A. A. CRIQUI.

CENTRIFUGAL FAN.

APPLICATION FILED FEB. 20, 1914.

1,167,152. Patented Jan. 4, 1916.

2 SHEETS—SHEET 1.

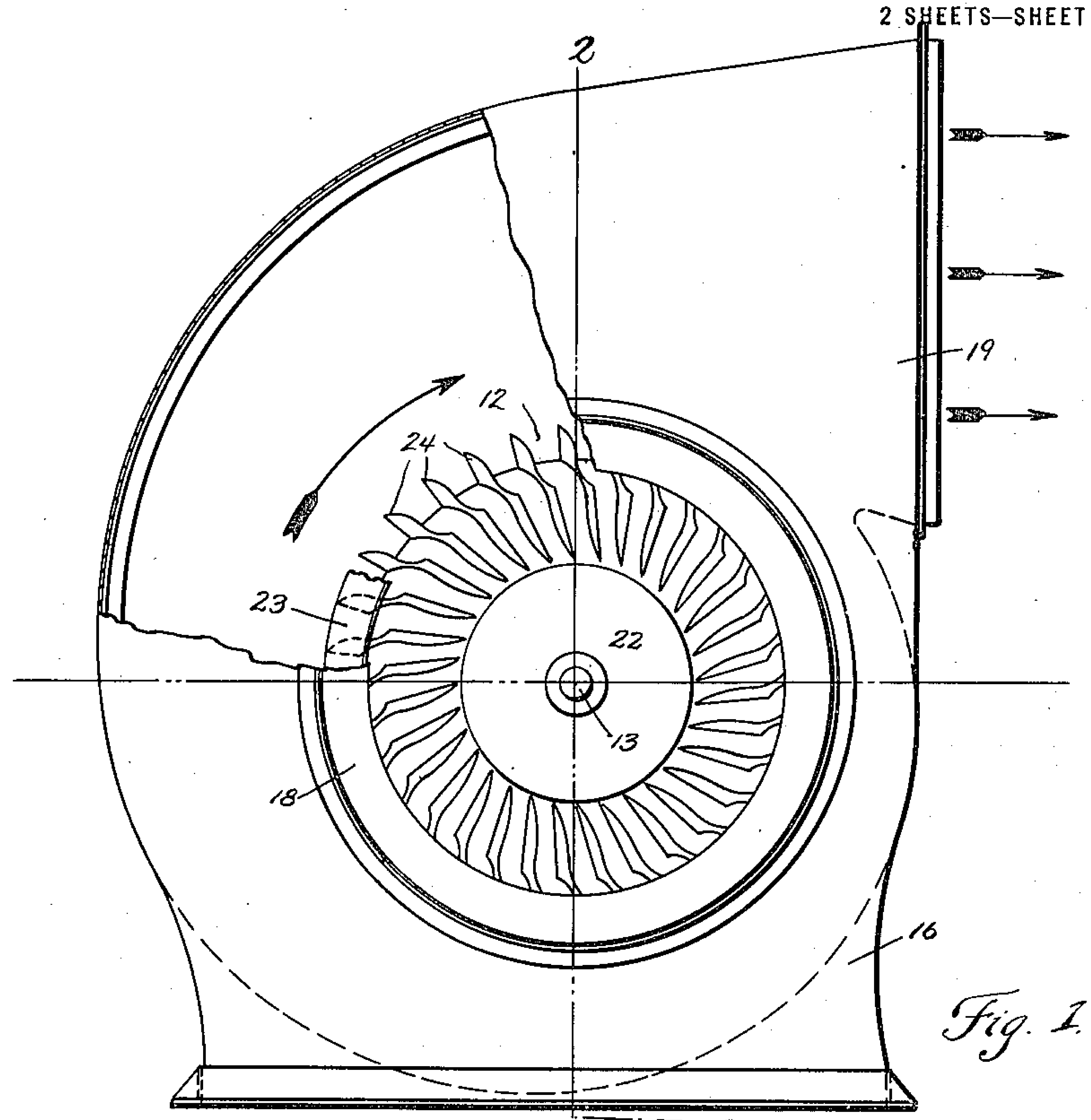

Fig. 1.

