C. H. DRAPER.

SCREW PROPELLER.

APPLICATION FILED JAN. 6, 1910.

1,019,437.

Patented Mar. 5, 1912.

2 SHEETS—SHEET 1.

Fig: 1.

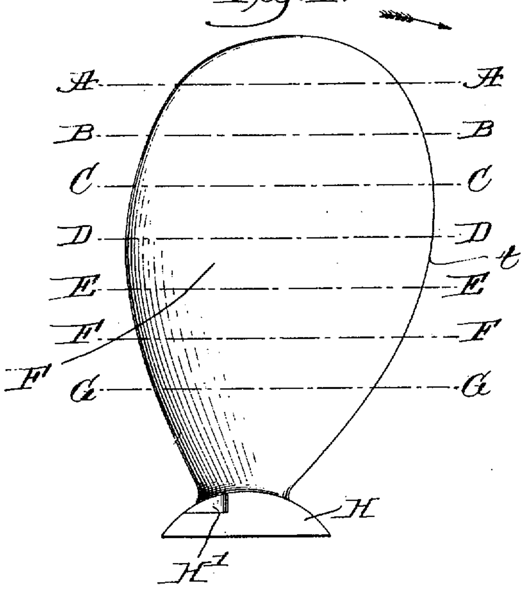


Fig: 3.

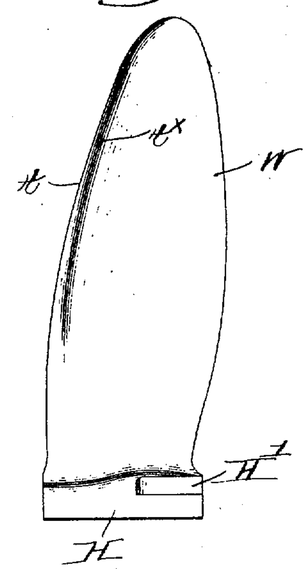


Fig: 2.

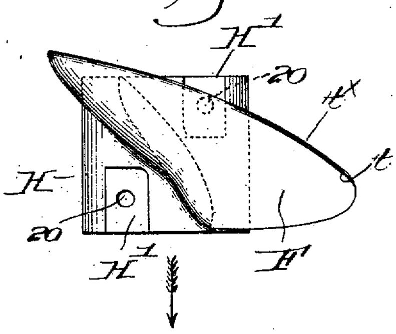
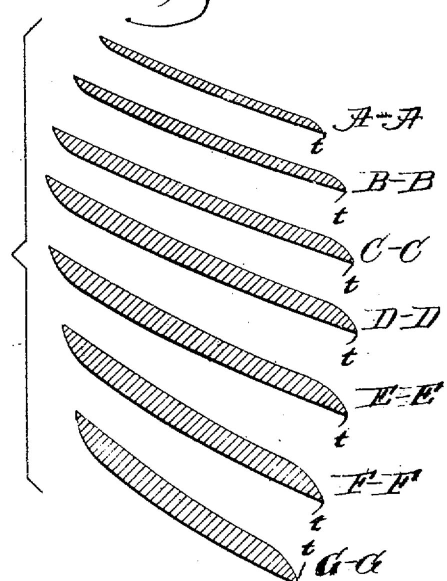


Fig: 4.



Witnesses,
Edward G. Allen.
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2 SHEETS—SHEET 2.

Fig: 5.

