May 9, 1939. F. CHARAVAY 2,157,999

VENTILATING FAN

Filed July 3, 1937

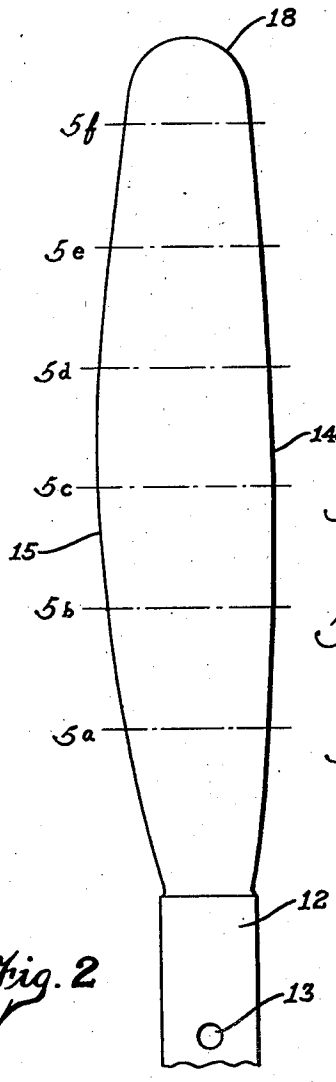
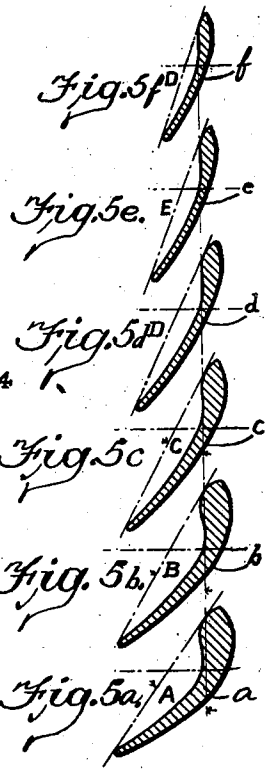


Fig. 2



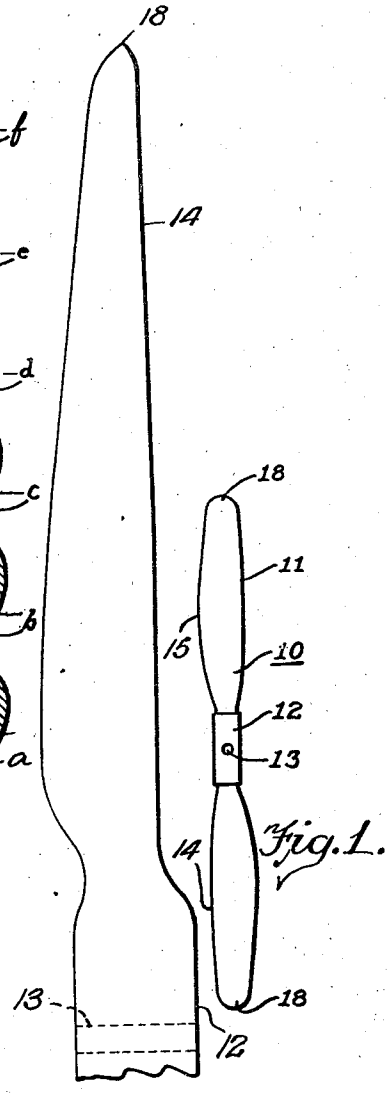


Fig. 1.

Fig. 3

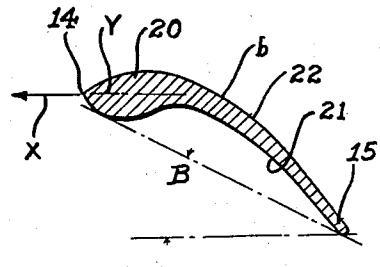


Fig. 4

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Patented May 9, 1939 2,157,999

UNITED STATES PATENT OFFICE

2,157,999

VENTILATING FAN

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Application July 3, 1937, Serial No. 151,799

6 Claims. (Cl. 170—159)

This invention relates to fans adapted for ventilating purposes and the like.

One object of the invention is the provision of a fan having a blade construction in which the lift-drag ratio is very large so that a very large amount of power is absorbed at any given speed of rotation, but with high efficiency.

Another object of the invention is the provision of a rotatable air ventilating fan having a blade in which the leading portions of the blade sections are relatively thick and are convexly curved on both sides, these leading portions projecting generally in the direction in which they move, while the trailing portion of the blade is comparatively thin and is deeply curved and arranged at comparatively large angles of attack.

