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

(11) EP 1 508 752 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**23.02.2005 Bulletin 2005/08**

(51) Int Cl.7: **F24F 3/153**, F24F 11/00

(21) Application number: **03018687.8**

(22) Date of filing: **22.08.2003**

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

(71) Applicants:
- **Huang, Chi-Seng**
  **Beitou Chiu, Tapei (TW)**
- **Pan, Chi-Chuan**
  **Sanchung City, Tapei (TW)**

(72) Inventors:
- **Huang, Chi-Seng**
  **Beitou Chiu, Tapei (TW)**
- **Pan, Chi-Chuan**
  **Sanchung City, Tapei (TW)**

(74) Representative: **VOSSIUS & PARTNER**
**Siebertstrasse 4**
**81675 München (DE)**

# (54) Thermohygrostat-type air conditioner with means for controlling evaporation temperature

(57) A thermohygrostat-type air conditioner with means for controlling evaporation temperature is characterized in that a temperature detector (72) is mounted on a return pipe between an evaporator (31,32) and a compressor (21,22) for detecting an existing temperature of the coiled return pipe from time to time. The detected temperature value is sent to a temperature controller (71) adapted to control operation of the compressor, so that the temperature controller (71) may regulate a rotary speed of the compressor (21,22) based on the existing temperature of the coiled return pipe and thereby maintains the return pipe at a preset temperature. In this manner, an evaporation temperature of a cooling coil pipe may be effectively controlled, and a stable humidity may be maintained in air conditioning with a low-cost and high-efficient apparatus.

