No. 839,273. PATENTED DEC. 25, 1906.

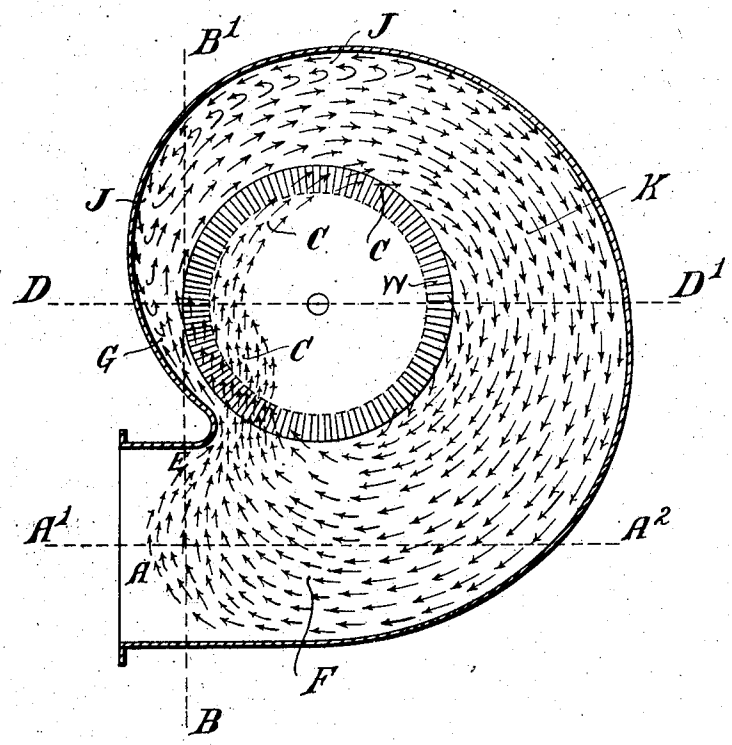
S. C. DAVIDSON.

CENTRIFUGAL FAN OR PUMP AND CASING THEREFOR.

APPLICATION FILED JULY 1, 1905.

4 SHEETS—SHEET 1.

Fig. 1.



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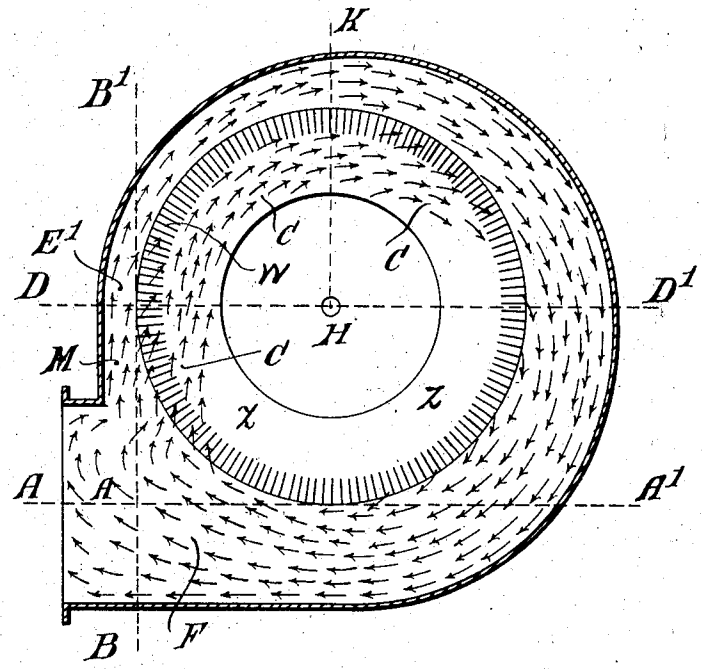
4 SHEETS—SHEET 2.

FIG. 2.



