Dec. 17, 1940. E. L. ANDERSON 2,225,406

FAN

Original Filed April 13, 1936 2 Sheets-Sheet 1

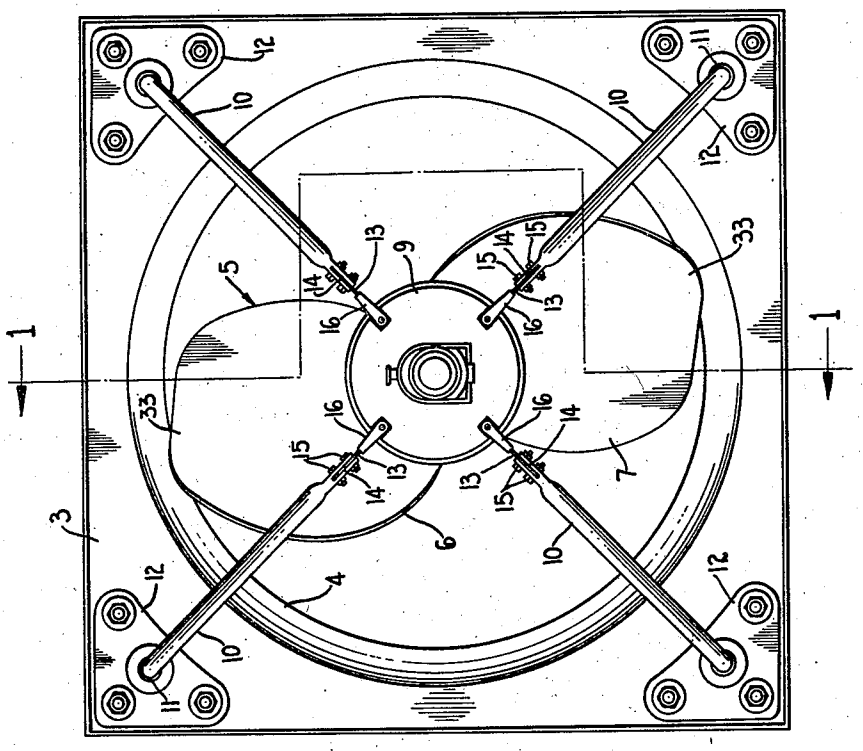


Fig. 2

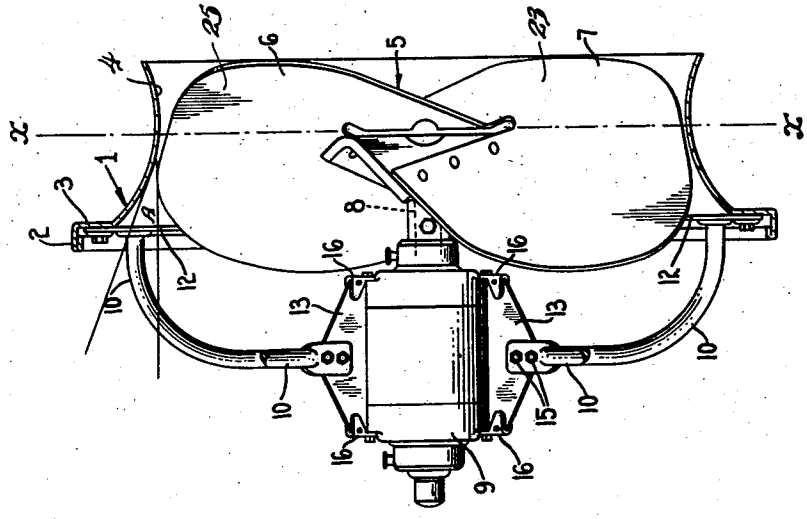


Fig. 1

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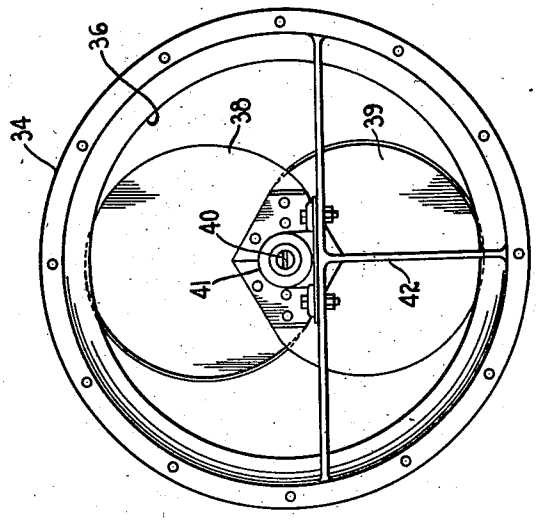


