No. 705,046. Patented July 22, 1902.

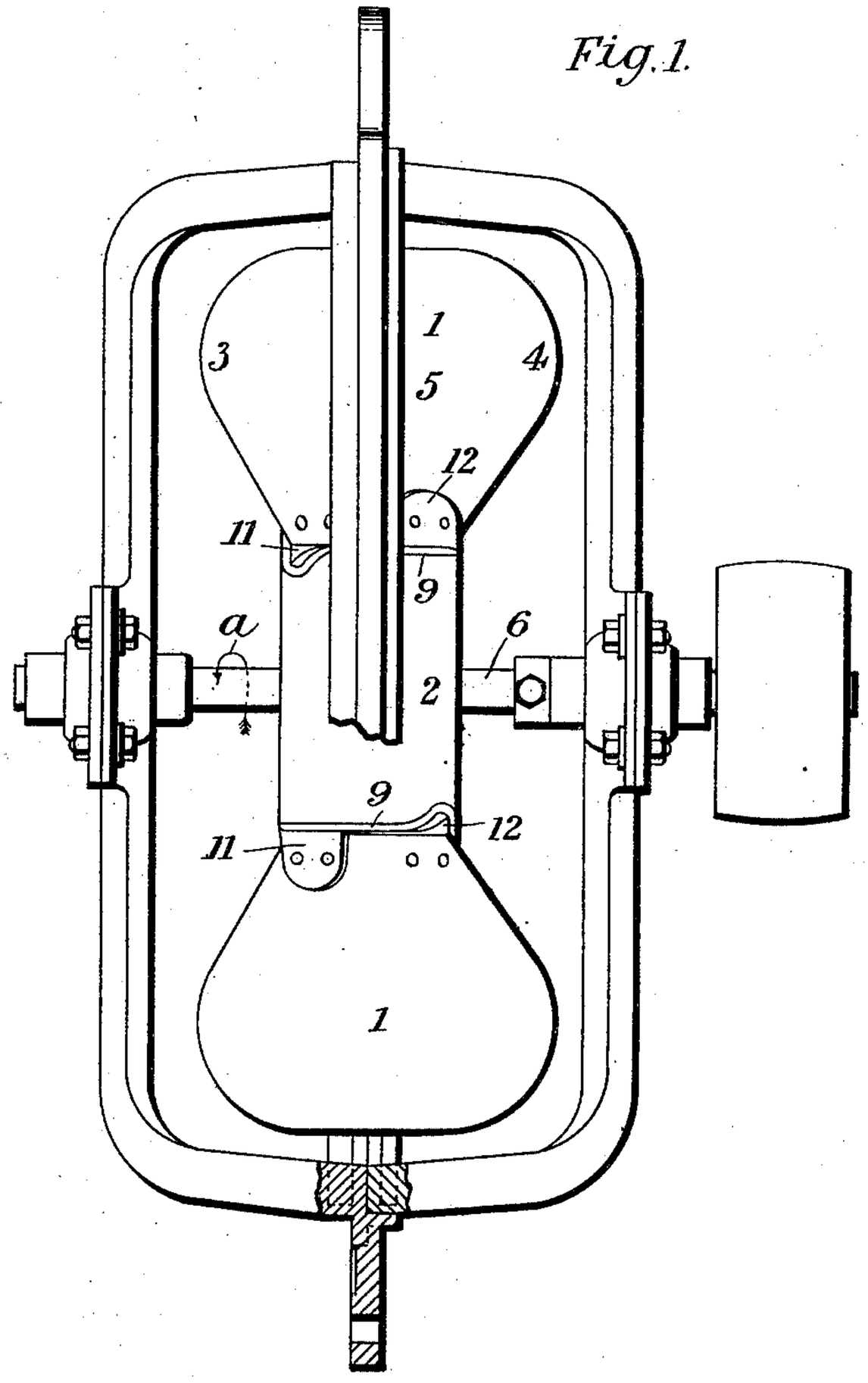
S. C. DAVIDSON.

ROTARY PROPELLER FAN AND PROPELLER FOR SHIPS.

(Application filed Apr. 6, 1901.)

(No Model.) 6 Sheets—Sheet 1.

Fig. 1.



WITNESSES:

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René Bruine

INVENTOR:

Samuel Cleland Davidson,

By his Attorneys:

Duhm & O'Brien

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Fig. 2.

