United States Patent

Schwisow

[15] **3,645,644**

[45] **Feb. 29, 1972**

[54] INTERLOCKING VARIABLE-PITCH PROPELLER ASSEMBLY

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[22] Filed: **Jan. 22, 1970**

[21] Appl. No.: **5,018**

[52] **U.S. Cl.** **416/157**, 416/157, 416/174

[51] **Int. Cl.** **B63h 3/08**

[58] **Field of Search** 416/156, 157, 167, 174

[56] **References Cited**

UNITED STATES PATENTS

2,693,243	11/1954	Strandell et al.	416/157
2,794,508	6/1957	Pehrsson et al.	416/157
3,171,494	3/1965	Liaaen	416/157
3,331,446	7/1967	Feroy	416/167 X
3,413,008	11/1968	Greiner	277/58
3,437,150	4/1969	Feroy	416/157
3,545,881	12/1970	Naulty	416/157
3,393,749	7/1968	Feroy	416/157
2,763,329	9/1956	Feroy	416/167

FOREIGN PATENTS OR APPLICATIONS

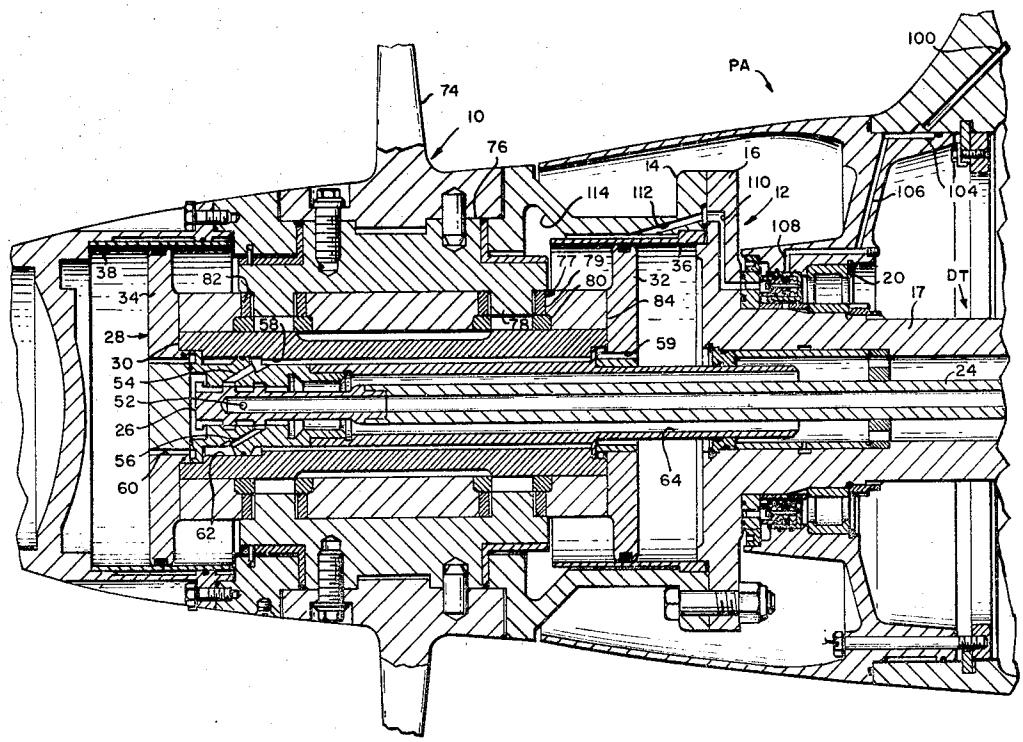
930,674	7/1955	Germany	416/174
606,280	8/1948	Great Britain	416/174
864,209	3/1961	Great Britain	416/174
916,310	1/1963	Great Britain	416/157
98,719	10/1961	Norway	416/174

