Aug. 20, 1935. T. F. W. MEYER ET AL 2,011,821

PROPELLER WHEEL

Filed Aug. 28, 1933 3 Sheets-Sheet 1

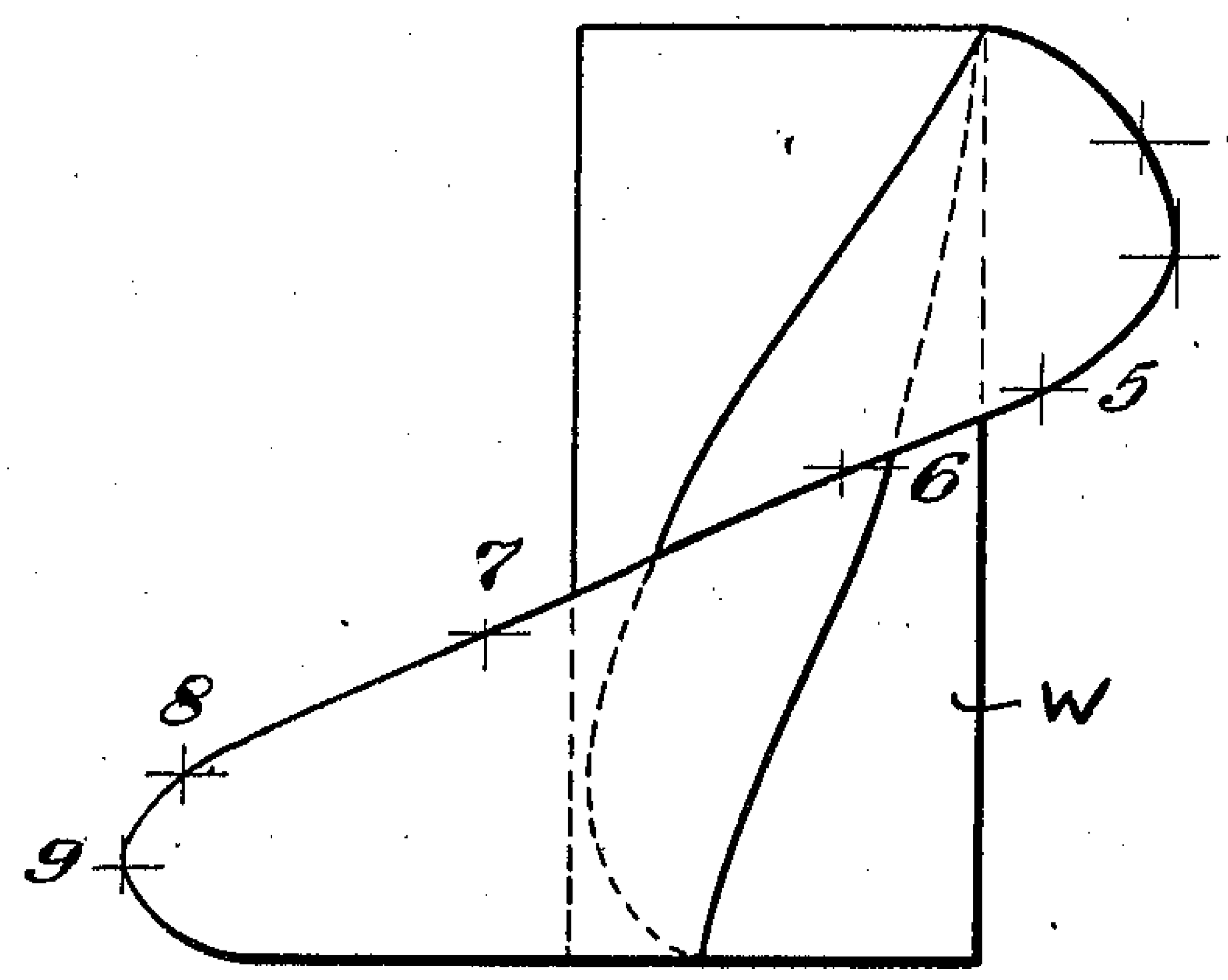

Fig. 2.

