R. M. DUNGAN.

SCREW PROPELLER.

APPLICATION FILED SEPT. 29, 1914. RENEWED FEB. 18, 1918.

1,371,610. **Patented Mar. 15, 1921.**

2 SHEETS—SHEET 1.

Fig. 1.

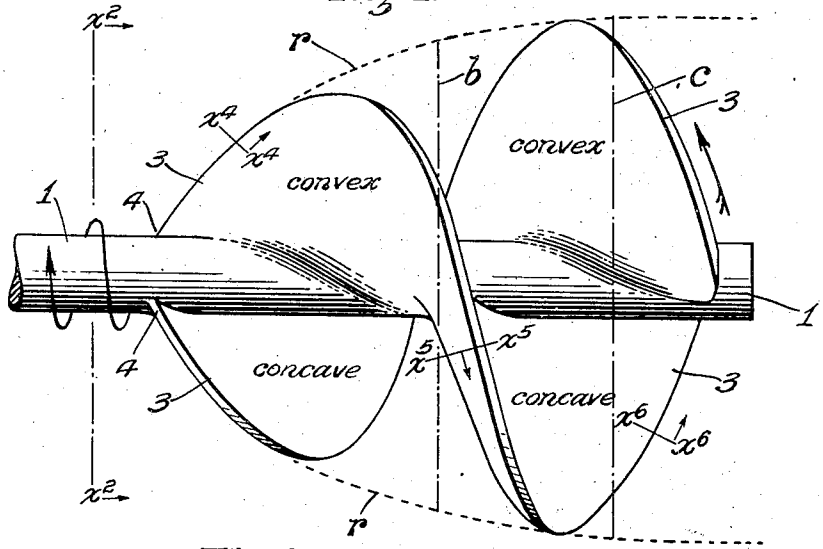


Fig. 2.

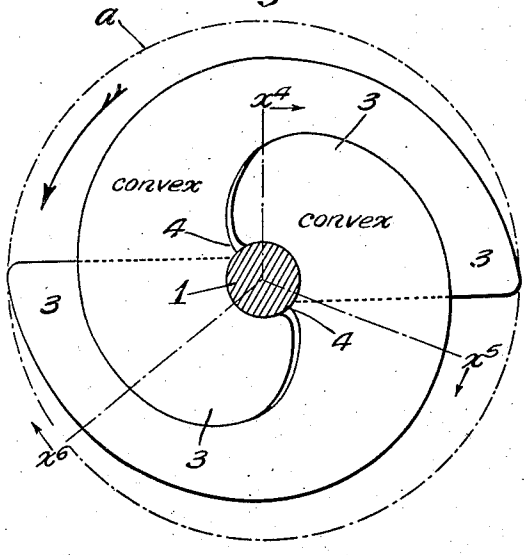


Fig. 3.

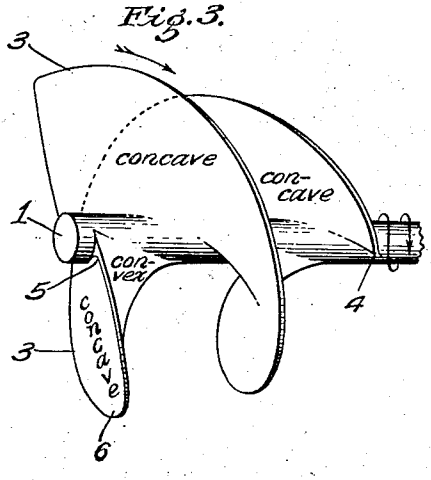


Fig. 4.

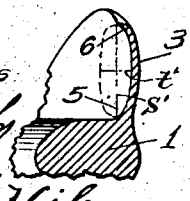


Fig. 5.

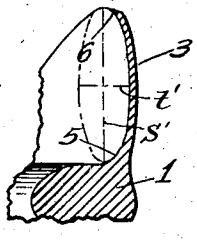
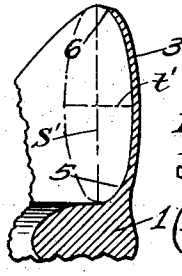


Fig. 6.



Witnesses
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2 SHEETS—SHEET 2.

Fig. 7.

