

SPECIFICATION **Improved Blower with Rotatable Air Deflector**

The present invention relates to a blower and, more particularly, to a blower which can supply a gentle comfortable air stream over a wide angular range.

In one blower known in the art, a deflector for supplying an air stream over a wide range is placed in front of an axial flow type of fan and is rotated at low speed. In another prior art blower, a deflector is rotatably placed in front of an axial flow fan so that the swirling air flow generated thereby can rotate it. To prevent the deflector from rotating at high speed, an adjustable friction plate has to be provided to slow down its rate of rotation. A blower is also known in which an air guide is fixed in front of an axial flow fan so that the air stream to be discharged is directed parallel to the axis of rotation of the fan, a rotating deflector being rotatably placed in front of the air guide. This blower can hardly be rotated under that condition, but the rotating deflector can be rotated at a low speed by making the inclination of one of the air guiding vanes adjustable.

It is an object of the present invention therefore to provide a blower with a wind deflector which is rotatable at low speed but without having to resort to the use of friction plates or air guides such as have been used in the prior art.

According to the present invention, there is provided a blower which comprises: an axial flow fan mounted in a housing; means for driving said axial flow fan; a freely rotatable wind deflector mounted in the front opening of said housing provided with rotation inducing vanes to receive swirling air from the fan and impart a rotational force to said deflector in one direction, and braking vanes to receive swirling air from the fan and impart a rotational force to said deflector in the opposite direction, whereby an air output can be supplied from the blower over a wide range while the wind deflector is rotated in one direction at a low speed.

Preferably, the deflector is arranged to rotate at between approximately 5 and 30 r.p.m.

By the use of the special wind deflector of the present invention, a gentle, comfortable, air stream can be supplied over a wide angular range merely by directing the swirling air flow generated by the axial flow fan to the wind deflector.

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a sectional side elevation showing one embodiment of a blower of the present invention;

Figure 2 is a perspective view showing the front of the blower of Figure 1 with its rotating wind deflector removed;

Figure 3 is a perspective view showing the rear of the blower of Figure 1 with its guard removed;

Figure 4 is a schematic view showing the

relationship between the body and the fan of the blower of Figure 1;

Figure 5 is an enlarged schematic view showing the relationship between the wind tunnel of the blower of Figure 1 and its fan and supporting rib,

Figures 6 and 7 are graphs illustrating the relationships between wind speed and noise over a range of distances of point *e* in Figure 5;

Figure 8 is another schematic view showing the relationship between the wind tunnel, fan and supporting rib of the blower of Figure 1;

Figures 9 and 10 are graphs illustrating the relationships between wind speed and noise over a range of distances of point *e* in Figure 8;

Figure 11 is a perspective view showing the relationship between the axial flow fan and a deflecting vane;

Figure 12(a) and (b) are diagrams showing the relationships between the deflecting vane and wind direction in Figure 11;

Figure 13 is a front elevation showing the blower of Figure 1;

Figure 14(c), (d), (e) and (f) are sections taken along lines *c—c*, *d—d*, *e—e* and *f—f*, respectively of Figure 13;

Figure 15 is a front elevation showing the construction of the part of the blower around the operating knob of Figure 13;

Figure 16 is a section taken along line *g—g* of Figure 15;

Figure 17 is a section taken along line *h—h* of Figure 16; and

Figures 18, 19, 20 and 21 are front elevations showing other embodiments of rotating wind deflectors.

The present invention will now be described in relation to the embodiment thereof shown in Figures 1 to 14.

Generally indicated at reference numeral 1 is a blower comprising separable front and rear housing members 3 and 4 which together define a wind tunnel 2, a guard 5 removably mounted on the rear opening of the wind tunnel 2, and a rotating wind deflector 6 rotatably mounted in the front opening of the wind tunnel 2.

The front and rear housing members 3 and 4 are joined together by means of an elastic rim 7, a hole 8 and screws (not shown) so that they are not readily capable of being disassembled. The part of the wind tunnel 2 in the front housing member 3 is formed at its centre with a motor mounting portion 9 which is partly supported in the wind tunnel by means of a plurality of radially extending supporting ribs 10 formed integrally with the front housing member 3. A motor 11 is secured to the back of the mounting portion 9 by screws 12. An axial flow fan 14 is positioned in the wind tunnel 2 on shaft 13 of the motor 11 and secured thereto by means of a nut 15. The upper portion of the front housing member 3 is formed with a space 18 for accommodating electric equipment such as a motor control switch 16 or a timer 17 (better illustrated in Figures 2 and 3), the operating unit of the switch 16 and

the timer 17 being formed to protrude from the upper part of the top of the front housing member. Upright supporting rib 10' extending upwardly from the motor mounting portion 9 is formed with a groove 20, in which power supply cord 19 is located. The other supporting ribs 10 are formed into a plate shape so that they tend to linearly direct the swirling air flow generated by the fan 14.

