No. 801,303. PATENTED OCT. 10, 1905.

S. C. DAVIDSON.

CENTRIFUGAL FAN OR PUMP.

APPLICATION FILED APR. 25, 1904.

2 SHEETS—SHEET 1.

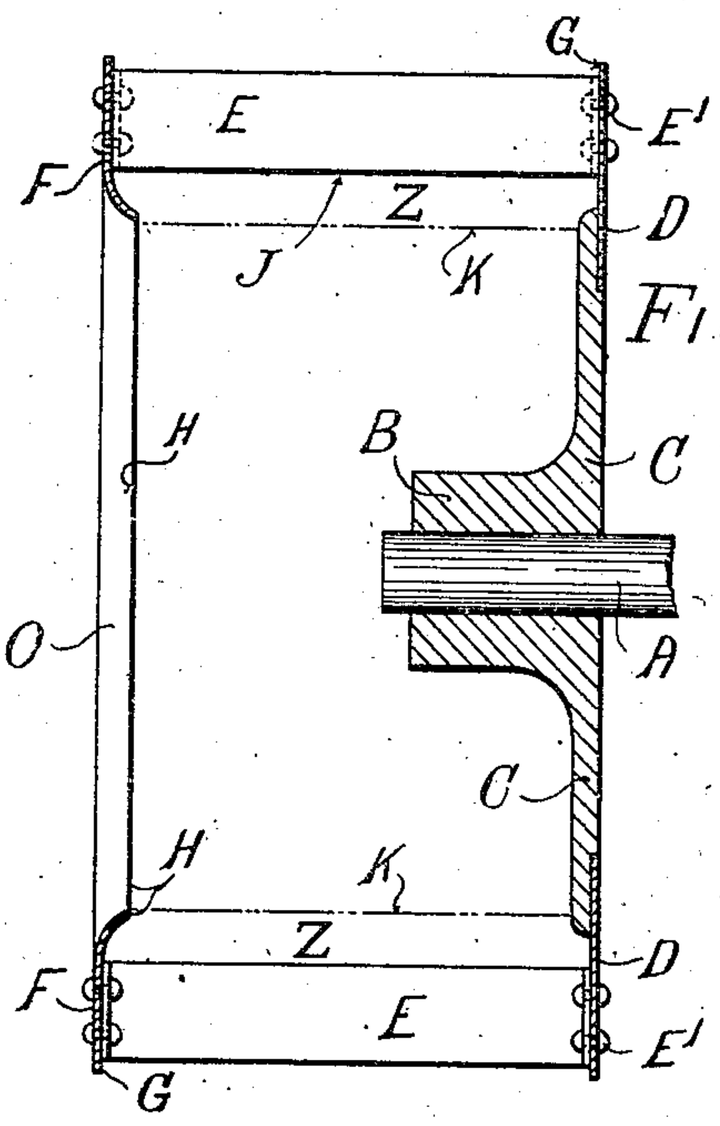

FIG. 1.

