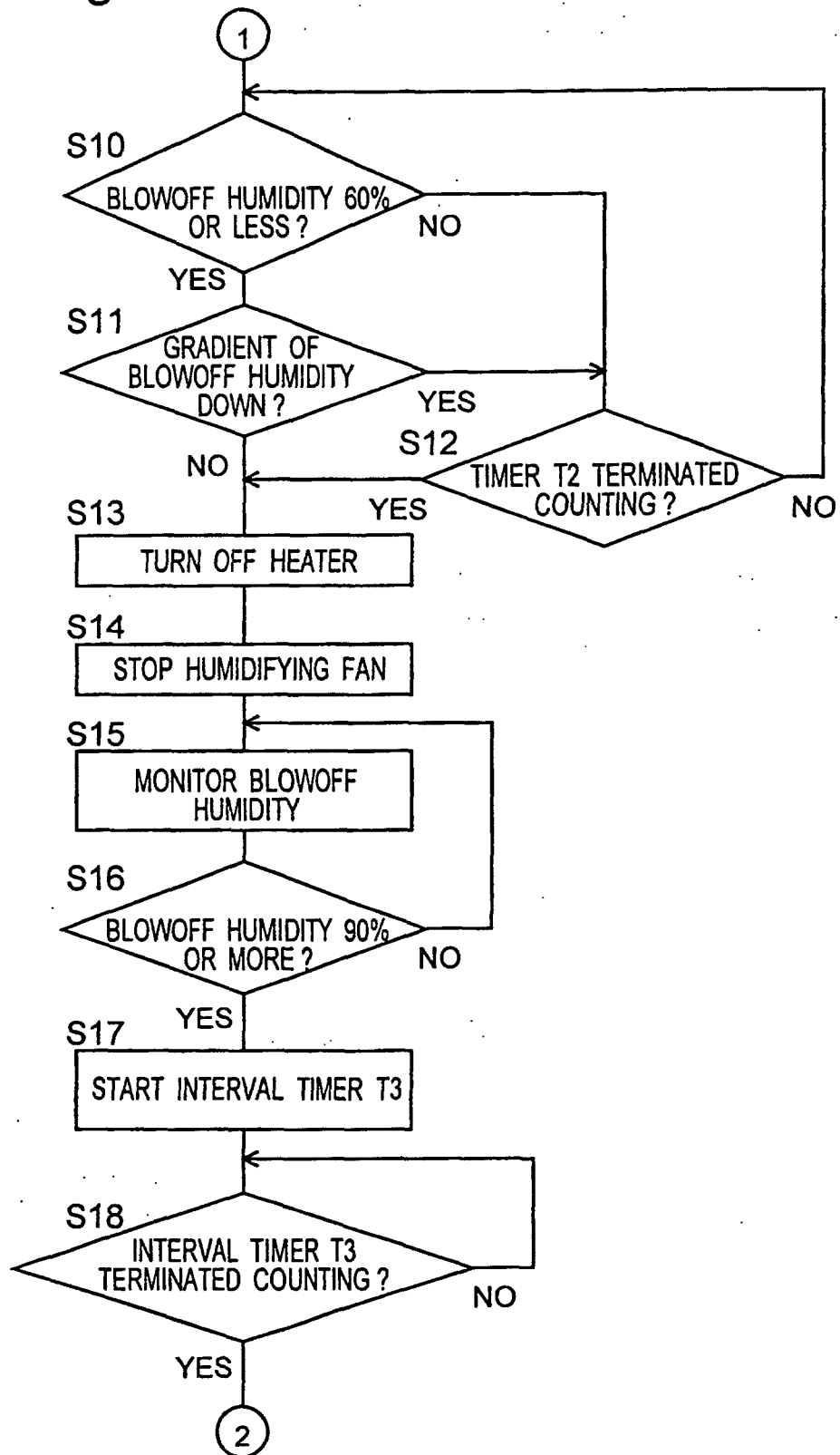


Fig.4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/08092

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ F24F11/02, 102 F24F6/00, 331		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ F24F11/02, F24F6/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2001 Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-267331 A (Sharp Corporation), 09 October, 1998 (09.10.98), (Family: none) Full text	1-9
Y	JP 5-272792 A (Kubota Corporation), 19 October, 1993 (19.10.93), (Family: none) Full text	1-9
Y	JP 4-208333 A (Matsushita Seiko Co., Ltd.), 30 July, 1992 (30.07.92), (Family: none) Full text	1-9
Y	JP 11-241842 A (Sanyo Electric Co., Ltd.), 07 September, 1999 (07.09.99), (Family: none) Full text	1-9
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Date of the actual completion of the international search 07 November, 2001 (07.11.01)		Date of mailing of the international search report 20 November, 2001 (20.11.01)
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