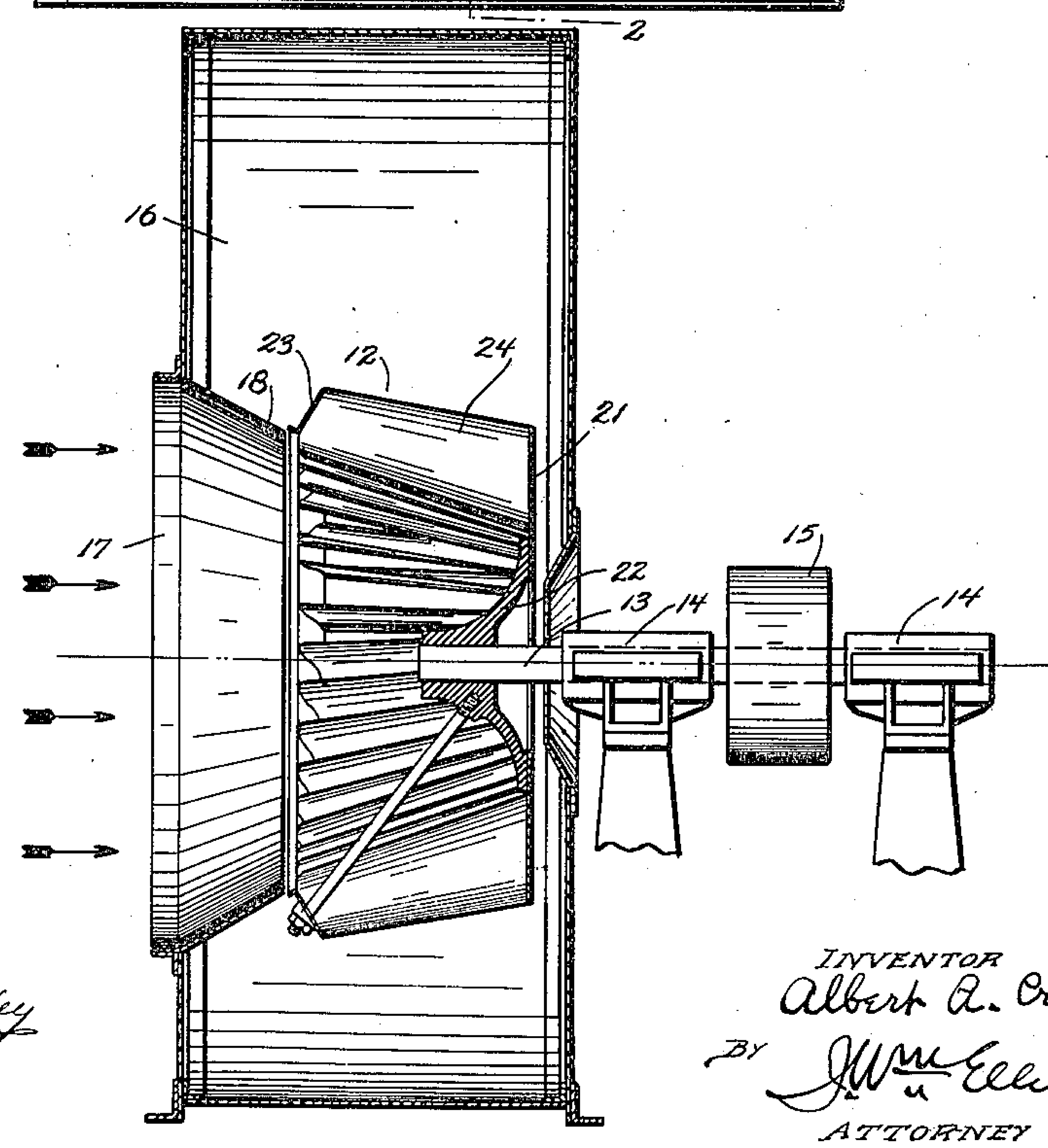

Fig. 2.