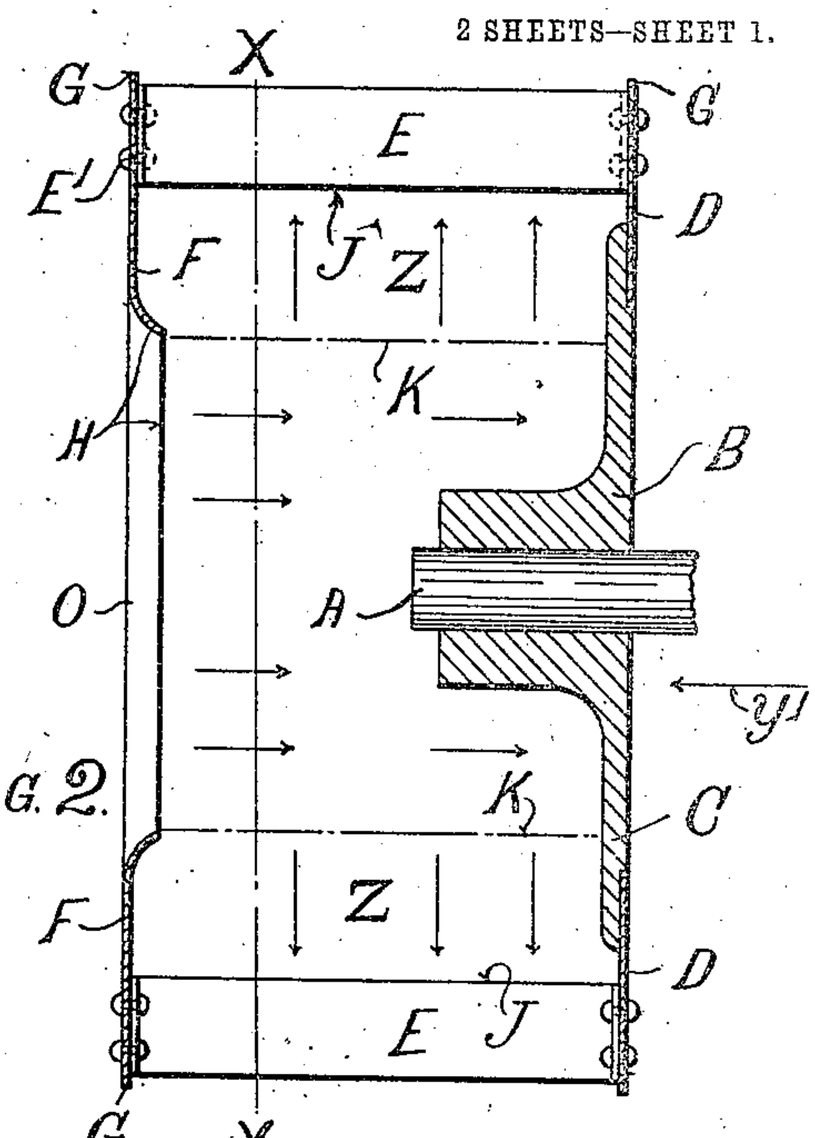

FIG. 2.

