

DESCRIPTION

Indoor Unit for Air Conditioner

TECHNICAL FIELD

5 The present invention relates to an indoor unit for an air conditioner, which employs a turbo fan for blowing out sucked air radially outwardly relative to an axis thereof.

BACKGROUND ART

10 Conventionally, there has been provided an indoor unit for an air conditioner, in which a cross-fin heat exchanger and a cross flow fan are disposed within a generally rectangular casing mounted on a wall surface, where air-conditioning air is blown out from an air outlet
15 provided at the underside of the casing. However, this indoor unit for an air conditioner is largely projected from the wall surface, incapable of being thinned in depth, thus having a drawback that the indoor unit does not fit indoor interior. Thus, the present applicant manufactured an
20 indoor unit for an air conditioner capable of improving the indoor interior properties by being thinned. This indoor unit for an air conditioner includes a heat exchanger having an axis oriented along the back and forth direction within the casing, and a turbo fan which is placed on the back side
25 of the heat exchanger within the casing and which serves for

blowing out air, sucked from the front side, radially outwardly relative to the axis of the turbo fan. Then, air outlets for blowing out air in four directions, up and down, right and left, are provided in the casing . As the turbo fan is rotated, the indoor unit blows out air, sucked through an air inlet on the front side, in four directions from the individual air outlets.

In the above indoor unit for an air conditioner with the turbo fan employed, the flow of air blown out from the turbo fan is controlled by a planar vane and a plurality of curved vanes mounted to the air outlets of the casing, whereas the air blown out from the turbo fan is blown out on the front side in the rotational direction of the turbo fan and about 40-degree outward with respect to a tangent to the outer circumference of the turbo fan. On this account, air is not blown out in a direction along a plane generally perpendicular to the longitudinal direction of the air outlets of the casing, posing a problem that desired air flow characteristics cannot be obtained. That is, because of the same configuration of the plurality of curved vanes and the generally same spacing between the curved vanes, if the curved surfaces of the curved vanes are uniformized in configuration so that the air is blown out in a direction along a plane generally perpendicular to the longitudinal direction of the air outlets on the front side in the

rotational direction of the turbo fan, the incident angle of the air flow on the vane surfaces of the curved vanes on the rear side becomes larger so that separation flows of air would occur. On the other hand, if the curved surfaces of the curved vanes are uniformized in configuration so that the air is blown out in a direction along a plane generally perpendicular to the longitudinal direction of the air outlets on the rear side in the rotational direction of the turbo fan, the incident angle of the air flow on the vane surfaces of the curved vanes on the front side becomes larger so that separation flows of air would occur. This poses problems that the air flow is not efficiently regulated, and that noise occurs due to the separation flows. Also, if the spacings between adjacent curved vanes are uniformized so that the flow regulation is optimized on the front side in the rotational direction of the turbo fan, the flow regulation effect on the curved vanes on the rear side becomes smaller. On the other hand, if the spacings between adjacent curved vanes are uniformized so that the flow regulation is optimized on the rear side in the rotational direction of the turbo fan, the flow regulation effect on the curved vanes on the front side becomes smaller. As a result, the air flow could not be regulated efficiently.

DISCLOSURE OF THE INVENTION

An object of the present invention is therefore to

provide an indoor unit for an air conditioner capable of efficiently regulating the blown-off air and reducing noise.

In order to achieve the above object, the present invention provides an indoor unit for an air conditioner in which a turbo fan disposed within a casing sucks air from a front side of the indoor unit and blows out the air radially outwardly relative to an axis of the turbo fan, comprising: a planar vane mounted to an air outlet provided in the casing; and a plurality of curved vanes arrayed on the planar vane in a longitude direction of the planar vane at the air outlet and curved so as to guide the air blown out from the turbo fan to an outward direction generally vertical to a longitudinal direction of the planar vane, where the plurality of curved vanes have curvatures increasing from a rear side of the planar vane relative to a rotational direction of the turbo fan toward a front side of the planar vane.