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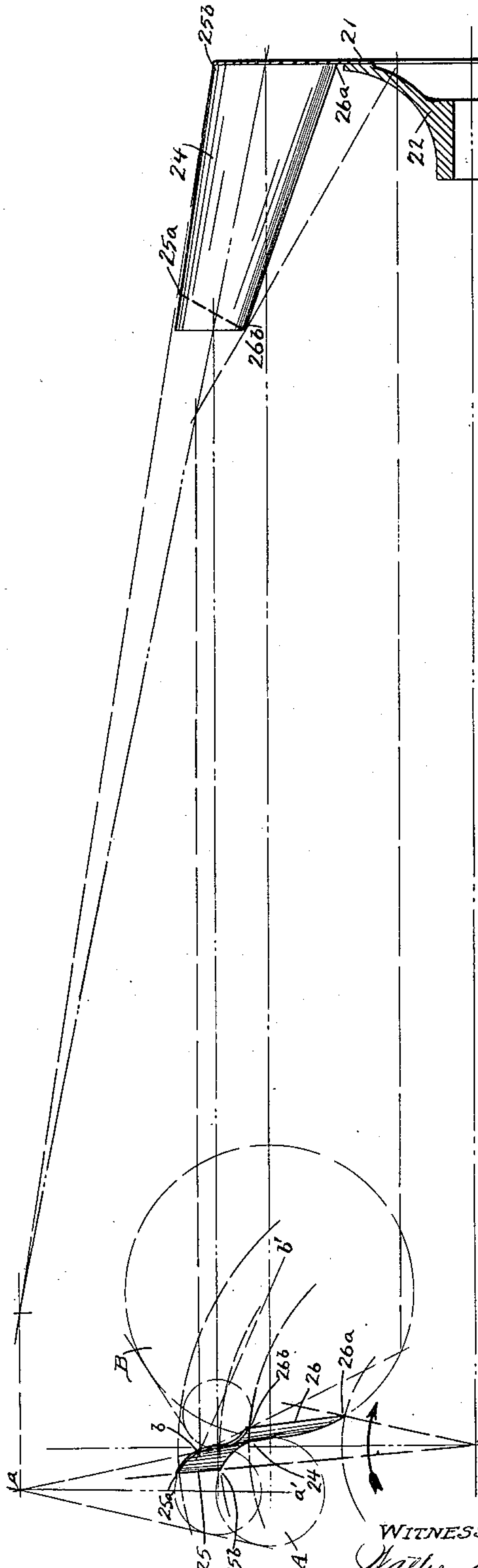

Fig. 3.