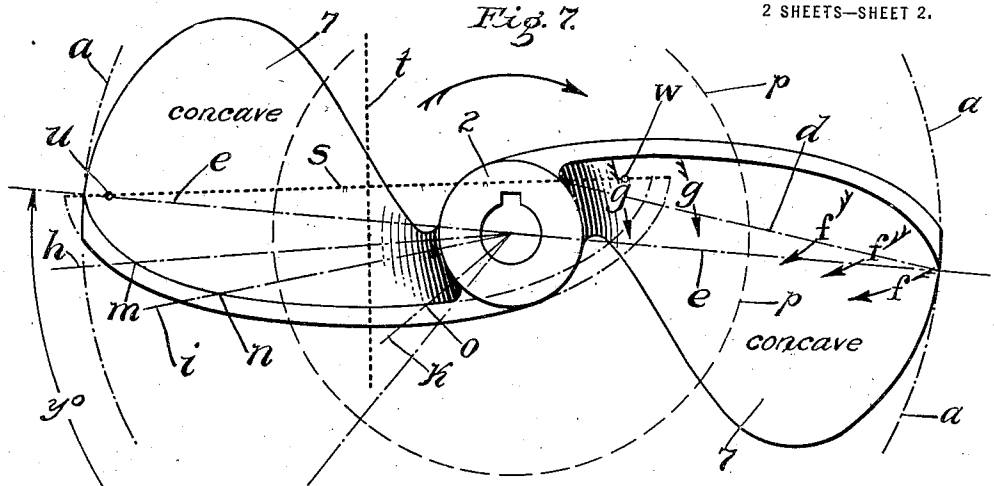


Fig. 8.

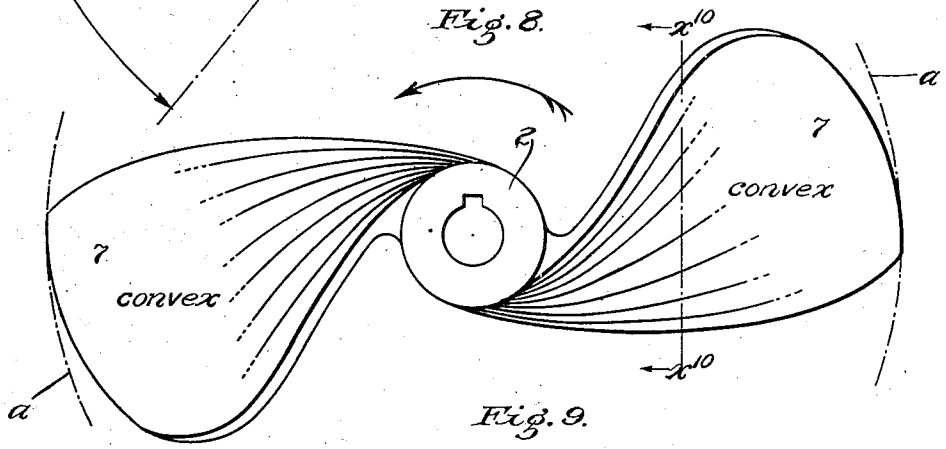


Fig. 9.

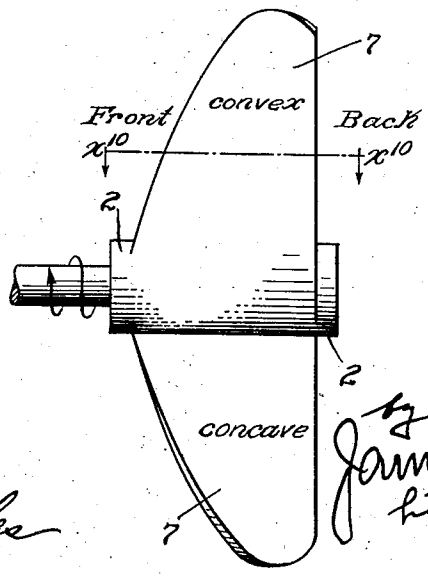
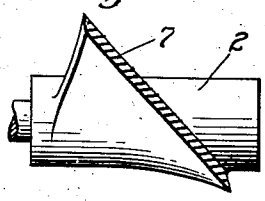


Fig. 10.



Witnesses

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UNITED STATES PATENT OFFICE.

