No. 662,396. Patented Nov. 27, 1900.

S. C. DAVIDSON.

CENTRIFUGAL FAN OR PUMP.

(Application filed Dec. 15, 1899.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 2.

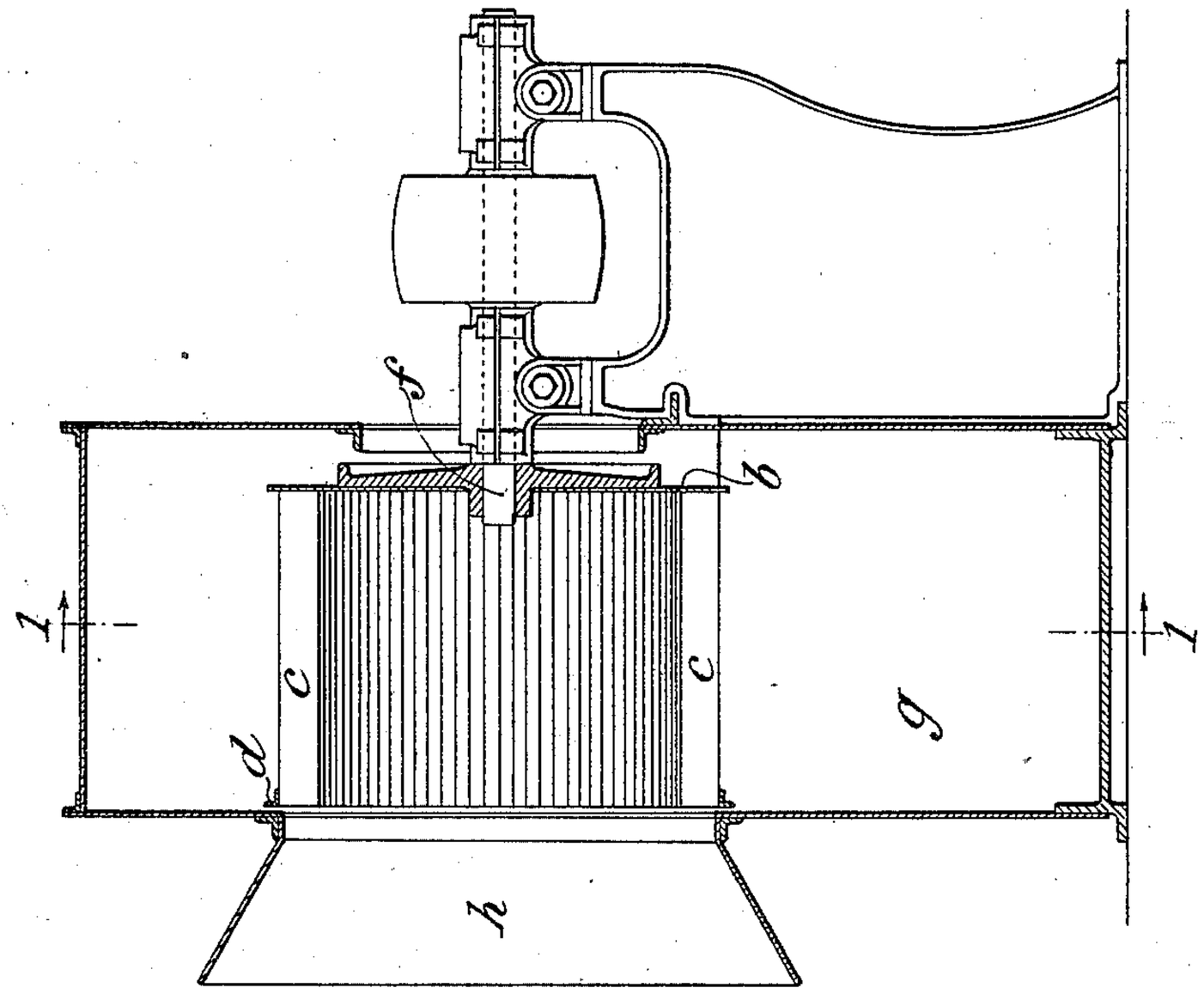
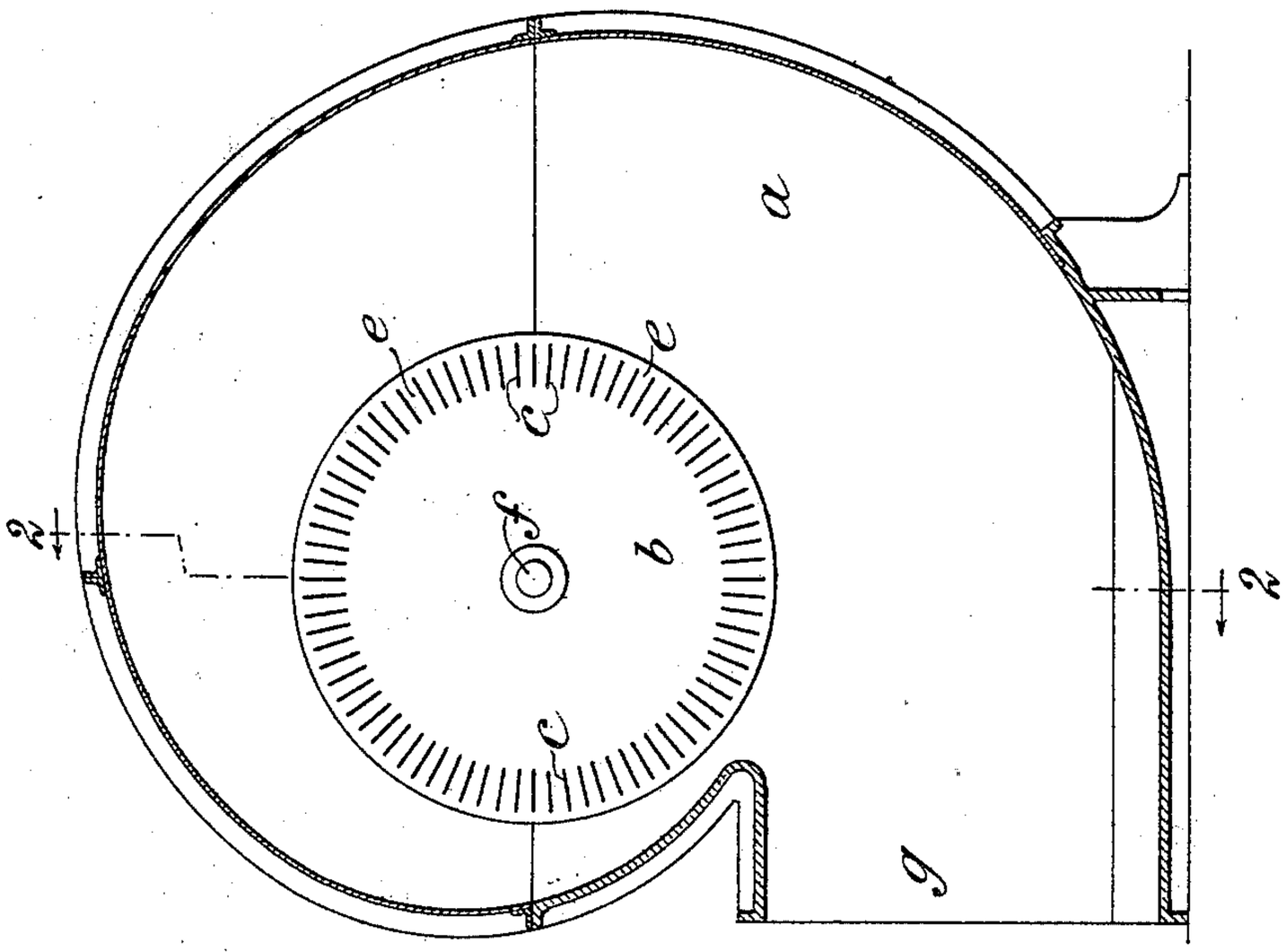


FIG. 1.