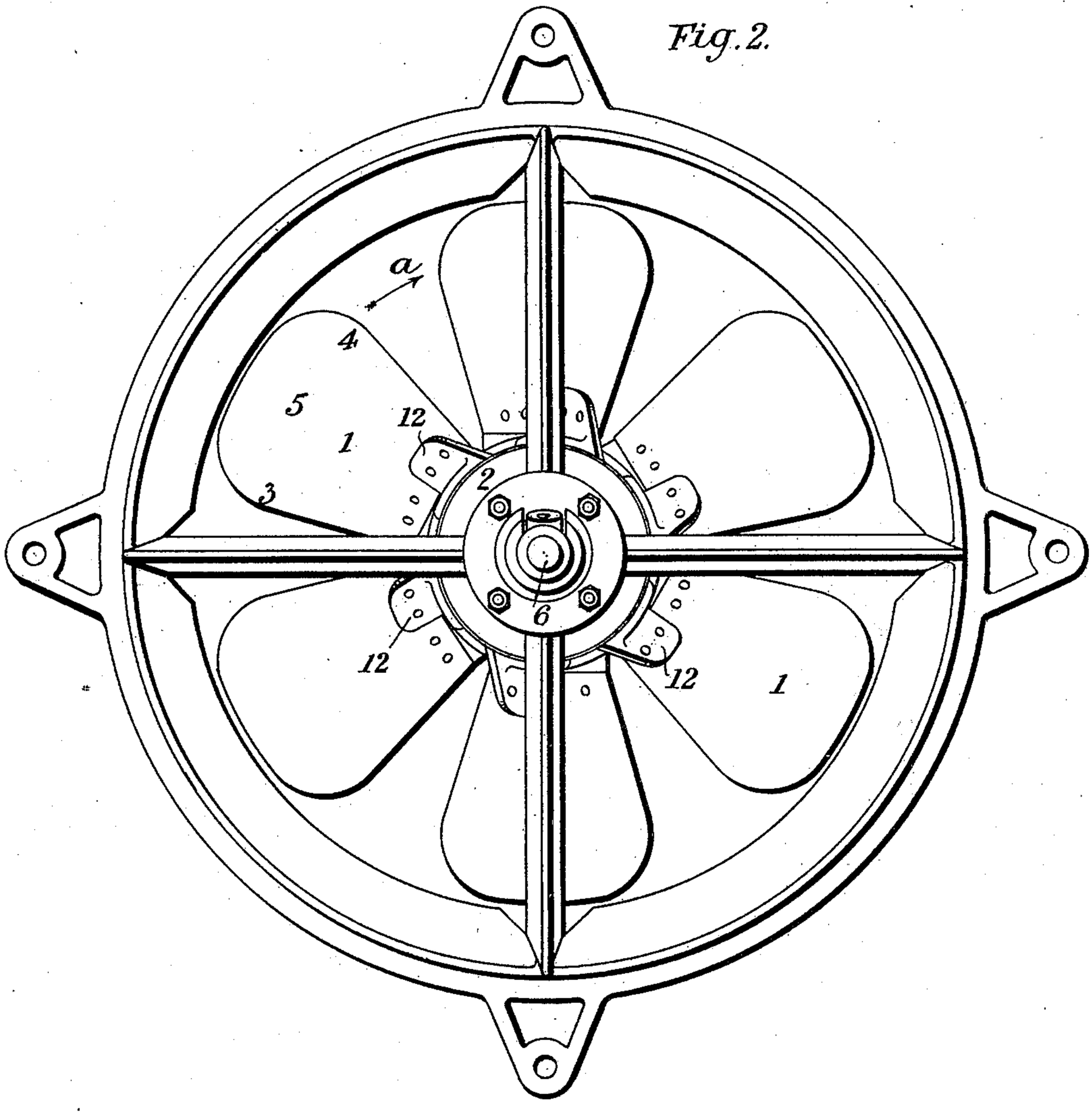

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Fig. 3.