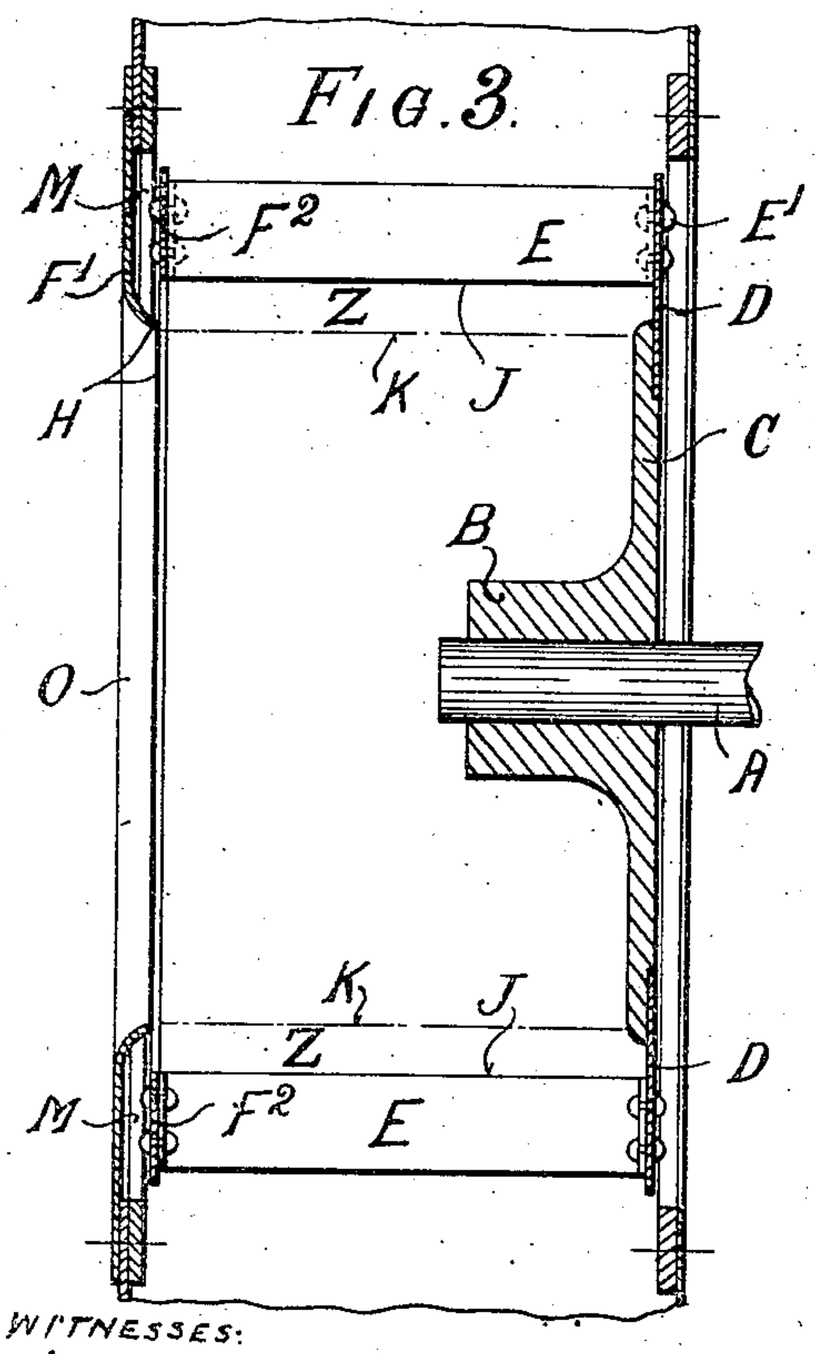

FIG. 3.

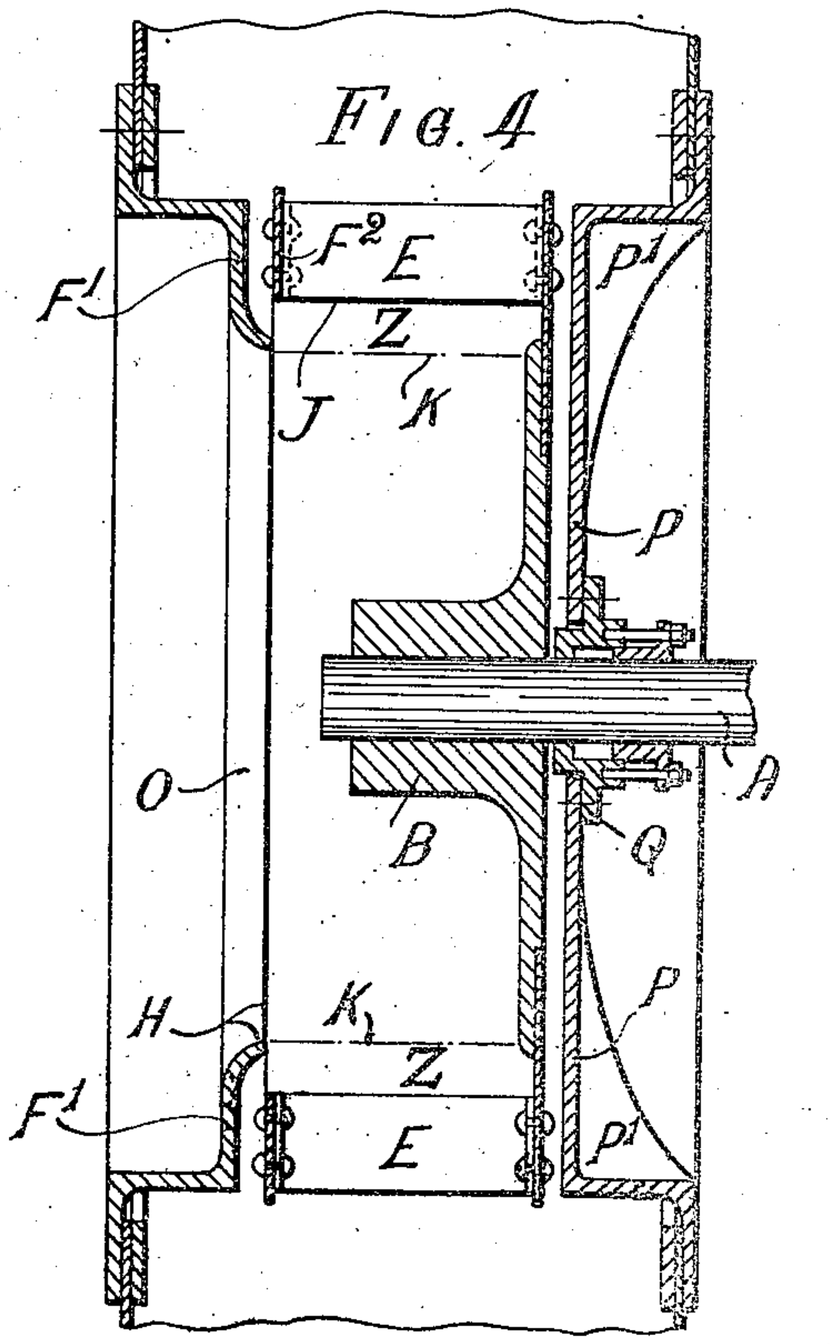

FIG. 4.