ROBERT M. DUNGAN, OF SANTA ANA, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-HALF TO SAMUEL M. DUNGAN AND ONE-HALF TO MARY E. MOORE.

SCREW-PROPELLER.

1,371,610. Specification of Letters Patent. Patented Mar. 15, 1921.

Application filed September 29, 1914, Serial No. 864,163. Renewed February 18, 1918. Serial No. 217,950.

To all whom it may concern:

Be it known that I, ROBERT M. DUNGAN, a citizen of the United States, residing at Santa Ana, in the county of Orange and State of California, have invented a new and useful Screw-Propeller, of which the following is a specification.

This invention relates to fluid propellers whether stationarily mounted so as to impel the fluid, as in propeller-pumps, or mounted so as to propel the vessel on which the propeller is mounted, it being understood that the element in which the propeller works may be a lighter fluid such as air, or may be a heavier fluid such as water; and, in those instances where the propeller acts against the resisting fluid medium to produce endwise movement of the propeller, the object propelled by the propeller may be an air ship or a marine vessel.

Broadly an object of this invention is to prevent radial and lateral displacement of the fluid medium and churning of said medium.

Propellers heretofore known include two classes, viz:

1. Propellers so constructed that while they produce a rearward thrust, they also produce an outward thrust upon the fluid medium from the axis of the propeller toward the periphery of the blades; and

2. Those so constructed as to partly oppose the centrifugal movement of the fluid medium and thereby produce a direct rearward thrust thereupon.

In the first class the outward thrust of the propeller naturally has a tendency considerably to diminish the volume of the fluid medium for some distance from the axis of the propeller and thereby to produce a partial vacuum rearwardly of the propeller blades, so that the force of the rearward thrust is effectively reduced.

In the second class the blades are so curved that they first intercept the centrifugal movement of the fluid medium and then utilize the centrifugal force as an auxiliary for driving the fluid medium rearwardly of the propeller in a direction parallel with the propeller axis.

In my invention the propeller blades are so shaped and are so mounted relative to the periphery of the shaft that the edges of the blades cut into the fluid medium separating that portion of said medium toward the propeller shaft from the main body of said medium and impelling it radially inward toward the shaft, whereafter because of the screw form of the blades, the fluid medium is forced rearward and away from the propeller without agitating the medium outside of the bore made by passage of the propeller through said medium.

Other important features of the present invention are that the inner propellent surfaces of the blades are so elliptically curved and the tips of the blades are so advanced beyond their roots in the direction of the forward rotation of the propeller relative to radial planes drawn through the axis of the propeller, that when the propeller is rotated in the forward direction, the propellent surfaces will first produce a centripetal movement of the fluid medium within the curve described by the propeller, and then drive the fluid medium rearwardly in a direction parallel with the propeller axis.

In some instances the propeller blades may describe a complete spiral around the shaft, thus making a longer propeller, and in other instances the propeller may be made quite short by shortening the blades so that they will describe only a fraction of a complete spiral around the shaft, for instance, one quarter turn, one-third turn and the like.

Another object of this invention is to provide a construction having minimum tendency to become weed bound, that is to provide blades of such construction as will cause sea weed and the like to slide from the front to the rear edges of the blades and to be discharged therefrom, and this is accomplished by curving the front edges of the blades from the shaft rearward toward the outer edges of said blades so that the weeds will slide from the front edges onto the peripheral edges and rearward along said peripheral edges till they are discharged from said blades.

The advance of the tips of the blades beyond the roots of said blades may be accomplished by any suitable construction but I prefer to make the blade at its root tangential to the hub or shaft and curve the blades concavely toward the direction of rotation, the curvature in the instance shown being substantially a segment of an ellipse with the greater degree of curvature nearer the outer edges of the blades.

Other objects and advantages may appear as the invention is unfolded in the drawings filed herewith and in the subjoined detail description.

The accompanying drawings illustrate various forms of the invention.

Figure 1 is a side elevation of one form of the invention wherein the blades describe a complete spiral around the shaft.

Fig. 2 is a front end elevation viewed from line x^2, Fig. 1.

Fig. 3 is a reduced perspective view of the propeller shown in the preceding views.

Figs. 4, 5 and 6 are fragmentary cross sections on lines indicated by x^4, x^5 and x^6 respectively, said sections being taken at right angles to the blade at the indicated lines of section.

