June 14, 1932. J. J. CALLAHAN 1,863,238

PROPELLER

Filed July 10, 1930

Fig. 1.

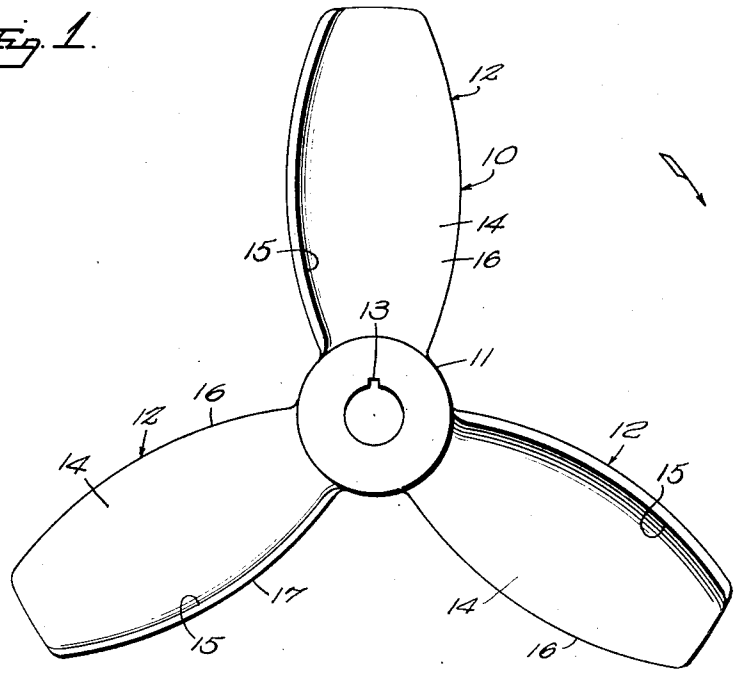


Fig. 2.

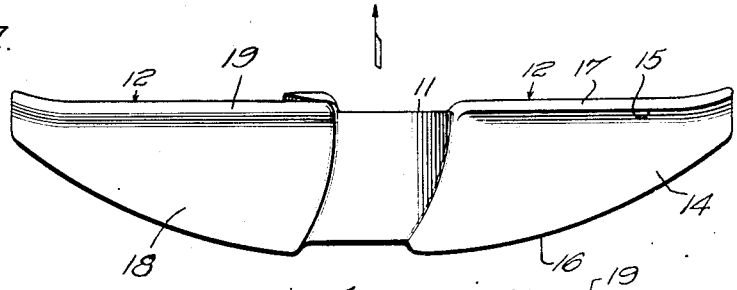


Fig. 3.

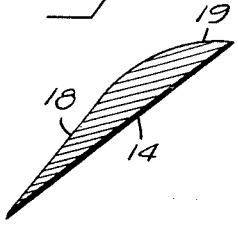


Fig. 4.

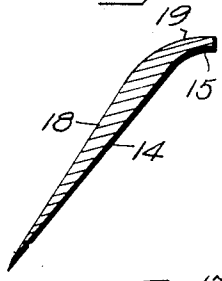


Fig. 5.

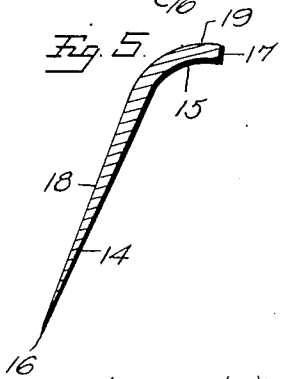


Fig. 6.

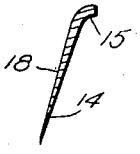
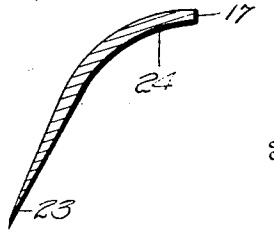


Fig. 7.



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UNITED STATES PATENT OFFICE

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PROPELLER

Application filed July 10, 1930. Serial No. 467,088.

