June 15, 1937. T. G. JONN 2,083,996

CENTRIFUGAL FAN

Filed Feb. 2, 1935

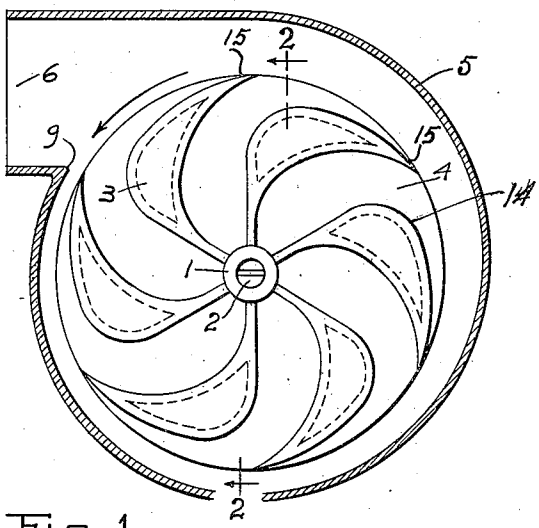


Fig. 1.

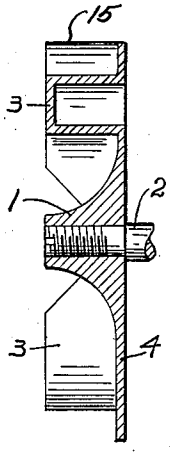


Fig. 2.

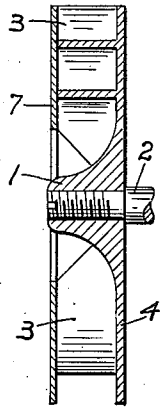


Fig. 3.

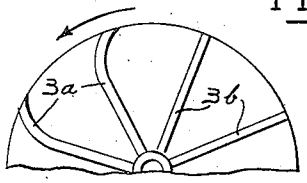


Fig. 8.

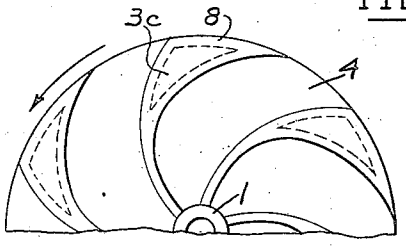


Fig. 4.

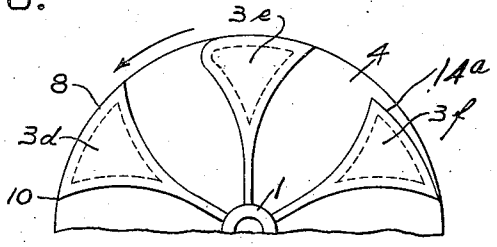


Fig. 5.

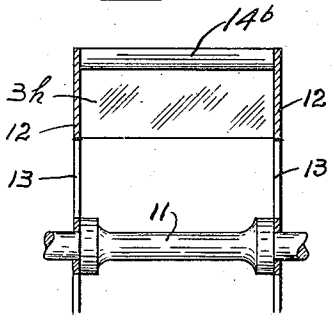


Fig. 7.

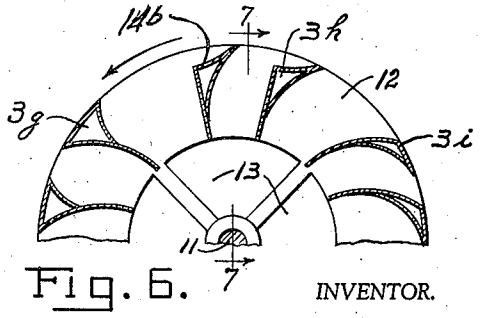


Fig. 6.