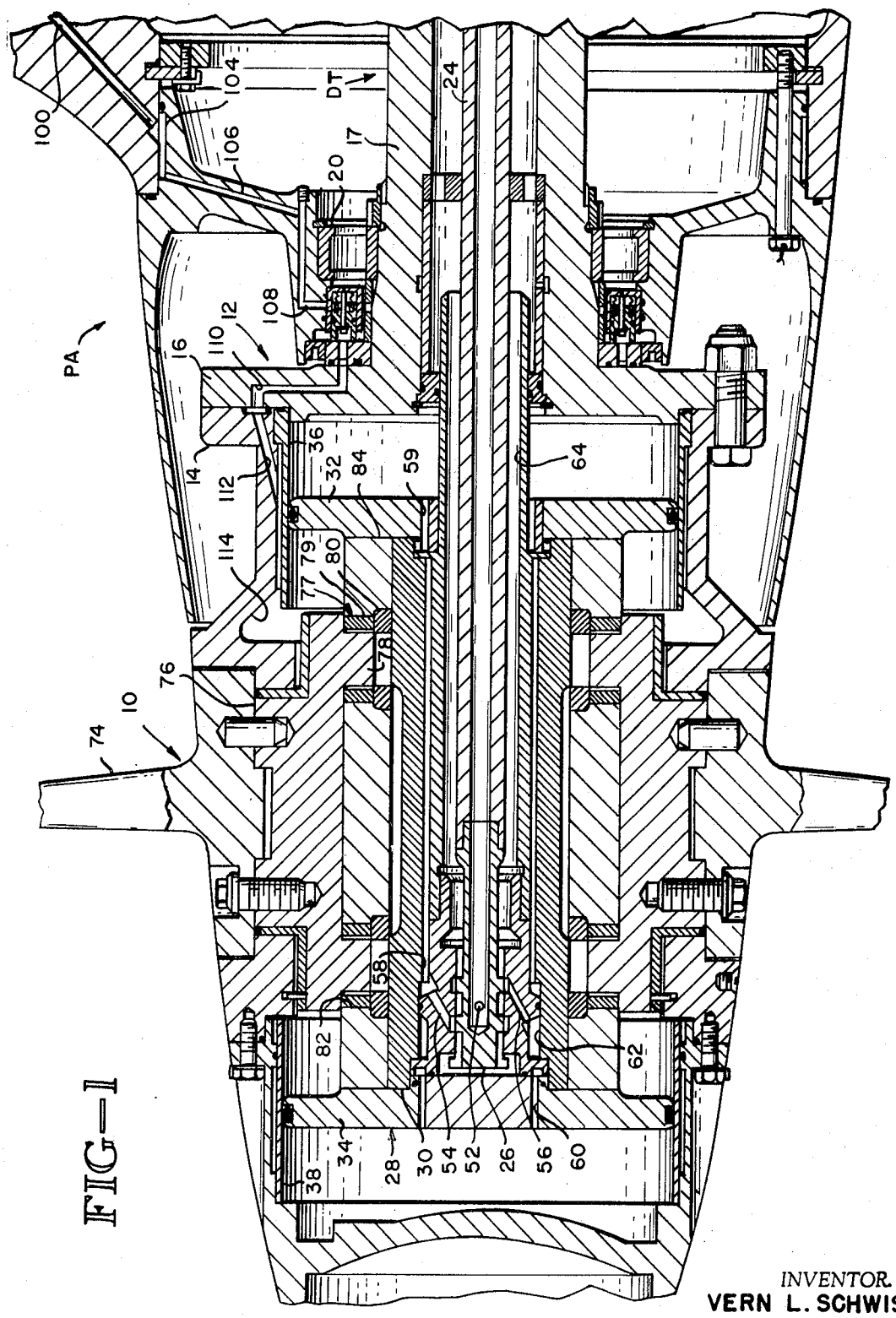
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[57] **ABSTRACT**

Variable-pitch propeller blades are mounted for rotation about the longitudinal axis of the propeller hub and also for independent rotation about radial axes of the hub. The blades are rotated about the radial axes to change their pitch by guides slidably mounted in slots in a plurality of interlocking floating plates. A sealing system includes a stationary double-ring seal biased against the sealing surfaces of the rotatable propeller hub and a static head of fluid acting at critical points of the propeller hub to prevent leakage of surrounding water into the propeller hub and drive assemblies.

