R. TJADER.

SCREW PROPELLER.

APPLICATION FILED APR. 27, 1908.

955,721.

Patented Apr. 19, 1910.

2 SHEETS—SHEET 1.

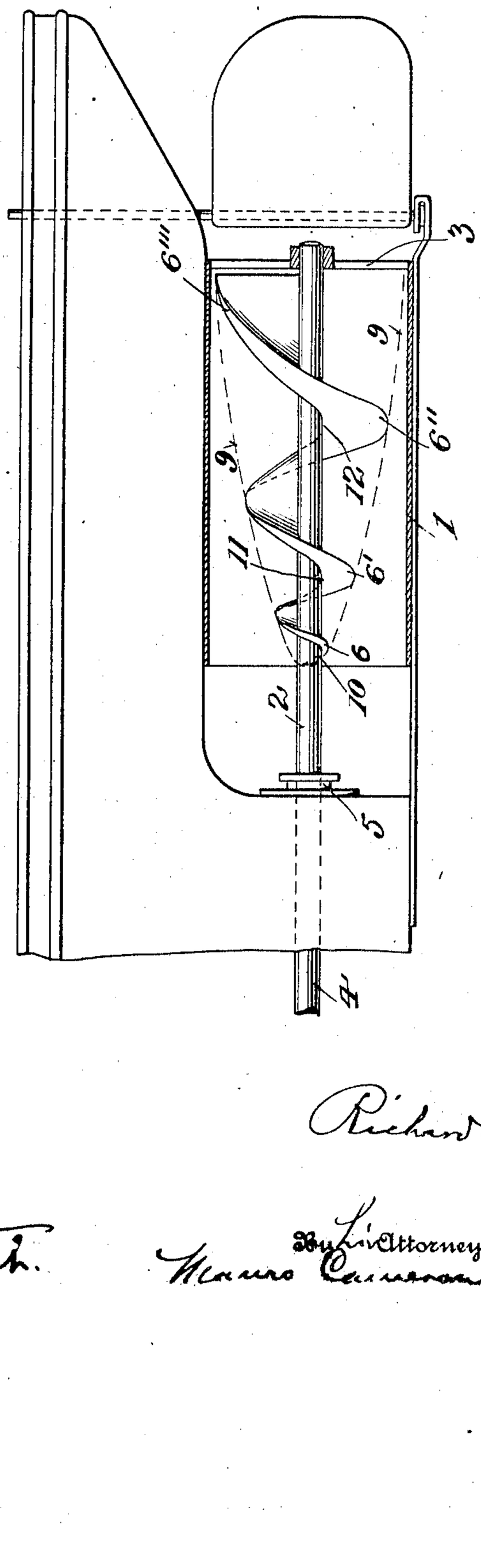

Fig. 1.

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2 SHEETS—SHEET 2.

Fig. 2.