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2,083,996

CENTRIFUGAL FAN

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Application February 2, 1935, Serial No. 4,616

6 Claims. (Cl. 230—127)

My invention relates to improvements in centrifugal fans and particularly to the shape of their blades or vanes; and the objects of my improvement are: first, to reduce the power required for operating a centrifugal fan; second, to increase the pressure of the fluid it delivers; and, third, to diminish the noise, characteristic of high speed fans.

I have attained these objects by inventing a new and novel type of blades, the prime feature of which is the introduction of the principle of streamlining, which I have applied to the rear of said blades and whereby the suction or drag, always created by rapidly moving bodies, is greatly reduced.

When, in addition, the pressure sides—as distinguished from the rear sides—of the fan blades are so shaped that the outer, or peripheral, parts of them take the form of cams, and as such act against the compressed air expelled from the fan and surrounding said fan within the fan chamber, a most considerable increase can be obtained in the pressure of the air delivered by said fan.

Further, a centrifugal fan the blades of which are properly streamlined will operate more quietly than if said blades were not streamlined, because of the smoother flow of the air through such a fan, but the major source of noise in a high speed fan of this type, is created when the blades pass the cutoff point; that is, the point at which the air is directed from the fan chamber and into the outlet from the same. Now, all sounds are due to vibrations and if all the blades in the fan are of exactly the same shape they will cause the same kind of vibrations when passing said cutoff point. This constant repetition of the same kind of vibrations will have a cumulative effect and the resultant noise will be of great enough volume to be offensive. However, if the blades differ in shape (and the difference does not need to be great) the vibrations they cause when passing the cutoff, will also differ and there will be produced a steady stream of varied vibrations, which, because the vibrations vary, they will not be cumulative and therefore not increase to a volume that will cause a seriously objectionable noise. Instead, the fan will operate with a comparatively subdued humming sound.

Several embodiments of the invention are illustrated in the accompanying drawing, in which—

Figure 1 is a front view of a fan constructed in accordance with this invention and positioned in a conventional fan chamber.

Figure 2 is a vertical cross section on line 2—2 in Figure 1.

Figure 3 represents a similar cross section of another fan, slightly different in construction, but embodying my invention.

Figure 4 shows another application of my invention to a fan of the same general type as illustrated in Figure 1.

Figure 5 shows still additional modifications of fan blades, slightly different in contour but all in accordance with the present invention.

Figure 6 illustrates three examples of my invention as applied in multiblade fans.

Figure 7 is a section on line 7—7 in Figure 6, showing, however, only one of the blades.

Figure 8 shows two kinds of blades, heretofore conventionally used in the type of fans illustrated in Figures 1 to 5 and without the application of my present invention, but the illustration is included for explanatory purposes.

As this invention is adaptable to all types of centrifugal fans and as such fans are designed for many purposes, it is not possible to show one embodiment thereof that would be preferable in all cases, but Figure 1 clearly illustrates its principal features. The fan shown here consists of a central hub 1 suitable for mounting on a drive shaft 2 and a plurality of blades or vanes 3 held together by a disc or web 4. The direction of the rotation of the fan is indicated by an arrow and the fan is positioned in a common type of casing 5, provided with an outlet 6.

In operation the air is drawn into a fan of this type at its center and discharged at its periphery into the surrounding space of a casing, commonly called fan chamber, from which it is exhausted through an outlet; and it is obvious that the action of the blades against the air will cause said air to be compressed on the pressure or forward sides of said blades, while behind the blades there will be areas of rarefied air, causing suction, eddies, and drag, provided means are not incorporated into the design of the blades to avoid this undesirable condition which is found wherever there is a moving body, but which is magnified in a fan as heretofore constructed because of the fact that the space between the blades in such a fan becomes greater the further they extend from the center, while at the same time the air between them, as it travels from the center and toward the periphery, becomes more and more compressed on the pressure sides of said blades and more and more rarefied at their rear sides. (See Figure 8, illustrating two types of heretofore commonly used fan blades, 3*a* and 3*b*.) This rarefaction of the air, creating a partial vacuum behind re-

volving blades such as 3a and 3b, not only causes power consuming suction and drag, but it has the effect of permitting some of the air that is being expelled from the pressure sides of the blades to re-enter the fan in the areas of rarefaction at the rears of the blades. This backlash creates noise, causes some of the air to be rehandled by the fan, prevents a smooth and even flow of the air streams, and is altogether objectionable.

