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CENTRIFUGAL FAN.
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1,314,049.

Patented Aug. 26, 1919.

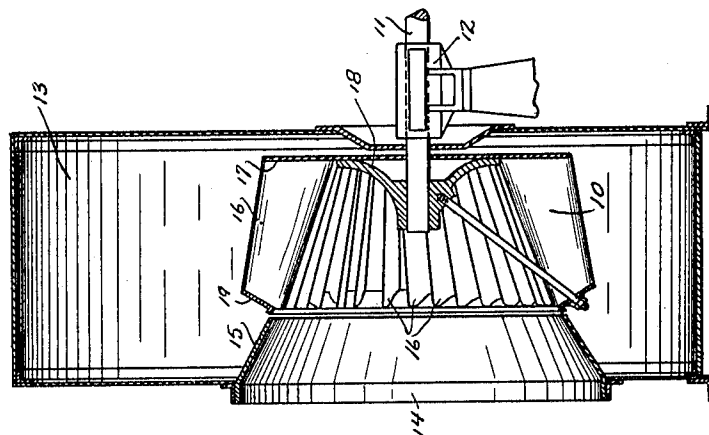


Fig. 1.

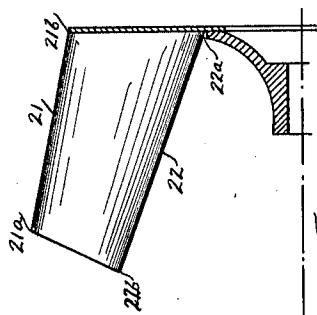


Fig. 3.

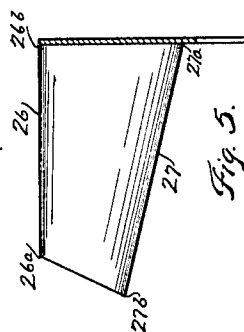


Fig. 5.

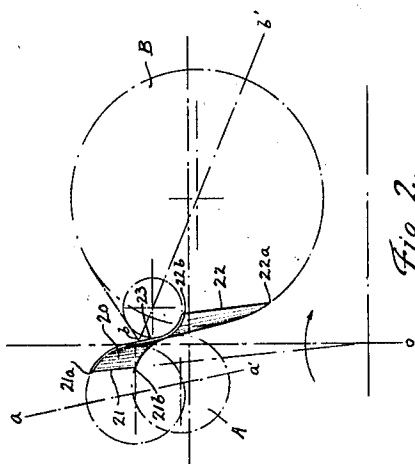


Fig. 2.

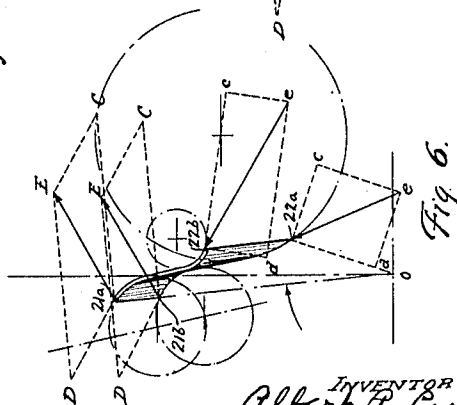


Fig. 6.

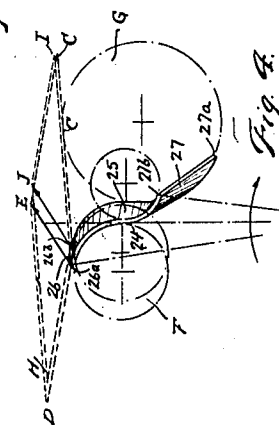


Fig. 4.

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CENTRIFUGAL FAN.

1,314,049.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, ALBERT A. CRIQUI, a citizen of the United States of America, and a resident of the city of Buffalo, county of Erie, and State of New York, have invented certain new and useful Improvements in Centrifugal Fans, of which the following is a full, clear, and exact description.

My invention relates generally to a multi-blade, centrifugal fan of the type in which a large number of blades are arranged in an annular series around a central space open at one side for the entrance of the air which is drawn in through the central opening and forced outwardly through the spaces between the blades by centrifugal force. This invention relates to the same type of fan as that shown and described in Patent No. 1,240,949, issued September 25, 1917.

My invention relates specifically to improvements in the formation of the blades which form part of the wheel of a centrifugal fan.

It is well known to those skilled in the art, that fans of this type are generally constructed to deliver air under pressure at a comparatively slow speed of rotation. In places where direct-connected fans of this type are installed and a low static pressure of air is desired, it is necessary to run the fan wheel at a slow speed, which requires a large frame motor in order that the slow speed may be maintained. This is because of the fact that in most fan constructions, inventors have sought to produce fans in which the velocity of the air leaving the wheel will be greater than the peripheral velocity of the wheel.

The general object of my invention has been, therefore, to provide a fan having a wheel with blades in which the velocity of the air leaving the wheel shall be less than the velocity of the periphery of the wheel, thereby producing a low velocity pressure at a comparatively high speed of rotation. In my fan, a snail-shaped casing is used, by means of which a portion of the velocity pressure of the air leaving the wheel is converted into static pressure. My wheel will, therefore, produce a lower static pressure than a wheel having forwardly curved blades, both wheels running at the same peripheral velocity.