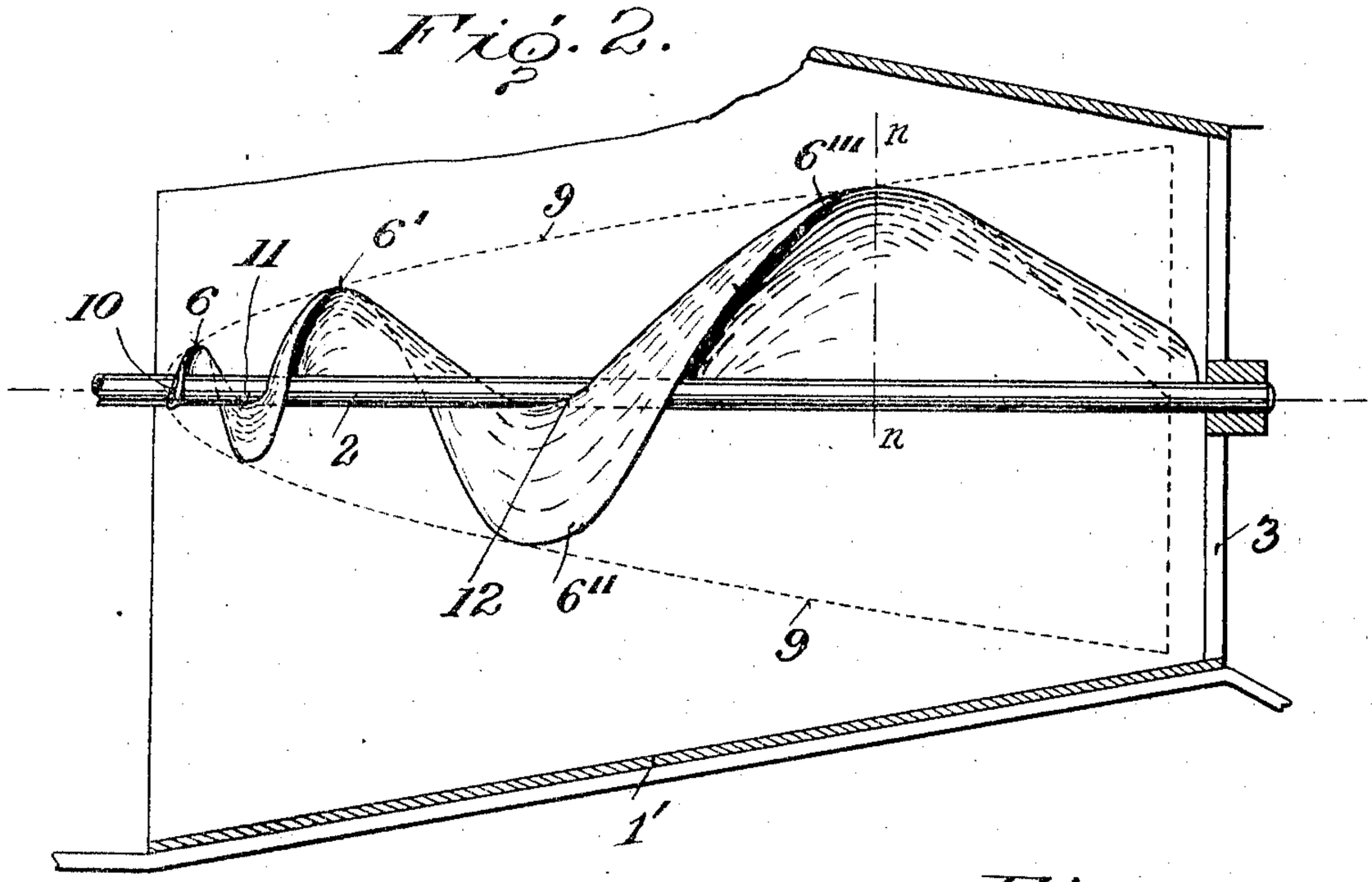


Fig. 3.

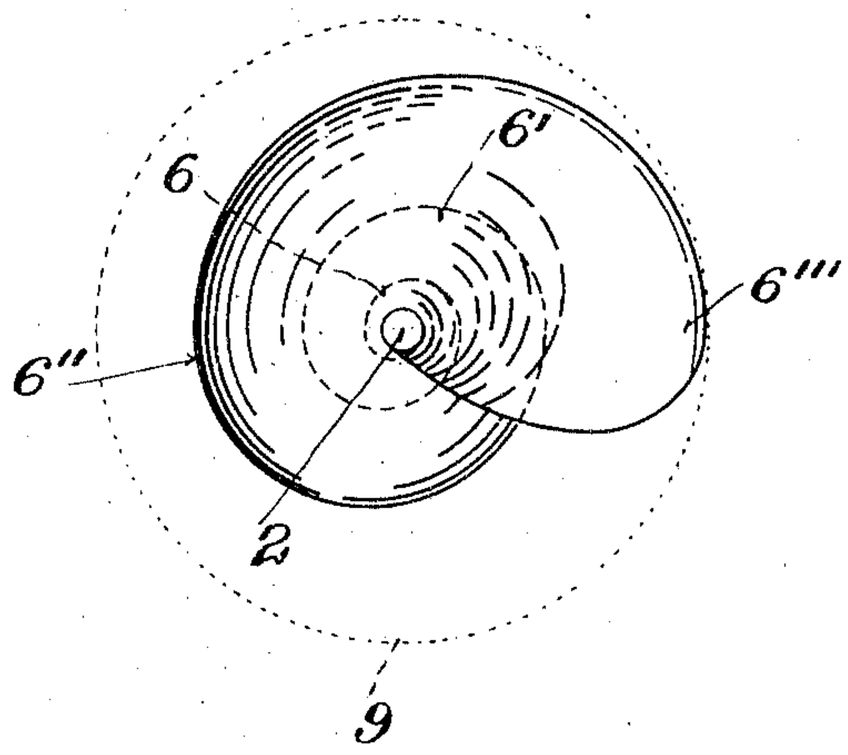
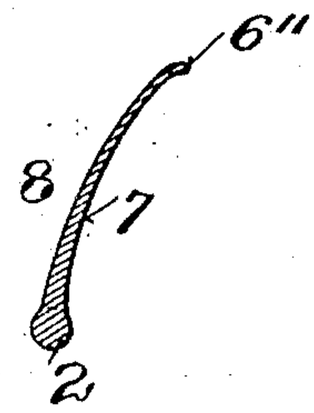


Fig. 4.