By now observing the blades 3 (Figure 1) which are designed according to my present invention, it readily will be seen that all of the above mentioned objectionable features have been eliminated. The front or pressure sides of the blades may be shaped in many desired forms according to the use for which a fan is intended, as will be discussed later, but their rear sides are turned backward and away from the front sides of the blades so as to eliminate the spaces that otherwise would be the areas of rarefied air; the actual shape of said rear sides may be curves, straight lines or a combination of the two—and these backsides, however thus shaped, will hereinafter be referred to as being curved. The front sides of the blades are also turned backward so that said front and rear sides join in edges 15 pointing backward in relation to the fan's rotation. Thus the two streams of air emerging from each side of such a blade will unite without creating suction, eddies, or backlash. Shortly expressed, I have streamlined the rear of the fan blades and obtained the known benefits accruing to streamlined bodies.

From what point the rear sides of the blades should start curving backward and away from the front sides and how far this curvature should reach will depend on two main factors; i. e., the speed of the fan and its intended use. As general rules it may be stated: first, that the greater the speed of the fan blades the more pronounced should be the streamlining; second, if a high pressure is of greater importance than the volume of the expelled air, then the best result is obtained by extending the rear sides of the blades so far backward and toward the front sides of the following blades that the openings between said blades are comparatively small at the periphery of the fan; while, third, if the volume of the exhausted air is of prime importance, then the spaces between the tips of the blades should be as large as possible, having in mind, however, that the streamlining always should be sufficient to prevent areas of rarefied air behind the blades.

A high pressure of the discharged air is obtained by restricting outlet 6. This, however, will cause the fan to operate against a backpressure; with the greatest load on the blades of said fan at their outer ends, where the density of the air is the greatest, thus any load will require the greatest amount of power for rotating the fan, where said blades move the fastest. With these points in mind, I have, in one embodiment of the present invention, designed a fan blade which in addition to the centrifugal force also utilizes the principle of the cam for developing a high pressure. The power of a cam is too well known to require discussion. Against a solid object that power is theoretically unlimited, but when used against a liquid, gas, or air and under conditions as herein discussed, its power of compressing said substances has practical limitations. However, the principle is the same and a fan blade so formed that its pressure side terminates in the shape of a cam 14 at its outer end, one form of which is shown in Figure 1 (blade 3), will compress the air to a much higher degree than any other type of blade with which I am familiar or with which I have experimented.

Having now described the cardinal features of this invention, I will briefly explain those of its many possible applications which are illustrated in the drawing.

The fan shown in Figures 1 and 2 has already been described, but a similar fan will have greater efficiency if provided with a front plate or ring 7 (see Figure 3). Such a plate is used in many types of fans and it is therefore not claimed as a part of my present invention, but it is illustrated as another type of fan to which this invention is adaptable. The same plate may also be used in the fans shown in Figures 4 and 5 if the intended use of said fans makes it advisable.

The blades 3c illustrated in Figure 4 are suitable in fans intended primarily for suction, where there is such a minor resistance at the exhaust as would be caused, for example, by the dustbag of a household vacuum cleaner. The front side of each of said blades is convex and turned slightly backward, but not enough to give said side the characteristics of a cam as in Figure 1. The rear side with a concaved surface is also turned backward and said front and rear sides are united at their outer ends by a third side 8 which prevents air already expelled into the fan chamber from re-entering the fan. The rear end of this peripheral side 8 joins the curved back side of the blade, streamlining said sides into an edge 15, thus permitting the outflowing stream of air from between the blades to meet and mingle with the air already in the fan chamber, without creating disturbing currents and eddies.

