No. 832,173. PATENTED OCT. 2, 1906.

D. W. TAYLOR.

SCREW PROPELLER.

APPLICATION FILED OCT. 9, 1905.

Fig. 1.

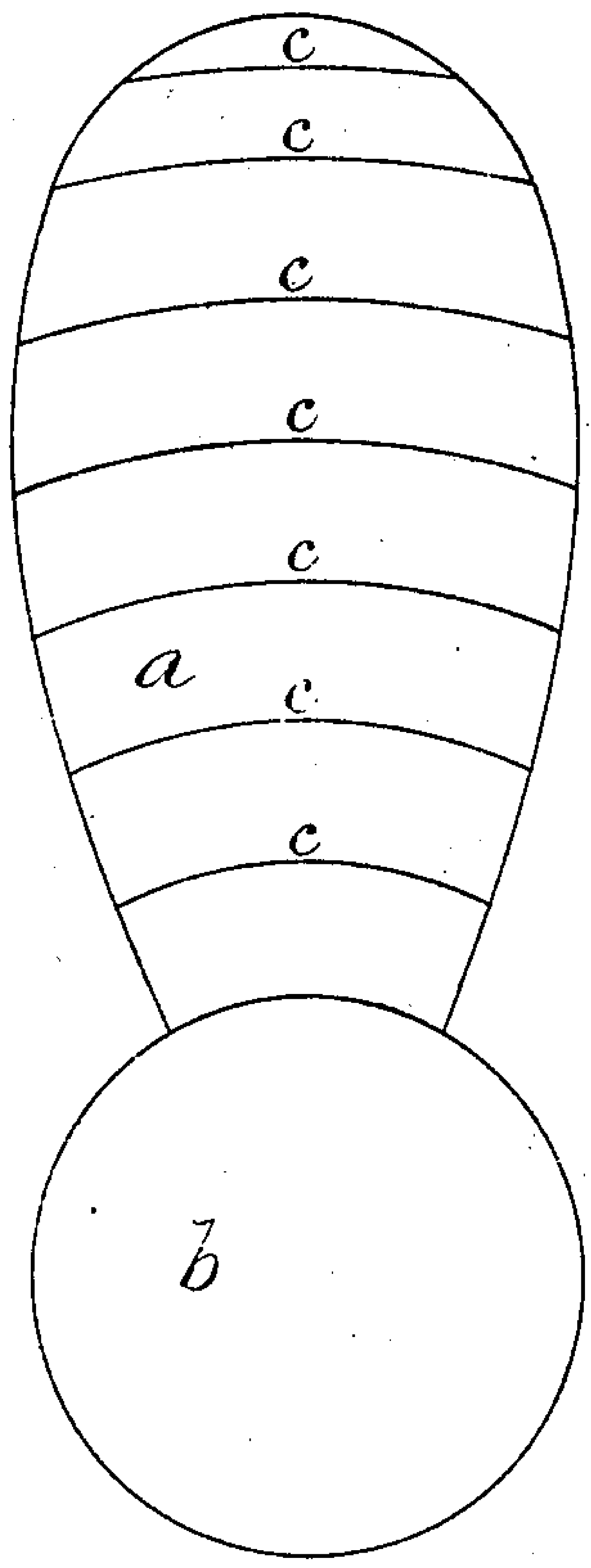


Fig. 2.