According to this invention, the air sucked from the front side of the indoor unit by the turbo fan is blown out outward in the rotational direction at an angle of about 40 degrees to a tangent to the outer circumference of the turbo fan. Then, the air flow is regulated along the planar vane and the plurality of curved vanes mounted to the air outlets of the casing. In this case, the angle of the air flow to the longitudinal direction of the air outlets (the

planar vane) becomes larger on the rear side of the air outlets in the rotational direction of the turbo fan, while the angle of the air flow to the longitudinal direction of the air outlets becomes smaller on the front side of the air outlets in the rotational direction of the turbo fan. Therefore, by increasing the curvatures of the curved vanes from rear side toward front side in the rotational direction of the turbo fan, the incident angle of the air flow on all the curved vanes is decreased so that the air flow regulated by the planar vane and the plurality of curved vanes is blown out in a desired direction (e.g., along the plane perpendicular to the longitudinal direction of the air outlets) without causing any separation of air flow to the curved vanes. Consequently, the blowoff air from the turbo fan can be efficiently regulated, and besides noise can be reduced.

In an embodiment of the indoor unit of the invention, a region where the plurality of curved vanes are arrayed is divided into a plurality of sub-regions, and the curvatures of the curved vanes are different among the plurality of sub-regions.

According to this embodiment, by making the curvatures of the curved vanes the same among the individual sub-regions, the design can be simplified as compared to when the configuration of the curved surfaces of all the

curved vanes is designed optimally depending on variations in the angle of air flow to the longitudinal direction of the air outlets, and besides efficient flow regulation and noise reduction can be achieved with a simple construction, thus allowing a cost reduction.

In an embodiment of the indoor unit of the invention, spacings between adjacent curved vanes become smaller from the rear side of the planar vane relative to the rotational direction of the turbo fan toward the front side of the planar vane.

According to the indoor unit for an air conditioner of this embodiment, by forming the plurality of curved vanes so that spacings between adjacent curved vanes become smaller from rear side toward front side in the rotational direction of the turbo fan, the flow regulation effect on the curved vanes on the rear side of the rotational direction of the turbo fan is decreased according to the variations in the angle of the air flow to the longitudinal direction of the air outlets, while the flow regulation effect on the curved vanes on the front side of the air outlets in the rotational direction of the turbo fan is increased. Thus, the blowoff air from the turbo fan can be regulated further efficiently without unnecessarily increasing the flow regulation effect, and besides noise can be reduced.

In an embodiment of the indoor unit of the invention, a region where the plurality of curved vanes are arrayed is divided into a plurality of sub-regions, and the curvatures of the curved vanes are different among the plurality of sub-regions while the spacings between adjacent curved vanes are different among the plurality of sub-regions.

According to the indoor unit for an air conditioner of this embodiment, by making the same size and spacing between adjacent curved vanes among the curved vanes in the sub-regions, the design can be simplified as compared to when the configuration of the curved surfaces of all the curved vanes is designed optimally depending on variations in the angle of air flow to the longitudinal direction of the air outlets, and besides efficient flow regulation and noise reduction can be achieved with a simple construction, thus allowing a cost reduction.

In an embodiment of the indoor unit of the invention, the planar vane and the plurality of curved vanes are integrally formed.

According to this indoor unit for an air conditioner of this embodiment, the planar vane serves also as a support member for supporting the plurality of curved vanes. Thus, the number of parts is decreased and therefore the air outlet structure can be simplified, thus

allowing a cost reduction.

In an embodiment of the indoor unit of the invention, an incident angle of the air flow is generally equal along an entire upstream-side leading edge of each curved vane on the planar vane.

According to the indoor unit for an air conditioner of this embodiment, the incident angle of the air flow is generally equal along the entire upstream-side leading edge each curved vane on the planar vane. Thus, the air flow is less subject to disturbance, so that noise can be further reduced.

Further, the present invention also provides an indoor unit for an air conditioner in which a turbo fan disposed within a casing sucks air from a front side of the indoor unit and blows out the air radially outwardly relative to an axis of the turbo fan, comprising: a planar vane mounted to an air outlet provided in the casing; and a plurality of curved vanes arrayed on the planar vane in a longitude direction of the planar vane at the air outlet, where spacings between adjacent curved vanes become smaller from a rear side of the planar vane relative to a rotational direction of the turbo fan toward a front side of the planar vane.