WITNESSES:
Fred White
Thomas F. Wallace

INVENTOR:
Samuel Cleland Davidson,
By Attorneys,
Dewey C. Fraser & Co

No. 662,396. Patented Nov. 27, 1900.

S. C. DAVIDSON.

CENTRIFUGAL FAN OR PUMP.

(Application filed Dec. 15, 1899.)

(No Model.) 2 Sheets—Sheet 2.

FIG. 5.

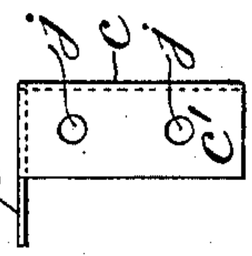


FIG. 4.

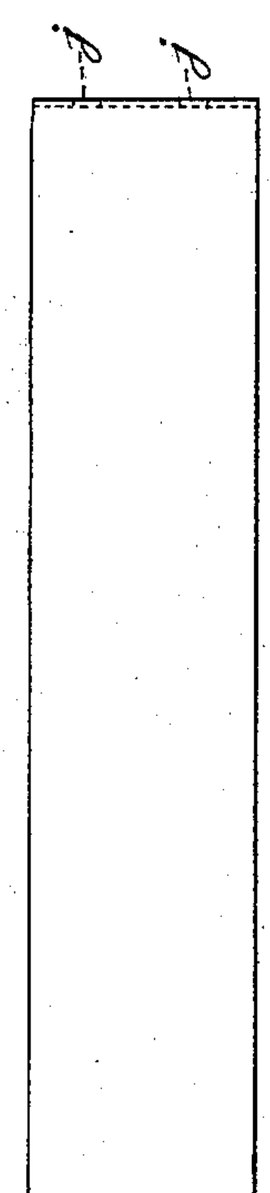


FIG. 6.

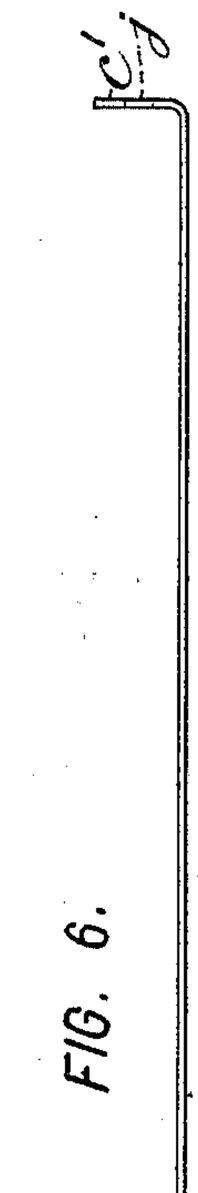


FIG. 7.

