H. FAEHRMANN.

PROPELLER.

APPLICATION FILED OCT. 27, 1915.

1,358,430.

Patented Nov. 9, 1920.

2 SHEETS—SHEET 1.

Fig. 1.

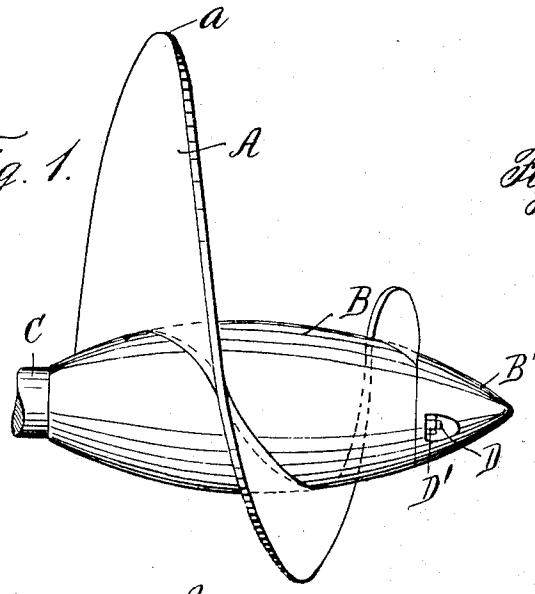


Fig. 2.

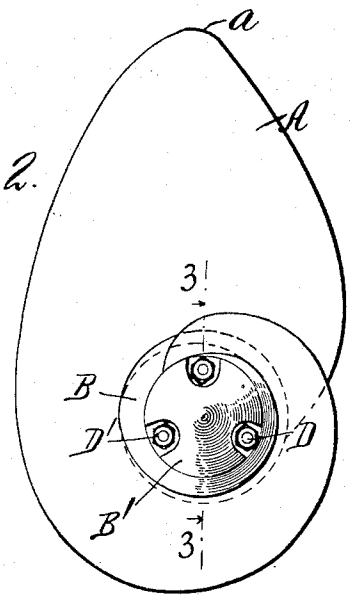


Fig. 3.

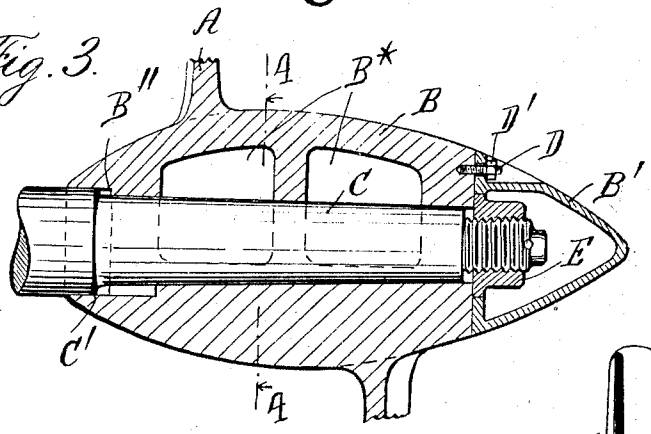


Fig. 4.

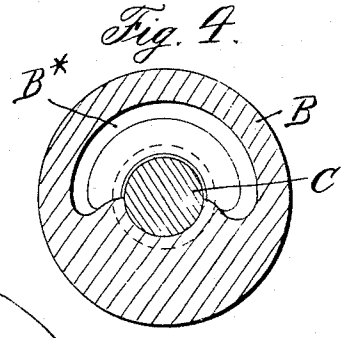




Fig. 6.

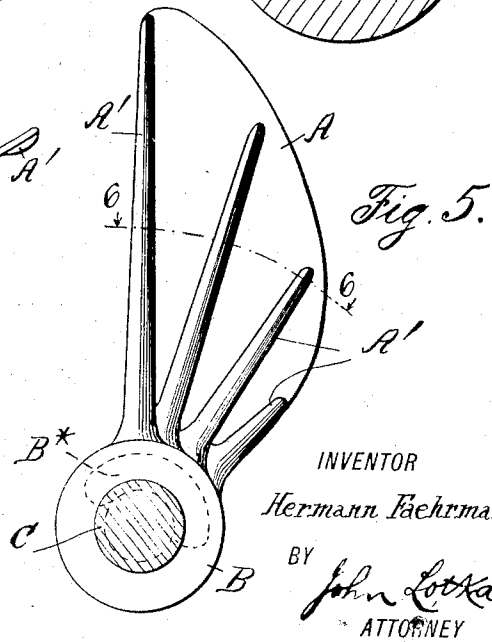


Fig. 5.