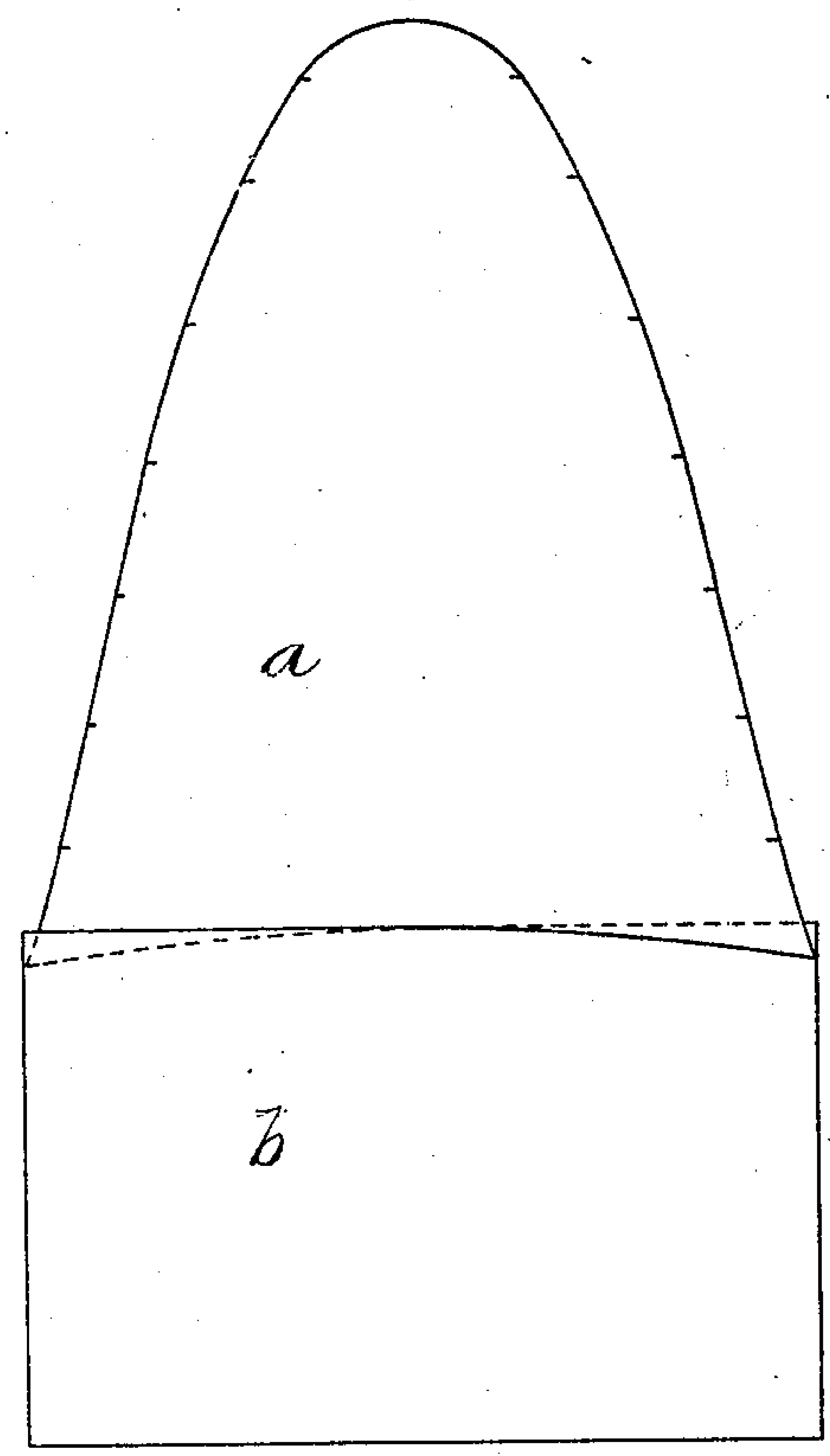


Fig. 4.

