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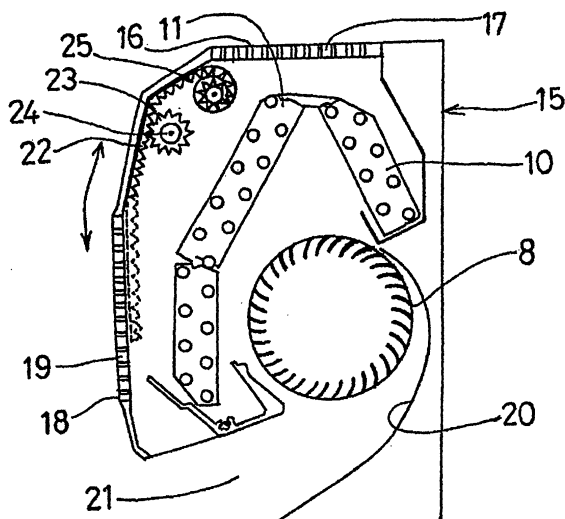
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(54) **AIR CONDITIONER**

(57) A reheat drying operation is conducted such that a refrigerant from a compressor 2 is circulated in the order of an outdoor heat exchanger 3, a depressurizing mechanism 4 and an indoor heat exchanger 5, while a first heat exchanger 10 and a second heat exchanger 11 are allowed to function as a condenser and an evaporator, respectively, in order to cool and dehu-

midify indoor air, then to reheat and return the air indoors. At this time, temperature of the second heat exchanger 11 functioning as an evaporator is controlled by a control means 13. Consequently, even when the interior of a room is slightly heated while dehumidified, a dehumidifying amount is increased by controlling temperature of the evaporator, and thus a reheat drying operation can be reliably conducted.

Fig. 2



Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioner capable of conducting a reheat drying operation.

BACKGROUND ART

[0002] As an air conditioner capable of conducting a reheat drying operation, the one having a refrigerant circuit shown in Fig. 1 is generally known. This air conditioner 1 is a heat pump type air conditioner equipped with a compressor 2, outdoor heat exchanger 3, depressurizing mechanism 4 and indoor heat exchanger 5. The refrigerant circuit is constituted such that a refrigerant from the compressor 2 is circulated. The discharge side and the suction side of the compressor 2 are connected to primary ports of a four-path switching valve 6. Furthermore, a refrigerant circuit from one of secondary ports of the four-path switching valve 6 to the other secondary port of the four-path switching valve 6 via each of the outdoor heat exchanger 3 equipped with an outdoor fan 7, the depressurizing mechanism 4 and the indoor heat exchanger 5 equipped with an indoor fan 8 is constructed by refrigerant piping. It is noted that the refrigerant returns from the four-path switching valve 6 to the suction side of the compressor 2 via an accumulator 9. Furthermore, the indoor heat exchanger 5 consists of a first heat exchanger 10 and a second heat exchanger 11, which are connected in series, and a depressurizing mechanism 12 is disposed between these heat exchangers 10, 11.

[0003] Types of air conditioning operations conducted by the aforementioned refrigerant circuit include a cooling operation, heating operation, reheat drying operation and so forth. During the cooling operation and the heating operation, the depressurizing mechanism 12 of the indoor heat exchanger 5 is made fully open, while the depressurizing mechanism 4 is adjusted to a prescribed opening and further the outdoor fan 7 and the indoor fan 8 are driven at a prescribed rotating speed. In the case of a cooling operation, a refrigerant discharged from the compressor 2 is circulated as shown with unbroken line arrows so that the outdoor heat exchanger 3 is allowed to function as a condenser and that the indoor heat exchanger 5 is allowed to function as an evaporator in order to cool indoor air. Furthermore, in the case of a heating operation, a refrigerant discharged from the compressor 2 is circulated as shown with broken line arrows so that the indoor heat exchanger 5 is allowed to function as a condenser and that the outdoor heat exchanger 3 is allowed to function as an evaporator in order to heat indoor air.

[0004] Meanwhile, during a reheat drying operation, the depressurizing mechanism 12 of the indoor heat exchanger 5 is adjusted to a prescribed opening, while the depressurizing mechanism 4 is made fully open. Fur-

thermore, the indoor fan 8 is driven at a prescribed rotating speed, while the outdoor fan 7 is stopped. Then, a refrigerant discharged from the compressor 2 is circulated by a cooling cycle as shown with unbroken line arrows so that the first heat exchanger 10 of the indoor heat exchanger 5 is allowed to function as a condenser, while the second heat exchanger 11 is allowed to function as an evaporator. Consequently, a reheat drying operation is conducted wherein indoor air is cooled and dehumidified in the second heat exchanger 11 functioning as an evaporator, then reheated in the first heat exchanger 10 functioning as a condenser and returned indoors.