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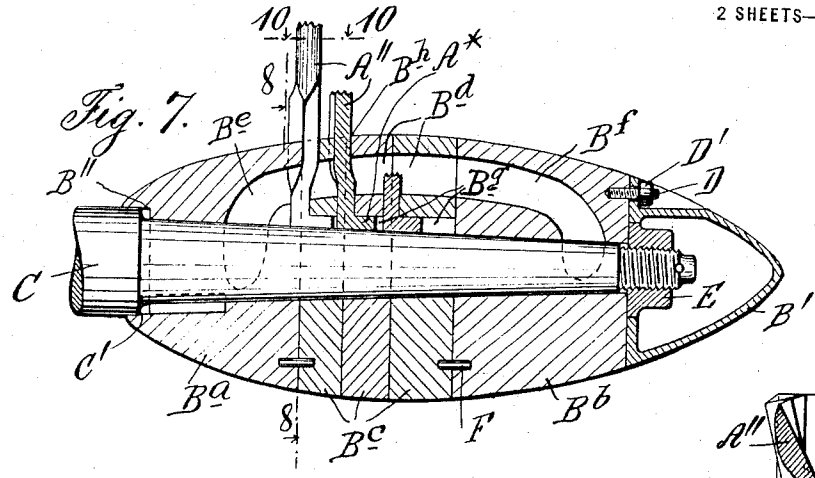
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2 SHEETS—SHEET 2.

Fig. 7.



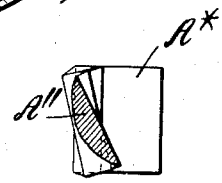
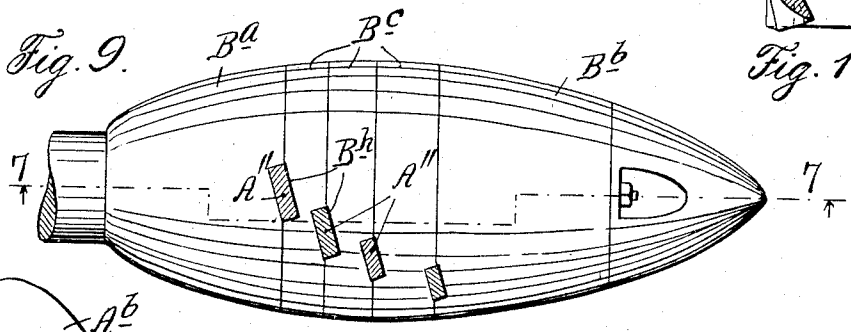


Fig. 10.

Fig. 9.



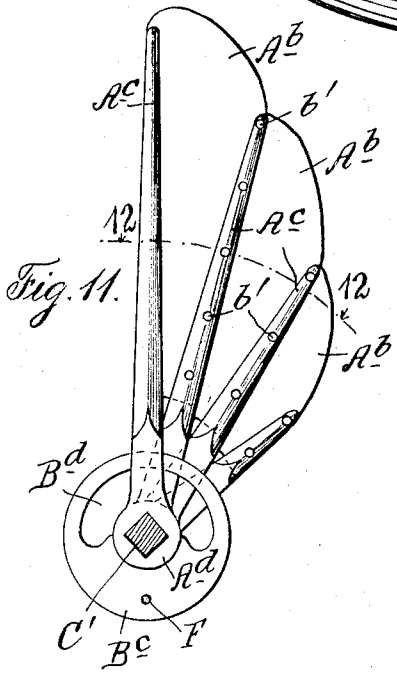


Fig. 11.

