June 15, 1926.

1,589,174

S. HEATH

VARIABLE PITCH PROPELLER

Filed August 10, 1921 3 Sheets-Sheet 1

Fig. 1.

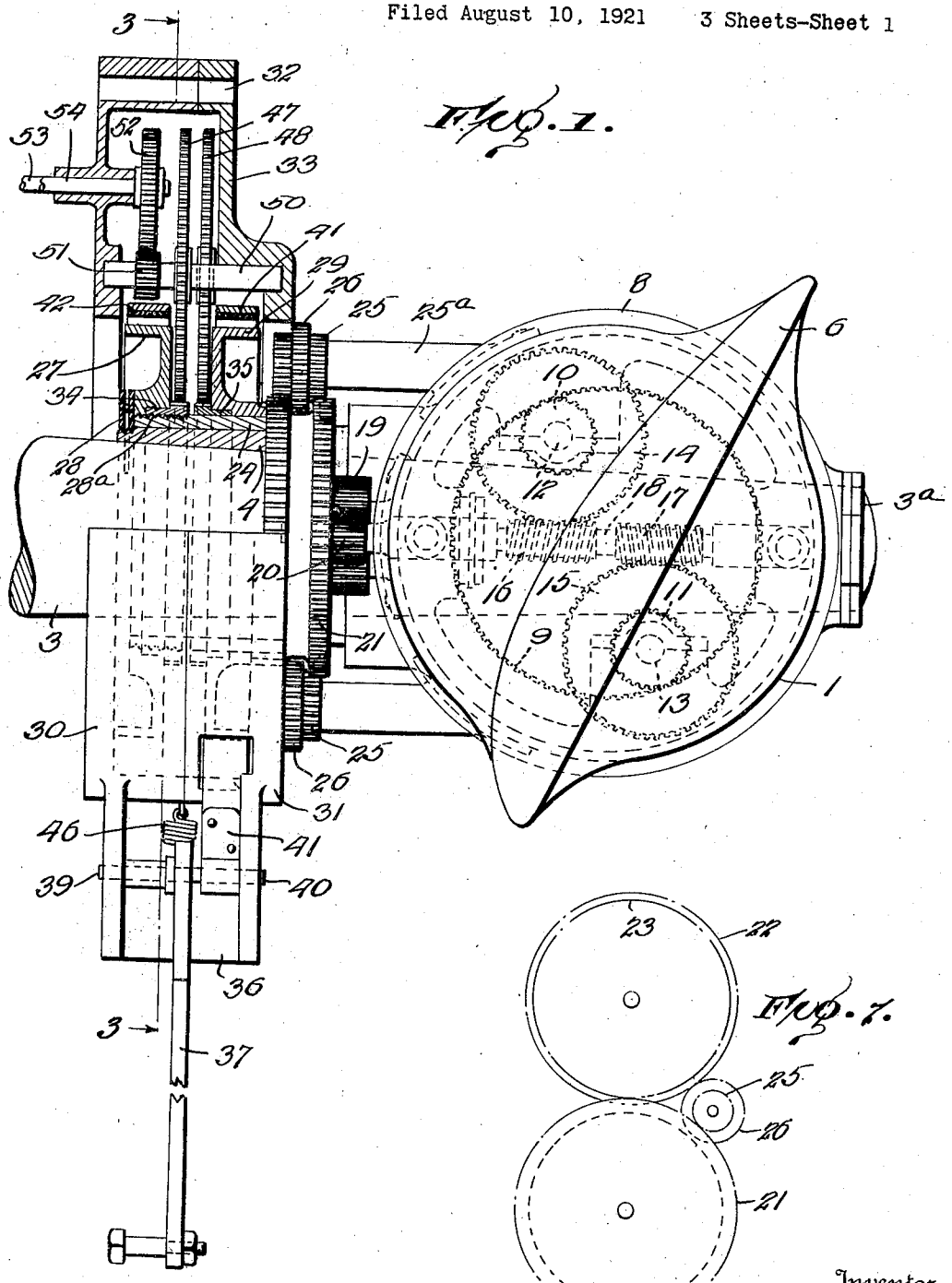


Fig. 7.