Other objects and advantages of the invention will be apparent from the following description, the appended claims, and the accompanying drawing, in which

Fig. 1 is a plan view of a ventilating fan embodying the present invention;

Fig. 2 is an enlarged plan view of one of the propeller blades;

Fig. 3 is a view of one of the blades looking transversely of the axis of rotation;

Fig. 4 is a sectional view taken through the blade, corresponding to one of the sections shown in Fig. 3; and

Figs. 5*a*, 5*b*, 5*c*, 5*d*, 5*e* and 5*f* are sectional views on the correspondingly numbered lines of Fig. 2 showing the sectional formation and angular positioning of the sections.

Referring more particularly to the drawing by reference numerals, 10 designates generally a fan, preferably made of aluminum, although it may be constructed of other suitable material. The fan 10 has a plurality of blades 11 which extend generally outwardly away from the central hub portion 12. The latter is provided preferably with a central opening 13 by means of which the hub of the propeller can be mounted on a suitable operating shaft, it being understood that the ventilating fan 10 is adapted to be driven by means of an electric motor or other suitable driving device which is mounted on a suitable fixed support.

The blades of the propeller are so formed as to operate in an efficient manner and displace large quantities of air or other medium in which it operates, the blade section being of relatively large lift-drag ratio so that a comparatively large amount of work can be done at any suitable speed of operation.

As will be apparent from Fig. 2 of the drawing, in which the fan blade is viewed looking in the direction of the axis of rotation, the leading edge 14 and the trailing edge 15 extend outwardly from the hub portion 12, and are rounded at their outer ends to provide the blade tip 16. The leading and trailing edges are suitably curved so that the maximum blade width, shown as being about one-fourth of the length of the blade, is near the middle of the blade length. The fan may have a total length of about four feet although its size is of course dependent on the work to be accomplished.

Figs. 5*a*, 5*b*, 5*c*, 5*d*, 5*e* and 5*f* show a series of sections *a*, *b*, *c*, *d*, *e* and *f* taken respectively on the lines 5*a*, 5*b*, 5*c*, 5*d*, 5*e*, and 5*f* of Fig. 2 at different points along the length of the blade. These blade sections, as will be apparent from these figures and from Fig. 3, decrease outwardly in chord length from the section *b*, and the blade is helically twisted so that the angles of attack of the various blade sections decreases outwardly from a point near the hub portion to the blade tip. Thus the angle of attack of the particular section *b* is represented by the angle B. The angles A, C, D, E and F represent the angles of attack of the blade sections *a*, *c*, *d*, *e*, and *f* respectively. As shown, the angles A to E inclusive,—that is, the angles of the blade sections with respect to the plane of rotation are about 36°, 30°, 27°, 24½°, 22°, 20°, respectively in the particular propeller herein shown, but these angles are chosen in accordance with the power, diameter, and speed requirements.

As will be apparent from Figs. 5*a*, 5*b*, 5*c*, 5*d*, 5*e* and 5*f*, the approximate centers of gravity of the various sections throughout the length of the blade lie approximately in the plane of rotation.

The form or shape of the section *b* is generally representative of the sections taken at other distances from the axis of rotation. As shown in Fig. 4, the leading portion 20 of the blade is relatively thick and is convexly curved on both the suction side and the thrust side. The thickness of this leading portion, as shown, is about one-half of its length, the length of this leading portion being less than half the blade width at all sections, and preferably extending only about one-third of the length of the section from the leading edge or, in other words, one-third of the blade width. This leading portion of the blade extends generally in the direction in which the section moves, that direction being indicated by the arrow X in Fig. 4. It will be noted that the direction of movement line X is about in parallelism with the central axis line Y of this particular

part of the blade section. This leading portion of the blade therefore offers comparatively small air resistance or drag to its passage in the air, since it has an angle of attack which is substantially zero, or not more than a few degrees, and since it is substantially stream-line in form. With an angle of attack that is negligible it will be apparent that it is not productive of high drag, but is of sufficient size to offer a comparatively high degree of strength, holding the blade rigid, and serving to conduct the air which is disturbed at the leading edge of the blade and arrange it in an orderly manner before the air engages the hollow portion of the thrust face.