6 Claims, 4 Drawing Figures





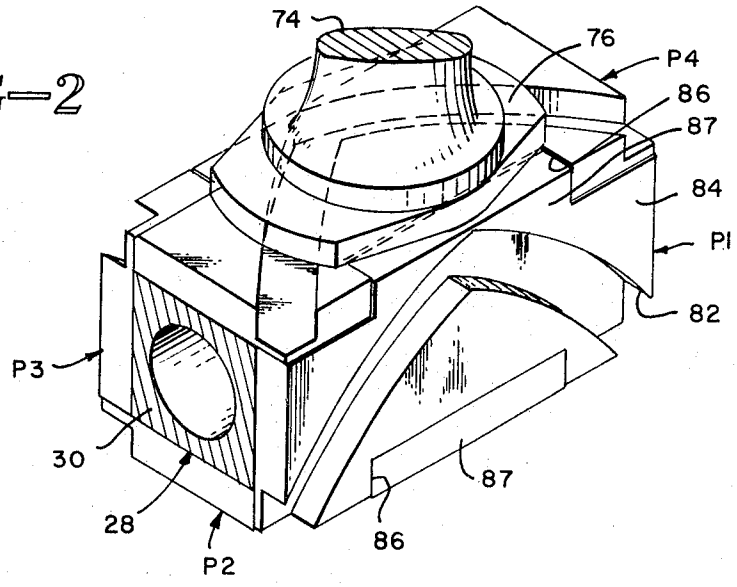
FIG—1

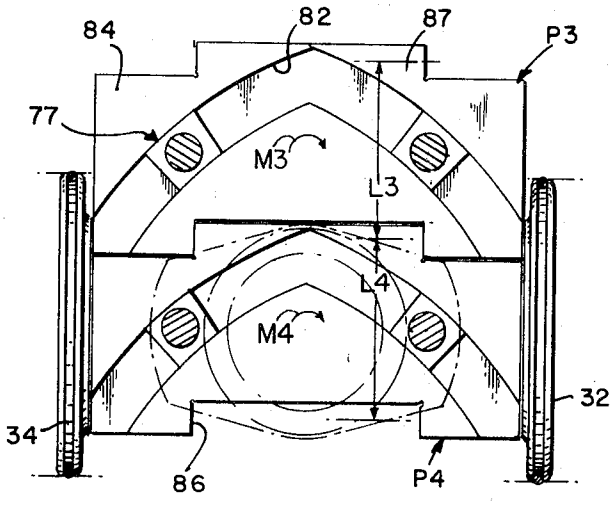
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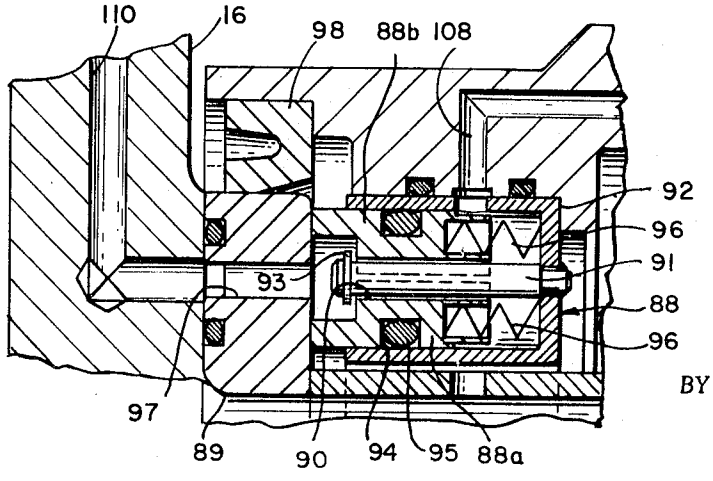
FIG—2





FIG—3

FIG—4



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INTERLOCKING VARIABLE-PITCH PROPELLER ASSEMBLY

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to variable-pitch propeller systems for marine use and, more particularly, to means for balancing the torque forces imposed by the propeller blades in a variable-pitch propeller system and for controlling their pitch. The invention also pertains to sealing systems for propeller hub and drive assemblies.

