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Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioner, and more particularly, to an air conditioner including a flow divider for appropriately dividing the flow of refrigerant to a plurality of paths in an indoor heat exchanger of the air conditioner.

BACKGROUND ART

[0002] Fig. 5 shows the structure of a typical wall-mount air conditioner (indoor equipment) 21 employing a cross flow fan 29. As shown in Fig. 5, the air conditioner 21 includes a main body casing 20 having an upper surface in which a first air intake grille 23 is formed and a front surface upper portion in which a second air intake grille 24 is formed. The main body casing 20 also has an air discharge port 25 arranged in a lower corner of the front surface.

[0003] An air passage 27 extends from the air intake grilles 23 and 24 to the air discharge port 25 in the main body casing 20. An indoor heat exchanger 26, which has a V-shaped cross-section so as to face toward the first and second air intake grilles 23 and 24, is arranged in an upstream region of the air passage 27. The indoor heat exchanger 26 is a lambda-type heat exchanger. A cross flow fan 29, a tongue 22, and a scroll 30 are arranged in the downstream region of the air passage 27. The cross flow fan 29 has an impeller (fan rotor) 29a, which is rotated in the direction of the arrow shown in Fig. 5 and which is arranged in an opening 22a of the tongue 22 and opening 30a of the scroll 30.

[0004] The tongue 22 is located at a position facing toward the second air intake grill 24 and has a predetermined length along the outer circumference of the impeller (fan rotor) 29a in the cross flow fan 29.

[0005] The tongue 22 has a lower portion that is continuous with an air flow guide 22b, which also serves as a drain pan and which is arranged below the indoor heat exchanger 26. The air flow guide 22b has a downstream portion, which extends toward the air discharge port 25 together with a downstream portion 30b of the scroll 30 and which forms an air discharge passage 28 having a diffuser structure as shown in the drawing. As a result, the flow of air generated by the impeller (fan rotor) 29a of the cross flow fan 29 is efficiently discharged from the air discharge port 25.

[0006] A stream deflection plate 31 is arranged in the air discharge passage 28 between the scroll 30 and the air flow guide 22b, which is located at the lower portion of the tongue 22.

[0007] The tongue 22 is shaped as shown in Fig. 5. The flow of air from the indoor heat exchanger 26 to the air discharge port 25 via the impeller (fan rotor) 29a of the cross flow fan 29 is curved in its entirety along the rotation direction of the impeller (fan rotor) 29a and dis-

charged in a direction perpendicular to the rotation axis of the impeller (fan rotor) 29a. Then, the flow of air is curved along the air discharge passage 28 toward the air discharge port 25 and discharged out of the front surface of the air conditioner 21.

[0008] In the indoor heat exchanger 26 having such a structure, the heat exchanger 26 was divided into portions A, B, C, and D to analyze the flow velocity distribution. As a result, the flow velocity in portion D, which directly faces toward the second air intake grille 24, was the highest. The flow velocity was lower than portion D in portion C, which diagonally faces toward the first air intake grille 23. Further, the flow velocity was lower than portion C in portion B, which is covered by the upper portion of the front surface of the main body casing 20 and thus does not directly receive the flow of air. The flow velocity was lower than portion B in portion A, which is blocked by the tongue 22 from the flow of air.

[0009] An indoor heat exchanger 26 having a plurality of paths in an air conditioner as described above usually includes a flow divider 6 including branch flow paths 7a and 7b, as shown in Fig. 6, to distribute the refrigerant that flows into the main body of the heat exchanger 26 into each path in the main body of the heat exchanger 26. The flow divider 6 determines the distribution ratio of the refrigerant for the branch flow paths 7a and 7b in accordance with rated operation. An expansion valve V and a refrigerant inlet 6a are arranged at the entrance of the flow divider 6. When the load is low, in the indoor heat exchanger 26, the branch flow path 7a extends through a portion 26a in which the flow velocity is high, and the branch flow path 7b extends through a portion 26b in which the flow velocity is low.