The rear of the thick leading portion of the blade section at a point about one-third the way back from the leading edge merges into a comparatively thin trailing portion which extends at a comparatively large angle of attack. The thrust face of this trailing portion has a substantially concave form as indicated by the numeral **21**, that line bending reversely where it merges smoothly into the convex form of the thrust side of the leading portion. The suction side of this trailing portion, indicated by the numeral **22**, is of convex form, continuing from the convex curve of the leading portion **20**. The included angle at the rear edge of the blade section between the thrust side and the suction side is comparatively small, and this section is quite thin, so that the flow of air leaving the trailing edge **15** will be quiet. With the trailing portion of the blade section extending at a large angle of attack this trailing portion cooperates with the leading and thicker entering portion to force large quantities of air at any given speed of rotation. The lift-drag ratio is large and the amount of work done is therefore large, especially in view of the efficient sectional form. With the leading edge portion arranged as described, a back flow is prevented through the hub portions of the blade especially where the blade operates under pressure.

The blade sections taken at other points along the length of the blade also provide comparatively thick entering portions which extend approximately in the direction in which they move, and which merge at a point about one-third the distance from the leading edge into deeply curved comparatively thin trailing portions the angle of attack of which is dependent upon the distance of the section from the axis of rotation.

As described, it will be apparent that the material of the blade is so disposed as to give a comparatively rigid and strong construction and provide a fan of light weight.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A rotatable fan of the character described having a blade the transverse sections of which taken at different distances from the axis of rotation are displaced relatively at outwardly decreasing angles of attack, the leading portions of the blade sections being relatively thick and convexly curved on both sides and providing an entering portion extending less than half the blade width from the leading edge, the various sections of said entering portion taken transversely of the blade axis and at different distances from the axis of rotation having an angle of attack which is substantially negligible so that the said entering portion of the blade is streamlined in a plane transverse to the axis of rotation, the rear of said entering portion merging into a comparatively thin trailing portion extending at large angles of attack, the thrust face of the trailing portion having a substantially concave shape.

2. A rotatable ventilating fan having a blade the transverse sections of which taken at different distances from the axis of rotation are displaced relatively at outwardly decreasing angles of attack, the leading portions of the blade sections being relatively thick and streamlined substantially in a plane transverse of the axis of rotation and providing an entering portion extending approximately one-third of the blade width from the leading edge, the rear of said entering portion merging into a comparatively thin trailing portion extending at large angles of attack, the thrust face of the trailing portion having a substantially concave shape.

3. A rotatable ventilating fan having a metal blade the transverse sections of which taken at different distances from the axis of rotation are displaced relatively at outwardly decreasing angles of attack, the leading portions of the blade sections having a thickness which is about one-half their length and being convexly curved on both sides and providing an entering portion extending approximately one-third of the blade width from the leading edge with its various sections, taken transversely of the blade axis, extending substantially in a plane transverse to the axis of rotation, the rear of said entering portion merging into a comparatively thin trailing portion extending at large angles of attack, the thrust face of the trailing portion having a substantially concave shape.

4. A rotatable ventilating fan having a blade the transverse sections of which taken at different distances from the axis of rotation are displaced relatively at outwardly decreasing angles of attack, the leading portion of the various transverse blade sections being relatively thick and convexly curved on the suction side with the various transverse sections of said leading portion taken at different distances from the axis of rotation all extending forwardly to the leading edge substantially in the direction of the plane of rotation and the leading portion of the blade for about ⅓ the chord length having a negligible angle of attack, the rear of said entering portion merging about one-third the chord length from the leading edge into a comparatively thin trailing portion extending at large angles of attack.

5. A rotatable ventilating fan having a blade the transverse sections of which taken at different distances from the axis of rotation are displaced relatively at angles of attack varying from about 36° near the blade axis to about 20° near the blade tip, the leading portions of the blade sections being relatively thick and convexly curved on both sides and providing an entering portion extending less than half the blade width from the leading edge with the various transverse sections taken at different distances from the axis of rotation through said entering portion all extending forwardly to the leading edge substantially in the direction of the plane of rotation, the rear of said entering portion merging into a comparatively thin trailing portion extending at large angles of attack.

6. A rotatable fan of the character described having a blade the transverse sections of which taken at different distances from the axis of rotation are displaced relatively at outwardly decreasing angles of attack, the leading portions of the blade sections being relatively thick and convexly curved on both sides and providing an entering portion extending less than half the blade width from the leading edge, the various transverse sections of said entering portion throughout at least the major portion of its length having their central axis lines located substantially in a common geometric plane extending transversely of the axis of rotation, the rear of said entering portion merging into a comparatively thin trailing portion extending at large angles of attack with the thrust face of the trailing portion having a substantially concave shape, the angles between the central axis lines of the various transverse sections of the entering portion and the angles of attack of the respective transverse sections of the trailing portion decreasing as the sections progress outwardly toward the end of the blade.

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