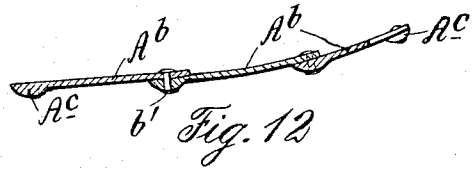


Fig. 12

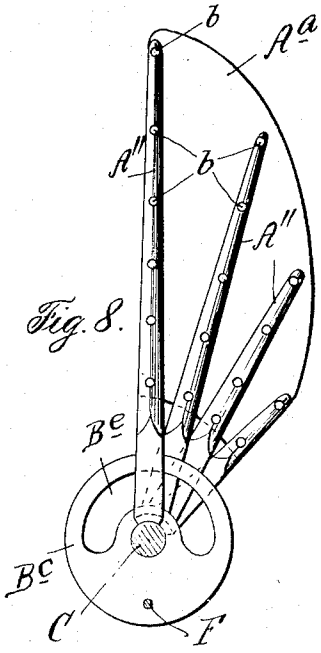
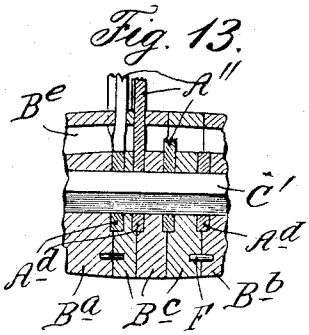


Fig. 8.

Fig. 13.



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UNITED STATES PATENT OFFICE.

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PROPELLER.

1,358,430. Specification of Letters Patent. Patented Nov. 9, 1920.

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To all whom it may concern:

Be it known that I, HERMANN FAEHRMANN, a citizen of the United States, and resident of the borough of Brooklyn, county of Kings, city and State of New York, have invented certain new and useful Improvements in Propellers, of which the following is a specification.

My invention relates to screw propellers for aerial or aquatic navigation, and has for its object to provide an exceedingly efficient propeller of great simplicity of construction and susceptible of operation at very high speeds. Experiments which I have been conducting for years have confirmed the correctness of my opinion that a high number of revolutions is conducive to an increased efficiency of such propellers, and my present improvement is designed especially in view of using a high rotary speed.

Several examples of my invention will now be described in detail with reference to the accompanying drawings, and the novel features will then be pointed out in the appended claims.

Figure 1 is a side view of one form of my improved propeller, Fig. 2 is an end view thereof, Fig. 3 is a partial longitudinal section, on an enlarged scale, on line 3—3 of Fig. 2, and Fig. 4 is a cross section on line 4—4 of Fig. 3, the propeller blade being omitted; Fig. 5 is a front view of a second form of my invention, and Fig. 6 is a section on line 6—6 of Fig. 5, shown on an enlarged scale; Fig. 7 is a longitudinal approximately central section of a third form of my invention, taken on line 7—7 of Fig. 9, Fig. 8 is a vertical section on line 8—8 of Fig. 7, shown on an enlarged scale, Fig. 9 is a top view of this form of my invention, with parts in section, and Fig. 10 is a detail cross section on line 10—10 of Fig. 7; Fig. 11 is a cross section similar to Fig. 8 of still another form of my invention, Fig. 12 is a section on the line 12—12 of Fig. 11, and Fig. 13 is a partial section of the same character as Fig. 7, but showing the form of my invention illustrated by Figs. 11 and 12.

The leading feature of my improved propeller structure as represented in the drawings, is the provision of a single propeller blade, and proper means for counterbalancing it. In the particular embodiment of my invention shown in Figs. 1 to 4, the blade A, of great thinness, extends farthest out at one side, and is comparatively narrow, measured circumferentially, at said side, while the other portions of the blade project less and less from the center or axis, but increase in width, measured circumferentially. That is, the outer edge of the blade forms a helical spiral which gradually approaches the center as the blade grows wider circumferentially. The pitch of the blade should be small for the securing of the best results, and I have found it desirable to use a pitch angle not exceeding 15° at the outer edge of the tip *a* of the blade. The pitch angle is defined as the angle which the helical or screw-line of the propeller blade, at any point thereof, forms with a plane laid through said point perpendicular to the axis of rotation. As shown in Figs. 1 and 2, the length of the blade A, measured in a direction parallel to said axis, is approximately equal to the maximum distance to which the blade projects radially from the carrier or hub B (at the tip *a*). Preferably the pitch angle increases gradually from said tip *a* to the other end of the blade that is to say, the pitch is smallest at that end of the blade which projects farthest from the axis, and greatest at the opposite end of the blade (right-hand end in Fig. 1). This blade is connected rigidly with the hub B, as by casting it integral with said hub. The latter is pointed at the free end B′, and is shown provided at its other end with a shoulder B″ adjacent to a shoulder C′ on the propeller shaft C. The pointed end B′ of the hub is represented as a separate piece, secured to the hub body B by screws D and nuts D′, the latter countersunk in recesses and readily accessible from the outside. The outer end of the shaft C, which is screw-threaded, is contained within the end or cap B′, and receives a nut E serving to secure the hub on the shaft, and, as shown, the latter and the axial bore of the hub may be tapered so as to increase the holding action of the nut E. Of course, the hub may be secured to the shaft in any other approved manner. The hub is cored out, as indicated at B*, on the side on which the blade A projects farthest out, so that the side of the hub opposite to said blade portion may be heavier and assist in balancing the blade and hub structure. As shown, the blade A extends entirely around the hub, so that one portion of the blade is utilized as