[0010] Accordingly, as expressed by the width of the arrows in Fig. 6, during rated operation, the refrigerant temperatures become substantially the same at the outlet of the paths 8A and 8B, which are located at the outlet of the heat exchanger 26. However, in a low load (partial load) state in which the amount of refrigerant decreases, the flow velocity distribution that differs in correspondence with the position of the air flow passage in the heat exchanger 26 has affects that result in problems that will now be described. For example, as shown in the graph of Fig. 7, the refrigerant temperature increases at the outlet of the paths 7a and 8A in which the flow velocity is high since there is a margin in heat exchange capacity. However, in comparison with the refrigerant temperature at the outlet of the paths 7a and 8A, the refrigerant temperature becomes lower (refer to ΔT in Fig. 7) at the outlet of the paths 7b and 8B in which the flow velocity is low since there is no margin in heat exchange capacity. In the graph of Fig. 7, the outlet of paths 7a and 8A in which the flow velocity is high is shown by the blank backgrounds, and the outlet of paths 7b and 8B in which the flow velocity is low is shown by the shadowed backgrounds.

[0011] As one solution for solving this problem, a refrigerant flow amount regulation valve V_1 is arranged in

the outlet of the paths 7b and 8B at which the temperature becomes low at least when the load is low. As a result, for example, as shown by the graph of Fig. 9, the temperature (dryness) at the outlet of the paths 7a and 8A is matched with the temperature (dryness) at the outlet of the paths 7b and 8B (for example, refer to patent publication 1). In the graph of Fig. 9, the paths of high flow velocity are shown by the blank backgrounds, and the paths of low flow velocity are shown by the shadowed backgrounds.

Patent Publication 1: Japanese Laid-Open Patent Publication No. 5-118682

DISCLOSURE OF THE INVENTION

[0012] However, with such a structure, particularly when the proportions of the shadowed portions in Figs. 6 and 8 are increased to increase the dryness, the capacity in a low load state does not increase that much.

[0013] It is an object of the present invention to provide an air conditioner that increases the heat exchanging capacity by appropriately controlling the refrigerant drift between the paths of a flow divider that corresponds to the heat exchanger of an air conditioner.

[0014] To achieve the above object, one aspect of the present invention is an air conditioner including a compressor, a four-way valve, an outdoor heat exchanger, a restriction device, and an indoor heat exchanger provided with a plurality of paths. These members are sequentially connected by a refrigerant pipe to form a refrigerant circuit. A flow divider including a plurality of paths is arranged between the indoor heat exchanger, which includes the plurality of paths, and the restriction device. A refrigerant flow amount regulation valve is provided for each of the plurality of paths in the flow divider. In a predetermined operation state, more refrigerant is distributed to a predetermined path in which the processing capacity is large and the refrigerant temperature at an outlet of the indoor heat exchanger is high in comparison with other paths.

[0015] With this structure, in a predetermined operation state, more refrigerant is positively distributed to paths having margins in processing capacities to increase the in-pipe flow velocity in such paths. Further, the difference between the temperature at the outlet of the indoor heat exchanger and the intake temperature increases. This increases the capacity of the indoor heat exchanger and increases the refrigerant capacity.

[0016] Preferably, the predetermined operation state is an operation state in which the load is low, and in the low load state, an opening is decreased in the refrigerant flow amount regulation valve of the path at which the processing capacity is small and the refrigerant temperature at the outlet of the indoor heat exchanger is low so that a large amount of refrigerant flows to the predetermined path in which the processing capacity is large and the refrigerant temperature at the outlet of the indoor heat

exchanger is high.

[0017] In this structure, when the load is low and the entire refrigerant flow amount decreases, the opening of the refrigerant flow amount regulation valve is decreased for the path at which the processing capacity is small and the refrigerant temperature at the outlet of the indoor heat exchanger is low. Further, by distributing more refrigerant to the predetermined path at which there is a margin in the processing capacity and the flow velocity is high, the in-pipe flow velocity of the path increases. Additionally, the difference between the temperature at the outlet of the indoor heat exchanger and the intake temperature increases. As a result, the capacity of the heat exchanger is effectively increased, and the refrigerant capacity is increased.

[0018] Preferably, the predetermined path is a path in which the flow velocity is high, and in a low load state, an opening of the refrigerant flow amount regulation valve is decreased for a path in which the flow velocity is low so that more refrigerant flows to the path that has a margin in heat exchange capacity and a high flow velocity. With this structure, the refrigerant flow amount regulation valve is closed for a path having a low flow velocity and no margin in the processing capacity so that more refrigerant is distributed to a path that has a margin in the processing capacity and has a high flow velocity. This increases the in-pipe flow velocity of the path. Additionally, the difference between the temperature at the outlet of the indoor heat exchanger and the intake temperature increases. As a result, the capacity of the heat exchanger is effectively increased, and the refrigerant capacity is increased.