FIG. 4

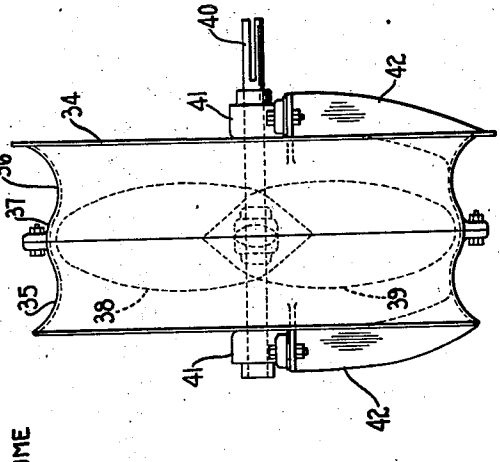


FIG. 3

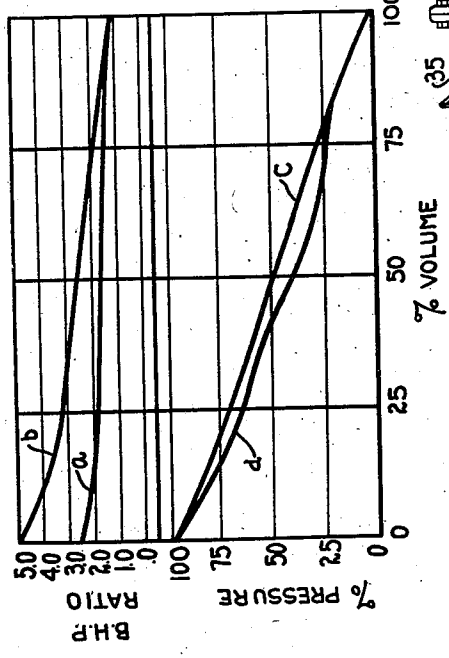


FIG. 5

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UNITED STATES PATENT OFFICE

2,225,406

FAN

Edward Lowell Anderson, Grosse Isle, Mich., assignor to American Blower Corporation, Detroit, Mich., a corporation of Delaware

Original application April 13, 1936, Serial No. 74,119. Divided and this application February 7, 1938, Serial No. 189,092

9 Claims. (Cl. 230—120)

My invention relates to new and useful improvements in fans, and more particularly to a fan of the disk or propeller type having radially extending blades.

An object of my invention is to provide a fan of novel construction which will operate with a high degree of efficiency and which can be manufactured at low cost.

Another object is to eliminate the occurrence of back suction between the fan blades and the fan ring so as to materially increase the range of air volumes which can be efficiently handled by the fan.

Another object is to provide a fan having an exceedingly low noise pitch.

Another object is to provide a fan in which the direction of the discharging air may be reversed by reversal of rotation of the fan blades without impairing the efficiency of the fan.

The invention consists in the novel construction of the fan and the cooperative relation between the fan blades and the fan ring, to be more fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawings, to be taken as a part of this specification, I have fully and clearly illustrated certain fan structures embodying my invention, in which drawings—

Figure 1 is a view in vertical section through the fan ring or housing, taken on the line 1—1 of Fig. 2 and showing the fan proper in side elevation;

Fig. 2 is a view in elevation, looking from left to right facing Fig. 1;

Fig. 3 is a view in side elevation of a fan housing containing a reversible type fan;

Fig. 4 is a view in end or front elevation, looking from right to left facing Fig. 3, and

Fig. 5 is a chart showing graphically the characteristics of the fans of Figs. 1 and 3.