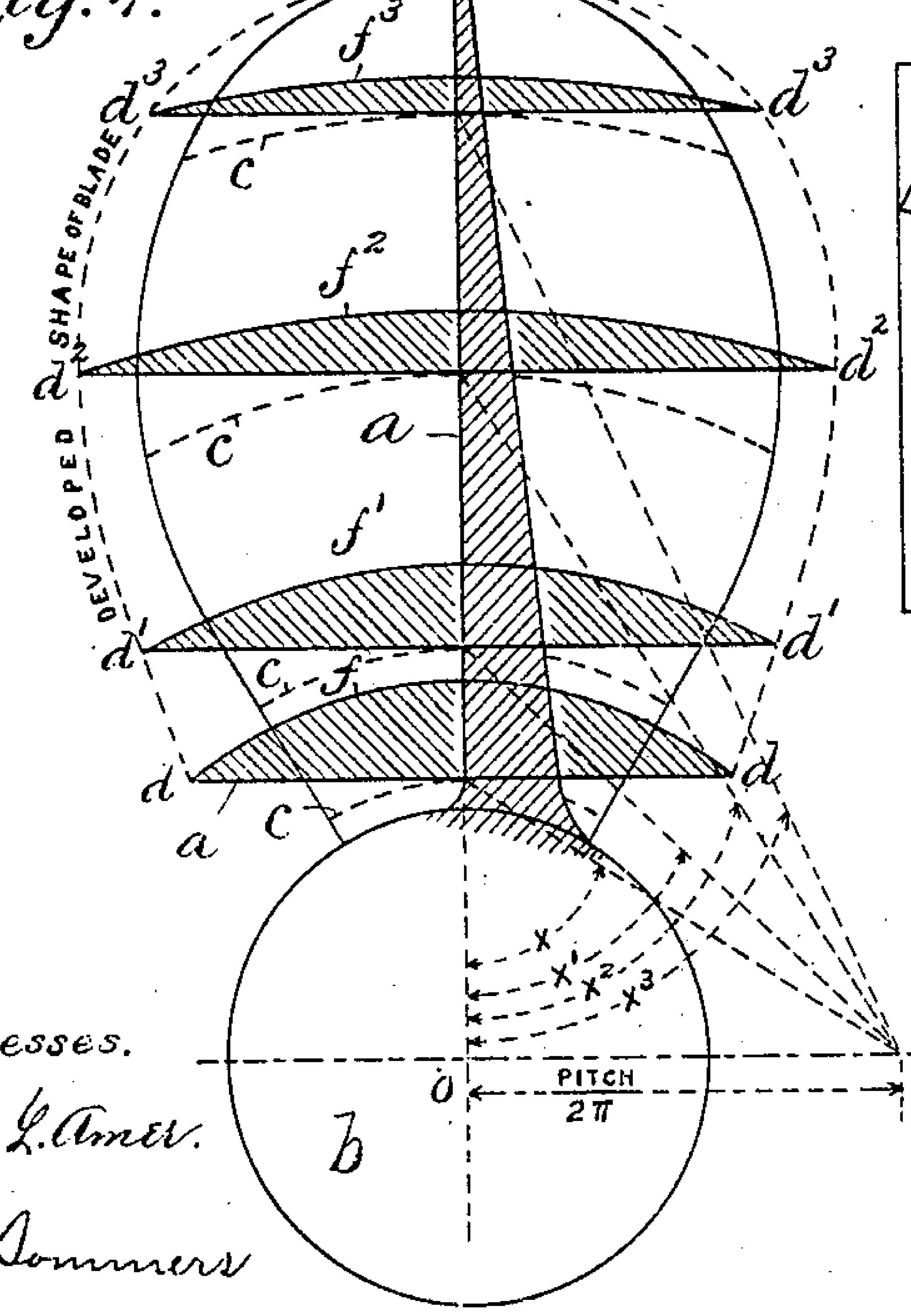


Fig. 3.