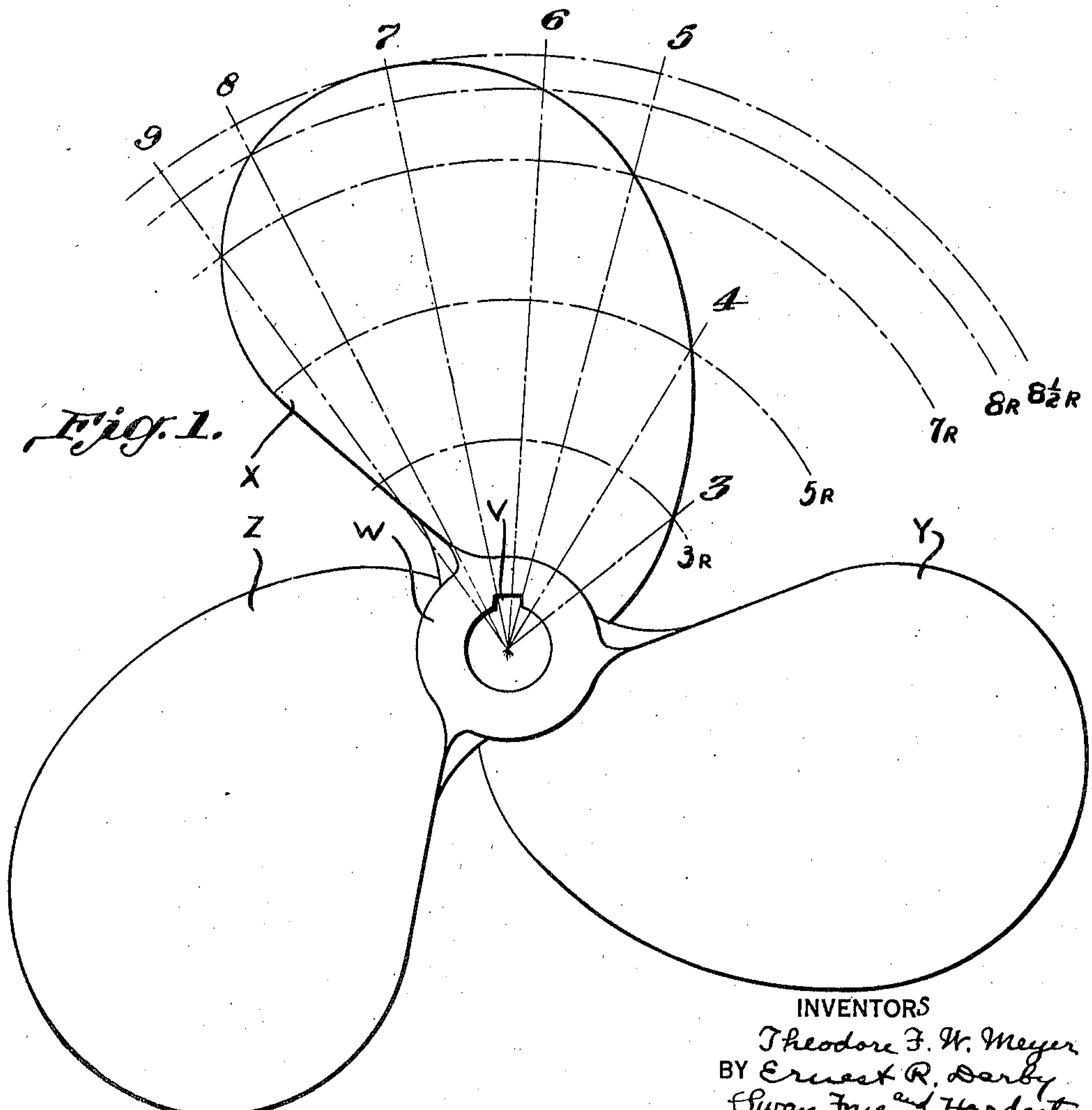

Fig. 1.

