Aug. 17, 1954 T. K. BRUCE, JR 2,686,569

HYDRAULIC CONTROLLABLE PITCH PROPELLER

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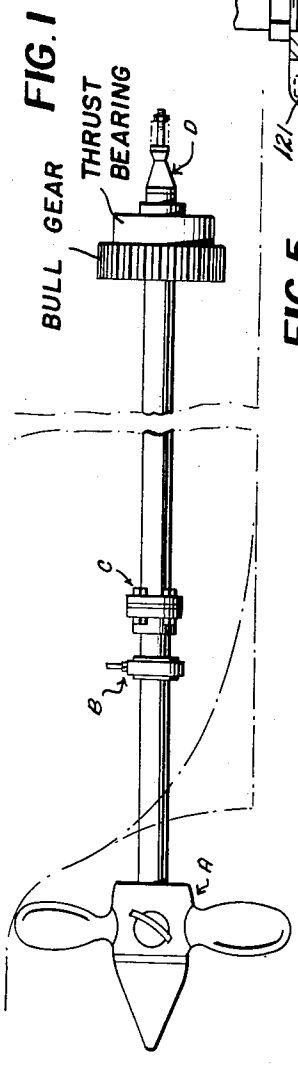


FIG. 1

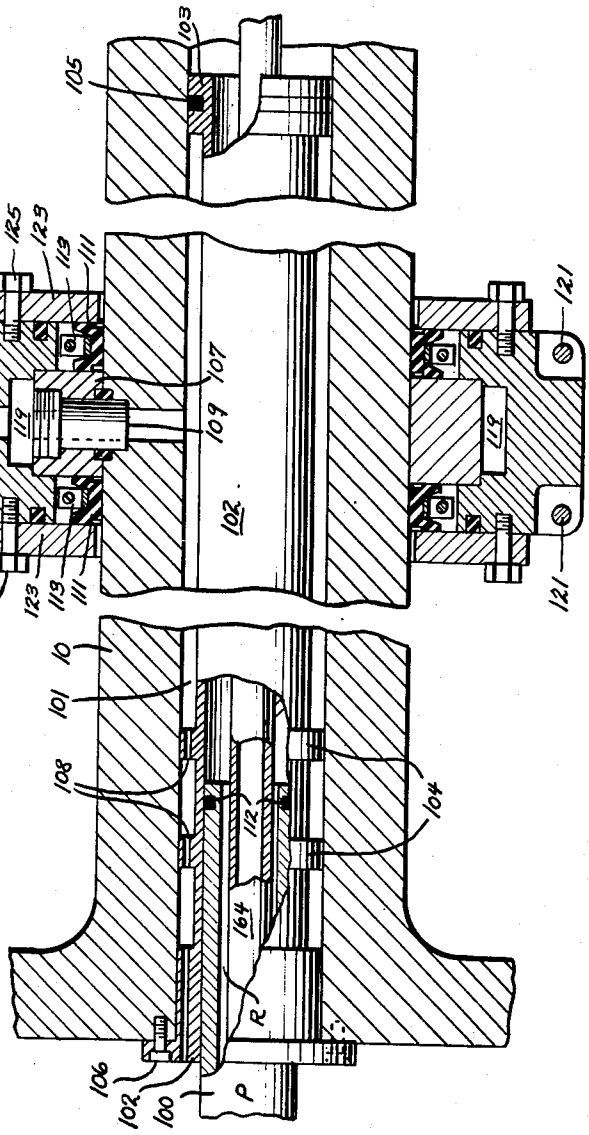


FIG. 5.

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HYDRAULIC CONTROLLABLE PITCH PROPELLER

