No. 679,499.

Patented July 30, 1901.

S. C. DAVIDSON.

ROTARY FAN AND PUMP.

(No Model.)

(Application filed Nov. 20, 1899.)

5 Sheets—Sheet 1.

FIG. 1.

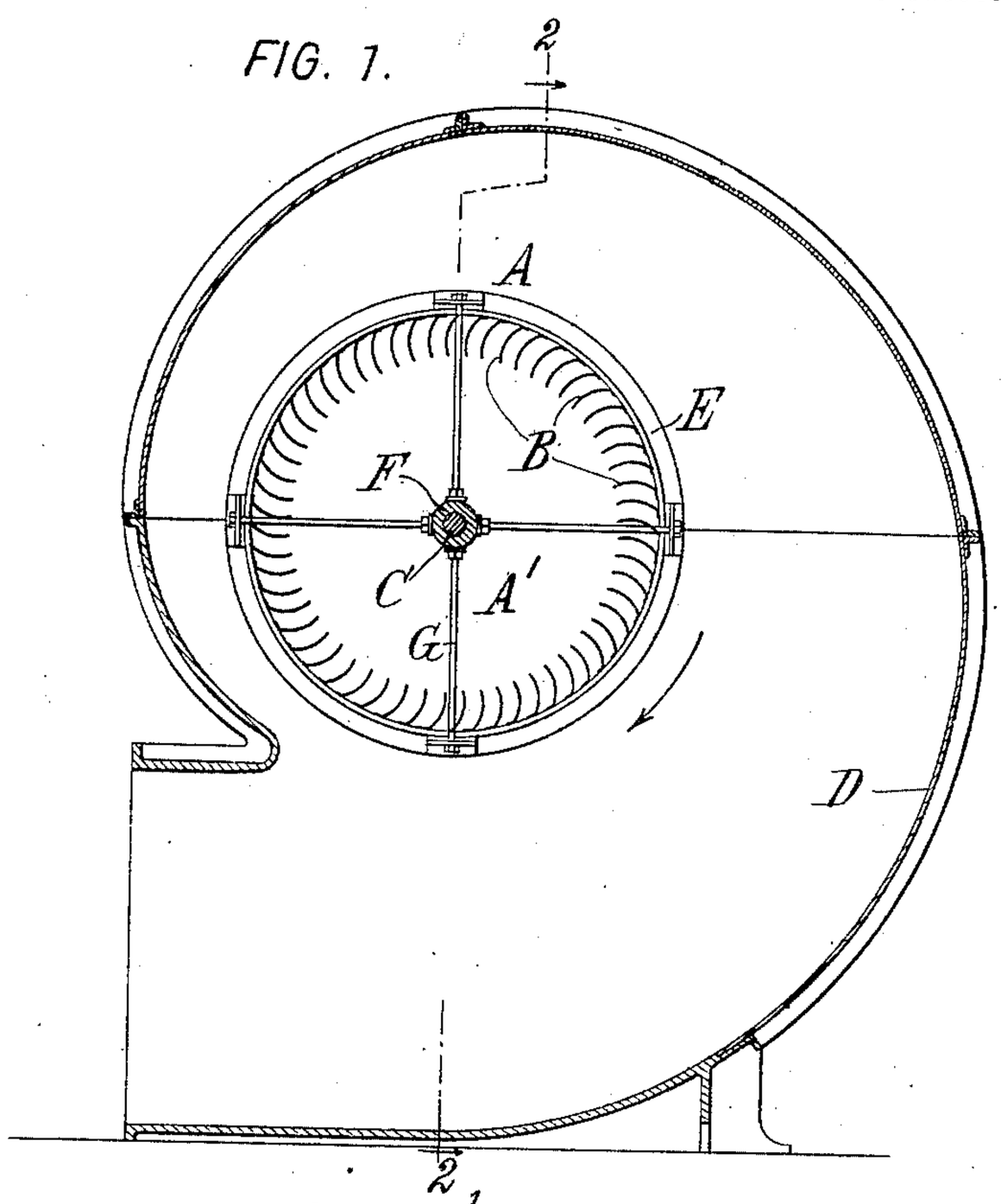
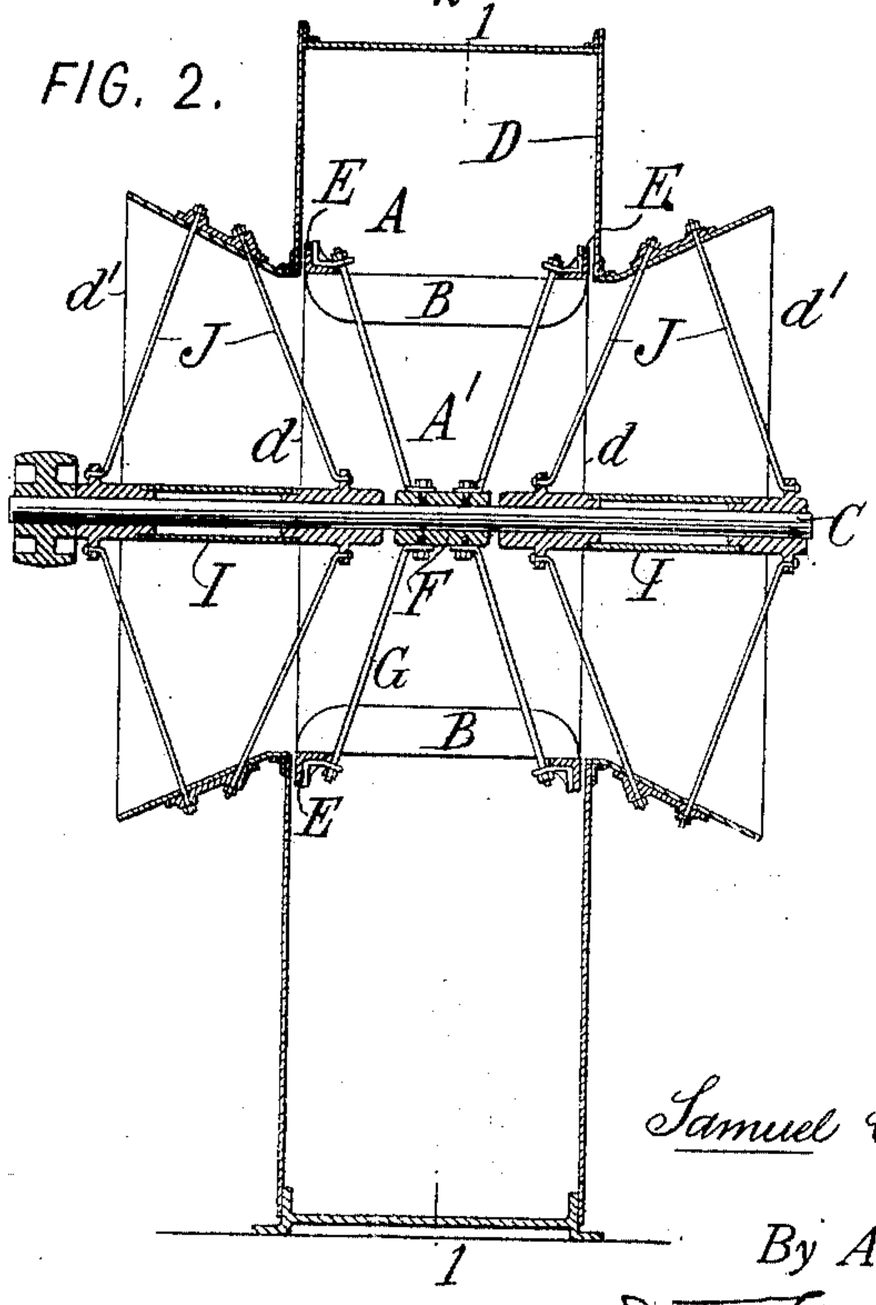