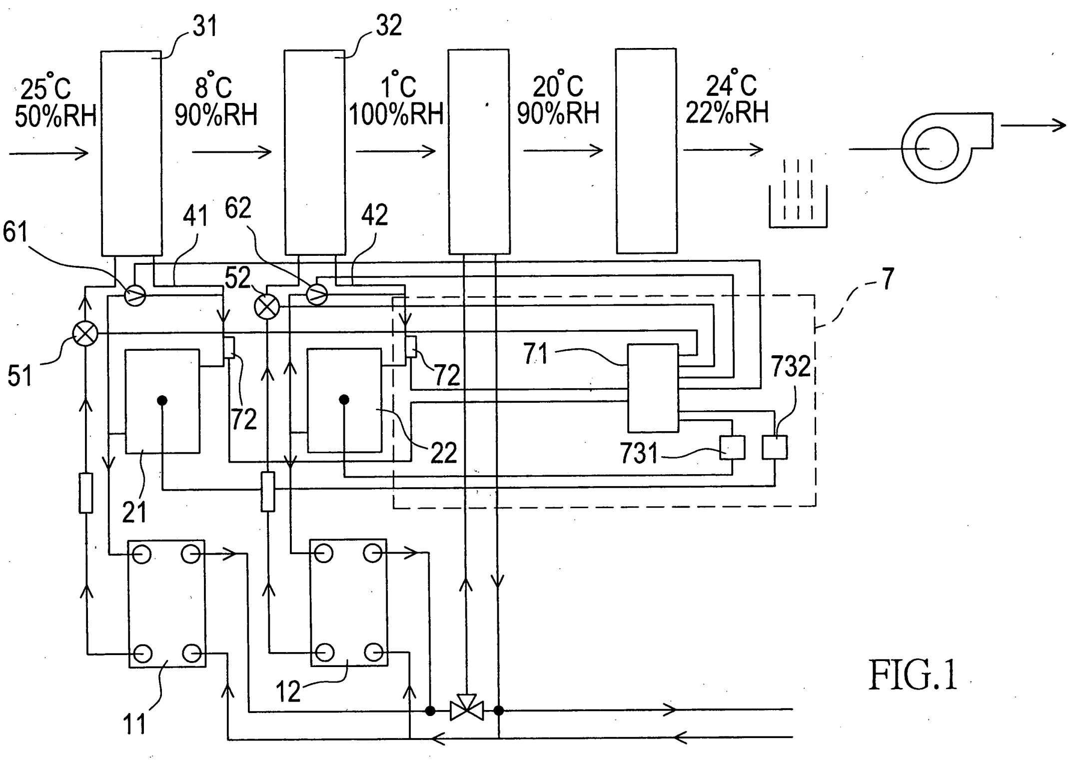


FIG.1

EP 1 508 752 A1

## Description

**[0001]** The present invention relates to a thermohygrostat-type air conditioner with means for controlling evaporation temperature, and more particularly to a low power-consumption air conditioner, an evaporator of which has a return pipe maintained at a preset temperature to enable stable control of indoor temperature and humidity.

**[0002]** When a general air conditioner is operated at low temperature and low humidity, a designed temperature difference of 5°C between an air-out temperature and a cooling coil pipe of an evaporator of the air conditioner is usually maintained. When the evaporator having a low temperature intercommunicates with the indoor high-temperature air, it would absorb water molecules in the indoor air to produce water drops, so as to achieve the purpose of dehumidifying. However, this type of freeze dehumidification tends to cause a surface temperature of the cooling coil pipe lower than the freezing temperature that results in frosting and freezing on, surfaces of a return pipe of the evaporator and prevents the air conditioner from stably controlling the dehumidification and the indoor humidity.

**[0003]** Fig. 3 is a block diagram showing an internal structure of a general air conditioner capable of stably maintaining a fixed humidity. The air conditioner mainly internally includes an evaporator 82 having a return pipe 821, and a chemical dehumidifier 90 provided near the return pipe 821. The chemical dehumidifier 90 includes:

a dehumidifying wheel 91 located above an outer pipe wall of the return pipe 821 for absorbing surplus moisture on the return pipe 821;

an electric heater 92 provided to one side of the dehumidifying wheel 91 for heating and drying the moisture absorbed by the dehumidifying wheel 91; and

at least one set of air feeder 93 provided at an air outlet of the dehumidifying wheel 91 for sending out moisture produced by the dehumidifying wheel 91 during drying.

**[0004]** In the main dehumidification principle employed by the chemical dehumidifier 90, the surplus moisture on the return pipe 821 is absorbed using the dehumidifying wheel 91 until the latter is saturated. Then, the electric heater 92 is heated to dry the moisture for the dehumidifying wheel 91 to proceed with the next cycle of dehumidification. However, while the chemical dehumidifier 90 proceeds with the drying by heating, it is also necessary to ensure the air-out of the evaporator has a temperature maintained at a preset value'. Thus, a compressor 81 of the air conditioner still has to keep operation at a high speed for a condenser 80 to provide more refrigerant to the evaporator 82. Therefore, it can be found that the use of the chemical dehumidifier 90 would cause double waste of energy by the air conditioner separately at the time the moisture produced by the dehumidifying wheel 91 is electrically heated and dried, and the condenser 80 consumes more power to reduce the temperature of the refrigerant sent to the evaporator 82 to balance a temperature difference produced at heating of the heater 92. Therefore, although the provision of the chemical dehumidifier 90 enables the air conditioner to achieve the function of reducing temperature and humidity, it also increases the manufacturing cost and power consumption of the air conditioner.

**[0005]** It is therefore necessary to improve the conventional air conditioner having the chemical dehumidifier associated therewith.

**[0006]** A primary object of the present invention is to provide an air conditioner that does not require a chemical dehumidifier and may effectively adjust refrigerant flow using internal structures, so that a cooling coil pipe thereof may be effectively controlled to maintain at a preset temperature. In this manner, a return pipe of an evaporator in the air conditioner may have a temperature not lower than the preset temperature.

**[0007]** Another object of the present invention is to provide a low power-consumption and low manufacturing cost thermostat.

**[0008]** These objects are achieved with the features of the claims.

**[0009]** The presentinventionrelatestoathermohygrostat-type air conditioner with means for controlling evaporation temperature, being characterized in that a temperature detector is mounted on a return pipe between an evaporator and a compressor for detecting a current temperature of the coiled return pipe from time to time.