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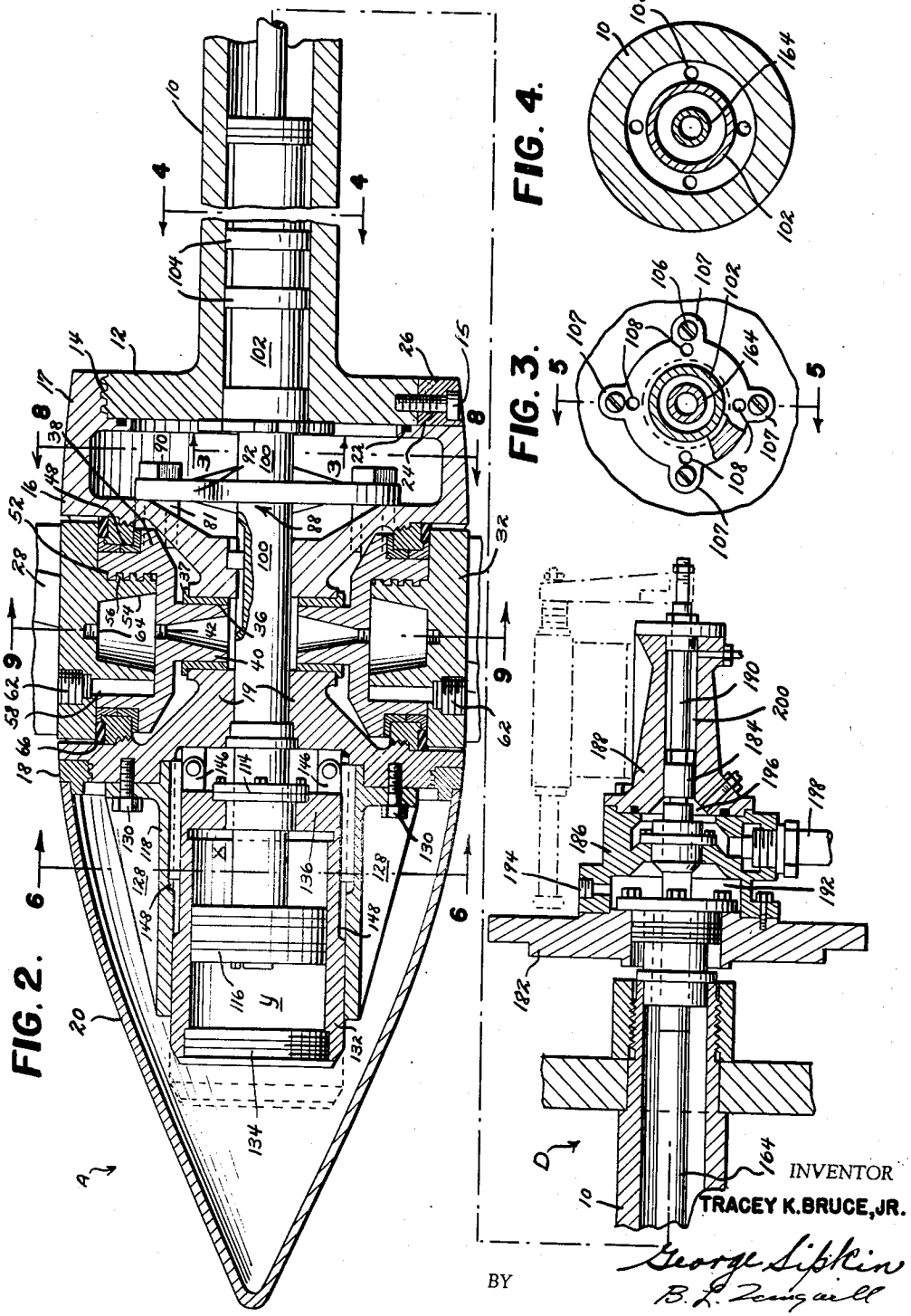


FIG. 2.

FIG. 4.

FIG. 3.

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HYDRAULIC CONTROLLABLE PITCH PROPELLER

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FIG. 6.

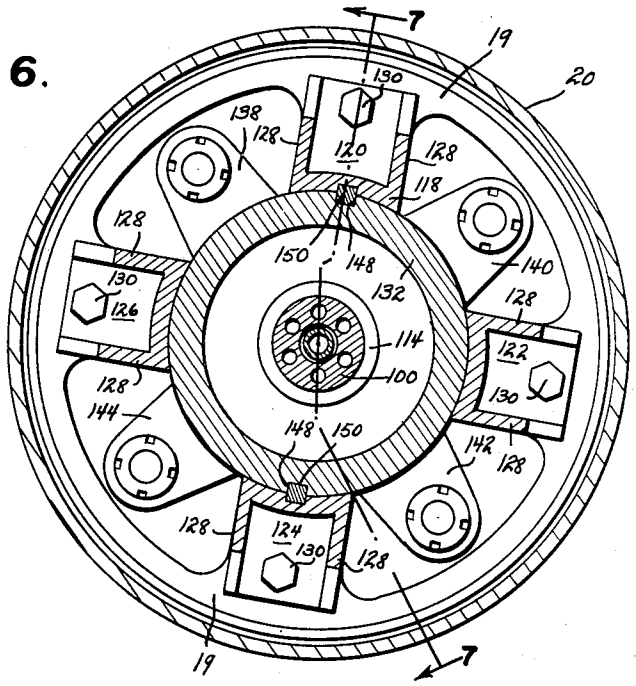
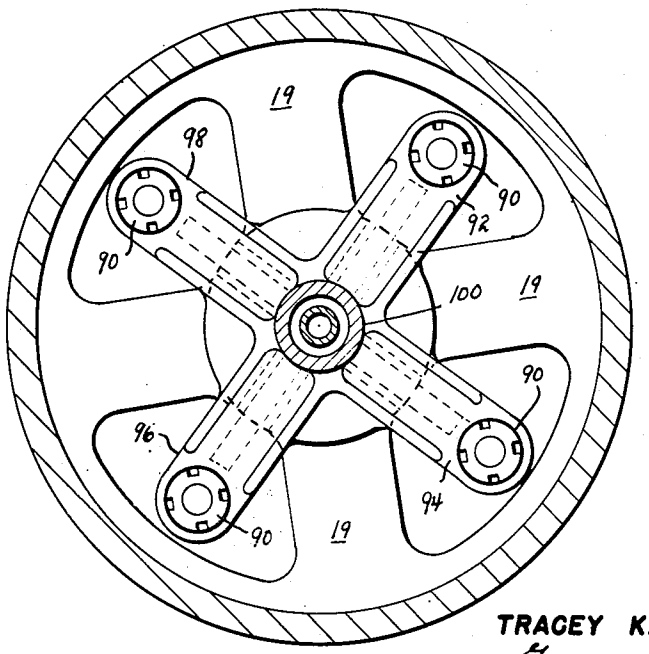


FIG. 8.