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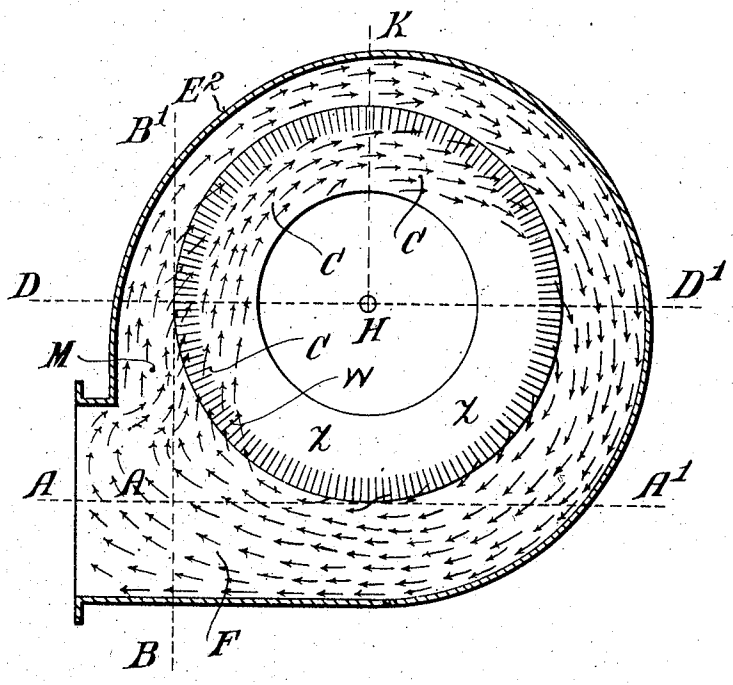
4 SHEETS—SHEET 3.

Fig. 3.



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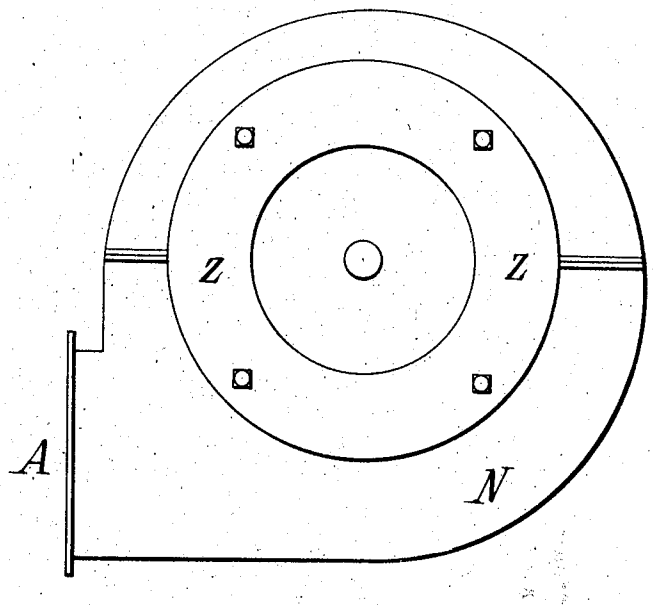
4 SHEETS—SHEET 4.

FIG. 4.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL FAN OR PUMP AND CASING THEREFOR.

No. 839,273. Specification of Letters Patent. Patented Dec. 25, 1906.

Application filed July 1, 1905. Serial No. 267,989.

To all whom it may concern:

Be it known that I, SAMUEL CLELAND DAVIDSON, merchant, of Sirocco Engineering Works, Belfast, Ireland, have invented certain new and useful Improvements in or Relating to Centrifugal Fans or Pumps and Casings Therefor, of which the following is a specification.

This invention relates to centrifugal fans or pumps, (hereinafter referred to as "fans,") and more particularly to the inclosing casing therefor, (hereinafter referred to as "casing,") wherewith fluid of any description may be operated upon, whether gaseous, like air, or liquid, like water, (which fluid is hereinafter referred to as "air.")

Some objects, among others, of my hereindescribed invention are to further improve the mechanical efficiency of said fans, more especially when operating with back pressure against the discharge or suctional resistance against the inflow of the fluid to the fan, and also to obtain when said fan is revolving at a constant speed of revolution a constant indication of pressure or suction, as the case may be, irrespective of any variation which may occur in the volume of fluid passing through the fan from approximately *nil* up to the full volumetric capacity for which it is designed.

In fans as hitherto ordinarily constructed and when same are rotated at a constant speed and when discharging into (for example) a pressure chamber or reservoir and if the outlet therefrom be entirely closed a much higher pressure will be indicated than if the outlet be sufficiently opened to allow of the discharge of the full volumetric capacity of the fan, but with fans constructed in accordance with my hereinafter-described improvements, and assuming the speed to remain constant, the pressure in the chamber will also remain substantially constant, whether the outlet from said pressure-chamber be entirely closed or opened to the full volumetric capacity that the fan is capable of dealing with. For numerous reasons this remarkable feature is of much practical utility and importance in connection with centrifugal fans or pumps, and the invention is particularly useful in combination with a fan having a laterally-confined cylindrical or annular zone-space within the inner edges of the blades, as described in my prior applications for patent, Serial Nos. 204,922 and 209,351, wherein the fan-wheel is mounted eccentrically in a snail-shaped casing, whereby when operating against a pressure or suction there is established a current of fluid moving inwardly from the further portion (in the direction of rotation of the fan-wheel) of the space in front of the discharge-opening through the ports between the blades and partially across and around the intake-chamber of said fan-wheel, that portion of said intake-chamber traversed by said current being practically unobstructed and having means for opposing the axial flow of fluid on the intake side thereof.