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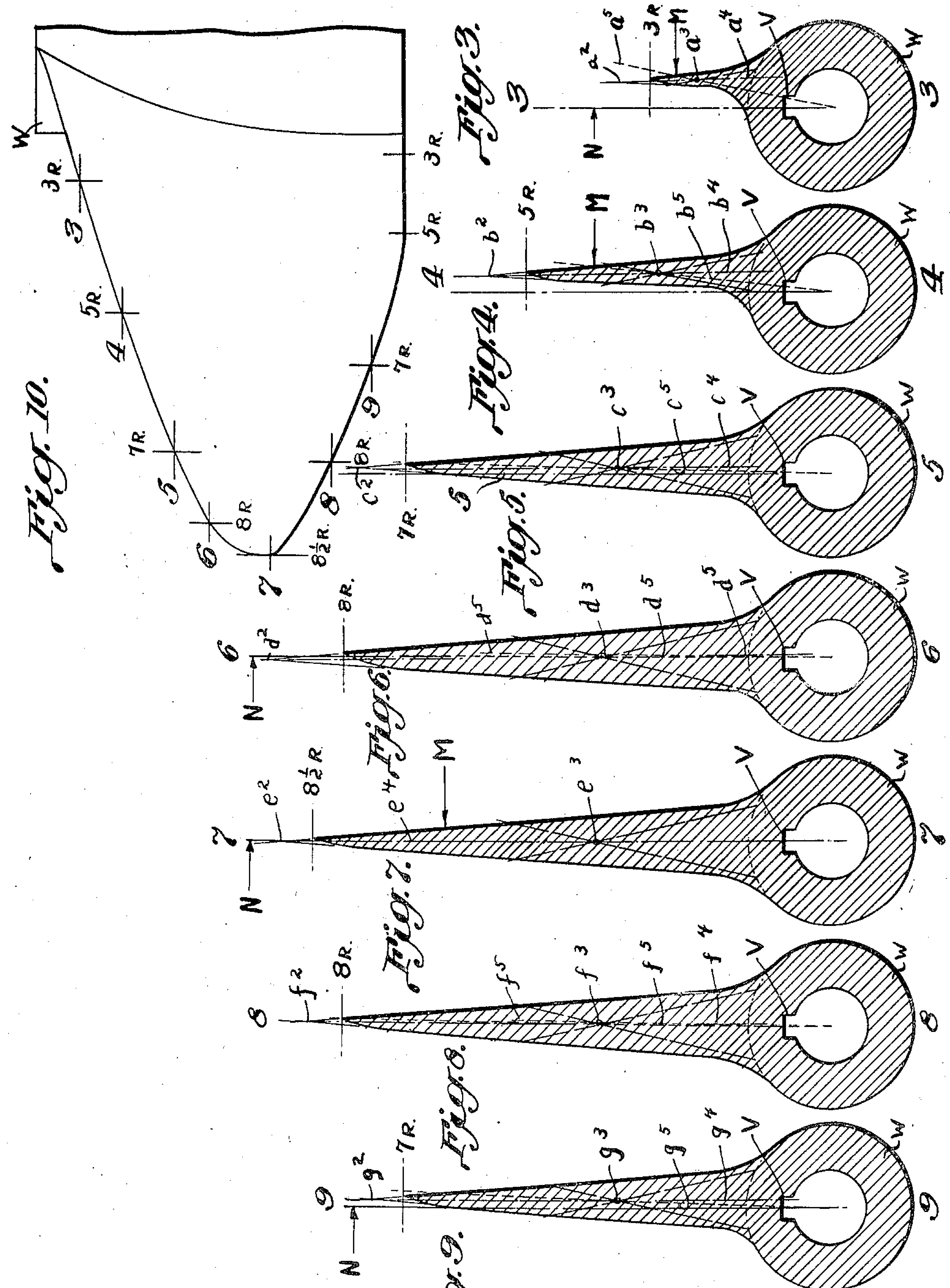

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Fig. 12.

