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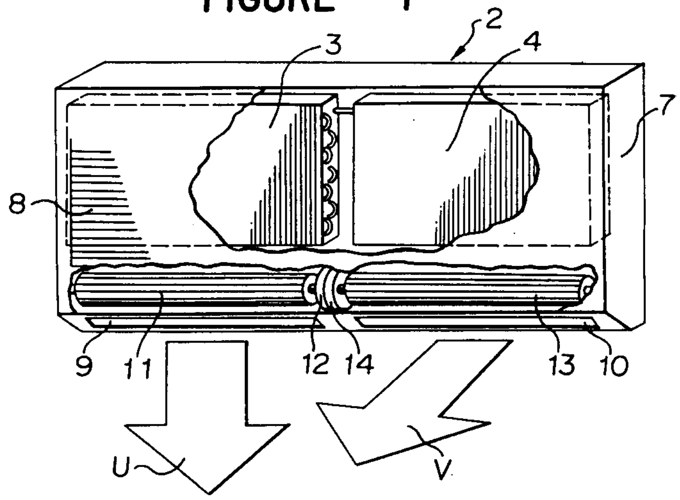
(54) Air conditioner.

(57) An air conditioner comprising a plurality of heat exchangers (3, 4) connected in series; a plurality of outlets (9, 10) which are arranged to correspond to the respective heat exchangers (3, 4); air supply means (11, 13) for blowing off through the outlets (9, 10) conditioned air which has passed through the heat exchangers (3, 4); and blowing direction control means (15, 18, 20, 23) which are arranged to correspond to the respective outlets (9, 10), and which are capable of separately controlling the blowing direction of the conditioned air.

FIGURE 1



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The present invention relates to an air conditioner, and in particular an air conditioner which can prevent temperature distribution near to an indoor floor from being inequable.

A conventional outlet structure in such air conditioner has been disclosed in e.g. Japanese Unexamined Patent Publication No. 196041/1988. Figure 9 is a cross sectional side view of an indoor unit in the conventional air conditioner. Figure 10 is an exploded perspective view of the indoor unit. Figure 11 is a perspective view showing the detail of the outlet in the indoor unit.

In Figures 9-11, reference numeral 41 designates an indoor unit casing. Reference numeral 42 designates an inlet which is formed in the casing 41. Reference numeral 43 designates a heat exchanger which is arranged in the casing 41. Reference numeral 44 designates an outlet. Reference numeral 45 designates a cross flow fan which blows off indoors from the outlet 44 conditioned air which has been introduced through the inlet 42 into the casing 41 and has been passed through the heat exchanger 43. Reference numeral 46 designates an auxiliary flap which is rotatably supported at its opposite ends in the outlet 44, and which has five passages 47 longitudinally formed therein. Reference numeral 48 designates a main flap which is rotatably supported in the outlet 44 to have the same axis as the auxiliary flap 47 at the indoor side.

Now, the operation of the conventional air conditioner as constructed above will be explained.

In heating, when power is turned on with the main flap 48 oriented at about 45 degrees and with the auxiliary flap 46 substantially vertically oriented, indoor air is introduced through the inlet 42 into the casing 41 by rotation of the cross flow fan 45. The introduced air is heated to a high temperature by the heat exchanger 43, and is blown off indoors from the outlet 44. When the air is being blown off through the outlet 44, a portion X of the diffused air flows along the main flap 48. Another portion Y of the diffused air has its blowing angle downward changed by the auxiliary flap 46. The other portion Z of the diffused air which has passed through the passages 47 in the auxiliary flap 46 flows along the main flap 48 like the portion X. In that manner, the two flaps 46 and 48 divide the diffused air into the one heading just under the indoor unit and the one heading far from the indoor unit, thereby causing temperature distribution near to an indoor floor to be more equable.

The outlet structure of the conventional air conditioner, which has been stated as earlier, can equalize the temperature distribution near to the floor at a location just below the indoor unit, but creates a problem in that the diffused air heading far from the indoor unit goes up and temperatures far from the indoor unit are liable to be lower in comparison with the temperatures just below the indoor unit. Temperature distribution near to the floor throughout a room to be air conditioned has not been satisfactory.

Although hot air which is heading far from the indoor unit ought to reach a resident's feet, it goes up to reach a location near to his or her head, which is slightly away from ideal comfort.

It is an object of the present invention to eliminate disadvantage of the conventional air conditioner and to provide a new and improved air conditioner capable of equalizing temperature distribution near to floor throughout a room to be air conditioned, and of realizing ideal heating in a way to keep a resident's head cool and feet warm.

The foregoing and the other objects of the present invention have been attained by providing an air conditioner comprising a plurality of heat exchangers connected in series; a plurality of outlets which are arranged to correspond to the respective heat exchangers; air supply means for blowing off through the outlets conditioned air which has passed through the heat exchangers; and blowing direction control means which are arranged to correspond to the respective outlets, and which are capable of separately controlling the blowing direction of the conditioned air.

In accordance with the present invention, a refrigerant which is compressed by a compressor in heating circulates the respective heat exchangers to raise temperatures of the heat exchangers. The heat exchanger closer to the compressor is kept at a higher temperature by the heat of the refrigerant, and the respective heat exchangers have different temperatures. As a result, the diffused air which is blown off from the outlets by the air supply means has different temperatures depending on its portions.

The air conditioner according to the present invention can separately control the blowing direction of different temperature portions of the diffused air by the blowing direction control means. A hotter portion of the diffused air can be blown off toward a location near to a floor, and a cooler portion of the diffused air can be blown off toward a location near to a resident's head to equalize temperature distribution near to the floor throughout a room to be air conditioned, as well as to realize ideal heating in a way to keep his or her head cool and feet warm.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 is a perspective view showing an indoor unit of the air conditioner according to an embodiment of the present invention;

Figure 2 is a refrigerant circuit diagram showing the air conditioner of the embodiment;

Figure 3 is a perspective view showing the details of an outlet in the indoor unit of the air conditioner of the embodiment;

Figure 4 is a block diagram showing an electrical structure of the air conditioner of the embodiment;

Figure 5 is a Mollier diagram of the air conditioner of the embodiment;

Figure 6 is a flowchart showing the process performed by a control circuit of the air conditioner of the embodiment;

Figures 7 and 8 are schematic diagrams to help explain blowing directions of diffused air from the air conditioner of the embodiment;

Figure 9 is a cross sectional side view of an indoor unit of a conventional air conditioner;

Figure 10 is an exploded perspective view of the indoor unit of the conventional air conditioner; and

Figure 11 is a perspective view showing the details of an outlet in the indoor unit of the conventional air conditioner.