[0019] Preferably, the predetermined operation state is an operation state during a rated load, and in the rated load state, the refrigerant flow amount regulation valve for each path is completely open, and the capacity of the heat exchanger is fully used. With this structure, in an operation state during a rated load, the refrigerant flow amount regulation valve for each path is completely open, and the capacity of the heat exchanger can be fully used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

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

Fig. 2 is a diagram showing the operation and structure of a heat exchanger including a plurality of paths and a flow divider corresponding to the paths of the heat exchanger in the indoor equipment of the air conditioner;

Fig. 3 is a graph showing the comparison of temperatures at the outlet of the indoor equipment heat exchanger resulting from the flow divider shown in Fig. 2 in a rated state and a low load state;

Fig. 4 is a diagram showing the operation and structure of a heat exchanger including a plurality of paths and a flow divider corresponding to the paths of the heat exchanger in the indoor equipment of an air conditioner according to a second embodiment of the present invention;

Fig. 5 is a diagram showing the structure of the indoor equipment for an air conditioner of the prior art;

Fig. 6 is a diagram showing the operation and structure of a heat exchanger including a plurality of paths and a flow divider corresponding to the paths of the heat exchanger in the indoor equipment of an air conditioner;

Fig. 7 is a graph showing the comparison of temperatures at the outlet of the indoor equipment heat exchanger resulting from the flow divider shown in Fig. 6 in a rated state and a low load state;

Fig. 8 is a diagram showing the operation and structure of a heat exchanger including a plurality of paths and a flow divider corresponding to the paths of the heat exchanger in the indoor equipment of a prior art air conditioner which has been modified to cope with the outlet temperature problems; and

Fig. 9 is a graph showing the comparison of temperatures at the outlet of the indoor equipment heat exchanger resulting from the flow divider shown in Fig. 8 in a rated state and a low load state.

BEST MODE FOR CARRYING OUT THE INVENTION

[First Embodiment]

[0021] Figs. 1 and 2 show the structures of a refrigerant circuit and its flow divider in an air conditioner according to a first embodiment of the present invention, and Fig. 3 shows the operation and effect of such a structure. To facilitate description, in the structure of this embodiment, the heat exchanger 26 is broadly divided into two flow velocity regions, low flow velocity portions A and B and high flow velocity portions C and D. Further, the flow divider 6 has two paths.

[0022] As shown in Fig. 1, the air conditioner includes outdoor equipment 1 and indoor equipment 10. The outdoor equipment 1 includes a compressor 2, a four-way valve 3, an outdoor heat exchanger 4, and a restriction device 5. The indoor equipment 10 includes a flow divider 6, an inlet 6a for the flow of refrigerant into the flow divider 6, a first branch flow path 7a in the flow divider 6, a second branch flow path 7b in the flow divider 6, an indoor heat exchanger 26, a first path 8A located at the outlet of indoor heat exchanger 26, a second path 8B located at the outlet of the heat exchanger 26, and an expansion valve V. These members are connected to a first refrigerant pipe 9A and a second refrigerant pipe 9B to form an irreversible refrigerant circulation circuit as shown in Fig. 1.

[0023] The expansion valve V and the flow divider 6 are arranged between the indoor heat exchanger 26 and the restriction device 5. First and second refrigerant flow

amount regulation valves V_1 and V_2 that are electromagnetic valves of which the opening degrees of each are electrically adjustable. The valves V_1 and V_2 are respectively arranged in first and second branch flow paths 7a and 7b of the flow divider 6. Under a predetermined operation state, more refrigerant is distributed to the one of the predetermined paths 7a and 7b at which the processing capacity is larger and the temperature at the outlet of the heat exchanger 26 is higher. This refrigerant distribution amount control is performed by separately controlling the opening degrees of the first and second refrigerant flow amount regulation valves V_1 and V_2 with, for example, a predetermined control unit including a microcomputer.

[0024] In this case, the predetermined operation state is, for example, a low load operation state in which the amount of refrigerant flowing to the refrigerant inlet 6a of the flow divider 6 becomes low. For example, as shown in Fig. 2, in a low load state, when the second branch flow path 7b extends through a portion 26b in which the flow velocity is low and the first branch flow path 7a extends through a portion 26a in which the flow velocity is high, that is, when the flow velocity is low in the second branch flow path 7b and the flow velocity is high in the first branch flow path 7a, there is, for example, no margin in heat exchange capacity. Thus, the opening degree is decreased for the refrigerant flow amount regulation valve V_2 that corresponds to the second branch flow path 7b in which the flow velocity is low. Therefore, in comparison with the second branch flow path 7b, more refrigerant flows to the first branch flow path 7a, in which the flow velocity is high and a margin in heat exchange capacity is provided.

