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PROPELLER TIP CENTRIFUGAL PITCH CONTROL

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Fig. 1

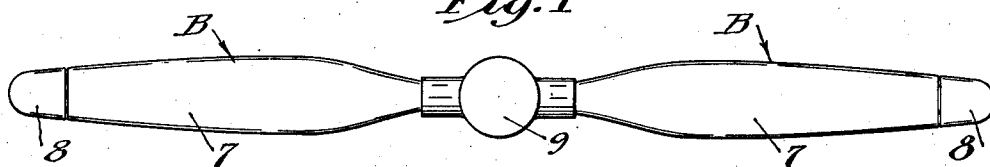


Fig. 2

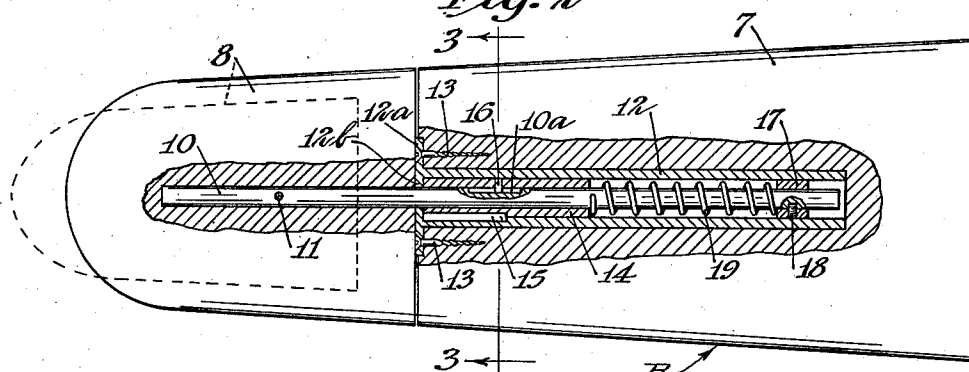


Fig. 3

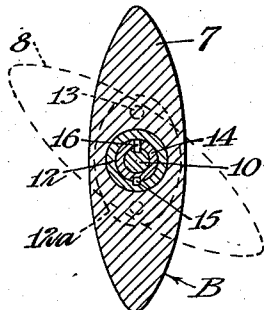


Fig. 4



Fig. 6

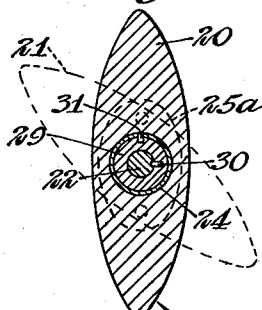
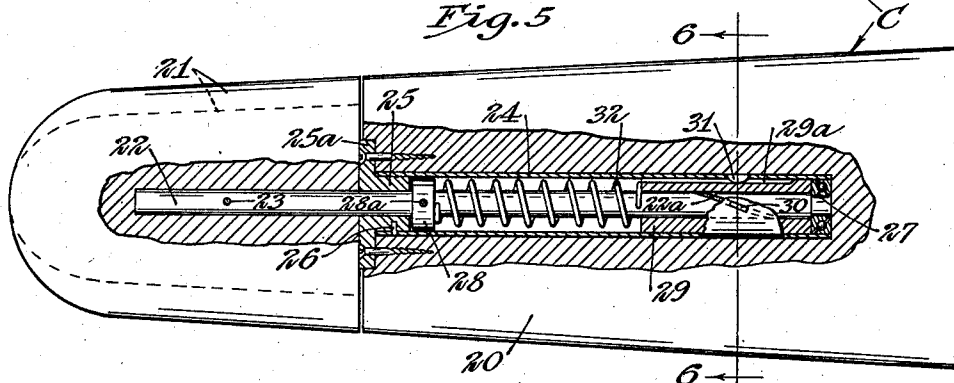


Fig. 5



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PROPELLER TIP CENTRIFUGAL PITCH
CONTROL

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3 Claims. (Cl. 170-162)

My invention relates to variable pitch propellers and particularly to such propellers wherein the pitch of the blade tip only is varied.

Many variable pitch propellers have been devised wherein the entire blade is variable in pitch. However, the construction in and near the hubs of such propellers is usually intricate and costly.