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to Figure 2 thereof, there is shown a refrigerant circuit diagram showing the air conditioner according to an embodiment of the present invention.

In Figure 2, reference numeral 1 designates a compressor which is arranged in an outdoor unit to compress a refrigerant. Reference numeral 2 designates an indoor unit which are arranged indoors. Reference numeral 3 designates a first heat exchanger in the indoor unit 2 which is connected to the compressor 1. Reference numeral 4 designates a second heat exchanger in the indoor unit 2 which is connected in series with the first heat exchanger. Reference numeral 5 designates an expansion valve which is connected to the second heat exchanger 4. Reference numeral 6 designates an evaporator which is connected to the expansion valve 5.

Referring now to Figure 1, there is shown a perspective view showing the indoor unit 2 of the air conditioner.

In Figure 1, reference numeral 7 designates a casing for the indoor unit 2 which houses the first and second heat exchangers 3 and 4. Reference numeral 8 designates an inlet which is formed in a front portion of the indoor unit 2. Reference numeral 9 designates a first outlet which is formed in a lower portion of the casing to correspond to the first heat exchanger 3. Reference numeral 10 designates a second outlet which is formed in a lower portion of the casing 7 to correspond to the second heat exchanger 4.

Reference numeral 11 designates a first cross flow fan which is arranged between the first heat exchanger 3 and the first outlet 9 in the casing 7. Reference numeral 12 designates a first fan driving motor for rotating the first cross flow fan 11. Reference numeral 13 designates a second cross flow fan which is arranged between the second heat exchanger 4 and the second outlet 10 in the casing 7. Reference numeral 14 designates a second fan driving motor for rotating the second cross flow fan 13.

In the embodiment, the first cross flow fan 11 and the second cross flow fan 13 constitute air supply means.

Referring now to Figure 3, there is shown a perspective view showing the details of the outlets 9 and 10 in the indoor unit 2.

In Figure 3, reference numeral 15 designates a first group of six louvers 15 which are pivoted in the first outlet 9 so as to be horizontally swingable. Reference numeral 16 designates a pair of first louver motors, the respective motors carrying out the swing operation of a set of three louvers through interlocking levers 17, independently from the other set of the three louvers. Reference numeral 18 designates a first flap which is pivoted in the first outlet 9 ahead of the first louvers 15 so as to be vertically swingable. Reference numeral 19 designates a first diffused air temperature detecting sensor which detects a diffused air temperature in the first outlet 9.

Reference numeral 20 designates a second group of six louvers which are pivoted in the second outlet 10 so as to be horizontally swingable. Reference numeral 21 designates a pair of second louver motors, the respective motors carrying out the swing operation of a set of three louvers 20 through interlocking levers 22, independently from the other set of three louvers 20. Reference numeral 23 designates a second flap which is pivoted in the second outlet 10 ahead of the second louvers 20 so as to be vertically swingable. Reference numeral 24 designates a second diffused air temperature detecting sensor which detects a diffused air temperature in the second outlet 10.

In the embodiment, the first and second louvers 15 and 20, and the first and second flaps 18 and 23 constitute blowing direction control means.

Referring now to Figure 4, there is shown a block diagram showing an electrical structure of the air conditioner according to the embodiment.

In Figure 4, reference numeral 25 designates an air conditioner control circuit which has an input side connected to the first diffused air temperature detecting sensor 19 and the second diffused air temperature detecting sensor 24, and which has an output side connected to the first fan driving motor 12, the second fan driving motor 14, the first louver motors 16 and the second louver motors 21 through driving circuits 26-29. Reference numeral 30 designates a first flap motor which can be connected to the output side of the control circuit 25 through a driving circuit 31 to carry out the swing operation for the first flap 18. Reference numeral 32 designates a second flap motor which can be connected to the output side of the control circuit 25 through a driving circuit 33 to carry out the swing operation for the second flap 23.

In the control circuit 25 is in advance stored a map which can select stable durations Ta, desired diffused temperature differences Δt, air volume differences ΔQ and stable time total air volumes Qs so as to correspond to several kinds of operation modes, and which controls the motors 12, 14, 16, 21, 30 and 32 in accordance with selected values.

The operation of the air conditioner of the embodiment which is constructed as stated above will be explained.

When the air conditioner according to the embodiment performs heating, the refrigerant which has been compressed by the compressor 1 is firstly introduced into the heat exchanger 3 to give up a part of its heat, and then is introduced into the second heat exchanger 4 to give up another part of its heat. In Figure 5, there is shown a Mollier diagram at this time, which shows that at the side of the first heat exchanger 3 the refrigerant carries out heat exchange in a superheat and two phase flow region, or a high temperature region indicated by reference A to be kept at a high temperature, and which shows that at the side of the second heat exchanger 4 the refrigerant carries out heat exchange in a two phase flow and subcool region, or a low temperature region indicated by reference B to be kept at at a low temperature at the side of the second heat exchanger 4. As a result, a diffused air U at the side of the first heat exchanger 3 has a high temperature whereas diffused air V at the side of the second heat exchanger 4 has a low temperature.

Referring now to Figure 6, there is shown a flowchart showing the process performed by the control circuit 25 when power is turned on in the air conditioner.

Now, the operation of the air conditioner will be explained referring to the flowchart. The program which is shown in the flowchart is called during the executing of a main program not shown.