The top of the rear housing member 4 is formed at its rear with a handle 21 and at its bottom with a receiving portion 22 which abuts against the bottom of the front housing member 3. Foldable legs 23 are hingedly connected to both the sides of the bottom of the receiving portion 22. At both the sides of the bottom of the rear housing member 4, there are provided a pair of supporting stands 24 which protrude away from the receiving portion 22, elastic heels 25 being secured to the leading lower ends thereof.

The aforementioned wind tunnel 2 is assembled by fitting the front and rear housing members 3 and 4 together, the guard 5 being removably mounted in the rear opening of the wind tunnel of the rear housing member 4 either due to its own elasticity or by means of clamping joints. The guard 5 thus mounted comprises a plurality of radial ribs 26 (see Figure 3) and a number of annular ribs 27, both of which are generally oval in shape. The annular ribs 27 are so inclined that the longer axes of their oval sections are extended the further they are away from the centre. As a result, the air to be sucked through the guard 5 into the fan 14 is allowed to pass therethrough smoothly with less resistance. To the front of the motor mounting portion 9, there is secured by screws 30 a mounting plate 29 with a spindle 28 protruding from the centre thereof. The mounting plate 29 also acts as a plate for reinforcing the motor mounting portion 9. On the spindle 28, there is rotatably mounted an intermediate rotor 35 formed with a stem 31 for fitting in the centre hole of the rotating wind deflector 6, a flange 32 to abut against the back of said deflector, and a threaded portion 34 to be fastened into a spinner 33 for clamping the aforementioned deflector 6 and the flange 32 therebetween (as better seen from Figure 2). The intermediate rotor 35 is prevented from coming out by an E-ring 36 which is mounted on the leading end of the spindle 28. The friction resistance between this spindle 28 and the intermediate rotor 35 is reduced by making the spindle 28 from a metal rod and molding the intermediate rotor 35 from an oil-impregnated resin so that the wind deflector 6 can rotate smoothly. However, suitable friction resistance can be attained by selecting suitable materials for the spindle 28 and the intermediate rotor 35. In either case, the wind deflector 6 can be molded from a variety of such material as take their strengths into consideration.

The positional relationship between the wind tunnel 2 and the axial flow fan 14 will now be described with reference to the explanatory

schematic views and graphs of Figure 4 to 10. In Figure 4, the rear and front edges of the axial flow fan 14 in the vicinity of the guard 5 are shown as points *a* and *c*, respectively, the middle point between the points *a* and *c*, i.e. the centre of the so-called "fan height" being shown as point *b*. The inner wall of the wind tunnel 2 is formed to have a generally trapezoidal section and includes a converging portion 36, which converges from the edge of the rear opening of the wind tunnel toward the point *b*, a cylindrical portion 37, which has a constant spacing from the fan between the points *b* and *c*, and a diverging portion 38 which diverges from the point *c* toward the front opening of the wind tunnel. The boundary edge between the cylindrical portion 37 and the converging portion 36 is shown as point *d*, and the boundary edge between the cylindrical portion 37 and the diverging portion 38 is shown as point *e*. Moreover, the rear edges of the aforementioned supporting ribs 10 formed in the wind tunnel 2 are shown as points *f*. In the front opening of the wind tunnel, there is mounted the rotating wind deflector 6 which changes the direction of the air flow coming from the fan 14. The supporting ribs 10 and wind deflector 6 thus assembled present a high resistance to incoming air flow and thereby provide a source of noise.

Since, in a conventional blower, the diverging portion 38 is not present but instead the cylindrical portion 37 is elongated to directly face the wind deflector 6, the air is sucked along the converging portion 36, when the axial flow fan 14 performs its blowing operation, to impinge upon the supporting ribs 10 and the wind deflector 6 at a maximum velocity V_1 . Hence, a resistance loss R is generally proportional to the square of the wind velocity V and is expressed by $R=KV^2$. As a result, according to the prior art, the resistance loss by the wind deflector is so high that the velocity of the wind to be blown out of the wind deflector is substantially lowered so noise is increased. In the illustrated embodiment, however, since the aforementioned diverging portion 38 is formed to extend from the front edge *c* of the fan 14 to the base end of the rear edge *f* of the supporting ribs 10, the wind velocity V_1 is decelerated at the diverging portion to V_2 whereby the wind velocity at the supporting ribs 10 and the wind deflector 6 is decelerated. As a result, the aforementioned resistance loss R is so noticeably reduced that the velocity of the wind having passed through the deflector is accelerated so there is much less noise.