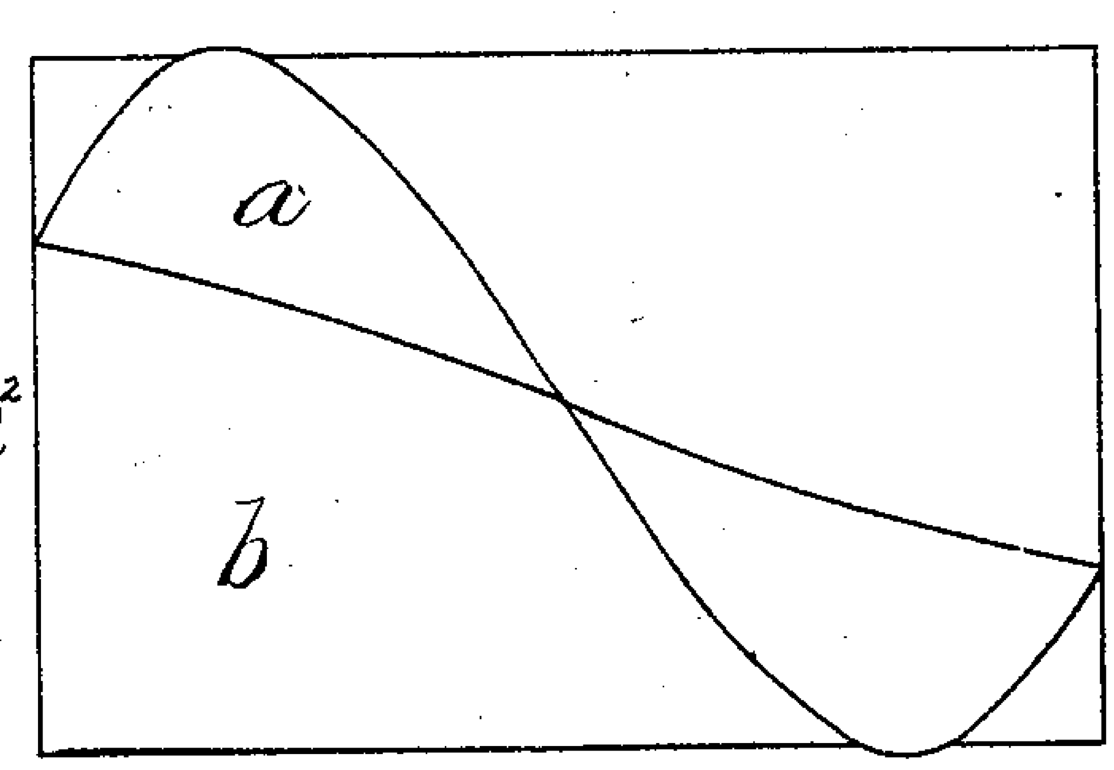


Fig. 5.

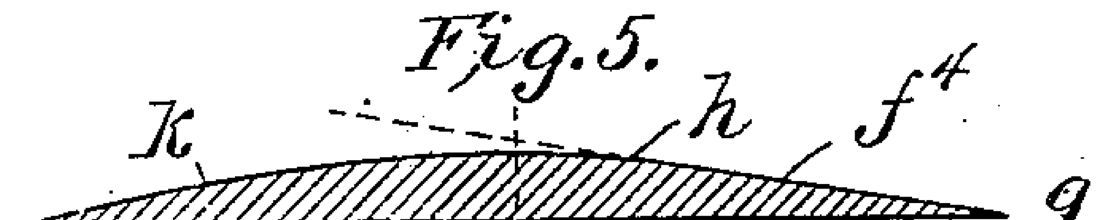
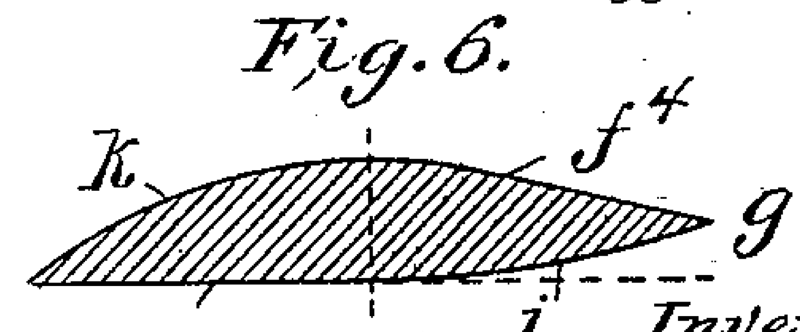


Fig. 6.



Witnesses.

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UNITED STATES PATENT OFFICE.

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SCREW-PROPELLER.

No. 832,173. Specification of Letters Patent. Patented Oct. 2, 1906.

Application filed October 9, 1905. Serial No. 281,964.

To all whom it may concern:

Be it known that I, DAVID WATSON TAYLOR, a citizen of the United States, residing at the United States Navy Yard, in the city of Washington, District of Columbia, have invented certain new and useful Improvements in Screw-Propellers, of which the following is a specification.

My invention relates to screw-propellers, and has for its object to increase the efficiency of the blades as well as to prevent as much as possible what is known as "cavitation."