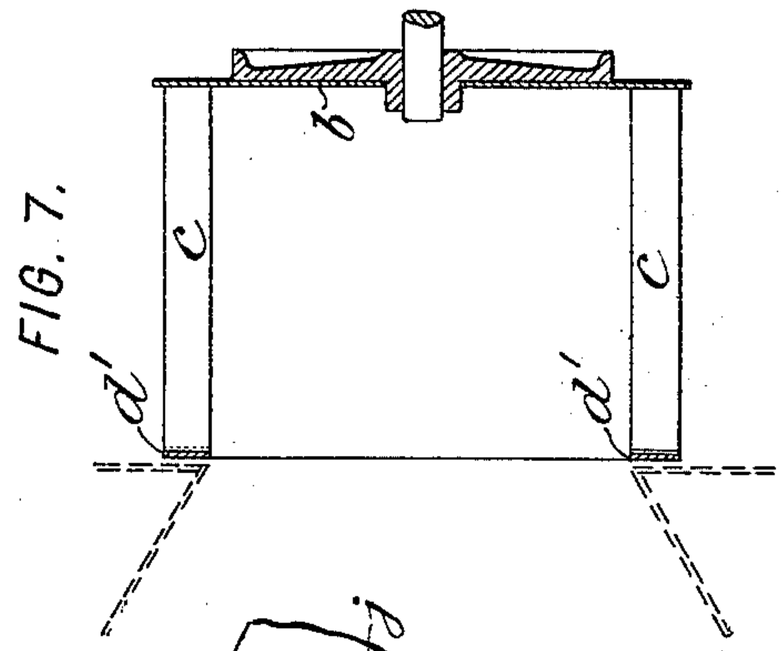
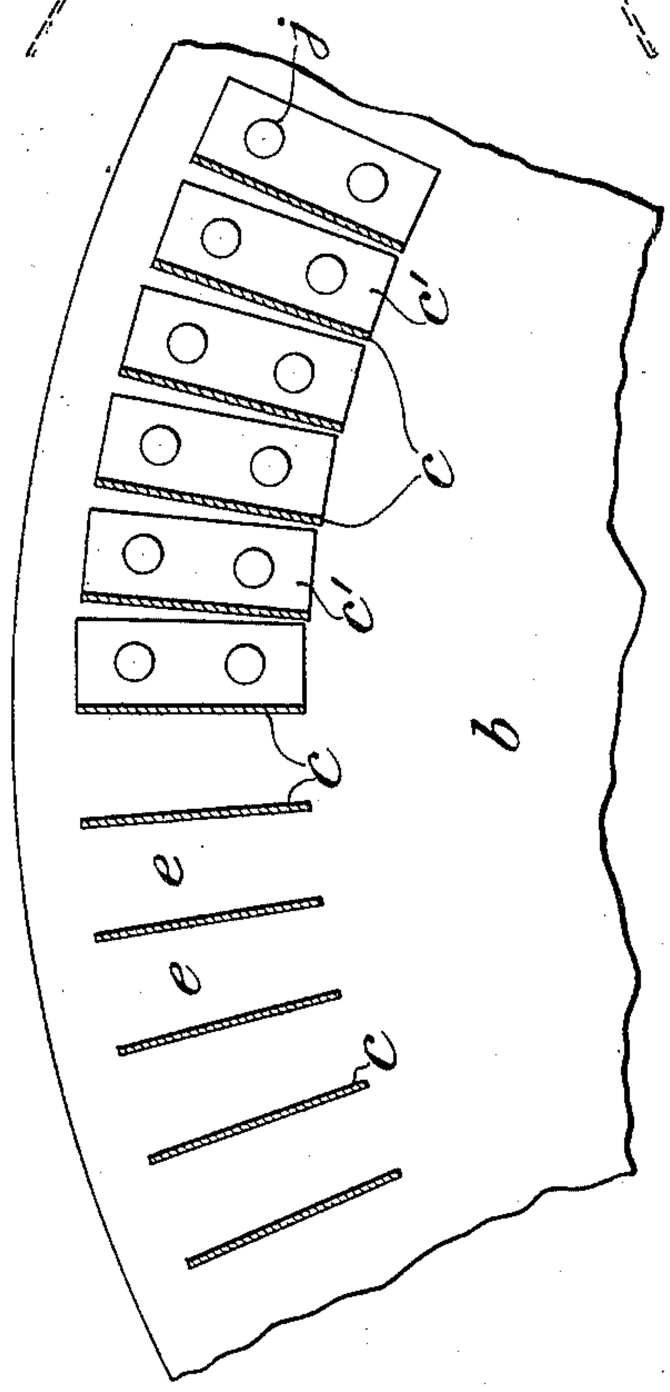


FIG. 3.



WITNESSES:
Fred White
Thomas F. Wallace

INVENTOR:
Samuel Cleland Davidson,

By Attorneys,
Arthur G. Draper & Co

UNITED STATES PATENT OFFICE.

SAMUEL CLELAND DAVIDSON, OF BELFAST, IRELAND.

CENTRIFUGAL FAN OR PUMP.

SPECIFICATION forming part of Letters Patent No. 662,396, dated November 27, 1900.

Original application filed September 21, 1898, Serial No. 691,495. Divided and this application filed December 15, 1899. Serial No. 740,399. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL CLELAND DAVIDSON, a subject of the Queen of Great Britain, residing in Belfast, Ireland, have invented certain new and useful Improvements in Centrifugal Fans or Pumps, of which the following is a specification.