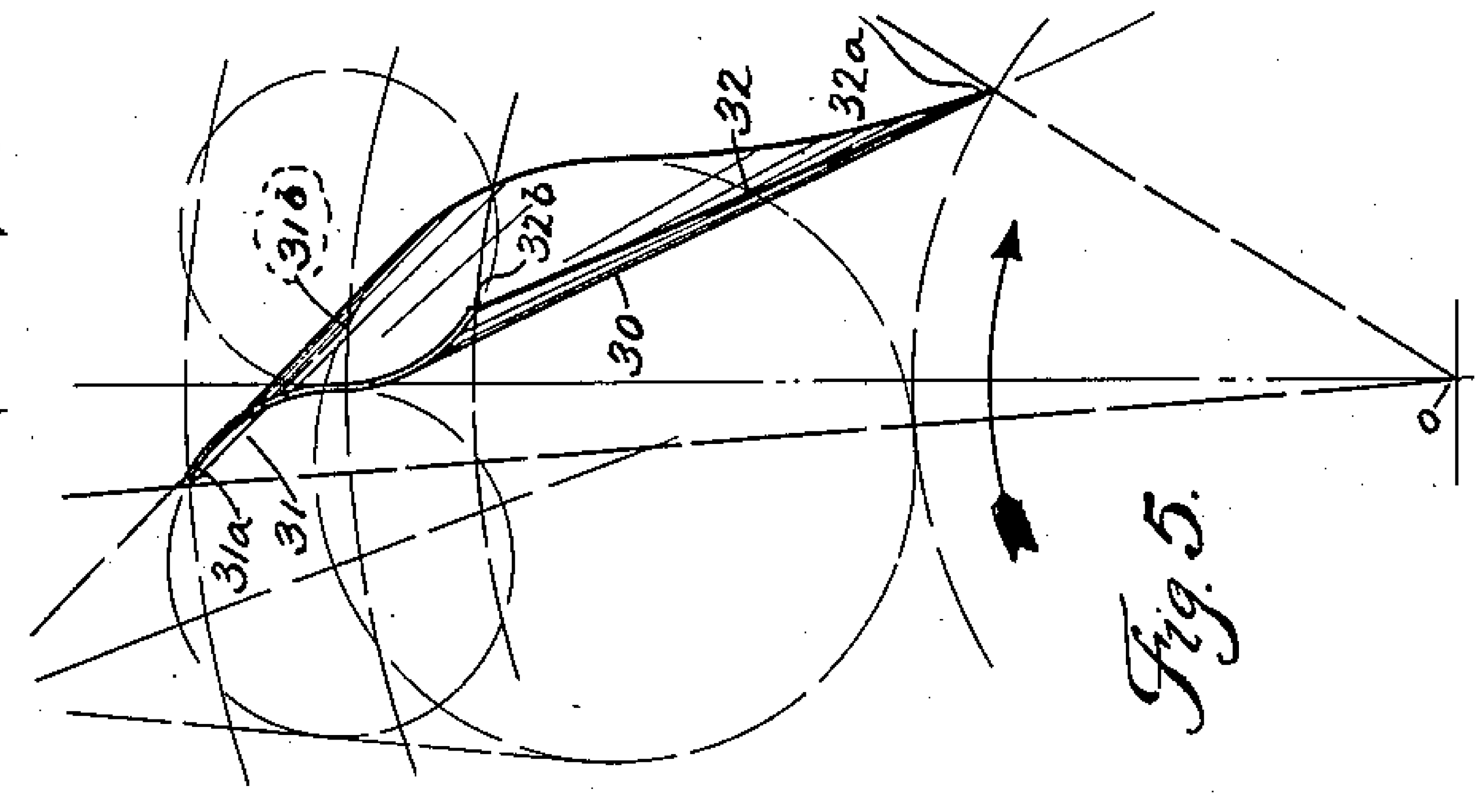

Fig. 5.