Description of the Prior Art

Certain types of control mechanisms for varying the pitch of propeller blades have heretofore transmitted the torque forces imposed by the different propeller blades directly to a control piston or mechanically actuated center block through the medium of various types of pivoted plates or slotted or serrated plates. An example of the pivoted plate type is shown in the Feroy U.S. Pat. No. 2,763,329. An example of the serrated plates is shown in Feroy U.S. Pat. No. 3,331,446.

SUMMARY OF THE INVENTION

Basically, the invention pertains to the broad principle of counteracting or balancing the various torques imposed by the propeller blades by balancing one such torque with another. The preferred means for accomplishing this employs floating plates that are interlocked to move in unison to simultaneously change the pitch of all the propeller blades but can also transmit torques between one another to balance the torques developed by each of the blades without necessarily transferring these torques to the control piston or center block. Several unique advantages result from such a concept. One advantage is that the distances between the lines of contact of the interlocking plates are generally greater than the lines of contact between the plates and center blocks of prior art devices. Consequently, there is less annular movement of the interlocked plates and thus more contact area for distributing the torque forces. Additionally, smaller forces are required to be transmitted between the plates. Another advantage is that the contact area between the interlocked plates is even further increased since the entire thickness of the plates is used to transmit forces between the plates. All of these factors contribute to increasing the life of the blade pitch control mechanism and to provide smoother operation thereof. An additional advantage is that close fits may be obtained between the interlocked plates thus reducing backlash resulting from the cyclic loading of the propeller blades. Still another advantage is that the plates are self-aligning which permits greater manufacturing tolerances, thus reducing costs, with each plate seeking its own center while maintaining geometric integrity or trueness. In the preferred form of the invention, which employs guides slidable in slots in the floating plates, the loading of the guides is more equally distributed so that the average forces imposed on each guide are minimized.

Basically, the sealing concept of this invention includes a seal combined with a static head of sealing liquid for sealing the stationary portion of the propeller drive assembly and the rotatable hub assembly for ingress of surrounding water. Two sealing elements are biased against a sealing surface of the rotatable propeller hub and a static head of sealing liquid is applied at possible leakage openings to prevent ingress of the surrounding, lower pressure water. In the preferred embodiment the sealing elements include sealing rings biased against a flat sealing plate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal section of a variable-pitch propeller assembly embodying the principles of the invention.

FIG. 2 is an isometric of a portion of the hub assembly of FIG. 1 showing the interconnected, floating plates.

FIG. 3 is a plan of one of the interconnected floating plates with an adjacent plate rotated 90° into an imaginary position to illustrate the various forces acting between the plates.

FIG. 4 is a fragmentary section of a seal employed in the unique sealing feature of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A propeller assembly PA illustrated in FIG. 1 is connected into a drive train DT, the details of which are not important to an understanding of the invention, which is secured to a boat in a conventional manner. Various drive trains are suitable and may be of the shaft drive or strut drive type. A strut drive type is illustrated for the purpose of this description. Pitch controls, which may be hydraulic or mechanical with an hydraulic control illustrated, are provided; however, the invention is not to be limited to such. A suitable hydraulic pitch control used in a strut drive is illustrated and described in my copending patent application Ser. No. 748,315, filed July 29, 1968 now abandoned.