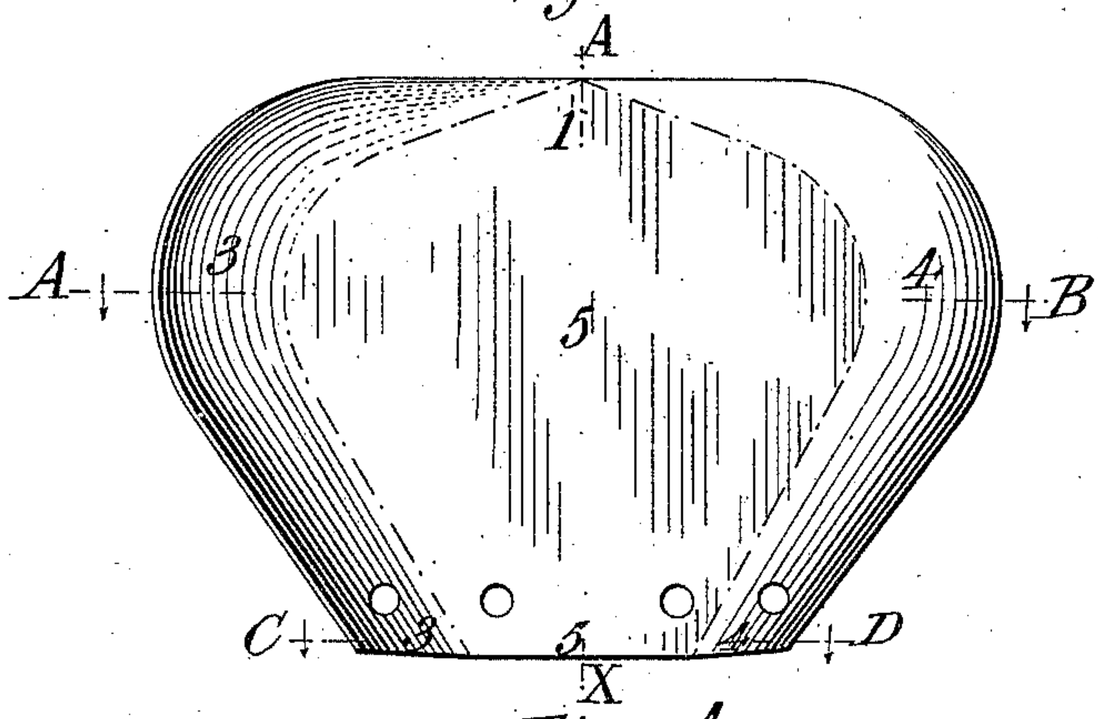


Fig. 3a

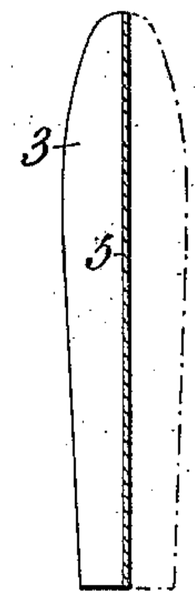


Fig. 4.

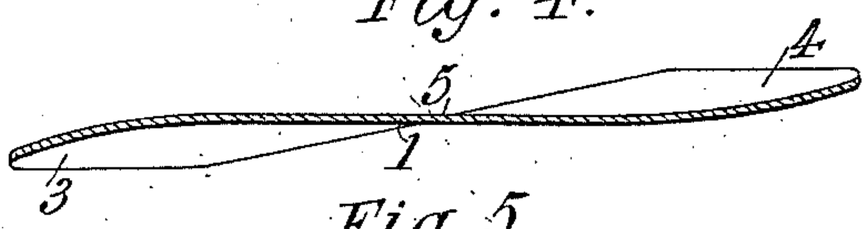


Fig. 5.

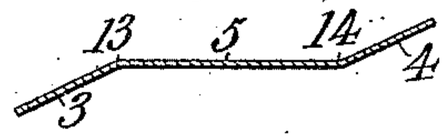


Fig. 6.

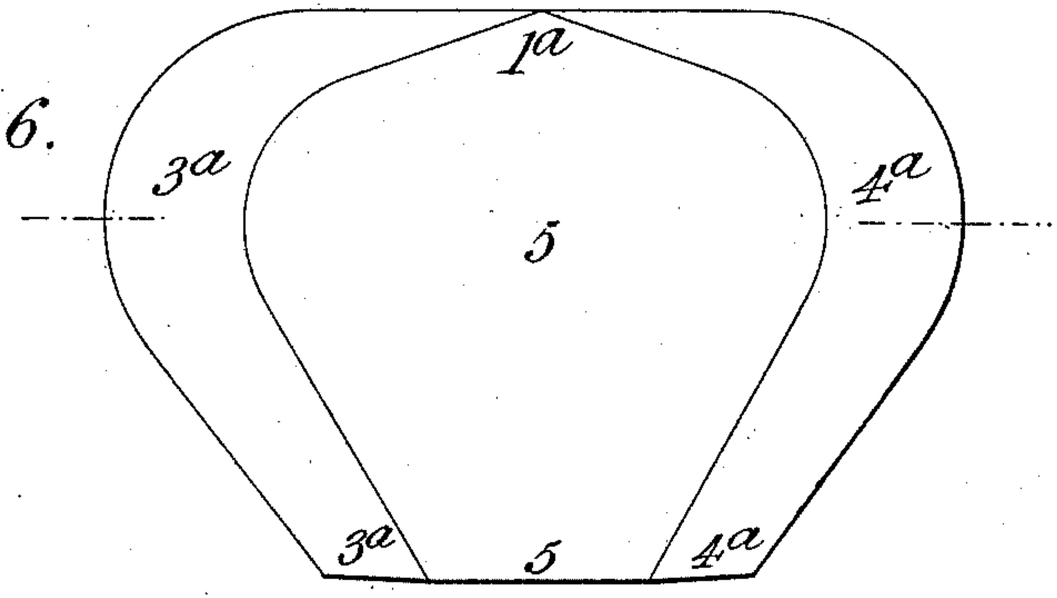


Fig. 7.

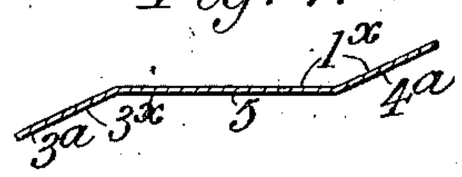
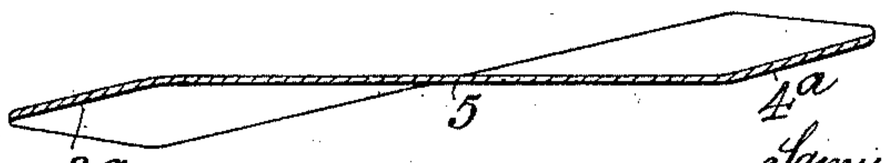


Fig. 8.



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No. 705,046. Patented July 22, 1902.

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Fig. 9.