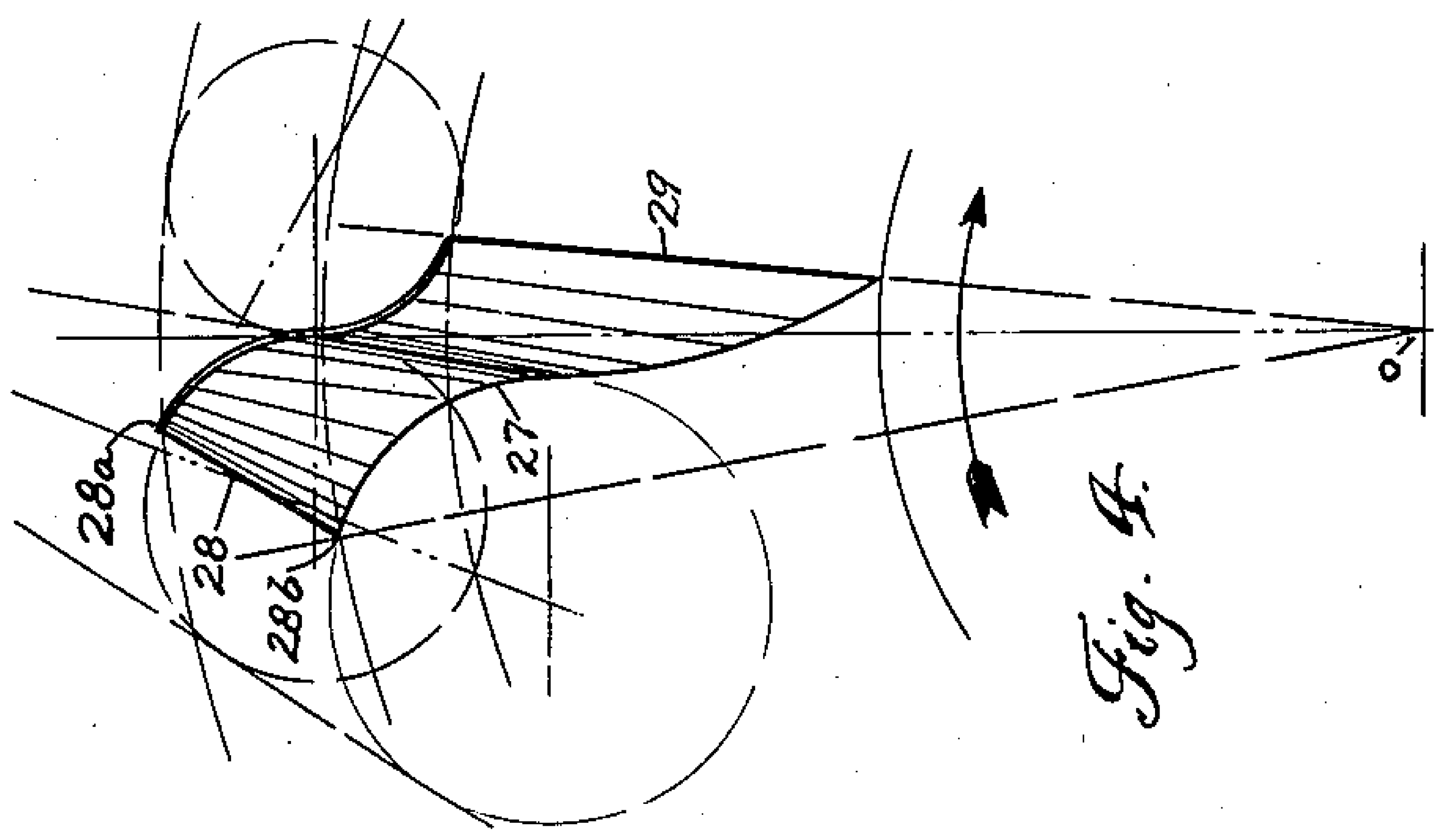

Fig. 4.