a partial counterbalance for another blade portion; the main counterbalancing effect, however, is obtained by coring out the hub at B*, the form of the cavity being shown in Figs. 3 and 4, that is to say, the cavity is arched both lengthwise and transversely. The outer surface of the hub B, B′ is torpedo-shaped, that is to say, of circular cross section at every point, and tapering toward both ends from the central or widest portion at which the blade A is placed. The blade and hub are balanced in two senses: first, the weight is balanced, that is to say, if the shaft C is horizontal the blade and hub, if turned to any particular position and stopped, will have no tendency to shift from such position; second, there is also balance of axial thrusts or pressures, that is to say, the sector containing the outer or tip portion of the blade exerts the same pressure on the air or water as the sector of equal angular extent diametrically opposite said tip portion; this latter result is due to the fact that the width of the blade, measured circumferentially, as well as the pitch angle of the blade increases from the tip toward the other, inner end of the blade. It will be observed that at the end or tip where the blade projects farthest from the axis (left-hand end in Fig. 1), where the outer portions of the blade have the highest linear velocity, the pitch angle is smallest, and the width of the blade, measured circumferentially, is least, both the pitch angle and the width of the blade, measured circumferentially, increasing toward the other end of the blade, where the blade does not project so far from the axis (right-hand end in Fig. 1) and where therefore the linear velocity is relatively low. Of course, the linear speed is in direct ratio to the distance from the axis, and on the other hand, other things being equal, the axial thrust or pressure increases with the pitch angle. Experiments have demonstrated that with a high linear speed, the best results are obtained when the pitch angle is small, while with a low linear speed, the best results are obtained with a relatively greater pitch angle. The balancing of the axial thrusts or pressures on different portions of the blade is obtained by a proper proportioning of the three factors, viz.: circumferential width of the blade, its radial extent or projection from the axis, and the pitch angle. Thus, with my improved propeller, the radial length of the helical blade decreases from front to rear, while the pitch increases in the same direction.

The propeller shown in Figs. 5 and 6 differs from the one illustrated by Figs. 1 to 4 by the provision of ribs A′ directed toward the shaft C, on the forward side of the blade A, that is the side toward which the boat or airship is traveling. These ribs, which may be cast integral with the blade, stiffen it considerably, and enable it to better resist the considerable strains due to centrifugal force when the blade is rotated at a high speed. The effect of centrifugal force is beneficial in my propeller, inasmuch as it counteracts the tendency of the pressure to bend the blade lengthwise of the shaft. Fig. 5 also shows that the blade, instead of continuing through about 360°, may be made to extend through a smaller angle, but its general shape, and the manner of balancing it, are the same as described above.