Fig. 7 is a rear end view of a different form of the invention, each of the blades describing only a fraction of a complete spiral around the shaft.

Fig. 8 is a front end view of the propeller shown in Fig. 7.

Fig. 9 is a plan view of Fig. 7 and an inverted plan view of Fig. 8.

Fig. 10 is a sectional view on line indicated by x^{10}, Figs. 8 and 9.

There is provided a propeller axis or core formed by a shaft 1 as in Figs. 1 to 6 or formed by a hub 2 as in Figs. 7 to 10.

On the shaft 1 or hub 2 as the case may be are secured or formed integral therewith the propeller blades or vanes and said blades may be of different constructions as will now be described.

First considering the form of blades shown in Figs. 1 to 6, each of the blades 3 if developed, that is unbent and laid out straight, is triangular in shape having its pointed end 4 at the front end of the propeller so that the front edges of the blades incline and curve outwardly away from the shaft 1 toward the peripheral edges of said blades, thus the narrowest part of the blades is at the front and the widest part is at the rear.

It is noted that the blades do not extend outwardly at their roots radially from said shaft but that said blades join the shaft tangentially as clearly shown in Figs. 4, 5, 6, 7 and 8, the roots or inner edges of the blades being diametrically opposite one another.

The inner portions 5 of the blades nearer the shaft 1 may be only slightly curved and the outer portions 6 may be curved to a greater degree in the direction of rotation of the blades, so that the outer edges of the blades engage the fluid medium, as stated above, and the curved outer edges start said medium inward toward the shaft, compressing said medium within the influence of the blades represented by the circular pitch line *a* so that greater resistance will be created to receive the thrust of the blades and said medium at the same time will be thrust rearward and discharge along the rear edge of the propeller blades without disturbing or agitating the fluid medium.

Figs. 4, 5 and 6 show sections on one of the blades taken along different lines in the length of one of the blades so as to clearly show that the inner thrust faces of the blades are so formed that the fluid medium will be driven inwardly toward the axis of the propeller during rotation of said propeller.

Now considering the form of the invention shown in Figs. 7 to 10 it is seen that it very closely conforms to the structure contained between the dotted lines *b*, *c* Fig. 1 and that structurally the blades 7 shown in Figs. 7 to 10 may be produced by cutting a suitable segment from the blades 3 shown in Fig. 1; and it is seen that by drawing the lines *b*, *c* farther apart or closer to one another the structure between said lines will produce propellers having blades describing more or less length of spiral curves around the shaft.

The foregoing is not to be construed as in any wise limiting the invention in respect to the proportions shown and in respect to the exact curvature of the blades shown, but it is particularly noted that whatever the proportions and the shape of the blades the plane *d* extending from the roots of the blade at the hub or shaft to the pitch line *a* at the tip is aslant in the direction of rotation relative to a radial plane *e* drawn from the axis of the propeller to the pitch line *a* at the tip of the blade so as to drive the fluid medium inward from the tips of the blades toward the axis of the propeller as indicated by feathered arrows *f* in Fig. 7.

By reason of the elliptical formation of the blades at their roots where they branch tangentially from the shaft, the fluid medium against which the propeller thrusts tends to drive said medium laterally outward away from the axis of the propeller as indicated by the curved feathered arrows *g*. Fig. 7, so as to minimize friction of the fluid medium on the propeller core, but the reverse conformation of the outer portions of the blades prevents radial and lateral displacement of said medium beyond the working radius of the propeller, thus making provision for utilizing the inner third of the diameter of the propeller for the purpose of maximizing the thrust.

To make the foregoing clear, note that in Fig. 7 radial planes *h*, *i*, *k*, intersect the blade 7 at different diametral points *m*, *n*, *o* respectively, and that at the outermost points *m*, *n* the concave face of the blade is aslant rearwardly relative to the plane *e* connecting the propeller axis and tip of the blade, and furthermore that said face

at the innermost point *o* is aslant forwardly relative to said plane *e*; thus pressure is exerted toward a mediam zone of the blades as indicated by the broken circular line *p*, Fig. 7.