This application is a division of my application filed September 21, 1898, Serial No. 691,495, and is filed for the purpose of protecting a modification of the invention shown in said application, but which cannot be specifically claimed therein.

This invention has reference to rotary fans or pumps in which the fluid operated on is taken in axially and discharged circumferentially; and it relates to centrifugal fans or pumps in which the blades carry the fluid with them in their rotation, and thereby throw it outward by centrifugal force, as distinguished from propeller fans or pumps in which the blades act upon the fluid with a wedging action, pushing it from them without materially rotating it.

An object of the present invention is to provide a fan which may be rotated in either direction with substantially the same efficiency.

In this specification the word "fan" is understood as including a pump. The word "axially" means in a direction coincident with or parallel with the axis of rotation. The word "blades" is used to indicate the vanes or wings which impart motion to the fluid. The expression "intake-chamber" is employed to indicate a chamber or space inclosed within the series of blades. The word "eye" is used to designate the inlet-opening in the casing or stationary member of the fan, through which opening the fluid enters the intake-chamber. By the "intake" end of the blades or ports is understood that end which is nearest the eye. The "depth" of the blades is their width measured radially from the inner to the outer edge, the "length" of the blades is their axial measurement, and the "ports" are the intervening spaces between the blades.

According to the invention set forth in my said application the rotary member of the fan is constructed with numerous thin elongated blades arranged in substantially drum form, being extended in approximately axial direction, so as to inclose within them a relatively large and practically-unobstructed intake-chamber, and said blades in transverse section being arranged relatively to the axis and direction of rotation to carry the fluid with them rotatively and discharge it tangentially, and said rotary member is so mounted as to permit the tangential escape of the fluid discharged from its blades. My present invention is directed to a fan of this character in which the blades are flat, or substantially so, and extend in substantially radial planes, so that the fan may be revolved in either direction.

The blades are best made of sheet metal and are elongated—that is to say, their length approximates at the least three times their depth, and being preferably as much as nine or more times their depth, it being preferable to make them as narrow or shallow as practicable consistent with strength of construction. Preferably their inner and outer edges are substantially parallel to each other. The blades must be so shaped relatively to the axis and direction of rotation as to carry the fluid with them in their rotation in order to throw it outward by centrifugal force, whereby it is discharged tangentially. To this end in the present invention the blades are preferably flat or formed with a substantially plane surface and are arranged in radial planes.

The blades are so numerous as to follow each other in close succession, being spaced apart, preferably, a distance approximating two-thirds of their radial depth, or it may be as much as twice the full depth of the blades.

The drum-like arrangement of the blades is such as to inclose within them an intake-chamber, which preferably is approximately cylindrical, and which is of large dimensions as compared with fans heretofore existing—that is to say, its diameter approximates at the least to four times the radial depth of the individual blades and in the preferred proportions is five-sixths of the external diameter of the series of blades, and its length or axial dimension approximates at least three

times the depth of the individual blades and in the preferred proportions is approximately nine times such depth.

The drum-like series of blades is supported in any suitable manner upon a shaft or spindle revolving in suitable bearings. A convenient supporting means consists of a disk mounted on the spindle, to which disk the blades are attached at their ends remote from the intake ends. A ring or annular support is preferably provided for the opposite or intake ends of the blades.

The rotary member of the fan is suitably mounted to permit the tangential escape of the fluid discharged from its blades. If not incased, this fluid can freely escape from it in all directions. If inclosed in a casing, the latter must be so constructed as to permit the tangential escape of the fluid—as, for example, by forming the casing of the usual snail shape with a tangential outlet beyond the periphery of the rotary member.

