Feb. 13, 1940. E. W. VOSE 2,189,767

FAN

Filed June 12, 1937

Fig. 2.

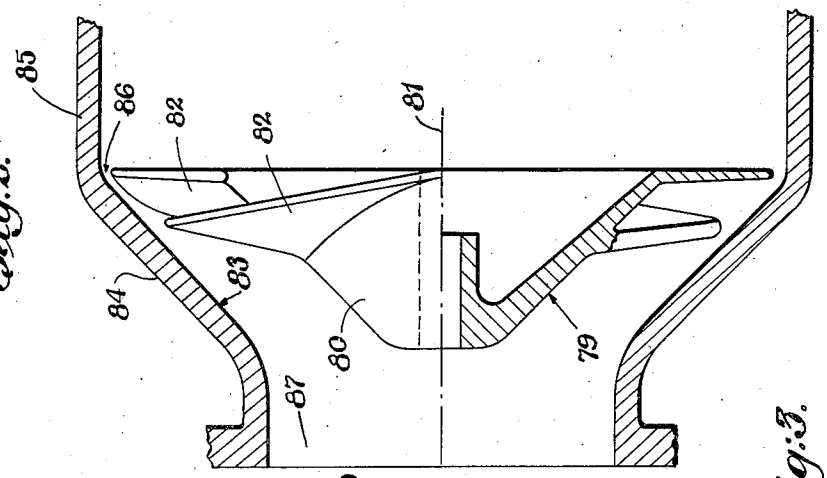


Fig. 3.

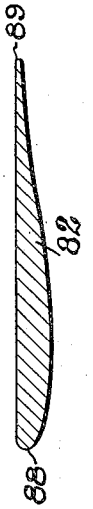
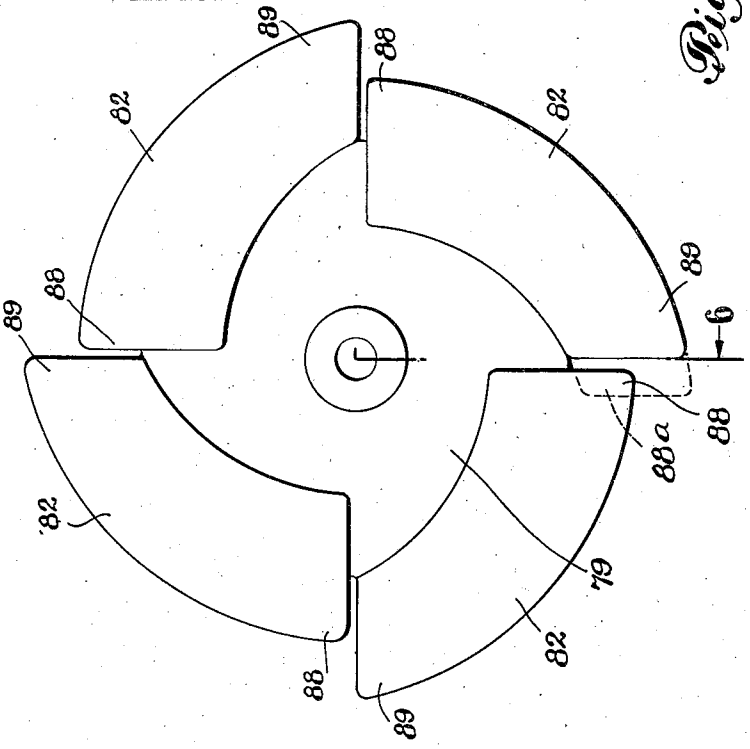


Fig. 1.



INVENTOR
Edwin W. Vose.

BY
Van Deventer & Gries
ATTORNEYS

Patented Feb. 13, 1940 2,189,767

UNITED STATES PATENT OFFICE

2,189,767

FAN

Edwin W. Vose, Orange, N. J., assignor of twenty-five per cent to the Estate of Henry D. Walbridge, deceased, late of New York, N. Y.

Application June 12, 1937, Serial No. 147,805

8 Claims. (Cl. 230—119)

This invention relates to improvements in fans and has for a principal object the provision of a fan having a conical hub, the apex of which is directed against the direction of air flow, whereby the central portion of the air stream is diverted toward the peripheral portions of the fan blades.

Another object of the invention is the provision in a fan, of blades so formed that the inner portion thereof effect a combined axial and centrifugal movement of air within a zone thereabout, and that the outer portions thereof effect purely axial movement both in a zone thereabout and on air centrifugally moved from said first zone to said second zone.