The control circuit 25 determines at Step S1 whether power is turned on in the air conditioner or not. If affirmative, the operation mode which is selected by a resident is inputted at Step 52. A stable duration Ta which corresponds to the selected operation mode is read out from the map at Step S3. It is determined at Step S4 whether the stable duration Ta has passed since the power has been turn on, or not. If the stable duration Ta has passed, data on diffused air temperatures t1 and t2 are inputted from the first diffused air temperature detecting sensor 19 and the second diffused air temperature detecting sensor 24, respectively, at Step S5.

The stable durations Ta are determined to be long enough to bring the temperatures of the heat exchangers 3 and 4 raised by the refrigerant into equilibrium states. After the temperatures of the heat exchangers 3 and 4 have got in the equilibrium states to cause the diffused air temperatures t1 and t2 to be stable, a blowing direction control, which will be explained later on, will be carried out.

Next, at Step S6, a desired diffused air temperature difference Δt which corresponds to the selected operation mode is read out from the map which has been stored in the control circuit in advance. At Step S7, the desired diffused air temperature Δt is compared to a value which is obtained by subtracting the diffused air temperature t2 from the diffused air temperature t1. If (t1 - t2) is smaller than Δt (which means that the actual temperature difference is small), a corresponding air volume difference ΔQ is read out from the map at Step S8, and the program proceeds to Step S9. At Step S9, the revolutions of the first fan motor 12 and the second fan motor 14 are controlled to adjust an air volume Q1 of the first diffused air U and a air volume Q2 of the second diffused air V so that the air volume Q1 is greater than the air volume Q2 by ΔQ. In addition, as shown in Figures 3 and 7, the first flap motor 30 is driven to direct the first flap 18 downward, and the second flap motor 32 is driven to direct the second flap 23 front. The first louver motors 16 and the second louver motors 21 are driven to direct both groups of louvers 15 and 20 inward with respect to each other, causing the diffused air U and V to flow a cross manner. The respective sets of first louvers 15 are opened with respect to each other to make an air supply area of the first diffused air U wider.

It is determined at Step S10 whether (t1 - t2) is equal to Δt or not. If affirmative, the program terminates. If negative, the program returns to Step S7, and (t1 - t2) is compared to Δt again.

If (t1 - t2) is greater than Δt at Step S7 (which means that the actual temperature difference is great), the program proceeds to Step S11 where the revolutions of the first fan motor 12 and the fan motor 14 are controlled to adjust the air volume Q1 of the first diffuse air U and the air volume Q2 of the second diffused air V so that both air volumes become equal. At the same time, the first flap motor 30 and the second flap motor 32 are driven to direct both flaps 18 and 23 downward, and the first louver motors 16 and the second louver motors 21 are driven to direct both groups of the louvers 15 and 20 in the same direction as each other.

If (t1 - t2) is equal to Δt at Step S10, the program terminates. If negative, the program returns to Step S7, and (t1 - t2) is compared to Δt.

If (t1 - t2) is equal to Δt at Step S7, a stable time total air volume Qs is read out from the map at Step S12, and the program proceeds to Step S13. At Step S13, the revolutions of the first fan motor 12 and the second fan motor 14 are controlled to adjust both air volumes Q1 and Q2 so that the air volume Q1 of the first diffused air U and the air volume Q2 of the second diffused air V are halves of Qs, respectively. In addition, as shown in Figures 3 and 7, the first flap motor 30 is driven to direct the first flap 18 downward, and the second flap motor 32 is driven to direct the second flap 3 front. The first louver motors 16 and the second louver motors 21 are driven to direct both groups of the louvers 15 and 20 inward with respect to each other, causing the diffused air U and V to flow a cross manner. The respective sets of first louvers 15 are slightly closed with respect to each other to make the air supply area of the first diffused air U narrower, and the program terminates.

As explained in deteil, if the actual temperature difference (t1 - t2) is smaller than Δt at Step S7, the air volume Q1 of the first diffused air U is made greater than the air volume Q2 of the second diffused air V at Step S9 to cause the first diffused air temperature t1 to be gradually raised, thereby allowing the temperature difference (t1 - t2) itself to increase to approach Δt. If the actual temperature difference (t1 - t2) is greater than Δt, the air volume Q1 of the first diffused air U is decreased until the air volume Q1 becomes equal to the air volume Q2 of the second diffused air V at Step S11. In that manner, the first diffused air temperature T1 is gradually lowered to cause the temperature difference (t1 - t2) itself to be decreased, thereby allowing the temperature difference to approach Δt.

Accordingly, A difference between the first diffused air temperature t1 and the second diffused air temperature t2 can be always kept in the vicinity of a predetermined air volume difference Δt. At Step S13, the first diffused air U, which has the high temperature, is blown off downward, or toward a location near to a floor of the room R by the first flap 18, and the second diffused air V, which has the low temperature, is blown off front, or the resident's head by the second flap 23 as shown in Figure 8. In addition, the diffused air V which is constituted by two cooler portions prevents the first diffused air U from going up, thereby allowing temperature distribution near to the floor in the room R to be equalized.

As explained in detail, the air conditioner according to the embodiment includes the first and second heat exchangers 3 and 4 which are connected in series with each other, the first and second outlets 9 and 10 which are arranged to correspond to the respective heat exchangers 3 and 4, the first and second cross for fans 11 and 14 which blow off indoors conditioned air as first and second diffused air through the outlets 9 and 10, the conditioned air having passed through the respective heat exchangers 3 and 4, and the first and second louvers 15 and 20, and the first and second flaps 18 and 23 which are arranged to correspond the respective outlets 9 and 10, and which can separately control the blowing direction of the first and second diffused air.

The arrangement of the embodiment can separately control the blowing directions of the high temperature diffused air from the first heat exchanger 3 and the low temperature diffused air from the second heat exchanger 4 by use of the first and second louvers 15 and 20, and the first and second flaps 18 and 23.

As a result, the first diffused air U which has the high temperature can be blown off toward a location near to the floor, and the second diffused air V which has the low temperature can be blown off toward a location near to the resident's head to keep his or her head cool and feet warm. In addition, the second low temperature diffused air V can prevent the first high temperature diffused air U from going up to equalize temperature distribution near to the floor.