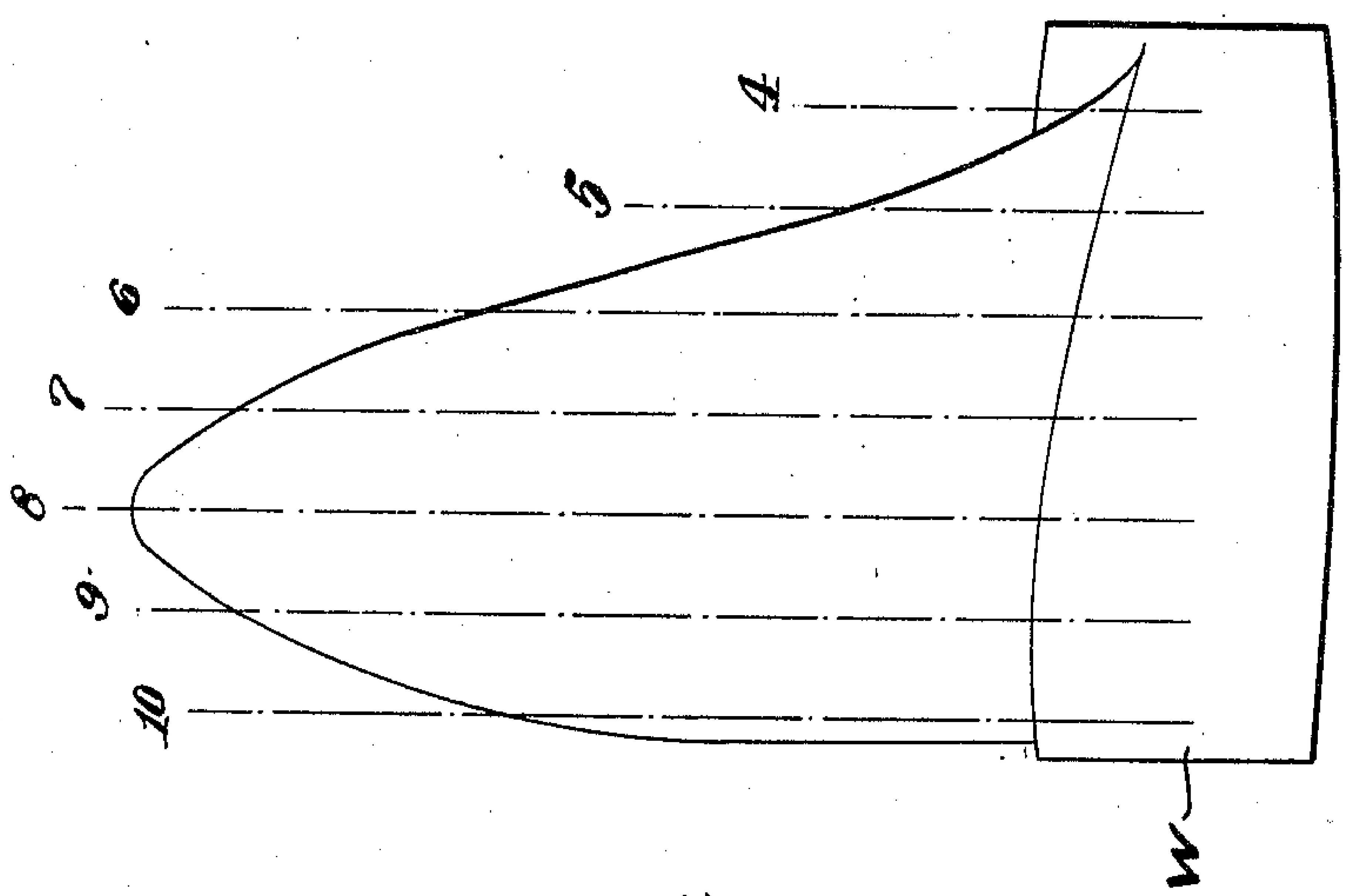
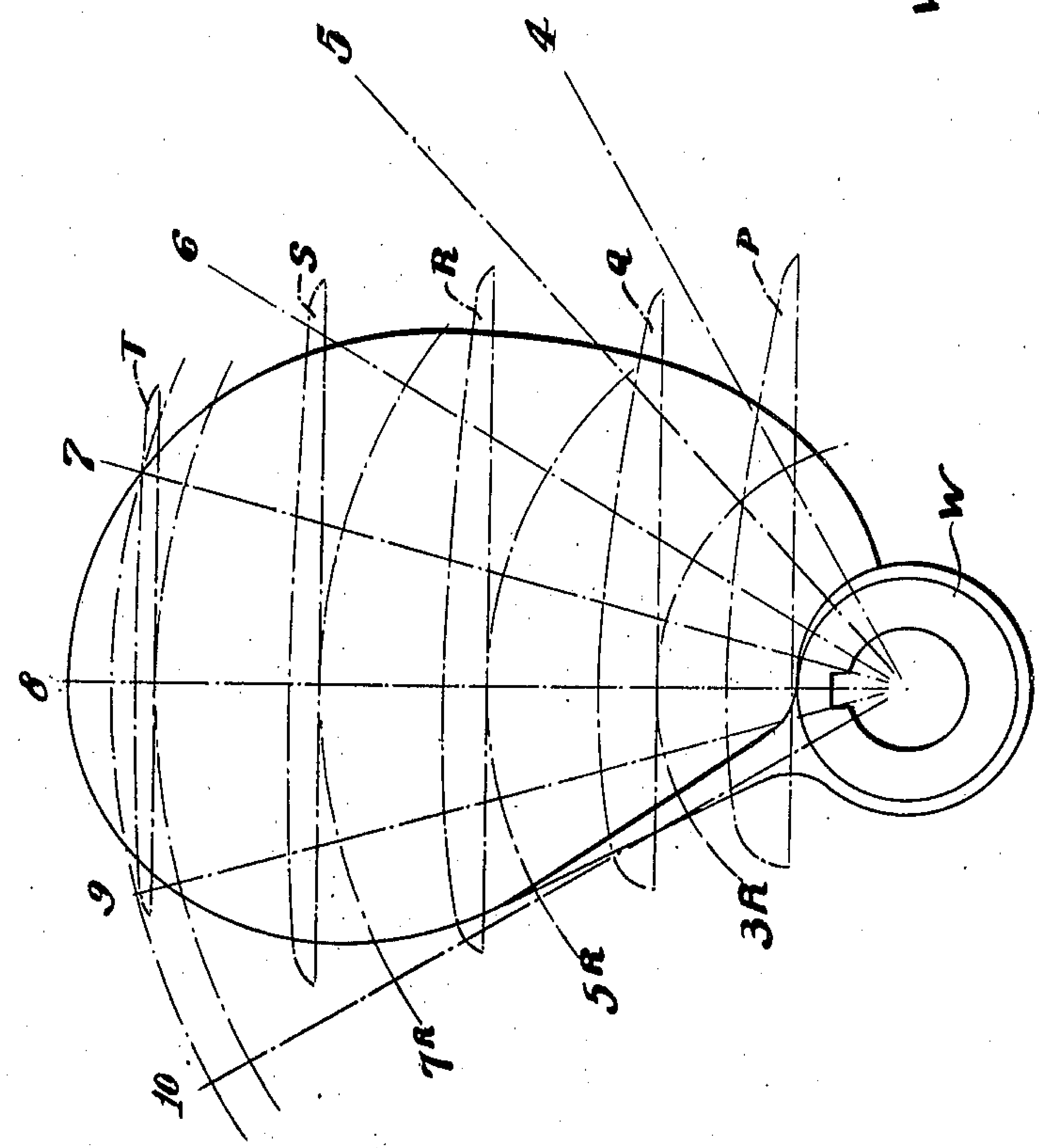