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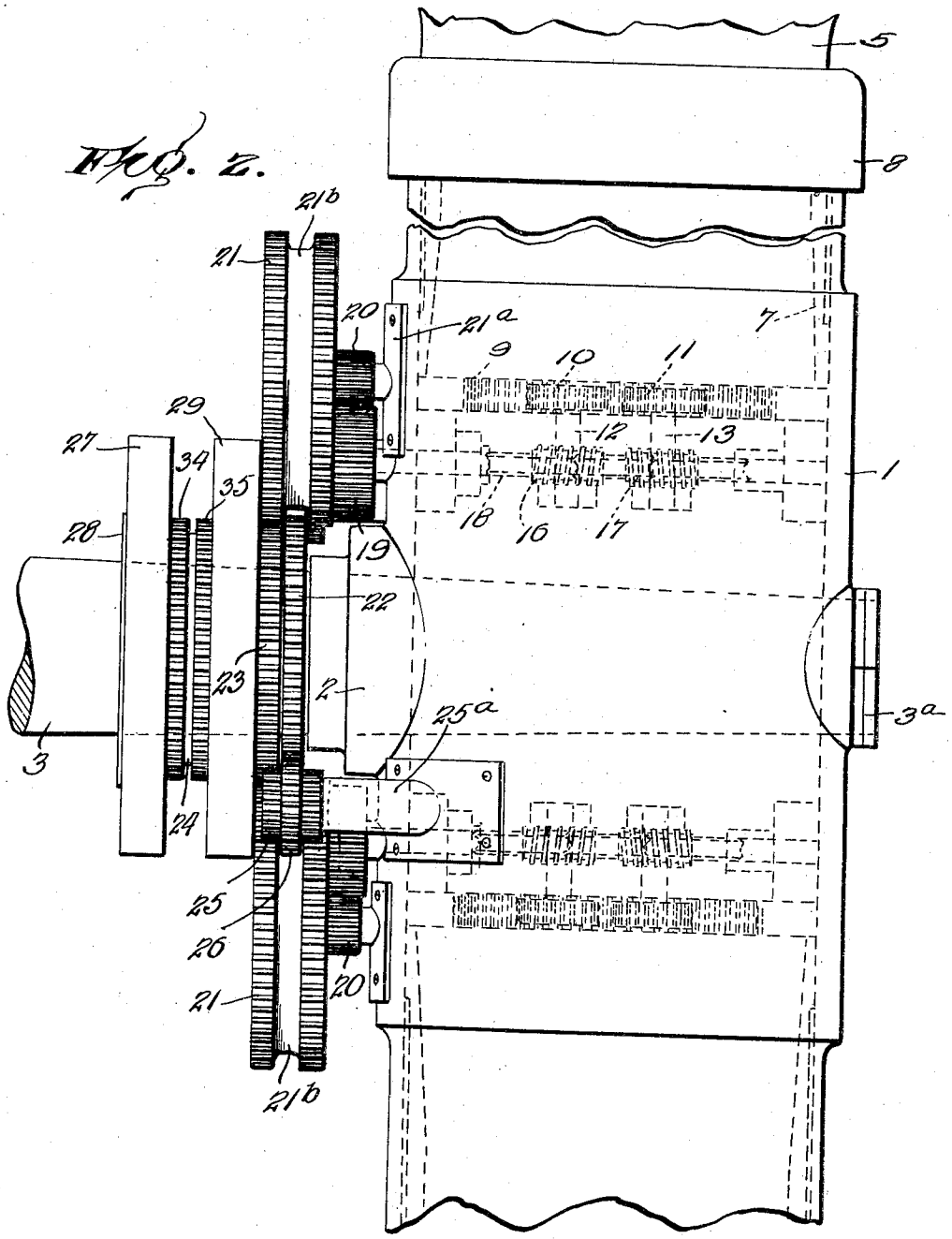
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Fig. 2.



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Fig. 3.