The following description will be made on the basis of some experimental results. Figure 5 shows the situation when point *e* is placed at (i) which is 5 mm behind point *c*; when point *e* is placed at (ii) which is 2.5 mm in front of the point *c*; and when point *e* is placed at (iii) and (iv) which are 10 mm and 50 mm, respectively, in front of point *c*. The width of the supporting ribs 10 is 22 mm, and the rear edge point *f* is placed 10 mm in front of point *c*. The axial flow fan 14 has eleven blades. The fan rotates at 1000 r.p.m., there being

42 arranged radially in the aforementioned first embodiment are made to have their centre base ends slightly advanced clockwise in relation to their outer terminal ends, a divergent air stream can be developed as shown by the arrows. On the other hand, as shown in Figure 19, the braking vanes 42 may be arranged radially with their radially outer terminal ends mounted in an oval configuration. As shown in Figure 20, moreover, the braking vanes 42 may be arranged radially outwardly from the centre of the wind deflector 6. As shown in Figure 21, on the other hand, a modified air flow changed by the rotation inducing vanes 41 can be achieved by arranging the ribs 43 of the deflector 6 and the air deflecting vanes 42 at right angles to each other to act as the braking vanes.

Although, in the embodiments thus far described, the numerous air deflecting vanes 42 are arranged in parallel at an angle $\theta > \theta_0 = \alpha$ at the outer circumferential portion to provide the rotation inducing vanes whereas the vanes 42 are radially arranged at an angle $\theta < \theta_0 = \beta$ to provide the braking vanes, it is not intended that the present invention be especially limited thereto. It can for instance be modified into a variety of modes by suitably changing both the swirling angle θ of the air flow A and the angle θ_0 of inclination of the air deflecting vanes on the basis of the rotating principles of the aforementioned wind deflector. For example, if the air deflecting vanes formed in the outer circumferential portion of the foregoing embodiments are also arranged at the same angle of $\theta < \theta_0 = \beta$ as the air deflecting vanes formed in the inner circumferential portion, not only the air deflecting vanes in the inner circumferential portion act as the braking vanes, but also the righthand half of the air deflecting vanes in the outer circumferential portion also act as the braking vanes whereas the lefthand half of the air deflecting vanes in the outer circumferential portion acts as the rotation inducing vanes. As a result, the wind deflector can be rotated at a lower speed than the foregoing embodiments, and the inclination of the air deflecting vanes can be made larger so that the air can be blown over a wider range. On the other hand, the case of $\theta < \theta_0$ explained in the rotating principles of the wind deflector 6 is applied so that the air deflecting vanes are inclined at a larger angle than the angle θ of the swirling air flow and are arranged in parallel. Then, the wind deflector has its righthand half acting as the braking vanes and its lefthand half acting as the rotation inducing vanes. Moreover, the wind deflector 6 is not inclined at the same angle from its right to left end but can be inclined at different angles at the righthand and lefthand halves. Furthermore, the angles of the respective air deflecting vanes may be gradually varied. In this particular modification, the braking vanes and the rotation inducing vanes are not grouped but are arranged under mixed conditions.

The rotation and interruption of the wind deflector 6 in the respective embodiments so far

described can be performed by bringing the leading end of a stopper lever 51 (see Figures 15 to 18), which is moved back and forth by a cam 53 rotatable by an operating knob 44 disposed in the front housing member 3 into and out of abutment contact with the outer circumference of the wind deflector 6. Rotation and interruption of the wind deflector 6 can however also be performed by making it movable back and forth as a whole to engage either the opening of the wind tunnel at the front housing member 3 or the projection formed in the mounting plate when it is moved back and forth. It will be appreciated that these rotating and interrupting mechanisms need not be restricted to those just mentioned.

As has been described hereinbefore, since the wind deflector to be rotated by the pressure of the swirling air flow generated by the axial flow fan comprises the rotation inducing vanes to which a rotational force in a positive direction is imparted by said air pressure, and the braking vanes to which a rotational force in the opposite direction is imparted by said air pressure, the wind deflector to be rotated at a high speed in synchronism with said air pressure need not be equipped with a separate brake device so the number of individual parts can be reduced, the construction can be simplified, and the braking force can be changed in proportion to the change in the wind pressure so that the wind direction can be suitably changed.

It should be noted that the present invention should not be limited to the described and illustrated box type blower as it can also be applied to window ventilation fans, or various other blowers using an axial flow fan, such as, air conditioners or humidifiers.