FIG. 2.



WITNESSES:
Fred Whitey
Thomas F. Wallace

INVENTOR:
Samuel Cleland Davidson

By Attorneys,
Dustin G. Dresser & Co

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5 Sheets—Sheet 2.

FIG. 4.

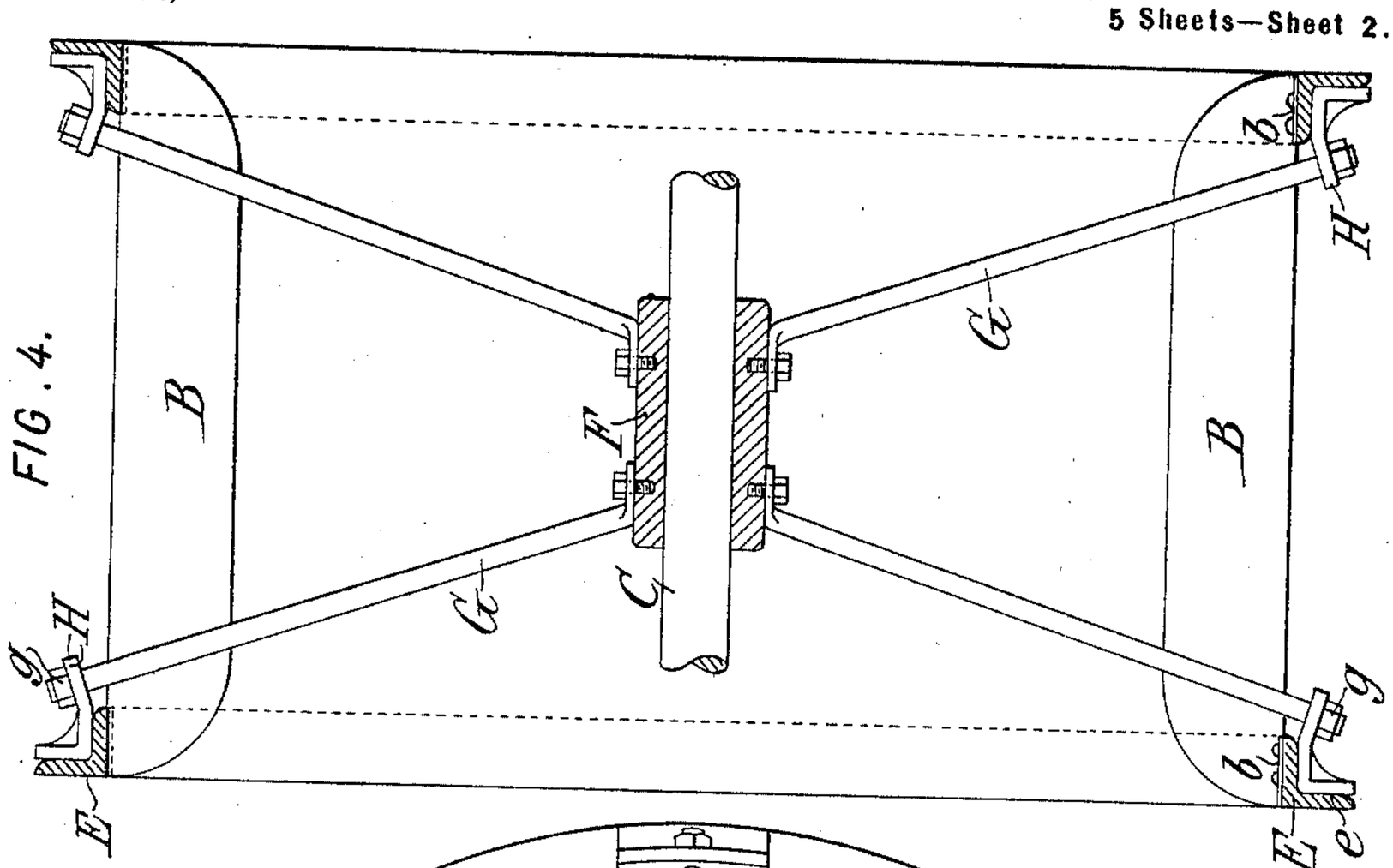
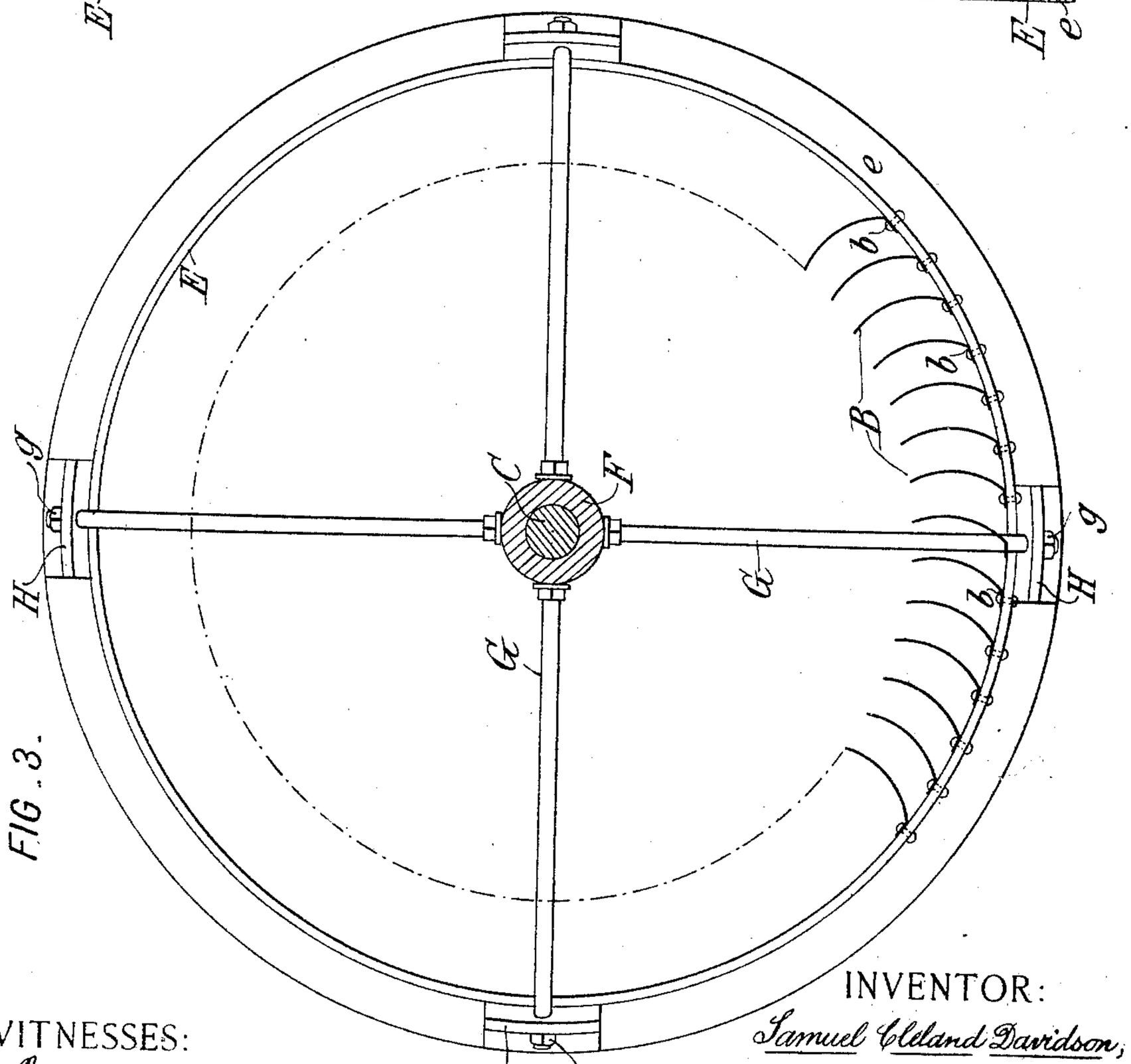