**[0010]** The detected temperature value is sent to a temperature controller adapted to control operation of the compressor, so that the temperature controller may regulate a rotating speed of the compressor based on the current temperature of the coiled return pipe and thereby maintains the return pipe at a preset temperature. In this manner, an evaporation temperature of a cooling coil pipe may be effectively controlled, and a stable humidity may be maintained in air conditioning with a low-cost and high-efficient apparatus.

**[0011]** To achieve the above objects, the air conditioner of the present invention includes:

at least one set of evaporator, each of which has an expansion valve provided on a refrigerant input pipe near an inlet thereof, and a return pipe connected to a refrigerant output thereof;

at least one set of compressor, each of which is connected to the return pipe of one corresponding evaporator;

at least one set of condenser, each of which has an output connected to a high-pressure high-temperature gaseous refrigerant output pipe of one corresponding compressor to lower the temperature of the refrigerant; and

a temperature-control circuit connected to each compressor and the return pipe of each evaporator for detecting an existing temperature of the return pipe, and comparing the detected temperature with a preset temperature for controlling the rotary speed of the compressor.

**[0012]** Via the temperature detector on the return pipe of the evaporator, the temperature control circuit determines whether the temperature of the return pipe is close to the present temperature. That is, when it is detected the temperature of the return pipe of the evaporator is lower than the preset temperature, the control circuit outputs a signal via a frequency converter to reduce the rotary speed of the compressor and thereby raises the temperature of cool air output from the evaporator and accordingly increases the temperature at the pipe wall of the return pipe. In this manner, it can be ensured the return pipe would not have a temperature lower than the preset temperature and the phenomenon of frosting on the surfaces of the return pipe may be eliminated.

**[0013]** With the same structure as the above-described air conditioner, the thermostat includes a temperature control circuit having low power-consumption temperature controller, frequency converter, and temperature detector, and can therefore save the power consumption and have a manufacturing costl ower than the conventional chemical dehumidifier.

**[0014]** The structure and the technical means adopted by the present invention to achieve the above and other objects can be best understood by referring to the following detailed description of the preferred embodiments and the accompanying drawings, wherein

Fig. 1 is a block diagram of an air conditioner according to a first preferred embodiment of the present invention;

Fig. 2 is a block diagram of an air conditioner according to a second preferred embodiment of the present invention; and

Fig. 3 is a block diagram of a conventional air conditioner using a chemical dehumidifier.

**[0015]** The present invention relates to an air conditioner having low power consumption and ensuring stable control of temperature. That is, the present invention relates to an air conditioner providing the function of a thermohygrostat without using a chemical dehumidifier.

**[0016]** Please refer to Fig. 1 that is a block diagram of an air conditioner according to the present invention. As shown, the air conditioner mainly includes the following components:

at least one set of evaporator 31, each of which has an expansion valve 51 provided on a refrigerant input pipe near an inlet thereof, and has a return pipe 41 connected to a refrigerant output thereof;

at least one set of compressor 21, each of which is connected to the return pipe 41 of one corresponding evaporator 31;

at least one set of condenser 11, each of which has an output connected to a high-pressure high-temperature gaseous refrigerant output pipe of one corresponding compressor 21, in order to lower the temperature of the refrigerant; and

a temperature-control circuit 7 connected between each compressor 21 and the return pipe 41 of a corresponding evaporator 31 for detecting an existing temperature of the return pipe 41, and the detected temperature being compared with a preset temperature for controlling movements of the compressor 21. The temperature-control circuit 7 includes:

a temperature controller 71, an output of which is connected to the expansion valve 51 of each evaporator 31 for controlling the amount of refrigerant input via the expansion valve 51 to the corresponding evaporator 31; and another output of which is connected to each heat bypass valve 61 for controlling the compressor 21, so that a part of surplus heat of the compressor 21 is automatically bypassed to a low-pressure side to further stabilize the evaporation temperature of the system;

at least one set of temperature detector 72, each of which is mounted on a surface of one corresponding return pipe 41, and has an output connected to said temperature controller 71; and

at least one set of frequency converter 731, each of which has an input connected to the above-mentioned temperature controller 71, and an output connected to one corresponding compressor 21 for controlling a rotary speed of the compressor 21.