In the operation of my new fan the fluid flows in axial direction into the intake-chamber, in which it expands without perceptibly revolving until it is caught by the blades and drawn into the ports between them, whereby the fluid in these ports is converted into a whirling shell of fluid, whereby it is thrown outward by centrifugal force and discharges from the outer sides of the ports as a whirling and expanding shell of fluid, the individual particles of which move in tangential direction. The blades are so narrow and so close together that no eddy-currents are caused in the ports between them, thus avoiding the loss of efficiency and the whirring or beating noise accompanying the operation of centrifugal fans as heretofore made.

In my preferred construction the intake ends of the blades are open to the inflowing fluid, so that the fluid may flow axially into the intake ends of the ports. In this case I make the eye or intake-opening in the casing leading to the fan of a diameter equal, or approximately so, to the full outer diameter of the drum-shaped series of blades, whereby the volume of fluid which will be propelled through the fan for a given diameter and speed of revolution is proportionately increased without loss of velocity in the flow of the fluid.

My improved fans or pumps when constructed as herein described may be employed with any fluids, either gaseous or liquids—as, for instance, with air or water.

Referring to the drawings illustrating my present invention, Figure 1 is a vertical section of the fan and casing cut on the line 1 1 in Fig. 2. Fig. 2 is a sectional elevation cut on the line 2 2 in Fig. 1. Fig. 3 is an enlarged fragmentary view of the supporting-disk, showing the preferred method of attaching the blades to the disk. Figs. 4, 5, and 6 are respectively enlarged side, end, and top views of a blade detached; and Fig. 7 is a modification in which the ports between the blades are closed.

Referring to the drawings, *a* designates a casing in which the rotary member of the fan is inclosed. It has an eye *h*, Fig. 2, through which the supply of fluid is drawn and is shown with a discharging-mouthpiece *g*.

The rotary member comprises blades *c c*, suitably supported upon a revolving shaft or spindle *f*. The support shown comprises a disk *b*, to which the blades are attached at one end, and an annular support for the opposite or intake ends of the blades. In Figs. 1 and 2 this support is formed by a ring *d*, to which the intake ends are riveted. The blades *c c* have at one end flanges *c'*, by which they are attached to the disk *b*, *j j* being holes in said flanges to give passage to the rivets or attaching devices, as shown in Figs. 3 to 6. In Fig. 3 at the left hand of the figure the blades are shown in section, while at the right hand the flanges *c'* are indicated to show the manner of attaching them to the disk. The intake ends of the blades may be flat, as shown in Figs. 2 and 4 and in dotted lines in Fig. 6, or if the fan is to be revolved in only one direction the ends may be curved forward, as shown in full lines in Fig. 6 at *l*. In either case flanges c^2 are preferably formed on the intake ends, by which the blades are fixed to the support *d* by riveting or otherwise. The ports or intervening spaces between the blades are lettered *e e*.

In proportioning the parts I make the length of the blades such that the aggregate open area of the ports around the periphery of the fan shall be about equal to the area of the intake-opening when the maximum volume of intake and discharge is required; but the length of the blades may be reduced to suit any special requirements.

The preferred proportions of my fan are shown in Figs. 1 and 2, where the radial depth of the blades is one-twelfth of the diameter of the fan and the length of the blades slightly exceeds nine times their depth. This construction affords a large intake-chamber of approximately cylindrical form, the diameter of which is ten times the depth of the individual blades, while its length, equaling that of the blades, is about nine times this dimension.

The provision of a relatively large intake-chamber in connection with shallow blades following each other at frequent intervals is a distinctive feature of my invention. In fans as ordinarily constructed employing blades of great radial measurement supplementary vibrations and eddies are set up, which reduce the efficiency of the fan. In those fans also in which the blades are extended inwardly to or near the axis the best efficiency is not obtained. I have discovered that by providing a relatively large intake-chamber practically unobstructed by the projection into it of blades or other parts and by

employing blades which extend as short a distance from the periphery of the rotary fan inward as is consistent with strength of construction the said supplementary vibrations and eddies are minimized and the velocity and volume of fluid discharged for a given speed of revolution are greatly increased.