Claims

1. A blower comprising: an axial flow fan mounted in a housing; means for driving said axial flow fan; a freely rotatable wind deflector mounted in the front opening of said housing provided with rotation inducing vanes to receive swirling air from the fan and impart a rotational force to said deflector in one direction, and braking vanes to receive swirling air from the fan and impart a rotational force to said deflector in the opposite direction, whereby an air output can be supplied from the blower over a wide range while the wind deflector is rotated in one direction at a low speed.

2. A blower according to Claim 1, wherein the deflector, in use, rotates at between approximately 5 and 30 r.p.m.

3. A blower according to Claim 1 or 2, wherein the rotation inducing vanes are arranged in parallel, the braking vanes being radially arranged.

4. A blower according to Claim 3, wherein the braking vanes are arranged in a centre circle, the rotation inducing vanes being arranged in an outer circumference around said centre circle.

5. A blower according to Claim 4, wherein the braking vanes have their centre base ends circumferentially advanced in a clockwise



20 supporting ribs 10 and the spacing between point *b* and the cylindrical portion being 4 mm. With these settings, the relationships between the relative position *L* of point *e* to point *c* and the wind velocity *V* and the noise *S* are illustrated in Figures 6 and 7. From these Figures it will be seen that for an air velocity *V*, the necessary velocity for the blowing operation can be ensured if the distance *L* of the point *e* is $-8 < L < 33$, and for noise *S*, a low noise level can be ensured if the distance *L* of point *e* is $0 < L < 10$. Hence, if point *e* is located between point *c* and point *f*, the air velocity *V* and the noise level *S* are at acceptable levels. Other experimental results are illustrated in Figures 9 and 10, in which the rear edge point *f* of the supporting ribs 10 is placed 24 mm in front of point *c*, as shown in Figure 8. From these results, excellent results for the air velocity *V* and for the noise level *S* can be attained if the distance *L* of point *e* is within ranges of $-5 < L < 37$ and $0 < L < 24$, respectively. Furthermore, the required air velocity *V* and noise level *S* can be ensured if point *e* is interposed between points *c* and *f* as with the foregoing results.

25 The wind deflector 6 is rotated by the air pressure of the swirling air flow *A* generated by the axial flow fan 14. The rotating principles of the wind deflector 6 will now be described with reference to Figures 11 and 12. As shown in Figure 11, the blades of the axial flow fan 14 are twisted by a predetermined radius of curvature so that the air flow *A* generated by that fan is discharged in a direction at an angle θ . Figure 12 explains the relationship of the force which is to be applied by the air flow to a number of air deflecting vanes 39 of the wind deflector 6 positioned in front of the fan 14 when the vane 39 has its longitudinal direction arranged horizontally. The righthand and lefthand halves of the air deflecting vane 39 are shown in Figures 12(a) and 12(b), respectively. As shown, the force *F*₀ to move the vane in the direction of the plane of rotation is expressed by $F_0 = F \sin(\theta - \theta_0) \cos \theta_0$, if the angle of inclination of the vane 39 is designated at θ_0 , if the force of the air flow *A* is designated at *F*, and if the blown angle of the air flow *A* is designated at θ . Now, if the right and left have an identical inclination, as shown in Figure 12, and if the relationship of $\theta > \theta_0$ holds, a downward force is exerted on the righthand half, whereas an upward force is exerted on the lefthand half. As a result, clockwise moments about a pivot 40 are exerted upon the wind deflecting vane 39 so that this vane 39 is rotated clockwise. For $\theta = \theta_0$, the relationship of $F_0 = 0$ holds at the righthand half so that the clockwise moment is exerted only upon the lefthand half. For $\theta < \theta_0$, the counter-clockwise moment is exerted on the righthand half, whereas the clockwise moment is exerted on the lefthand half. As a result, the air deflecting vane 39 is rotated clockwise by the difference between the two moments. Although the explanation with reference to Figure 12 has been made using a positive angle with θ measured counter-

clockwise, if θ_0 is taken clockwise and inclined in the negative direction and if $|\theta| < |-\theta_0|$, the clockwise moment is exerted on the righthand half, whereas the counterclockwise moment is exerted on the lefthand half. As a result, the air deflecting vane 39 is rotated clockwise by the difference of the two moments thus far described. For $\theta < \theta_0$ on the righthand half and $|\theta| < |\theta_0|$ on the lefthand half, on the contrary, the counterclockwise moment is exerted on the righthand half, and the counter-clockwise moment is exerted on the lefthand half, too. As a result, the vane 39 is rotated counter-clockwise.