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HYDRAULIC CONTROLLABLE PITCH PROPELLER

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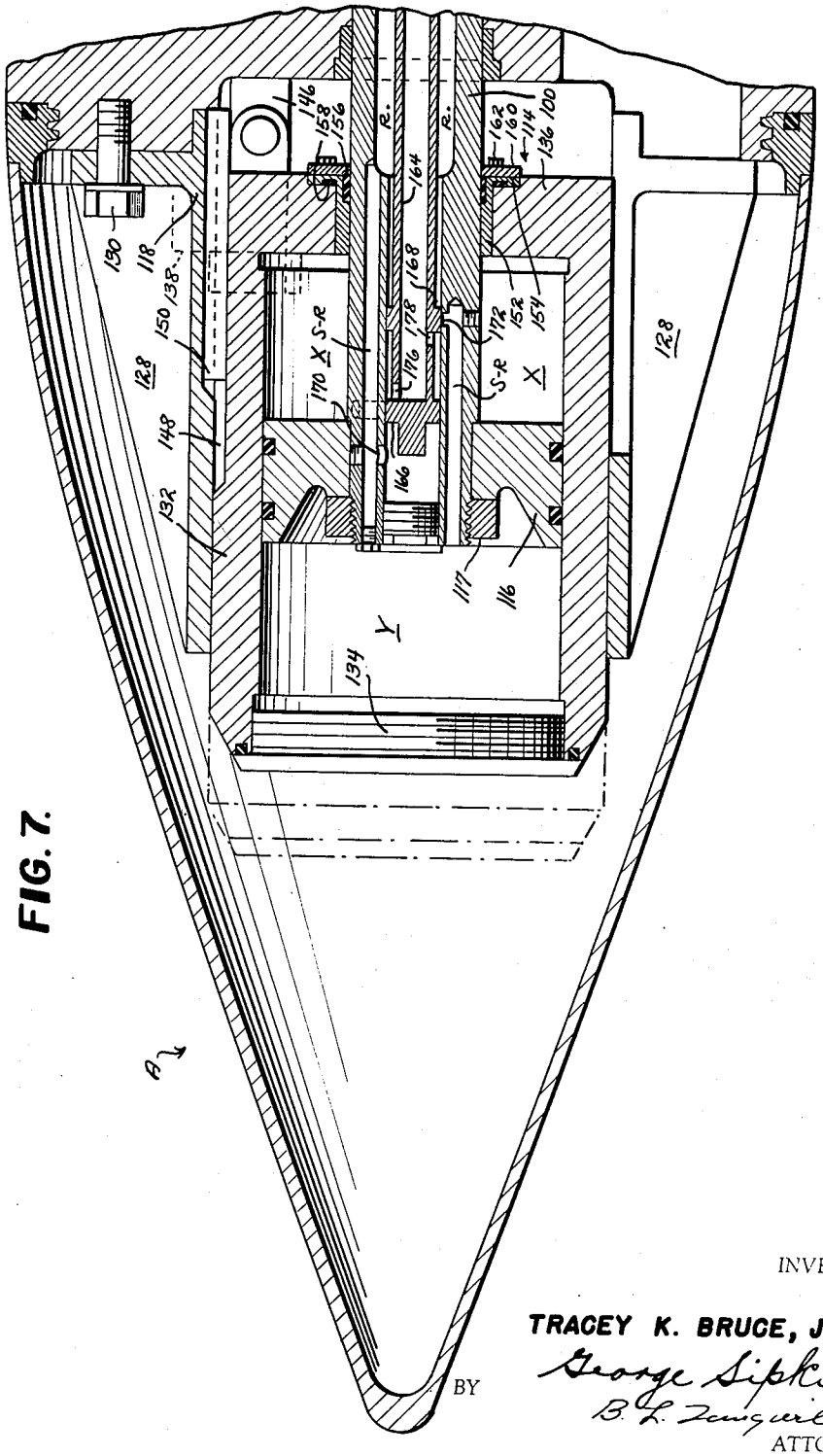


FIG. 7.

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HYDRAULIC CONTROLLABLE PITCH PROPELLER

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FIG. 9.