WITNESSES:
Fred White
René Bruine

INVENTOR:
Samuel Cleland Davidson.
By his Attorneys
Arthur C. Fraser & Co

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2 SHEETS—SHEET 2.

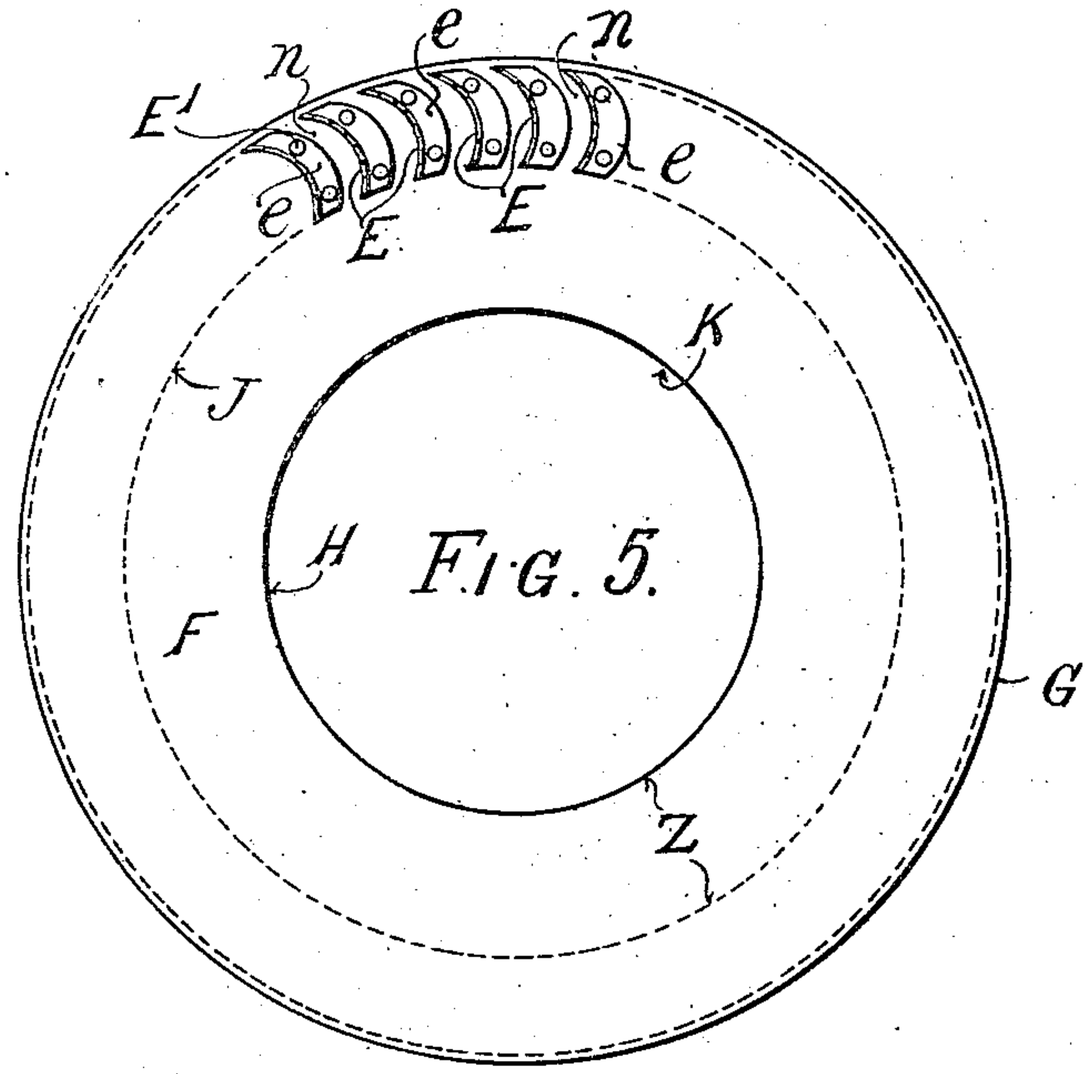

FIG. 5.