[0025] In this manner, in a low load state in which the entire refrigerant flow amount decreases, the in-pipe flow velocity becomes high in the first branch flow path 7a in which the flow velocity is high by decreasing the opening degree for the refrigerant flow amount regulation valve V_2 of the second branch flow path 7b in which the flow velocity is low to distribute more refrigerant to the first branch flow path 7a in which the flow velocity is high than the second branch flow path 7b. Further, as shown by the graph in Fig. 3, the difference ΔT is increased between the temperature at the outlet of the heat exchanger 26 and the intake temperature. As a result, the capacity of the indoor heat exchanger 26 is increased, and the refrigerant capacity is increased. In the graph of Fig. 3, the first branch flow path 7a is shown by the blank backgrounds, and the second branch flow path 7b is shown by the shadowed backgrounds.

[0026] In a rated load state, the first and second refrigerant flow amount regulation valves V_1 and V_2 are completely open so that the heat exchange capacity of the heat exchanger 26 is fully used. As a result, in the present embodiment, in comparison with the prior art structure that merely equalizes the temperatures at the outlets of the paths 8A and 8B of the indoor heat exchanger 26, the heat exchange capacity of the indoor heat exchanger

26 for an air conditioner is effectively increased.

[Second Embodiment]

[0027] Fig. 4 shows the structure of a flow divider and a heat exchanger for an air conditioner according to a second embodiment of the present invention. In the structure of the first embodiment, to facilitate description, for example, the indoor heat exchanger 26 of Fig. 6 is divided into two flow velocity regions, low flow velocity portions A and B and high flow velocity portions C and D, and refrigerant is distributed to the two paths, the first and second branch flow paths 7a and 7b. The features of the second embodiment are in the structure that will now be described. The flow velocity region of the heat exchanger 26 shown in Fig. 6 is finely divided into, for example, four flow velocity regions, low flow velocity portions A, B, and C and high flow velocity portion D. First, second, third, and fourth branch flow paths 7a to 7d are respectively arranged in correspondence with the velocity regions. In the same manner as the first embodiment, first to fourth refrigerant flow amount regulation valves V_{21} to V_{24} are respectively arranged in the branch flow paths 7a to 7d.

[0028] In this manner, in a low load state in which at least the entire refrigerant flow amount is low, even when using the first to fourth branch flow paths 7a to 7d, the opening degrees are decreased for the first to third refrigerant flow amount regulation valves V_{21} to V_{23} of the first to third branch flow paths 7a to 7c in which the flow velocity is low and no margin is provided for the processing capacity. Further, more refrigerant is distributed to the fourth branch flow path 7d in which the flow velocity is high and a margin is provided for the processing capacity. This increases the in-pipe flow velocity of the fourth branch flow path 7d and increases the difference between the temperature at the outlet of the indoor heat exchanger 26 and the intake temperature. As a result, the capacity of the indoor heat exchanger 26 is increased, and the refrigerant capacity is increased. In a rated load state, the refrigerant flow amount regulation valves V_{21} to V_{24} are completely open so that the capacity of the heat exchanger 26 is fully used.

a refrigerant flow amount regulation valve provided for each of the plurality of paths in the flow divider, wherein in a predetermined operation state, more refrigerant is distributed to a predetermined path in which the processing capacity is large and the refrigerant temperature at an outlet of the indoor heat exchanger is high in comparison with other paths.

2. The air conditioner according to claim 1, being **characterized in that** the predetermined operation state is an operation state in which the load is low, and in the low load state, an opening is decreased in the refrigerant flow amount regulation valve for the path at which the processing capacity is small and the refrigerant temperature at the outlet of the indoor heat exchanger is low so that a large amount of refrigerant flows to the predetermined path in which the processing capacity is large and the refrigerant temperature at the outlet of the indoor heat exchanger is high.
3. The air conditioner according to claim 1, being **characterized in that** the predetermined path is a path in which the flow velocity is high, and in a low load state, an opening is decreased in the refrigerant flow amount regulation valve for a path in which the flow velocity is low so that more refrigerant flows to the path that has a margin in heat exchange capacity and a high flow velocity.
4. The air conditioner according to claim 1, being **characterized in that** the predetermined operation state is an operation state during a rated load, and in the rated load state, the refrigerant flow amount regulation valve for each path is completely open, and the capacity of the heat exchanger is fully used.