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RICHARD TJADER, OF NEW YORK, N. Y.

SCREW-PROPELLER.

955,721. Specification of Letters Patent. **Patented Apr. 19, 1910.**

Application filed April 27, 1908. Serial No. 429,516.

To all whom it may concern:

Be it known that I, RICHARD TJADER, a citizen of the United States of America, and a resident of New York city, New York, have invented a new and useful Improvement in Screw-Propellers, which improvement is fully set forth in the following specification.

My invention consists of an improved form of screw-propeller with or without an inclosing tunnel of tapering or ordinary cylindrical form.

Broadly stated, the invention comprises one or more of the following features: First, a continuous screw whose pitch increases from front to rear, preferably in geometric ratio as will be explained; second, a continuous screw whose blade increases in radial width from front to rear, preferably so as to outline a paraboloid of revolution as will be explained; third, the blade in cross-section curves rearwardly, so that its rear surface is concave, and preferably its front surface convex; and, fourth, in surrounding the propeller with a casing or tunnel, which may be made tapering (*e. g.*, in the form of a truncated cone), and preferably when the tunnel tapers its larger end will be in front.

My invention consists further in the various combinations of two or more of these parts as hereinafter set forth and claimed.

The invention will be best understood by reference to the accompanying drawings that illustrate preferred embodiments, and in which—

Figure 1 is a side view of the stern of a vessel showing one form of my invention, the tunnel being in cross-section; Fig. 2 is a similar view of the propeller, with a theoretically preferred form of tunnel shown in vertical section and partly broken away; Fig. 3 is a rear view of the propeller-shaft; and Fig. 4 is a transverse section of the propeller-blade, through line *n*—*n* of Fig. 2, as viewed from the front.

1 is the casing or tunnel, open at both ends and secured to the hull of the vessel in any suitable manner. In Fig. 2 this casing is indicated as a truncated cone 1′ with its larger opening forward.

2 is the shaft of the propeller, which may be conveniently supported at its rear by a bearing in the bridge-piece 3 held in the rear opening of the tunnel; and its forward end passes into the hull, or is made fast to the driving-shaft outside of the hull, in either case a suitable packing-gland 5 will protect the entrance into the hull. The propeller-screw or blade is indicated by 6—6′—6″. The rear face of this blade is concave, as at 7 in Fig. 4; while its forward face 8 is preferably convex. The concavity of this face 7 enables it to take a better hold upon the water, while the convexity of the forward face 8 lessens the opposition to forward travel. It will be noticed that if a radius should be passed from the shaft at any point of origin of the blade, this radius would not lie within the blade, which curves away therefrom. This relation will be indicated by the expression "radially-curved blade."

The radial width of the blade increases from front to rear; and preferably the contour or outline produced by the revolution of the propeller is a paraboloid of revolution around the major axis (as indicated by dotted lines 9—9). Or, stated in another way, the continuous outer edge of the blade would be represented by a line wound spirally around a solid paraboloid. The longitudinal distance (along shaft 2) from one convolution of the blade to the next (as from point 10 to point 11, from 11 to 12 etc.) increases,—in other words, the "pitch" of the screw increases from front to rear. Preferably, instead of increasing by a simple additional increment (in arithmetical ratio) the pitch increases in geometric ratio.

To understand the reference to the paraboloid and to the geometric increase of pitch as well as the improved form of tunnel, let it be assumed for the moment that the vessel is held stationary while its propeller is caused to revolve: Now, considering only one small portion of the forward part of the blade (as at 6) and the water acted upon by that portion, the tendency is to drive this particular body of water rearward, in a straight line, extending diagonally away from the axis of the propeller (being the resultant effect of the centrifugal force of the revolving blade and the rearward movement imparted by the inclined, or cam-like, surface of the blade). And this movement is likewise theoretically true of each separate body of water acted upon by each separate part of the blade. In short, if the vessel be stationary, we might