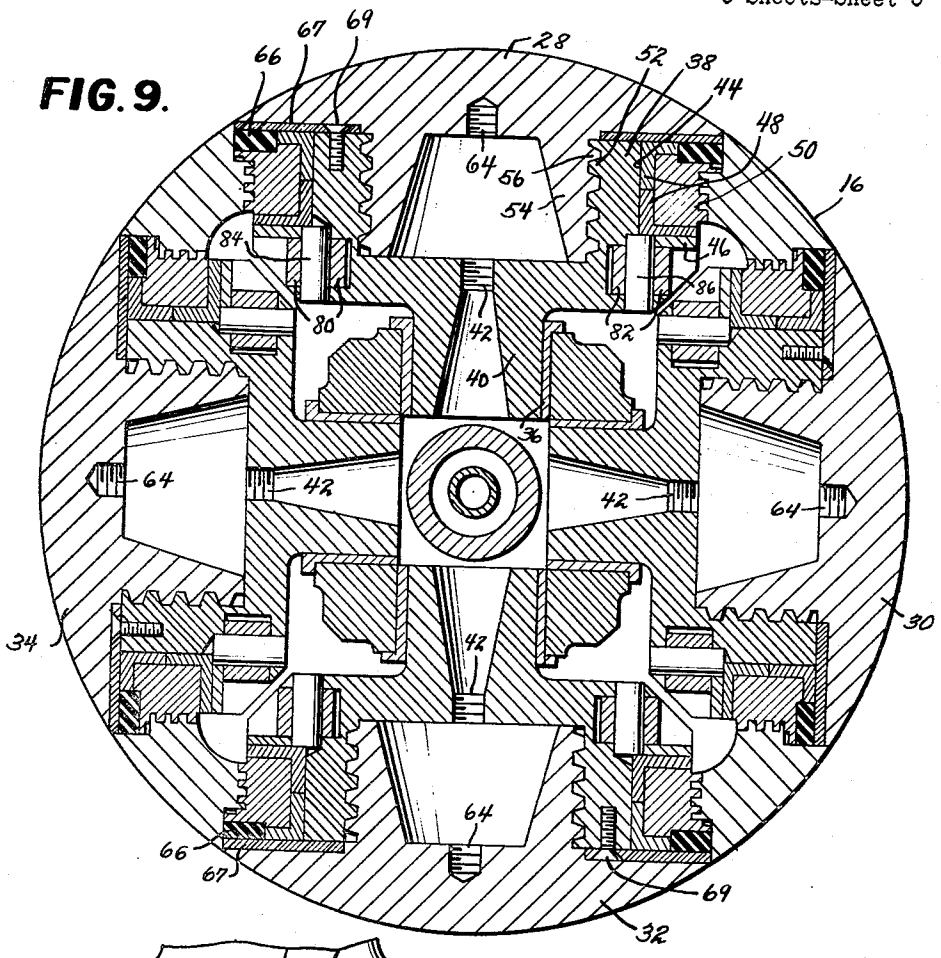
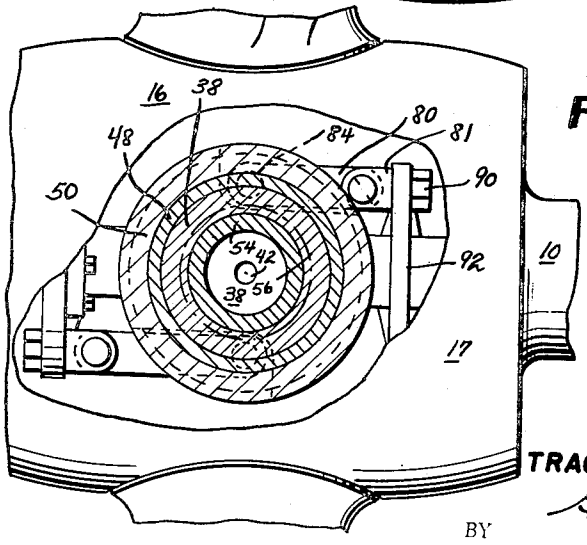


FIG. 10.



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HYDRAULIC CONTROLLABLE PITCH PROPELLER

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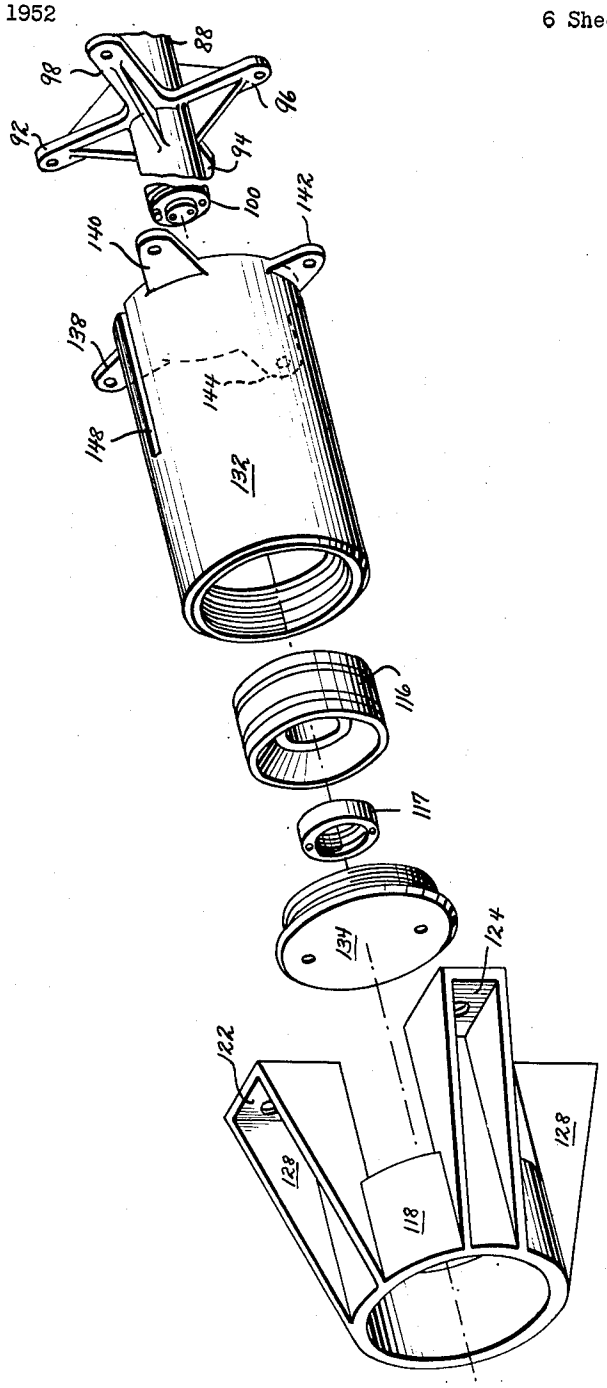


FIG. II.

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UNITED STATES PATENT OFFICE

2,686,569

HYDRAULIC CONTROLLABLE PITCH PROPELLER

Tracey K. Bruce, Jr., Hyattsville, Md.