[0005] In the above-described reheat drying operation, since the indoor equipment has the first heat exchanger 10 endowed with a function as condenser and the second heat exchanger 11 endowed with a function as an evaporator, dehumidification can be achieved while the indoor temperature is maintained at a generally constant level. Meanwhile, in a chilly season, when the interior of a room is required to be slightly heated while dehumidified, a high condensation temperature needs to be set in the first heat exchanger 10 used as a condenser. However, when the condensation temperature is controlled to be higher, the evaporation temperature is raised along therewith. When the evaporation temperature of the second heat exchanger 11 becomes higher as described above, the difference from the dew-point temperature of the indoor air becomes smaller. Thus, a problem arises that the dehumidifying amount is extremely reduced.

[0006] The present invention was accomplished to solve the above-described conventional problem. Accordingly, an object of the present invention is to provide an air conditioner capable of reliably conducting a reheat drying operation by controlling the temperature of an evaporator to increase the dehumidifying amount even when the interior of a room is slightly heated while dehumidified.

DISCLOSURE OF THE INVENTION

[0007] In order to achieve the above-mentioned object, the present invention provides an air conditioner having an indoor heat exchanger 5 consisting of a first heat exchanger 10 and a second heat exchanger 11, which are connected in series, and a depressurizing mechanism 12 disposed between these heat exchangers 10, 11 and capable of conducting a reheat drying operation where the first heat exchanger 10 is allowed to function as a condenser, while the second heat exchanger 11 is allowed to function as an evaporator so that indoor air is cooled and dehumidified, then reheated and returned indoors, wherein there is provided a control means 13 for controlling temperature of the second heat exchanger 11 functioning as an evaporator during the reheat drying operation.

[0008] In this air conditioner, the indoor equipment is

equipped with a control means 13 for controlling the temperature of the second heat exchanger 11 functioning as an evaporator. Consequently, when the interior of a room is slightly heated while a reheat drying operation is conducted, the control means 13 can be used to lower the temperature of the second heat exchanger 11 or suppress its temperature rise even if the condensation temperature of the first heat exchanger 10 functioning as a condenser is raised. Therefore, a reheat drying operation can be reliably conducted without reducing the dehumidifying amount. As a result, indoor environment required by a user can be achieved, and hence comfort is improved. It is noted that, when the temperature of the second heat exchanger 11 is controlled as described above, there is an advantage that a reliable dehumidifying effect can be obtained during a usual reheat drying operation.

[0009] In an embodiment of the air conditioner of the present invention, an indoor temperature sensor 27 and a humidity sensor 28 are provided to obtain dew-point temperature obtained from temperature and humidity measured by these sensors 27, 28, while temperature of the second heat exchanger 11 is controlled on the basis of the dew-point temperature.

[0010] Since this air conditioner is equipped with the indoor temperature sensor 27 and the humidity sensor 28, indoor temperature and humidity are measured, and the temperature of the second heat exchanger 11 is controlled on the basis of the dew-point temperature obtained from the measurement results by using the control means 13. As a result, precise dehumidifying control can be performed. Consequently, a reheat drying operation according to indoor environment required by the user can be conducted further reliably.

[0011] In an embodiment of the air conditioner of the present invention, the control means 13 includes an air volume control means for controlling an air volume to the second heat exchanger 11.

[0012] In this air conditioner, the temperature of the second heat exchanger 11 can be controlled by reducing a passing air volume by using the air volume control means. As a result, the dehumidifying amount can be reliably increased in a simple constitution.

[0013] In an embodiment of the air conditioner of the present invention, the control means 13 includes a pressure control means which is constituted to be able to change opening of the depressurizing mechanism 12.

[0014] In this air conditioner, the temperature of the second heat exchanger 11 can be controlled by controlling the depressurizing amount to the second heat exchanger 11 by using the pressure control means. As a result, the dehumidifying amount can be reliably increased in a simple constitution.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a refrigerant circuit diagram showing a constitution of an air conditioner according to an embodiment of the invention;

Fig. 2 is a vertical cross sectional view showing indoor equipment of the air conditioner according to an embodiment;

Fig. 3 is a vertical cross sectional view showing indoor equipment of the air conditioner according to another embodiment.

Fig. 4 is a perspective view of the indoor equipment of the air conditioner; and

Fig. 5 is a flow chart for explaining a control operation of the air conditioner.

BEST MODE FOR CARRYING OUT THE INVENTION

[0016] Hereinafter, embodiments of the air conditioner of the present invention will be described in detail with reference to accompanying drawings.

[0017] A refrigerant circuit of an air conditioner according to an embodiment of the invention basically has the same constitution as that of the refrigerant circuit of a common air conditioner 1 shown in Fig. 1, but has an improved control. That is, as shown in Fig. 1, the air conditioner 1 is a heat pump type air conditioner equipped with a compressor 2, outdoor heat exchanger 3, depressurizing mechanism 4 and indoor heat exchanger 5. Its refrigerant circuit is constituted such that a refrigerant from the compressor 2 is circulated. The discharge side and the suction side of the compressor 2 are connected to primary ports of a four-path switching valve 6. Furthermore, the refrigerant circuit from one of secondary ports of the four-path switching valve 6 to the other secondary port of the four-path switching valve 6 via each of the outdoor heat exchanger 3 equipped with an outdoor fan 7, the depressurizing mechanism 4 and the indoor heat exchanger 5 equipped with an indoor fan 8 is constructed by refrigerant piping. It is noted that the refrigerant returns from the four-path switching valve 6 to the suction side of the compressor 2 via an accumulator 9. Furthermore, the indoor heat exchanger 5 consists of a first heat exchanger 10 and a second heat exchanger 11, which are connected in series, and a depressurizing mechanism 12 is disposed between these heat exchangers 10, 11.