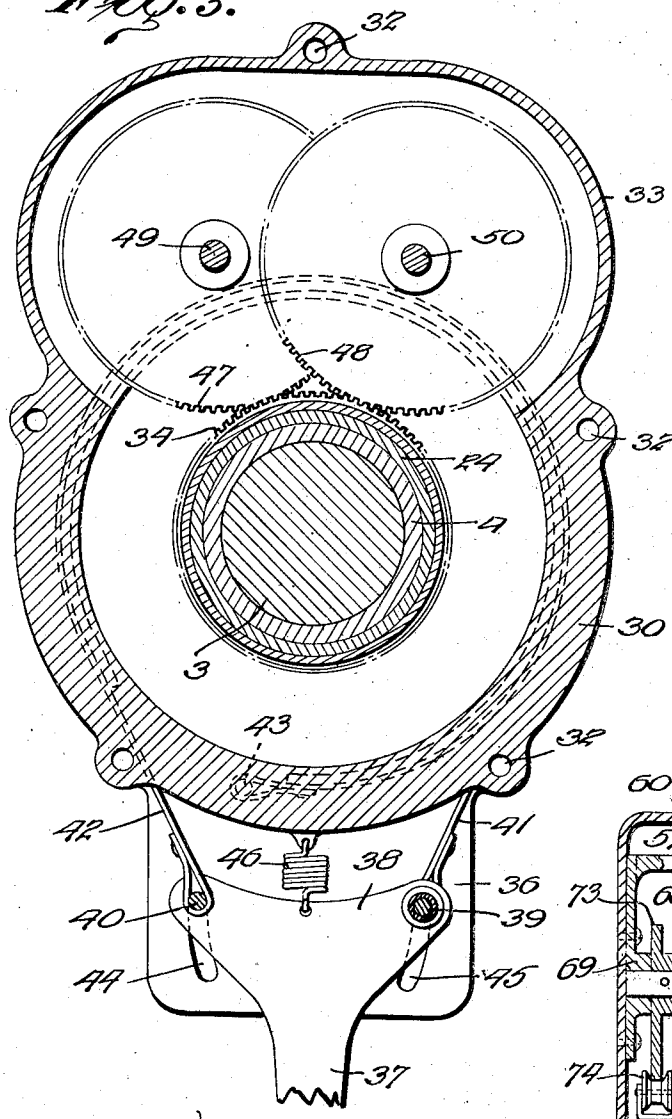


Fig. 6.

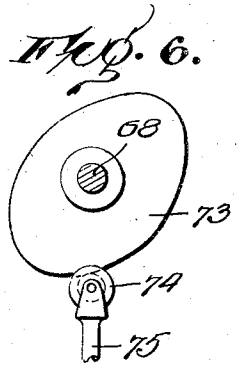


Fig. 4.

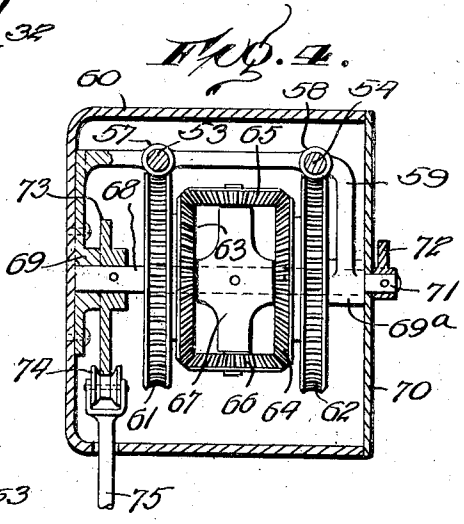
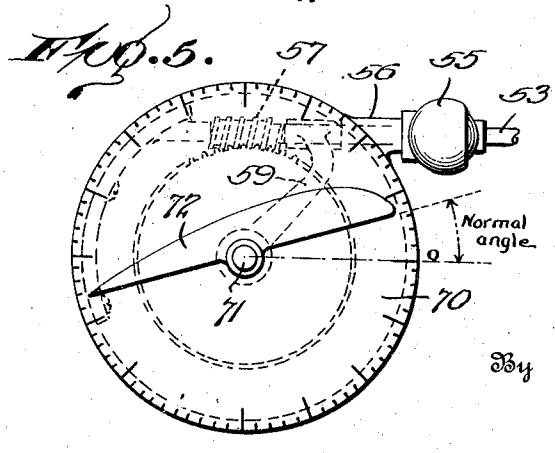


Fig. 5.