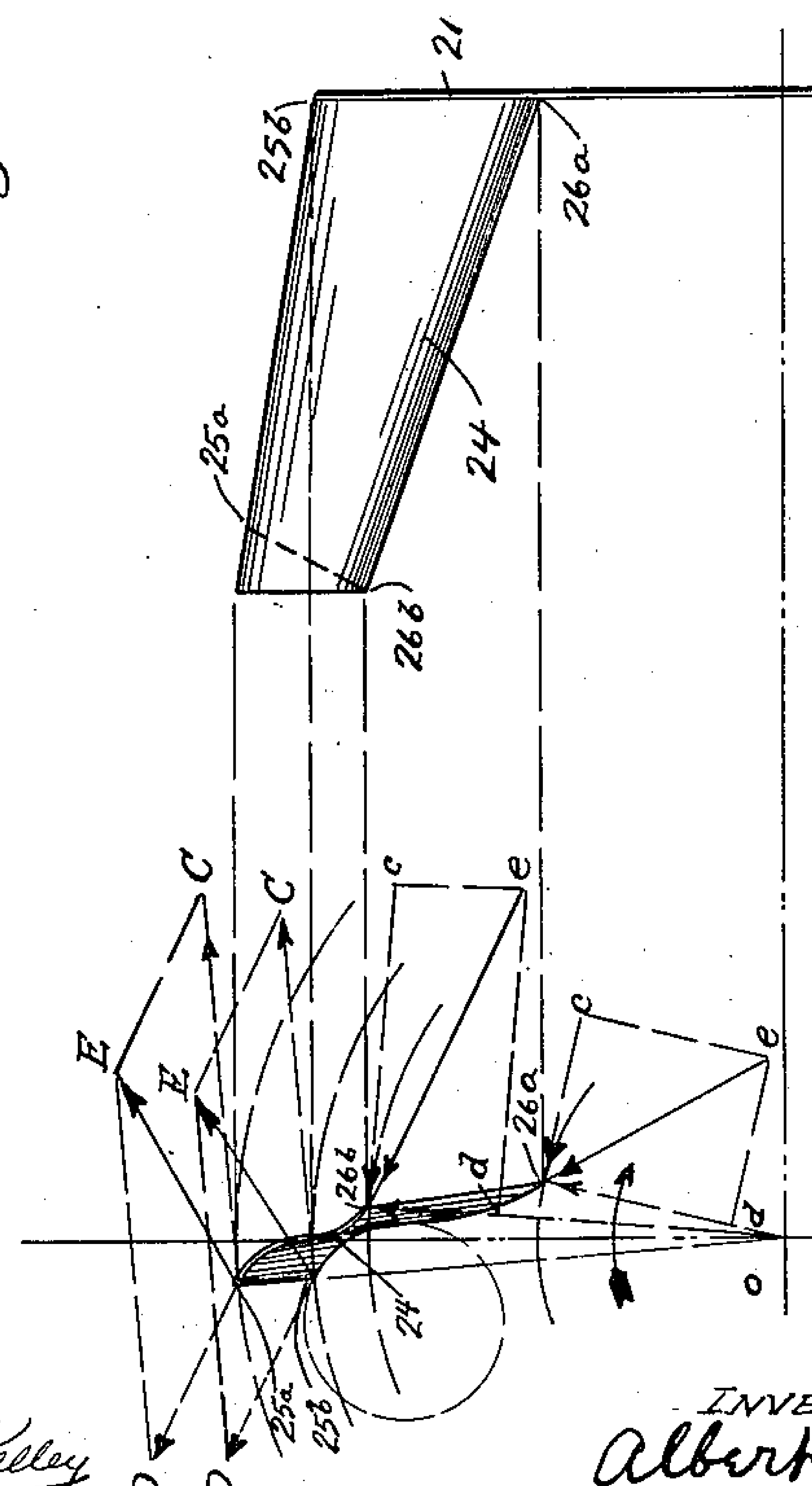

Fig. 6.

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UNITED STATES PATENT OFFICE.

ALBERT A. CRIQUI, OF BUFFALO, NEW YORK.

CENTRIFUGAL FAN.

1,167,152. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed February 20, 1914. Serial No. 819,861.

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 multiblade 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.

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

As is well known by those skilled in the art, 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 and a large frame motor is therefore required in order that the slow speed may be obtained. 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 would 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.

A snail-shaped casing is used in connection with the wheel, by means of which a portion of the velocity pressure of the air leaving the wheel is converted into static pressure. And my wheel in connection with its casing will produce a lower static pressure than a wheel having forward, curved or straight blades in connection with its casing, when both wheels are 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 discharge of 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.

Another object has been to provide a blade, the surfaces of which are developed from two cones, each having an element included in a plane tangent to both of their surfaces.

Each blade of my fan, as shown herein, has a forward curve at the heel and a backward curve at the 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 surfaced type of blade.

Throughout this description I use the term air as applied to my fan, but obviously the same may be used for gases or other fluids, and it is not intended to restrict this application to the use of air.

In my application for Letters Patent upon improvements in centrifugal fans, filed September 3, 1914, Serial No. 860,024, I have described a structure somewhat similar to that disclosed herein.