FIG. 3.



WITNESSES:

Fred White

Thomas F. Wallace

INVENTOR:

Samuel Cleland Davidson,

By Attorneys,

Dustin & Fraser

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(No Model.) 5 Sheets—Sheet 3.

FIG. 6.

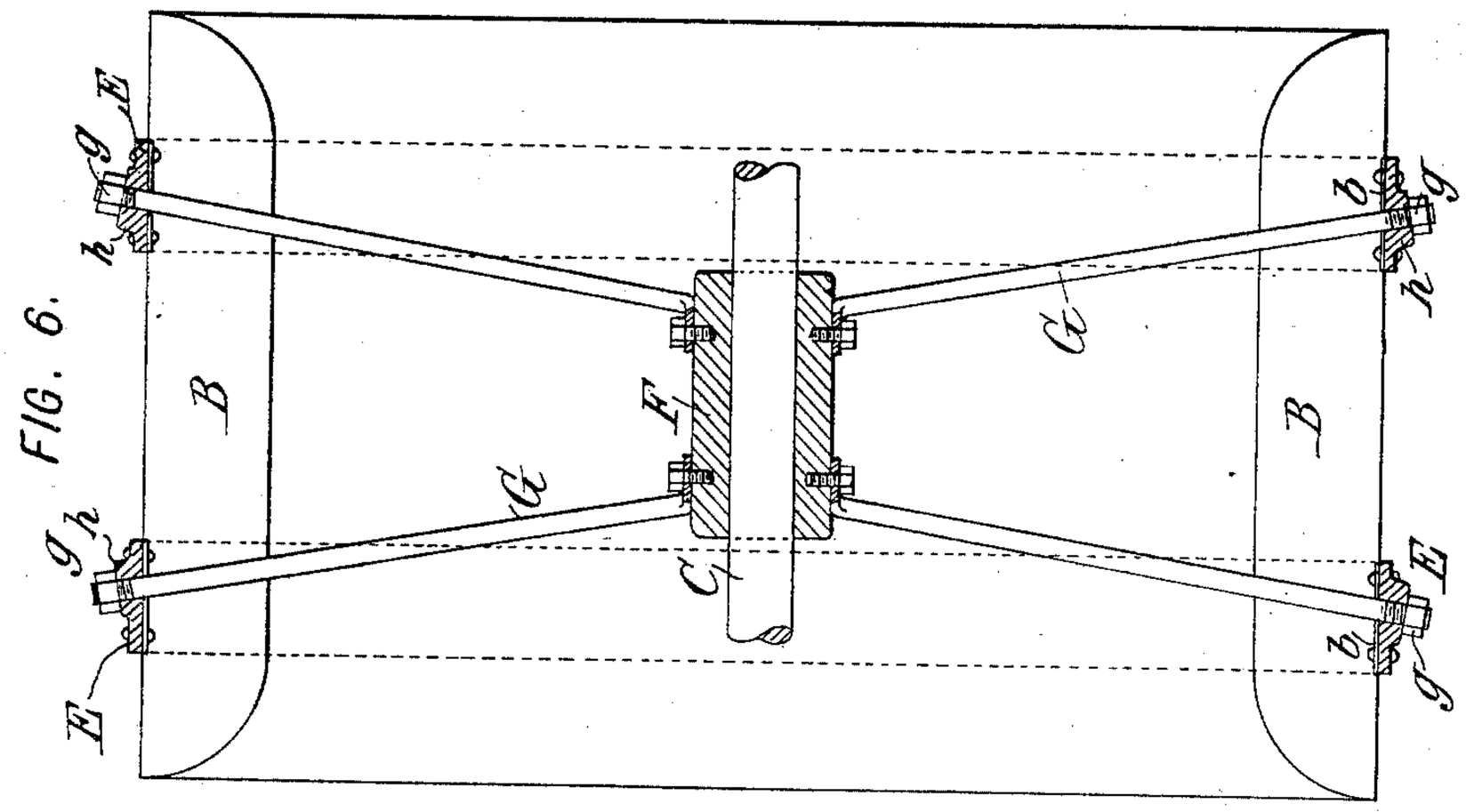
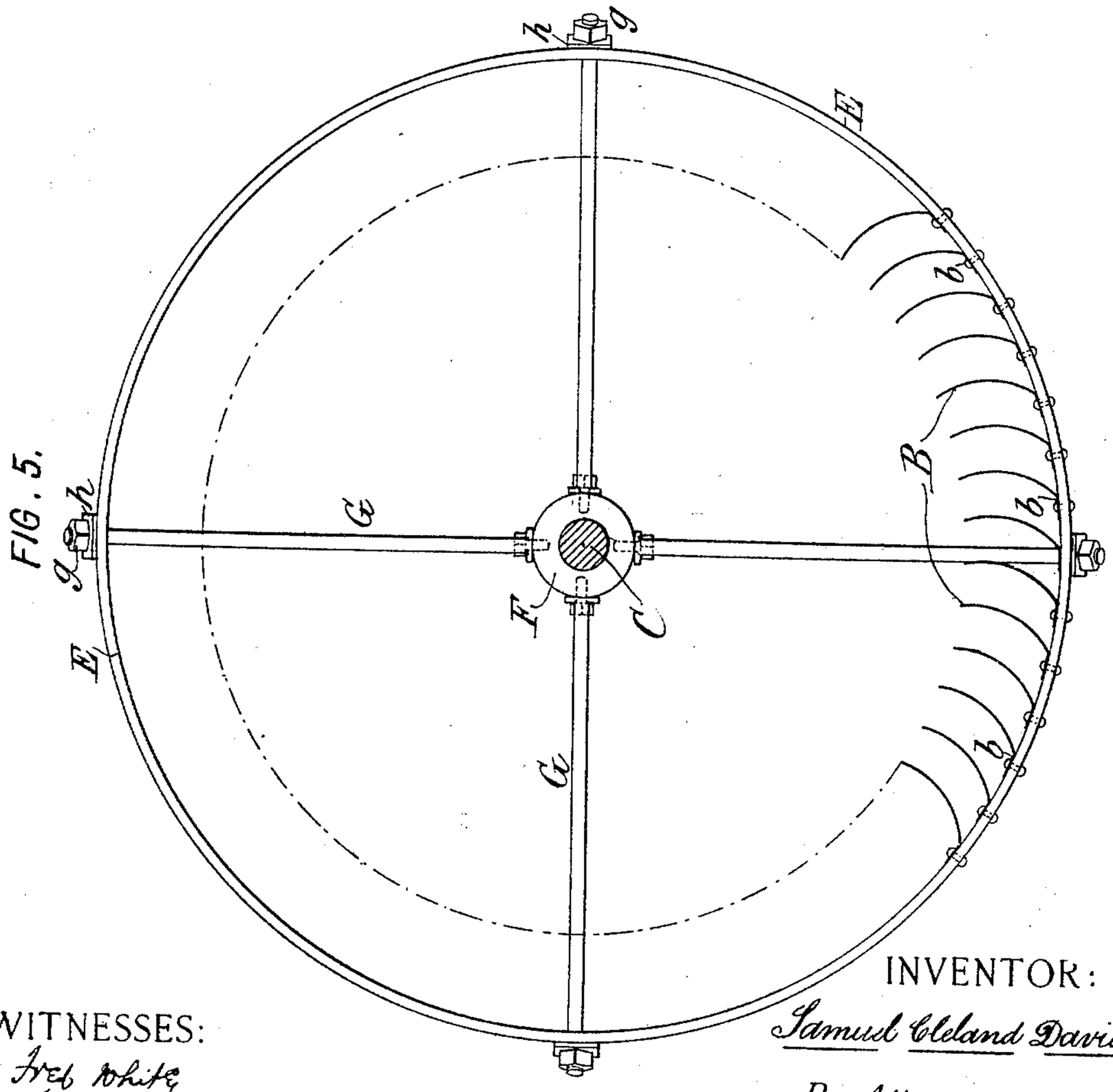


FIG. 5.



WITNESSES:
Fred White
Thomas F. Wallace

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

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S. C. DAVIDSON.

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(Application filed Nov. 20, 1899.)

(No Model.)

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FIG. 8.