An object of my invention is to provide a propeller capable of substantially the same results as the usual variable pitch propeller but of such nature that an ordinary hub such as employed in non-variable propellers may be used.

A more specific object is to provide such a propeller wherein the main portion of the blade is fixed in pitch and only the tip portion is variable in pitch.

Another object is to provide such a propeller wherein the tip portion is automatically varied in pitch responsive to variation in the speed of rotation of the propeller.

A further object is to provide such a propeller of simple, light, compact, reliable and inexpensive construction.

These and other objects will be more apparent from the following description made in connection with the accompanying drawing wherein like reference characters refer to similar parts throughout the several views, and in which:—

Fig. 1 is a front view of a propeller comprising an embodiment of my invention;

Fig. 2 is a partially broken away front view of the outer portion of a blade of the propeller of Fig. 1;

Fig. 3 is a cross sectional view taken along the line 3-3 of Fig. 2 as indicated by the arrows;

Fig. 4 is a detail view;

Fig. 5 is a partially broken away front view of another form of my propeller and

Fig. 6 is a cross sectional view taken along the line 6-6 of Fig. 5 as indicated by the arrows.

Referring to the drawing, and particularly to Figs. 1 to 4 thereof, each blade B of my propeller comprises a main section 7 and a tip section 8 as shown. The main sections 7 of the blades B are mounted in a hub 9 of conventional design and are fixed therein so as to be fixed in pitch.

The tip section 8 is mounted on the main section 7 of the blade B so as to be shiftable relative thereto to vary the pitch of the tip section 8 independently of the fixed pitch at which the main section 7 is set. To this end a shaft 10, disposed longitudinally of the blade B, is received in its outer portion in a suitable axial aperture in the tip section 8 and is fixedly se-

cured therein by suitable means such as the pin 11. The portion of the shaft 10 not within the limits of the tip section 8 projects axially of the blade B toward the hub 9 to be received within the main section 7 of the blade B as will be described.

A sleeve 12 having both inwardly and outwardly radially projecting annular flanges 12a and 12b at its outer end is disposed in a suitable outwardly opening axial aperture in the outer end portion of the main section 7 of the blade B. The sleeve 12 is secured in the above described position by suitable means such as screws 13 projecting through apertured portions of the flange 12a into the material of the main section 7. The inwardly projecting flange 12b is of such width that the inwardly facing periphery thereof is of a diameter suited for a bearing in which the shaft 10 may be journaled. The portion of the shaft 10 projecting from the tip section 8 of the blade B is disposed inside the sleeve 12 in journaled relation with the inwardly projecting flange 12b. An inner sleeve 14 is snugly fitted within the outer portion of the sleeve 12 and has an interior periphery fitting the shaft 10 in the manner of a bearing. The inner sleeve 14 is restrained from rotation relative to the sleeve 12 and the main section 7 of the blade B by means of a key 15.

The shaft 10, in the portion thereof disposed within the inner sleeve 14, is provided with a helical groove 10a as shown. The inner sleeve 14 carries a rigidly mounted pin 16 projecting into the groove 10a.

The innermost portion of the shaft is provided with a collar 17 secured thereto by suitable means such as the setscrew 18. The outer periphery of the collar 17 is preferably of a diameter which fits the interior periphery of the sleeve 12 with only sufficient clearance to permit rotational and longitudinal sliding movement of the collar 17 within the sleeve 12. A helical compression spring 19, coiled about the shaft 10, bears at its respective ends against the collar 17 and the inner end of the inner sleeve 14 to resiliently urge the shaft 10 and the tip section 8 of the blade B toward the hub 9. Inward movement of the shaft 10 and tip section 8 responsive to the pressure of the spring 19 is, of course, limited by engagement of the inner end of the tip section 8 with the flanged outer end of the sleeve 12.