Although the heat exchanger unit of the embodiment is constituted by the two, i.e. the first and the second heat exchangers 3 and 4, the present invention is not limited to such arrangement, but is also applicable to a case wherein the number of the heat exchangers is three or four. However, the provision of at least two kinds of diffused air having different temperatures can keep the resident's head cool and feet warm. When two heat exchangers are used to practice the present invention, it has an advantage in that production costs are reduced, in comparison with the case using three or four heat exchangers.

Although the flowing direction control means of the embodiment is constituted by the first and second louvers 15 and 20 for horizontally controlling the blowing direction, and the first and second flaps 18 and 23 for vertically controlling the blowing direction, the present invention is not limited such case, but is also applicable to a case wherein the blowing direction control means can be constituted by a blowing direction control louver for controlling the blowing direction in a slant direction as far as the flowing direction of the diffused air can be controlled at a desired manner.

Although the blowing direction control means of the embodiment is constituted by the louvers 15 and 20, and the flaps 18 and 23 through which the blowing direction of the diffused air can be automatically controlled by use of the motors 16, 21, 30 and 32 controlled by the control circuit 25, the present invention is not limited to such case, but is also applicable to a case wherein the louvers 15 and 20, and the flaps 18 and 23 can be manually operated.

Claims

1. An air conditioner characterized in comprising:

a plurality of heat exchangers (3, 4) connected in series;

a plurality of outlets (9, 10) which are arranged to correspond to the respective heat exchangers (3, 4);

air supply means (11, 13) for blowing off through the outlets (9, 10) conditioned air which has passed through the heat exchangers (3, 4); and

blowing direction control means (15, 18, 20, 23) which are arranged to correspond to the respective outlets (9, 10), and which are capable of separately controlling the blowing direction of the conditioned air.

2. An air conditioner according to Claim 2, wherein the blowing direction control means (15, 18, 20, 23) are capable of simultaneously controlling the blowing direction of the conditioned air in a plurality of ways.

3. An air conditioner according to Claim 1, wherein the blowing direction control means (15, 18, 20, 23) are capable of controlling the blowing direction at the respective outlets (9, 10) in vertical or horizontal ways.

4. An air conditioner according to Claim 3, wherein the blowing direction control means (15, 18, 20, 23) include flappers (18, 23) and louvers (15, 20) in the respective outlets (9, 10), the flappers (18, 23) being vertically movable, and the louvers (15, 20) being horizontally movable.

5. An air conditioner according to Claim 1, wherein the blowing direction control means (15, 18, 20, 23) blows off upward the conditioned air from the outlet (9) which is arranged to correspond to the heat exchanger (3) nearer to a compressor (1), and blows off downward the conditioned air from the outlet (10) which is arranged to correspond to the heat exchanger (4) further from the compressor (1).

6. An air conditioner according to Claim 5, wherein the conditioned air which is blown off downward is controlled to be distributed equally in the horizontal direction.

7. An air conditioner according to Claim 1, wherein the blowing direction control means (15, 18, 20, 23) control the blowing direction, depending on temperatures which are detected by temperature sensors (19, 24), the sensors (19, 24) being arranged in proximity to the outlets (9, 10).

8. An air conditioner according to Claim 7, wherein the blowing direction is to control downward the outlet (9 or 10) whose temperature is detected as being high by the corresponding temperature sensor.

9. An air conditioner according to Claim 5, 7 or 8, wherein the blowing direction control means (15, 18, 20, 23) control the blowing direction when a predetermined duration has passed since the commencement of operation.