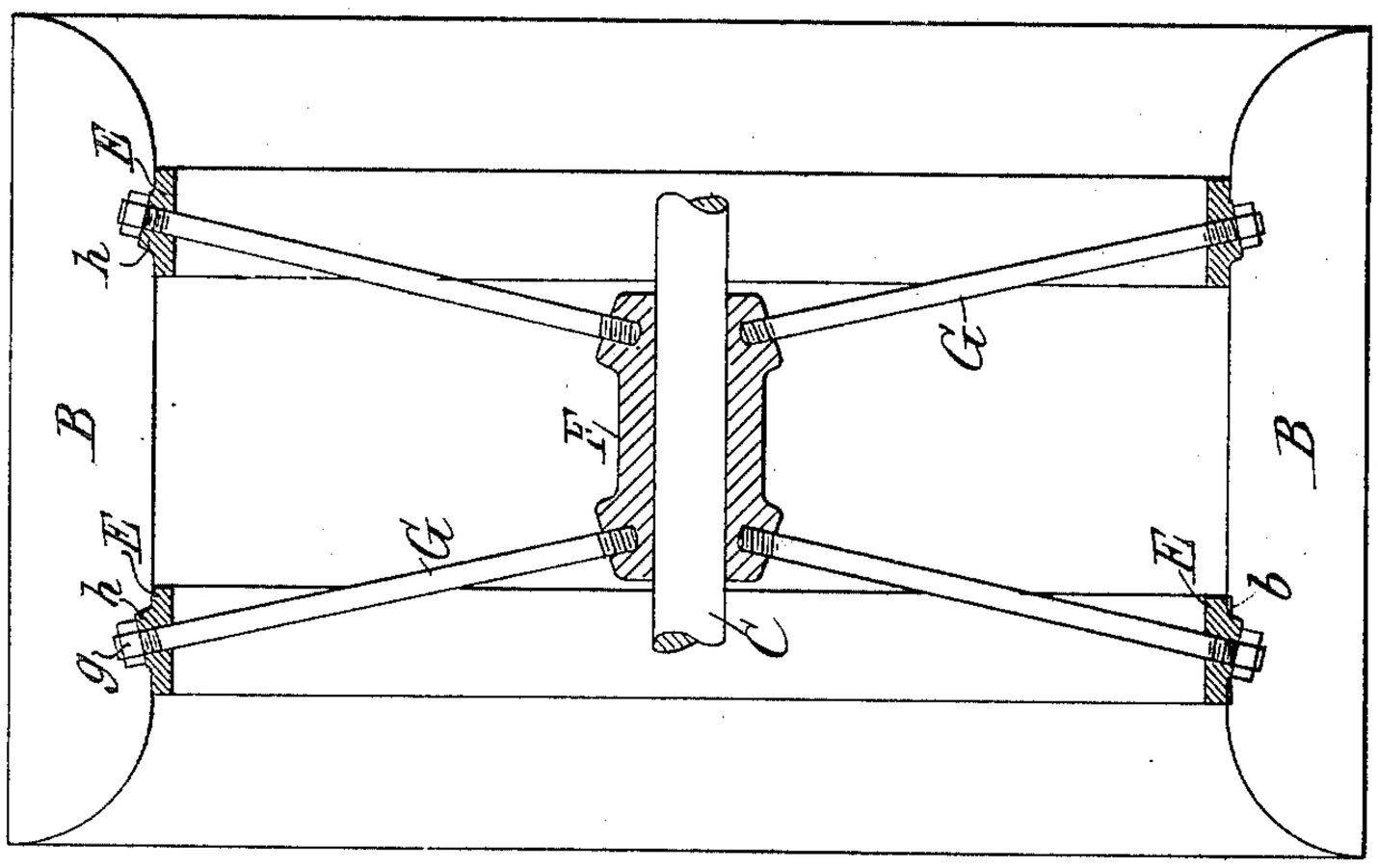
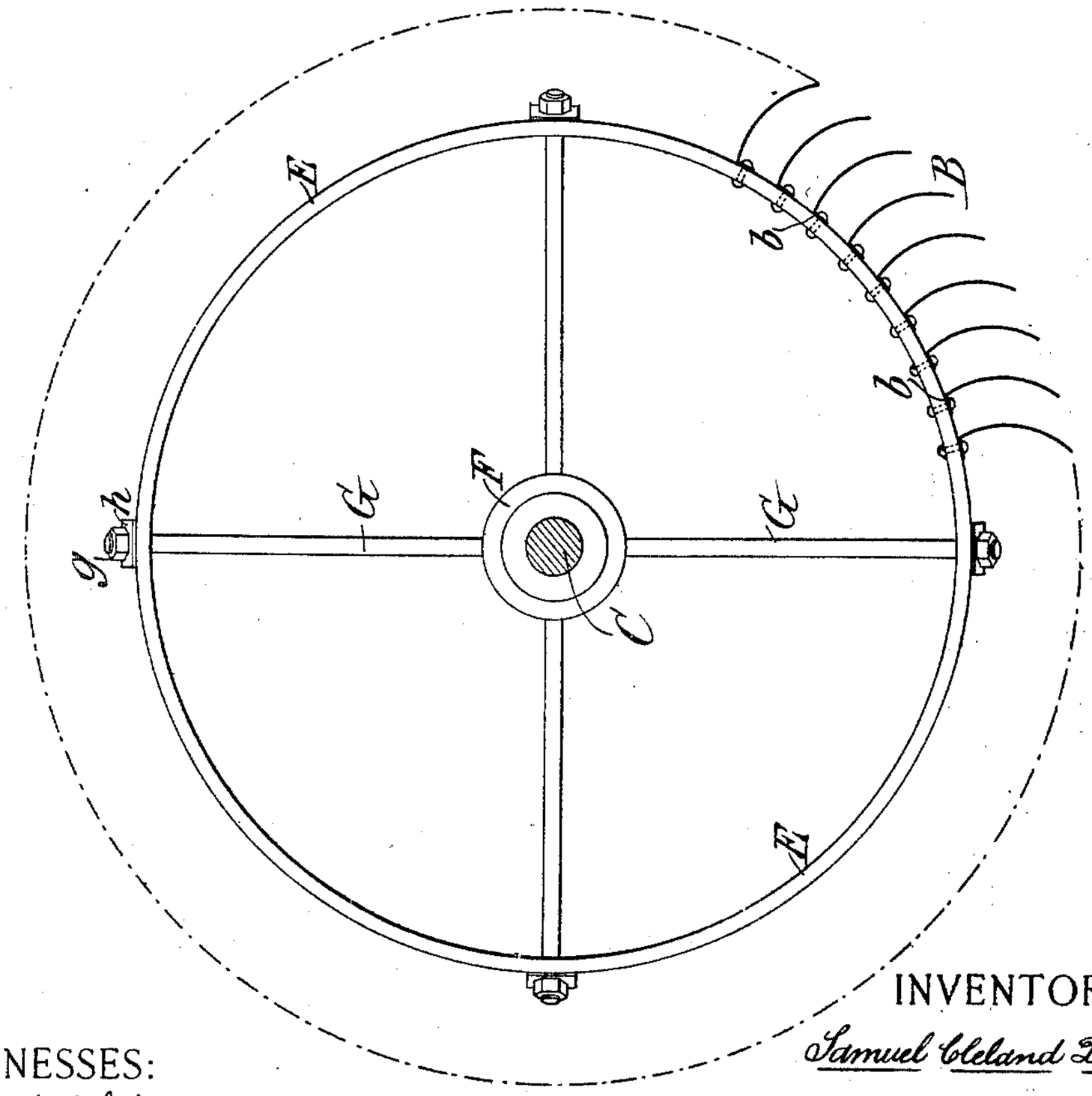