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UNITED STATES PATENT OFFICE.

SPENCER HEATH, OF ELKRIDGE, MARYLAND.

VARIABLE-PITCH PROPELLER.

Application filed August 10, 1921. Serial No. 491,202.

This invention relates to variable pitch propellers and more particularly to propellers employed in connection with airplanes, and airships.

It has heretofore been proposed to so construct and mount the propeller blades that they may be rotated upon their own axes in order to adjust their angular relation to the plane of rotation of the propeller. Such angular adjustment is desirable to compensate for variations in the density of the air at different altitudes, and particularly for reversing the pitch of the blades when landing, in order to bring the machine to a quick stop.

When using propellers of this character, however, it has been found in practice that it is difficult for the operator to ascertain or determine the extent of the angular adjustment or displacement of the blades when he operates the adjusting means, since the propellers are revolving at a high rate of speed and the blades are invisible. He can only judge of the degree of adjustment by the results produced, and this method of control is obviously more or less uncertain.

It is therefore an object of the present invention, to provide means for accurately indicating to the operator, the exact angular position of the blades at all times, so that he may be able to make the necessary adjustments intelligently.

In the use of variable pitch propellers, it has been found that as the angle increases, the resistance also increases, and consequently more power is required to drive the propeller. This necessitates opening the throttle of the motor when the angular position of the blades is increased. Likewise as the blades approach the plane of rotation of the propeller, the resistance becomes less and the motor has a tendency to race, unless the throttle is closed. This opening and closing of the throttle has heretofore been done manually, as occasion required, but it is an object of the present invention to provide means for automatically opening and closing the throttle or otherwise varying the power of the driving motor, in accordance with the angular position of the blades. Thus the operator is relieved of the necessity of manipulating the throttle as the blades are adjusted.

In order that the invention may be readily understood, reference is had to the accompanying drawings illustrating one embodiment thereof, and forming part of this specification, in which drawings:

Fig. 1 is a view partially in elevation and partially in section, showing my improved variable pitch propeller, with its control mechanism, and also illustrating part of the indicating and motor control gear.

Fig. 2 is a side elevation of my improved propeller hub and control mechanism, parts being broken away and the housing being omitted for the sake of clearness, this view being taken on a plane at right-angles to that of Fig. 1.

Fig. 3 is a transverse section substantially on the line with 3—3 of Fig. 1 looking in the direction of the arrow.

Fig. 4 is a longitudinal section through the indicating and motor controlling apparatus, parts being shown in elevation.

Fig. 5 is a face view of the indicator.

Fig. 6 is a side elevation of the motor controlling cam which I employ, and

Fig. 7 is a diagrammatic view of part of the gearing shown in Figs. 1 and 2.

By way of illustration, I have shown a construction of variable pitch propeller blades and controlling mechanism very similar to that illustrated in my prior application, Serial No. 356,040, filed February 3, 1920.

Referring to the drawings in detail, 1 designates the propeller hub having a central portion 2 provided with a tapered bore to receive the tapered end of the power shaft 3 which drives the propeller, the hub being secured to this shaft by means of lock nuts 3^a.

5 designates the shanks of the propeller blades 6 and these may be secured in the hub in any suitable manner. As shown, the shanks are set in metal ferrules 7 mounted for rotation in the hub sockets and held in place by means of retaining rings 8.

At the inner ends of the blade shanks are secured annular internal gears 9 with which mesh pinions 10 and 11, mounted on shafts 12 and 13, to which are also secured worm wheels 14 and 15 respectively, which mesh with a pair of worms 16 and 17 on a shaft 18. The shaft 18 is journaled in bearings in the hub and has its end projecting outside of the same. On this projecting end is secured a gear wheel 19 which meshes with a pinion 20 rigid with a gear 21, the gears

20 and 21 being mounted for rotation on a stub shaft carried by a bracket 21[a] secured to the hub.