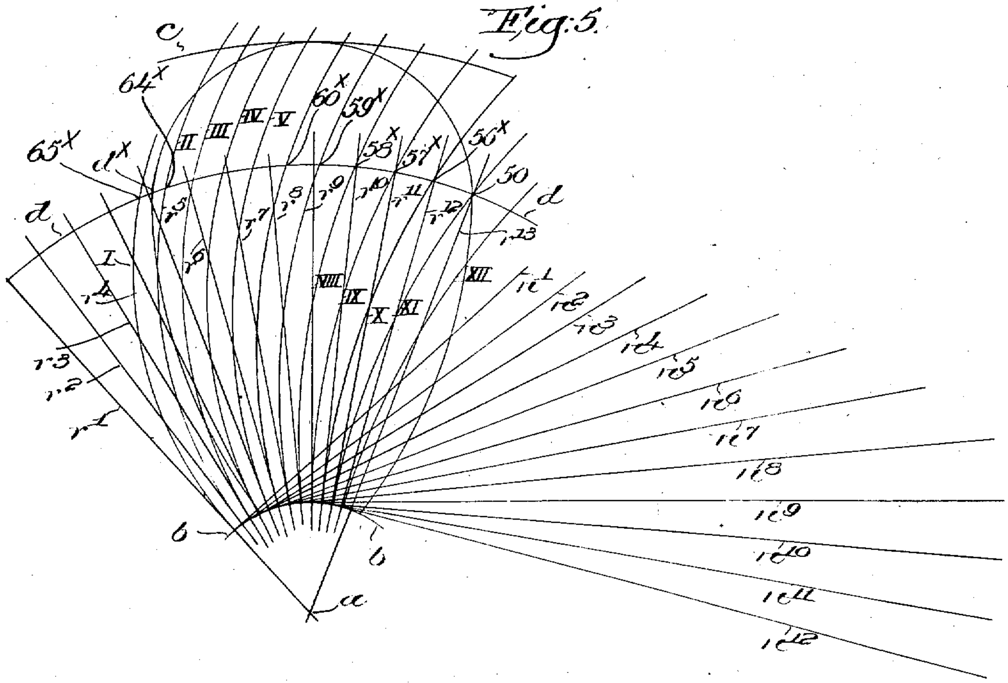


Fig: 6.

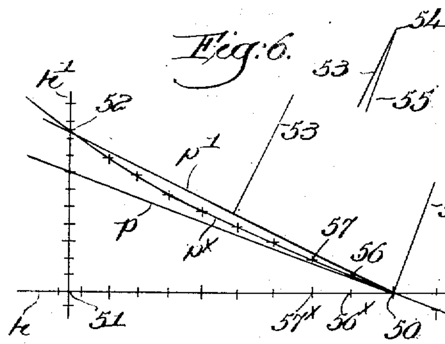


Fig: 7.

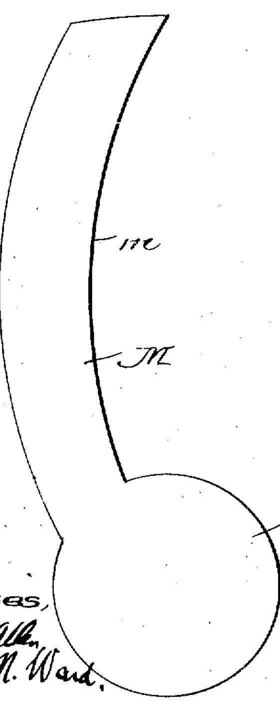
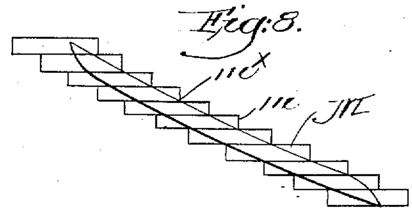


Fig: 8.



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UNITED STATES PATENT OFFICE.

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SCREW-PROPELLER.

1,019,437. Specification of Letters Patent. Patented Mar. 5, 1912.

Application filed January 6, 1910. Serial No. 536,688.

To all whom it may concern:

Be it known that I, Clare H. Draper, a citizen of the United States, and resident of Hopedale, county of Worcester, State of Massachusetts, have invented an Improvement in Screw-Propellers, of which the following description, in connection with the accompanying drawing, is a specification, like characters on the drawing representing like parts.

This invention has for its object the production of a novel and improved propeller embodying certain features of construction whereby for a given expenditure of power and size of blade improved results are obtained.

As is well known to those skilled in the art the pitch of a propeller blade theoretically determines the axial distance traveled in one revolution, but as a matter of fact a propeller working in water does not travel such axial distance in one revolution, by an amount designated the apparent slip.

The great majority of screw propellers are of uniform pitch at all points of the driving surface of the blade, and when so constructed are termed true screw propellers, but in my present invention I depart from a true screw propeller in many particulars, some of which may in themselves be old, but so far as I am aware the combination of various features of construction in one blade is novel.