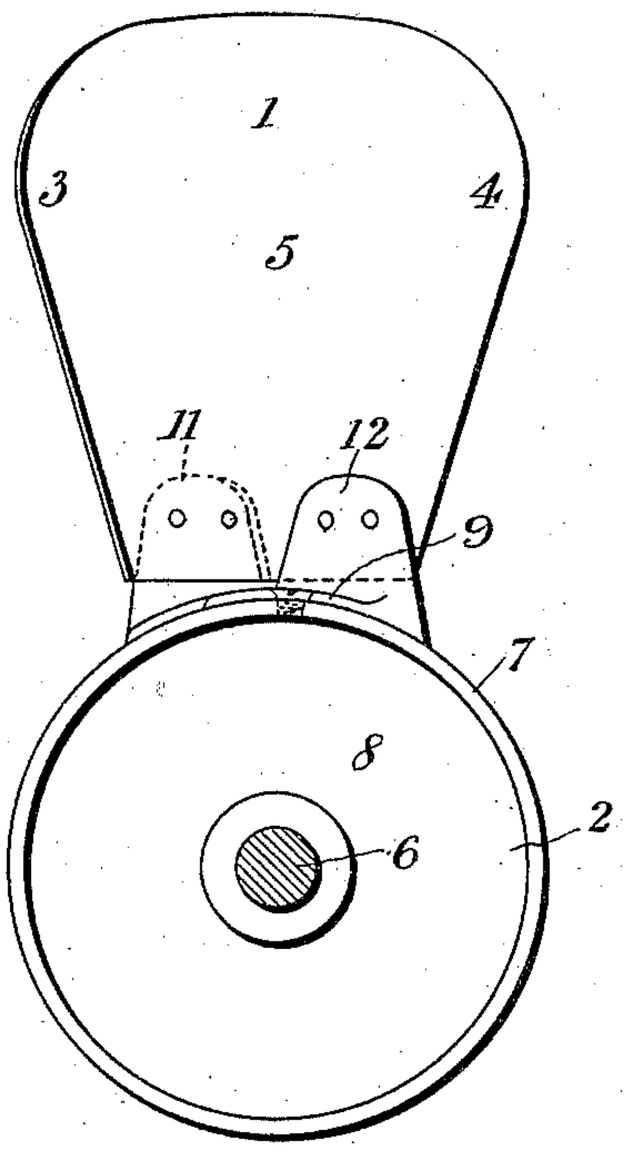


Fig. 11.

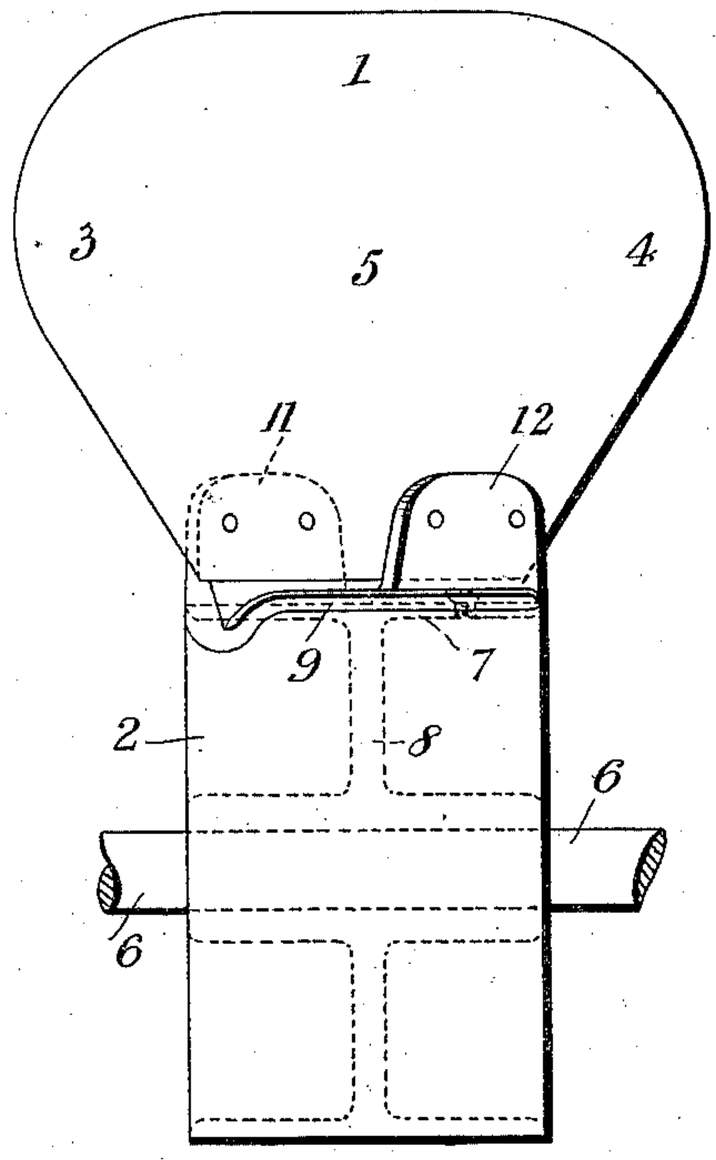


Fig. 10.