Another object has been to provide a fan

wheel having blades so formed that the friction of the air passing through the blades shall be greatly minimized and thus produce a fan having maximum efficiency.

Another object has been to provide a blade which shall equalize the air along the entire length of the same and also one which shall pick up the air at a minimum loss by shock or impact with the entering air.

Moreover, my invention provides a blade that will make it possible to attain different air pressures with the same revolutions per minute with the wheel by varying the radial dimension of the flat portion of the blade to suit the pressure requirements.

Furthermore, I have provided a blade, the surfaces of which are formed from a cylinder, a truncated cone, and a flat surface, said flat surface lying in a plane which is tangent to the surfaces of the cylinder and the cone.

Each blade of my fan, as described herein, has a forwardly curved heel and a backwardly curved tip. By reason of the backward curve at the tip, the kinetic energy of the air, as it leaves the tip, is reduced to a minimum, thereby producing a static pressure resulting from the conversion of velocity which is far less than that produced by the inwardly curved or straight surface type of blade.

Throughout this description, I have used the term air, but, obviously, my device may be advantageously used with gas or other fluids, and it is not intended to restrict my invention to the use of air.

A structure somewhat similar to that disclosed herein, is described in my Letters Patents of the United States of America, bearing Nos. 1,161,926 and 1,167,152, issued November 30, 1915, and January 4, 1916, respectively.

I have accomplished the above objects and advantages by the device shown in the accompanying drawings which form a part of this application. In the drawings:

Figure 1 is a sectional, side elevation of a complete fan.

Fig. 2 is an end elevation of a complete blade and shows, diagrammatically, the manner in which the blade is developed.

Fig. 3 shows a side elevation of the blade illustrated in Fig. 2.

Fig. 4 is an end elevation of a modified form of blade and shows, in a diagrammatic- 110

cal manner, a means of ascertaining the comparative pressures and velocities developed at each corner of the tip of the blade.

Fig. 5 is a side elevation of the blade 5 shown in Fig. 4.

Fig. 6 is an end elevation of the blade similar to that shown in Fig. 2 and shows, in a diagrammatical manner, a means of ascertaining the comparative pressures and 10 velocities developed at each corner.

Referring to the drawings, 10 represents the wheel of my fan which is carried by a shaft 11, mounted within a suitable bearing 12 and provided with any desired means of 15 motive power (not shown). The wheel 10 is inclosed within a snail-shaped casing 13 having an inlet opening or eye 14 adjacent to the inlet of the wheel 10 and also with an inlet cone 15, which fits into the inlet eye 20 14 and directs the air from the exterior of the casing into the central opening of the wheel. The casing is also provided with the usual tangential opening, which, for clearness of illustration, has not been shown. 25 The blades 16 are secured at one end to a disk 17, carried by a hub 18, secured to the shaft 11. An annular band or ring 19 is arranged at the inlet end of the wheel and the outer ends of the blades 16 are secured 30 to said ring by any suitable means.

In the ordinary type of fan, as is well known, the tendency of the entering air is to rush to the end farthest from the entrance and be discharged from that part of the 35 wheel, thus making the discharge at the entrance end of the wheel comparatively slight. In order to produce a uniform discharge of air along the entire length of the blade, I have made the wheel 10 conical in shape, as 40 shown in Fig. 1. It will be seen from this figure that the wheel is larger in diameter at the entrance end than at the disk end thereof. The blades 16 are also narrower at the entrance end of the wheel than they are 45 at the disk end thereof. Owing to this difference of diameters of the wheel, the peripheral velocity of the tips of the blades will be greater at the entrance end of the wheel than at the disk end, and thus force 50 the greater amount of air through the blades at this point, which tends to equalize the velocity of the air along the tip of the blade.

The blades of my fan are each formed 55 from a cylinder, a cone and a flat surface, said flat surface lying in a plane which is tangent to the surfaces of the cylinder and the cone. The blades are so formed that the concave surface of each is presented to the 60 air at the heel of the blade and the convex surface is presented to the air as it leaves the tip of the blade. These blades may have their tips and heels coplanar or non-coplanar with the axis of the wheel, and may have 65 the entrance end of the tip and heel preced-

ing or following the disk end thereof, as required, to suit different conditions.

Referring now to Fig. 2, it will be seen that the blade 20 is formed partly from the surfaces of a cylinder A and a truncated 70 cone B. This cylinder and cone are arranged to have their surfaces tangent to the plane which passes through the flat surface of the blade. The axis of the cylinder A is represented by the line $a-a'$. The apex of 75 the cone B is represented at b , and its axis is represented by the line $b-b'$.