Referring to the drawings, in which like parts are similarly designated, Figure 1 illustrates a true helicoidal blade viewed fore and aft. Fig. 2 is a view of the same athwartships. Fig. 3 is a plan of said blade. Fig. 4 is a blade having a true helicoidal face and rounded back, as shown by the developed sections. Fig. 5 shows the developed section of a blade where the face is a true helicoid and the leading side also a true helicoid of less pitch than the face, both meeting at the leading edge. Fig. 6 is a like section taken where the blade is so thick that the helicoidal face at the leading side does not meet the helicoidal side of the back, but has to be rounded off to meet the back at the leading edge.

In describing screw-propellers confusion often arises, owing to the fact that as fitted at the stern of a ship the driving face or surface is aft or to the rear and the back of the blade forward or to the front.

In a screw-propeller the face is usually a helicoidal surface, being a portion of a helicoid swept by a line intersecting an axis which revolves around the axis and advances along it, both the revolution and the advance being at a uniform rate. This line, called in mathematics the "generatrix," is also generally a straight line perpendicular to the axis, though often it is inclined aft and sometimes forward, while a curved generatrix may be and sometimes is used. The distance which the generatrix advances along the axis during one revolution about it is called the "pitch" of a screw, and for a true screw the pitch is uniform at every point of the helicoidal surface.

The outline of a propeller-blade face is usually an oval curve or contour upon the helicoidal surface. Now if a helicoidal screw-face be cut by a right cylindrical surface c, Fig. 1, concentric with the screw-axis it will intersect the screw-face in a helix, and if the cylinder be then developed or unrolled into one plane the helix will appear as a straight line in this plane. A true helicoidal surface cannot be developed into one plane; but it is the conventional practice to intersect a screw-surface by a number of cylinders of varying radii, develop each cylinder into the plane tangent to the cylinder at the center or radial line of the screw-face and revolve the developed helix until it is perpendicular to the axis of the screw and lay off its length represented by the straight lines $d\ d$, $d'\ d'$, $d^2\ d^2$, and $d^3\ d^3$, Fig. 4. The surface obtained by joining the extremities of the lines thus obtained is called conventionally the "helicoidal" surface of the screw, and the contour of the area is called the "developed shape of blade."

Figs. 1, 2, and 3 show the fore and aft, athwartship, and vertical projection of one blade a true screw with a straight generatrix perpendicular to the axis, the blade being bounded by a cylindrical hub and having no thickness. For such an ideal screw the face and back are identical. Now the face of such a screw need not necessarily have the same pitch at every point. The pitch along the helical intersection, with a right cylinder concentric with the axis, may be constant at a given radius, but vary for other radii, in which case the pitch is said to vary radially. Again, the pitch at a given radius may vary in passing from the leading edge, which is the edge that first meets the water, to the following or opposite edge. In this case the pitch is said to vary axially. Over a given screw-surface the pitch may vary both radially and axially. Now an actual propeller-blade must have a certain thickness for strength, being the usual practice to have the thickness diminish radially, and very frequently the developed sections of the blades are arcs of circles.

Fig. 4 shows one blade of a true screw, the developed blade sections having their maximum thickness in each case at the center or medial line of the blade and the backs $f\ f'\ f^2\ f^3$ of the blade-sections being circular arcs. The line $o\ e$ is equal to the pitch divided by 2π, and x, x', x^2, and x^3 are pitch-angles at the points where the sections are taken. It will be evident upon reflection that the surface of the back of the blade will have a different pitch at each point and that the pitch of the back surface will vary both radially and axially. If the uniform pitch of the face be designated the "nominal pitch," each cylindrical section of the blade will have the pitch of the leading portion of the back less than the nominal pitch. The pitch of the back will increase, so as to be equal to the nominal pitch in the center of the blade and will be greater than the nominal pitch over the following half of the blade-section. Hence the back of the blade will have varying pitch all over.

