

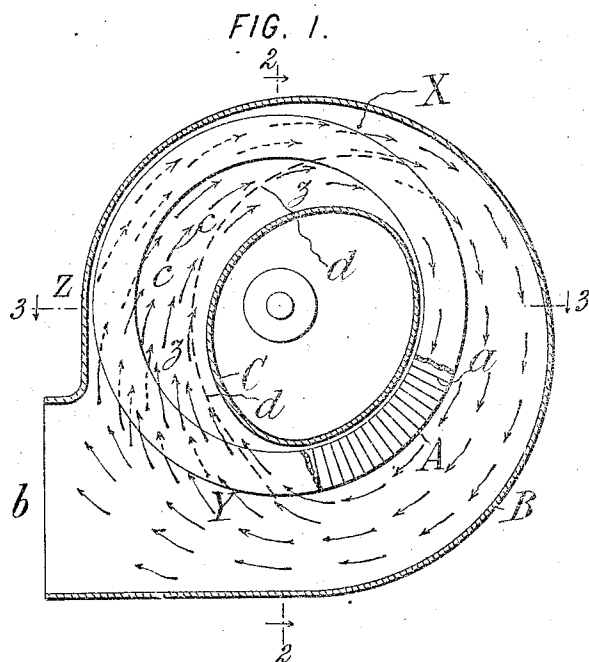
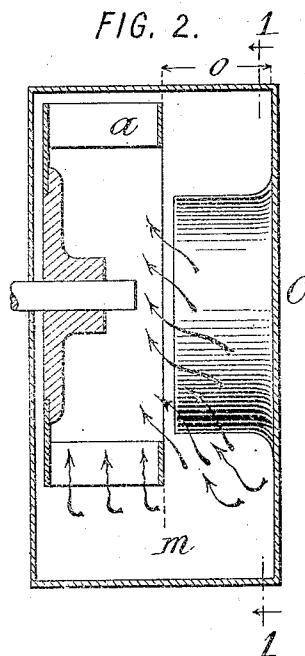
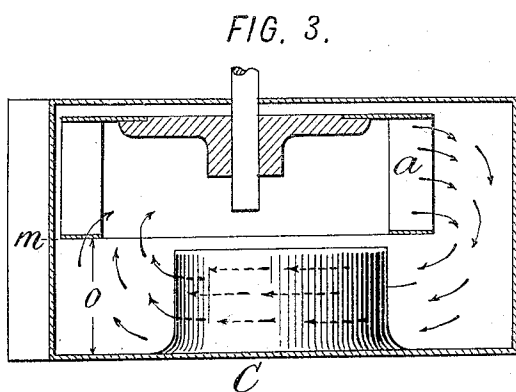
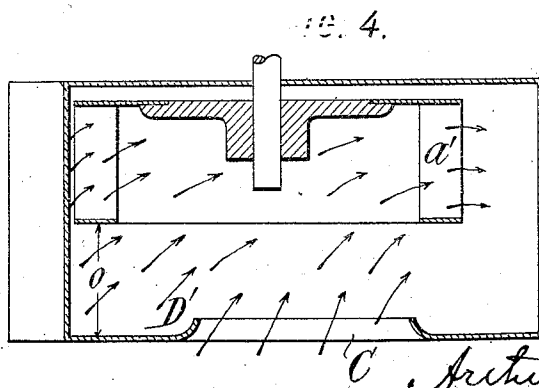
No. 820,398.

PATENTED MAY 15, 1906.

S. C. DAVIDSON.
CENTRIFUGAL FAN OR PUMP.

APPLICATION FILED OCT. 25, 1904.

4 SHEETS—SHEET 1.



WITNESSES:
René Gruine
J. M. Wallace

INVENTOR:
Samuel Cleland Davidson,
By Attorneys,
Arthur C. Thacker & Co.

No. 820,398.

PATENTED MAY 15, 1906.

S. C. DAVIDSON.
CENTRIFUGAL FAN OR PUMP.
APPLICATION FILED OCT. 25, 1904.

4 SHEETS—SHEET 2.

FIG. 5.