According to the construction shown in Figs. 7 to 10, the hub body is made of two spaced sections B^a and B^b, with rings or collars B^c interposed between them. These rings have openings B^d which register with each other and also with cavities B^e and B^f in the hub body portions B^a and B^b respectively, forming together a cavity similar in arrangement and purpose to the one shown at B* in the form of my invention first described. The collars B^c engage the shaft C, and have recesses B^g at their inner portion to receive the feet A* of ribs A″ which are held individually within recesses B^h in the adjacent faces of the outer portions of the rings or collars B^c, the two end recesses extending into the end faces of the hub body portion. The blade A^a is shown of substantially the same form as in Fig. 5, but is a separate member secured to the ribs A″ in any suitable manner, as by rivets *b*. Preferably the width of the collars B^c increases from left to right, as shown in Figs. 7 and 9, so that the pitch angle will be increased from the tip of the blade to the other end. The inner ends of the ribs A″, at the feet A*, are perpendicular to the axis of the shaft, but the outer rib portions are twisted (Fig. 10) so as to bring them into an alining position substantially like the one shown in Fig. 6. The outer portions of the ribs are half-round, the blade being applied against the flat surfaces. The cross sections in Fig. 9 show the ribs where they emerge from the hub. If desired, pins F may be provided to anchor the rings B^c to the body portions of the hub.

Figs. 11, 12 and 13 illustrate a construction differing from the one shown in Figs. 7 to 10, by the construction of the blade in sections instead of one piece, and the connection of these sections with each other and with the ribs, and also by the manner of securing the ribs on the shaft. Each of the blade sections A^b is made integral with one of the ribs A^c, and the free edge of each blade section is suitably secured to the next following rib, as by rivets *b*′. Figs. 11 and 13 also show a different construction of the inner portions of the ribs, which latter in these two views are shown as formed integral with rings A^d fitting around the shaft

C' (shown square). In other respects, this construction is substantially the same as in Figs. 7 to 10.

The torpedo shape of the hub also increases the efficiency of the propeller, such shape preventing injurious whirling of the water or air through which the boat or airship (or aeroplane) is being propelled.

The constructions illustrated by Figs. 5 to 13 may if desired be applied to a blade of large circumferential extent (such as shown in Figs. 1 and 2).

While I have described my improved structure as a propeller for aerial or aquatic navigation, it will be obvious that it may be employed for other purposes; thus, when driven by connection with an engine, the structure may also be used as a ventilator (fan) or pump, or, when exposed to the action of a current of air, water, gas or steam, the device will be available for use in turbines, water-motors, anemometers, meters for water and gas, etc.—For use in water, I prefer to employ a comparatively long blade (as in Figs. 1 to 4), while when the blade works in air, I prefer a shorter blade (as in Figs. 5, 8 and 11)

The balancing of the rotary structure may also be obtained by making the portion of the blade on the lower side of the shaft (Fig. 2) heavier than the portion on the opposite side of the shaft, which result can be obtained by varying the thickness of the blade (or of the ribs, when they are employed). Furthermore, by making the shaft very heavy, I may secure a practically sufficient approximation to a perfect balance, the shaft being then able to bear all the strains even though the blade itself is not fully balanced.

Various modifications may be made without departing from the nature of my invenion as set forth in the appended claims.

I claim as my invention:

1. A structure adapted for use as a propeller or for other purposes, provided with a helical blade whose radial length is greatest at one end of the helix and decreases toward the other end of the helix, while the width of the blade, measured circumferentially, and its pitch angle both increase gradually from the portion of greatest radial length to the opposite end of the helix, said radial length, circumferential width, and pitch angle being proportioned to balance the pressures on different portions of the blade in the direction of axial thrust.

2. A structure adapted for use as a propeller or for other purposes, provided with a helical blade whose radial length decreases from one end of the helix to the other while its pitch angle increases in the same direction, the parts of the blade being proportioned to balance the pressures exerted in the direction of axial thrust, on diametrically opposite blade sectors of like angular extent.

3. A structure adapted for use as a propeller or for other purposes, provided with a helical blade whose radial length decreases from front to rear, while the pitch angle increases in the same direction, the parts of the blade being proportioned to balance the pressures exerted in the direction of axial thrust, on diametrically opposite blade sectors of like angular extent.

4. A structure adapted for use as a propeller or for other purposes, provided with a hub which is heavier on one side than on the other, and a blade different portions of which project to different distances from the hub, the portion of the blade which projects farthest out, being located on the lighter side of the hub.

5. A structure adapted for use as a propeller or for other purposes, provided with a hub having an interior cavity whereby the hub is made heavier on one side than on the other, and a blade different portions of which project to different distances from the hub, the portion of the blade which projects farthest out, being located on the lighter side of the hub.

In testimony whereof I have signed this specification.

HERMANN FAEHRMANN.