All of the parts above described are substantially similar in construction and operation to the corresponding parts disclosed in my above mentioned co-pending application, except for the gear 21. This gear corresponds in function with the similarly numbered gear in my above mentioned application, but is of slightly different construction. In the present case, this gear 21 is shown as comprising two parallel toothed portions united by a smooth portion 21[b] of reduced diameter, thus in effect providing a central annular groove around the gear 21. This groove is for the purpose of accommodating a gear 22 mounted on an extension 4 of the hub 1, as in the above mentioned application, while a similar gear 23, mounted concentrically with the gear 22, meshes with one side of the gear 21.

Co-operating with the above described gears, is a compensating pinion or back gear which comprises a relatively large central portion 26, and a pair of smaller portions 25, arranged one on each side of the portion 26. It will be observed that the gear 22 is somewhat larger than the gear 23, and the portions 25 and 26 of the compensating pinion are proportional in size to the gears 22 and 23. Thus for example, if the gears 23 and 22 are provided with 65 and 70 teeth respectively, the portions 25 and 26 of the compensating pinion may properly have 26 and 28 teeth respectively. By reference to Fig. 7, it will be seen that the gear 23 meshes directly with the gear 21, while the gear 22 meshes with the portion 26 of the compensating pinion, the portions 25 thereof meshing with the gear 21, the groove 21[b] serving also to accommodate the portion 26. By this means it will be understood that equal angular displacements of the gears 22 and 23 produce the same angular displacement of the gears 21. The compensating pinion 25—26 is therefore simply in the nature of an idler or back gear, and is journaled upon a stub shaft carried by a bracket 25[a] secured to the hub 1.

As in my former application above identified, a pair of brake drums 27—29 is provided for producing the angular adjustment of the blades. The brake drum 29 is preferably formed integral with the gear 23, while the drum 27 is rigidly secured to a sleeve 24 which is also rigid with the gear 22, the sleeve 24 being journaled upon the extension 4 of the hub and the brake drum 29 and gear 23 being in turn journaled upon the sleeve 24. The drum 27 is secured in position by means of a suitable locking ring 28.

Surrounding the brake drums 27 and 29 is a housing preferably formed of two halves or sections 30 and 31, held together by means of bolts passing through suitably located holes 32. A bracket 36 extends from one side of the housing, and between the walls of this bracket is located a lever 37 for controlling the brakes. This lever is exactly similar in construction and operation to that shown and described in my prior application above mentioned. It comprises a T-shaped head or end 38 carrying cross pins 39 and 40. The ends of these pins extend through and work freely in arc-shaped slots 44 and 45 formed in the walls of the bracket 36. To the pin 39 is secured one end of a brake band 41 which encircles the brake drum 29, and to the pin 40 is secured one end of a second brake band 42 which encircles the drum 27, the other ends of these bands being anchored to the housing as indicated at 43 in Fig. 3. It will be obvious that as the lever 37 is swung to one side or the other, it pivots about one or the other of the pins 39 and 40 and selectively causes one or the other of the brake bands 41 and 42 to engage the respective drums 29 and 27, all as described in my above mentioned application.

I preferably provide a centering spring 46 as clearly shown in Fig. 3, one end of which being secured to the lever 37 and the other end being anchored to the housing 30. The object of this spring is to return the lever 37 to its central or normal position when released, in which position both brake bands are free from their respective drums.

In order to operate my improved indicating and motor controlling mechanism, I provide the following construction. The adjacent sides of the drums 27 and 29 are bored out to receive rings or flanges carrying a pair of annular gears 34 and 35, these rings being preferably forced into the drums with a driving fit. The gear 35 is free to rotate with the drum 29 upon the sleeve 24, but the gear 34, with its drum 27, is rigidly secured to the sleeve 24, as by means of screw threads 28[a].