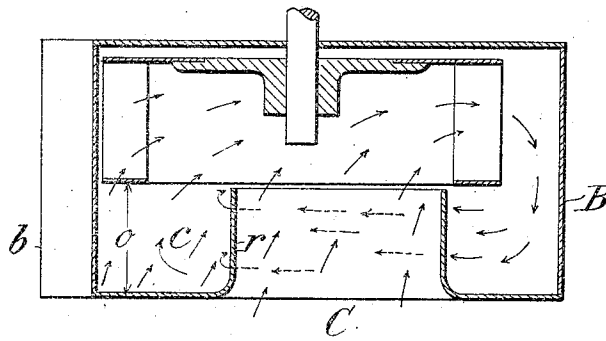


FIG. 5.^a

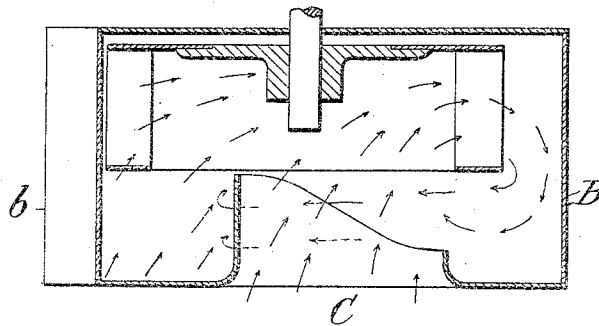
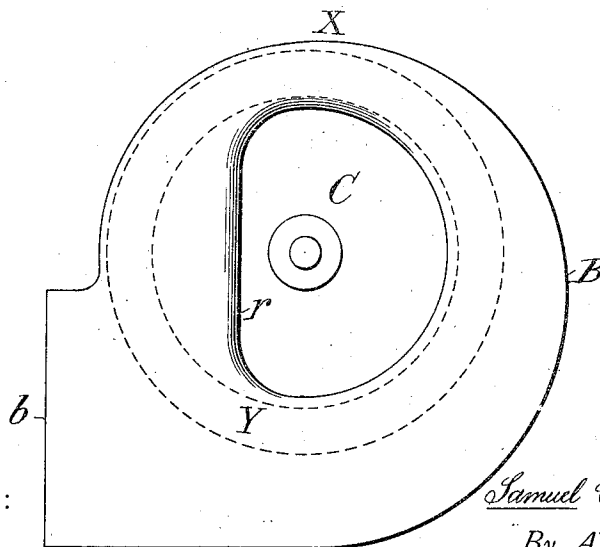


FIG. 6.



WITNESSES:
Fred White
Rene' Muine

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

No. 820,398.

PATENTED MAY 15, 1906.

S. C. DAVIDSON.
CENTRIFUGAL FAN OR PUMP.
APPLICATION FILED OCT. 25, 1904.

4 SHEETS—SHEET 3.

FIG. 7.

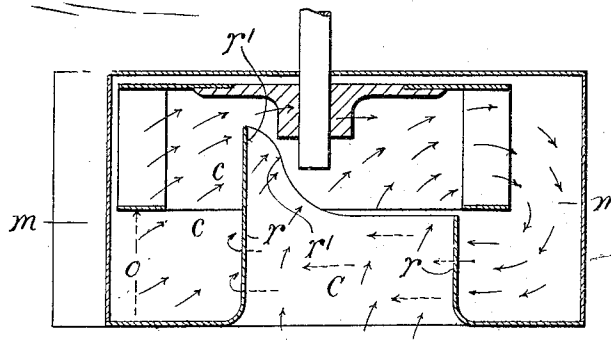
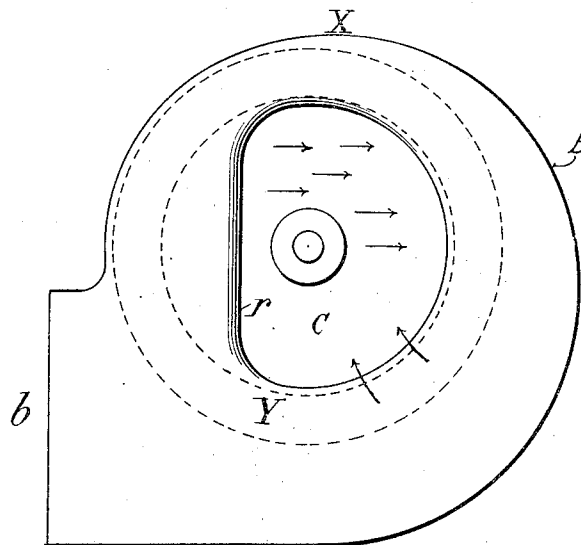