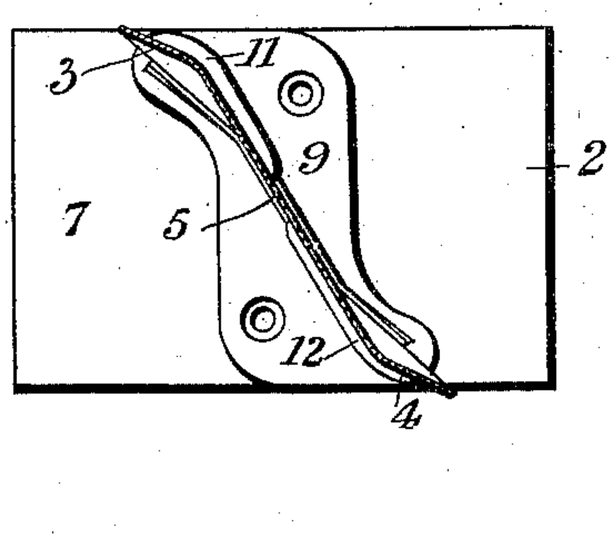


Fig. 12.

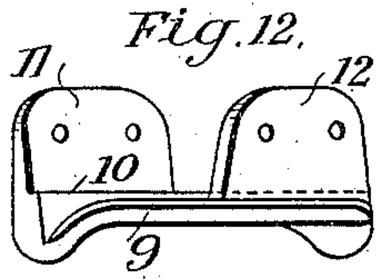
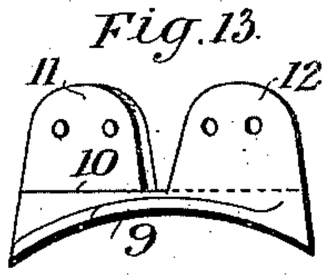


Fig. 13.



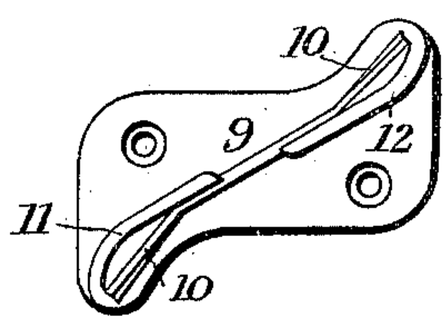


Fig. 14.

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No. 705,046. Patented July 22, 1902.

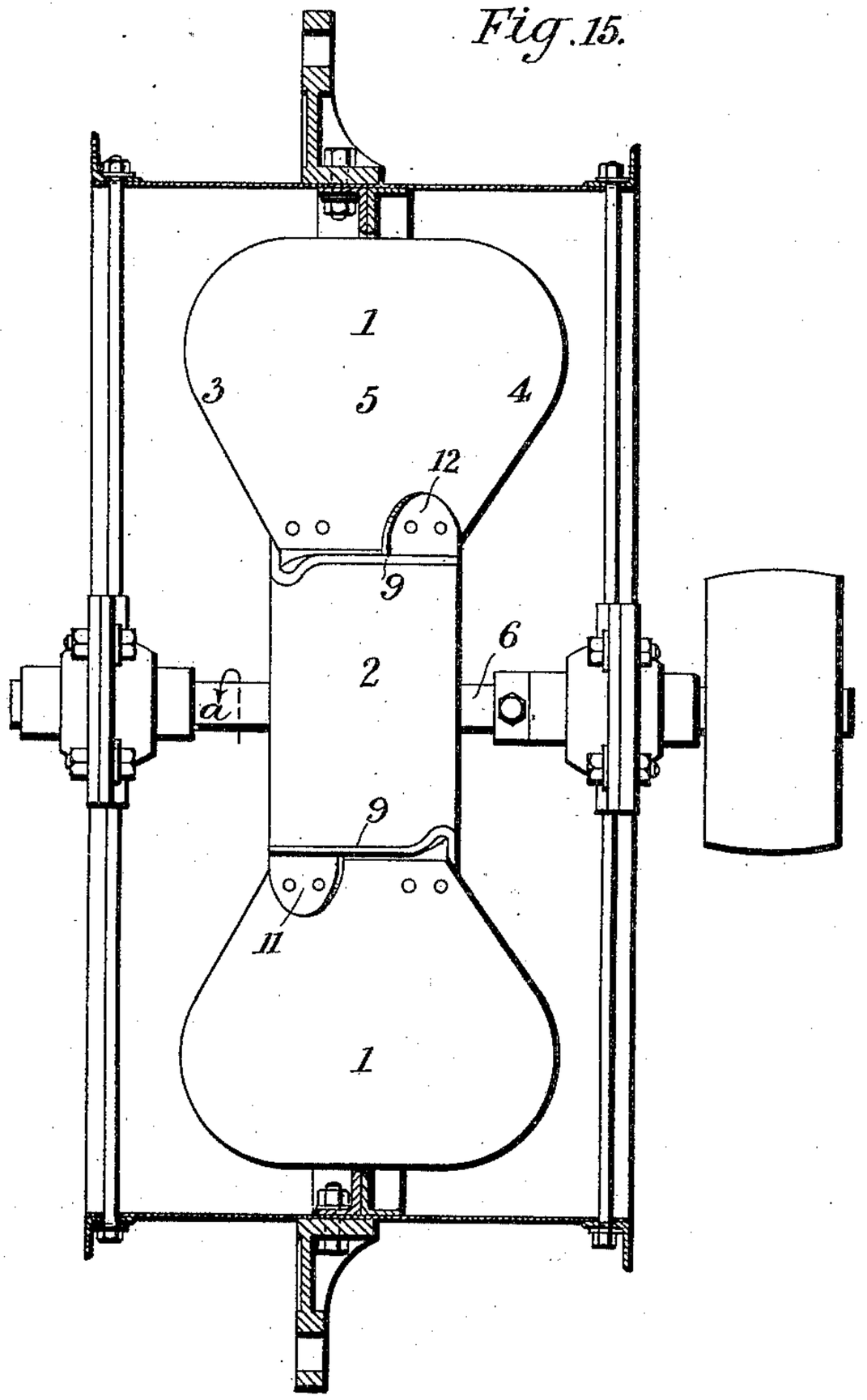
S. C. DAVIDSON.