In the drawings which show the embodiment of my invention, like characters of reference indicate like parts throughout the several views, of which:

Figure 1 is a side elevation of a complete fan with a portion of the casing thereof broken away. Fig. 2 is a sectional elevation of the same and is taken on line 2—2 of Fig. 1. Fig. 3 is an end and side elevation of a complete blade and shows diagrammatically the manner in which the blade is developed. In this figure is shown a blade having its tip coplanar with the axis of the wheel and its heel non-coplanar therewith. Fig. 4 is an end elevation of a slightly modified blade where the tip of the same is non-coplanar to the axis of the wheel and the heel thereof is coplanar with said axis. Fig. 5 is an end elevation of a modified form of blade where the tip and heel are both non-coplanar with the axis of the wheel, and shows diagrammatically the manner of developing the same. Fig. 6 is an end and side elevation of a single blade, similar to that shown in Fig. 3, showing in a diagrammatical manner a means of ascertaining the comparative pressures and velocities developed at each corner of the blade.

Referring to the drawings, 12 is the wheel of my fan which is carried by a shaft 13, rotatably mounted in suitable bearings 14. For convenience of illustration, I have shown the shaft provided with a pulley 15 for driving the same, but obviously an electric motor, or any other suitable direct-connected or belted means, may be used to furnish motive power to the fan. The wheel 12 is inclosed within a snail-shaped casing 16, which is provided with an inlet opening or eye 17 adjacent to the inlet end of the wheel 12 and provided with an inlet cone 18, which directs the air from the exterior of the casing into the central opening in the wheel. The casing 16 is also provided with a tangential discharge opening 19.

The blades 24 of the wheel 12 are secured laterally at one end to a disk 21, carried by a hub 22 secured to the shaft 13. An annular band or ring 23 is disposed at the inlet end of the wheel and the outer ends of the blades are secured thereto 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 wheel, thus the discharge at the entrance end of the wheels is comparatively light. In order to overcome this disadvantage and to produce a uniform discharge of air along the entire length of the blade, I have made the wheel 12 conical in shape, as shown in Fig. 1. In this figure the wheel is larger in diameter at the entrance end than at the disk end of the wheel. The blades are also narrower at the entrance end than they are at the disk end. Owing to this difference in diameter of the wheel, the peripheral velocity of the tips of the blades will be greater at the entrance end than at the disk end of the wheel, and thus force a greater amount of air through the blades at this point which will tend to equalize the velocity of the air along the tips of the blades.

The blades of my fan are each developed from two cones, each of which has an element included in a plane tangent to both of their surfaces, and are arranged so that the concave surface of each blade is presented to the 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 the entrance end of the tip and heel precede or follow the disk end thereof, as desired to suit different conditions.

Referring now more particularly to Figs. 1, 2, 3 and 6, where the blades shown have their entrance ends farther from the axis in a radial direction than the opposite ends, each blade 24 is developed from two truncated cones A and B, (see Fig. 3) which have their surfaces in contact along a line composed of a series of points included in the circumference of each of said cones, thus having one element in common. The apex of the cone A is represented at *a* and its axis represented by line *a—a'*. The cone B has its apex at *b* and its axis represented by line *b—b'*. In these figures it will be seen that the cones are so arranged with relation to each other that when the blade is wrapped around their surfaces, a smooth forward and backward curve is produced. The tip 25 of the blade, as shown in these figures, is coplanar with the axis *o* of the wheel. The end 25^a of the tip of the blade is farther from the axis in a radial direction than the end 25^b, and the end 26^a of the heel of the blade is nearer the axis than the end 26^b and it precedes the same. In Figs. 3 and 6, the forward end of the blade, for clearness of diagrammatical illustration, is shown extended out and has its face parallel with the disk 21, it being understood that this blade is cut off at an angle, as indicated by the dotted line extending from the ends of the blade 25^a to 26^b.