Referring to the drawings, Figs. 1 and 2, by characters of reference, the numeral 1 designates a fan housing preferably of sheet metal and of rectangular external contour having a marginal surrounding flange 2 which serves to reenforce the orifice plate 3. Extending from the inner periphery of the plate 3 in a direction opposite to flange 2 and in the direction of air flow, there is a fan ring or shroud 4 of converging-diverging form defining the fan orifice and having its inlet end of greater internal diameter than its outlet end. The fan ring 4 is preferably formed as shown by a series of conic sections joined by conic sections and said sections preferably intersect tangentially. Positioned in the orifice, there is a fan proper 5 having radially and oppositely extending blades 6, 7 and which is mounted on the shaft 8 of the driving motor 9 which is supported by the housing 1. The blades 6, 7 are offset so that the width of the leading edge portions of each blade is greater than the width of the trailing edge portion of that blade, the leading portions preferably being substantially twice as wide as the trailing portions. The leading edge portion of each blade is also preferably of greater radial length than its respective trailing edge portion so that the blades will cooperate with the fan ring to overcome back suction. The radial length of the blades on the line separating the leading and trailing edge portions of each blade and which is in the plane normal to the axis of rotation, is slightly less than the minimum internal diameter or the throat diameter of the ring 4 so that the tips 33 of the leading edge portions of the blades act to discharge air against the converging, convexly curved inlet side of the fan ring 4. As will be apparent from the drawings, Fig. 1, the direction of lines of flow of the air stream discharging parallel to the fan axis of rotation will strike the internal converging ring surface 4 at a sharp acute included angle A, Fig. 1, of less than 45° for example, and preferably not more than 28° to 30°, for to use a larger included angle would result in a very material loss of power consumed in the abrupt change in the direction of air flow. The trailing edge portions 23 and 25 extend beyond the plane of minimum diameter of the ring 4 so that the blades can exert a maximum effort on the air stream. The portion of the plate 3 which extends around the orifice and at right angles thereto serves to guide the air stream which is drawn into or enters the orifice to maintain the lines of flow at the least angle of approach to the blades and to provide approximately uniform air velocity. The imaginary line separating the leading edge portions from the trailing edge portions is shown in the drawings by the line X—X.

The motor 9 is held in concentric relation to the ring 4 by radially extending supporting arms 10, preferably four in number and spaced equally about the motor shaft. Each of these arms is rigidly fixed at one end, as at 11, to a supporting pad or reenforcing plate 12 which is rigidly secured as by bolts or in other suitable manner to the corner portions of the plate 3 on the inlet side of the fan housing. The arms 10 are

bent or curved so that their motor supporting ends lie in a common plane spaced from the inlet face of and parallel to the plane of the plate 3. The motor supporting ends of the arms 10 are flattened and bifurcated to provide end slots in planes radial to the motor shaft. Positioned in these slots and rigidly secured to the arms are resilient supporting plates 13. The plates 13 are rigidly clamped midway between their ends in the end slots 14 of the arms 10 by bolts 15. The opposite ends of the plates 13 are received by fastening members 16 which are rigidly secured to the opposite end faces of the motor 9. It will thus be seen that the motor 9 is rigidly held against movement radially or longitudinally of its shaft while being permitted a limited oscillatory movement about its shaft due to the resilience of the plates 13.

Referring to Figs. 3 and 4, the casing or housing 34 is of uniform internal contour with spaced, inwardly converging, annular portions 35, 36 forming spaced throats with an internal, outwardly concave portion 37 forming a channel to receive the fan proper. Positioned within the housing 34, there is a fan comprising the blades 38, 39 which are mounted on a driving shaft 40 supported in bearings 41 carried by frame members 42. The diameter of the fan between the tips of blades 38 and 39 is greater than the internal diameter of the throats 35 and 36 so that on rotation of the blades in either direction, air will be forced against the internal converging, convexly curved inlet side or surface of either the throat 35 or the throat 36, whichever is on the outlet side of the fan blades and thereby prevent back suction between the blade tips and the fan ring or housing. The blades 38 and 39 are similar in external contour with the leading and trailing portions of each blade being made symmetrical to each other and of equal surface area so that the fan is reversible and can be rotated in either direction without change in efficiency of operation. The fan ring housing 34 is preferably formed as shown by a series of conic sections joined by conic sections and said sections preferably intersect tangentially.

In Fig. 5, the curve *a* shows the power consumed in the movement of air by my fan as compared to the power to move the same volume of air by fans now on the market, as indicated by curve *b*. Curve *c* shows graphically the relation of volume of air discharged relative to pressure by my fan as compared in curve *d* to the volume pressure characteristic of standard fans now on the market. From the curve *c*, it will be noted that my fan is capable of efficient operation over the full range of air displacement whereas standard fans as shown by curve *d* have a limited range of efficient operation and that the volumetric displacement falls off considerably as the pressure against which they operate is increased.

This application is a division of my copending application Serial No. 74,119, filed April 13, 1936, for Fan, now Patent 2,126,599, dated Aug. 9, 1938.

What I claim and desire to secure by Letters Patent of the United States is:

1. A propeller fan comprising a fan ring having a convex internal face converging from its inlet side in the direction of fluid flow, a supporting member concentric with said ring, fan blades carried by said supporting member and positioned on the inlet side of and within said ring, the diameter of the circle defined by the fan blade tips being of greater length than the minimum internal diameter of said ring and said blades extending at their trailing edges through the plane of minimum diameter of said ring whereby the outer end portions of said blades act to force fluid obliquely against the inlet side of the convex ring surface thereby reducing back suction.