Screws have been proposed in which the extreme forward portion of the blade-back has been made tangent to a helicoidal surface having a pitch of the same percentage less than the nominal pitch of the face as the percentage of slip. I have proposed such a screw myself in the past. My present improvement, however, is to make not less than one-fourth of the surface of the back a true helicoid of constant pitch, and this constant pitch instead of being equal to the nominal pitch, diminished by the desired percentage of slip, is to be the nominal pitch diminished by a greater percentage, preferably about ten per cent. greater. That is to say, if we have a screw of ten feet nominal pitch designed to work at twenty-per-cent. slip I would make not less than one-fourth the surface of the back a true helicoid of thirty per cent. less than the nominal pitch or seven-feet pitch. If the same screw were designed to work at ten-per-cent. slip, I would make the leading portion of the back a true helicoid of eight-feet pitch. Then according to the pitch and proportions of length and thickness of the sections a propeller-blade constructed as described above results in two types of blades. If the blade is thin and the pitch of the back much less than the nominal pitch, the leading edge *g* is sharp and face *a* and back f^4 developed are straight lines at the leading edge. The helicoidal portion of the back will then meet the convex surface in a ridge *h*, which is to be slightly rounded. If the blade is thick compared with its length, the helicoidal surface f^4 of the back, even when starting from the center of the blade, does not reach or intersect the helicoidal face *a* at the leading edge. In such case it is necessary to make the leading portion of the face of the blade convex, as shown at *i*, Fig. 6, by striking in a circular arc that is tangent to the helicoidal portion of the face and passes through the leading point of the helicoidal portion of the back which extends forward from the center of the back.

Figs. 5 and 6 illustrate possible types. Thus for the type of propeller proposed we have the following characteristics considering the developed blade-sections: The contour of the back of the blade-section is made up of a circular arc *k* and a straight line, the latter extending from the leading edge not less than one-fourth and not more than one-half the total distance from leading to following edge. This straight line corresponds to a true helicoidal surface of pitch equal to the nominal pitch of the face, less about ten per cent. and the designed slip per cent. The face of the blade-section is represented by a straight line corresponding to a true helicoid, whose pitch is the normal pitch of the propeller or a straight line, as above, for the rear half of the blade and a circular arc tangent to this straight line at the center portion of the blade and curving to pass through the leading point of the helicoidal back.

Actual trial of a propeller made in accordance with this invention and comparison with other propellers of like size, number of blades, and under like conditions, showed a decided increase in efficiency over the best types now in use.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. A propeller-blade in which the back of the blade is a true helicoid for at least one-fourth of the surface, from the forward edge, the pitch of the helicoidal surface being less than the nominal pitch by an amount greater than the percentage of slip.

2. A propeller-blade in which the face of the blade is a helicoidal surface and the back of the blade for at least one-fourth of its width at the leading side is also a helicoidal surface, the difference of pitch between the two helicoidal surfaces being greater than the designed slip per cent., and the juncture of said last helicoidal surface with the adjacent surface is rounded and the face of the blade at the leading side is curved from the medial line to meet the helicoidal surface of the back at the leading edge.

3. A propeller-blade in which the developed section of the blade contains two straight lines making an angle with each other at the entering side corresponding to two helicoidal surfaces differing in pitch by an amount greater than the designed slip per cent., one on the face and the other on the back of the blade and the straight line on the face connected to the entering edge where it meets the straight line of the back by the arc of a circle tangent to said straight line on the face at the center of the blade.

4. A propeller-blade having on its face a helicoidal surface and on its back a helicoidal surface at the entering side of the blade, the pitch of the helicoidal surface on the back of the blade for about one-fourth of the distance from the leading edge being less than the pitch on the face when diminished by the slip per cent.

5. A propeller-blade having on its face a

helicoidal surface and on its back a helicoidal surface at the entering side of the blade, the pitch of the helicoidal surface on the back being less than the pitch on the face when diminished by the slip per cent.

6. A propeller-blade having on its face a helicoidal surface and on its back a helicoidal surface at the entering side of the blade, the pitch of the helicoidal surface on the back differing from the pitch of the helicoidal surface on the face by ten per cent. plus the designed slip per cent.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

DAVID W. TAYLOR.

Witnesses:
PHILIP F. LARNER,
HENRY ORTH, Jr.