Meshing with the annular gears 34 and 35 are relatively large gears 47 and 48 mounted upon shafts 49 and 50, journaled in the opposite walls of an extension 33 of the housing 30—31. On each shaft 49 and 50 is also secured a relatively small gear or pinion 51. These pinions 51 mesh with relatively larger gears 52 mounted on shafts 53—54 journaled in the wall of the housing. These shafts 53 and 54 are led to the indicating and controlling device situated at any suitable point, and may be either in the nature of flexible shafts or may be provided with suitable universal joints as indicated at 55 in Fig. 5. The indicating and controlling device consists of a casing or housing 60 in which is mounted differential gearing now to be described. The shafts 53 and 54 enter

the casing 60 through bearings 56, and are provided within the casing with worms 57 and 58, these worms being suitably supported by means of a frame work 59. The worms 57 and 58 mesh respectively with worm wheels 61 and 62 loosely mounted upon a shaft 68, and having rigidly united thereto bevel gears 63 and 64 respectively. These bevel gears are both in mesh with a pair of bevel idlers 65 and 66 carried by a spider 67, after the manner common in differential gearing. This spider 67 is rigidly secured to the shaft 68 and this shaft is journaled in bearings 69 and 69ª carried by the frame work 59, and supported by the housing 60.

At the front end of the housing 60 is a dial 70, preferably circular in form, and graduated as shown in Fig. 5. The reduced end 71 of the shaft 68 projects through the center of this dial and on the projecting end thereof is mounted a pointer 72. This may be an ordinary indicating needle, but is shown as being in the nature of an "aerofoil" or miniature propeller blade. In other words, the shape of the pointer 72 preferably corresponds to that of the end of the propeller blade such as shown at 6 in Fig. 1.

On the dial 70 is laid off a zero line corresponding with zero pitch, or in other words, the position of the propeller blades when they coincide with the plane of rotation. Also the dial preferably bears another mark indicating the normal angle which the blades should ordinarily occupy, and the movement of the indicator 72 on either side of this line shows to the operator the angular displacement of the blades from their normal pitch.

From the above described construction, it will be apparent that when the propeller is running normally, with both brake bands free, the two gears 34 and 35 revolve with the brake drum at the same speed and consequently the two shafts 53 and 54 are driven at the same speed. Therefore, owing to the differential gearing shown in Fig. 4, the shaft 68 remains stationary. When, however, the brake band is tightened on one or the other of the drums, such drum is retarded, and through the medium of the gears 22 or 23 as the case may be, and the transmission gearing 21, 20, 19, etc., actuates the pinions 10 and 11 and rotates the blades upon their own axes, as described in detail in my former application. At the same time, this retarding of one of the drums produces a rotation or displacement of such drum relative to the other, and this, acting through the gears 34—35, 47—48, and 51—52, immediately produces a difference in the speed of the shafts 53 and 54. This difference in speed is in turn transmitted to the worm wheels 61 and 62 in Fig. 4, with the result that the shaft 68 is correspondingly displaced, and the pointer 72 caused to travel over the dial. Since the shaft 68 rotates whenever the blades rotate about their axes and remains stationary when the blades are stationary in their sockets, it may be termed a mimic shaft. It will be observed that the blades 6, as well as the pointer 72, will continue their angular movement so long as one of the drums 27 or 29 is retarded, and that since it is the extent of retardation or relative shifting of these drums which produces both the adjusting of the blades and also the movement of the pointer, such movement will always be exactly proportional to the angular adjustment of the blades. This exact proportionality is secured by virtue of the employment of the compensating pinion 25—26, above described, by means of which the angular movement of the blades is made to exactly correspond to the angular displacement of the drums.

It will thus be seen that the pointer 72 serves at all times to indicate to the operator the exact angular position of the blades relative to the plane of rotation of the propeller, and that by watching this pointer, the operator can intelligently make just such adjustments as occasion may demand.