[0018] Operations of this air conditioner 1 are controlled by a controller 13 disposed in the indoor equipment main body 14 of the air conditioner 1 shown in Fig. 4.

[0019] Types of air conditioning operations conducted by the aforementioned refrigerant circuit include a cooling operation, heating operation, reheat drying operation and so forth. During the cooling operation and the heating operation, the depressurizing mechanism 12 of the indoor heat exchanger 5 is made fully open, while

the depressurizing mechanism 4 is adjusted to a prescribed opening and further the outdoor fan 7 and the indoor fan 8 are driven at a prescribed rotating speed. In the case of a cooling operation, a refrigerant discharged from the compressor 2 is circulated as shown with unbroken line arrows so that the outdoor heat exchanger 3 is allowed to function as a condenser and that the indoor heat exchanger 5 is allowed to function as an evaporator in order to cool indoor air. Furthermore, in the case of a heating operation, a refrigerant discharged from the compressor 2 is circulated as shown with broken line arrows so that the indoor heat exchanger 5 is allowed to function as a condenser and that the outdoor heat exchanger 3 is allowed to function as an evaporator in order to heat indoor air.

[0020] Meanwhile, during a reheat drying operation, the depressurizing mechanism 12 of the indoor heat exchanger 5 is adjusted to a prescribed opening, while the depressurizing mechanism 4 is made fully open. Furthermore, the indoor fan 8 is driven at a prescribed rotating speed, while the outdoor fan 7 is stopped. Then, a refrigerant discharged from the compressor 2 is circulated as shown with unbroken line arrows so that the first heat exchanger 10 of the indoor heat exchanger 5 is allowed to function as a condenser, while the second heat exchanger 11 is allowed to function as an evaporator. Consequently, a reheat drying operation is conducted wherein indoor air is cooled and dehumidified in the second heat exchanger 11 functioning as an evaporator, then reheated in the first heat exchanger 10 functioning as a condenser and returned indoors. During a reheat drying operation, although the outdoor heat exchanger 3 can also function as a condenser, outside air surrounding the outdoor heat exchanger 3 is not flowed therethrough by stopping the outdoor fan 7 as described above so that heat exchange is not performed in the outdoor heat exchanger 3 where possible.

[0021] Meanwhile, when the interior of a room is slightly heated and dehumidified during a reheat drying operation, the condensation temperature of the first heat exchanger 10 used as a condenser needs to be raised to perform sufficient heat exchange (heating). However, since the evaporation temperature is also raised along therewith, the dehumidifying amount may be extremely reduced. Therefore, a controller 13 shown in Fig. 4 serves as a control means and controls the temperature of the second heat exchanger 11 functioning as an evaporator.

[0022] This control method will be described in detail below.

[0023] Fig. 2 is a vertical cross sectional view showing indoor equipment of the air conditioner according to an embodiment. In the figure, in a casing 15 of the indoor equipment, a grid-like top suction port 17 is formed over almost the whole surface of a top panel 16, and a grid-like front suction port 19 is formed over almost the whole surface of a front panel 18. Furthermore, the indoor heat exchanger 5 disposed in the casing 15 is divided into a

rear side heat exchanger 10 (first heat exchanger) and a front side heat exchanger 11 (second heat exchanger) and is constituted by combining these in an inversed V shape. Furthermore, a crossflow fan 8 is disposed as an indoor fan inside the inversed V shaped indoor heat exchanger 5. Furthermore, a scroll unit 20 is formed behind this crossflow fan 8, and smoothly connected to a blowoff port 21 opening in a front side lower portion of the casing 15 of the indoor equipment. In this air conditioner 1, air cooled and dehumidified in the front side heat exchanger 10 and air heated in the rear side heat exchanger 11 are mixed in the equipment and blown off from the blowoff port 21 so that a reheat drying operation can be conducted.

[0024] Furthermore, the indoor equipment of the air conditioner 1 is equipped with an air volume control means cooperating with the controller 13 to control an air volume supplied from the front suction port 19. That is, in the case of this embodiment, the air volume control means is constituted by a shutter 22 capable of opening and closing the front suction port 19, a gear 23 with a motor for moving the shutter 22 along the inside of the front panel 18 and a reel 25 for reeling up the shutter 22. More specifically, a rod-like reel 25 is disposed in an upper portion of the casing on the front panel 18 side so that its longitudinal direction should be substantially in parallel to the longitudinal direction of the casing 15. An upper end portion of the generally rectangular shutter 22 is attached to the reel 25 so that the shutter 22 is reeled up to the reel 25. Furthermore, a gear 23 having a rotating shaft 24 of a motor in its center is disposed at a position on the lower side of the reel 25, and the shutter 22 is disposed between the gear 23 and the front panel 18. Furthermore, projections and depressions having the same pitches as those of the gear 23 are formed on the inside surface of the shutter 22, that is a surface in a direction facing the gear 23. By engaging the projections and depressions formed on the shutter 22 and those formed on the gear 23, rotation of the gear 23 can be transferred to the shutter 22. Furthermore, with this constitution, the front suction port 19 can be opened or closed by sliding the shutter 22 in a vertical direction along the inside of the front panel 18. Thus, the air volume supplied from the front suction port 19 can be controlled.