Figure 1 is a diagrammatic view illustrating a multi-bladed drum type of fan when inclosed in a snail-shaped casing such as is described in a prior patent granted to me, No. 662,395. Fig. 2 is a similar view showing the same type of fan-wheel and illustrating one form of the casing which is provided by my invention, the parts being constructed to form a cylindrical zone-space within the fan, with means for opposing the outflow of the fluid axially through the intake end of the fan. Fig. 3 is a view similar to Fig. 2, illustrating another embodiment of my invention. Fig. 4 is a side elevation of a fan provided by my present invention, illustrating the construction of the eye.

Fig. 1 is intended to illustrate diagrammatically the hitherto ordinary construction of casing wherein there is a gradual widening of the space which exists between the spiral or snail-shaped contour of same and the fan-wheel W, beginning from the top of the discharge-opening A and continuing round the fan-wheel in its direction of rotation and back to the front of said discharge-opening, and the arrows in this figure indicate approximately the flow of the air-currents within the casing when the fan is operating against back pressure or suctional resistance, the currents within the fan being indicated by the letters C C.

It will be observed that in Fig. 1 the point of closest proximity of the fan-casing to the periphery of the fan-wheel W at E (hereinafter called the "cut-off") is practically at the point of junction of the circumference of the casing with the top of the discharge-opening A and that from said point E around the fan-wheel (in the direction of rotation) the space

gradually widens out to maximum measurement at F in front of the discharge-opening at A.

To render my description more clear, I have shown in each of the three diagrams a line marked A′ A², which is intended to represent what would be approximately the axis of discharge from the casing if the outflow of fluid were unobstructed in any way, and parallel to this line I have shown the line D D′, drawn parallel to A′ A² through the center of the fan-wheel W, and in addition the line B B′, which is at right angles to A′ A² and D D′ from that point of the periphery of the fan-wheel where the line D D′ cuts same, and it will be observed that the point of closest proximity of the fan-casing to the fan-wheel in Fig. 1 is substantially at the top of the discharge-opening A and that from the cut-off thus formed at E the space between the fan-wheel and the circumference of the casing gradually widens out via G and K to F. The space marked G, which lies between the line D D′ and the cut-off at E, will be seen to have a wedge-like form with the point of the wedge at the cut-off E and its broadest part along line D D′, and therefore farther away from the discharge A around the fan in the direction of rotation than the cut-off at E.

If the fan-wheel W in Fig. 1 be rotated, the blades impel a continuous flow of air into the space in front of the discharge-opening at A, the force and velocity of which is strongest on the lower or outer side of the line A′ A² from the fan-wheel. If then this current cannot, owing to existing back pressure or resistance, force its way out through the discharge-opening, it swirls or is deflected upward at A toward the top of the discharge and then takes a centripetal direction at the cut-off E, where it passes into the interior of the fan-wheel W through the ports between the fan-blades. It will be observed, however, that the current at this point, as indicated by the arrows, is very crowded and that its further progress circumferentially is thereby subject to a pronounced check and shock, whereby there occurs a loss of some of the initial velocity at which it was driven toward the discharge-opening at A, and consequently the equivalent loss of power which same represents. This initial velocity will, however, be reacquired on the fluid again passing outward through the fan-wheel blades; but the greater the loss of velocity due to said shock the greater will be the power absorbed by the fan-wheel to reimpart the velocity lost. Further, however, with this construction of casing the said regurgitated fluid after again passing out through the blades is subject to an eddying action, which I have indicated by arrows pointing in the opposite direction to the general flow of the current, close to the circumference of the casing at J J, which also involves some loss of power. It is thus evident that in order to maintain full velocity in the circumferential flow of the air around the fan that this back eddy at J J should be eliminated, and I have found that when the circumference of the casing is concentric with that of the fan-wheel, which consequently means the non-existence therein of any cut-off, there is no regurgitation of the current to the interior of the fan-wheel, and at the same time the back eddies at J J are swept away by the free circumferential flow of the fluid, and thus disappear; but, on the other hand, a worse condition develops, owing to the circumferential flow of the air around the casing being too free, the result of which is that with same speed of revolution as when a spiral casing with cut-off is used the pressure then falls, and it becomes necessary in order to reinstate the required pressure to materially increase the revolutions of the fan-wheel, which, however, involves the employment of more power than is saved by the elimination of the back eddy J J, so that such free circumferential flow of the air between the circumferences of the fan-wheel and casing is disadvantageous. Consequently, in order to produce suitable compression in front of the discharge-opening it is necessary to check or retard the free circumferential flow of the air near to the farther side of the discharge, (in the direction of rotation,) where a cut-off effect must be provided for, and I also find that the position of said cut-off relative to the discharge-opening and its form are important in effecting said compression with a minimum of detrimental shock and loss of power therefrom and, further, that the passage of the regurgitated air back to the interior of the fan-wheel should be arranged for in such manner as to avoid a sudden or too great deflection from the line of its concentric and circumferential path and that a larger portion of the circumference of the fan-wheel should be available for the passage of the regurgitated air through it than indicated in Fig. 1.