Application June 30, 1952, Serial No. 296,526

9 Claims. (Cl. 170—160.32)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to an improvement in controllable pitch propellers, such as used on ships, having blades which can be angularly adjusted from a remote point while the ship is waterborne. The blades are mounted on the propeller shaft hub and are simultaneously rotated about their own axis, for changing the pitch thereof, by a servomotor mounted inside the hub which is responsive to a hydraulic power source located inside the ship. The prior art discloses controllable pitch propellers of this general design but they are subject to many inherent deficiencies such as uneven and excessive wear on blade bearing surfaces, leaky hubs, improper hub lubrication, lack of positive means for moving the blades to a forward pitch position in the event of a casualty to the blade moving means, etc. It is these deficiencies that have been corrected or eliminated by the present invention, culminating several years of research and testing of experimental models installed in operating ships.

It is therefore an object of the invention to provide an improved controllable pitch propeller suitable for use on marine vessels.

A further object of the invention is the provision of a unique piston-cylinder servomotor for actuating the propeller blades.

Another object is the provision of a mechanism for changing the pitch of the blades which comprises a pair of crank arms connecting the servomotor with the blades for accommodating large loads at high shaft speeds while still maintaining a uniform bearing load on the structure.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description, when considered in connection with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof and wherein:

Figure 1 is a diagrammatic showing of the controllable pitch propeller and control unit therefor as applied to a ship.

Figure 2 is a sectional view in elevation longitudinally of the propeller hub and differential servomotor located within the ship.

Figure 3 is a view in elevation, partly shown in section, and taken on lines 3—3 of Figure 2.

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Figure 4 is a sectional view in elevation taken on lines 4—4 of Figure 2.

Figure 5 is a detailed sectional view in elevation of the transfer unit used for supplying oil to the hub.

Figure 6 is a sectional view in elevation taken on line 6—6 of Figure 2.

Figure 7 is a detailed sectional view in elevation showing the servomotor arrangement located in the propeller hub.

Figure 8 is a detailed sectional view in elevation taken on lines 8—8 of Figure 2.

Figure 9 is a detailed sectional view in elevation taken on lines 9—9 of Figure 2.

Figure 10 is a detailed plan view showing how the connecting rods are connected to each crank pin ring with a section of the hub broken away to show this structure.

Figure 11 is a blown-up view of the parts comprising a servomotor located in the hub.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Figure 1, a propeller hub indicated at A, an oil transfer unit for providing the hub cavities with oil at B, a coupling connecting two sections of the propeller shaft at C and a differential servomotor at D. Positioned between coupling C and differential servomotor D is a bull gear which is appropriately shafted to the main propulsion equipment in the engineering spaces of the ship. The location of elements A, B, C and D relative to the ship's structure is as follows: Differential servomotor D is connected to the cover of a Kingsbury thrust bearing at the forward end of the bull gear as will be more fully explained hereinafter. Hollow propeller shaft 10 is shafted to the after end of the bull gear and extends aft inside the ship where coupling C connects two sections comprising the propeller shaft together. Aft of this coupling, the propeller shaft 10 extends through the ship's hull to hub A containing the propeller blades.

Referring now to hub A, shown in Figure 2, it will be seen that the shaft 10 flares outwardly at 12 and is provided with screw threads 14 for receiving hub casting 16, and threadably secured to said casting 16 is a spacer ring 18 which properly positions and connects dunce cap 20 to the hub body. These members are snugly fitted to one another by means of packing so as to form a watertight fit, thus preventing the entry of water into or the escape of oil from the hub, since the latter is adapted to be filled with oil at a pressure somewhat higher than the out-

side water pressure at all times. In some cases where the parts cannot form such a watertight fit, circular rubber seals are provided as shown at 22, for example, and held in place by the coaction of flange 12 on propeller shaft 10 and hub casting 16. In order to prevent casting 16 from becoming disengaged from propeller shaft 10, key 26 is fitted in mating slots respectively positioned in casting 16 and flange 12 and securely held therein by means of cap screw 15.

The blade holding hub casting 16 has four circular openings equidistantly spaced and extending around its periphery, the diameter of each being sufficiently large to accommodate a propeller blade and its associated parts for securing the blades to the hub casting 16. The structural members for forming said circular openings are indicated at 19, Figures 1, 6 and 7 and provide the casting with the strength for supporting the blades. The propeller blades are respectively indicated at 28, 30, 32 and 34, Figures 2 and 9, and since each part employed for holding the blades to the casting are exactly the same, description of only one of such blades and its associated parts will be given, with the same reference characters being used to denote like parts throughout the corresponding views.

Positioned deep in casting 16 is a bearing member 36 adapted to fit into a circular opening in said casting. This bearing member 36 has a flange 37 extending outwardly and at the top of the bearing for properly positioning said bearing in the casting opening. Rotatably mounted within said bearing is a crank pin ring 38 formed in the shape of a cup having a neck 40 extending downwardly from the bottom of the cup and is adapted to fit in bearing 36, this crank pin ring serving the function of securing the blade to the propeller hub. The neck 40 is hollow and has a screw threaded opening 42 at its upper end for receiving a crank pin ring puller when it is necessary to remove the crank pin ring from the bearing and casting for repairs. The outer upper peripheral portion of crank pin ring 38 is cut away forming a vertical wall 44 and horizontal seat 46 for receiving bearing or bushing members 48. Bearings 48 are soft soldered to ring 50 and are adapted to take the thrust exerted by blade 28 and are held in rigid position between casting 16 and crank pin ring 38 by means of ring 50 which is screw threaded to casting 16.