FIGURE 1

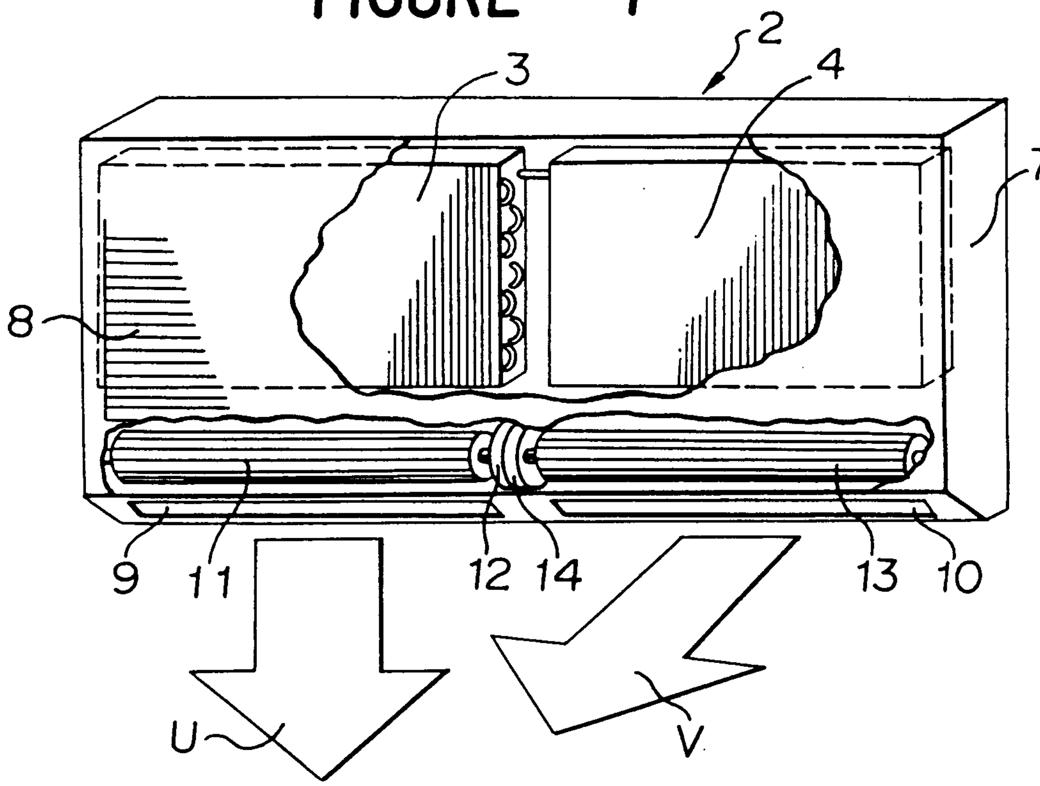


FIGURE 2

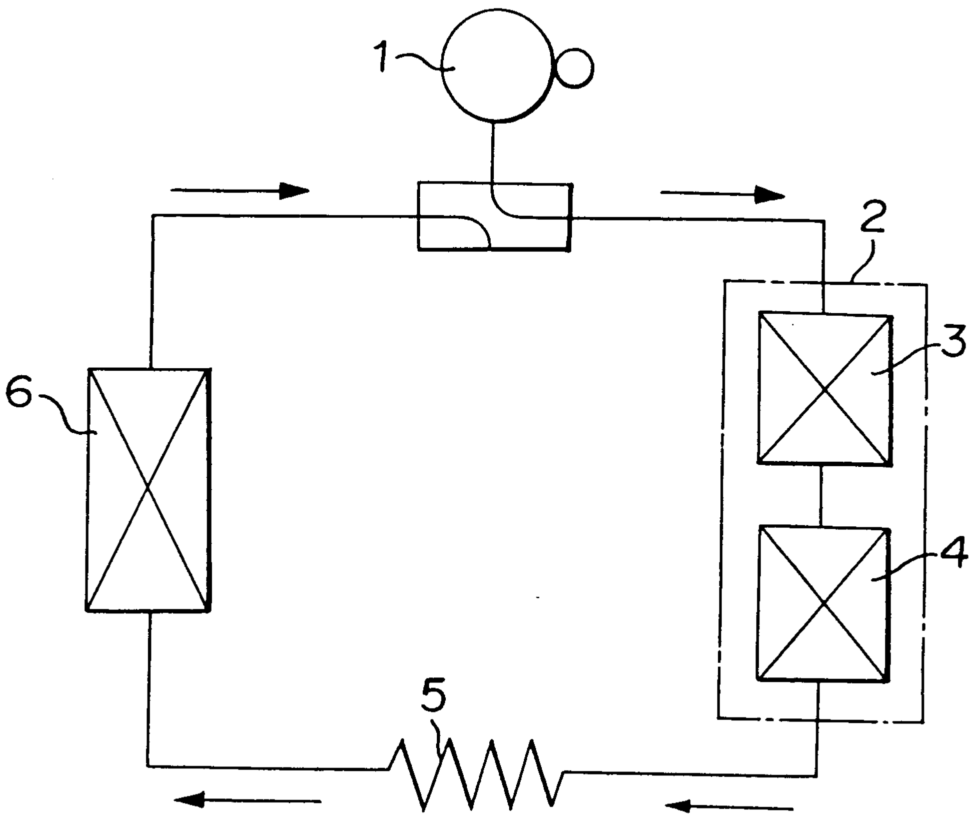


FIGURE 3

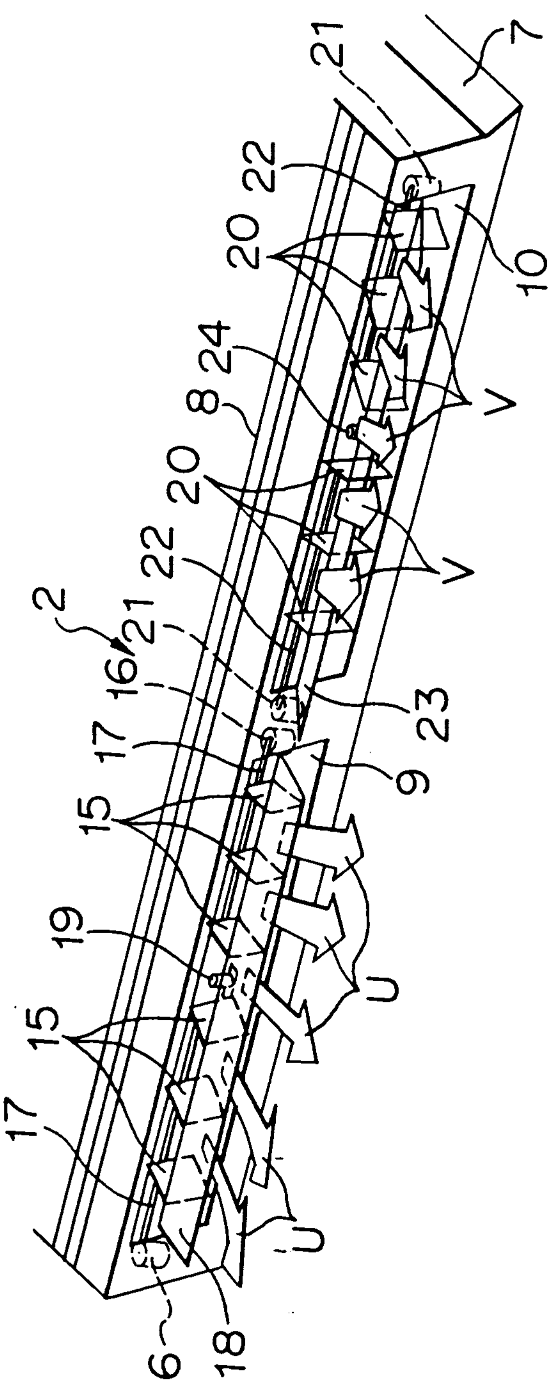


FIGURE 4

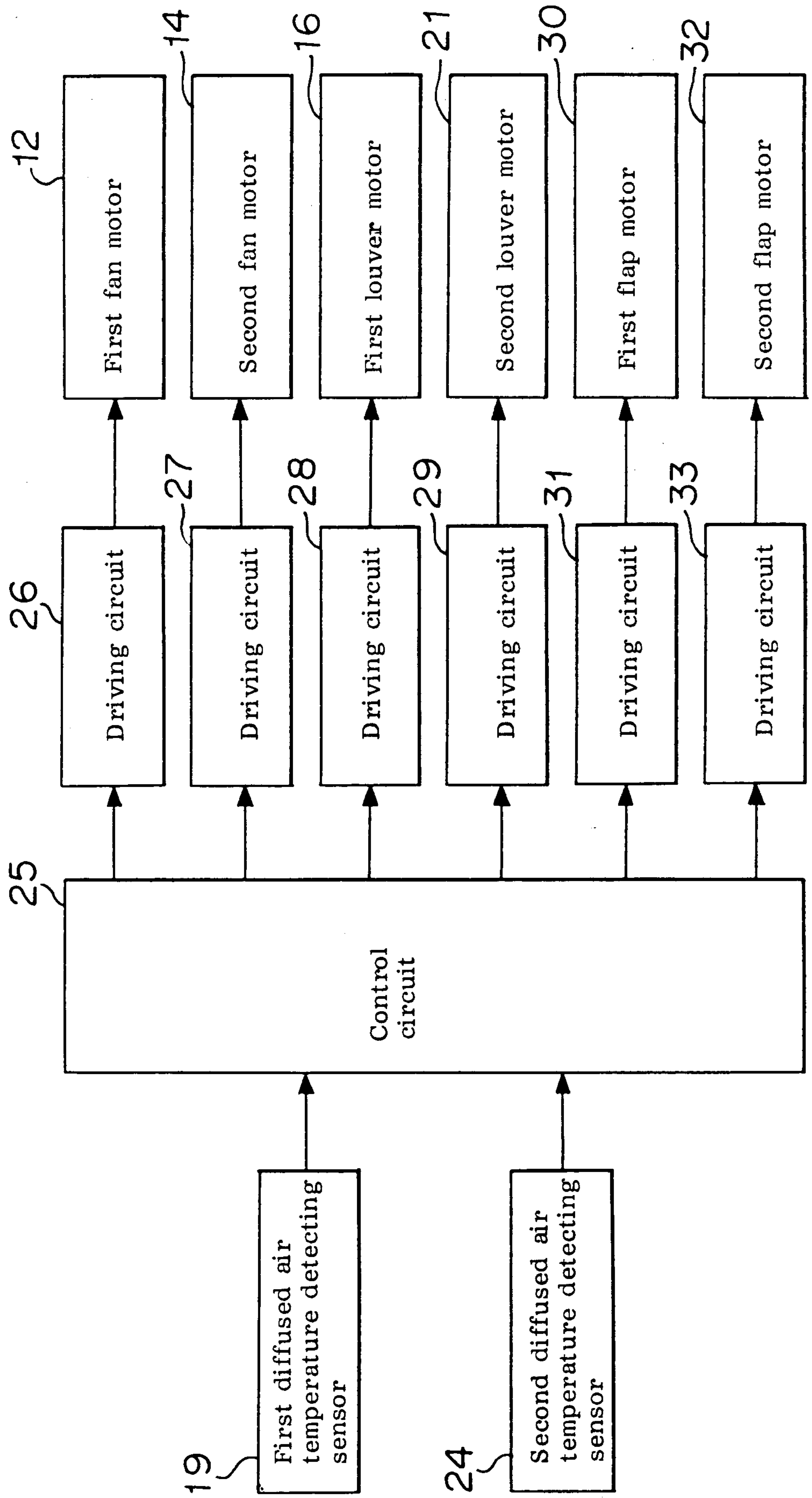

First fan motor
12
Second fan motor
14
First louver motor
16
Second louver motor
21
First flap motor
30
Second flap motor
32
Driving circuit
26
27
28
29
31
33
Control circuit
25
First diffused air temperature detecting sensor
19
Second diffused air temperature detecting sensor
24