A further object of the invention is the provision of a fan having a conical hub, the apex of which extends opposite to the direction of air flow, having a hollow casing, spaced apart from said hub, and having blades extending from said hub so formed as to effect at least two zones between said hub and said casing. One of these zones is adjacent to said hub and the blades within this zone effect both an axial and centrifugal movement of the air. The other zone is adjacent to the interior of the casing and the fan blades effect an axial movement of air within this zone.

Still another object of the invention is the provision of a fan having a hub and an outer casing, as set forth above, in which an aperture, formed in the outer casing, admits air to said fan at a given volume and a given pressure; said casing, said hub and the fan blades being so proportioned that when the aperture is increased the volume of air passing therethrough is increased and the pressure decreased.

Another object of the invention is the provision in a fan of a conical hub with blades mounted thereon, said blades being non-overlying, and the sides of the conical hub being so formed that due to the centrifugal action of the fan air is delivered to the most efficient portion of the blade thereby holding the re-circulation of air at a minimum.

Other objects and advantages of the invention will appear to those skilled in the art.

In the drawing—

Figure 1 is a plan view of the new and improved fan cast in one piece;

Figure 2 is a side elevation, partly in section, of the fan shown in Figure 1 having an outer casing superimposed thereabout; and

Figure 3 is an enlarged sectional view of one of the blades of the fan shown in Figure 1.

Referring now to the drawing, I have illustrated a cast form of the new and improved fan which may be mounted on a shaft of a suitable motor (not shown) and comprises a hub 79 of conical form, having a plurality of blades 82 mounted thereon.

In the drawing the surface 80 of the hub 79 makes a 45° angle with the center axis 81 of the fan.

In this specification, the hub of the fan has been described as "conical." However, it must be distinctly understood that I am not limited to hubs having a true conical shape. For example, I have constructed fans utilizing hubs of spheroid form which have given, in some instances, slightly better results, but for constructional reasons the conical form of the hub may be preferable due to the fact that the construction of the cone is an easier machining operation.

In the appended claims, the term "conical hub" may be taken to mean any hub whether it be conical or spheroidal so long as it is of a form capable of diverting the central portion of the air-stream outwardly to the peripheral portion of the fan blades. Where conical hubs are employed, I do not wish to limit myself to cones having surfaces making an angle of 45 degrees with the axis, because I have obtained excellent results with cone surfaces of from 40 to 60 degrees with the axis.

The blades 82 are so formed and are mounted upon the surface of the cone 79 at such an angle that portions thereof, which are ineffective for pressure and volume and which also allow recirculation of air, are greatly reduced. Due to the cone and to this portion, air is forced outwardly by centrifugal force to the most efficient portion of the blades (toward the portions traveling at the highest peripheral speed).

The blades 82 are shown in the drawing as having a 10° tip pitch. However, I have obtained excellent results with blades having different pitches to either side of 10° within wide limits.

I have found in fans of this type employing hubs of the kind described, that the pressure or the volume, or both the pressure and the volume may be affected both up and down by changing the diameter of the hub, the number of blades, the location, curve and pitch angle of the blades.

The inner surface 83 of the inclined portion 84 of the casing 85 bears a definite relation to the surface 80 of the cone hub. This relation may be such that the surfaces 83 and 80 are parallel to each other, or that they are angular with respect to each other and so arranged that the angle widens as the volume increases over pressure. In other words, the area at the intake end is of greater cross section than the area at the discharge end. The clearance 86 between the outer edges of the blades 82 is approximately 1/16" for the size fan illustrated in Figures 1 and 2. I do not limit myself to this dimension, as it will vary where larger or smaller fans are used,

and this clearance must be kept to a minimum, the structure being considered.

The size of the aperture 87 depends upon the structure of the fan, the pitch of the blades, etc. However, I have obtained consistent results with fans employing apertures having diameters of 40% to 55% of the outside diameter of the fan. The aperture 87 may be made larger if it is desired to increase the volume of air passing to the fan. This would result in a reduction of the pressure of the air.