The curved outer part of the propellent surface of each blade is so curved that a tangent plane as at *d*, to said curved outer part of the blade, is inclined inwardly and rearwardly in the direction of rotation to a radial plane as at *e*, *h*, *i*, *k* drawn from the axis of the propeller to the tangent point as at the tip of the blade or at *m*, *n*, *o*, of such tangent plane and said curved part and the inner part of the propellent surface of each blade is so curved that the tangent plane to said curved inner part is also inclined inwardly and rearwardly to a radial plane drawn from the axis of the propeller to a tangent point of said tangent plane and said curved inner part.

It is seen that one advantage of the elliptical conformation of the blades is that the larger volume of water is driven inward to offset the lesser volume of water being forced outward near the axis of the propeller.

By reference to Figs. 4, 5 and 6 it is seen that the radial width of each blade increases from front to rear so that the outline produced by revolution of the propeller will be in the form of a paraboloid as indicated by dotted lines *r* Fig. 1. The edges therefore lie in the outline of a paraboloid of revolution, the relative proportions across the major and minor axes *s*, *t* Fig. 7 being capable of variation without departing from the spirit and scope of the invention.

Characteristic features of the form of blades shown in the drawings, reside in the peculiar radial formation of the ellipse, first in the particular manner in which the blade is joined to the shaft or hub, each blade springing from the shaft or hub tangentially and the concave side of each blade being attached so that the fluid medium is not driven outwardly but rather forced inward toward the shaft or hub during revolution of the propeller.

This structural form and arrangement of the blades so that they are substantially in the outline of a paraboloid, as stated, is of advantage in the particular that in this type of propeller, when the fluid element is gathered in by the blades, it is forced not only rearwardly but also inwardly toward the axis of the propeller, so that it is readily understood that the radial widths of the blades are such that at the forward end the radial dimensions increase rapidly, just where the ingathering of the fluid medium is greatest and the radial dimensions thereafter increase less rapidly and more gradually as the "compressed" medium is discharged rearwardly.

Again, the concave face of each blade at its outer edge represents a bisected curve described from foci *u*, *w* on the major axis *s*, which axis may or may not pass through the axis of the propeller. The proportions of this elliptical curve may be varied but it is important to so curve the edges of the blades as to drive the fluid medium inwardly.

It is obvious that the blades will show in cross sections, taken successively from the front to the rear relative to the propeller shaft, increasing depths of the concavities of the elliptical curves in the same ratio as the lengths of the constant major and minor axes of the curves increase from front to rear. In other words, the curve taken in cross section rearwardly of another curve will show a dish formation so much deeper than that shown in the cross section of the forward curve, as the constant major and minor axes of the rearward curve are longer than the respective constant major and minor axes of the forward elliptical curve. In Figs. 4, 5 and 6, where the lengths of the major axes *s'* are shown approximately proportional to the lengths of the minor axes *t'* as three is to one, the dish formation in Fig. 5 will be so much deeper than the dish shown in Fig. 4 as the length of its constant major and minor axes is increased over that of the corresponding axes in Fig. 4. It is clear therefore that Fig. 6, having an elliptical curve with the lengths of the axes further increased in the same proportion, will also have a proportionally deeper dish than that shown in Figs. 4 and 5. Thus, the effect of this successively increased depth of curvature in the blades from the front to the rear of the shaft is such that when the forward and narrower portion of the blade cuts the fluid medium, said medium is driven rearwardly along the shaft as the propeller turns. In effect, therefore, as the succeeding cross sections of the blades, which increase diametrically, gather in larger areas of water, the whole mass is utilized to exert a pressure axially to a degree not possible with a propeller having a simple curved outline.

Owing to the forward edges of the propeller blades extending aslant outward from the shaft or hub and rearward the propeller will not foul in sea weed and kelp and become entangled with lines and cables, for said sea weed, kelp, lines and cables will readily ride outward and rearward on said inclined edges and be discharged from the rear of the propeller. This satisfactory result is accentuated by the forward surfaces of said blades being elliptically convex.

In Fig. 7 the major axis *s* of the elliptical curve of the blade passes outside of the axis of the propeller and it is seen that the tips of the blades are advanced *y* degrees of cir-

cular measurement in the direction of rotation beyond the roots of said blades relative to radial planes drawn from the axis of the propeller to the tips of the blades, the amount of advance being, in this instance, about 54° of circular measurement.

