Aug. 20, 1935. A. BARKER 2,011,672

SCREW PROPELLER

Filed April 25, 1934

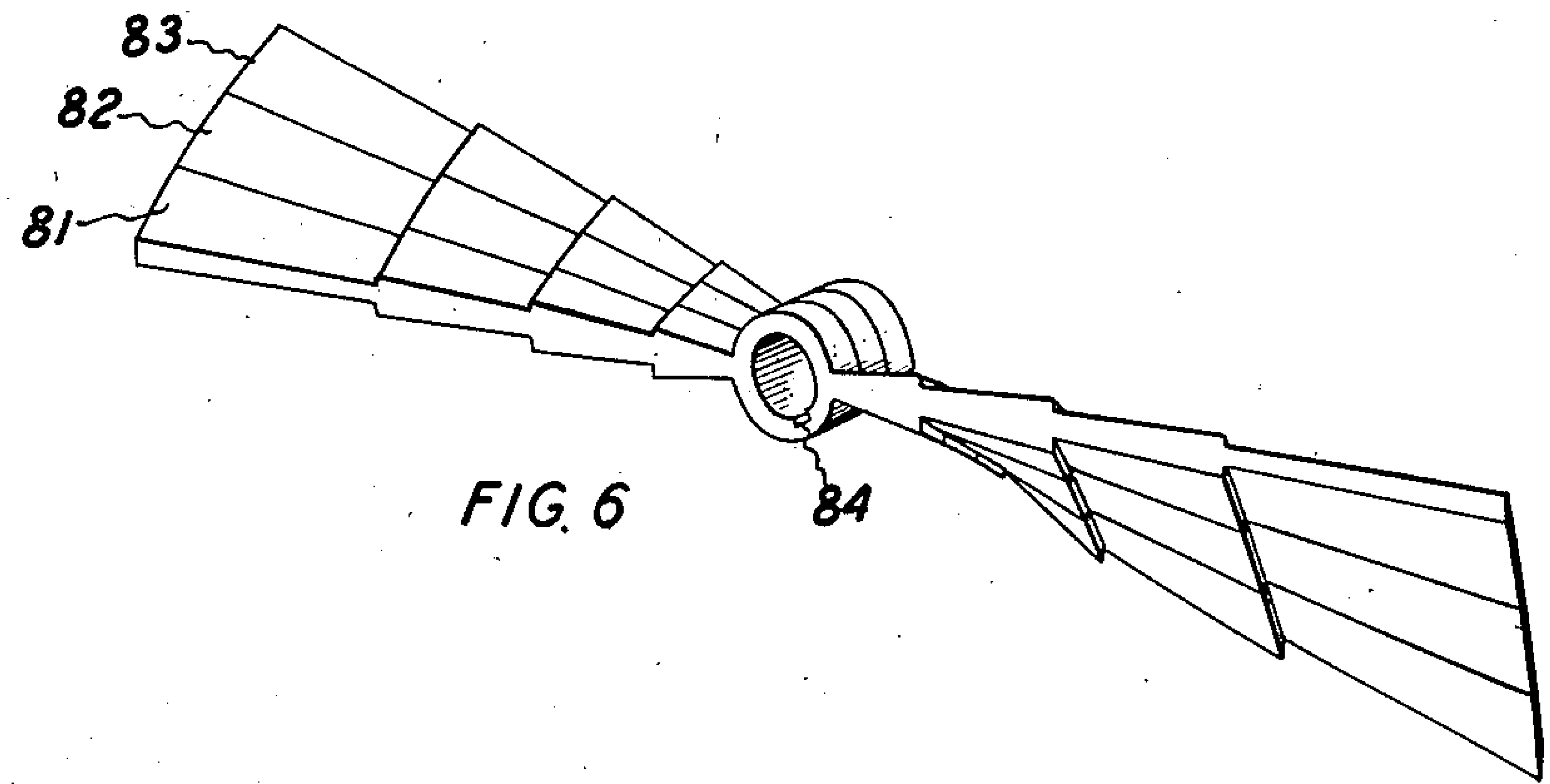

FIG. 6

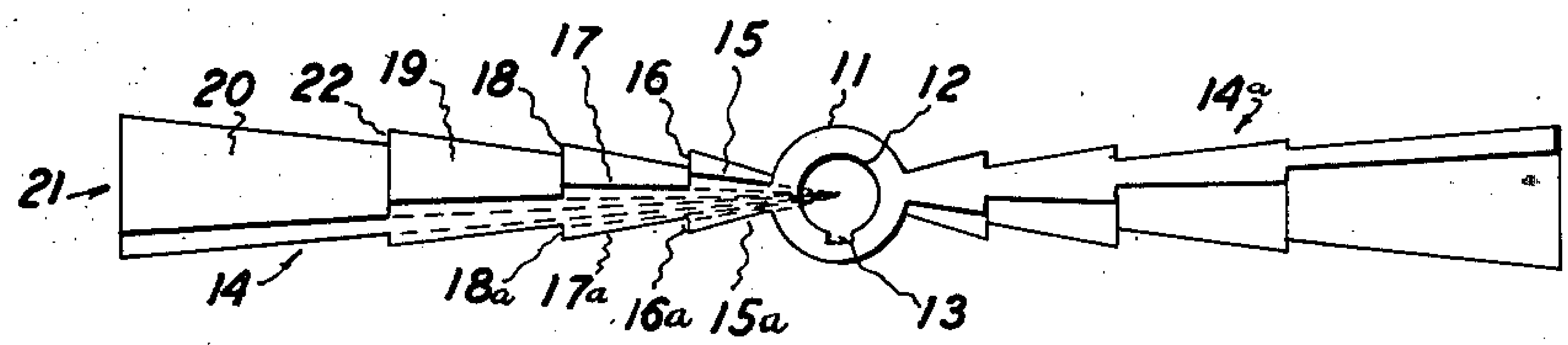

FIG. 1

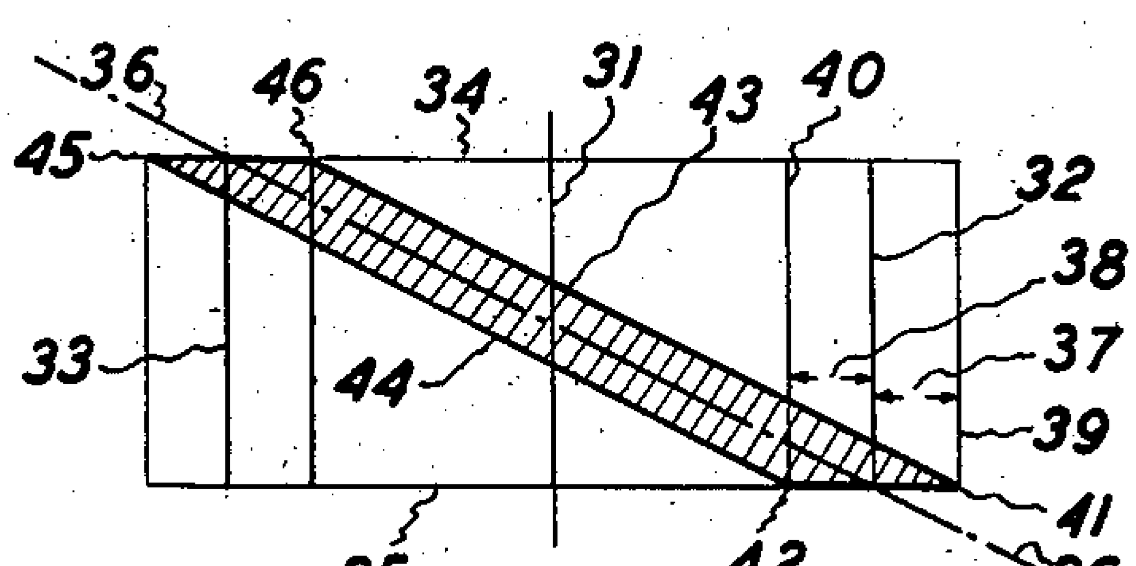

FIG. 2