FIG. 7.



WITNESSES:
Fred White
Thomas F. Wallace

INVENTOR.
Samuel Cleland Davidson

By Attorneys,
Dustin C. Fraser & Co.

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S. C. DAVIDSON.

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(No Model.) 5 Sheets—Sheet 5.

FIG. 10.

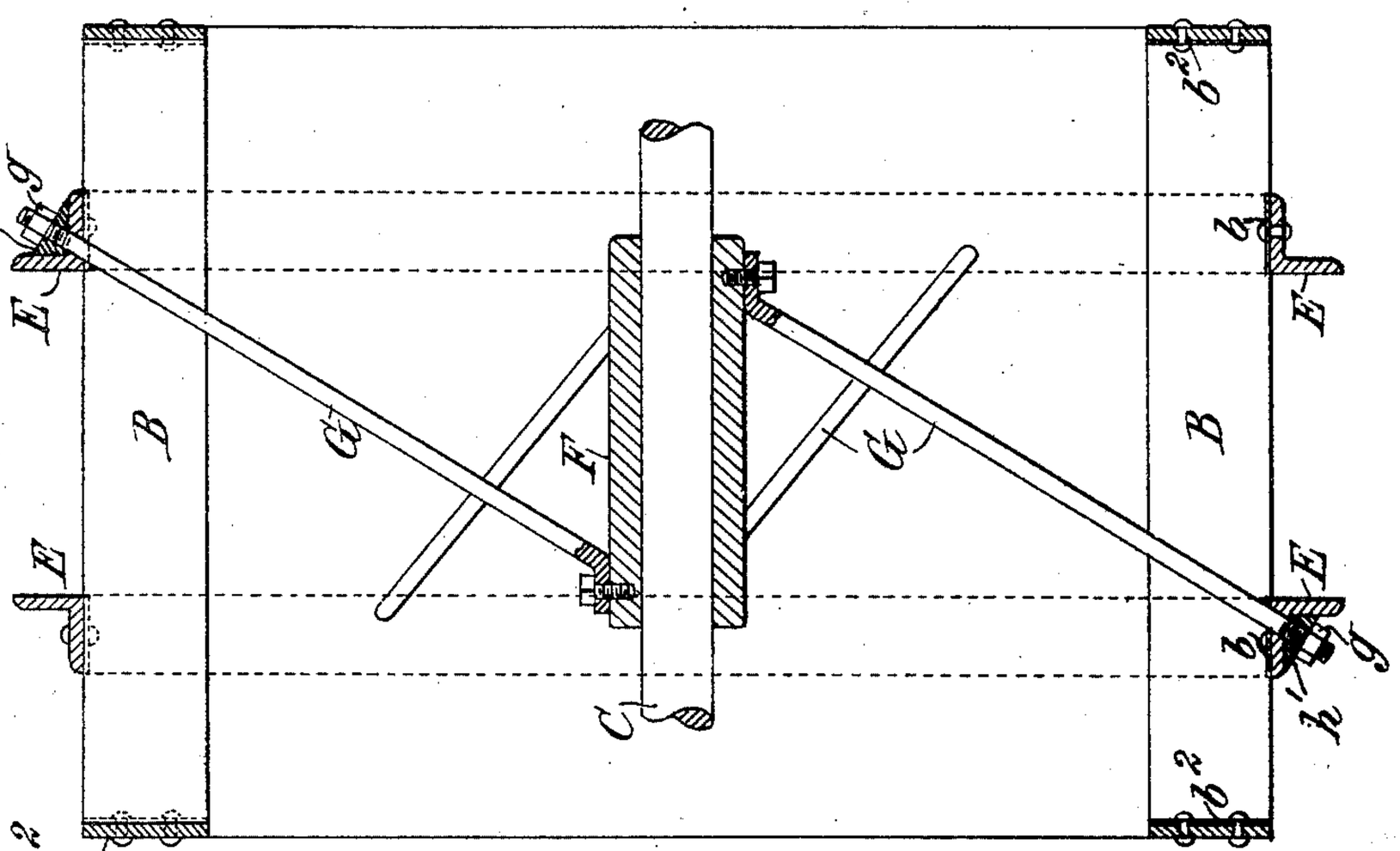
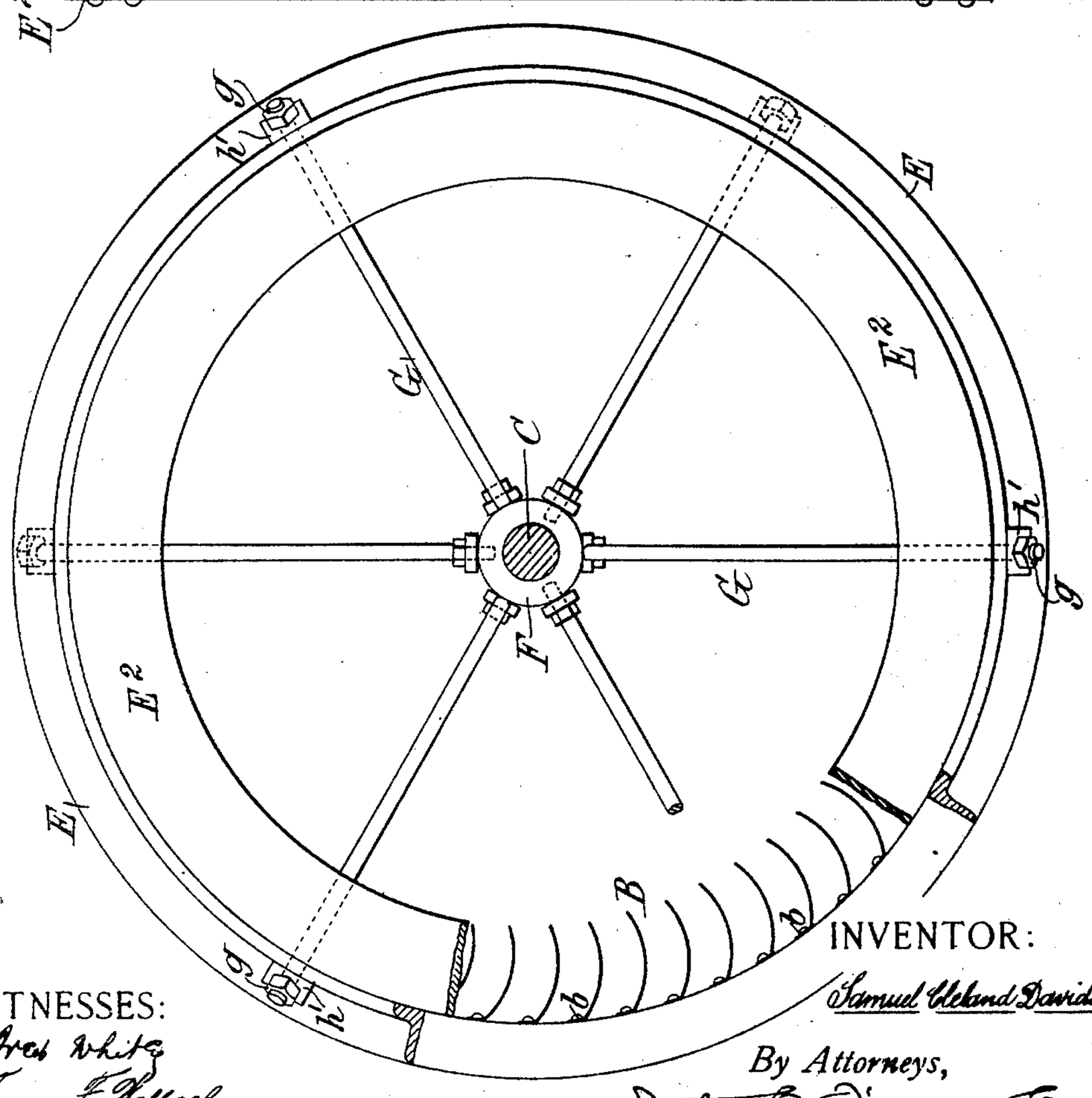