The tip 21 of the blade shown in Figs. 2 and 6 is coplanar with the axis o of the wheel and the heel 22 of the blade is non- 80 coplanar with the axis of the wheel. The end 21^a of the tip of the blade is farther from the axis in a radial direction than the end 21^b and the end 22^a of the heel of 85 the blade is nearer the axis of the wheel in a radial direction than the end 22^b and it precedes the end 22^b. From these figures, it will be clearly seen that the tip and heel portions of the blade are curved 90 backwardly and forwardly, respectively, and that between them and tangent to these curved surfaces is a substantially flat surface 23, which in this figure lies in a plane 95 arranged at an angle to a radial line passing through the wheel. By varying the width of this flat surface, (that is the radial dimension of the flat portion of the blade) the fan can be made to suit different pressure requirements. By increasing the width 100 of this flat surface I am able to increase the static pressure produced by the fan, while maintaining a constant speed; and by decreasing the width of this flat surface, I am able to decrease the static pressure produced 105 by the fan while maintaining a constant speed.

Referring now more particularly to Fig. 6—where I show, in a diagrammatic manner, a means for ascertaining the comparative pressures and velocities at the different 110 points of the blade—the broken line 22^{a-c} represents the lineal velocity of the end 22^a of the heel of the blade; and the broken line 22^{a-d} represents the radial velocity of the air passing through the blade at the end 22^a. The 115 resultant velocity is indicated by the full line 22^{a-e}. The lineal velocity of the blade at the end 22^b of the heel is indicated by the broken line 22^{b-c} and the radial velocity of the air through the blade at this end is indicated by 120 the broken line 22^{b-d}. The resultant velocity of the air at the end 22^b of the heel of the blade is represented by the full line 22^{b-e}. The lineal velocity of the end 21^a of the tip 125 of the blade is represented by the broken line 21^{a-C}, which line is tangent to the periphery of the wheel at the end 21^a. The blade at this end being curved backwardly, the air leaves the blade at a tangent to the outer curved surface of the same, and is repre- 130

sented by the broken line 21^a—D. The resultant velocity of the air leaving the end 21^a of the tip of the blade is indicated by the full line 21^a—E. The lineal velocity of the air leaving the end 21^b of the tip is indicated by the tangential broken line 21^b—C, and the line 21^b—D represents the tangential line of discharge of the air as it leaves this end of the tip of the blade. The resultant velocity of the air at the end 21^b of the tip is indicated by the full line 21^b—E. It will be understood that the radial velocity of the air at the tip of the blade is indicated by the distance between the line indicating the lineal velocity of the tip of the blade and the line of the parallelogram which is parallel thereto. It will thus be seen that the resultant velocity of the air leaving the tip of the blade is far less than the lineal velocity of the tip of the blade, thus giving a low resultant velocity pressure at a high speed of rotation.

Referring now to Figs. 4 and 5—where I show a type of blade used in a wheel of substantially equal diameter at each end—the blade 24 is developed from a cylinder F and a truncated cone G, arranged to have a line along each of their surfaces tangent to a plane passing through the flat surface 25, which is formed on the blade between the two curved surfaces. It will be seen that in this form of blade this flat surface lies in a plane which is parallel to the axis of the wheel. The tip 26 of this blade is non-coplanar and parallel with the axis of the wheel. The end 26^a of the tip of this blade is the same radial distance from the axis as the end 26^b, and the end 26^b precedes the end 26^a. The heel 27 of this blade is non-coplanar with the axis of the wheel and has its end 27^a nearer the axis of the wheel than the end 27^b and preceding the same. The lineal velocity of the end 26^a of the tip of the blade is represented by the broken line 26^a—C, which line is tangent to the periphery of the wheel at the end 26^a. The tip of the blade being curved backwardly, the air leaves the blade at a tangent to the outer curved surface of the same and is repre-

sented by the broken line 26^a—D. The resultant velocity of the air leaving the end 26^a of the tip of the blade is indicated by the full line 26^a—E. The lineal velocity of the end 26^b of the tip of the blade is represented by the broken line 26^b—I, and the tangential line of discharge of the air as it leaves this end of the tip of the blade is represented by the broken line 26^b—H. The resultant velocity of air leaving this end of the tip of the blade is represented by the full line 26^b—J.

While I have shown and described my invention as applied to a fan having a single wheel and a single inlet opening, it is obvious that it may be applied to fans having a double opening or to fans having two wheels each provided with an inlet opening. It is to be understood, that, while I have shown and described the connecting surface as a flat surface, still substantially the same results may be obtained by the use of a connecting surface which is somewhat curved. These and other modifications of the details herein shown and described may be made without departing from the spirit of my invention or the scope of the appended claims.

Having thus described my invention, what I claim is:

1. A centrifugal fan having a wheel provided with a plurality of blades, the entire surface of each of said blades being formed from a portion of the surfaces of two solids having curved surfaces and a plane connecting the surfaces of the solids.

2. A centrifugal fan having a wheel provided with a plurality of blades, a part of the surface of each of said blades being formed from the surface of a cone, and a part of the surface of each of said blades being made from the surface of a cylinder, each of said surfaces being united by a surface which is tangent to the surfaces of both said cone and said cylinder.

In testimony whereof, I have hereunto signed my name.

ALBERT A. CRIQUI.