Referring more particularly to Figs. 4, 5 and 6, it is seen that the curvature of the blade at different radial planes x^4, x^5, x^6, Figs. 1 and 2 from front to rear form segments of differently curved ellipses of which the proportionate lengths of the major and minor axes s' and t' are constant, and also that the ratio of the length of the minor axes to the major axes respectively is substantially as one to three.

I claim:—

1. A screw propeller constructed so that a plane extending from the root of the blade to the tip at the front face of the blade is aslant in the direction of rotation relative to a radial plane drawn from the axis of the propeller to the tip of the blade; the front surfaces of the blades being elliptically convex.

2. A screw propeller constructed so that a plane extending from the root of the blade to the tip at the front face of the blade is aslant in the direction of rotation relative to a radial plane drawn from the axis of the propeller to the tip of the blade and is substantially tangential to the core of the propeller; the front surfaces of the blades being elliptically convex.

3. A screw propeller constructed so that a plane extending from the root of the blade to the tip at the front face of the blade is substantially tangential to the core of the propeller; the front surfaces of the blades being elliptically convex.

4. A screw propeller having blades in which the front surfaces are elliptically convex and the tips advanced in the direction of the forward rotation of the propeller beyond the roots of said blades and relative to radial planes drawn from the axis of the propeller; the propellent surfaces of said blades being so curved from said roots that every tangent-plane to any of the propellent surfaces is at an acute angle to the radial plane drawn to the tangent-point of the tangent-plane and said surface, said acute angle being measured in said forward direction; and the propellent surfaces by said acute-angled relation to said radial plane being adapted to produce a centripetal movement of the fluid medium within the curve described by said propeller when it is rotating in said forward direction.

5. A screw propeller constructed so that a plane extending from the root of the blade to the tip at the front face of the blade is substantially tangential to the core of the propeller, the tip of the blade being curved in the direction of rotation; the front surfaces of the blades being elliptically convex.

6. A screw propeller constructed so that a plane extending from the root of the blade to the tip at the front face of the blade is substantially tangential to the core of the propeller, the blade being curved to substantially form a segment of an ellipse.

7. A screw propeller constructed so that the face of the blade at its outer portion is aslant rearwardly relative to a plane connecting the propeller axis and tip of the blade; the front surfaces of the blades being elliptically convex.

8. A screw propeller having a central core, and a blade of substantially elliptical conformation springing tangentially from the core.

9. A screw propeller having a blade formed to substantially an elliptical curve, the major axis of said elliptical curve passing outside of the axis of the propeller between said propeller axis and said elliptical curve.

10. A screw propeller having the tips of its blades advanced about 54° of circular measurement in the direction of rotation beyond the roots of said blades relative to radial planes drawn from the axis of the propeller to the tips of the blades; the front surfaces of the blades being elliptically convex.

11. A screw propeller having its blades spring tangentially from the central core and extending aslant forward in the direction of rotation to a line drawn from tip to tip through the axis of the core; the front surfaces of the blades being elliptically convex.

12. A screw propeller having a central core, and curved blades springing tangentially from said core, the blades being curved to a greater degree at their outer portions than at their inner portions.

13. A screw propeller having a pair of oppositely projecting continuous blades, each of which curves radially and extends a complete convolution about the propeller axis, and each increases in width from front to rear, the inner surfaces of the blades being so formed that any tangent-plane to either of said surfaces is at an acute angle to the radial plane drawn to the tangent-point of the tangent-plane and said surface, said acute angle being measured in the direction of the forward rotation of the propeller; and said surfaces by said acute-angled relation to said radial planes being adapted to produce a centripetal movement of the fluid medium within the curve described by the rotating propeller.

14. A screw propeller having a pair of oppositely projecting continuous blades, each of which extends a complete convolu-

tion about the propeller axis and increases in width from front to rear in the outline of a paraboloid, the rear end of the propeller being the greatest width, and the inner surfaces of the blades being so formed that the fluid medium will be driven inwardly during rotation of the propeller.