**[0017]** A more detailed description of an operating procedures of the above-mentioned embodiment of the present invention will now be provided with reference to the accompanying drawings. Please refer to Fig. 1 in which an air conditioner according to a first preferred embodiment of the present invention is shown. As shown, the air conditioner includes two sets of evaporators 31, 32, two sets of condensers 11, 12, two sets of compressors 21, 22, and a set of temperature control circuit 7 on which a temperature value absolutely not lower than a freezing temperature is preset. When the air conditioner is initially started, there is a relatively high indoor temperature, and the temperature detector 72 connected to the return pipe 41 of the evaporator 31 detects a temperature higher than the preset temperature value. At this point, the temperature controller 71 would control the first and the second compressor 21, 22 via two corresponding frequency converters 731, 732. That is, the first compressor 21 is caused to operate at a full speed while the second compressor 22 is caused to operate at a normal speed, so that the indoor temperature may be lowered within a short time. And, when the temperature detector 72 detects that the return pipe 42 has a lowered temperature and a difference between it and the preset temperature value is only 0.5°C, the temperature controller 71 would control the frequency converter 731 connected to the first compressor 21 for the first compressor 21 to slow down and finally return to its normal operating speed.

**[0018]** In the event the temperature detector 72 detects that the return pipe 42 has reached the preset temperature, the temperature controller 71 would also control the frequency converter 731 for the first compressor 21 to lower down its rotary speed to a minimum allowable speed while the second compressor 22 is maintained at its normal rotary speed. At this point, since the indoor temperature, is very close to the preset temperature for the air conditioning, only one compressor, that is the first compressor 21, is used as a main power source to circulate the refrigerant.

**[0019]** When the second compressor 22 keeps operating for the evaporator 32 to output air having a relatively low temperature, the temperature detector 72 connected to the return pipe 42 of the evaporator 32 would detect a temperature lower than that preset on the temperature controller 71. Therefore, the temperature controller 71 would reduce the rotary speed of the second compressor 22 via the frequency converter 732 connected to the second compressor 22. Thereby, the gaseous refrigerant output from the condenser 12 to the evaporator 32 is relatively reduced in volume, and the temperature at an outlet of the evaporator 32 rises to maintain a surface temperature of the return pipe 42 at the preset temperature value. In other words, moisture condensed through heat exchange in the air makes the evaporator 32 having a temperature not lower than the temperature preset for the return pipe 41, so that the air conditioner may stably control the temperature and the humidity. When a load of the air conditioner is further reduced, the heat bypass valve 61 controlled by the output of the temperature controller 71 is used to control the surplus energy of the compressor 21, so that a part of the heat is automatically bypassed to the low-pressure side to further stabilize the evaporation temperature of the system.

**[0020]** Please refer to Fig. 2 that shows a second preferred embodiment of the present invention. The air conditioner of the second embodiment is generally structurally similar to the first embodiment, except that an additional set of refrigerant circulation system is provided to more quickly reduce the indoor temperature within a preset time. Similarly, the additional refrigerant circulation system is provided on the return pipe 43 of the evaporator 33 with a temperature detector 72 to detect a temperature on the return pipe 43 and input the detected value into the temperature controller 71, so that the temperature controller 71 determines a difference between the temperature detected by the temperature detector 72 and the preset temperature value to control the movements of the compressors 21, 22, 23 based on the determined difference of temperature. That is, the air conditioner may stably control the temperature and humidity through adjusting an output of the refrigerant.