Fig. 11.



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Patented Aug. 20, 1935

2,011,821

UNITED STATES PATENT OFFICE

2,011,821

PROPELLER WHEEL

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Application August 28, 1933, Serial No. 687,124

17 Claims. (Cl. 170—156)

This invention relates to screw propeller wheels, and has for its object an improved and selective contouring of its several blades, and such disposition of the component mass of each relatively to their several radial and stress lines, that, while a greater smoothness of action results, there is present in each blade of a wheel as thus constituted an offsetting force against their tendency to bend in the direction of the propulsion thrust. In the wheel whose details will be dealt with specifically in later paragraphs hereof, this desired result is secured without sacrifice of the accepted principle that the whole working surface of each blade must remain of truly screw-threaded contour. This can best be done if the working surface of each blade along any selected radial line be that of a V thread, whereas the now commonly used wheels have blades any one of whose radial sections is in the form of a square thread, with its working surface only truly radial.

Generally speaking, we accomplish these desired results by so locating the center of mass of each blade that the neutral axis of the blade section either coincides with a radial, or is so located relatively thereto that as the several blades attempt to align themselves, there is set up in each one a bending force counter to the propulsion thrust. This is in marked contrast to the wheels heretofore relied upon, in that the radial working surfaces of each blade are there so disposed relatively to the center of mass and the neutral axis that any tendency of the latter to align itself radially with respect to the then prevailing centrifugal force sets up a bending tendency in the direction of, and supplementary to, the thrust propulsion load, which of course tends to effect a warping or bending of the blades.

The advantages of our improved construction become particularly apparent in the case of racing boats or other craft, water or aerial, whose engine speed, measured in revolutions per minute figures, far exceeds what was demanded or even thought of only a comparatively few years ago, though of course holding true in lesser degree as to wheels used on slower propeller speed craft.