According to this invention, the air sucked from the front side by the turbo fan is blown out outward in the

rotational direction at an angle of for example about 40 degrees to a tangent to the outer circumference of the turbo fan. Then, the air flow is regulated along the planar vane and the plurality of curved vanes mounted to the air outlets
5 of the casing. In this case, the angle of the air flow to the longitudinal direction of the air outlets (the planar vane) becomes larger on the rear side of the air outlets in the rotational direction of the turbo fan, while the angle of the air flow to the longitudinal direction of the air
10 outlets becomes smaller on the front side of the air outlets in the rotational direction of the turbo fan. Therefore, by forming the plurality of curved vanes so that spaces between adjacent curved vanes become narrower from rear side toward front side in the rotational direction of the turbo fan, the
15 flow regulation effect on the curved vanes on the rear side of the rotational direction of the turbo fan is decreased, while the flow regulation effect on the curved vanes on the front side of the air outlets in the rotational direction of the turbo fan is increased. Thus, on the front side in
20 the rotational direction of the turbo fan, the air flow is regulated securely on one side on which the curved vanes have smaller angles of air flow to the longitudinal direction of the air outlets without unnecessarily increasing the flow regulation effect on the rear side in
25 the rotational direction of the turbo fan, so that the

regulated air is blown out from the air outlets in a desired direction (e.g., along the plane perpendicular to the longitudinal direction of the air outlets). Thus, the blowoff air from the turbo fan can be efficiently regulated, and besides noise can be reduced.

In an embodiment of the indoor unit of the invention, a region where the plurality of curved vanes are arrayed is divided into a plurality of sub-regions, and the spacings between adjacent curved vanes are different among the plurality of sub-regions.

According to the indoor unit for an air conditioner of this embodiment, by making spacings between adjacent curved vanes the same among the individual sub-regions, the design can be simplified as compared to when all the spacings between adjacent curved vanes are designed optimally depending on variations in the angle of air flow to the longitudinal direction of the air outlets, and besides efficient flow regulation and noise reduction can be achieved with a simple construction, thus allowing a cost reduction.

In an embodiment of the indoor unit of the invention, the planar vane and the plurality of curved vanes are integrally formed.

According to the indoor unit for an air conditioner of this embodiment, the planar vane serves also

as a support member for supporting the plurality of curved vanes. Thus, the number of parts is decreased and therefore the air outlet structure can be simplified, thus allowing a cost reduction.

5 In an embodiment of the indoor unit of the invention, an incident angle of air blown out from the turbo fan is generally equal along an entire upstream-side leading edge of each curved vane on the planar vane.

 According to the indoor unit for an air
10 conditioner of this embodiment, the incident angle of air blown out from the turbo fan is generally equal along the entire upstream-side leading edge of each curved vane on the planar vane. Thus, the air flow is less subject to disturbance, so that noise can be further reduced.

15 BRIEF DESCRIPTION OF DRAWINGS

 Fig. 1 is a front view of an indoor unit for an air conditioner according to an embodiment of the invention;

 Fig. 2 is an enlarged view of a cross section of
20 the indoor unit taken along the line II - II;

 Fig. 3 is a perspective view of a planar vane and curved vanes of the indoor unit; and

 Fig. 4 is a main-part enlarged view of an air outlet of the indoor unit of Fig. 2.

25 BEST MODE FOR CARRYING OUT THE INVENTION

Hereinbelow, an indoor unit for an air conditioner according to the present invention is described in detail by way of embodiments thereof illustrated in the accompanying drawings.

5 Fig. 1 is a front view of an indoor unit for an air conditioner according to an embodiment of the invention. Reference numeral 1 denotes a generally square-shaped casing whose rear is mounted on an indoor wall surface, and 2 denotes a turbo fan whose axis is placed at a generally
10 center of the casing 1 and along the back-and-forth direction and which blows out air, sucked from the front side, radially outwardly relative to the axis of the turbo fan. Air flow control members 11 are mounted to rectangular air outlets 21 - 24 provided at both side faces
15 and upper-and-lower faces of the casing 1, respectively. It is to be noted that, for an easier explanation, Fig. 1 shows a state in which the front panel and the heat exchanger have been removed. Guide portions 31 - 34 for guiding the air blown out from the turbo fan 2 are also
20 mounted to near four corner portions of the casing 1, respectively.