ROTARY PROPELLER FAN AND PROPELLER FOR SHIPS.

(Application filed Apr. 6, 1901.)

(No Model.) 6 Sheets—Sheet 5.

Fig. 15.



WITNESSES:

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No. 705,046. Patented July 22, 1902.

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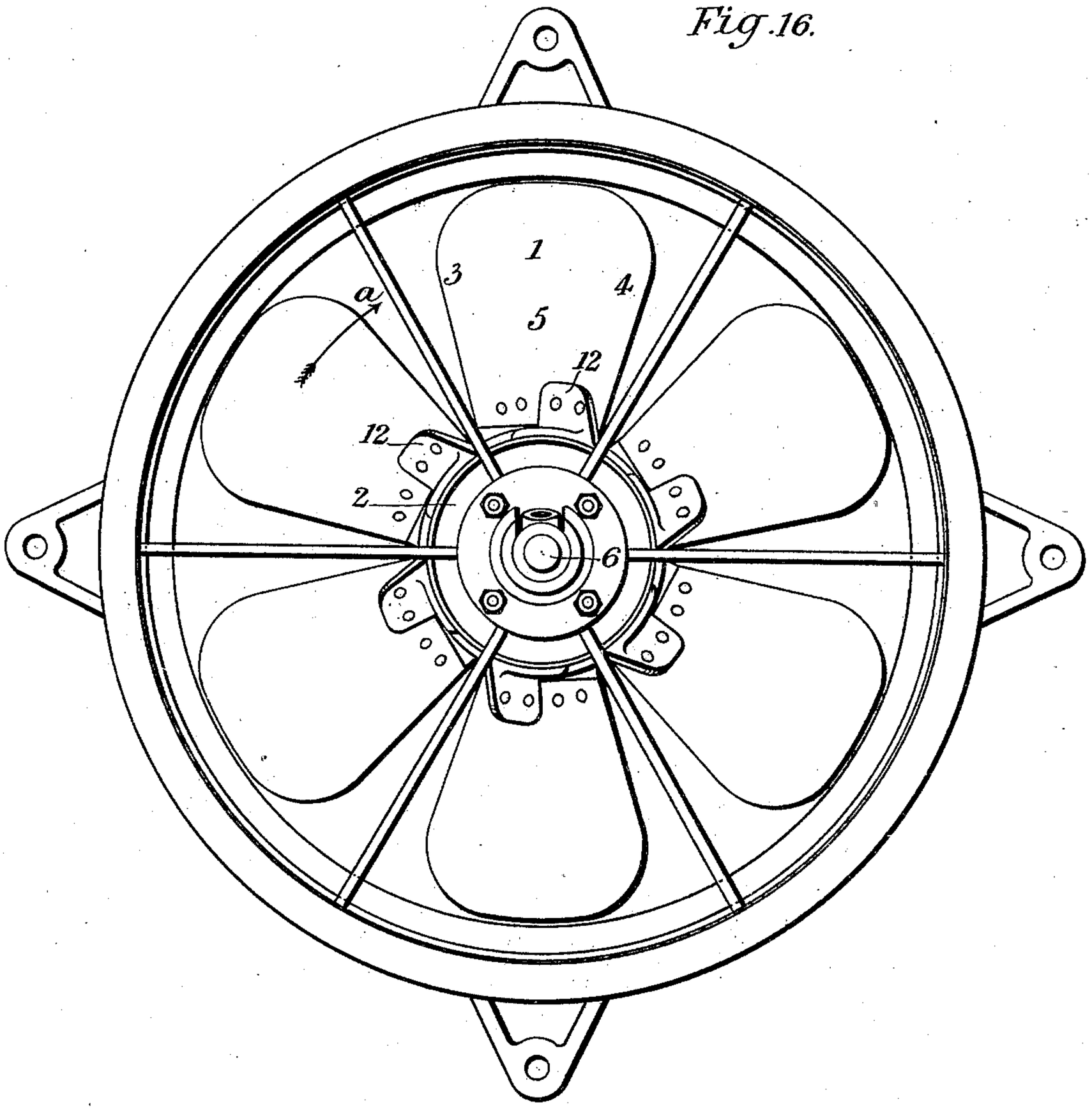
(Application filed Apr. 6, 1901.)

(No Model.) 6 Sheets—Sheet 6.

Fig. 16.



WITNESSES:

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René Bruine

INVENTOR:

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UNITED STATES PATENT OFFICE.

SAMUEL CLELAND DAVIDSON, OF BELFAST, IRELAND.

ROTARY PROPELLER-FAN AND PROPELLER FOR SHIPS.

SPECIFICATION forming part of Letters Patent No. 705,046, dated July 22, 1902.

Application filed April 6, 1901. Serial No. 54,651. (No model.)