In operation of the above described propeller, centrifugal force tends to act on the mass of the tip section 8 and the shaft 10 to project the same radially outwardly. However, such outward

projection is yieldingly resisted by the spring 19. As the speed of rotation of the propeller increases, the centrifugal force will increase and the tip section 8 and shaft 10 will be moved outwardly to a point where the spring 19 is sufficiently compressed to exert a force equal to the effect of centrifugal force on the mass of the tip section 8 and the shaft 10. It is then apparent that the tip section 8 and the shaft 10 will move outwardly and inwardly responsive to respective increase and decrease in the rotational speed of the propeller. As the shaft 10 moves outwardly and inwardly it is forced by the combination of the helical groove 10a therein and the pin 16 to rotate through an angle determined by the pitch of the helical groove 10a and the distance of outward or inward movement. Such rotation of the shaft 10 of course is accompanied by change in the pitch of the tip section 8 of the blade B. Thus the pitch of the tip section 8 varies in response to variation in the rotational speed of the propeller. The propeller may obviously be constructed for either increase or decrease of tip section pitch responsive to increase in speed by making the helical groove wind respectively right handed or left handed. Also the propeller may be readily arranged so that the tip section will reach a position normal to the plane of rotation of the propeller or even reach a position of reverse pitch.

My propeller is, of course, well adapted for use either as a power driven propeller for creating movement of a fluid or as a power producing propeller to be rotated by a moving body of fluid directed thereagainst. However, my intended use of the propeller is in wind electric plants wherein my automatic blade tip pitch varying feature serves to regulate the speed of rotation of the propeller as the velocity of the wind to which it is subjected varies. For such use the helical groove 10a is made right-handed, as shown, so that the tip section pitch will increase with propeller speed and the parts of the propeller are so proportioned that the tip section pitch can increase to such an extent that the tip section 8 can reach a position normal to the plane of rotation of the propeller.

The tip section 8 is of relatively small area compared to the area of the main section 7 of the blade B but, since it moves at a much greater linear velocity than portions of the blade B closer to the hub, it has a strong controlling effect on the characteristics of the propeller as to the ratio between wind velocity and propeller speed.

As the wind velocity increases and the propeller speed tends to increase accordingly, the pitch of the tip section 8 increases to reduce the effectiveness of the wind in rotating the propeller and thus prevents the propeller speed from increasing as much as it would if the entire blade of the propeller were fixed in pitch. Further increases in wind velocity accompanied by moderate increases in propeller speed finally cause the tip section 8 to assume a position normal to the plane of rotation of the propeller. In such position the tip sections 8 operate much in the manner of centrifugal blower vanes so as to place a substantial mechanical load on the propeller and to greatly increase the blade tip losses relative to the blade tip losses of a propeller wherein the entire blade is fixed in pitch. The result, of course, is that the propeller speed will vary through a reasonably narrow range when the wind velocity varies through a very wide range and will have a very much lower maximum speed than a propeller wherein the entire blade is fixed in pitch.

The form of my propeller shown in Figs. 5 and 6 is generally similar to the above described form but differs therefrom in details as will be described. The main section 20 and tip section 21 of the blade C are similar to the main section 7 and tip section 8 of the blade B. The tip section 21 carries a shaft 22 anchored therein by a pin 23 in the same manner as the shaft 11 was anchored in the tip section 8 of the first form.

A sleeve 24 is disposed in a suitable outwardly opening axial recess in the outer end portion of the main section 20 of the blade C and is retained therein by the flange 25a of a flanged bearing element 25 secured to the outer end of the main section 20. The bearing element 25 projects inwardly into the outer end of the sleeve 24 and a pin 26 projects through the wall of the sleeve 24 into the bearing element 25 to prevent rotation of the sleeve 24 relative to the bearing element 25. The shaft 22 is journaled at one point in the bearing element 25 and at the inner end of the sleeve 24 is supported by a suitable bearing such as the ball bearing 27. A collar 28 is mounted on the shaft 22 just inwardly of the bearing element 25 and is secured to the shaft 22 by means of a pin 28a so as to prevent longitudinally outward movement of the shaft 22.

The inner end of the shaft 22 is provided with a left-handed helical groove 22a. A sleeve 29 comprising an annular weight is mounted loosely on the inner end portion of the shaft 22 so as to be longitudinally slidable relative to the shaft 22 and the sleeve 24. The weight 29 carries a Woodruff key in a recess in its inner periphery, this key being engaged in the helical groove 22a of the shaft 22. The weight 29 also has a longitudinal keyway 29a in its exterior periphery in which is engaged a Woodruff key 31 carried in a recess in the inner periphery of the sleeve 24.

The key 31 mounted in the sleeve 24 and engaged in the longitudinal keyway of the weight 29 prevents rotation of the weight 29 relative to the sleeve 24 and hence limits the weight 29 to longitudinal movement relative to the sleeve 24. The key 30 carried by the weight 29 and working in the helical groove 22a of the shaft 22 brings about rotation of the shaft 22 in response to longitudinal movement of the weight 29.