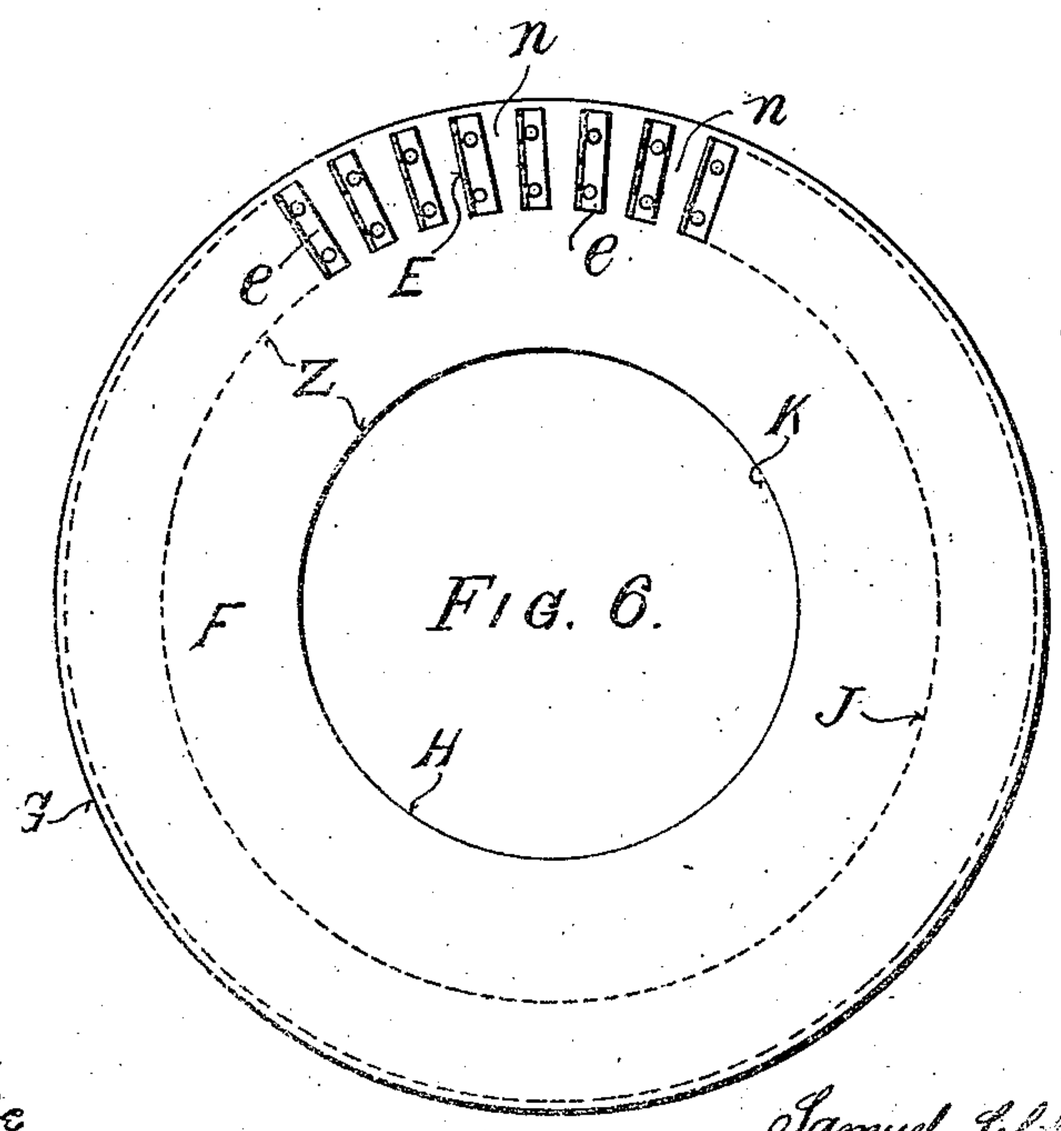

FIG. 6.

WITNESSES:
Fred Whitty
René Bluine

INVENTOR:
Samuel Cleland Davidson,
By his Attorneys
Arthur G. Fraser & Co.

UNITED STATES PATENT OFFICE.

SAMUEL CLELAND DAVIDSON, OF BELFAST, IRELAND.

CENTRIFUGAL FAN OR PUMP.

No. 801,303. Specification of Letters Patent. Patented Oct. 10, 1905.

Application filed April 25, 1904. Serial No. 204,922.