This invention relates to propellers.

An important object of the invention is to utilize the advantages of the screw and compression type propellers to the best advantage.

A further object is to provide a propeller of the type referred to wherein objectionable losses are greatly minimized, thus increasing the efficiency of the device.

A further object is to minimize radial and axial losses of the fluid in which the device is operated and thus to translate the greatest possible proportion of torsional force into longitudinal force to increase the efficiency of the propeller.

A further object is to provide a novel propeller of the type referred to wherein the pressure of the fluid is substantially equalized throughout the length of the blade, thus minimizing unequal pressures in the projected column of fluid.

A further object is to provide a propeller having blades so constructed as to introduce centripetal forces to overcome the radial and axial losses generally resulting from the centrifugal force and uneven pressure generated by the rotation of the propeller about its axis.

A further object is to provide a propeller having one or more blades and provided with rear faces which are so correlated to the active faces of the blades as to eliminate losses from friction and other resistance.

A further object is to provide a propeller blade constructed so as to introduce compression forces in the plane of rotation of the blade and to translate such forces into longitudinal forces without substantial loss.

A further object is to provide a novel propeller of the character referred to wherein resistance due to unequal pressures at the rear of tht blade is greatly minimized.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawing I have shown several embodiments of the invention. In this drawing,

Figure 1 is an elevation showing the active faces of the blades,

Figure 2 is an edge view,

Figures 3 to 6 inclusive illustrate a series of diagrammatic sectional views taken along planes at right angles to the radius of one of the blades progressively from the hub end to the tip end of the blade, and,

Figure 7 is a detail sectional view taken transversely of a somewhat modified form of blade.

Referring to Figures 1 to 6 of the drawing the numeral 10 designates a propeller as a whole including a hub 11 and a plurality of blades 12. The hub is substantially cylindrical in accordance with the usual practice, and is provided with a key slot 13 whereby the propeller is adapted to be secured to a suitable drive shaft.

In the drawing the propeller is illustrated as being provided with three of the blades 12, but it will be apparent that any suitable or desired number of blades may be employed according to the use to which the propeller is to be put, and the conditions under which it is to be operated. The propeller is adapted to rotate in the direction of the arrow shown in Figure 1 and to create longitudinal pressure in the fluid in which it is operated, in the direction of the arrow shown in Figure 2. Obviously the longitudinal direction of movement of the device, when used as a propeller, will be opposite to the direction indicated by the arrow in Figure 2.

As clearly shown in Figures 1 and 2, portions of the blades are curved in the direction of rotation and away from the longitudinal direction of travel of the propeller, since with such construction it has been found that radial and longitudinal losses can be minimized. This is particularly true because of the construction of the elements of the propeller to be described. It also will be apparent that the edge portions of the blade are convexly curved with respect to each other, whereby the greatest width of the blade lies intermediate the ends thereof. The latter feature is preferred for most installations, but is not essential.

The active side of each blade includes an angular impeller face 14 and a compressor face 15. The portions of the blade referred to may be considered for the purpose of discussion to be separate faces, but it will be ap-

parent that since they are preferably connected to each other through an intermediate transversely curved portion, the two faces are in fact continuations of each other, but they have separate and distinct functions to perform in the operation of the propeller. Obviously the free edge 16 of the compressor face 14 constitutes the entering edge of each blade, the free edge 17 of the compressor face constituting the following edge. Referring to the diagrammatic sections illustrated in Figures 3 to 6 inclusive, it will be apparent that the slope of the impeller face of each blade decreases from the tip end of the blade toward the hub end thereof. This graduation in slope has been found necessary, in conjunction with other structural features of the device, to secure the desired high degree of efficiency. Due to structural limitations, and to other considerations, the portion of the blade adjacent the hub is preferably in the form of a true screw, as indicated in Figure 3.

The compressor face 15 is arranged substantially at right angles to the direction of rotation to introduce compressive forces into the fluid medium in which the propeller operates, and the introduction of such circumferential forces is translated into longitudinal forces to cause the fluid to escape in the direction of the arrow in Figure 2.