**[0021]** From the above description, it is understood the present invention utilizes simple temperature control circuit to monitor and control movements of the evaporators and compressors inside the air conditioner, so that the return pipes of the evaporators are always maintained at a temperature higher than the preset temperature value without the risk of having a frozen pipe wall. Unlike the conventional air conditioner that has a compressor consuming increased power, the air conditioner of the present invention with the above-described design not only consumes low electric energy, but also effectively eliminates the problem of a return pipe having frozen pipe wall through utilization of surplus heat to dry the return pipe. Therefore, the present invention enables a general air conditioner to stably control the humidity at low cost and low power consumption without mounting the chemical dehumidifier.

## Claims

1. A thermohygrostat-type air conditioner with means for controlling evaporation temperature, comprising:

   at least one set of evaporator, each of which having an expansion valve provided on a refrigerant input pipe near an inlet thereof, and a return pipe connected to a refrigerant output thereof;

   at least one set of compressor, each of which being connected to said return pipe of a corresponding one of said evaporator;

   at least one set of condenser, each of which having an output connected to a high-pressure high-temperature gaseous refrigerant output pipe of a corresponding one of said compressor for lowering a temperature of said refrigerant;

and

a temperature-control circuit being connected between said return pipe of each said evaporator, each said compressor, and said expansion valve for detecting an existing temperature of said return pipe, and comparing a detected temperature with a preset temperature for controlling a rotary speed of said compressor, as well as open and close of said expansion valve to prevent said return pipe from having a frozen pipe wall; and

said temperature control circuit being also connected to a heat bypass valve provided between a high-pressure outlet of each said compressor and said return pipe of each said evaporator for controlling an existing temperature of said return pipe, and comparing said existing temperature of said return pipe with a preset temperature to control surplus energy of said compressor for further stabilizing an evaporation temperature of said air conditioner system.

**2.** The thermohygrostat-type air conditioner with means for controlling evaporation temperature as claimed in claim 1, wherein said temperature control circuit includes:

a temperature controller;

at least one set of temperature detector, each of which being mounted on a surface of a corresponding one of said return pipe, and having an output connected to said temperature controller;

at least one set of frequency converter, each of which having an input connected to said temperature controller, and an output connected to a corresponding one of said compressor for controlling a rotary speed of said compressor; and

at least one set of heat bypass valve, each of which having an input connected to said temperature controller, and each said heat bypass valve being connected to the high-pressure outlet of a corresponding one of said compressor and said return pipe of a corresponding one of said evaporator for controlling the evaporation temperature of said air conditioner system.