Fig. 2 shows an enlarged view of a cross section taken along the line II - II of Fig. 1. A motor 3 is mounted at a generally center of the casing 1, and the
25 turbo fan 2 is mounted to an output shaft 3a of the motor 3.

Then, in the casing 1, a partitioning plate 4 having a circular hole 4a at a generally center thereof is mounted on the front side of the turbo fan 2. Besides, a heat exchanger 5 is mounted on the front side of the partitioning plate 4. On the front side of the casing 1, a front panel 6 having an air inlet 6a is mounted so as to cover the heat exchanger 5. A front grille 7 is mounted to the air inlet 6a of the front panel 6.

Fig. 3 shows a perspective view of the air flow control member 11. The air flow control member 11 includes a generally rectangular planar vane 12, and a plurality of curved vanes 13, 14, 15. The curved vanes 13, 14, 15 are provided upright on the planar vane 12 with spacings from one another and each have a curved surface whose generatrix is generally vertical to the planar vane 12. Arms 16, 18 are provided upright at both ends of the planar vane 12. On the fore end side of the arm 16, a rotating shaft 17 is provided so as to extend outward and lengthwise of the planar vane 12. Meanwhile, on the fore end side of the arm 18, a coupling portion 29 is provided outside and lengthwise of the planar vane 12. Also, ribs 25, 26 are provided on one side of the arm 16 closer to the planar vane 12. Ribs 27, 28 are provided on one side of the arm 18 closer to the planar vane 12. An output shaft of an unshown stepping motor is coupled to the coupling portion

29 so as to allow the air flow control member 11 to be rotated coaxially about the output shaft and the rotating shaft 17.

It is noted that a region where the plurality of curved vanes 13, 14, 15 are arrayed is divided into regions A, B, C. Four curved vanes 13 are arrayed at intervals of about 18.5 mm in the region A, four curved vanes 14 are arrayed at intervals of about 17 mm in the region B, and eight curved vanes 15 are arrayed at intervals of about 15 mm in the region C. Also, the curved vanes 13, 14, 15 are so formed that their curvatures become larger in the order of regions A, B, C from rear side to front side in the rotational direction of the turbo fan 2 (a direction of arrow R1 in Fig. 1), and further that their spacings between adjacent curved vanes become smaller in the order of regions A, B, C from rear side to front side in the rotational direction of the turbo fan 2. In addition, a spacing between the region A and the region B, and a spacing between the region B and the region C, may be set a spacing equal to that of one of the two regions, or to a mean value of the spacings of the two regions.

Fig. 4 shows an enlarged view of a vicinity of the air outlet 21 of Fig. 2. As shown in Fig. 4, in the vicinity of the air outlet 21 of the casing 1, a guide portion 1a is formed so as to gradually increase in

thickness from near the turbo fan 2 toward the air outlet 21 so that the blowoff air from the turbo fan 2 is blown out obliquely forward. Also, at a position on the front side of the casing 1 opposite to the guide portion 1a, is provided a guide member 20 which gradually decreases in thickness from near the turbo fan 2 toward the air outlet 21. Then the air flow control member 11 is mounted to the air outlet 21 so as to be rotatable about the rotating shaft 17. In Fig. 4, the air flow control member 11 in its fully open state is shown.