According to my improved construction I employ with a casing of spiral contour an improved arrangement of cut-off in conjunction with a space leading to it from the discharge-opening, the shape of which space and its location allow the surplus air from the space in front of the discharge-opening to be deflected to the interior of the fan-wheel more gradually and through a larger area of the circumference of the fan-wheel than hitherto, whereby the initial velocity at which it is driven into the space in front of the discharge-opening is better maintained. This improved construction exposes a larger area of the fan-wheel through which the regurgitated current can pass toward the interior thereof without crowding or projecting the current too far toward the center of the wheel, as shown in Fig. 1, and the detrimental effects

of sudden shock are thereby reduced to the lowest practical minimum, and the effective work performed is accomplished with improved mechanical efficiency for a given expenditure of power.

Figs. 2 and 3 illustrate my improved construction, and while both represent the same operative principles Fig. 3 illustrates the development of same to a further degree than Fig. 2, the location of cut-off or closest proximity of the circumference of the casing to the periphery of the fan-wheel W being at E′ on the line D in Fig. 2, whereas in Fig. 3 it is at E², which is farther around the wheel in the direction of rotation. Then also the clearance-space between the casing and the fan-wheel periphery is not so large as in Fig. 3; but the principle involved in both figures is the same—viz., that a wedge-shaped or tapering space M is provided between the periphery of the fan-wheel and the circumference of the casing, the characteristic features of which are that the end of same which adjoins the discharge-opening forms the wide or base end thereof and that the apex or narrow end thereof is at the cut-off, which is substantially beyond the discharge-opening in the direction of rotation and in that quarter of the fan-wheel circumference which after passing the discharge-opening lies approximately between the two radial lines H D and H K, which are at right angles to one another. It will be apparent from a further comparison of Figs. 2 and 3 with Fig. 1 that the fact of the regurgitated current entering the intake-chamber of the fan-wheel within the circular path of the blades with a less deflected and freer flow than in Fig. 1, and its initial velocity being thereby more fully retained, an equivalent centrifugal force outward will be set up, tending to press this current through the blades to the exclusion of any fresh air entering until reaching where the casing is sufficiently far away from the outer circumference of the fan-wheel to contain the full volume of the regurgitated current, and it consequently absorbs the least possible reinforcing requirement from the blades to bring it up to the original initial velocity at which it was driven into the space in front of the discharge-opening, and a considerable saving in power is thus effected.

It is to be understood that my present invention is not limited to the particular type of fan-wheel herein referred to, such merely being taken as a particularly efficient combination convenient for illustration, and that the dimensions and shape of the tapering or wedge-like space marked at H in Figs. 2 and 3 and also the position occupied by that part of the casing which is in closest proximity to the periphery of the fan-wheel marked E′ in Fig. 2 and E² in Fig. 3 may be varied, while still retaining the hereinbefore-described characteristic features, even though such variations may modify the operative effects of same.

In the improved construction that point of the casing which is referred to as the "cut-off" may extend for a suitable distance parallel with the fan-wheel, or nearly so, and is not necessarily limited to a point or very short portion of the circumference of the casing.

In Figs. 2, 3, and 4 I have shown the fan as constructed with means for opposing the outflow of fluid axially through the intake end of the fan. The means shown comprises a plate Z Z, fixed to the casing N, Fig. 4, and having an eye or opening through which the fluid enters the fan which is smaller than the intake-opening of the fan. Any other construction effecting substantially the same result may be substituted therefor.