FIGURE 5

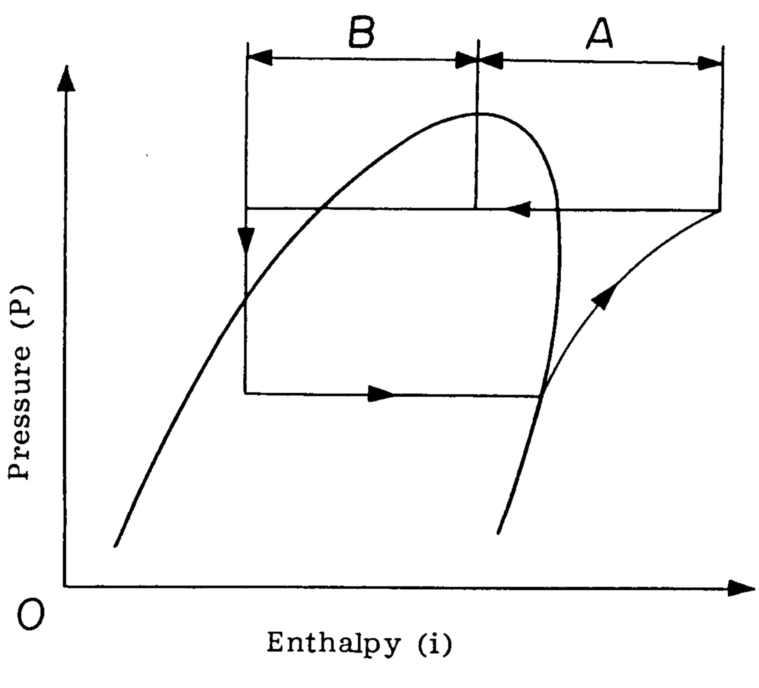


FIGURE 6

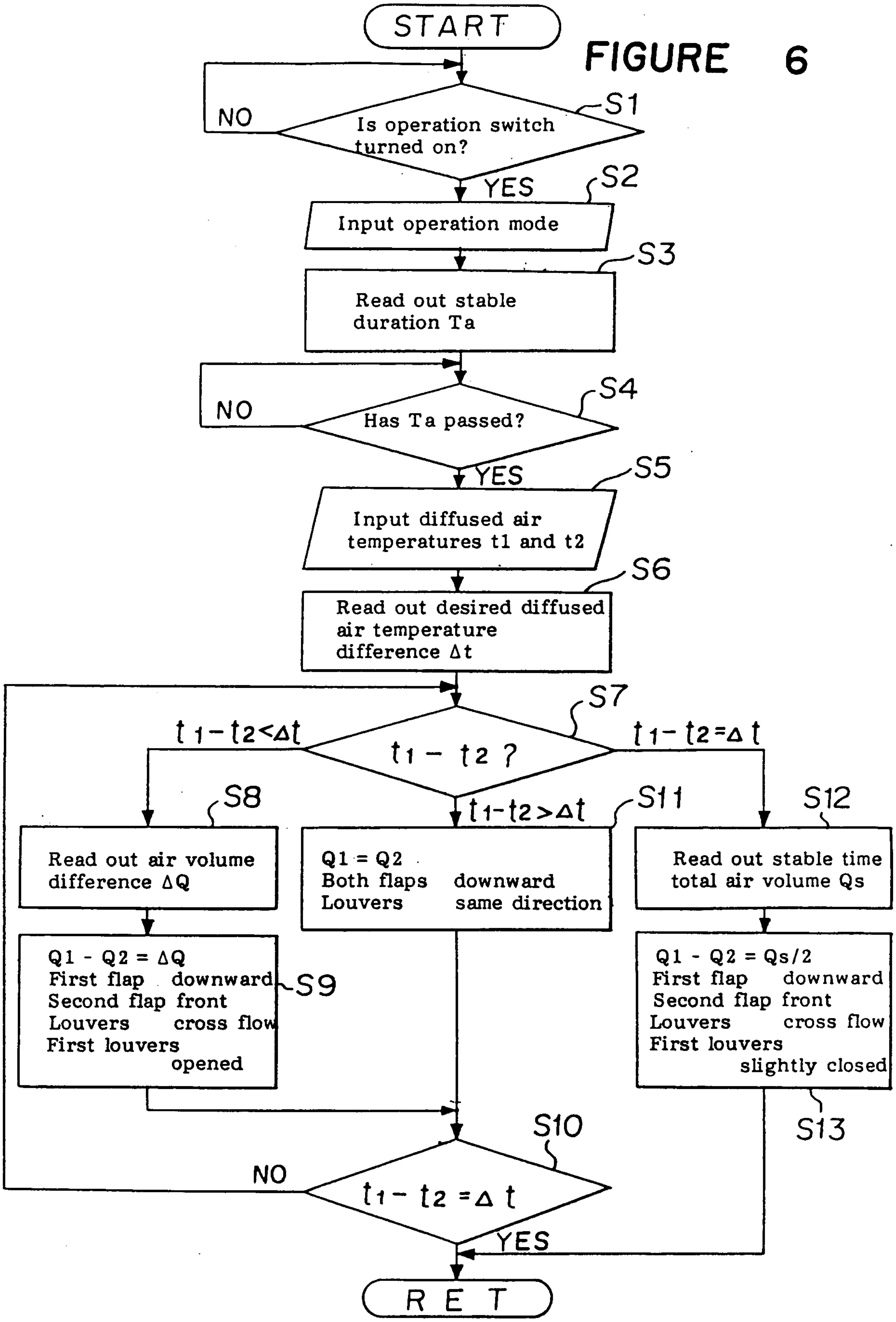

START
NO
Is operation switch turned on?
S1
YES
S2
Input operation mode
S3
Read out stable duration Ta
NO
Has Ta passed?
S4
YES
S5
Input diffused air temperatures t1 and t2
S6
Read out desired diffused air temperature difference Δt
S7
t1 - t2 ?
t1-t2<Δt
t1-t2=Δt
t1-t2>Δt
S8
Read out air volume difference ΔQ
S11
Q1 = Q2
Both flaps downward
Louvers same direction
S12
Read out stable time total air volume Qs
Q1 - Q2 = ΔQ
First flap downward
Second flap front
Louvers cross flow
First louvers opened
S9
Q1 - Q2 = Qs/2
First flap downward
Second flap front
Louvers cross flow
First louvers slightly closed
S13
S10
NO
t1- t2 =Δ t
YES
R E T