FIG. 8.



WITNESSES:

Fred White
Rene' Muine

INVENTOR:

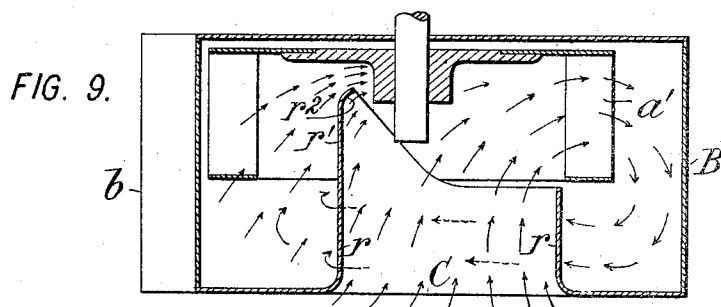
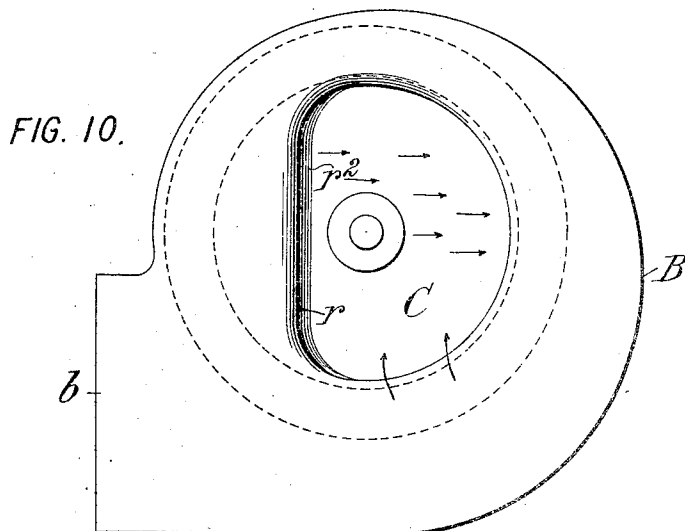
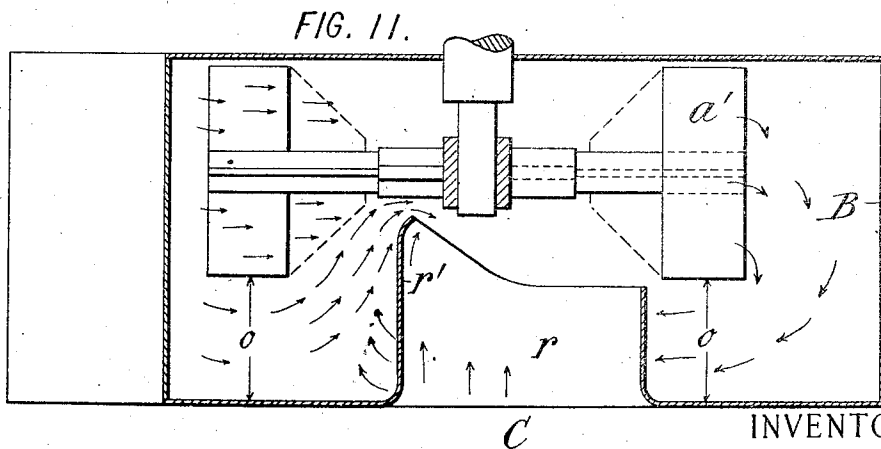
Samuel Cleland Davidson,
By his Attorneys
Arthur C. Fraser & Co.