A helical compression spring 32, mounted on the shaft 22 in encircling relation thereto, bears at its respective ends against the collar 28 and the weight 29 so as to yieldingly resist outward movement of the weight 29.

In operation of the propeller centrifugal force tends to throw the weight 29 outwardly against the pressure of the spring 32. At any given rotational speed of the propeller the weight 29 will be disposed in an outwardly moved position wherein the spring 32 will be sufficiently compressed to exert a pressure equal to the effect of centrifugal force on the weight 29. Increase and decrease in the rotational speed will obviously cause the weight to be displaced respectively outwardly and inwardly. As the weight 29 moves outwardly and inwardly the shaft 22 will be rotated to alter the pitch of the tip section 21 of the blade C. Thus the pitch of the tip section 21 is varied responsive to variation in the rotational speed of the propeller. With the helical groove 22a of the shaft 22 extending in the manner of a left hand screw thread, as shown, the pitch of the tip section 21 will be increased responsive to increase in the rotational speed of the propeller. The effect of this pitch variation in controlling the speed at which the propeller will

be driven by the wind is the same as previously explained in connection with the first described embodiment of my invention.

The combination of a main blade section of fixed pitch and a tip section of variable pitch enables hub and blade shank construction of a more compact, lighter, simpler and much less expensive nature than that of propellers wherein the entire blade is variable in pitch and yet affords the advantages of variable pitch operation. The great effectiveness of a relatively small blade area, such as that of the tip section of my propeller, varied through a wide range of pitch and situated at a considerable radius from the propeller hub enables effective speed control and yet requires only very light, compact and inexpensive pitch varying mechanism.

Commercial units embodying my invention in both of the forms disclosed have been built and operated and have been found highly satisfactory in practical use.

It is apparent that I have invented a novel, simple, light, compact, reliable, effective and inexpensive form of propeller automatically controlled through variation in the pitch of the tip sections of the blades thereof.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts without departing from the scope of my invention.

What is claimed is:—

1. A propeller having a hub and at least one blade mounted thereon in generally radial relation thereto, the main portion of said blade being fixed in pitch, the tip portion of said blade being divided from said main portion, a shaft element connecting said tip portion to said main portion, said shaft element having one portion fixed in one of said blade portions and a helically grooved second portion journaled in the other of said blade portions, a guide element fixed in said other blade portion and engaged in said helical groove, said shaft and said guide element being so constructed and arranged that centrifugal force created by rotation of said propeller and acting on the mass of said tip portion will cause

outward movement of said tip portion accompanied by rotation thereof to vary the pitch thereof, and resilient means yieldingly resisting outward movement of said tip portion.

2. A propeller having a hub and at least one blade mounted thereon in generally radial relation thereto, the main portion of said blade being fixed in pitch, the tip portion of said blade being divided from said main portion, a shaft fixed in said tip portion and projecting into said main portion in journaled relation thereto, the journaled portion of said shaft having a helical groove therein, a guide element fixed in said main portion and engaged in said groove, and resilient means yieldingly resisting outward movement of said shaft and said tip portion, said shaft and said guide element being so constructed and arranged that centrifugal force acting on the mass of said tip portion and said shaft responsive to rotation of said propeller will cause radial movement and change of pitch of said tip portion in response to change in the speed of rotation of said propeller.

3. A propeller having a hub and at least one propeller blade mounted in and projecting outwardly thereof, said blade being divided into respective main and tip portions of which said main portion is fixed in pitch, a shaft on said tip portion, a bearing in the outer part of said main portion wherein said shaft is journaled and inwardly of which said shaft projects, the journaled portion of said shaft having a helical groove therein, an element fixed in said bearing and engaged in said groove, said shaft, bearing, groove and element being so constructed and arranged that outward movement of said tip portion and said shaft responsive to centrifugal force created by rotation of said propeller will be accompanied by rotation altering the pitch of said tip portion, a collar mounted on the inner portion of said shaft, and a helical compression spring disposed co-axially on said shaft and, at its respective ends, abutting said bearing and said collar to yieldingly resist outward displacement of said shaft and said tip portion.

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