To all whom it may concern:

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

My improvements refer more particularly to the type of centrifugal fans or pumps (hereinafter referred to as "fans") described in the specification of previous Letters Patent granted to me and dated November 27, 1900, No. 662,395, hereinafter referred to as my previous specification.

Now the object of my present invention is to improve the working efficiency of fans of this or similar types, especially for certain duties.

According to this invention the blades of the fan-wheel have within their circular path an unobstructed chamber, and a cover-plate is fitted upon or closely adjacent to the intake ends of the blades, so as to leave an inlet-opening or eye of smaller diameter than that of the circle described by the inner edges of the blades, whereby there is formed a cylindrical zone or space, (hereinafter referred to as the "cylindrical zone space,") which is bounded exteriorly by the inner margins of the blades and laterally upon the side toward the eye by said cover-plate and which cylindrical zone space is free of obstruction from the inner margins of the blades to the circumference of the inlet or eye of said plate, so that the fluid can only enter the center of the fan-wheel axially through said eye and thence radiate outwardly through said cylindrical zone space to the blades.

Reference to the accompanying drawings will more fully explain the nature of my invention and how the same is carried into effect.

In the drawings, Figure 1 is a vertical section of a fan-wheel made in accordance with the invention. Figs. 2, 3, and 4 are similar views to Fig. 1, showing three modified constructions. Fig. 5 is a section of the improved fan-wheel in the plane of revolution on line *x y* of Fig. 2 looking in the direction of the arrow *y'*. Fig. 6 is a similar view to Fig. 5, showing a fan with a different form of blade.

Referring now to Fig. 1, A is the fan-shaft; B, the hub of the fan-wheel, mounted on shaft A. C is a circular disk-like extension of the hub B. E represents vanes or blades riveted at the ends E' to a disk D, which is fastened to the disk-like extension C. F is a cover-plate in the form of an annulus riveted or otherwise fastened to the intake ends of the blades E. G is the outer circumference of the annulus F and corresponds with that of the disk D. H indicates the inner edge of the annulus F and the circumference of the eye or intake-opening O of the fan. J indicates the circle described by the inner edges of the fan-blades E and the outer circumference of a cylindrical zone space Z. K is a dotted line indicating the interior circumference of the cylindrical zone space Z. In Fig. 1 the radial depth of said cylindrical zone space Z, bounded by the circle J and K, is shown relatively shallow as compared with the diameter of the central intake-opening O in the annulus F. This construction is adapted for a large volumetric output (relatively to the diameter of the fan) against low resistances either of back pressure or suction.

In Fig. 2, where similar letters of reference are used, the diameter of the central eye or intake-opening O in the annulus F is shown relatively less than in Fig. 1, whereby the radial depth of the cylindrical zone space is greater than in Fig. 1. This construction is adapted for smaller volumetric output against high resistances of back pressure or suction.

In Fig. 3, where similar letters of reference are employed, with the exception of those relating to the annulus, a construction is shown which is adapted for similar duties to those provided for in Fig. 1, it being, however, modified, in that a fixed or non-rotating annulus F' is employed to laterally inclose at the intake end of the fan-wheel the cylindrical zone space Z. This fixed annulus is mounted upon the fan-casing as close as possible to the intake ends of the blades E, which in this form are shown as connected by an annular plate F², riveted to the blades E, the inner edge of which annular plate corresponds in diameter with the circle described by the inner edges of the blades. The clearance-space M between the rotating annulus F² and the fixed annulus F' is preferably made as small as possible consistent with free rotation when the fan is running at high speeds. This construction, however, involves a slight loss of mechanical strength and rigidity at the intake ends of the blades for very high speeds of revolution as compared with the construction shown in Figs. 1 and 2.

In Fig. 4 a further modified construction is shown, wherein P is a cast-metal circular

plate inclosing on the outer side of the fan-wheel hub B and disk D the opening in the fan-casing around the fan-shaft A. P′ represents radial fins extending from the circumference of the metal plate P inward to stiffen the central part thereof around the shaft. Q is a gas or water tight gland mounted at the center of the circular plate P and fitted around the shaft A to prevent leakage of fluid into or out of the fan-casing on the side opposite the inlet O. This figure shows the annulus F, which for high speeds of rotation is of similar construction to that shown in Fig. 1, in combination with a fixed annulus F′, which is shaped to correspond with the outer circumference of the cast-metal plate P on the opposite side of the casing, whereby both ends of the fan-wheel blades are the same distance from the sides of the fan-casing. Apart from the special construction of plate P and adjacent parts the reference-letters are the same as in Fig. 3. This construction of fan is adapted for dealing with gas or acting as a centrifugal pump.