No. 820,398.

PATENTED MAY 15, 1906.

S. C. DAVIDSON.
CENTRIFUGAL FAN OR PUMP.
APPLICATION FILED OCT. 25, 1904.

4 SHEETS—SHEET 4



WITNESSES:

Fred White
Rene Ruine

INVENTOR:

Samuel Cleland Davidson,
By Attorneys,
Arthur C. Thayer & Co.

UNITED STATES PATENT OFFICE.

SAMUEL CLELAND DAVIDSON, OF BELFAST, IRELAND:

CENTRIFUGAL FAN OR PUMP.

No. 820,398.

Specification of Letters Patent.

Patented May 15, 1906.

Application filed October 25, 1904. Serial No. 229,896.

To all whom it may concern:

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

This invention aims to improve the efficiency of rotary fans and pumps in which the fluid operated on enters the center of the said fans or pumps axially and is discharged therefrom circumferentially against a material degree of back pressure or suction resistance. Specifically my invention relates more particularly to the multibladed drum form of centrifugal fan set forth in my Patent No. 662,395, granted November 27, 1900. This fan has a high volumetric efficiency when the fluid operated on is under practically no back pressure or suction resistance; but its efficiency diminishes as the back pressure or resistance increases until a point is reached at which the type of fan shown in said patent possesses little advantage over other types of centrifugal fans which are designed for operating under or against a considerable pressure or resistance.

I have set forth in a pending application an invention for improving the efficiency of centrifugal fans by providing the fan with an eye or inlet-opening eccentrically located in relation to the axis of the fan-wheel or wherein the inlet-opening is formed of such shape that the boundary of the inlet area extends more to one side of the circle of the fan-blades than the other, the said eye or inlet-opening being preferably of D shape, such or any other shape of suitable contour or outline being included in the term "eccentric," which is hereinafter employed for simplicity and clearness. I also described in my said pending application a preferred form of casing which is shown in another pending application.

In order that the present invention may be more clearly understood, I will repeat the experiments referred to in my said pending application, wherein I stated that I have ascertained by experiments that the operation of centrifugal fans generally, more definitely so in those of drum form, such as set forth in my aforesaid Patent No. 662,395, when inclosed in the usual form of spiral or snail shaped casing is materially altered from what takes place when same is operating with a

free intake and free discharge for the fluid to and from the casing if the inlet or discharge to said casing be obstructed, so as to cause either a back pressure against the discharge or a suction resistance to the fluid entering the eye. In fans of the said drum form when uncased the circumferential discharge of fluid therefrom is uniform around the entire circumference of the fan in any given plane perpendicular to the axis of rotation, and when inclosed in a snail-casing having a free inlet and free discharge this action is only slightly modified, due to the tangentially-discharged currents being collected by the casing and delivered in one stream through the discharge-outlet. If, however, the discharge or suction be obstructed, an inequality of action around the circumference of the drum is caused, which inequality reaches its maximum when the discharge is nearly or entirely closed, and under these circumstances instead of the air flowing outwardly through the ports or spaces between the blades around the entire circumference of the fan-wheel such outward flow mainly occurs on one side of the drum, while on the opposite side there is a stream of fluid flowing inwardly through the ports and then partially across or around the interior space within the blades and finally passing outwardly again through the blades on the opposite side of the fan-wheel. These operative effects will be better understood by reference to Figure 1 of accompanying drawings, which is a diagram corresponding to a section on the line 1 1 in Fig. 2 in my said other pending application. In this diagram, A designates the rotary fan-wheel, which is shown of drum form of the type described in my former patent, No. 662,395, with its blades *a a* and with a snail-casing B, inclosing the fan-wheel. The eye or inlet-opening to the fan-wheel is indicated at C and is of approximately D-shaped form and disposed eccentrically to the axis of rotation in accordance with the improvements set out in my aforesaid pending application. Assuming the outlet *b* of the casing to be closed and the fan-wheel rotated, the air-currents will be somewhat as indicated by the arrows; but the precise direction, as well as the velocity of these currents, varies with different back pressures, speeds of the fan-wheel, and other conditions. Consequently only an approximate illustration can be given of same. Taking, however, the ex-