It is to be understood that there are sixteen bearing surfaces for the four propeller blades, or four for each blade. They are the inner cylindrical bearing appearing at the point of contact of the outer peripheral portion of crank pin ring neck 40 with the inner surface of bearing member 36; the outer cylindrical bearing appearing at the point of contact of ring 38 with the inner portions of bearing members or bushings 48; the inner thrust bearing appearing at the point of contact of horizontal seat 46 with the bottom portion of lower bushing 48; and the outer thrust bearing appearing at the point of contact of bearing member 67 with top portion of upper bushing 48. The purpose of this propeller blade bearing arrangement is to give the best possible distribution of the extremely large bearing forces in the space available in the relatively small hub casting. During the blade turning moment or reversing period of the propeller, the following large forces are acting on the bearings; the inner and outer cylindrical bearings are subjected to radial load caused by the following:

(a) Propeller thrust and torque.

(b) The radial load caused by the centrifugal couple due to the centrifugal force of the propeller blade itself when rotating.

(c) The forces from the connecting rods turning the crank arms consisting of the reaction forces, large frictional forces and dynamic forces.

The inner thrust bearing takes the thrust caused by the centrifugal force of the propeller blade assembly. It also takes the force caused by the tipping action of the propeller blade thrust and torque.

The outer thrust bearing takes the reaction force caused by tipping action of the propeller blade thrust and torque. The inner portion of the cup shaped crank pin ring 38 is provided with female threads 52 which are of the type normally found in the breech mechanism of guns having a bore greater than, say, 3 inches, i. e., the threads are of the interrupted type in which the inner portion is threaded, and then every other 45° sector of threads is milled out leaving an inner cylindrical portion that alternately contains a sector of threads at 45° intervals, the remaining inner portion between each sector of threads being of a smooth surface and of the same curvature of said threads. The blade 28 has a reduced neck portion 54, having on its outer peripheral portion a like set of interrupted male threads 56, such as those explained above, which are adapted to mate with the threads on the crank pin ring. In operation, the male threads 56 of the blade neck are aligned with the smooth cut away section between the sectors of threads on the crank pin ring, the blade neck is dropped into the crank pin ring and when it bottoms, the blade is turned 45°, thus interlocking the threads and securing the blade in a fixed position. The blade and crank pin ring respectively have a slot 58 which align with one another when the blade is in a fixed or secure position and said slots are adapted to take a key 60, Figures 1 and 8, which positively locks the blade and blade adapter in position. Cap 62 is screwed into the slotted blade portion so as to prevent the key from dropping out when the hub is rotated. The blade neck is hollowed out and contains a threaded opening 64 for receiving a blade carrying tool when the blade is removed from the hub and transported from one location to another. In order to prevent leakage of water into or loss of oil from the hub, circular rubber seal 66 is provided between metal ring 50 and blade 28.

As mentioned above, the hub A, with the attached blades 28, 30, 32 and 34 is rotated by the main propulsion equipment located inside the ship, and in order to eliminate stopping and then physically reversing the direction of rotation of the propeller shaft to secure reverse movement of the ship, the angle of pitch of the propeller blades is changed, while the hub and propeller shaft blades are rotating in the same direction, from an ahead to astern pitch, or vice versa, to effect reversal in the direction of movement of the ship. Each blade is turned or rotated in its bearings by means of two crank arms which are respectively connected to guides positioned on opposite sides of the center line of the blades, which in turn receive their power from two pistons, one serving each of the guides.

Referring more specifically to the drawings, it will be seen in Figures 2, 9 and 10 that crank pin ring 38 is recessed on opposite sides thereof to provide for free movement of crank arms 80 and 82 which are respectively secured to the crank

pin ring by means of pins 84 and 86. The crank arm 80 is connected at its other end to arm 92 of guide 88 by means of crank clevis 81 and clevis bolt 90. As more clearly shown in Figure 11, guide 88 comprises four guide arms, 92, 94, 96 and 98, each of said guide arms being respectively apertured to receive the securing means for each crank clevis, that is, guide 88 has four arms which extend outwardly from its center and to each of these guide arms is secured a crank clevis and the other end of each crank clevis is secured to a crank arm which extends to and is connected to its own crank pin ring. One such arrangement of guide arm, crank arm and crank pin ring is shown in Figure 2 and respectively designated by reference characters 92, 80 and 38. Formed integrally with guide 88 and extending on each side thereof is a hollow shaft 100, which extends forwardly to emergency piston 102 and aft to servo piston 104.

Referring to Figures 2, 3, 4, and 5 the forward end of guide shaft 100 extends into and terminates in the after section of propeller shaft 10. Positioned around guide shaft 100 and also extending into the after end of propeller shaft 10 is a cylindrical tube 102 having spacing members 104 for positioning the tube within the hollow propeller shaft. The tube is secured to the after end of the propeller shaft 10 by means of machine bolts 106 which are inserted through aperture arms 107 integrally secured to the after end of tube 102. Spacing members 104 with drill openings 108 therein provide a passageway for oil introduced through oil-carrying tube 110 for passage to the interior of hub A.

The hub A is adapted to be filled with oil and maintained at a pressure of approximately 15 p. s. i. and this oil is supplied to the hub through tube 110 which in turn is connected to a remote source of oil supply. In order to prevent the flow of oil from the return passageway designated R to the passageway for supplying oil to the hub, shaft 100 is provided with O-type seal rings as shown at 112 and positioned within the forward end of shaft 100.