In order to automatically control the power supplied to the shaft 3 for driving the propeller, as the angle of the blades changes, I provide a suitably shaped cam 73 (see Fig. 6) and secure it upon the shaft 68 as shown in Fig. 4. This cam is adapted to bear against a roller 74 carried by a push rod 75, which rod controls the power supplied to the motor. In the case of an internal combustion engine, the rod 75 preferably controls the throttle supplying motive fuel to the engine. It will be noted that the cam 73 is so shaped and mounted as to push the rod 75 outward and thus close the throttle or shut off the power as the blades approach the position of zero pitch, or in other words, approach the plane of rotation, and that the rod 75 is permitted to move in the other direction under the influence of a spring (not shown), so as to increase the power or open the throttle as the angle of the blades increases. Thus the power delivered to the propeller shaft is always maintained proportional to the resistance which the propeller encounters, and the speed thereby rendered substantially constant.

What I claim is:

1. The combination with a propeller having a blade angularly adjustable about its axis, a shaft for driving said propeller, mechanism for adjusting said blade and simultaneously indicating the angular position thereof, said mechanism comprising two elements normally rotating with said shaft but rotatable relative thereto, means for causing either of said elements to rotate

relative to the other and relative to said shaft, means affected by such relative movement between said elements for angularly adjusting the blade and means for simultaneously operating said indicating mechanism.

2. The combination with a propeller having a blade angularly adjustable about its own axis, a shaft for driving said propeller mechanism for adjusting said blade and simultaneously indicating the angular position thereof, said mechanism comprising two elements normally rotating with said shaft but rotatable relative thereto, means for retarding the rotation of either of said elements relative to the other and to said shaft, means actuated by the difference in the speed of rotation of said elements for adjusting said blade and means for simultaneously operating said indicating mechanism.

3. The combination with a propeller having an angularly adjustable blade and a shaft on which the same is mounted, of mechanism for adjusting said blade at will, such mechanism comprising a pair of elements rotatably mounted on said shaft and normally rotating with the propeller, and means for causing rotary movement of either of said elements relative to the other element, an indicator having a movable pointer for indicating the angular position of said blade and means affected by the relative movement between said elements for actuating said pointer.

4. The combination with a propeller having an angularly adjustable blade, of mechanism for adjusting the same at will in either direction, such mechanism comprising a pair of elements normally rotating with the propeller, and means for selectively retarding one or the other of said elements, an indicator for showing the angular position of said blade, and means due to the difference in the speed of rotation of said two elements for actuating said indicator.

5. The combination with a propeller having an angularly adjustable blade, of mechanism for adjusting the same at will, such mechanism comprising a pair of brake drums normally rotating with the propeller, a pair of brakes adapted to selectively engage said rotating drums to retard one relative to the other, and thus operate said adjusting means, an indicator for showing the angular position of said blade, and means responsive to the angular displacement of one of said drums relative to the other for actuating said indicator.

6. The combination with a propeller having an angularly adjustable blade, and a shaft for driving said propeller, of mechanism for adjusting said blade at will, such mechanism comprising a pair of elements normally rotating with said shaft, said elements being rotatable relative to said shaft and to each other, an indicator having a movable member for showing the angular position of said blade, and mechanical connections between said rotatable elements and the movable member of said indicator whereby the latter is actuated by the relative movement between the former, said connections including differential gearing.

7. The combination with a propeller having an angularly adjustable blade, of mechanism for adjusting the same at will in either direction, such mechanism comprising a pair of elements normally rotating with the propeller, and means for selectively retarding one or the other of said elements, a movable device for varying the amount of power driving said shaft in accordance with the angular position of said blade, and mechanical connections between said elements and said movable device whereby the latter is actuated by the difference in speed of rotation of said two elements.

8. The combination with a propeller having an angularly adjustable blade, and a motor for driving the same, of means for angularly adjusting such blade while the motor is running, and means for automatically controlling the supply of motive fuel to said motor in accordance with the angular position of said blade, said last named means including differential mechanism responsive to the action of said adjusting means.

9. A propeller having an angularly adjustable blade, and means for angularly adjusting the same, such means comprising a pair of brake drums normally rotating with the propeller, a pair of brakes adapted to engage said rotating drums to actuate the adjusting means, a lever for selectively shifting said brakes into engagement with their respective drums, and a spring for normally maintaining said lever in such position as to hold the brakes out of contact.