Claims

1. An air conditioner including a compressor, a four-way valve, an outdoor heat exchanger, a restriction device, and an indoor heat exchanger provided with a plurality of paths, wherein the four-way valve, outdoor heat exchanger, restriction device, and indoor heat exchanger are sequentially connected by a refrigerant pipe to form a refrigerant circuit, with a flow divider including a plurality of paths being arranged between the indoor heat exchanger, which includes the plurality of paths, and the restriction device, the air conditioner being **characterized by**:

Fig.1

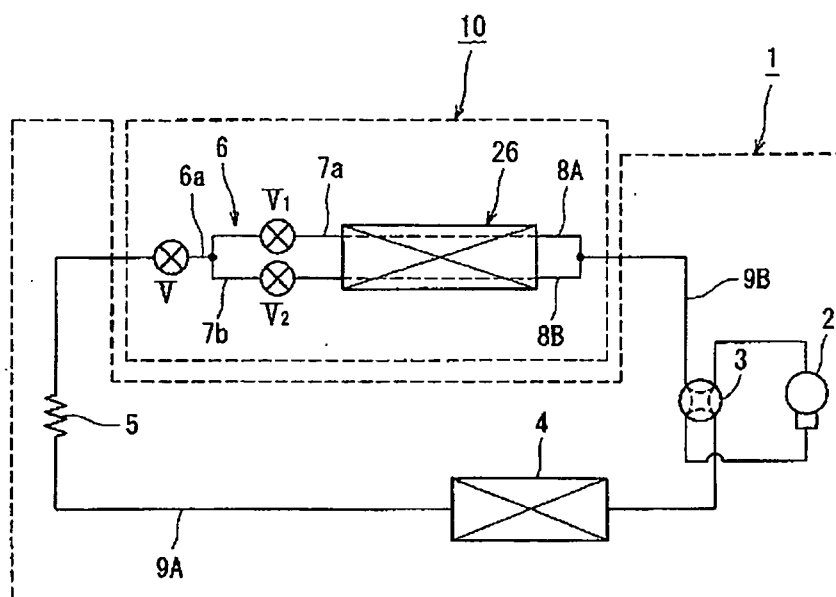


Fig.2

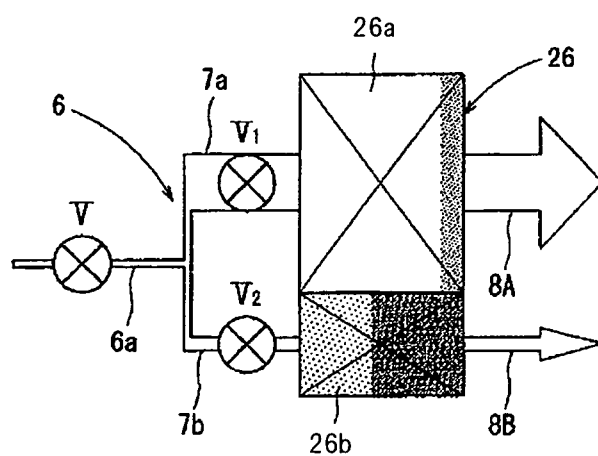


Fig.3

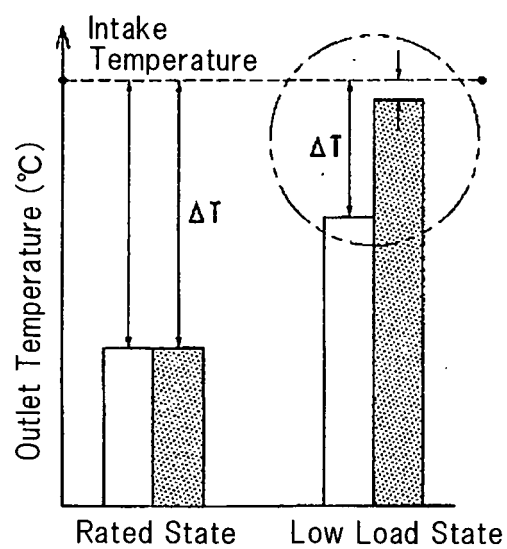


Fig.4

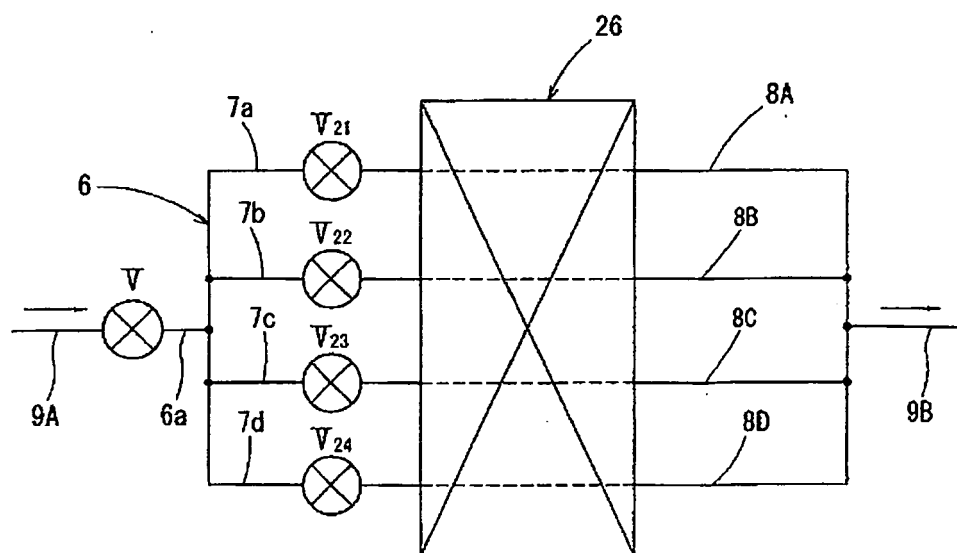


Fig.5

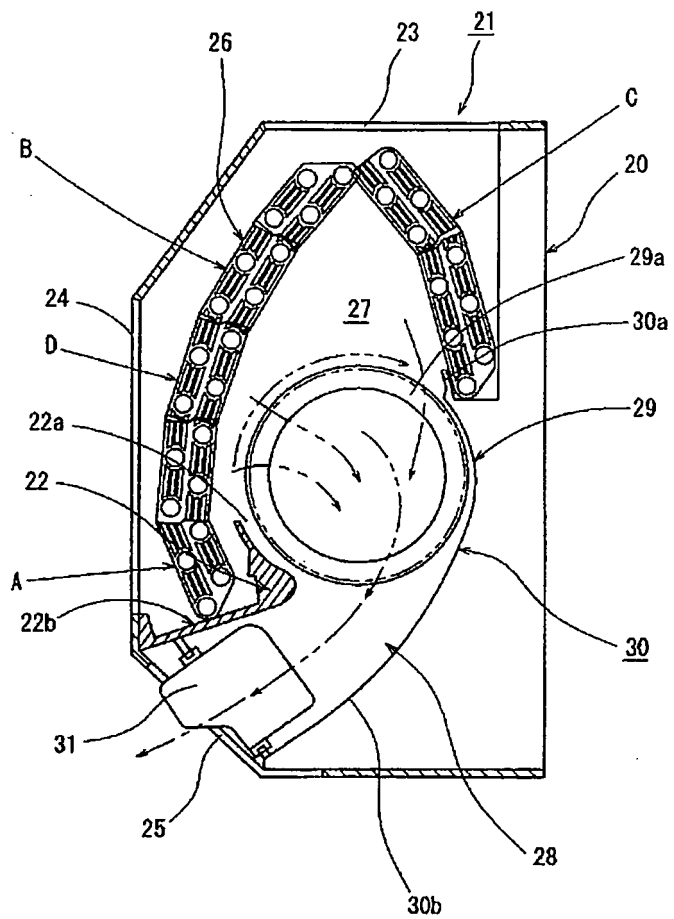