It has been found that if the rear face of the blade were formed substantially flat throughout its width, an area of low pressure will be formed rearwardly of the compressor face, thus introducing material torsional losses. Accordingly the portion 18 of the rear face, that is, the portion extending from the entering edge of the blade may be made substantially flat or slightly convex, while the portion 19 of the rear face, lying adjacent the following edge of the blade, is curved transversely throughout the length of the blade as shown in the diagrammatic figures. The two sections of the rear face of the blade are substantially coextensive respectively with the impeller and compressor faces of the active side of the blade.

As previously stated, the slope of the impeller face decreases toward the inner end of the blade, and this also is true of the main section 18 of the rear face of the blade. The variations in slope however, are not critical, and will vary according to the application of the propeller. However, the impeller face of one blade has been illustrated diagrammatically in Figures 3 to 6 inclusive to illustrate various angular slopes of the impeller faces which are preferred in some installations.

As previously stated, a considerable torsional loss would be introduced if any portion of the rear face of the blade were arranged at right angles to the plane of rotation, that is, substantially parallel to the compressor face 15. However, the arrangement of the curved portion 19 of the rear face produces a stream line effect for the rear face of the blade, thus minimizing the introduction of low pressure areas and resulting torsional losses.

The form of the invention shown in Figure 7 is similar to the form previously described except that the impeller face 23 extends to the following edge of the blade through a relatively gradually curved face 24, the rear portion of which constitutes the compressor face of the blade.

The operation of both of the forms of the device illustrated will be apparent from the foregoing description, and since the operation is identical in each case, only the form illustrated in Figures 1 to 6 inclusive will be referred to. The impeller face 14 tends to create a direct thrust on the liquid in the direction of the arrow shown in Figure 2. The curving of the compressor face in the direction of rotation of the blade as well as the curvature of the blade as a whole toward its end away from the longitudinal direction of movement largely minimizes radial and longitudinal losses due to centrifugal and centripetal forces, and to other causes. Thus, substantially the greatest loss occurring from the impeller face 14 will be slippage along the blade transversely thereof, toward the compressor face 15. The fluids escaping from the impeller face through circumferential slippage as well as fluids directly intercepted by the compressor face 15 will be acted upon by such face to create material circumferential pressure which obviously will be translated into longitudinal pressure in the direction of the arrow illustrated in Figure 2, and thus the fluid will escape from the blade longitudinally of the axis of rotation.

The slope of the blade provides the necessary depth of lip or compressor surface and also reduces the losses at the back of the blade. The ideal slope is that which most greatly minimizes losses at the back of the blade and allows sufficient depth for the compressor portion. Attention also is invited to the fact that the provision of the compressor face 15 also tends to stabilize the action of the impeller face.

While it has been stated that the impeller face 14 creates a direct thrust longitudinally of the axis of rotation, it also will be apparent that much of the forces generated by such impeller face will be in the plane of rotation of the propeller, and thus the impeller face materially assists the relatively narrow compressor face in building up the compressive forces previously referred to. In this connection, it has been found that the impeller face, in practice, preferably but not necessarily, should be materially wider than the compressor face, and that a line connecting any point on the entering edge 16 and

a corresponding point along the following edge 17 must be 45 degrees or less to the plane of rotation. Thus it will be apparent that the invention is not limited to the specific proportions and angles illustrated in the drawing, but may be varied considerably.

The propellers illustrated in the drawing have been described merely as preferred embodiments of the invention, and it should be understood that the invention is not limited to the specific details of construction described. For example, the portion of the rear face of the blade adjacent the entering edge, and portions of the compressor face have been described as being substantially flat, but the invention is fully operative and is efficient in operation without such structural limitations.