In the illustrated embodiment, the wind deflector 6 has its outer circumferential portion formed with a number of air deflecting vanes 41, which are juxtaposed at the aforementioned angle $\theta > \theta_0 = \alpha$, and its inner circumferential portion formed with a number of air deflecting vanes 42 which are radially arranged at the aforementioned angle $\theta < \theta_0 = \beta$. Thus, at the lefthand half, the air deflecting vanes 42 are formed at the aforementioned angle of $|\theta| < |-\theta_0| = |-\beta|$. The rotation of the wind deflector 6 having the construction thus far described will now be described with reference to Figure 14. Figures 14(c), (d), (e) and (f) show sections taken along lines *c—c*, *d—d*, *e—e* and *f—f*, respectively, about the spindle 28. As shown in Figures 14(c) and (f), clockwise moments *F*₁ and *F*₂ are exerted so that the wind deflector 6 is rotated clockwise by the composed force *P* of the forces *F*₁ + *F*₂. As shown in Figures 14(d) and (e), on the contrary, a counter-clockwise moment *F*₃ is exerted so that the composed force *Q* of 2*F*₃ will rotate the wind deflector 6 in the counter-clockwise direction. Because of $P > Q$, the wind deflector 6 is rotated clockwise slowly at a low speed so that it can supply a soft comfortable breeze over a wide angular range. Needless to say, the aforementioned counter-clockwise moment *Q* acts as a braking force so that the vanes 41 formed in the outer circumferential portion act as rotation inducing vanes whereas the vanes 42 formed in the inner circumferential portion act as braking vanes. However, if the ratio of the vanes 42 in the inner circumferential portion to the wind deflector 6 is so increased that the force relationship of the aforementioned two moments becomes $P < Q$, the vanes 41 act as the braking vanes and the vanes 42 act as the rotation inducing vanes. Since the two moments *P* and *Q* vary in proportion to the r.p.m. of the fan 14 and to the force *F* of the air flow, the rotational velocity of the wind deflector 6 is not significantly changed even with an increase or decrease in the r.p.m. of the fan 14. Since the vanes 42 are radially formed in the inner circumferential portion of the deflector 6, the swirling air flow *A* generated by the fan 14 is directed into a generally straight air stream of increased velocity.

Although the vanes 42 of Figure 13 are radially arranged, they can be made to act as the braking vanes even if they are arranged in parallel.

As shown in Figure 18, since the braking vanes



42 arranged radially in the aforementioned first embodiment are made to have their centre base ends slightly advanced clockwise in relation to their outer terminal ends, a divergent air stream can be developed as shown by the arrows. On the other hand, as shown in Figure 19, the braking vanes 42 may be arranged radially with their radially outer terminal ends mounted in an oval configuration. As shown in Figure 20, moreover, the braking vanes 42 may be arranged radially outwardly from the centre of the wind deflector 6. As shown in Figure 21, on the other hand, a modified air flow changed by the rotation inducing vanes 41 can be achieved by arranging the ribs 43 of the deflector 6 and the air deflecting vanes 42 at right angles to each other to act as the braking vanes.

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2. A blower according to Claim 1, wherein the deflector, in use, rotates at between approximately 5 and 30 r.p.m.

3. A blower according to Claim 1 or 2, wherein the rotation inducing vanes are arranged in parallel, the braking vanes being radially arranged.

4. A blower according to Claim 3, wherein the braking vanes are arranged in a centre circle, the rotation inducing vanes being arranged in an outer circumference around said centre circle.

5. A blower according to Claim 4, wherein the braking vanes have their centre base ends circumferentially advanced in a clockwise



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direction in relation to their radially extending outer terminal ends.

5 6. A blower according to Claim 3, wherein the braking vanes are arranged in a centrally located oval, the rotation inducing vanes being arranged around said central oval.

10 7. A blower according to Claim 3, wherein the braking vanes are radially arranged within a predetermined angular range from the centre to the outer circumference of said wind deflector, the rotation inducing vanes being arranged in parallel within the remaining angular range.

15 8. A blower according to Claim 1 or 2, wherein the rotation inducing vanes are arranged in parallel all over the surface of said wind deflector,

the braking vanes comprising warp preventing ribs which extend at right angles with respect to said rotation inducing vanes from their centre base ends to their radially outer terminal ends, and two braking vanes which are arranged in parallel with said rotation inducing vanes.

20 9. A blower according to Claim 1 or 2, wherein the wind deflector has its respective vanes arranged in parallel and partially or wholly inclined at a larger angle than the angle of the swirling air flow generated, in use, by said axial flow fan.

25 10. A blower substantially as herein described with reference to any of the accompanying drawings.

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