FIG. 9.



WITNESSES:
Fred White
Thomas F. Wallace

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

UNITED STATES PATENT OFFICE.

SAMUEL CLELAND DAVIDSON, OF BELFAST, IRELAND.

ROTARY FAN AND PUMP.

SPECIFICATION forming part of Letters Patent No. 679,499, dated July 30, 1901.

Application filed November 20, 1899. Serial No. 737,597. (No model.)

To all whom it may concern:

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

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.

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 or openings the fluid enters the intake-chamber. 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.

In my application, Serial No. 691,495, filed September 21, 1898, I have shown a fan the rotary member of which is constructed with numerous 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, 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 being so mounted as to permit the tangential escape of the fluid discharged from its blades. My present invention relates to a fan of this type and provides a rotary member which is open at both ends. When combined with a casing or stationary member, the latter is preferably formed with diametrically opposite openings in alinement with the open ends of the rotary member of the fan, so that the fluid operated on may enter the intake-chamber from both ends thereof and be discharged through the circumferential ports which are formed by the spaces between the blades. A central hub is preferably provided which is fixed to the driving-shaft, and the blades are provided with an annular support which preferably engages the edges of the blades at their ends and is connected to such hub by suitable spokes or stays, so that the blades are centrally supported. Such spokes or stays are made adjustable, so that the blades may be drawn into concentric relation with the hub. 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 six 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 the blades are shown as formed as curved plates, with their outer edges turned forward in the direction of rotation. The particular form of blades is, however, immaterial to my present invention. 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 about 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 six or more times such depth. 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 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 eyes 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 may be proportionately increased without loss of velocity in the flow of the fluid.

Fans or pumps constructed according to my present invention may be employed with any fluids, either gaseous or liquid—as, for instance, with air or water.

In the drawings, in which I have shown several forms of my invention, Figure 1 is a vertical mid-section of the preferred form of my invention, taken on the line 1 1 in Fig. 2 and showing the rotary member mounted in a suitable casing. Fig. 2 is a vertical section taken on the line 2 2 in Fig. 1. The remaining figures show the rotary member of the fan removed from the casing and on a larger scale. Fig. 3 is a mid cross-section, and Fig. 4 is a diametrical section, of the construction shown in Figs. 1 and 2. Fig. 5 is an end view, and Fig. 6 is a diametrical section, of a modified construction in which the fan-blades are supported at two points inwardly of their ends by encircling rings. Fig. 7 is an end view, and Fig. 8 a diametrical section, of a modification in which the blades are supported upon two rings arranged interiorly of the blades. Fig. 9 is an end view, and Fig. 10 is a diametrical section, of a modification in which the ports between the blades are closed.