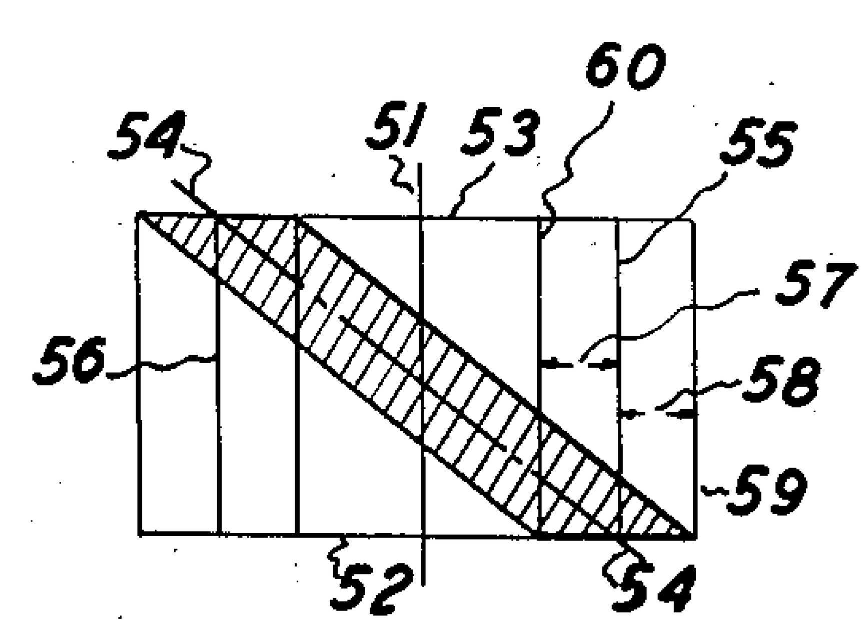

FIG. 3

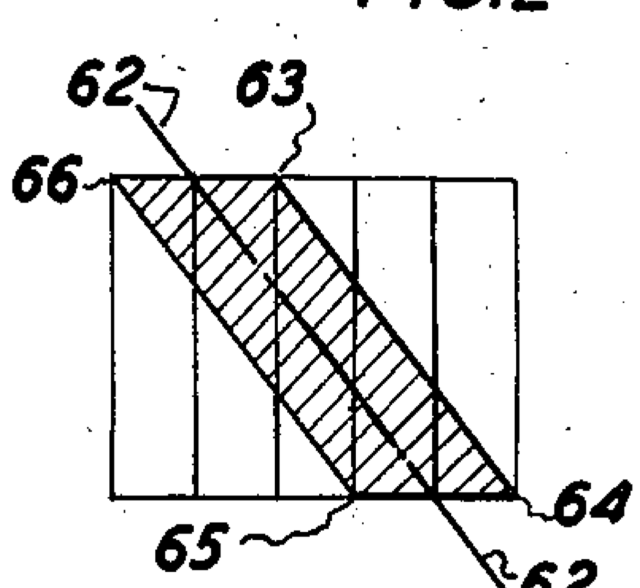

FIG. 4

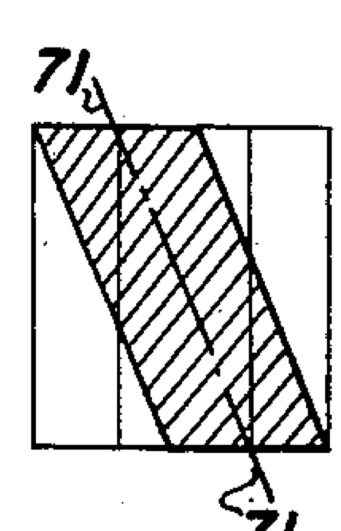

FIG. 5

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SCREW PROPELLER

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In Australia June 7, 1933

3 Claims. (Cl. 170—159)

This invention relates to screw propellers; it is equally applicable to airplane propellers, ships' propellers, air propeller fans, and circulating propellers for various fluids.