The front sides of the blades shown in Figure 5 are concave, otherwise—with reference to the present invention—they are much like those shown in Figure 4. However, blades thus shaped will create more noise when passing the cutoff 9 (Figure 1) than blades curved as shown in Figures 1 and 4. I have therefore selected this type to illustrate that feature of this invention by which a slight change in the blades' contour will materially reduce the noise of the fan's operation. Blade 3d has a sharp forward edge where the front side joins the peripheral side at 16. At relatively the same point in blade 3e there is a rounded corner. And blade 3f is shown with a similarly sharp edge as in blade 3d, but it is disposed slightly inside the periphery of the fan whereby the outer side of the blade becomes a cam 14a. Any number of variations or combination of variations of such or similar nature may be introduced in designing the blades of a fan for the purpose of decreasing the noise of operation of said fan, as has already been explained.

In addition to the fans already discussed, there are also centrifugal multiblade fans of which one simple type is illustrated somewhat diagrammatically in Figures 6 and 7. It is shown with a drive shaft 11 on which two side plates 12 are mounted. These are provided with ports 13 through which the air enters the fan, whereupon it is expelled centrifugally. Many such fans have flat side plates, as illustrated, while said plates in other types are shaped as truncated cones so that the space between them is less at their peripheries than at their centers. As in the fans previously discussed, so also in these fans the vanes may have several shapes, three of which are illustrated in Figure 6. Blade 3g has a concave pres-

sure side, a streamlined rear side, and a peripheral side that connects the other two. In blade 3*h* the pressure side is straight, the peripheral side is formed into a cam 14*b*, and the rear is streamlined. Blade 3*i* is very similar to 3*g*, except that the pressure side is convex.

While I have shown and described several applications of my invention, other modifications may be made without departing from its spirit or the scope of the appended claims.

What I claim is:

1. A centrifugal fan with a plurality of blades radiating from the hub toward the fan's periphery; the forward surface, which is presented to the air, of each of said blades being curved backwardly relative to the fan's rotation and so formed that said surface will have the shape and function of a cam; said cam reaching the fan's periphery at a point so close to the forward surface of the following blade that the peripheral opening between the blades is restricted relatively to the distance between said blades at a point some distance inside of the fan's periphery.

2. In a centrifugal fan, a plurality of blades radiating from the hub of said fan toward the fan's periphery, each of said blades comprising a forward side which curves backward relatively to the direction of the fan's rotation, a rear side also curving backward but at a shallower curvature than said forward side, said forward and rear sides joining in a trailing edge at a point on the fan's periphery so close to the forward side of a following blade that the peripheral opening between the blades is restricted relatively to the distance between said blades at a point closer to the hub of said fan.

3. In a centrifugal fan, a plurality of blades each comprising a forward side, a rear side and a peripheral side connecting said forward side to said rear side; the junction point of said peripheral side with said forward side on one of said blades being at a different position relatively to the fan's periphery than the corresponding point on the following blade.

4. In a centrifugal fan, a plurality of blades each comprising a forward side, a rear side, and a peripheral side connecting said forward side to said rear side; the junction points of said peripheral side with said forward side in one group of blades being at a different position relative to the fan's periphery than the corresponding points in another group of blades.

5. In a centrifugal fan, a plurality of blades each comprising a forward side, a rear side, and a peripheral side connecting said forward side to said rear side; the junction point of said peripheral side with said forward side on each of said blades having a different shape than the corresponding point on each of the other blades.

6. In a centrifugal fan, a plurality of blades each comprising a forward side, a rear side, and a peripheral side connecting said forward side to said rear side; the junction point of said peripheral side with said forward side on each of said blades having a different shape than the corresponding point on each of the other blades and each of said points being at a different position on each of said blades relative to the fan's periphery.

TAGE G. JONN.