2. A reversible fan comprising a fan ring having an internal face undulating in longitudinal cross-section defining inwardly convex circumferential portions and an intermediate outwardly concave circumferential portion, a propeller fan positioned in said ring and having its length between opposite blade tips of greater dimension than the minimum diameters of said convex portions whereby the outer end portions of said blades act to force fluid against the inlet face of the convex portion on the outlet side of said fan thereby reducing back-suction.

3. A propeller fan comprising a fan ring having an inlet and an outlet and having an annular inlet section with its inner wall surface of convexly curved converging contour, supporting means concentric with the center line of fluid flow through said ring, fan blades extending radially from said supporting means and discharging toward the plane of minimum diameter of said inlet section, the tips of said blades being positioned within said inlet section and extending beyond the circle of minimum diameter of said inlet section so that the circumferential annular portion of the discharged fluid stream will impinge obliquely against the convexly curved wall surface.

4. A propeller fan comprising a fan ring having an inlet and an outlet and having an annular inlet section with its inner wall surface of convexly curved converging contour, supporting means concentric with the center line of fluid flow through said ring, fan blades extending radially from said supporting means and discharging toward the plane of minimum diameter of said inlet section, the tips of said blades extending beyond the circle of minimum diameter of said inlet section so that an outer annular portion of the discharged fluid stream will impinge obliquely against the convexly curved wall surface, said ring having an annular outlet section extending from said inlet section and of a diameter at least equal to the minimum diameter of said inlet section thereby to eliminate substantially all eddy currents at said ring outlet.

5. A propeller fan comprising a fan ring having an inlet and an outlet and having an annular inlet section with its inner wall surface of convexly curved converging contour, supporting means concentric with the center line of fluid flow through said ring, fan blades extending radially from said supporting means and discharging toward the plane of minimum diameter of said inlet section, the tips of said blades extending beyond the circle of minimum diameter of said inlet section so that an outer annular portion of the discharged fluid stream will impinge obliquely against the convexly curved wall surface, said ring having an annular outlet section with its inner wall surface of convexly curved diverging contour and extending from said inlet section thereby to eliminate substantially all eddy currents at said ring outlet.

6. A propeller fan comprising a fan ring having an inlet and an outlet and having an annular inlet section with its inner wall surface of convexly curved converging contour, said ring having a wall surface surrounding said inlet and

joining said inlet section to guide the fluid stream entering said inlet, supporting means concentric with the center line of fluid flow through said ring, fan blades extending radially from said supporting means and discharging toward the plane of minimum diameter of said inlet section, the tips of said blades extending beyond the circle of minimum diameter of said inlet section so that an outer annular portion of the discharged fluid stream will impinge obliquely against the convexly curved wall surface.

7. A propeller fan comprising a fan ring having a convex internal face converging from its inlet side in the direction of fluid flow, a supporting member concentric with said ring, fan blades carried by said supporting member and having leading and trailing surface portions intersecting on a line substantially in a plane normal to the direction of fluid flow, said leading portions being positioned on the inlet side of and having parts thereof within said ring, the circle defined by rotation of the tips of said leading portions being of greater diameter than the minimum internal diameter of said ring, said normal plane being substantially at the minimum internal diameter of said ring whereby the outer end portions of said leading portions act to force fluid obliquely against the inlet side of the convex ring surface thereby reducing back suction, and whereby said trailing portions act on said fluid in the area of substantially greatest fluid velocity.

8. In combination, a propeller fan comprising leading and trailing surface portions, said portions intersecting in lines lying in a plane substantially perpendicular to the direction of air flow through said fan, and a shroud ring having an inlet and an outlet and comprising a series of conic sections joined together by other conic sections, said sections intersecting each other tangentially so as to form a conduit member having a converging-diverging bore with a portion of minimum diameter, said fan trailing edge portion extending on the outlet side of said minimum diameter of said ring, and said leading surface portions being on the inlet side of said minimum diameter of said ring.

9. In combination, a propeller fan comprising leading and trailing surface portions, said portions intersecting in lines lying in a plane substantially perpendicular to the direction of air flow through said fan, and a shroud ring having an inlet and an outlet and comprising a series of conic sections joined together by other conic sections, said sections intersecting each other tangentially so as to form a conduit member having a converging-diverging bore with a portion of minimum diameter, said leading edge portions defining by rotation of the tips thereof a circle of larger diameter than the minimum diameter of said ring, said defined circle being within said ring, said fan trailing edge portions extending on the outlet side of said minimum diameter of said ring, and said leading surface portions being on the inlet side of said minimum diameter of said ring.

EDWARD LOWELL ANDERSON.