According to this invention the pitch of a screw propeller is made 1.5708, that is to say, for one revolution the advance of the propeller due to its mean helix is equal to 1.5708 times the diameter of the propeller measured over the extreme ends of the blades; the mean angle of the blades at the extreme ends describes a helix which in one revolution of the prop ller advances 1.5708 times the diameter of the propeller. Further, the mean radial centre line of each blade describes a right helicoid, the angle of the blade with respect to the axis of rotation at any diameter being such that the advance at that diameter will be equal to the advance at the extreme diameter. A propeller so designed operates with a minimum loss and creates minimum disturbance in axial direction in the fluid in which it runs, and the losses due to centrifugal displacement of the fluid in which the propeller works are reduced to a minimum.

Both faces of the blades form oblique helicoids, situated equally on both sides of the right helicoid representing the pitch of the propeller.

This arrangement if schemed as above described, would result in blades of unnecessary thickness at the tips; the tip thickness is obviated by reducing the thickness of the blades in steps, the reduction being such that the cross sectional area of the blade at any point is not reduced below that necessary to provide strength to withstand the working stresses to which the propeller will be subjected normally at such points respectively. The faces of the blades thus form a number of oblique helicoids, equally disposed on opposite sides of the right helicoid which forms the pitch line, the angle of obliquity diminishing in steps taken outwardly from the axis of rotation.

A further object of this invention is to provide a propeller which will minimize losses due to slip caused partly by excessive thickness of the blades at the root, where the thickness of the blades is usually greatest, and partly is a consequence of the tilting back of the blades from the plane of revolution. Back tilting of the blades of a screw propeller results in the imparting of movement to the fluid in which the propeller is operating and owing to the progression of the propeller this radially moving fluid is met by the blades where tilted backwards. This disturbing condition is avoided in the present invention because of the relative thinness of the blades at the root, small axial length of the propeller, and elimination of tilt of the blades.

A still further object of this invention is to provide a propeller made in axial sections, and these sections assembled so that the axial length of the propeller can be varied with facility.

In the accompanying drawing:—

Fig. 1 shows an elementary section of a propeller according to this invention. Figs. 2, 3, 4, and 5 illustrate graphically the method of determining the correct angle and major cross sectional area of the blades at the end **21** and at the steps marked **22**, **18** and **16**, respectively in Fig. 1.

Fig. 6 shows a propeller in which three of the units shown in Fig. 1 are assembled in close contact so that the contacting blades form a continuous helical surface. In Fig. 1, **11** is a boss or hub, **12** being the shaft bore and **13** the keyway. The blades **14** and **14***a* extend outwardly and oppositely from the hub. Two blades are shown, but three blades or four blades spaced symmetrically may be fitted. The root portions of each blade **15** on both sides is helically angled with respect to the axis of the hub in such a manner as to produce in one revolution an advance equal 1.5708 times the extreme diameter of the propeller. The sides of the blade root portions **15** and **15***a* lie along lines drawn radially from and normal to the axis of rotation, or the centre line of bore **12**. The radial sides **15** and **15***a* diverge from the axis at a relatively great angle and at the points **16** and **16***a* the blade sides are stepped inwardly, reducing the thickness of the blade at that point to the smallest practicable dimension consistent with the necessary strength, and thereafter again expand radially outwards along sides **17** and **17***a*, until a thickness of blade is reached at which it is desirable to again step it inwardly, as shown at **18** and **18***a*. This progression goes on in stages on the sections marked **19** and **20**, the mean pitch at each step and intermediately being such that the advance in one revolution is equal to 1.5708 times the diameter of the propeller. The number of stages whereat the thickness of the blade is reduced will vary with the diameter of the propeller, and is not confined to the four stages shown.