It has hitherto been considered impossible to get pressure or partial exhaust with centrifugal fans unless the blades are inclosed on the sides and the eye or intake-opening is of not greater diameter than about one-half the diameter of the rotary fan. With my present invention, however, the eye may be of equal diameter to that of the fan-periphery. This is clearly shown in Fig. 2. This is made possible by making the intake ends of the blades open or unobstructed, so as to form open-ended ports between them. To support and strengthen the intake ends of the blades I prefer (when the fan is to revolve in only one direction) to make them laterally curved or concavo-convex, as shown at *l* in Fig. 6.

When greater strength of construction is required, as when the fan or pump has to be driven at a very high velocity or when it has to be employed for pumping a heavy medium, as a liquid, the intake ends of the blades may be closed in the manner shown in Fig. 7. In this figure the ends of the ports are closed by a flat ring *d'*, which is fixed to suitable flanges formed on the ends of the blades.

A fan of the construction herein described has the important advantage that it may be rotated in either direction with substantially the same efficiency. Hence it may be used in connection with a casing in which the delivery-outlet leads in either right or left hand direction.

The blades are shown as flat; but it is to be understood that slight deviations may be allowed, so long as the blades occupy substantially radial planes.

In the construction shown and described the fan is within a casing. It will, however, be readily understood that a casing is not necessary in all instances—as, for instance, when the inflowing fluid is led to the eye of the fan by a pipe or when the fan projects through an orifice in a wall, so as to revolve, say, outside a house, with the eye of the fan facing the bearings in which the spindle revolves. The fan when driven would then draw the air through that orifice and discharge it freely all around into the open air.

It is essential to my invention that the fan-blades shall be adapted to carry the fluid with them rotatively, so that it shall be thrown outward by centrifugal force and be discharged tangentially, in contradistinction to merely exerting a wedge-like action upon the fluid, tending to thrust it outward in radial direction, unaccompanied by rotation or whirling of the fluid. In a true centrifugal fan it is almost solely the rear surface of the blade which acts upon the fluid, drawing it around by suction, whereas in blades which thrust the fluid outward by a wedge-like action it is the front or advancing side of the blade which is the active face. Blades of the latter kind require to be inclined or curved rearwardly to a considerable angle, so that the outer edge follows behind the middle or major portion of the blade.

The operation of my fan when propelling air is accompanied by the existence of a thin shell or film of rapidly-whirling air immediately surrounding the drum-like series of blades, which air is apparently compressed, and outside of this shell the air discharging from the fan escapes tangentially. Whether the fan is provided with a casing or not the construction must be such as to permit the whirling fluid discharged from the blades to escape tangentially therefrom in outward direction.

To realize the full advantages of my invention, it is practically essential that the inflow of fluid to the intake-chamber be unobstructed and that the inlet-opening be of the full diameter of said chamber, as any throttling of this opening results in a proportionate diminution of volumetric efficiency. It is also practically essential that the whirling fluid discharged from the fan-blades shall be permitted to escape tangentially outward therefrom, as any attempt to divert the revolving fluid inwardly results in a rapid diminution of efficiency; but the whirling fluid can be collected in a casing, and if the outlet from this casing be arranged beyond the radius of the circle described by the outer edges of the blades the fluid will freely escape through said outlet, its whirling motion being thereby resolved into a direct motion, after which it can be led through a suitable conduit in any desired direction.

The fan provided by my present invention is distinguished from that shown in Fig. 7 of my United States Patent No. 544,758, wherein the blades are triangular and project into the central hub, that in my present form the blades are extended approximately parallel to the axis of rotation, being arranged in drum form, so as to inclose within them an approximately cylindrical intake-chamber which is practically unobstructed by blades or other parts.

It will be understood that many of the distinguishing features and advantages herein referred to are equally true of all the forms or modifications of fans shown and described in my main application, Serial No. 691,495, of which my present application is a division and to which it is subordinate. In my present application I make no claim to any of the generic features of my main invention, as such are fully claimed in my aforesaid application. Nor do I in this application make any specific claim to the mounting of the rotary member of the fan without any inclosing casing, so as to permit free tangential discharge from the rotary blades in all directions, as this specific feature is made the subject of another divi-