The oil passage 101, defined by the space existing between propeller shaft 10 and tube 102, is closed at its forward end by a built up flange 103 having packing means 105 positioned in the outside periphery of the flange. The structure for providing an oil flow connection between tube 110 and passageway 101 comprises a ring 107, cast in two parts, or singly as shown in Figure 5, which is adapted to receive a hollow locking pin 109 extending through the ring and into shaft 10. Two circular rubber sealing bands 111 are positioned on each side of ring 107 and are held in place by circular bands 113. A housing 115 having an opening for receiving tube adapter 117, is provided with a hollow cavity 119 for receiving oil from tube 119 prior to delivery through hollow locking pin 109 to passageway 101. The housing is secured to a bulkhead by bolts 121, and plates 123 secured to the housing by bolts 125, hold the aforementioned rubber bands in position. It is to be noted that the rubber bands 111, ring 107 and hollow locking pin 109 rotate with the shaft 10 while housing 115 and plates 123 are stationary since they are secured to a bulkhead or similar supporting means in the ship.

Referring specifically to Figures 2, 6, 7, and 11, guide shaft 100 moves rearwardly with guide 88, passes through a circular oil sealing member 114 and terminates in a piston 116. The piston

is secured to the shaft 100 by means of a nut 117 and imparts a moving force to shaft 100 as a result of oil pressure acting thereon, said shaft being connected to the crank pin ring for each blade through a pair of crank arms and crank clevises, such as indicated at 80 and 81, and through guide arms connected to shaft 100. Thus far only one-half of the means used for rotating the blades has been defined, that is, the piston, shaft, guide arms, crank arms and crank pin rings. The other half of the means used for assisting the first guide arm for rotating the blades comprises substantially identical parts which are located on the opposite or rearward side of the center line of the blades. This structure comprises a hollow cylindrical housing 118 having four arms respectively designated as 120, 122, 124, and 126 extending outwardly therefrom; each of these arms having strengthening members on each side thereof designated at 128.

The hollow housing 118 is secured to hub casting 16 by means of bolts 130, a perspective view thereof being shown in Figure 11. Slidably mounted within housing 118 is a hollow cylinder 132 closed at its after end by means of a plug 134 and provided at its forward end with a centrally apertured wall 136. Extending outwardly from wall 136 are four guide arms spaced 90° apart and indicated at 138, 140, 142 and 144 which are appropriately bored to receive the after end of crank arms and crank clevises, such as 142 and 144 which are appropriately bored to receive the after end of crank arms and crank clevises, such as indicated at 146. The forward ends of such crank arms are connected to the crank pin rings in the same manner as the crank arms for guide 88, except that crank arms 146 are connected to the crank pin rings at 180° from the former. It is therefore seen that when cylinder 132 moves horizontally it imparts a rotating movement to the blades through the following structures: wall 136, arms 138, 140, 142 and 144, crank clevises and crank arms 146, crank pin rings and the blades.

In order to prevent relative rotary movement of the cylinder 132 in housing 118, a key and slot arrangement is built into these parts to make such movement impossible. Each of these two units, that is, the housing and the cylinder, are slotted at 148 and adapted to successfully fit within the opening formed by these two slots and two keys 150, each being displaced 180° apart.

The area formed by the forward end of piston 116 and the after inside end of wall 136 is adapted to be filled with oil at the system pressure and in order to prevent the escape of oil from this area, oil sealing member 114 is effectively used to preclude this from happening. The oil sealing member is of a customary high pressure type and comprises a hollow cylindrical packing ring 152 having outwardly flanged ends 154 which is adapted to fit between shaft 100 and wall 136 as clearly shown in Figure 7. Rubber packing glands 156–158 are positioned on either side of hollow portion 152 and respectively pressed into engagement with wall 136 and shaft 100 by means of plate 160 which is secured to wall 136 by means of bolts 162.

Shaft 100 is centrally bored and receives a control rod 164 which extends from the servomotor in the hub forwardly to differential servomotor mechanism B located inside the ship. The after end of control rod 164, as shown in detail in Figure 7, is equipped with two sets of valve lands 166 and 168 which extend around

the periphery of rod 164 and engage ports 170 and 172. Positioned between the valve lands in the control rod are openings 176 and 178. As shown in the center of Figure 6, there are a plurality of bored passageways in shaft 100 which are located in the solid portion defined by the outer and inner diameter of shaft 100. These bored passageways serve both as supply and return lines for oil delivered to such bored passageways from the interior of the control rod 164. In addition to the ports 170 and 172 which lead from the interior of shaft 100 to such bored passageways, S—R are also openings which connect every alternate passageway with the area defined by the forward end of piston 116 and the wall 136 of exterior cylinder 132. This area is indicated at X. The other of the alternate bored passageways connects with the area defined by the after end of piston 116 and the cap 134 which closes cylinder 132 and this area is designated as Y.

In operation, high pressure oil is delivered through control rod 164 to ports 176 and 178 therein to the space between valve lands 166 and 168. When a change in the pitch of the blades is desired to an ahead pitch, the control rod 164 is moved by means of differential servomotor B located in the ship. The control rod, to achieve an ahead pitch on the blades, is moved aft and valve lands 166 and 168 uncover ports 170 and 172 respectively. This allows oil to flow from the control rod through openings 176 and 178 through ports 170 to openings 180 and into area X. Since the oil is under pressure of approximately 1500 p. s. i., this pressure will exert a force against piston 116 moving it rearwardly or to the left, as shown in Figure 7, while this same pressure will likewise exert a force against the rearward or inner wall 136 of exterior cylinder 132 thus pushing this cylinder to the right or in a forward direction. As described above, piston 116 is connected to the blades through shaft 100, guide 88, guide arms 92, 94, 96 and 98 and the crank arms and crank clevises 146, which are connected at one end to said arms and at the other end to the crank pin rings for each blade. Cylinder 132 is connected to the opposite sides of said blades through guide arms 120, 122, 124 and 126 and crank arms and crank clevises which are connected at one end to said arms and at the other ends to the crank pin ring for each blade. It is therefore apparent that the movements of the piston 116 and cylinder 132 exert a turning moment on each of the blades to rotate them to ahead pitch position. The oil which is displaced by the movement of piston 116 and end cap 134 of exterior cylinder 132 (area Y) towards each other flows through alternate bored passageways and ports 168 into the return passageway R, thus connecting area Y with the return lines in the system.