Fig. 2 is a projected view of the end **21** of the blade shown in Fig. 1, the angle being derived as follows: **31** is a centre line parallel to the axis of rotation, **32** and **33** are two lines equal to 0.0375 times the outside diameter of the propeller, and parallel to 31, and at such distances from 31 as to form with portions of the upper and lower lines 34 and 35 two squares conjoined at 31 and forming a parallelogram of which 36 is a diagonal. The thickness of the blade at this point is found by taking a distance 37 outwardly from 32, and a distance 38 inwardly from 32, each equal to one quarter of the length of line 32, drawing lines 39 and 40 at said distances from 32 and parallel to 32, and intersecting line 35 at 41 and 42. From these intersections, lines 43 and 44 are drawn parallel and equal to the diagonal 36; these lines 43 and 44 meet line 34 at points 45 and 46, and the rhomboid 45—46—41—42 represents the projected area and angle of the extreme end of the blade 21 in Fig. 1.

From the extreme end 21 in Fig. 1, the faces of section 20 are tapered helically, converging inwards until a point 22 is reached where calculation shows that the material has been reduced in effective strength to a safe low limit. The pitch angle at 20 is then ascertained by calculation, and laid out at 54, Fig. 3, between parallel lines 55 and 56—equal to lines 32 and 33 Fig. 2. On each side of lines 55 and 56 at distances 57 and 58 equal to distances 37 and 38, Fig. 2, are drawn lines 59 and 60 parallel to 55. On a base thus determined by the intersection of lines 59 and 60 with line 52 a rhomboid is drawn, having a central axis 54 and a height 55. This rhomboid therefore determines the major dimensions of the blade at step 22, Fig. 1.

In the same way the dimensions of step 18 Fig. 1, are derived in Fig. 4. 62 is a diagonal ascertained by calculation of the angle at 18, about which is described on an equal base, and between the same parallels a rhomboid 63—64—65—66, which represents the major cross section at the step 18.

Fig. 5 shows a rhomboid on an equal base and between the same parallels about a diagonal 71, which represents the angle and major cross sectional area of the blade at the step 16, Fig. 1.

In the same manner the pitch angle at any diameter having been calculated, the major area at any step can be ascertained by constructing a rhomboid about such diagonal having a height of 0.0375 times the diameter, and a base of half that amount.

If it be desired to increase the axial length of the propeller, then at any step in the blade the pertinent rhomboid would still have a base of half of 0.0375 times the diameter of the propeller, with a height to correspond to the desired axial length. The area of the rhomboid at any major section is equal to

$$\frac{(DE)^2}{2}$$

where D is the extreme of the propeller concerned and E is 0.0375.

Fig. 6 shows a propeller in which sections 81, 82, and 83 are assembled together to increase the axial length of the propeller, the sections having their several keyways 84 cut in correct relation to permit of the assembly of the sections in an unbroken helix. Any number of sections may be used in the assembly of a propeller according to my invention, but it is found that the axial length should not greatly exceed one eighth of the diameter of the propeller.

What I claim as my invention and desire to secure by Letters Patent is:—

1. A propeller in which the blades have a constant pitch in the form of a right helicoid, and the faces of the blades are in the forms of oblique helicoids, equally disposed on either side of the right helicoid.

2. A propeller in which the blades have a constant pitch in the form of a right helicoid, and the faces of the blades are in the forms of oblique helicoids, equally disposed on either side of the right helicoid and divided into stepped sections.

3. A propeller in which the blades have a constant pitch in the form of a right helicoid and a pitch ratio of 1.5708 and the faces of the blades are in the forms of oblique helicoids equally disposed on either side of the right helicoid, and divided into stepped sections.

AURIOL BARKER.