In the indoor unit for an air conditioner constructed as described above, as the turbo fan 2 is rotated counterclockwise (in the direction of arrow R1 in Fig. 1) by rotating the motor 3, air is sucked from the front side in directions of arrows R2, R4 and blown out in directions of arrows R3, R5 radially outwardly of the turbo fan 2, as shown in Fig. 2. The air blown out from the turbo fan 2 is guided along the vane surfaces of the planar vane 12 and the curved vanes 13, 14, 15 of the air flow control member 11 shown in Fig. 3 so as to be blown out obliquely forward from the air outlets 21 - 24 (only air outlets 21, 22 are shown in Fig. 2). In this connection, as shown in Fig. 1, the flow direction of air blown out from the lower air outlet 24 is angled at θ_1 to the longitudinal direction of the air outlet 24 on the rear

side in the rotational direction of the turbo fan 2, and at $\theta_2 (< \theta_1)$ to the longitudinal direction of the air outlet 24 on the front side in the rotational direction of the turbo fan 2. As a result of this, the flow of air is regulated by the curved vanes 13, which are smaller in curvature and wider in spacing, the curved vanes 15, which are larger in curvature and narrower in spacing, the curved vanes 14, which are medium in curvature and spacing between the curved vanes 13 and 15, and the planar vane 12, so that the air is blown out along a plane generally vertical to the longitudinal direction of the air outlet 24. Similarly, air blown out from the other air outlets 21, 22, 23 is also blown out along a plane generally vertical to the longitudinal direction of each air outlet.

As shown above, by forming the plurality of curved vanes 13, 14, 15 so that their curvatures become increasingly larger from rear side toward front side in the rotational direction of the turbo fan 2, the incident angle of air flow on all the curved vanes 13, 14, 15 becomes small. By so doing, air is blown out from the air outlets 21 - 24 along the plane perpendicular to the longitudinal direction of the air outlets 21 - 24. Thus, the blowoff air from the turbo fan can be regulated efficiently, and besides noise can be reduced.

Further, by dividing the region where the

plurality of curved vanes 13, 14, 15 are arrayed, into the regions A, B, C, and by differentiating the curvatures of the curved vanes among the sub-regions A, B, C, the design can be simplified as compared to when all the configurations of the curved surfaces of the curved vanes are designed optimally depending on variations in the angle of air flow to the longitudinal direction of the air outlets 21 - 24, and besides efficient flow regulation and noise reduction can be achieved with a simple construction, thus allowing a cost reduction.

Further, by arraying the curved vanes 13, 14, 15 so that their spacings between adjacency curved vanes become smaller from rear side toward front side in the rotational direction of the turbo fan, a flow regulation effect exerted on the front side of the air outlets 21 - 24 in the rotational direction of the turbo fan 2 is increased without unnecessarily increasing a flow regulation effect on the rear side of the air outlets 21 - 24 in the rotational direction of the turbo fan 2. Thus, the blowoff air from the turbo fan 2 can be regulated even more efficiently, and besides noise can be reduced.

Further, by integrally forming the planar vane 12 and the curved vanes 13, 14, 15 so that the planar vane 12 serves also as a support member for supporting the curved vanes 13, 14, 15, the number of parts is decreased and

therefore the air outlet structure can be simplified, thus allowing a cost reduction.

Further, while the planar vane 12 of the air flow control member 11 is in the fully open state as shown in Fig. 4, an upstream-side leading edge 15a of the curved vanes 13, 14, 15 (only one curved vane 15 is shown in Fig. 4) is so arranged that the incident angle (θ_3 in Fig. 4) of the air flow holds generally equal in any region with respect to the flow direction of the blowoff air from the turbo fan 2. Therefore, the air flow is less subject to disturbance, so that noise can be further reduced.

In the above embodiment, the curved vanes 13, 14, 15 are so arranged that their curvatures become larger and their spacings between adjacent curved vanes become smaller from rear side toward front side in the rotational direction of the turbo fan 2. However, it is also possible that the curvatures of the curved vanes 13, 14, 15 become larger and the spacings between adjacent curved vanes are generally equal from rear side toward front side in the rotational direction of the turbo fan 2, or that the configuration of the curved surfaces of the curved vanes 13, 14, 15 are identical and the spacings between adjacent curved vanes become smaller from rear side toward front side in the rotational direction of the turbo fan 2.

Also in the above embodiment, it has been

arranged that, as shown in Fig. 3, three sub-regions are provided as the region A for the curved vanes 13, the region B for the curved vanes 14, and the region C for the curved vanes 15, where the curvatures of the curved vanes 13, 14, 15 and the spacings between adjacent curved vanes are set individually for the regions A, B, C. However, the curvature of the curved vanes may be continuously changed, or the spacing between the curved vanes may be continuously changed.