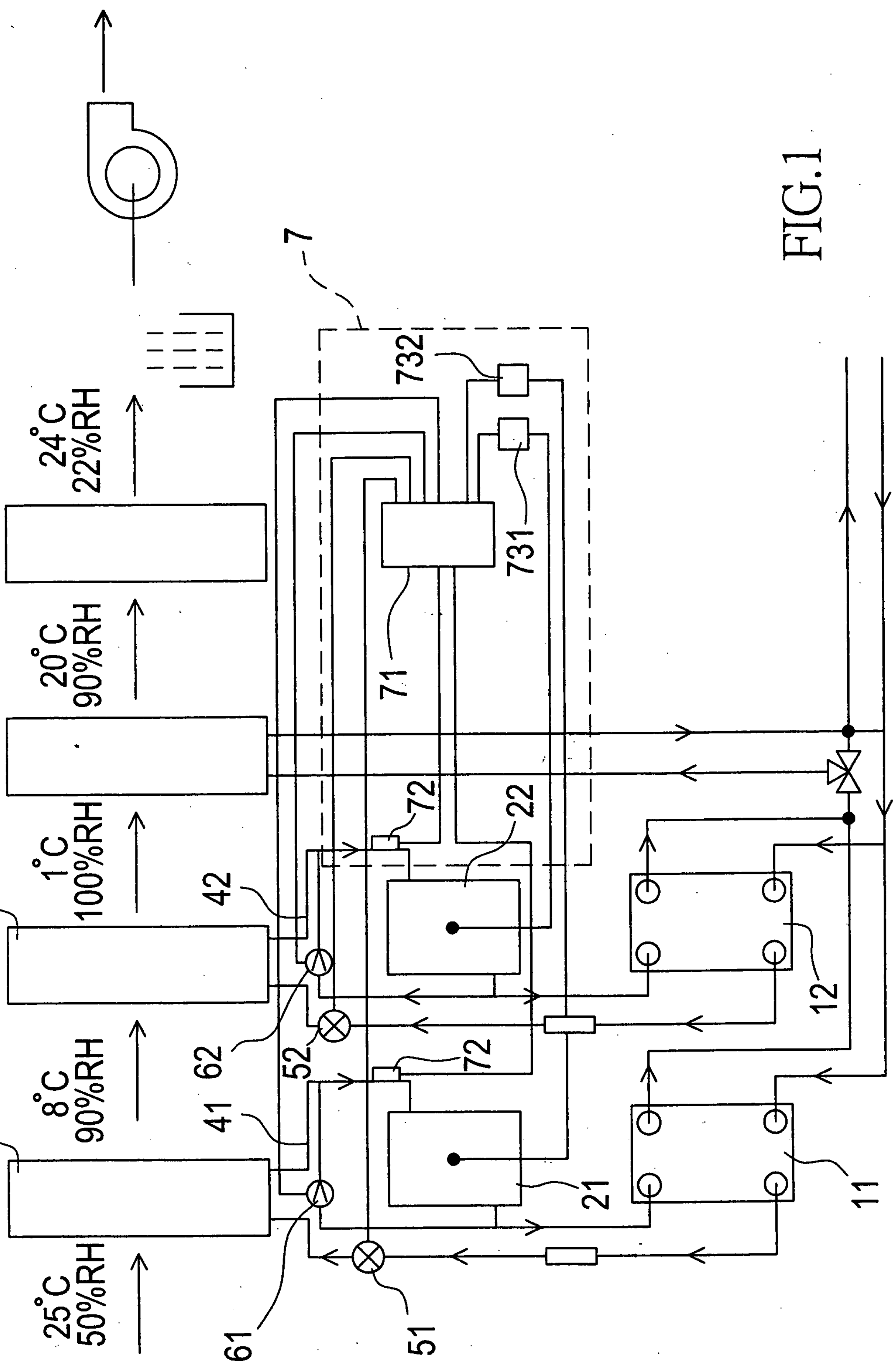
25°C
50%RH
8°C
90%RH
1°C
100%RH
20°C
90%RH
24°C
22%RH
31
32
41
42
61
62
51
52
72
72
21
22
71
731
732
7
11
12