Fig.6

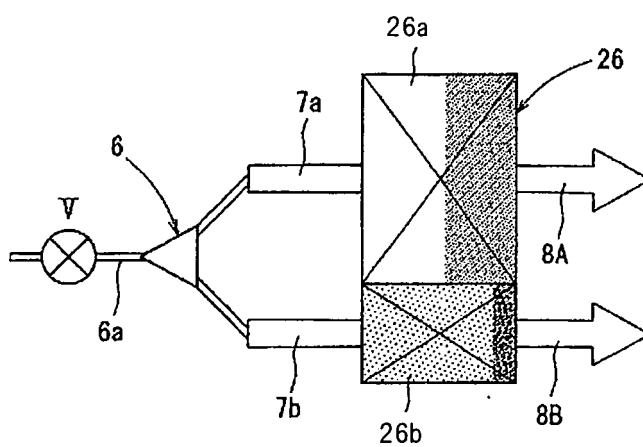


Fig.7

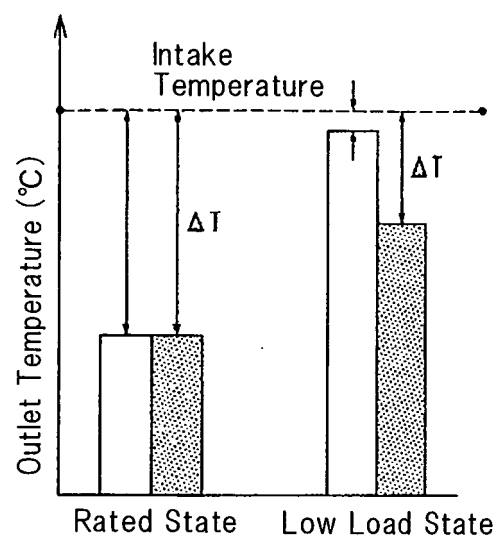


Fig.8

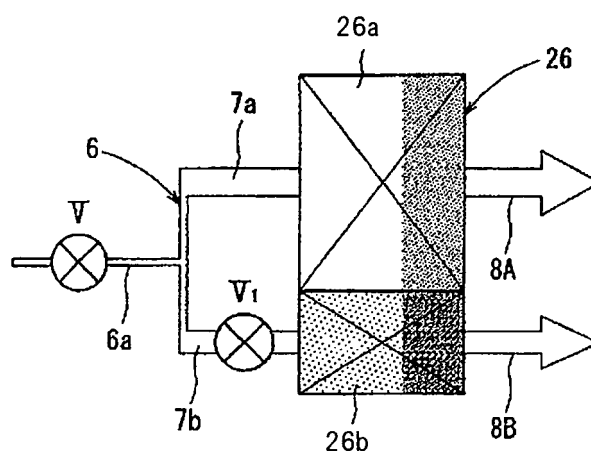
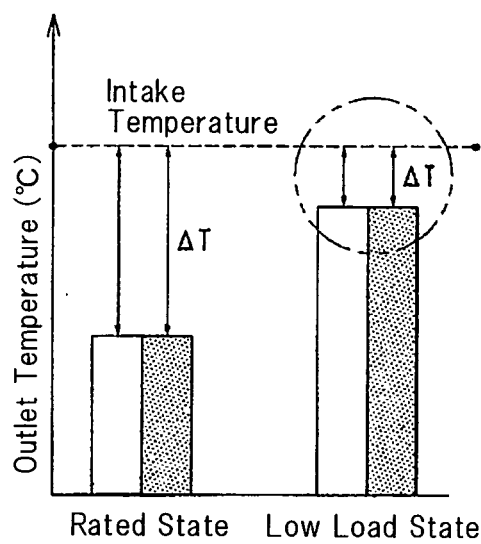


Fig.9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/050476

A. CLASSIFICATION OF SUBJECT MATTER

F25B41/00(2006.01) i, F24F11/02(2006.01) i, F25B1/00(2006.01) i

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)

F25B41/00, F24F11/02, F25B1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007

Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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 5-118682 A (Sharp Corp.), 14 May, 1993 (14.05.93), Fig. 1; Par. No. [0004] (Family: none)	1-4
Y	JP 4-208363 A (Matsushita Electric Works, Ltd.), 30 July, 1992 (30.07.92), Page 2, upper left column, line 16 to upper right column, line 15; Fig. 1; page 3, upper left column, line 4 to lower left column, line 7 (Family: none)	1-4

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

* Special categories of cited documents:

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Date of the actual completion of the international search
02 April, 2007 (02.04.07)Date of mailing of the international search report
10 April, 2007 (10.04.07)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/050476

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-179968 A (Fujitsu General Ltd.), 30 June, 2000 (30.06.00), Par. No. [0005]; Fig. 6 (Family: none)	1-4
A	JP 5-280829 A (Matsushita Electric Works, Ltd.), 29 October, 1993 (29.10.93), Fig. 3 (Family: none)	1-4

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5118682 A [0011]