The propeller assembly PA comprises a hub assembly **10** and a drive assembly **12** which forms a part of the drive train DT. The hub assembly is cantilevered from the rear end of the drive assembly and includes a hub flange **14** bolted to a drive flange **16** formed on a tubular drive shaft **17** of the drive assembly **12**. the tubular drive shaft **17** is supported by rear bearing **20** in a well-known manner. In the preferred form of the invention a tubular rod **24** is reciprocably mounted within the tubular drive shaft to position a spool valve **26** within a control piston **28**. The control piston includes a rectangular body **30** and forward and rear pistons **32** and **34**, respectively. The details of the piston and the valving for controlling the axial position thereof is well understood by one skilled in the art. Suffice it to say that the pistons **32** and **34** slide in respective cylinders **36** and **38** under the influence of pressurized hydraulic fluid transmitted through the tubular rod **24**. The flow is controlled by the spool valve **26** which includes a discharge port **52** communicating with either a port **54** or a port **56** depending on the position of the lands on the spool valve. When the spool valve is positioned such that fluid from the discharge port **52** flows through the port **54** the fluid is transmitted through an annular passage **58**, thence through port **59** in the forward piston **32**, into the cylinder **36** on the forward side of the piston **32** to move the control piston to the left, as viewed in FIG. **1**, rotating the propeller blades. Fluid in the rear cylinder **38** is discharged through ports **60** in the rear piston **34**, thence into an annular passage **62**, the port **56**, between the lands on the spool valve **26** and finally into an annular passage **64** surrounding the tubular rod **24**. When the tubular rod **24** is shifted to the right, as viewed in FIG. **1**, pressurized fluid is transmitted through the discharge port **52**, port **56**, annular passage **62**, ports **60** into the cylinder **38** on the rear side of the rear piston **34** to rotate the blades in the opposite direction.

A plurality of conventional reversible pitch propeller blades **74**, four blades in the embodiment shown, are secured to blade root flanges **76**. In the preferred form the root flanges are shown pinned to the blades but can be integral if desired. Each blade root flange is provided with a pair of depending guides that include pins **78** circumscribed by sliding blocks **79** and inserts **80**. The guides ride in slots **82** formed in interlocking floating plates **84**. The configuration of the slots is best shown in FIGS. **2** and **3** and their function as well as a detailed description of the interlocking floating plates **84** will be given herein below.

An important feature of the invention is the interaction between the floating plates **84** to counteract or balance the torques imposed by the propeller blades **74** as well as also functioning to rotate the blades about the hub radial axes when the control piston **28** is shifted. The torques on the propeller blades **74** vary continuously during rotation of the hub about its longitudinal axis and may vary considerably between each of the individual blades. As best shown in FIGS. **2** and **3**, each of the floating plates **84** is provided with a notch **86** and a rectangular boss **87** depending from the side of the plate opposite the notch. To enable a clearer description of the function of the floating plates, they will be lettered succes-

sively in a clockwise direction in FIG. 2 as P1, P2, P3, and P4. As is readily apparent, the inner faces of the floating plates are slidably supported on the faces of the rectangular body 30 with the notches and bosses of adjacent plates interlocked.

To best illustrate the function of the interlocking floating plates 84 to overcome the varying torques presented by the propeller blades, reference is made to FIG. 3. The figure illustrates two adjacent floating plates P3 and P4 with plate P3 having been rotated out of its vertical position shown in FIG. 2 into the same plane as plate P4. Placing both of the plates on the same plane greatly facilitates the theoretical discussion of the forces acting on the plates, it being understood that the actual forces act in a substantially similar manner when the plates are in their normal operating positions. Each of the propeller blades imposes a torque on its respective floating plate 84. Taking the two plates P3 and P4 it can be seen that a torque M3 is at one instant imposed in a clockwise direction on the plate P3. Assume that a similar torque M4 is applied to the floating plate P4. The moments M3 and M4 may be balanced by a force and its reaction force acting at the line of contact between plate P3 and P4 or theoretically at the respective distances of L3 and L4 with L3 equal to L4. Thus, the torque M4 which tends to turn the plate P4 in a clockwise direction, as viewed in FIG. 3, will counteract the torque M3 in the plate P3 by the force acting at the distance L4. If the torque in each of the floating plates is equal, they will be balanced by the interlocking plates. If torque M4, for example, exceeds torque M3, the excess torque will tend to shift the plates in opposite directions so that the excess torque is counteracted by forces acting between floating plate P3 and the forward piston 32 and between floating plate P4 and rear piston 34. It is obvious, of course, that the amount of force applied by the pistons necessary to offset the excess in torque between plates P3 and P4 is substantially less than the force that would otherwise be necessary if there were no interlocking plates and the counterforces were transmitted directly to the control piston. The floating plates may also be moved simultaneously to change the path of the blades by shifting the control piston 28.