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 Rotary Propeller-Fans and Propellers for Ships, of which the following is a specification.

My improvements relate to rotary propeller-fans and to screw-propellers for ships (hereinafter referred to as "propeller-fans") in which the fluid operated on (which may be either gaseous or liquid—as for instance, air or water) passes between and is discharged from the blades in a direction approximately parallel to the axis of the fan-shaft. A typical construction of such propeller-fans as hitherto known comprises thin blades arranged in a circle around a central hub, said blades being arranged in screw fashion on said hub. My improvements relate more particularly to the form and construction of the blades of said propeller-fans and to the means for mounting them on the fan-hub, the objects thereof being to increase the operative efficiency of the blades and to simplify the construction of the fan as a whole, while maintaining therein ample strength and stiffness for their practical operation.

My invention further comprises improved means for attaching and mounting the blades on the fan-hub.

In the accompanying drawings, Figure 1 is a side elevation of my propeller-fan carried in a cast-iron frame. Fig. 2 is an end view of Fig. 1. Figs. 3, 3ª, 4, and 5 are separate views of one modification of a fan-blade, in which the axial extremities of the blade are of concavo-convex or spoon-shape formation, Fig. 3 being a front elevation of the blade, Fig. 3ª a longitudinal section of the blade through its flat middle portion on the line A X of Fig. 3, Fig. 4 a section on the line A B of Fig. 3, and Fig. 5 a section on the line C D of Fig. 3. Figs. 6, 7, and 8 are corresponding views of another modification of blade. Figs. 9, 10, and 11 are respectively an end elevation, a plan, and a front elevation of a blade mounted in position on the fan-hub. Figs. 12, 13, 14 are respectively a side elevation, an end elevation, and a plan of a blade-holder. Figs. 15 and 16 are respectively a side elevation and an end view of my propeller-fan carried in a frame constructed of iron or steel sheets mounted on angle or T iron rings. Figs. 3 to 14, inclusive, are drawn to a larger scale than Figs. 1, 2 and 15, 16.

The blades 1 of my improved propeller-fans may be constructed of either sheet or cast metal, according to requirements, and are in outline preferably shaped somewhat like one of the triple members of the leaf of a trefoil or clover-plant, the widest part of their measurement parallel with the fan-shaft being nearer to the periphery than to the axis of the fan; but I do not limit my invention to constructing said blades with this particular outline of shape, as for some special purposes wherein a relatively higher pressure with lower volumetric output are required I reduce the radial measurement—namely, from the hub to the tip of the blade—by increasing the diameter of the hub, which thus makes their measurement parallel with the fan-shaft greater relatively to their radial measurement, and while still retaining in their construction the essential features (as hereinafter more particularly described) on which their improved efficiency depends their shape in outline is thereby equivalently altered. Each of the blades 1 is mounted diagonally—that is to say, at an angle with the plane of the fan's revolution upon the fan-hub 2—and the leading edges 3 of the blades (according to the direction in which the fan is rotated, as indicated by the arrow *a*) are hereinafter referred to as the "intake" edges and the opposite or trailing edges 4 as the "discharge" edges. The central part 5 of the blades between their intake and discharge edges is formed from the hub end to the outer tip of the blade as an approximately flat radial plane, which is mounted on the hub at any suitable transverse angle relatively to the fan-shaft 6. The axial extremities of the blade—namely, the intake and discharge edges 3 4 thereof—are oppositely curved relatively to each other by being formed as oppositely-dished surfaces of concavo-convex form, like the end of a spoon, from approximately the middle part of the peripheral edge (marked 1ª in Fig. 6) of the blade around the margin thereof to the hub or axle (in this case the hub) on which the blade is mounted in such manner that the ad-

vancing surface of the blade is at the intake edge substantially concave and at the discharge edge substantially convex, or, as shown in Figs. 6, 7, and 8, said axial extremities may be formed as oppositely-angled surfaces 3^a and 4^a, respectively, adjusted to an obtuse angle or curve relatively to the central surface 5 of the blade, said angle or curve at $3^\times$ at the intake edge being substantially the same as, but in the opposite direction to, the angle or curve at $1^\times$ of the discharge edge. The operative effect of this construction of said blades is that the front or advancing surfaces 3 and 5 thereof press against the fluid, and their forwardly-bent margins, as it were, scoop it in and push it forward from the intake edges 3 toward the center of the plane portion 5 on its way to the discharge edges 4. At the same time the rotary forward movement of the blade produces a partial vacuum at back of the intake edges 3 of the blades, into which fluid is drawn, so that the concavity of the front and convexity of the back of the intake edges 3 of the blades coöperate to produce a combined and convergingly-directed flow of the fluid on both sides of the blade toward the flat central part 5 thereof, where it is, as it were, focused or concentrated, and from this point the convexity of the advancing surface of the discharge edge 4 of the blade and the concavity on back thereof have a divergent or diffusive action on this flow, which propels the fluid from both sides of the discharge edges 4 of the blades with a minimum of shock.

It will be obvious, owing to the construction of the blades as hereinbefore described, that if the direction of rotation of my improved propeller-fans be reversed then what were the discharge edges of the blades will become their intake edges, with the concave side thereof on the advancing face, and what were the intake edges will become the discharge edges, with the convex side thereof on the advancing face, so that by merely rotating the fan in one direction or the other the fluid operated on can be propelled with equal efficiency in either direction, as required.