FIG.1

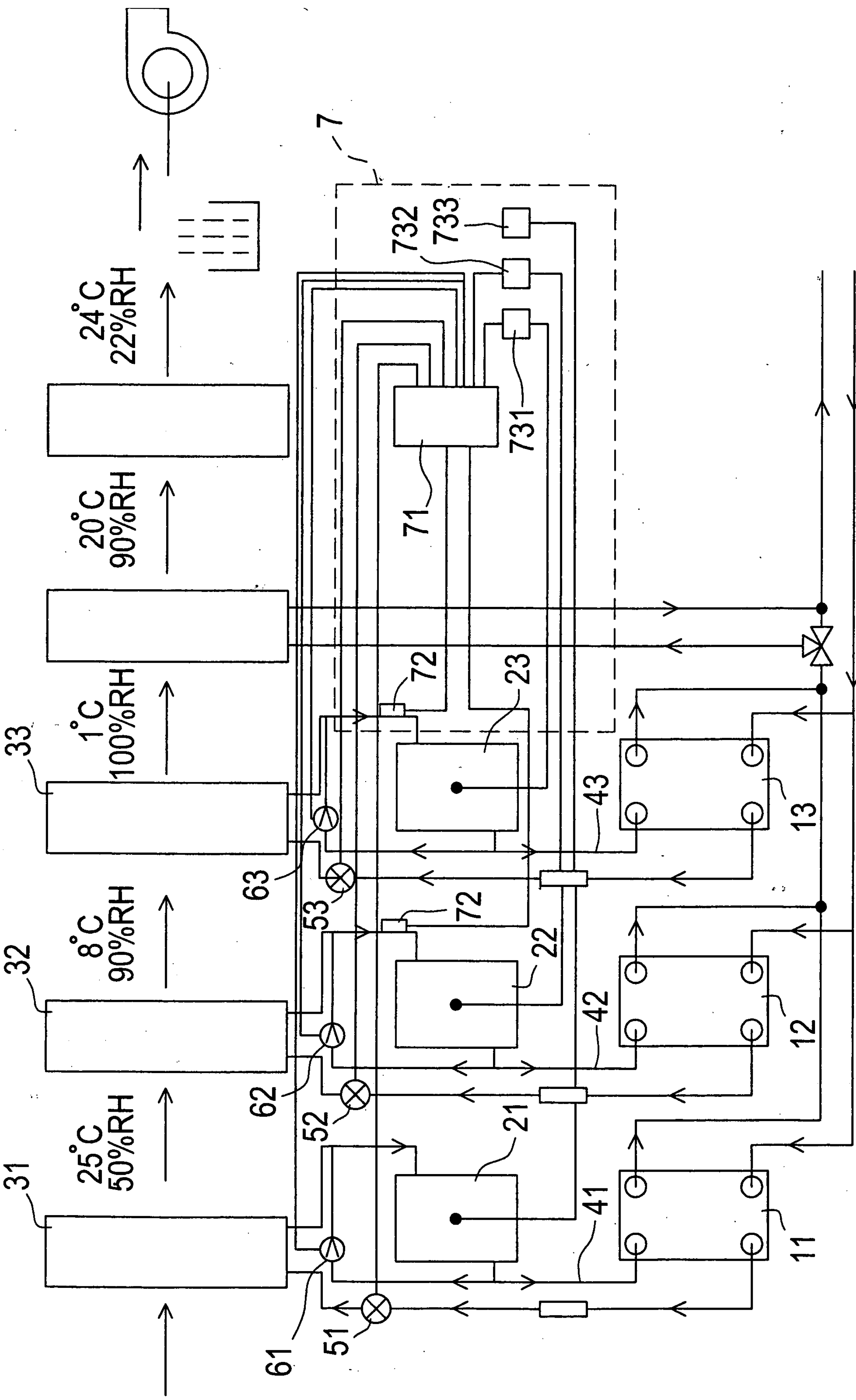
7
732
733
731
71
72
23
72
22
21
33
32
31
25°C
50%RH
8°C
90%RH
1°C
100%RH
20°C
90%RH
24°C
22%RH
43
42
41
13
12
11
63
53
62
52
61
51