Referring now to Fig. 6, where I show in a diagrammatical manner a means of ascertaining the comparative pressures and velocities at the different points of the blade, the broken line 26^{a-c} represents the lineal velocity of the end 26^a of the heel of the blade and the broken line 26^{a-d} represents the radial velocity of the air passing through the blade at end 26^a. The resultant velocity is indicated by the full line 26^{a-e}. The lineal velocity of the blade at end 26^b of the heel is indicated by broken line 26^{b-c} and the radial velocity of the air through the blade at this end is indicated by the broken line 26^{b-d}. The resultant velocity of the air at the end of 26^b of the blade is represented by the full line 26^{b-e}. The lineal velocity of the end 25^a of the tip of the blade is represented by the broken line 25^{a-C}, which line is tangent to the periphery of the wheel at the end 25^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 represented by the broken line 25^{a-D}. The resultant velocity of the air leaving the end 25^a of the tip of the blade is indicated by the full line 25^{a-E}. The lineal velocity of the air leaving the end 25^b of the tip is indicated by the tangential broken line 25^{b-C}, and the line 25^{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 25^b of the tip is indicated by the full line 25^{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 therewith. 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.

In Fig 4 is shown a blade of the same type as employed in the wheel shown in Figs. 1 and 2, but is developed from different sized cones, and in this figure the blade 27 has its tip 28 non-coplanar with the axis *o* of the wheel, the end of the tip 28^a preceding the end 28^b of the same. This blade has its heel 29 coplanar with the axis *o* of the wheel.

In Fig. 5, the blade 30 is developed from different cones than those shown in Figs. 3 or 4. In this blade, the tip 31 is non-coplanar with the axis *o* of the wheel, and has its end 31^b preceding the end 31^a. The blade in this figure also has its heel 32 non-coplanar with the axis *o* of the wheel, and its end 32^a precedes the end 32^b.

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 where two wheels are provided, each with an inlet opening. Moreover, instead of having each blade formed of two curved surfaces meeting and joining each other, they may be formed with a flat and preferably radially disposed surface lying in a plane common to both curved surfaces and disposed between and joining the same. 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 surfaces of each of said blades being made from a portion of the surfaces of two cones.

2. A centrifugal fan having a wheel provided with a plurality of blades, a portion of the surfaces of each of said blades being made from a portion of the surfaces of two cones, each of which has an element included in a plane tangent to their surfaces.

3. A centrifugal fan having a wheel provided with a plurality of blades, the surfaces of each of said blades being made from a portion of the surfaces of two cones, each of said blades having a forward and backward curve.

4. A centrifugal fan having a wheel provided with a plurality of blades, the surfaces of each of said blades being made from a portion of the surfaces of two cones, each of said blades having a forward and backward curve and the surfaces of each of said blades, which is presented to the air, being concave at its heel and convex at its tip.

5. A centrifugal fan having a wheel provided with a plurality of blades, the surfaces of each of said blades being made from a portion of the surfaces of two cones, and the tip of each blade being substantially coplanar with the axis of said wheel.

6. A centrifugal fan having a wheel provided with a plurality of blades, the surfaces of each of said blades being made from a portion of the surfaces of two cones, the tip of each blade being substantially coplanar with the axis of said wheel and the heel of each blade being non-coplanar with the axis of said wheel.

7. A centrifugal fan having a wheel provided with a plurality of blades, the surfaces of each of said blades being made from a portion of the surfaces of two cones, and the entrance end of said wheel being larger in diameter than the disk end thereof.

8. A centrifugal fan having a wheel provided with a plurality of blades, the surfaces of each of said blades being made from a portion of the surfaces of two cones, the entrance end of said wheel being larger in diameter than the disk end thereof, and the tip of each blade being so shaped that the angle formed between the line representing the lineal velocity of the tip of the blade and the line representing the tangental discharge of air from the blade increases from the entrance end of the wheel toward the disk end thereof.

9. A centrifugal fan having a wheel provided with a plurality of blades, the surfaces of each of said blades being made from conical surfaces, the edge of the blade which is nearer the axis of the wheel having a forward curve, and the edge of the blade which is farther from the axis of the wheel having a backward curve.

In testimony whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

ALBERT A. CRIQUI.

Witnesses:

J. WM. ELLIS,

WALTER H. KELLEY.