ample indicated, it will be seen that from a point indicated approximately at X around (in the direction of rotation) to another point (approximately indicated at Y) the air is discharged outwardly and tangentially from the blades, while beyond Y (in the direction of rotation) to a point adjacent to the nearest point Z of the casing there is an inflow of air through the ports between the blades, as indicated by the broken arrows, and thence a current or stream *c c* within the fan-wheel, which stream passes outwardly again through the ports between the blades from about the point X onward (in the direction of rotation) toward Y. This current or stream *c c* is found to be flowing at a high velocity, similar to that pertaining on the outer side of the blades at Y, and the direction of the current can be conclusively shown by means of a thread attached on the end of a wire, and a line may be plotted indicating what I may call the "inner margin" of this current and is shown by the dotted line *d d d*. As the position of said line *d d d* varies with different degrees of back pressure or suction resistance, it is to be understood that the location indicated by said dotted line is only approximate. This line may be taken as the inner limit of the reflow of this inwardly-regurgitated or return stream of fluid, which stream is marked by letters *c c*. In accordance with the improvements in my aforesaid pending application an outblow of air through the eye of the fan on the side coincident with the stream *c c* is prevented by disposing the eye eccentric with the axis of rotation, its position being more nearly concentric to the outline of the casing than formerly, and by preference the eye is, as stated, of non-circular shape, conforming on its side which is adjacent to the internal current or stream to the form taken by such stream, and on the opposite or suction side of the fan-wheel its circumference preferably coincides, or nearly so, in outline with the inner margin of the path of the fan-blades. Thus the eye assumes a shape roughly approximating to an ellipse somewhat flattened on the side, which axially confines the return or internal current *c c* and takes the D shape referred to. In the operation of a fan of this general type the air is found to leave the blades between the points X and Y with a whirling motion, which tends to cause it to return inwardly through the blades into the interior of the fan. This action, however, is so far modified by the tangential or rotary movement imparted to the air that the latter moves a considerable distance circumferentially of the fan before flowing inwardly. The greater part of the air hence does not show any marked tendency to return to the chamber inclosed by the blades until it approaches the point Y. In a fan in which the blades extend fully across the casing nearly all of the air which

thus seeks to reënter the fan-chamber between the points Y and Z is compelled to force its way through the ports between the blades. As this portion of the air moves at a high speed, usually considerably greater than the fan-blades themselves, the latter oppose the ingress of the air, with the effect of materially checking the velocity of the latter and reducing the output of the fan.

According to the present invention I shorten the blades of the fan so as to leave between the intake end of the fan-wheel and the opposite side of the casing a space *o*, (see Fig. 2,) which may be approximately equal to the length of the blades. By this construction the air which is seeking to reënter the fan-chamber instead of having to force its way back through the ports between the blades is enabled in large part to pass into said chamber around the ends of the blades, as indicated by the continuous arrows in Figs. 1 to 3. The latter course offers much less resistance to the inward passage of the current, and a considerable gain in the efficiency of the fan is thus produced.

I prefer to provide a throat, which extends across the space *o* upon the side of the regurgitated current, to confine such current to a definite path and to separate it at this point from the incoming current passing through the eye. Such a throat is, however, not strictly necessary, as it is found in practice that the regurgitated current tends of itself to follow a sufficiently-restricted course to avoid any material loss of efficiency on this account. The effective opening of such throat should be eccentric to the axis of rotation of the fan-wheel, so that there is left a free passage for the regurgitated current into the interior of such wheel. If the throat is constructed as shown in Figs. 1 to 3, such opening will assume the form of a meniscus-shaped space *z z*, located principally at the discharge side of the fan, as shown in Fig. 1.

I have also found in practice that a fan-wheel of the type shown when rotated at an appropriate speed is capable of delivering substantially the theoretically-correct quantity of air required to supply the discharge-opening if the blades of such fan-wheel approximate one-half the depth of the casing. As such a fan-wheel can be driven at a given speed with a much less expenditure of power than a fan-wheel of the long-bladed type, a considerable saving is effected in operation.