In the drawings:

Figure 1 is an elevational view of a three-bladed propeller whereon are selectively located various radial section lines.

Figure 2 is an edge elevational view of the propeller wheel shown in plain elevation in Figure 1.

Figures 3 to 9 inclusive are developed sections, each representing the developed cross-sectional contour of a blade along its corresponding radial section line as shown in Figure 1;

Figure 10 is a plan or elevational view of a single propeller blade, showing a preferred form of contouring therefor, and like Figures 3 to 9, having various sectioning locations which tie it in with the other figures.

Figure 11 is a developed sectional elevation of a single wheel blade, taken along a plane perpendicular to the axis of the wheel as a whole, the face or working surface thereof being a portion of a true screw thread generated by a series of radials successively drawn in helical order from, and in uniform angular relationship with the axis.

Figure 12 is a similar developed sectioning, complementary to Figure 11, in that the several radials are therein shown as applied to the blade as viewed at right angles to the position shown in the former figure, that is to say, the plane of this view being parallel to the axis of the wheel as a whole.

As shown elevationally in Figure 1, the propeller wheel wherein our invention is embodied seems, when viewed from this direction, to be but little if any variant from present usage, having a central hub W, key slot V, and three blades as X, Y, and Z, the description to be offered for any one of these blades sufficing for either of the others, of which there may be any number desired, such for example, as two or four, instead of the three here illustrated.

At variant radial distances on each of the blades, as X for example, from the axial center of the wheel as shown in Figure 1, are placed concentric arcs, as 3R, 5R, etc. which respectively intersect the peripheral edge of the blade X at the several points therealong at which a true radius line emerges from the mass of the blade. These several radial lines, designated 3, 4, 5, 6, 7, 8, and 9 respectively A—A to G—G inclusive, shown in Figure 1, are in numerical order throughout their arranged sequence from right to left, and in Figure 7 which is representative of the center of the blade X, the vertically rising radial line passes accurately through the ascertained center of mass at that point, as e^3, of the blade section. In the preceding lettered figures, representing the approach toward this approximate center, the diminution in the degree of variance between the central section lines and the radial lines through the respective centers of mass and the line representing centrifugal bending thrust is steady; and similarly in Figures 8 and 9 representing the taper toward the rear, or left-hand, edge of the blade, the angular variance again increases. The reason for this is obvious, since the sectioning of the blade X along the line 7—7 comes the nearest, of the several sectioning lines shown, to so truly intersecting the blade that the cross-sectional mass thereof along that line is neither in one wing, i. e. toward one edge, nor toward the other edge of the blade X as a whole, which wings or edges of course conform with the screw-thread contouring and angular positioning of the blade as a whole relatively to the wheel's hub and axial center, which the very nature of a propeller wheel makes necessary.

When this type of blade is employed at speeds when centrifugal forces become seriously active upon the mass of the blades, the centrifugal force acts outward along the radius passing through the center of gravity of the outer portion, and has a magnitude equal to the product of the mass of the outer portion, the distance of the center of mass from the axis of rotation and the square of the angular velocity, mathematically expressed, $Fr=M\omega^2r$. In this form the main section is so located longitudinally on the hub, and the circumferential contour of the blade as a whole is so formed about it that by using the base-altitude ratio of the main section as a constant we arrive, at a series of wedge-shaped cylindrical blade sections, the narrower ends of which combine to form the leading edge of the blade, which is in entire conformity with well-known principles dealing with water flow about submerged hull appendages, where the submergence is not so great, but wherein two media, water and air in highly varying and indeterminate proportions, are present. While none of these sections remain symmetrical, due to back curvature of the blade, with the working surface remaining in a predetermined helical plane the center of mass of each respective section is so located that the bending resultants arising from centrifugal force act therein in a direction opposite to that of thrust upon the blade, and thus tend to set up an equilibrium between the stresses arising from centrifugal bending and thrust forces.

As to each of the cross-sectional representations in Figures 3 to 9 inclusive, it should be noted that the heavy line contourings of the blade's edge represented by the several figures all stop short of the actual intersection lines of the two converging surface lines of the blade. Their respective positions relatively to the thin line extensions to their several intersection points, a^2, b^2, c^2, d^2, e^2, f^2, and g^2, enables the ascertainment, by well-known engineering formulæ, of their respective centers of mass, a^3, b^3, c^3, d^3, e^3, f^3, and g^3; and as already remarked, only in the case of Figure 7 does the located center of mass fall squarely on the true radius 7—7.