The form of hub 2 which I employ may be described as a cylinder or pulley, Figs. 9, 10, 11, with its circumferential face 7 extending axially on one or both sides of an approximately central supporting-disk 8 or arms connected to a boss which is bored to fit the rotating shaft on which the hub as a whole is mounted.

The devices or blade-holders which I preferably employ for attaching the blades to the hub consist each of a plate or flat strip 9, Figs. 12, 13, 14, which is shaped to fit evenly upon a portion of the circumferential face of the hub 2 and is formed with a flat projecting strip 10, upon which the inner end of one blade rests. The plate 9 is also formed with two lugs 11 12, projecting radially therefrom and so adjusted as to accurately hold the blade thereon at the required angular pitch or inclination to the plane of the fan's revolution. One lug 11 is located and shaped to fit evenly against and a short way around the convex side of the meeting angle or curve between the intake edge 3 and the central portion 5 of the blade. The other lug 12 is similarly formed and located around the convex side of the meeting angle or curve between the discharge edge 4 and said central portion 5 of the blade. The lugs 11 12 of the blade-holder are riveted or otherwise firmly secured to the hub end of the blade, and the plate part 9 of the blade-holder is similarly secured to the circumferential face 7 of the hub. The angles or curves of the intake and discharge edges give sufficient strength and stiffness to the blades from the lugs of the blade-holders to the tips of the blades to obviate any requirement for backstays or stiffening-bars, the avoidance of which leaves the surface of the blade on each side smooth and free from obstructive projections to the flow of the fluid, while at same time simplifying the construction of the fan and cheapening its cost of manufacture.

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

1. A rotary propeller-fan or screw-propeller of the disclosed type, in which the intake and discharge edge portions of each blade are formed as oppositely-dished surfaces, from approximately the central part of the peripheral edge of the blade around the margin thereof toward the hub or axle, in such manner that the advancing surface of the blade is, at the intake edge portion, substantially concave, and at the discharge edge portion substantially convex, substantially as hereinbefore described.

2. A rotary propeller-fan or screw-propeller of the disclosed type, in which the intake and discharge edges of each blade are formed as oppositely-dished surfaces, from approximately the central part of the peripheral edge of the blade around the margin thereof toward the hub or axle, the intervening central part of the blade having approximately a plane surface and the dished edge portions inclined toward it in directions approximately perpendicular to the edges of the blade, whereby the intake edge portion of each blade has a converging or focusing action on the fluid operated upon, from the intake edge toward the center of the blade, and the discharge edge portion thereof has a divergent or diffusive action thereon, from said center to its discharging edge, substantially as set forth.

3. A rotary propeller-fan or screw-propeller of the disclosed type, in which the intake and discharge edge portions of each blade are formed as oppositely-dished surfaces, from approximately the central part of the peripheral edge of the blade around the margin thereof toward the hub or axle, in such manner that the advancing surface of the blade is, at the intake edge portion, substantially concave, and at the discharge edge portion

substantially convex, with the intervening central portion of the blade having an approximately plane surface, and the blades arranged with their central portions inclined to the plane of revolution, substantially as set forth.

4. A rotary propeller-fan or screw-propeller of the disclosed type, in which the intake and discharge edge portions of each blade are formed as oppositely-dished surfaces, from approximately the central part of the peripheral edge of the blade around the margin thereof toward the hub or axle, in such manner that the advancing surface of the blade is, at the intake edge portion, substantially concave, and at the discharge edge portion substantially convex, and said dished portions merging gradually into the intermediate central portion of the blade, their surfaces on lines radiating approximately from the center of the blade being curved so that the intake and discharge edge portions of the blade are of concavo-convex form or approximately spoon-shaped, substantially as set forth.

5. A rotary propeller-fan or screw-propeller of the disclosed type, in which the intake and discharge edge portions of each blade are formed as oppositely-dished surfaces, from approximately the central part of the peripheral edge of the blade around the margin thereof toward the hub or axle, in such manner that the advancing surface of the blade is, at the intake edge portion, substantially concave, and at the discharge edge portion substantially convex, and with the intervening central portion of the blade formed with an approximately plane surface, the blades being mounted in screw form around the hub with their intake and discharge edge portions directed at obtuse and substantially equal angles to the plane of revolution, whereby they will operate with approximately equal efficiency in either direction of revolution, substantially as set forth.

6. In screw-propellers and rotary propeller-fans, a hub formed as a cylinder upon which the blades are arranged diagonally, and a series of plates mounted upon said hub each having lugs projecting radially from it upon which the blades are mounted and are held by their inner ends at any required angular pitch or inclination to the plane of the fan's revolution, substantially as set forth.

7. In screw-propellers and rotary propeller-fans, the combination with a hub, and blades arranged diagonally on said hub, of blade-holders each consisting of a plate which is shaped to fit evenly upon a portion of the circumferential face of the hub, with lugs projecting radially therefrom, upon which each of the blades is mounted and is held by its inner end accurately at the required angular pitch or inclination to the plane of the fan's revolution, substantially as set forth.

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

SAMUEL CLELAND DAVIDSON.

Witnesses:
HUGH TAYLOR COULTER,
GEORGE GOOLD WARD.