[0025] Fig. 4 is a perspective view showing the indoor equipment of the air conditioner 1. As shown in the figure, slits 29 are provided in a lower portion of the side surface of the indoor equipment main body 14. A temperature sensor 27 for measuring indoor temperature and a humidity sensor 28 for measuring indoor humidity are disposed in the rear of these slits. These sensors 27, 28 are provided so that the dew-point temperature is obtained from the indoor temperature and humidity in order to judge from this dew-point temperature whether temperature of the front side heat exchanger 11 should be controlled by using the air volume control means or not. Here, although these sensors 27, 28 are disposed

in the indoor equipment, precise dew-point temperature can be obtained since indoor air comes in and out from the slits 29 provided in front of the sensors 27, 28. Therefore, indoor humidity and temperature can be precisely measured.

[0026] Described below is a control method wherein the controller 13 controls an air volume to the front suction port 19 by using these sensors 27, 28 and the air volume control means so that the interior of a room is slightly heated while dehumidified. Fig. 5 is a flow chart for explaining control operations using the air volume control means.

[0027] During a reheat drying operation, first, in step S1, whether temperature of the front side heat exchanger 11 functioning as an evaporator is lower than the dew-point temperature obtained from indoor temperature and humidity measured by the sensors 27, 28 is judged. In this case, when the temperature of the front side heat exchanger 11 is equal or higher, it means that dehumidifying ability may be insufficient. Therefore, the operation proceeds to step S2, where air volume distribution control using the shutter 22 used as an air volume control means is started and opening of the front suction port 19 is narrowed. Subsequently, the operation proceeds to step S3, where this state is maintained until the operation state is stabilized with the above opening (for about 10 minutes). Then, after the certain time elapses, the operation returns again to step S1, where whether the air volume distribution control should be performed or not is judged. On the other hand, in step S1 when the dew-point temperature is higher, it means that dehumidifying ability is sufficient. Therefore, air volume distribution control using the shutter 22 is not performed, and the current state is maintained (step S4). Then, after a certain time elapses, the operation returns to step S1 again.

[0028] According to the method described above, first of all, a usual reheat drying operation is started so that the ratio of air volumes passing to the heat exchangers 10, 11 is basically constant. The reason why the air volume is not controlled from the beginning is to prevent degradation of the whole operation ability due to initial reduction of the air volume to the front side heat exchanger 11. Furthermore, according to this embodiment, when the temperature of the front side heat exchanger 11 used as an evaporator is equal to or higher than the dew-point temperature obtained from the indoor temperature and humidity, opening of the front suction port 19 is adjusted to be automatically narrowed by the shutter 22 so that the suction air volume is reduced. Consequently, heat exchange in the front side heat exchanger 11 is restricted, and hence the temperature in the front side heat exchanger 11 can be lowered, resulting in an increased dehumidifying amount. Furthermore, opening of the front suction port 19 can be adjusted by the shutter 22 continuously, and the air volume distribution control is performed continuously until a reheat drying operation is executed while the interior of a room is

slightly heated. Furthermore, even when the above operation is executed, the above judgment and control are performed every certain time so that this state is maintained at all times. Thus, even when condensation temperature of the rear side heat exchanger 10 functioning as a condenser is raised to heat the interior of a room slightly, temperature of the front side heat exchanger 11 functioning as an evaporator is lowered or its temperature rise can be suppressed by the air volume control means. Therefore, a reheat drying operation can be conducted reliably without reducing the dehumidifying amount. As a result, indoor environment desired by a user can be achieved, and hence comfort is improved. It is noted that, when temperature of the front side heat exchanger 11 is controlled as described above, there is an advantage that a reliable dehumidifying effect can be obtained during a usual reheat drying operation.

[0029] A specific embodiment of the present invention has been explained so far. However, the present invention is not limited to the above embodiment, but various modifications can be implemented within a scope of the present invention. Firstly, in the above embodiment, when the air volume should be controlled by the air volume control means is judged, this is judged by comparing the temperature of the front side heat exchanger 11 used as an evaporator and the dew-point temperature. However, this may be judged by comparing the temperature of the front side heat exchanger 11 and the evaporation temperature required to make indoor humidity 50% or lower. The evaporation temperature required in this case can be obtained by using a sensor or the like, but a particular temperature may be preset in advance in consideration to an actual use state or the like.