In my present invention I construct the blade of the propeller with an increasing axial pitch, in order that the leading edge of the blade as it enters the water shall not accelerate it in either direction, while the rest of the blade acts gradually upon the water and finally gives the maximum acceleration at the back or following edge of such blade. Increasing axial pitch means that there is greater pitch on the back part or following edge of the blade than on the leading edge thereof, the driving surface of the blade being necessarily somewhat concaved as compared to a true helical surface.

When it is considered that a propeller does not advance in accordance with its pitch it will be evident that the blade of a true screw propeller must catch the water at its leading edge and suddenly accelerate it by approximately as much as the slip. My novel propeller has an increasing radial pitch, that is, the blade has greater pitch at the circumference than at the hub, this feature resulting or flowing from the embodiment of the various principles of construction in accordance with my invention.

In my improved propeller the blade presents what I term a centripetal surface, that is, a surface which is not only inclined with relation to the axial movement or direction of advance but which is also inclined backward from a radial plane at right angles to the propeller shaft. Such centripetal surface tends to throw the water inward toward the axis of the shaft as well as to drive it backward in columnar form. The blade of a true screw propeller imparts a centrifugal motion to the water acted upon, leaving it so that such water tends to spread astern in the form of a cone, thereby reducing the reaction upon the boat which tends to push it ahead. If a section of such a centripetal blade be taken in an intersecting plane at right angles to the axis of rotation the edge of the section will be a curve inclining from the hub portion of the blade outward in the direction of rotation of the propeller, and herein such curved lines or edges I designate as the generating lines of the blade.

When laying out a blade in accordance with my invention I prefer to make such generating lines tangent to radii at the hub and increasing in curvature from the leading edge of the blade to the back or following edge thereof. Such increase in the curvature of the generating lines is due to the fact that as the leading edge does not accelerate the water to any extent it will not cause much centrifugal action, and accordingly there is not so much necessity for counter-acting centrifugal action as there is at or near the following edge of the blade. Inasmuch as this portion of the blade is accelerating the water more than any other portion increased centripetal action is required, and consequently greater curvature, obtained by the increasing curvature of the generating lines, referred to.

My improved blade preferably has uniform pitch at the hub, for the reason that in a blade of increasing axial pitch the increasing curvature of the generating lines is permitted by but is not necessarily due to uniform pitch at the hub. At the hub the pitch is the same as at the leading edge of the blade, such surface performing practically no work except to support the working part of the blade, and it is, consequently and necessarily, of less pitch than at any other point except the leading edge. The reason for using increasing radial pitch hereinbefore referred to is thus made manifest. By having generating lines of less curvature at the leading edge of the blade the latter is set more nearly at right angles to the propeller shaft than would be the case if all the generating lines were of the maximum curvature. This is advantageous in that the blade is practicable for reversing propellers, which might not be true with a blade inclined aft to a marked degree.

I prefer to make my improved propeller blade approximately elliptical in outline, not only because such a shape is generally considered to be the most efficient but also because the rounded ends of the blades are less apt to be bent or broken when striking obstacles or tangled up in weeds, ropes, etc. Such centripetal blades as have heretofore been devised are, so far as I have been able to discover, of a more or less hooked form corresponding to the curves of the generating lines, and are objectionable for the reasons pointed out. The leading edge of the blade I round off on the working surface instead of on the opposite or forward side of the blade, as is the common practice, for by so doing I make it certain that all water acted upon by the blade is forced astern, whereas with the common form a certain amount of water—and especially so with blades of axially increasing pitch—is forced ahead in the direction of travel of the boat and by so much inevitably reduces the propeller efficiency.

Figure 1 is a front elevation of a screw propeller blade embodying my present invention, viewing the blade in a direction looking aft with relation to the shaft or axis of rotation; Fig. 2 is a top plan view of the blade shown in Fig. 1, the large arrow indicating the direction of axial movement effected by revolution of the blade from left to right; Fig. 3 is a right hand side elevation of the blade, viewing Fig. 1, and showing the working side or face of such blade; Fig. 4 are transverse sections through the blade, taken on the lines A, B, C, etc., Figs. 1 and 3; Fig. 5 is a diagrammatic view showing the manner in which the generating lines are laid out for constructing a propeller blade in accordance with my invention; Fig. 6 is a diagram used in laying out the generating lines shown in Fig. 5; Fig. 7 is a plan view of one of the blanks or plates from which the pattern is built up; Fig. 8 is a sectional detail of the several plates or laminæ, superimposed one upon the other and also showing the manner in which the generating lines are used in completing the pattern for the blade.