FIG.2

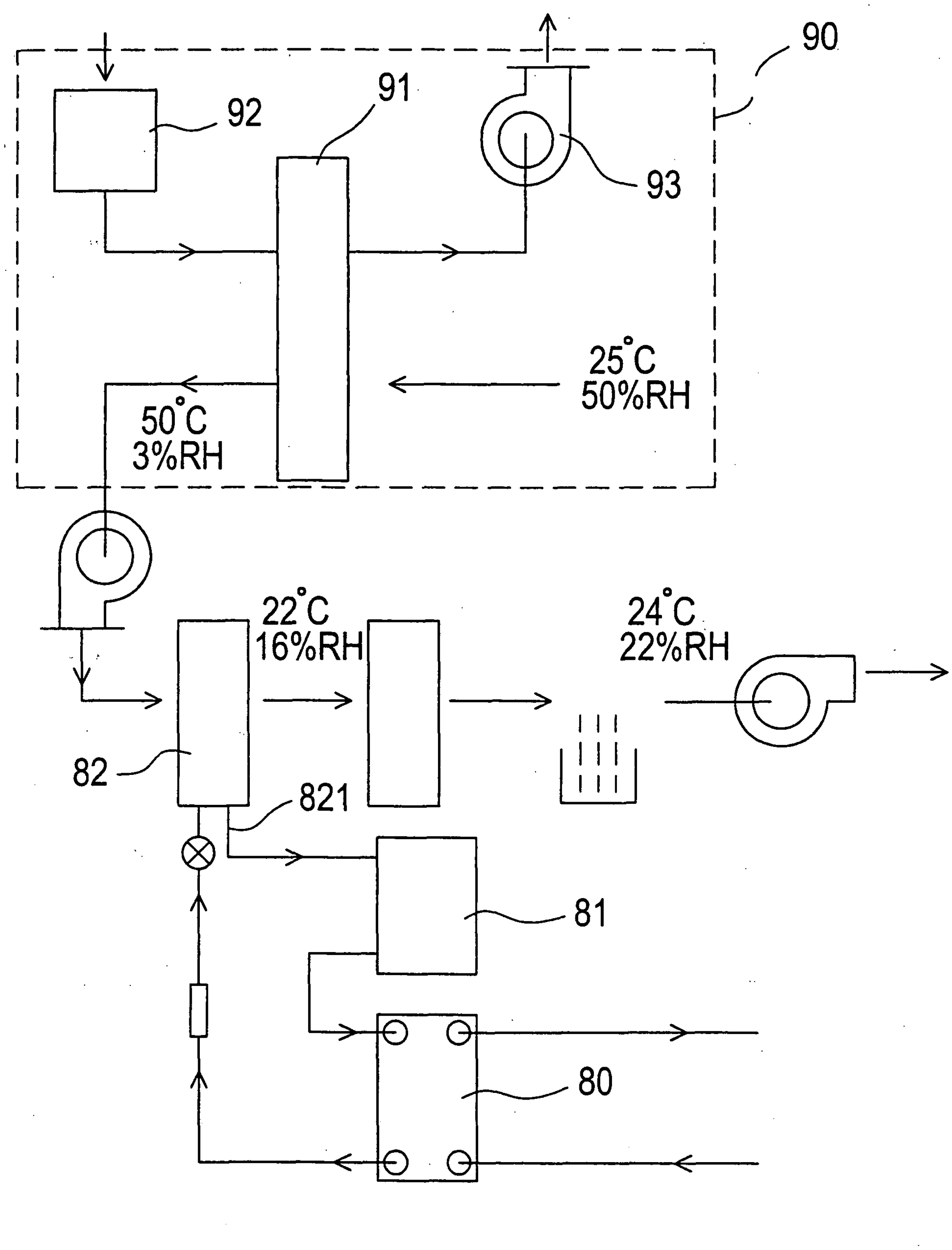


FIG.3

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 03 01 8687

## 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) |
|---|---|---|---|
| A | US 6 427 461 B1 (CHAPIN MERLIN K ET AL) 6 August 2002 (2002-08-06)<br>* abstract; figures 2,3 * | 1 | F24F3/153<br>F24F11/00 |
| A | PATENT ABSTRACTS OF JAPAN vol. 2000, no. 10, 17 November 2000 (2000-11-17)<br>-& JP 2000 203249 A (DENSO CORP), 25 July 2000 (2000-07-25)<br>* abstract * | 1,2 | |
| A | PATENT ABSTRACTS OF JAPAN vol. 017, no. 222 (M-1404), 7 May 1993 (1993-05-07)<br>-& JP 04 356646 A (MATSUSHITA ELECTRIC IND CO LTD), 10 December 1992 (1992-12-10)<br>* abstract * | | |
| A | US 6 012 296 A (SHAH DIPAK J) 11 January 2000 (2000-01-11) | | |

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
F24F
F25B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 16 January 2004 | Gonzalez-Granda, C |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 01 8687

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.

16-01-2004

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 6427461 B1 | 06-08-2002 | NONE | |
| JP 2000203249 A | 25-07-2000 | NONE | |
| JP 04356646 9 A | | NONE | |
| US 6012296 A | 11-01-2000 | CN 1268216 T | 27-09-2000 |
| | | ID 24428 A | 20-07-2000 |
| | | JP 2001514369 T | 11-09-2001 |
| | | WO 9910684 A1 | 04-03-1999 |

EPO FORM P0459

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