[0030] Furthermore, in the above embodiment, the air volume supplied from the front suction port 19 is controlled by using the shutter 22 as the air volume control means. However, as shown in Fig. 3, in the above indoor equipment, the suction air volume can also be controlled by providing a front lid 30 which can cover the front suction port 19 from outside. That is, the front lid 30 has a shape obtained by slightly bending a generally rectangular plate in the vertical direction and is disposed so that its recessed portion faces inside, while its lower end portion is attached rotatably to the casing 15 at the lower portion of the front suction port 19. Furthermore, a rotating shaft 32 of a motor is provided at the center of an attaching portion 31, to which the front lid 30 is attached. By driving the motor, the front lid 30 rotates inward and outward by using the rotating shaft 32 of the attaching portion 31 as a center. Thus, the suction air volume can be controlled by adjusting opening of the front suction port 19 by the rotation of the front lid 30.

[0031] Furthermore, according to the above method, temperature of the front side heat exchanger 11 is lowered to increase the dehumidifying amount by controlling the air volume passing through the front side heat exchanger 11 functioning as an evaporator, that is, reducing the suction air volume from the front suction port

19. However, the evaporation temperature of the front side heat exchanger 11 can also be lowered to increase the dehumidifying amount by controlling a pressure of the refrigerant, which flows into the front side heat exchanger 11. For example, evaporation temperature in the front side heat exchanger 11 can be reduced to increase the dehumidifying amount by utilizing a depressurizing mechanism 12 provided on the entrance side of a refrigerant passage of the front side heat exchanger 11 as a pressure control means to narrow the opening of the depressurizing mechanism 12 and thereby increase the depressurizing amount. In this constitution, since these modifications can be achieved without adding a special mechanism, a cost increase due to addition to the constitution can be prevented. It is noted that, in the above embodiment, the indoor temperature sensor and the humidity sensor are disposed in the indoor equipment main body 14, but these may be disposed anywhere as long as indoor temperature and humidity can be measured.

Claims

1. An air conditioner having an indoor heat exchanger (5) consisting of a first heat exchanger (10) and a second heat exchanger (11), which are connected in series, and a depressurizing mechanism (12) disposed between these heat exchangers (10), (11) and capable of conducting a reheat drying operation where the first heat exchanger (10) is allowed to function as a condenser, while the second heat exchanger (11) is allowed to function as an evaporator so that indoor air is cooled and dehumidified, then reheated and returned indoors, wherein there is provided a control means (13) for controlling temperature of the second heat exchanger (11) functioning as an evaporator during the reheat drying operation.
2. The air conditioner according to Claim 1, wherein an indoor temperature sensor (27) and a humidity sensor (28) are provided to obtain dew-point temperature obtained from temperature and humidity measured by these sensors (27), (28), while temperature of the second heat exchanger (11) is controlled on the basis of the dew-point temperature.
3. The air conditioner according to Claim 1, wherein the control means (13) includes an air volume control means for controlling an air volume to the second heat exchanger (11).
4. The air conditioner according to Claim 1, wherein the control means (13) includes a pressure control means which is constituted to be able to change opening of the depressurizing mechanism (12).