To facilitate the construction of the pattern for making the mold in which the blade is cast I build up such pattern from superposed and relatively thin wooden plates or laminæ, the forward edge of each plate being cut to a curve corresponding to one of the generating lines, the plates or laminæ being glued or otherwise secured together. The length of the laminæ is sufficient to enable the blade of desired length to be cut therefrom, the hub portion of the blade pattern having a length, fore and aft, or axially, equal to the thickness of a plate multiplied by the number of such plates, as will be obvious, though the length of such hub portion can be increased if necessary in any suitable manner. Taking a point a, Fig. 5, to represent the center or axis of rotation of the propeller I strike therefrom arcs b, c, the former indicating the external diameter of the hub and the latter the circumference of the propeller, the radii of both arcs being determined according to the desired dimensions of the propeller. I first decide at what distance from the center a I will take what I call the base-line, and at which approximately the greatest width of the blade is to be, and draw an arc d with the radius decided upon, and on this arc I lay off the distance $d^{\times}$, 50, Fig. 5, equal to the width of the proposed blade as projected upon a plane at right angles to the axis of rotation of the propeller. Then measuring the actual length $d^{\times}$, 50, along the arc d I lay this distance off at 50—51 on the horizontal line h, Fig. 6, and erect a perpendicular h' at 51. After deciding upon the average pitch along arc d and the pitch of the hub and leading edge of the blade I determine the angles corresponding to these pitches and draw lines p' and p passing through point 50 and making the determined angles with the horizontal line h, Fig. 6. The angle between p' and h corresponds to the average pitch and the angle between p and h corresponds to the pitch of the leading edge of the blade and at the hub. I now bisect that part of line p' between its points of intersection with h and h' and erect a perpendicular 53 at the center, and erect a perpendicular 55 to line p at the point 50. The intersection 54 of these two perpendiculars I take as a center and describe the arc $p^{\times}$, Fig. 6, passing through the points 50, 52 and to which the line p is tangent at 50. This curved line $p^{\times}$ represents a section of the working surface of the blade along the line d, Fig. 5. Now the line h', Fig. 6, is divided into as many parts as there are to be laminæ in the pattern, and which practically corresponds to the length of the hub, and the points of division are projected horizontally onto the curve $p^{\times}$, as at 56, 57, etc. These intersections are projected onto the base line h at $56^{\times}$, $57^{\times}$, etc., as shown in Fig. 6, and it will be seen that the distances between successive points on the base line gradually decrease from right to left, indicative of an increase in axial pitch from the leading to the following edge of the blade. The divisions of the base line so obtained are now laid off on the arc d, Fig. 5, beginning at the point 50, the leading edge of the blade in said Fig. 5 being at the right hand, and the points thus laid off on arc d are similarly lettered. Radial lines r^{13}, r^{12}, are now drawn through points 50 and $56^{\times}$ and the center a, Fig. 5, such radii intersecting the arc b of the hub portion, and other radii r^{11}, r^{10}, etc., at the left, Fig. 5, are drawn to intersect the arc b equal distances apart, and equal to the distance between the first two radii on the said arc. This must give the same pitch at the hub as between 50 and $56^{\times}$, for it will be remembered that generating lines which are straight and radial form a uniform pitch or true screw blade.

The varying pitch of the blade is not necessarily due to the uniform pitch at the hub, for obviously the pitch at the hub may be an increasing or a decreasing pitch and yet permit of an increasing pitch at the outer portion of the blade. Increasing or decreasing the pitch at the hub in this particular case interferes with or modifies the "hook" of the blade, in the one instance giving more hook at the leading edge, where it is not needed, and less at the following edge, where it is needed, while in the other instance the whole blade is given entirely too much hook, which is not desirable and which I desire to obviate. Uniform pitch at the hub enables me to secure the desired results, and the increased curvature of the centripetal surface is permitted, so it will be seen that the generating lines must intersect the arc b at equal distances apart.