In the drawings, A is the rotary member or fan; B, its blades; C, its operating-shaft, and D a casing within which the fan A is mounted.

Referring first to Figs. 1 to 4, inclusive, I will describe the preferred form of my invention. The fan or rotary member A comprises a number of thin blades B, arranged, preferably in drum form, or substantially so, and shown as extending with their largest dimension in a direction approximately parallel with the axis of rotation. The length of the blades is relatively great as compared with their depth, and they are arranged closely together, as shown, so that a relatively large number is employed in a given diameter of fan. They may be curved, as shown, and their ends may be rounded, although these features are not essential to my present invention. The blades inclose an intake-chamber A′, of relatively large diameter as compared with the common form of fan. The provision of a relatively large intake-chamber in connection with shallow blades following each other at frequent intervals is a distinctive feature of the form of fan shown. 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. 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 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. I prefer to make the intake ends of the blades open or unobstructed, so as to form open-ended ports between them, as shown in Figs. 1 to 8. With this construction of fan I prefer to form the eye or eyes of the casing (when one is used) of equal diameter to that of the fan periphery. The fluid may thus enter freely through such eyes into the open ends of the ports.

The blades are shown in Figs. 1 to 4 as fixed upon the inner sides of two annular supports or rings E E, which encircle the blades at their ends, the latter being secured to the rings by rivets passing through the rings and through flanges *b*, formed on the ends of the blades. Any other suitable means of fastening the blades to the supports may be employed. The latter are preferably formed with perpendicular flanges *e*, so as to stiffen them and make them better resist the strains of use.

The fan is connected to its hub F by stays G, of which eight are shown, and which at their inner ends are suitably fastened to the hub, preferably by screws, as shown. At their outer ends the stays G engage the rings or supports E E, preferably by passing through plates or brackets H, fixed to said supports, being secured to said brackets by nuts *g*. The rotary member or fan may be trued or drawn to concentric form by the nuts *g* during manufacture or subsequently in case the rotary fan or any part thereof assumes a position eccentric to its operating-shaft. By the construction just described the rotary fan is supported in a very strong and lasting manner, and it will be observed that as it is held from a central hub the fan is balanced—that is to say, the pressure of the air and the strain of centrifugal force act substantially alike upon both ends of the fan

and the tendency to distortion is to a large extent avoided. While fans of this construction may be operated with good results within a casing with a single eye, I prefer that the intake to the rotary fan shall be through both ends thereof. I therefore form the casing D with two eyes *d d*, which are oppositely arranged and are of a diameter equal to that of the intake-chamber, or preferably when the ports between the blades of the fan are open at their ends the eyes may advantageously be of the full exterior diameter of the fan. These ports may be closed at their ends, as shown in Figs. 9 and 10; but in that case the efficiency of the fan is somewhat decreased. Each of the eyes *d* is preferably provided with a mouth or funnel *d'* for directing the air into the eyes. The shaft-bearings I may be constructed and supported in any suitable way. Preferably they are connected to the mouths *d'* by suitable braces J, as shown in Fig. 2. This construction of bearings is set forth in my Patent No. 630,529, granted August 8, 1899.

The preferred form of my invention, where the fan takes in air at both ends of the intake-chamber, has the important advantage of practically increasing the intake-opening with a given diameter of fan, and hence the volumetric efficiency of the fan may be increased by increasing its length, the diameter remaining the same.

In Figs. 5 and 6 I have shown a modified form of my invention in which the supports E are arranged inwardly of the ends of the blades, being formed, preferably, with inclined bearing-faces *h*, which are engaged by the nuts *g* on the stays G.

Figs. 7 and 8 illustrate a modified construction of Figs. 5 and 6 in that the supports are arranged interiorly of the fan-blades and engage the inner edges of the blades. The flanges *b* are here formed on the inner edges of the blades and are riveted to the supports in the manner before described.

In the construction shown in Figs. 9 and 10 the supports E E are arranged on the outer edges of the blades inwardly of their ends in a manner similar to the construction shown in Figs. 5 and 6. In this case loose triangular blocks *h'* may be placed on the supports E E to form bearing-faces for the nuts *g* of the stays G. The spaces or ports between the blades B are shown as closed by the supports E^2, the latter constituting flat rings arranged at the ends of the blades. The blades in this case are preferably formed with square ends which are formed with suitable flanges b^2, by which they are connected to the rings E^2 by rivets, as shown. While ordinarily I prefer that the ports between the blades should be open, yet when operating upon a heavy fluid, as water, I find that the construction just described is advantageous, because the ends of the blades are thus strongly and rigidly supported.

It is essential 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 any material 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. I use the expression "in transverse section arranged relatively to the axis and direction of rotation to carry the fluid with them rotatively and discharge it tangentially" to exclude such rearwardly-inclined or wedging blades and include generically any form of blade adapted to act upon the air by rotating or whirling it, thus including blades which are substantially radial as well as those which incline forwardly and either flat, curved, or angled.

The operation of the fan shown 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.

It is 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.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. A centrifugal fan or pump, comprising a rotary member having 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 in transverse section arranged, relatively to the axis and direction of rotation, to carry the fluid with them rotatively and discharge it tangentially, said rotary

member being open at both ends, so that the fluid operated on may be taken in axially through both ends thereof, and having a hub, annular supports engaging the outer edges of said blades and adjustable stays connecting said supports with said hub, and a means for so mounting said rotary member as to permit the tangential escape of the fluid discharged from said blades.

2. A centrifugal fan or pump, comprising a rotary member having 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 in transverse section arranged, relatively to the axis and direction of rotation, to carry the fluid with them rotatively and discharge it tangentially, said rotary member being open at both ends, so that the fluid operated on may be taken in axially through both ends thereof, and having a hub, annular supports engaging said blades at their ends, and adjustable stays connecting said supports with said hub, and a means for so mounting said rotary member as to permit the tangential escape of the fluid discharged from said blades.

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

SAMUEL CLELAND DAVIDSON.

Witnesses:
HUGH TAYLOR COULTER,
ARTHUR C. FRASER.