FIGURE 7

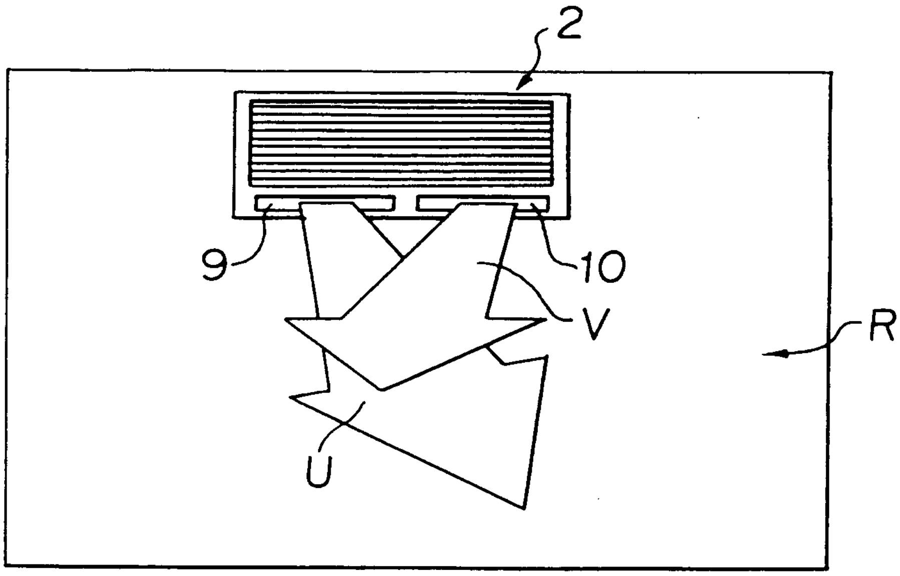


FIGURE 8

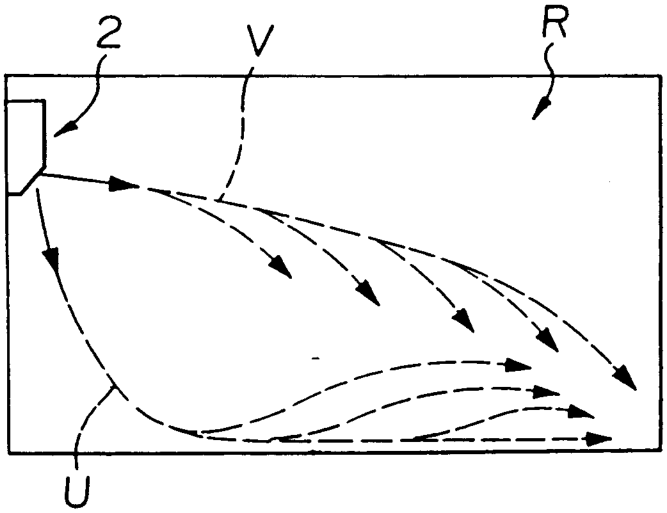


FIGURE 9

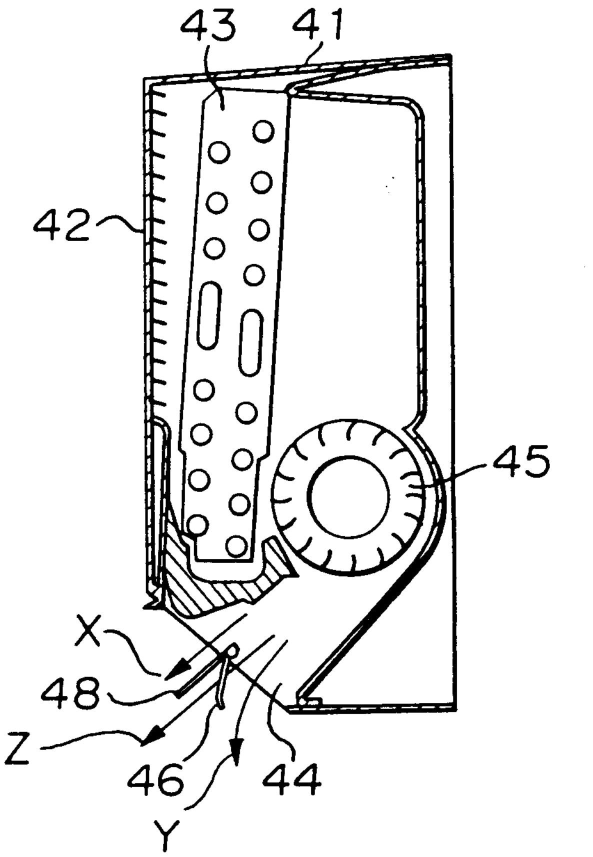


FIGURE 10

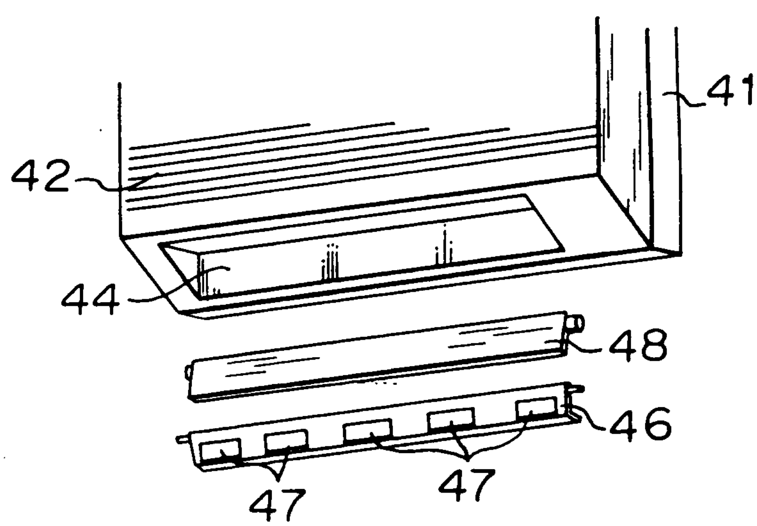
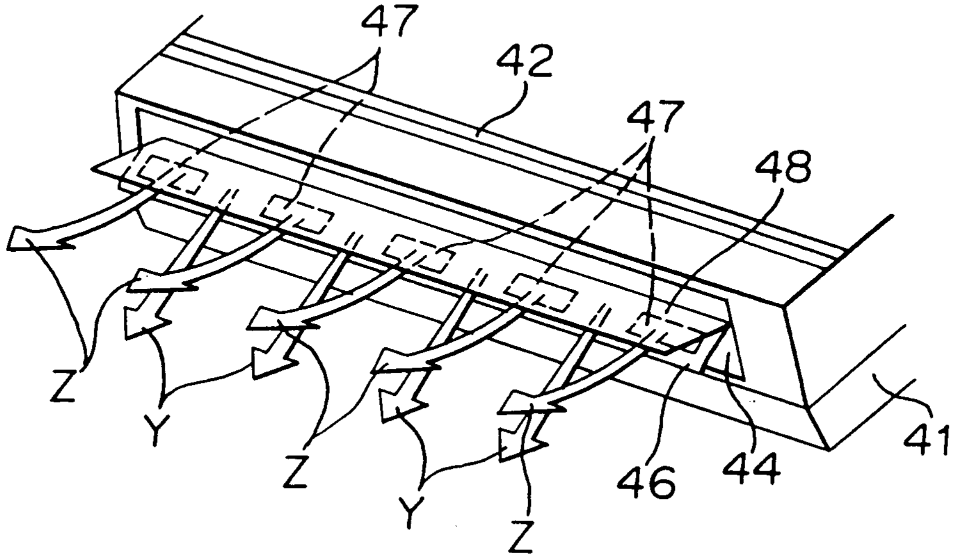


FIGURE 11



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 9006

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.5)
A	EP-A-0 269 282 (TOSHIBA) * column 4, line 34 - column 5, line 34; figure 2 * -----	1	F24F 1/02 F24F 13/072 F24F 11/053
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	19 FEBRUARY 1992	PIEPER C.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
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EPO FORM 1503 03.82 (P0401)