In practical operation of the above invention I have obtained the following results—viz., that provided the number of revolutions per minute of the fan-wheel employed be constant the pressure or suction set up by the fans in a reservoir attached to either the discharge or the inlet opening will also remain substantially constant whether the outlet from or inlet to said reservoir be completely closed or opened out to a sufficient extent to permit of the discharge (or inflow, as the case may be) of the full volume of fluid that the fan can efficiently deal with, and at same time these duties are performed with a remarkably high ratio of mechanical efficiency.

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

1. A centrifugal fan or pump comprising a fan-wheel a snail-shaped casing wherein the position of cut-off or closest proximity of the circumference of the casing to the circumference of the fan-wheel is situate sufficiently farther round the fan-wheel in the direction of rotation than the discharge-opening, to provide an intervening space between the fan-wheel and casing which from said discharge-opening to said cut-off is progressively decreasing like a wedge having its base or broad end toward and leading from said discharge-opening, and its point or narrower end toward said cut-off.

2. A centrifugal fan or pump comprising a snail-shaped casing, and a fan-wheel mounted eccentrically therein whereby when operating against a pressure or suction there is established a current of fluid moving inwardly from the space between the circumferences of the fan-wheel and casing and in front of the discharge-opening through the ports between the blades of said fan-wheel and partially across and around the intake-chamber thereof, that portion of said intake-chamber traversed by said current being practically unobstructed, and said fan or pump having

means for opposing the outflow of fluid axially through the intake end, the position of cut-off between the fan-wheel and the inclosing casing being situate sufficiently farther round the fan-wheel in the direction of rotation than the discharge-opening to provide an intervening space between the fan-wheel and casing which from said discharge-opening to said cut-off is progressively decreasing like a wedge having its base or broad end toward and leading from said discharge-opening, and its point or narrower end toward said cut-off.

3. A centrifugal fan or pump, comprising a snail-shaped casing, and a fan-wheel mounted eccentrically therein whereby when operating against a pressure or suction there is established a current of fluid moving inwardly from the space between the circumferences of the fan-wheel and casing and in front of the discharge-opening through the ports between the blades of said fan-wheel and partially across and around the intake-chamber thereof, that portion of said intake-chamber traversed by said current being practically unobstructed, and said fan or pump having means for opposing the outflow of fluid axially through the intake end, said means comprising a plate having an eye which is smaller than the intake-opening of said chamber the position of cut-off between the fan-wheel and the inclosing casing being situate sufficiently farther round the fan-wheel in the direction of rotation than the discharge-opening to provide an intervening space between the fan-wheel and casing which from said discharge-opening to said cut-off is progressively decreasing like a wedge having its base or broad end toward and leading from said discharge-opening and its point or narrow end toward said cut-off.

4. A centrifugal fan or pump, comprising a snail-shaped casing and a fan-wheel mounted eccentrically therein whereby when operating against a pressure or suction there is established a current of fluid moving inwardly from the space between the circumferences of the fan-wheel and casing and in front of the discharge-opening through the ports between the blades of said fan-wheel and partially across and around the intake-chamber thereof, that portion of said intake-chamber traversed by said current being practically unobstructed, and said fan or pump having means for opposing the outflow of fluid axially through the intake end, said means comprising a plate fixed or forming part of said casing and having an eye concentric to the axis of said fan-wheel and smaller than the intake-opening of said intake-chamber the position of cut-off between the fan-wheel and the inclosing casing being situate sufficiently farther round the fan-wheel in the direction of rotation than the discharge-opening to provide an intervening space between the fan-wheel and casing, which from said discharge-opening to said cut-off is progressively decreasing like a wedge having its base or broad end toward and leading from said discharge-opening and its point or narrower end toward said cut-off.

5. A centrifugal fan or pump comprising a fan-wheel a snail-shaped casing wherein the position of cut-off or closest proximity of the circumference of the casing to the circumference of the fan-wheel is situate at a position farther round the fan-wheel in the direction of rotation than the discharge-opening and within that quarter of the fan-wheel circumference which lies next beyond the discharge-opening between a line drawn through the fan-wheel axis and parallel to the axis of the discharge-opening and a line drawn perpendicular thereto through said fan-wheel axis, and the fan-wheel being located so as to provide an intervening space between the fan-wheel and casing which from said discharge-opening to said cut-off is progressively decreasing like a wedge having its broad end or base toward and leading from said discharge-opening and its narrow end or point toward said cut-off.

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

SAMUEL CLELAND DAVIDSON.

Witnesses:
GEORGE GOOLD WARD,
EDWARD FERGUSON.