Fig.1

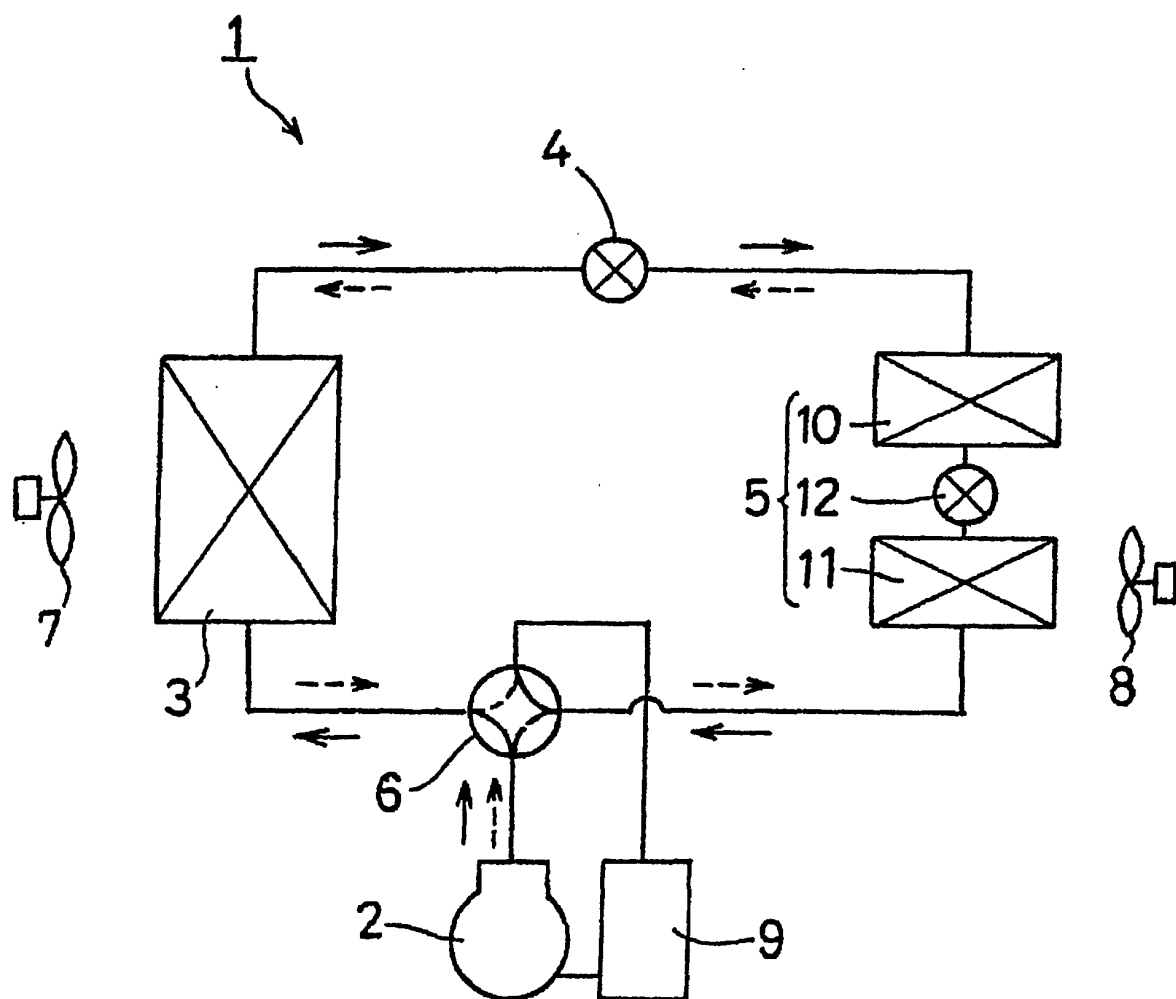


Fig. 2

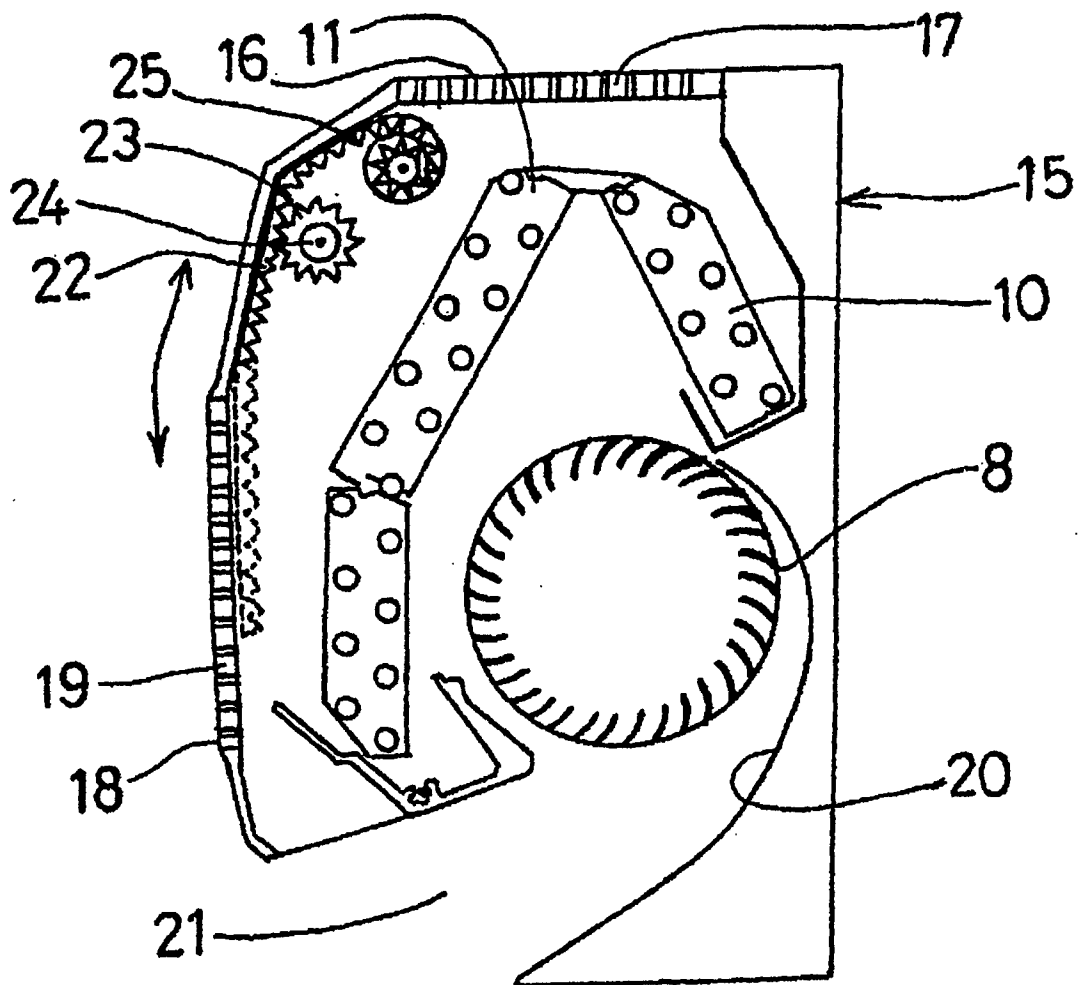


Fig. 3

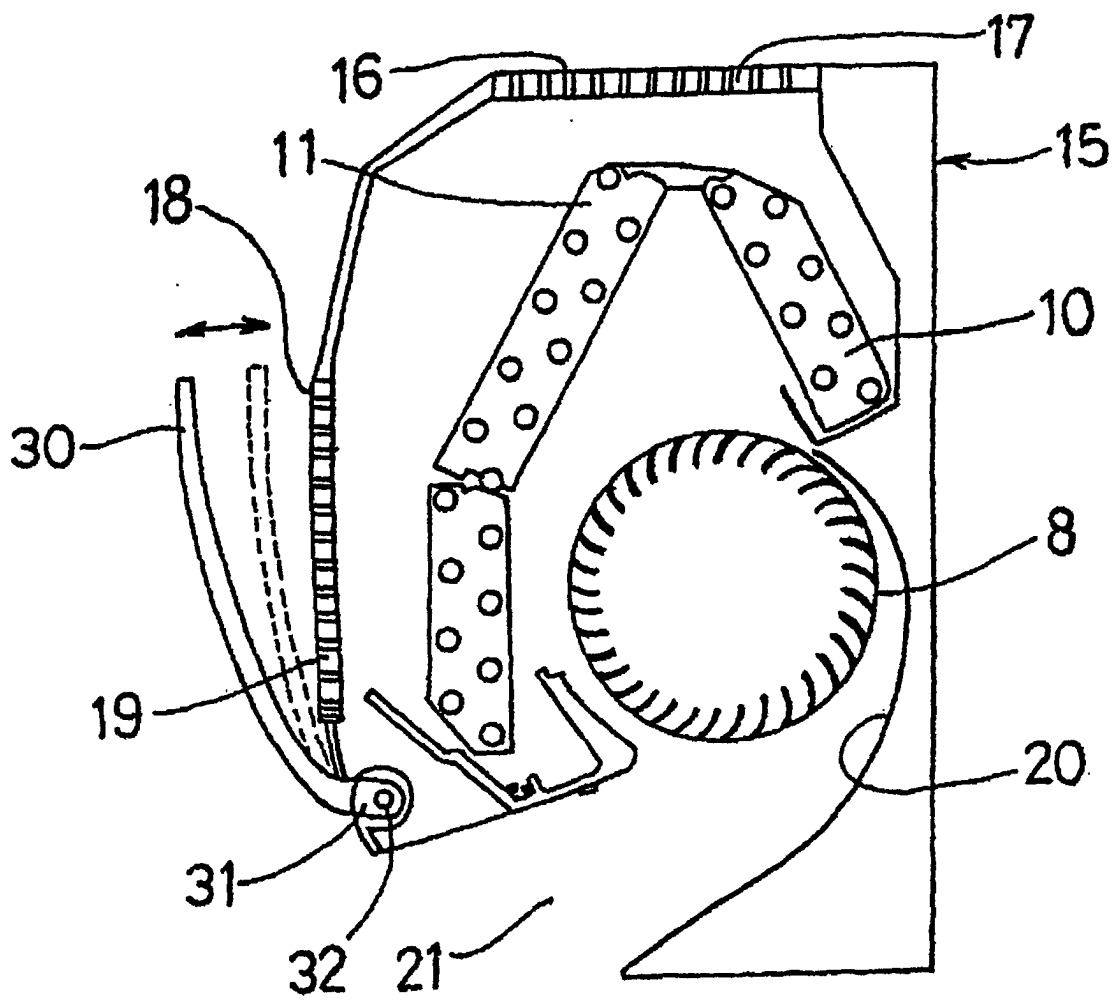


Fig. 4

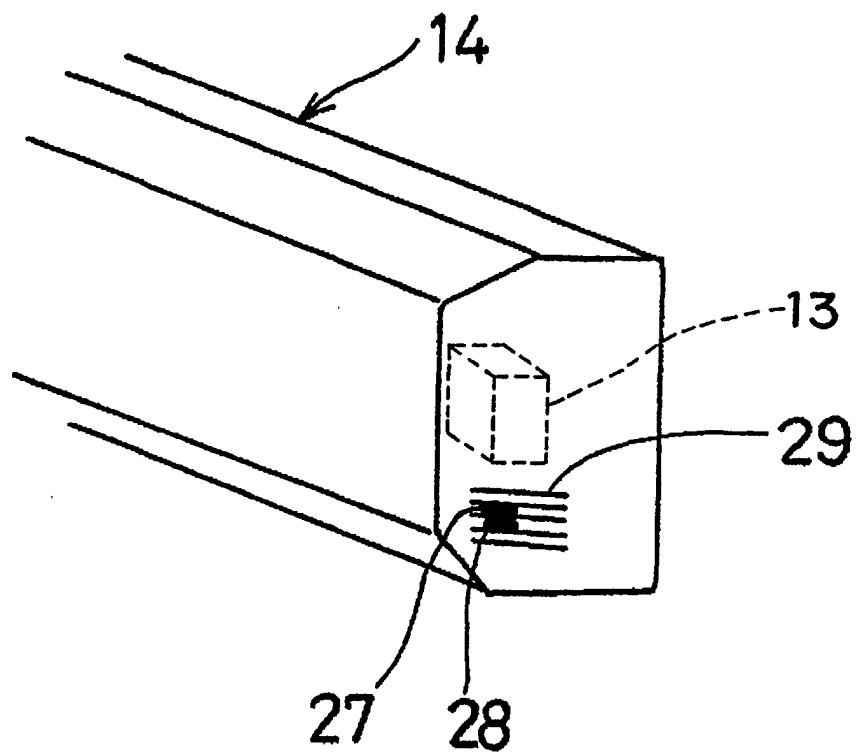
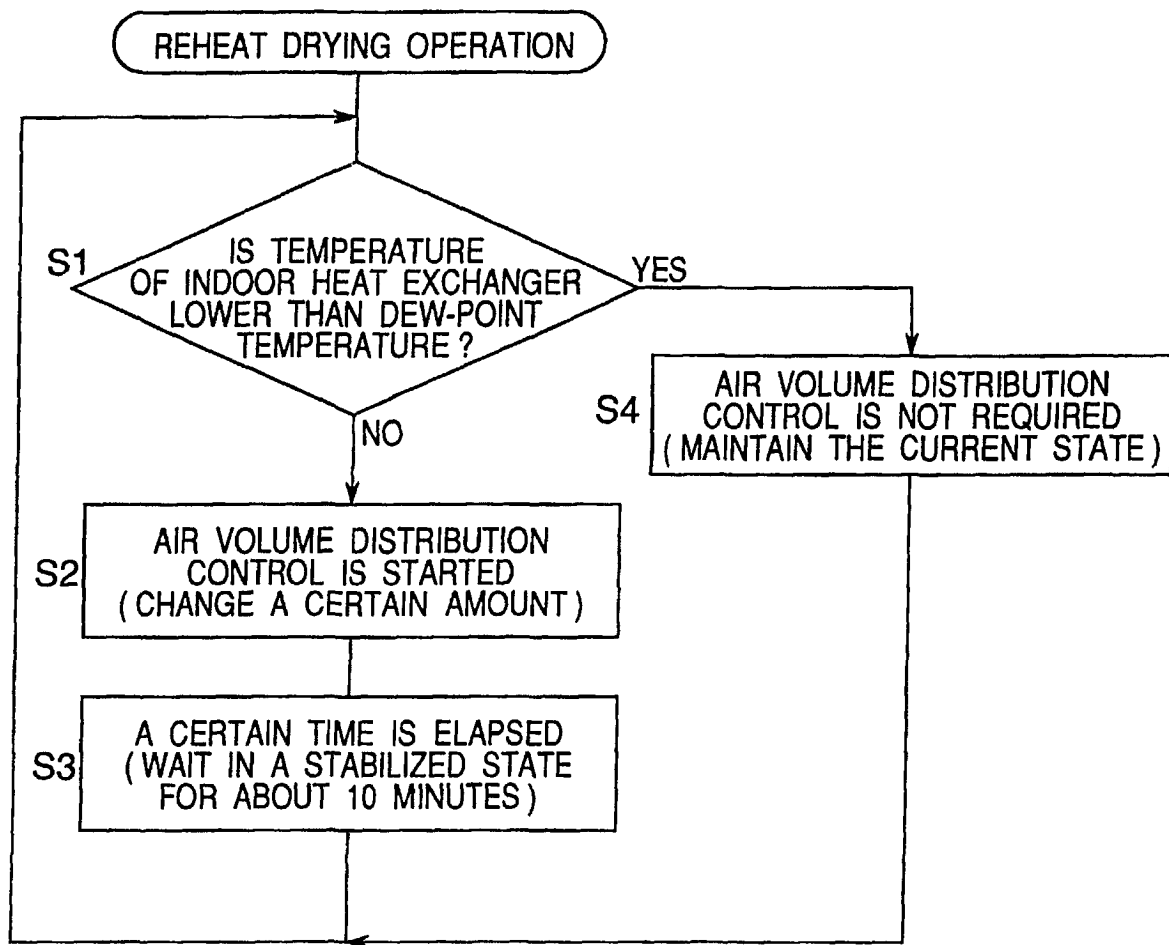


Fig.5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/07369

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl⁷ F25B29/00, 391 F24F11/02, 102

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.Cl⁷ F25B29/00, 391 F24F11/02, 102 F25B29/00, 411

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)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 8-254372, A (Hitachi, Ltd.), 01 October, 1996 (01.10.96),	1, 4
Y	page 2, right column, line 3 to page 3, left column, line 2 (Family: none)	2, 3
A	JP, 5-26498, A (Hitachi, Ltd.), 02 February, 1993 (02.02.93) (Family: none)	1, 3
A	JP, 7-4724, A (Fujitsu System Construction K.K.), 10 January, 1995 (10.01.95) (Family: none)	1, 2, 3
A	JP, 5-5547, (Mitsubishi Electric Corporation), 14 January, 1993 (14.01.93) (Family: none)	1, 4

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
12 January, 2001 (12.01.01)Date of mailing of the international search report
23 January, 2001 (23.01.01)Name and mailing address of the ISA/
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