It will also be noted, in Figure 1, that the trailing edges 89 of the blades 82 are not overlapped by the leading edges 88 of a succeeding blade. The projected gap between these leading and trailing edges of the blades are shown in the drawing as approximately $\frac{3}{32}$''. This is due to the fact that the fan illustrated in Figure 1 is designed to be die-cast and these projected gaps are designed to simplify the die. However, it is preferable to have the trailing edge of one blade overlap the leading edge of the succeeding blade; therefore, I do not limit the invention to fans in which projected gaps appear. In other words, the trailing edge 89 may extend to the position shown in dotted lines and indicated by the numeral 88^a.

It should be understood that my new and improved fan can be used either to create suction such as, for example, in a vacuum cleaner or to create pressure such as, for example, in a blower.

In fans of the prior art, noise is due to the following causes:

(1) Vortices formed in the air at the trailing edges of the blades.

In any axial flow type of fan having either high or low tip speeds, for example, aeroplane propellers, and ordinary electric fans.

(2) Vortices formed on any interfering parts of the mechanism by air after it leaves the blades.

(3) Forced changes in the direction of the airflow where abrupt turns or corners are made.

In vacuum cleaners of the prior art using centrifugal fans and volute casings, the whine is due to the sharp cut-off in the volute casing.

(4) The expansion of air at the outlet of centrifugal fans against atmospheric pressure.

(5) Vibration of the blades per se.

In my new and improved type of fan, the absence of noise is due to the following features:

(1) The trailing edges of the blades, most of the length of which are along the surface of the cone and secured thereto or formed integral therewith, do not deliver air into the air stream except the trailing tips 89 which represent only a small percentage of the normal trailing edge as compared to the trailing edges of the blades of axial flow fans of like diameter.

(2) The discharged air is delivered substantially axially or in a straight line, and, therefore, does not strike any parts at an acute angle.

(3) The air does not turn any sharp corners and there is substantially no change of its direction.

(4) The long dimension of the blades are secured to or formed integral with the hub, thereby vibration is practically eliminated.

Due to the fact that my new and improved fan is provided with a conical hub which occupies the center of the slip stream and diverts the central portion of the air toward the peripheral portions of the fan blades, the most effective portions of the blade works upon the full one-hundred percent of the incoming air, and due to the absence of re-circulation I am able to move a greater percentage of air for the power expended than other fans are capable of doing, or the same amount of air with less consumption of power.

In constructing aircraft propellers along the same lines, I have found that the efficiency of the propeller increases when the central portion of the propeller is cowled, for example, a coverage of 20% resulted in an increase of as much as 2% in efficiency. With this in view, I construct a conical hub which occupies around 20% of the slip stream in low pressure large volume fans, and which occupies as high as 80% in high pressure types of fans.

Although a simp'e embodiment of the new and improved fan is described, it is obvious that many changes may be made in the fan without departing from the spirit of the invention as set forth in the annexed claims.

What is claimed is:

1. A rotary fan comprising a conical member having its apex directed against the direction of air flow, a plurality of blades mounted on and having axially active extremities projecting beyond the largest diameter of said conical member to form an outer zone in which air is moved axially, a substantial portion of said conical member extending in front of the entering edges of said blades being smooth and unbroken and forming an inner non-turbulent zone in which the entering air is parted, the portions of said blades between said outer zone and said non-turbulent zone forming an intermediate zone in which the parted air is given combined axial and centrifugal movement and is delivered to said outer zone to be moved axially.

2. A fan according to claim 1 in which trailing edges of the blades terminate along a line coinciding with the base line of said conical member.

3. A fan according to claim 1 in which a member of spheroidal form is substituted for said conical member.

4. A fan according to claim 1 in which the blades are helically inclined and the entering edges are thicker than the trailing edges.

5. A rotary fan comprising a conical member having its apex directed against the direction of air flow, a plurality of blades mounted on and having axially active extremities projecting beyond the largest diameter of said conical member to form an outer zone in which air is moved axially, a portion of said conical member extending sufficiently in front of the entering edges of said blades being smooth and being unbroken to form an inner non-turbulent zone in which the entering air is parted, the portions of said blades between said outer zone and said non-turbulent zone forming an intermediate zone in which the parted air is given combined axial and centrifugal movement and is delivered to said outer zone to be moved axially.

6. A fan according to claim 5 in which a fan casing surrounds said fan.

7. A fan according to claim 5 in which a fan casing surrounds said fan, said fan casing having a conical extension spaced apart from the surface of said conical member.

8. A fan according to claim 5 in which a fan casing surrounds said fan, the inner wall of said casing and the outer surface of said conical member being spaced apart and angularly disposed relatively to each other.

EDWIN W. VOSE.