regard the water as forced rearward by the screw in a series of nested conical (or frusto-conical) sheets, the apex of each being in the axis of the propeller shaft, and the cones extending rearwardly. It is to be observed that if any particular portion of water (thus separately considered) should in its passage strike against the next succeeding convolution of the propeller-blade (*e. g.*, if water driven off from portion 6 should impinge upon portion 6′) it would be deflected and retarded,—a positive loss of efficiency. Again, if the said water should reach the next succeeding convolution (as 6′) at the precise instant that that convolution was turning out of the way, there would be no effect (either positive or negative). But, if each rearward convolution is placed sufficiently far back from its predecessor as not to interfere with the particular water-bodies being driven back by its predecessor and yet sufficiently far out (radially) as to act upon a fresh portion or portions of water (not broken up by preceding portions of the blade), the maximum driving-effect is obtained.

What has just been said, was upon the assumption that the vessel is remaining stationary while the propeller is revolving. But the principle is all the more obvious if we consider the vessel as in motion: The successive "nested cones of water" (which have been assumed for the purpose of explanation) are passing simultaneously and constantly from every successive portion of the blade (without interference from any other part of the blade) while the vessel and the propeller are themselves likewise advancing forward. This means that the amount of advance (measured along the axis of the shaft 2) should equal the diagonal distance theoretically attributed to the "conical sheets of water". Further, since the ship is going ahead, the rearward parts of the blade are constantly being brought into positions where (but for the peculiarities of pitch and radial width) they would be acting upon waters already broken up by the forward portions of the blade. But the features of construction just described prevent this. It will now be perceived that, geometrically speaking, the locus of the outer edge of the blade is a paraboloid of revolution, since the well-known property of a parabola (or paraboloid) is that any point in its curve is equi-distant from its focus and from a right line perpendicular to its major axis; that is, the diagonal distance traveled by the hypothetical water-cone is equal to the horizontal distance traveled by the vessel. In like manner, it will be understood that the increase of the pitch of the screw is in geometric ratio.

My new propeller-shaft may be employed without any casing or tunnel, being mounted as any ordinary propeller-shaft, and the rear end of the shaft 2 may be supported as by the rudder-post. But better results would be obtained, theoretically at least, by employing a tapering tunnel having its larger opening forward as indicated in Fig. 2,—and, indeed, instead of the truncated cone shown in Fig. 2, the tunnel may also be a paraboloid. But, since the use of this tapering tunnel would involve the re-designing of the shape of the hull of the vessel, and tends to impede the progress of the ship, I prefer to employ as a compromise the ordinary cylindrical tunnel. But, as already stated, the tunnel may be dispensed with entirely.

While the foregoing explanations as to the paraboloid outline of the screw and the geometric increase of its pitch is the one most easily stated, yet without insisting upon this explanation the fact remains that improved results are obtained by having the pitch of the screw increase in geometric ratio, and by having the radial width of its blade increase in the outline of a paraboloid; yet it will be understood that variations from these rules may be made without entirely losing the benefit of my invention. Moreover, parts of my invention may be used to the exclusion of other parts, and changes may be made in details of construction and of arrangement, without in any case departing from the spirit of the invention. Among other changes it may be noted that my new propeller-shaft does not require such depth of immersion, so that the vessel equipped with it can go into comparatively shallow waters; moreover, where the ordinary propeller-blade might be raised out of the water by the pitching and tossing of the vessel and would then come down with a sharp blow, this would not occur with my form of propeller. The tunnel not only increases the driving-efficiency, so as to produce greater speed with the same power (or equal speed with less fuel consumption), but also tends to prevent in large measure the washing of the banks of the river or canal in which the vessel may be driven. This same benefit also follows from the form of screw itself, which produces little or no vibration, and has slight tendency to throw waves on either side of the course of the vessel. And, besides, when the tunnel is omitted the wedge-like shape of the propeller obviates to a great extent any danger due to running against floating ice or other solid objects.

Having thus described my invention, I claim:

1. A screw-propeller having a continuous blade that extends a complete convolution about its shaft and that increases in pitch from front to rear in geometric progression.

2. A screw-propeller whose blade extends a complete convolution about its shaft and

increases in width from front to rear in the outline of a paraboloid of revolution.

3. A screw-propeller having a continuous blade that extends a complete convolution about its shaft and increases in pitch from front to rear, and the width of which blade increases in the same direction in the outline of a paraboloid.

4. A screw-propeller having a continuous blade that extends a complete convolution about its shaft and increases in pitch from front to rear in geometric ratio, while the width of said blade increases in the same direction.