The sealing feature of the invention includes a seal identified by the general reference numeral 88 which includes inner and outer sealing rings 88*a* and 88*b*, respectively. The sealing rings are preferably of carbon but may be of any other suitable material. Springs 96 bias the rings against a flat, steel plate 89 which rotates with the flange 16 of the drive assembly 12. The rings are provided with a plurality of opposed, circumferentially spaced recesses 90 which receive pins 91 welded or otherwise fixed to a stationary support flange 92 in the drive assembly 12. The sealing rings are loosely retained on the pins by snap rings 93. Each of the sealing rings is provided with a peripheral recess 94 which receives a conventional O-ring seal 95. The opposed faces of the inner and outer sealing rings between the spaced recesses 90 are spaced from one another so that sealing fluid may pass between the sealing rings into circumferentially spaced ports 97 in the steel plate 89. A debris seal 98 is seated around the steel ring to prevent relatively large debris from contacting the outer sealing rings 88*b*.

As is readily apparent the sealing rings 88*a* and 88*b* provide a tight seal against the steel plate 89. The effectiveness of this seal is greatly increased by the use of a sealing fluid surrounding the rings. For this purpose a fluid line 100 (FIG. 1) is connected to a tank on the vessel which provides a static head equivalent to approximately 10 p.s.i. pressure. The line 100 is connected to the seal 86 by recess 104, port 106 and port 108. Ports 97 in the steel ring deliver the fluid to a port 110 in the flange 16, a port 112 in the flange 14, and then into a cavity 114 surrounding the control piston 28. Thus, the static pressurized fluid is available at all of the exposed, critical sealing points between the hub assembly 10, drive assembly 12 and the surrounding water.

It should be apparent that changes in the details of the invention and the operation thereof may be made without departing from the principles of the invention. For example, one such change would be in the number of blades and interlocking plates employed. Obviously, any number may be used and the invention is not to be limited to the four in the embodiment shown.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A variable-pitch propeller assembly comprising a propeller hub having a plurality of radial axes and a longitudinal axis; means for mounting a plurality of propeller blades for rotation about said radial axes so as to change the pitch of each blade; guide means secured to each blade; a plurality of floating plates each having slots slidably receiving said guide means of a respective blade and shaped to cause said rotational movement of said blades to change their pitch when said plates are shifted, each said plate being interlockingly engaged with an adjacent plate for conjoint movement parallel to said longitudinal axis for simultaneously changing the pitch of the blades and for independent movement transverse to said longitudinal axis; and actuating means for moving said plates longitudinally of said propeller hub.

2. The propeller assembly of claim 1 wherein said blades each includes a root flange and said guide means include a pair of spaced pins secured to said root flange, said plates each having a pair of slots for receiving said pair of spaced pins.

3. The blade assembly of claim 1 wherein said plates each include a notch along one side and a boss extending from an opposite side and registrable within a notch of an adjacent plate.

4. The blade assembly of claim 3 wherein said actuating means includes spaced pistons, and wherein each of said plates includes opposites end faces engageable with said spaced pistons.

5. A variable-pitch propeller assembly comprising a plurality of propeller blades mounted for rotation about a longitudinal axis to produce thrust and for independent rotation about radial axes passing through said blades for changing the pitch of the blades; torque compensating means for balancing the torque of one of said blades by the torque of another, said torque compensating means including a plurality of floating plates each abutting adjacent plates along planes substantially normal to said longitudinal axis and having means interconnecting each plate to a respective blade for shifting the plate in a direction parallel to said longitudinal axis upon rotation of said blades about said radial axes whereby countertorques of adjacent blades are at least partially resisted by reaction forces imposed directly between adjacent plates; and actuating means for simultaneously shifting said plates along said longitudinal axis for rotating said blades about said radial axes to change the pitch of the blades.

6. The propeller assembly of claim 5 wherein said blades include flanges having spaced guides, said plates include slots for receiving said guides and notches and bosses for interlocking with adjacent plates, and said actuating means including a control piston engageable with the opposite ends of said plates.

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