On each of the several Figures 3 to 9 inclusive I have shown a dot and dash line, as a^4, b^4, etc., and a plain dotted line, as a^5, b^5, etc., which respectively represent true radials through the center of mass and the thrust due to centrifugal bending, due in turn to the wheel's rotation. The direction of load thrust against a representative face of the blade is indicated by the horizontal arrows M, while the arrows N similarly represent the direction in which the centrifugal bending force exerts itself.

Beginning now with Figure 3, and progressing through the group in their arranged right-to-left sequence, it will be noted that the center of mass, as a^3, either coincides with a radial line, as a^4, or is so located relatively thereto that in attempting to align itself radially, it sets up a bending force in the blade's contour which is counter to the propulsion thrust. The angularity between the radial a^4 which passes through the center of mass a^3 in Figure 3 and the truly vertical radial 3—3 is here greatest, and represents, as already stated, the section through the blade at the point where the arc 3R intersects the blade's edge in Figure 10. This angle gradually diminishes in size, and the line a^5 denoting the centrifugal bending stress moves toward the true vertical radial line, until in Figure 7 both it and the radial e^4 are coincident therewith, thereafter again increasing in Figures 8 and 9, as already explained. By contrast, the wheels now commonly used have the centers of mass of their several blades so positioned relatively to the neutral axis that the response of the blade as a whole to the bending action of centrifugal force is in the direction of, that is to say, supplemental to, the propulsion thrust load, and the tendency of the blades to bend is thereby increased accordingly.

It will be noted that in varying degrees the working surface of the blade against which the thrust load acts, in the Figures 3 to 9 inclusive, the right-hand face of the blade sections 3—3 to 9—9 inclusive, is uniformly tangential to the circle representing the hub, at the same time retaining the working or thrust-receiving surface as a whole in true screw-thread form. The response or reaction of the blade, and of each and every point thereon, to the applied load thrust, represents the centrifugal counteractive bending force as opposed to the propulsion thrust. At the point of maximum diameter and greatest root thickness, represented by Figure 7, on section line 7—7, the neutral axis and the radial through the center of mass are coincident; at all other points on both tapering off and shorter blade sections, they are both positively to one side of the true vertical radial, in the direction from which the stress of the propulsion load comes.

It has been our experience that, while even the ordinary symmetrical peripheral contouring of a blade which otherwise fulfills the requirements here set forth can work with considerable efficiency, the form thereof shown in Figure 10 is preferable, in that section 7—7 is so located longitudinally on the hub, and the circumferential contour of the blade as a whole is so formed about it, that by using the base altitude ratio of said section 7—7 as a constant in the proportioning of the other radial sections illustrated, there are developed a series of wedge-shaped cylindrical blade sections, the narrow ends of which combine to form the leading edge of the blade as illustrated in Figure 12, which form of cylindrical blade sectioning tends to substantially reduce cavitation tendency and produces a blade of greater efficiency than the conventional semi-elliptical cylindrical section, particularly where submergence is not so great but that the propeller is actually working in a combination of two media, water and air in highly varying and indeterminate proportions, rather than in a monogeneous medium. Figure 10 being taken perpendicularly to the plane of Figure 1, that is, looking edgewise of the blade and perpendicularly to the central axis of the propeller wheel as a whole, shows the upper and outer shoulders of the blade's contour as somewhat cut away from the roundness of outline ordinarily associated with such blades, and even as suggested in elevational Figure 1. At points along its periphery, as shown in Figure 10, intersection points, such as for example 7R—C, corresponding to the arcs and radial lines appearing in Figure 1 and to the radial lines, are indicated.

It is also worthy of note that this tapering of the edge allows the various sections approaching the entering edge of a blade to be proportioned with due respect to strength as compared with the section of greatest root thickness.

Developed Figures 11 and 12 may be looked upon as further refinements of Figures 1 and 10 respectively, in that they similarly show the emergence of the several radial lines at the several peripheral points of the blade, though the radial lines are, for clearness of illustration, therein designated as B^9 to H^9 inclusive. Figure 11 represents a further illustrative development beyond what is shown in Figure 1, in that the tapering of the blade, as it would be viewed in cross-section at various points looking lengthwise thereof, is indicated by the several dot-and-dash contourings P, Q, R, S, and T.