15. A screw propeller having a core, a pair of oppositely projecting blades secured to the core, the cross section of each blade from the core to the outer edge at any point being in the form of an elliptical curve bisected across its major axis, the minor axis of said curve terminating outside of the the center of said core, and the inner surfaces of the blades being so formed that any tangent-plane to either of said surfaces is at an acute angle to the radial plane drawn to the tangent-point of the tangent-plane and said surface, said acute angle being measured in the direction of the forward rotation of the propeller; and said surfaces by said acute-angled relation to said radial planes being adapted to produce a centripetal movement of the fluid medium within the curve described by the rotating propeller.

16. A screw propeller having a core, a pair of oppositely projecting blades secured to the core and extending therealong a complete turn, the cross section of each blade from the core to the outer edge thereof at any point being in the form of an elliptical curve, the minor axis of said curve terminating outside of the center of said core, the concave side of said curve being in the direction of rotation of the propeller, and the inner surfaces of the blades being so formed that any tangent-plane to either of said surfaces is at an acute angle to the radial plane drawn to the tangent-point of the tangent-plane and said surface, said acute angle being measured in the direction of the forward rotation of the propeller; and said surfaces by said acute-angled relation to said radial planes being adapted to produce a centripetal movement of the fluid medium within the curve described by the rotating propeller.

17. A screw propeller having a core, oppositely projecting blades mounted tangentially on the core and opposite one another in spiral formation along the core, varying in width from end to end, each blade in cross section being constructed in such manner that an elliptical curve is formed from the core to the outer edge, with the concave side in the direction of rotation of the propeller, and the inner surfaces of the blades being so formed that the fluid medium will be driven inwardly during rotation of the propeller.

18. A screw propeller having a core, oppositely projecting blades mounted on the core tangentially and opposite one another, extending in spiral formation along the core, varying in width from end to end, each blade being curved in cross section to assume an elliptical curve, the concave side being in the direction of rotation of the propeller whereby the outer edges of the blades are always in advance of the concave body to prevent lateral displacement of the fluid medium, and the inner surfaces of the blades being so formed that the fluid medium will be driven inwardly during rotation of the propeller.

19. A propeller having a core, oppositely projecting blades mounted on the core tangentially and opposite one another, extending in spiral formation along the core, varying in width from end to end, each blade being curved in cross section to assume an elliptical form, the concave side being in the direction of rotation of the propeller, and the inner edge of each blade being secured to the core in such manner that the core is on the inner or concave side of the blade, whereby the advanced cutting edges of the blades as well as the concave blade surfaces will cause the fluid medium to move inwardly and axially along the core.

20. A screw propeller having a core, oppositely projecting blades mounted tangentially on the core and opposite one another, extending in spiral formation along the core, varying in width from end to end, each blade being curved in cross section to assume an elliptical form, the ellipse being in the proportion of one to three from a line connecting the root to the tip, the concave side being in the direction of rotation of the propeller, and the inner edge of the blade being secured to the core in such manner that the core is on the inner or concave side of the blade, whereby the advanced cutting edges of the blades as well as the concave blade surfaces will cause the fluid medium to move inwardly and axially along the core, thus utilizing the inner third of the diameter of the propeller.

21. A screw propeller having a curved blade, the curvature of the blade at different radial planes from front to rear forming segments of differently curved ellipses of which the proportionate lengths of the major and minor axes are constant.

22. A screw propeller having a curved blade increasing in width from front to rear, the curvature of the blade at different radial planes from front to rear forming segments of ellipses of which the proportionate lengths of the major and minor axes are constant.

23. A screw propeller having a curved blade increasing in width from front to rear, the curvature of the blade at different radial planes from front to rear forming segments of ellipses of which the ratio of the length of the minor axes to the length

of the major axes respectively is substantially as one to three.

24. A screw propeller having a curved blade increasing in width from front to rear, the curvature of the blade at different radial planes from front to rear forming segments of ellipses of which the proportionate lengths of the major and minor axes are constant and the ratio of the length of the minor axes to the length of the major axes respectively is substantially as one to three.

25. A screw propeller having a central core; blades springing tangentially from the core; each of the blades having a propellent surface curved at a distance from the core so as to drive the fluid medium inwardly during the rotation of the propeller; and each of the blades being curved at the core so as to drive the fluid medium at the core outwardly and thereby to counteract the pressure upon the core of the inwardly driven fluid medium.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 24th day of September, 1914.

ROBERT M. DUNGAN.

In presence of—

JAMES R. TOWNSEND,

GEORGE H. HILES.