As a further example, it is not essential that the blades include any transversely flat surfaces, since the active face of the blade could be formed on a continuous transverse curve from the entering to the following edges, and the rear face of the blade could be correspondingly shaped to provide the desired stream line effect. It is desired, however, that where such a continuous transverse curve is employed, the rear extremity of the compressor face should terminate in a tangent at right angles to the direction of rotation of the blade, as suggested in the forms of the invention illustrated.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, said blade having a rear face the major portion of which, lying adjacent the entering edge of the blade, is sloped to increase the angle with the axis of rotation from the tip end of the blade toward the axis of rotation, the remaining portions of said rear face being curved toward the following edge of the blade.

2. A propeller comprising a blade having an active face including an angular impeller face, and a relatively narrow compressor face arranged substantially at right angles to the plane of rotation, said impeller and compressor faces being disposed with respect to each other whereby a line drawn transversely of the blade from a point on the entering edge of the impeller face to a corresponding point on the remote edge of the compressor face will form an angle of not in excess of 45 degrees with respect to the vertical, the rear face of the blade being sloped to increase the angle with respect to the axis of rotation from the tip of the blade toward the axis of rotation.

3. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, the rear face of said blade being sloped substantially throughout its length and having such slope decreasing from the tip of the active face toward the axis of rotation, said blade being curved substantially throughout its length in the direction of rotation.

4. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, the rear face of the blade being sloped whereby it increases the angle with the axis of rotation progressively substantially throughout its length from the tip of the blade toward the axis of rotation, said blade being curved substantially throughout its length in the direction of rotation.

5. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, the rear face of said blade being substantially straight transversely thereof adjacent the entering edge of the blade, the slope of said rear face increasing outwardly from the axis of rotation, said active face being curved substantially throughout its length in the direction of rotation.

6. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, said blade having a main rear face sloped substantially throughout its length and having such slope decreasing from the tip of the blade toward the axis of rotation, said active face being curved substantially throughout its length in the direction of rotation.

7. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, said blade having a rear face the major portion of which, lying adjacent the entering edge of the blade, is sloped to increase the angle with the vertical from the tip end of the blade toward the axis of rotation, said active face being curved substantially throughout its length in the direction of rotation.

8. A propeller comprising a blade having an active face including an angular impeller face, and a relatively narrow compressor face arranged substantially at right angles to the plane of rotation, said impeller and compressor faces being disposed with respect to each other whereby a line drawn transversely of the blade from a point on the entering edge of

the impeller face to a corresponding point on the remote edge of the compressor face will form an angle of not in excess of 45 degrees with respect to the axis of rotation, the rear face of the blade being sloped to increase the angle with the axis of rotation from the tip of the blade toward the axis of rotation, said compressor face being curved substantially throughout its length in the direction of rotation.

9. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, the rear face of said blade being sloped substantially throughout its length and having such slope decreasing from the tip of the blade toward the axis of rotation, said blade being curved substantially throughout its length in the direction of rotation, and being curved toward its end away from the longitudinal direction of travel of the propeller.

10. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, the rear face of the blade being sloped whereby it increases the angle with the axis of rotation progressively substantially throughout its length from the tip of the blade toward the axis of rotation, said blade being curved substantially throughout its length in the direction of rotation, and being curved toward its end away from the longitudinal direction of travel of the propeller.

11. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, the rear face of said blade being substantially straight transversely thereof adjacent the entering edge of the blade, the slope of said rear face increasing outwardly from the axis of rotation, said active face being curved substantially throughout its length in the direction of rotation, and being curved toward its end away from the longitudinal direction of travel of the propeller.

12. A propeller comprising a blade having an active face adapted to create pressure on the fluid in which it operates at right angles to the direction of rotation, the rear face of said blade being sloped substantially throughout its length and having such slope decreasing from the tip of the blade toward the axis of rotation, said active face being curved substantially throughout its length in the direction of rotation, and being curved toward its end away from the longitudinal direction of travel of the propeller, said active face having its entering and following edges disposed with respect to each other whereby a line drawn between corresponding points on the entering and following edges of the active face will form an angle of not in excess of 45° with respect to the axis of rotation.

In testimony whereof I affix my signature.

JOSEPH JEREMIAH CALLAHAN.