The fan-wheel provided by my present invention has also certain mechanical advantages over the long-bladed form of fan, in that it is of much stiffer construction and requires no braces or other devices for preventing distortion or the adjustable stays for drawing it into concentric relation with the shaft.

Referring to the drawings, which illustrate several forms of my invention, Figs. 1, 2, and 3, as before stated, are diagrams illustrat-

ing my invention, Fig. 1 corresponding to a section on the line 1 1 of Fig. 2 and Figs. 2 and 3 corresponding to sections on the lines 2 2 and 3 3, respectively, in Fig. 1. Fig. 4 is a diagram showing the action of my improved fan with free intake and discharge. Figs. 5 and 5^a are horizontal sections showing two forms of my invention. Fig. 6 is a side elevation of Fig. 5. Fig. 7 is a horizontal section showing a further modification, and Fig. 8 is a side elevation thereof. Fig. 9 is a horizontal section showing a still further modification. Fig. 10 is a side elevation thereof, and Fig. 11 a view illustrating the application of my invention to the paddle-wheel type of fan.

In the drawings, A designates the fan-wheel, having blades *a a*; B, the casing, and C the eye or inlet-opening. The eye C is shown in the drawings as D-shaped and eccentrically arranged, so that on its flattened side D it axially incloses or confines the inwardly-flowing or regurgitated current *c c*, which by reason of the shortening of the blades to the point *m*, or thereabout, is free to flow inwardly without being obstructed by the blades. The air passing into the fan is indicated by the arrows at the eye, and this inflow of air will, owing to its being restricted or determined by the eccentricity of the eye, keep the high-pressure flow *c c* to substantially its own path, even though no throat is used.

Where a fan such as shown in Fig. 3 is required for use as a volumetric fan working against little or no pressure, the shortening of the blades combined with the eccentric eye will be equally suitable, because although under such conditions there occurs no regurgitation of the fluid back from the discharge-outlet toward the center of the fans nevertheless the strongest suction from the eye to the blades occurs through that half of the fan-wheel which in its rotation leads up to the discharge-outlet, and as the curved side of the D-shaped eye is coincident, or nearly so, with this part of the fan-wheel the admission thereto of the fresh inflowing fluid is as free as it can be, while there is but little tendency on the part of the opposite half of the fan-wheel to draw fluid into it. Hence its being sheltered by the plate on the flat side of the D-shaped eye constitutes no detrimental obstruction, and, further, the unobstructed discharge of the fluid from the blades through the discharge-outlet from the casing creates a slight induction which draws a further volume of air outward through the space *o*, where same is in line with the discharge-outlet. This action, which is illustrated in Fig. 4, only takes place when working against a free discharge, and the action referred to in Fig. 3 always takes place when the discharge is obstructed and the fan is working against back pressure or suction resistance.

I have discovered that the efficiency of the fan may be further increased by extending the eccentric eye inward over the space *o* and up to the plane of the intake ends of the blades, and, further, that the side of the eye which laterally confines the return-current *c c* and guides it into the center of the fan-wheel may be projected into the interior of the fan-wheel to within a short clearance-space from the fan-wheel disk and that such extension beneficially affects the pressure efficiency and still more so the suction efficiency.

Figs. 5, 5^a, and 6 show in section and elevation, respectively, the above-described projection of the eye, which is of D-shaped outline up to the intake ends of the blades.

Figs. 7 and 8 similarly show the same projection of the eye as in Figs. 5 and 6, but with that part of said projection which is adjacent to the return-current *c c* carried into the space within the path of the blades.

Figs. 9 and 10 show a similar projection of the eye to that shown in Figs. 7 and 8 with, in addition, the extreme end of the portion which projects into the interior of the fan-wheel itself slightly curved inward toward the center of the fan, which curvature promotes the union of the fluid entering the eye with the return-current crossing the center of the fan-wheel, as indicated by the arrows, without concussive noise, both currents being guided by this curvature into the same direction of flow before meeting.