10. A propeller having an angularly adjustable blade, and means for angularly adjusting the same, such means comprising a pair of brake drums normally rotating with the propeller, a pair of brakes adapted to engage said rotating drums to actuate the adjusting means, a lever shiftable in either direction from a central position for selectively shifting said brakes, and means for automatically returning said lever to and yieldingly maintaining it in such central position.

11. A propeller having an angularly adjustable blade, and means for angularly adjusting the same in either direction, such means comprising a pair of brake drums normally rotating with the propeller, a pair of brakes adapted to engage and relatively angularly displace said rotating drums to actuate the adjusting means in one direction or the other, and mechanism connecting said brake drums with said blade in such a man-

ner that the same angular displacement of either of said drums relative to the propeller shaft produces equal angular adjustments of said blade.

12. A propeller having an angularly adjustable blade, and means for angularly adjusting the same in either direction, such means comprising a pair of brake drums normally rotating with the propeller, a pair of brakes adapted to engage and relatively angularly displace said rotating drums to actuate the adjusting means in one direction or the other, and mechanism connecting said brake drums with said blade in such manner that the angular adjustments of the blade, in one direction or the other, are strictly proportional to the angular displacement of the respective drums relative to the propeller shaft.

13. The combination with a propeller having an angularly adjustable blade, and a power shaft on which it is mounted, of mechanism for adjusting said blade at will, such mechanism comprising a pair of rotatable elements, a movable device for varying the amount of power driving said shaft in accordance with the angular position of said blade, and mechanical connections between said rotatable elements and said movable device whereby the latter is actuated by the former, said connections including differential gearing.

14. In a variable pitch propeller, in combination with a hub and blades adjustably journaled therein, a pair of normally rotating elements coaxial with the propeller hub, means for causing differential motion between the said pair of elements, a gear train from said elements to each journaled blade, a mimic shaft, differential gearing for operating said shaft and including two gears, and a gear train from each member of said pair of elements to one of said last named gears, and means operated by movement of said mimic shaft for indicating the angular position of the blades.

15. In a variable pitch propeller, in combination with a hub and blades adjustably journaled therein, of a main shaft on which said hub is mounted, a pair of normally rotating elements coaxial with the propeller hub, means for causing differential motion between the said pair of elements, a gear train from said elements to each journaled blade, a mimic shaft, differential gears for rotating said shaft and including two gears, a gear train from each member of said pair of elements to one of said last named gears, and means operated by said mimic shaft for indicating the angular position of said blades and for varying the amount of power driving said main shaft.

16. In a variable pitch propeller, in combination with a hub and blades adjustably journaled therein, of a main shaft on which said hub is mounted and an engine for rotating the same, a pair of normally rotating elements, means for causing differential motion between said elements, a mimic shaft, means for communicating said differential motion respectively to said journaled blade and to said mimic shaft, an indicating device, an engine control device, both of said devices being operatively connected with and controlled by the movements of said mimic shaft.

17. A propeller comprising a hub having a socket, a blade having a shank rotatable about its own axis in said socket, and means for so rotating said blade in either direction, said means comprising a pair of independent toothed gears rotatable about the same axis, a gear wheel meshing with one of said gears, said gear wheel comprising two parallel toothed portions and an intermediate smooth portion of reduced diameter, an idler pinion having on each end a toothed portion meshing with said toothed portions of said gear wheel, said pinion also having an intermediate toothed portion of large diameter than said end portions, said intermediate portion meshing with the other of said toothed gears.

18. A propeller comprising a hub having sockets, a blade mounted in each of said sockets for rotation about its own axis, and means for simultaneously rotating said blades, said means comprising a pair of independent toothed gears rotatable about the same axis, two gear wheels carried by said hub and mounted on opposite sides of said toothed gears, both of said gear wheels being in mesh with one of said gears, each of said gear wheels comprising two parallel toothed portions and an intermediate smooth portion of reduced diameter, an idler pinion for each of said gear wheels, each of said idler pinions having toothed portions at its ends meshing with the parallel toothed portions of one of said gear wheels, each of said idler pinions also having an enlarged intermediate toothed portion meshing with the other of said toothed gears.

In testimony whereof I affix my signature.

SPENCER HEATH.