It will of course be obvious that the constructional and operative principles herein illustratively discussed can be adapted, as regards size and proportioning of the constituent parts, to the particular conditions and requirements of the various uses to which propeller wheels are put, without departure from the principles herein involved, so long as the completed wheel's characteristics still comply with the requirements set forth herein and in the appended claims.

What we claim is:

1. A propeller wheel each of whose blades has its working surface of true thread contour, with the centers of mass of the various radial sections disposed for effecting a neutralizing action between the thrust load and the centrifugal bending force incident to the wheel's rotation.

2. A propeller wheel having a plurality of blades whose respective working surfaces are arranged tangentially to a circumference centered about the axis of rotation while maintained in true screw contour.

3. A propeller wheel having a plurality of blades, the neutral axis of any radial section of each of which is positioned intermediate opposing lines of force due respectively to the action of the propulsion thrust and the bending component of the centrifugal force due to the wheel's rotation.

4. A propeller wheel having the constituent masses of its blades disposed relatively to the several radii drawn from the axis of rotation to set up a bending force resultant from centrifugal forces in rotation counteractive to the thrust load thereupon.

5. A propeller wheel, the working surface of each of whose blades is contoured relatively to its neutral axis for offsetting against one another the opposing and normally flexing influence of the load thrust and the bending force resultant from the centrifugal force due to the wheel's rotation.

6. A propeller wheel, having blades whose working surfaces are of uniformly threaded contour, and all portions of each of which are disposed relatively to the neutral axis of the blade in adequate intermediate relation for effecting the offsetting against one another of the normal bending forces due to load thrust and centrifugal force.

7. A propeller wheel, having the component mass of each of its several blades selectively disposed relatively to the neutral axis and the center of mass of each as taken along a true radial section, for forcing the load thrust and the centrifugal bending stress to act opposingly to one another.

8. A propeller wheel, each of whose constituent blades has its component material disposed in selective relation to the neutral axis and to the center of radial action, for preventing action upon it from the same general direction of the forces of load thrust and of centrifugal bending stress.

9. A propeller wheel, the mass of each of whose several blades is disposed on either side of their several neutral axes, in proportions, and as regards their truly threaded working surfaces, adequate to bring about a neutralizing action between the stresses of load thrust and centrifugal bending force under rotation.

10. A propeller whose blades are of uniformly threaded surface contour and the center of mass of each radial section of which is traversed by a true radial and by the neutral axis representing the opposing action under rotation of the load thrust and of the centrifugal bending stress.

11. A propeller wheel whose blades have working surfaces of true thread contour, such surfaces and their bounded blade material being disposed on either side of the neutral axes of the several blades in proportions eliminative of the bending forces and stresses respectively resulting from rotation of the wheel and from propulsive thrust.

12. A propeller wheel, the back of each of whose blades is contoured relatively to its working surface for effecting the offsetting against one another of the normally flexing influence of the load thrust and the bending influence resultant from centrifugal force due to the wheel's rotation.

13. A propeller wheel, the constituent masses of whose several blades are selectively allocated on either side of their respective neutral axes in proportions effective of a substantial neutralization of the flexing influences due to propulsive thrust and to centrifugal force resultant from the rotative movement of the wheel.

14. A propeller wheel, each of whose constituent blades is of true thread contour and in each of which the disposition of its constituent material on either side of the neutral axis is in proportions adequate to effect the offsetting against one another of the forces of load thrust and of centrifugal bending stress.

15. A propeller wheel, whose blades have their component material located on either side of their respective neutral axes in proportions adequate to bring about the action, upon the opposing faces of the blade, of the bending forces incident to propulsive thrust and to centrifugal bending stresses due to the wheel's rotation.

16. A propeller wheel having integral blade elements with working surfaces of true thread contour and with the material forming the body of each blade selectively disposed on either side of its neutral axis for effecting the eliminative offsetting against one another of the bending forces due to propulsive thrust and to centrifugal force when the wheel is rotated.

17. A unitary propeller wheel construction, the working surfaces of whose blades are of true thread contour and the proportioned positioning of the component mass of each of which on either side of its neutral axis effects an eliminative offsetting against one another of the normally flexing influence of the load thrust and of centrifugal force resulting from rotative movement of the wheel.

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