Referring now to Figs. 5 to 10, *r* is the inward extension of the eye *d* over the space *o* and up to the intake ends of the blades. *r'* is the further extension of the eye on the side adjacent to the return-current *c c*, so as to more fully divide same from the fluid entering axially through the eye, and *r''* is the curved end of *r'*.

Although I have described these improvements in their applicability more particularly to drum-shaped fans, such as described in my said prior patent, the said improvements are equally applicable to fans of ordinary type, and for an example I have shown in Fig. 11 in a sectional plan corresponding to Fig. 9 the application of the invention to a paddle-wheel type of fan of the hitherto ordinary construction, in which, however, the blades extend too far inwardly to give best results, and while my herein-described invention can be employed with same, nevertheless as this amount of inward extension tends to break up and confuse the flow of the return-current *c c* it is distinctly preferable to have the blades of a less radial depth, and accordingly I have only shown the ordinary inward extension of same in dotted lines and their preferable radial depth in solid lines. The letters used to indicate the various parts in this figure are the same as employed for similar parts in the previously-described figures.

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

1. A centrifugal fan or pump comprising a snail-casing, and a fan-wheel mounted eccentrically therein, said fan-wheel being formed of blades of a length materially less than the depth of the casing, and arranged to form a space between the blades and casing through which fluid may flow past the ends of the blades, said fan-wheel having a practically unobstructed intake-chamber, and said fan having an eye disposed eccentrically to the axis of the fan-wheel.

2. A centrifugal fan or pump, comprising a snail-casing, and a fan-wheel mounted eccentrically therein, said fan-wheel being formed of blades of a length materially less than the depth of the casing, and arranged to form a space between the blades and the casing through which fluid may flow past the ends of the blades, said fan having an eye disposed eccentrically to the axis of the fan-wheel, and said eye being formed as a throat having a portion extending across said space to the plane of the end of the fan-wheel.

3. A centrifugal fan or pump, comprising a snail-casing, and a fan-wheel mounted eccentrically therein, said fan-wheel being formed of blades of a length materially less than the depth of the casing, and arranged to form a space between the blades and the casing through which fluid may flow past the ends of the blades, said fan having an intake-chamber, and having an eye disposed eccentrically to the axis of the fan-wheel, and said eye being formed as a throat having a portion extending across said space into said intake-chamber.

4. A centrifugal fan or pump, comprising a snail-casing, and a fan-wheel mounted eccentrically therein, said fan-wheel being formed of blades of a length materially less than the depth of the casing, and arranged to form a space between the blades and the casing through which fluid may flow past the ends

of the blades, said fan having an intake-chamber, and having an eye disposed eccentrically to the axis of the fan-wheel, and said eye being formed as a throat having a portion extending across said space into said intake-chamber, such portion at its inner end being curved toward the center of the fan-wheel.

5. A centrifugal fan or pump, comprising a snail-casing, and a fan-wheel mounted eccentrically therein, said fan-wheel being formed of blades of a length materially less than the depth of the casing, and arranged to form a space between the blades and the casing through which fluid may flow past the ends of the blades, said fan having an eye disposed eccentrically to the axis of the fan-wheel, and said eye being formed as a throat having a portion extending across said space, said throat being of less depth on the side most remote from fan-wheel axis.

6. In a centrifugal fan or pump, a fan-wheel having a practically unobstructed intake-chamber, and an eye disposed eccentrically to the axis of said fan-wheel, and formed as a throat extending into said intake-chamber.

7. In a centrifugal fan or pump, a snail-casing, a fan-wheel mounted eccentrically therein adjacent to one side thereof, said fan-wheel having a practically unobstructed intake-chamber, and an eye disposed eccentrically to the axis of said fan-wheel, and adapted to deliver a larger proportion of fluid to that side of the fan-wheel which is farthest from the casing, said eye formed as a throat extending into said intake-chamber.

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

SAMUEL CLELAND DAVIDSON.

Witnesses:

JOHN MOORE,
THOMAS DIXON.