In the construction of the fan-blades shown in the drawings both ends of the same are made exactly alike, with flanges formed thereon at right angles to the axis of the blades in the same manner as described in my previous specification for those ends which are riveted to the fan-wheel disk, and to the opposite ends of the blades which project from the fan-wheel disk I apply and rivet thereon the annulus F, which is cut, preferably, out of a flat metal sheet, the outer circumference G of which annulus F is of equal or rather larger diameter than that of the circumference of the circle described by the outer edges of the fan-blades and the inner circumference of either equal or less diameter than that of the circle described by the inner edges of the fan-blades, according to whether the said annulus forms the means for inclosing the cylindrical zone space or whether an adjacent cover-plate is employed for this purpose. When the inner circumference of the annulus F is of less diameter than the circle in which the inner edges of the blades revolve, the said inner edge is preferably curved or dished inward toward the fan-wheel disk, as shown at H in Figs. 1, 2, and 4 of the drawings, whereby the stiffness and strength of said annulus is greatly enhanced, and a rounded-over edge is presented to the fluid entering the center of the flange; which minimizes the *vena contracta* effects in regard to the inflow of said fluid, and for same reasons the fixed annulus F′ is preferably made with its inner edge rounded over, as shown in Figs. 3 and 4. I preferably make the rivet-holes in said annulus F which connects the intake end of the blades to exactly correspond with those in the fan-wheel disk D to which the other ends of the blades are riveted, and when said blades are accurately flanged to length and the rivet-holes accurately located therein the riveting of said annulus upon the intake ends of the blades insures the intake end of the fan-wheel revolving in a perfectly true running circle relatively to the plane of revolution of the fan-wheel disk and to the axis of the fan, and the rigidity of the whole fan-wheel when thus constructed is such that it will stand being driven at the highest speeds employed in practice without deviation from true rotation.

Figs. 5 and 6 show the boundaries of the cylindrical zone space in front elevation and also show the preferred proportion of blades E E. wherein the passage-way *n* between said blades is substantially greater in radial measurement than the widest space between the blades measured circumferentially. The cross-sectional shape of the blades of the fan may be of any suitable type. For instance, they may be curved, as shown in Fig. 5, or radial, as shown in Fig. 6.

The axially-directed arrows shown in Fig. 2 indicate the direction of flow of the fluid through the inlet-opening O, and the radially-directed arrows indicate the direction of flow through the cylindrical zone space Z, which flow is radial when the fan is operating with free intake and free discharge; but when operating against resistances either on the suction or discharge this flow is both radial and circumferential when said fans are employed without an inclosing casing, the outward radial flow being through about the half-length of the blades nearest the disk D and mainly circumferential within the circle of the inner edges of the other half, which is nearest the annulus F. It is essential that the space within the blades should be so free from obstruction that these currents should not be broken up or seriously disturbed, as by such action the efficiency of the fan is materially reduced. When operating inside a spirally-shaped casing or housing, the circumferential flow is very marked within the whole length of the blades from where the circumference of the spiral is closest to the fan-blades and extends, according to the strength of the resistance relatively to the periphery speed of the blades, for more or less half-way round the circumference of the interior circle of the blades, and for part of this circumference when the resistance is strong relatively to the periphery speed of the blades its velocity of flow is considerably higher than the speed of rotation of the inner edges of the blades. Hence if any of the inner edges of the blades projected inside the circle described by the inner edges of the blades at J toward the inner circumference of the cylindrical zone space their effect would be to check this high velocity of circumferential flow of the fluid in the cylindrical zone space, and thereby materially reduce the pressure

or suction set up by the fan for a given speed of rotation and decrease the mechanical efficiency of the fan relatively to the duties performed. It is therefore of importance that the said cylindrical zone space be free from any obstructions whatever to either the radial or circumferential flow of fluid through or within it.

It is obvious that fans constructed as above described may have blades mounted on one or both sides of the fan-wheel disk C D.