It will be manifest that the blade embodying my invention is not a true screw blade, hence the generating lines cannot be the straight radii, but are curved lines, the first one to be laid off on Fig. 5 being determined to a very great extent by experience, such line determining the greatest amount of "hook" which is desired for the blade. The shorter the radius of such curved generating line the greater will be the hook, a longer radius giving less hook, and in laying off this first generating line I decide, from experience, upon the approximate angle, at the line d, Fig. 5, between a radius and the generating line. I now find a point from which, as a center, an arc can be drawn through the point $65^{\times}$ (on the line d) tangent thereat to one side of the angle decided upon, and also tangent on the line b to one of the radii previously drawn, and manifestly this center point must lie on a normal to the selected radius.

In Fig. 5 I have chosen to make the first generating line tangent at b to the radius r', hence the center point will lie on its normal n', and the curved line I is the first generating line, which intersects the line d at the point $65^{\times}$. Normals n^2, n^3, n^4, etc., are laid off from the respective radii at their intersections with the arc b, and in the present instance, circular arcs II, III, IV, etc. are struck from centers on the respective normals, passing through the previously found points, $64^{\times}$, etc., to the point 50, laid off on the arc d, and tangent to radii r^2, r^3, etc., at the hub. We now have the necessary generating lines for the blade, and they are transferred to the front or leading edges of the wooden plates or laminæ from which the pattern is built up, it being understood that viewing Fig. 5, the forward or non-working face of the blade would be nearer the observer. It must be understood that the actual angle of the generating line I, at the line d, may vary slightly from the angle first chosen or fixed upon, as it is necessary to make the curve of the generating line I tangent to one of the radii at b, but the variation, if there is any, is necessarily small. Inasmuch as the generating lines increase in curvature from the leading to the following edge, for reasons hereinbefore set forth, it follows that successive generating lines laid out at the right of line I decrease in curvature, and the distance between the intersections of successive pairs of generating lines with the arc d gradually increases from left to right, according to the desired increasing axial pitch of the blade.

In Fig. 7 is shown one of the blanks or plates M, in plan, its edge m having the curve of one of the generating lines, in this case the line V, Fig. 5, and the part $M^{\times}$ of the plate is the hub portion. After all of the plates have been shaped they are superposed and glued together, as shown in Fig. 8, and a warped and stepped surface is presented, which is cut down on each face to give the desired curvature to the surfaces of the blade.

Referring to Fig. 8, the working face of the blade passes through the several points $m^{\times}$, and when the working face has been completed the opposite face of the blade is completed similarly, depending of course upon the thickness of the blade, and the particular curvature which the forward or non-working face is to have. The building up of the pattern from laminæ is well known in constructing patterns for propeller blades, and I make no claim thereto.

An inspection of Figs. 1, 2 and 3, showing the completed blade, (made from a pattern derived as has been described,) together with the several sections of the blade shown in Fig. 4 will make clear the general contour and features of the blade constructed in accordance with my invention. The outline of the blade as shown in Fig. 5 is elliptical, for the reasons hereinbefore set forth, and such outline in Fig. 5 is actually the projection of the finished blade upon a plane surface at right angles to the axis of rotation of the blade. The leading edge t of the blade is rounded off on the working face or surface W, as at t^x, Fig. 3, while the opposite or forward face F is brought directly to said leading edge almost flat. This change is also clearly shown in the blade sections, Fig. 4, the leading edge of each section being indicated at t.

The hub is indicated at H, Figs. 1, 2 and 3, and in practice the flat face of the hub of each blade will be secured to the shaft, or a part carried thereby, in any suitable manner, as by bolts passed through the holes 20, Fig. 2, in the sockets H' formed in the hub.

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

1. A propeller blade having generating lines for its working surface increasing in curvature from the leading to the following edge, said generating lines being tangent to radii at the periphery of the hub, the pitch being uniform at the hub.

2. A propeller blade whose working surface has generating lines increasing in curvature from the leading to the following edge, said generating lines being tangent to radii at the periphery of the hub and forward of such radii throughout their length.

3. A propeller blade whose working surface is of uniform pitch at the hub, the generating lines of such surface increasing in curvature from the leading to the following edge of the blade, said lines being tangent to radii at the periphery of the hub and lying wholly between such radii and the leading edge.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

CLARE H. DRAPER.

Witnesses:

WENDELL WILLIAMS,
BERTHA I. SNARE.