Further, in the above embodiment, the planar vane and the curved vanes are integrally formed. However, the planar vane and the curved vanes may also be fabricated separately from each other and thereafter combined together.

Furthermore, in the above embodiment, when the air flow control member 11 is in the fully open state, the incident angle of the air flow is generally equal in any region of the leading edge on the upstream side of the curved vanes 13, 14, 15. However, the incident angle may be set appropriately depending on the flow direction of the blowoff air from the turbo fan.

INDUSTRIAL APPLICABILITY

As described above, the indoor unit for an air conditioner according to the present invention is applicable to air conditioners in which conditioning air is blown out up and down, right and left.

CLAIMS



1. An indoor unit for an air conditioner in which a turbo fan (2) disposed within a casing (1) sucks air from a front side of the indoor unit and blows out the air radially outwardly relative to an axis of the turbo fan (2), comprising:

a planar vane (12) mounted to an air outlet (21 - 24) provided in the casing (1); and

a plurality of curved vanes (13 - 15) arrayed on the planar vane (12) in a longitude direction of the planar vane (12) at the air outlet (21 - 24) and curved so as to guide the air blown out from the turbo fan (2) to an outward direction generally vertical to a longitudinal direction of the planar vane (12), where the plurality of curved vanes (13 - 15) have curvatures increasing from a rear side of the planar vane (12) relative to a rotational direction of the turbo fan (2) toward a front side of the planar vane (12).

2. The indoor unit for an air conditioner as set forth in claim 1, wherein

a region where the plurality of curved vanes (13 - 15) are arrayed is divided into a plurality of sub-regions, and the curvatures of the curved vanes are



different among the plurality of sub-regions.

3. The indoor unit for an air conditioner as set forth in claim 1, wherein

5 spacings between adjacent curved vanes (13 - 15) become smaller from the rear side of the planar vane (12) relative to the rotational direction of the turbo fan (2) toward the front side of the planar vane (12).

10 4. The indoor unit for an air conditioner as set forth in claim 3, wherein

a region where the plurality of curved vanes (13 - 15) are arrayed is divided into a plurality of sub-regions, and the curvatures of the curved vanes (13 - 15)
15 are different among the plurality of sub-regions while the spacings between adjacent curved vanes are different among the plurality of sub-regions.

5. The indoor unit for an air conditioner as set
20 forth in claim 1, wherein

the planar vane (12) and the plurality of curved vanes (13 - 15) are integrally formed.

6. The indoor unit for an air conditioner as set
25 forth in claim 1, wherein



an incident angle of air blown out from the turbo fan (2) is generally equal along an entire upstream-side leading edge of each curved vane (13 - 15) on the planar vane (12).

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7. An indoor unit for an air conditioner in which a turbo fan (2) disposed within a casing (1) sucks air from a front side of the indoor unit and blows out the air radially outwardly relative to an axis of the turbo fan (2),
10 comprising:

a planar vane (12) mounted to an air outlet (21 - 24) provided in the casing (1); and

a plurality of curved vanes (13 - 15) arrayed on the planar vane (12) in a longitude direction of the planar
15 vane (12) at the air outlet (21 - 24), where spacings between adjacent curved vanes become smaller from a rear side of the planar vane (12) relative to a rotational direction of the turbo fan (2) toward a front side of the planar vane (12).

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8. The indoor unit for an air conditioner as set forth in claim 7, wherein

a region where the plurality of curved vanes (13 - 15) are arrayed is divided into a plurality of sub-
25 regions, and the spacings between adjacent curved vanes are



different among the plurality of sub-regions.

9. The indoor unit for an air conditioner as set forth in claim 7, wherein

5 the planar vane (12) and the plurality of curved vanes (13 - 15) are integrally formed.

10. The indoor unit for an air conditioner as set forth in claim 7, wherein

10 an incident angle of air blown out from the turbo fan (2) is generally equal along an entire upstream-side leading edge of each curved vane (13 - 15) on the planar vane (12).