What I claim, and desire to secure by Letters Patent, is—

1. A centrifugal fan or pump in which the fluid enters axially and discharges radially, the rotary member or fan-wheel comprising a series of elongated blades of substantially the same depth throughout having within their circular path an unobstructed chamber, and a cover-plate at the inlet side, closely adjacent to the intake ends of the blades, and having an eye smaller than the circle described by the inner edges of the blades and forming a zone space, said space bounded exteriorly by the circular path in which the blades revolve and laterally by the said plate, and extending inwardly free of obstruction to the circumference of the inlet-opening or eye of said plate, so that the fluid entering the fan-wheel axially through said eye circulates thence outwardly through said zone space to the blades.

2. A centrifugal fan or pump in which the fluid enters axially and discharges radially, the rotary member or fan-wheel comprising a series of elongated blades of substantially the same depth throughout having within their circular path an unobstructed chamber, and a cover-plate fastened to the inlet ends of the blades, and having a concentric eye smaller than the circle described by the inner edges of the blades, closely adjacent to the intake ends of the blades, whereby a cylindrical zone space is formed which is bounded exteriorly by the circular path in which the blades revolve and laterally by said cover-plate, and extending inwardly free of obstruction to the circumference of the inlet-opening or eye of said plate, so that the fluid entering the fan-wheel axially through said eye circulates thence outwardly through said zone space to the blades.

3. A centrifugal fan or pump in which the fluid enters axially and discharges radially, the rotary member or fan-wheel comprising a series of blades having within their circular path an unobstructed chamber, and a cover-plate at the inlet side, closely adjacent to the intake ends of the blades, and having an eye smaller than the circle described by the inner edge of the blades, and said eye entering partly within the intake ends of the blades, said plate forming a zone space bounded exteriorly by the circular path in which the blades revolve, and laterally by the said plate, and extending inwardly free of obstruction to the circumference of the inlet-opening or eye of said plate, so that the fluid entering the fan-wheel axially through said eye circulates thence outwardly through said zone space to the blades.

4. In a centrifugal fan or pump, a rotary member or fan-wheel comprising a series of blades having within their circular path an unobstructed chamber, and an annular plate to which the inlet ends of the blades are fastened, said plate having a concentric eye of smaller diameter than that of the circle described by the inner edges of the blades.

5. A centrifugal fan or pump in which the fluid enters axially and discharges radially, the rotary member or fan-wheel comprising a series of blades having within their circular path an unobstructed chamber, and a cover-plate at the inlet side, closely adjacent to the intake ends of the blades, and having an eye smaller than the circle described by the inner edges of the blades and forming a zone space, said space bounded exteriorly by the circular path in which the blades revolve and laterally by the said plate, and extending inwardly free of obstruction to the circumference of the inlet-opening or eye of said plate, so that the fluid entering the fan-wheel axially through said eye circulates thence outwardly through said zone space to the blades, said rotary member or fan-wheel being uninclosed whereby the fluid discharged from its blades may freely escape tangentially therefrom in all directions.

6. A centrifugal fan or pump in which the fluid enters axially and discharges radially, the rotary member or fan-wheel comprising numerous elongated blades arranged lengthwise in approximately axial direction, and in substantially drum form, so as to inclose within them a relatively large and practically-unobstructed intake-chamber, and a cover-plate at the inlet side, closely adjacent to the intake ends of the blades, and having an eye smaller than the circle described by the inner edges of the blades and forming a zone space, said space bounded exteriorly by the circular path in which the blades revolve, and laterally by the said plate, and extending inwardly free of obstruction to the circumference of the inlet-opening or eye of said plate, so that the fluid entering the fan-wheel axially through said eye circulates thence outwardly through said zone space to the blades.

7. A centrifugal fan or pump in which the fluid enters axially and discharges radially, the rotary member or fan-wheel comprising numerous elongated blades arranged lengthwise in approximately axial direction, and in substantially drum form, so as to inclose within them a relatively large and practically-unobstructed intake-chamber, and spaced apart a distance no greater than twice their radial depth, and a cover-plate at the inlet side, closely adjacent to the intake ends of

the blades, and having an eye smaller than the circle described by the inner edges of the blades and forming a zone space, said space bounded exteriorly by the circular path in which the blades revolve, and laterally by the said plate, and extending inwardly free of obstruction to the circumference of the inlet-opening or eye of said plate, so that the fluid entering the fan-wheel axially through said eye circulates thence outwardly through said zone space to the blades.

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

SAMUEL CLELAND DAVIDSON.

Witnesses:

EDWARD FERGUSON,

JOHN JOHNSON.