5. A screw-propeller, whose screw increases in pitch from front to rear in geometric ratio, while the width of its blade increases in the same direction in the outline of a paraboloid.

6. The combination with a tunnel, of a screw-propeller located therein and having a continuous blade that extends a complete convolution about its shaft and that increases in pitch from front to rear in geometric ratio.

7. The combination with a tapering tunnel having its large end forward, of a screw-propeller mounted therein and having a continuous blade extending a complete convolution about its shaft and increasing its pitch from front to rear in geometric ratio.

8. The combination with a tapering tunnel, of a screw-propeller mounted therein and having a continuous blade extending a complete convolution about its shaft and increasing its pitch from front to rear in geometric ratio.

9. A screw-propeller having a continuous blade that extends a complete convolution about its shaft and whose pitch increases from front to rear in geometric ratio and whose blade is curved radially.

10. A screw-propeller whose blade is curved radially and extends a complete convolution about its shaft and increases in width from front to rear in the outline of a paraboloid.

11. The combination of a tapering tunnel having its large end in front, and a screw-propeller whose pitch increases from front to rear and the width of whose blade increases from front to rear in the outline of a paraboloid.

12. The combination of a tapering tunnel, and a screw-propeller whose pitch increases from front to rear and the width of whose blade increases from front to rear in the outline of a paraboloid.

13. The combination of a tapering tunnel with its large end in front, of a screw-propeller whose pitch increases from front to rear in geometric ratio and whose blade increases in width from front to rear.

14. The combination of a tapering tunnel, and a screw-propeller whose pitch increases from front to rear in geometric ratio and whose blade increases in width from front to rear.

15. A screw-propeller having a radially curved blade extending a complete convolution about its shaft and whose pitch increases from front to rear and whose width increases from front to rear in the outline of a paraboloid.

16. A continuous screw-propeller having a blade that extends a complete convolution about its shaft and whose pitch increases from front to rear in geometric ratio, and which blade is curved radially and increases in width from front to rear.

17. A screw-propeller whose pitch increases from front to rear in geometric ratio, and whose blade is curved and increases in width from front to rear in the outline of a paraboloid.

18. The combination with a tunnel of a continuous screw-propeller having a radially-curved blade extending a complete convolution about its shaft and increasing in pitch from front to rear in geometric ratio.

19. The combination with a tapering tunnel, of a continuous screw-propeller having a radially-curved blade extending a complete convolution about its shaft and increasing in pitch from front to rear in geometric ratio.

20. The combination with a tapering tunnel having its large end forward, of a continuous screw-propeller having a radially-curved blade that extends a complete convolution about its shaft and that increases in width from front to rear in the outline of a paraboloid.

21. The combination with a tapering tunnel, of a continuous screw-propeller having a radially-curved blade that extends a complete convolution about its shaft and that increases in width from front to rear in the outline of a paraboloid.

22. The combination with a tunnel, of a continuous screw-propeller having a radially-curved blade that extends a complete convolution about its shaft and that from front to rear increases in pitch in geometric ratio while increasing in width.

23. The combination with a tapering tunnel, of a screw-propeller having a curved blade that from front to rear increases in pitch in geometric ratio while increasing in width.

24. The combination with a tapering tunnel whose large end is forward, of a screw-propeller having a curved blade that from front to rear increases in pitch in geometric ratio while increasing in width.

25. The combination with a tunnel, of a continuous screw-propeller having a radially-curved blade that extends a complete convolution about its shaft and that from

front to rear increases in width in the outline of a paraboloid while increasing in pitch.

26. The combination with a tapering tunnel, of a screw-propeller having a curved blade that from front to rear increases in width in the outline of a paraboloid while increasing in pitch.

27. The combination with a tapering tunnel whose large end is forward, of a screw-propeller having a curved blade that from front to rear increases in width in the outline of a paraboloid while increasing in pitch.

28. The combination with a tunnel, of a screw-propeller having a curved blade that from front to rear increases in pitch in geometric ratio while increasing in width in the outline of a paraboloid.

29. The combination with a tapering tunnel, of a screw-propeller having a curved blade that from front to rear increases in pitch in geometric ratio while increasing in width in the outline of a paraboloid.

30. The combination with a tapering tunnel whose large end is forward, of a screw-propeller having a curved blade that from front to rear increases in pitch in geometric ratio while increasing in width in the outline of a paraboloid.

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

RICHARD TJADER.

Witnesses:
RALPH L. SCOTT,
WILLARD H. HARTING.