Assuming now, that it is desired to change the pitch of the blades to a reverse position, the control rod 164 would then be moved in a forward direction by differential servomotor B. This movement uncovers ports 172 in the bored passageways and oil then flows through the control rod 164 through openings 176 and 178, ports 172 to the area indicated by Y. The force exerted by the oil pressure in area Y moves piston 116 to the right or forwardly and cylinder 132 to the left or rearwardly and this action is then transmitted to the blades through the crank arms and crank clevises as above described. The oil thus displaced by the movement of piston 116 to the right flows through openings 180 to return passageway R connecting with the source of hydraulic supply. Either of the above described processes for changing the pitch of the blades may be followed in the event that a change in pitch is desired. The coaction of the various parts may be more clearly seen and understood by referring to the blow-up perspective view of these parts shown in Figure 11.

The differential servomotor for making possible the movement of control rod 164 is broadly shown in Figure 2, the specific details of which are shown and described in the co-pending application of John H. Strandell et al., Serial No. 300,564, filed July 23, 1952.

This structure generally comprises the control rod 164 which extends forwardly through propeller shaft 10, thrust bearing plate 182 and terminates in a differential piston 184. Secured to the forward end of thrust bearing cover 182 is a first housing 186, and secured to said first housing is a second housing 188, the latter being centrally bored to contain control rod extension 190. The first housing 186 is so shaped in design that it forms a hollow opening 192 with the forward end of thrust bearing cover 182. Located in the top of said first housing is an outlet opening 194. Return passageway R extends the full length of the propeller shaft from the hub to the differential servomotor mechanism B and is formed by the space defined by the exterior surface of the control rod and the inner surface of propeller shaft 10. This return passageway R conducts oil through cover 182 into chamber 192 and out through opening 194 to a sump and pump (not shown). The second housing 188 is so shaped and designed that it forms with said first housing a high pressure chamber 196, said high pressure chamber receiving its oil pressure supply through conduit 198 which in turn is connected to the discharge side of the pump. The area within the hollow portion of said second housing and surrounding control rod extension 190, as indicated at 200, is adapted to be filled with oil at the same pressure as that existing in chamber 196, namely, 1500 p. s. i.

The movement of the control rod takes place as follows: a pilot valve (not shown) controls the volume and pressure of oil in chamber 200, that is, if a change in direction of movement of control rod to the right is desired, the pilot valve relieves chamber 200 of the pressure therein and the pressure (1500 p. s. i.) existing in chamber 196 acts against the left or rearward side of piston 184 to move the control rod 164, which is connected thereto, to the right. When it has moved the desired amount the pilot valve prevents further flow of oil from chamber 200 and the piston 184 and attached control rod therefore stops moving as a result of the equalization of pressures in chambers 196 and 200 acting on opposite sides of piston 184. Likewise whenever an opposite direction of movement of the control rod 164 is desired, the pilot valve opens and allows pressure at 1500 p. s. i. to enter chamber 200 to move piston 184 to the left or rearwardly and after it moves a desired amount the pilot valve is then closed and a balance of pressures on both sides of piston 184 is once again achieved and the control rod stops moving. It should be noted that piston 184 in the latter described instance moves even though the pressure on both sides of the piston is equal, that is, 1500 p. s. i. This movement is due to the fact that the area on the right side of the piston which is exposed

to such oil pressure is slightly greater than that present on the left side of said piston.

It should be understood that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

What is claimed is:

1. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of said blades, said means comprising a hub casting having a plurality of openings around its periphery and a longitudinal bore therein, means for securing said blades to said hub casting, a hollow cylindrical housing attached to said hub, a piston in said housing, a first guide having a plurality of arms extending radially therefrom, a hollow guide shaft, means connecting said shaft at one end to said piston and at its other end to said first guide, a movable cylinder, means positioning said movable cylinder between said piston and said housing, a second guide integrally formed on said cylinder, a plurality of arms extending radially from said second guide, means connected at one end to said guides and at the other end to said blades whereby movement of said guides changes the pitch of said blades.

2. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of said blades, said means comprising a hub casting having a plurality of openings and a longitudinal bore therein, a plurality of crank pin rings secured in said openings, means securing said blades to said crank pin rings, a cylindrical housing having an opening therein adapted to be aligned with said longitudinal bore, means securing said housing to said hub casting, a movable cylinder in said housing terminating at one end in a first guide, means closing said cylinder at its other end, a plurality of arms radially extending from said first guide, means connected at one end to said first guide arms and at the other end to one side of said crank pin rings, a piston in said cylinder, a second guide, a hollow shaft positioned in said longitudinal bore and connected at one end to said piston and at its other end to said second guide, a plurality of arms on said second guide, means connected at one end to said second guide arms and at its other end to the other side of said crank pin rings, a plurality of bored passageways in the piston end of said hollow shaft, a control rod, means positioning said control rod in said hollow shaft, a plurality of valve lands on the after end of said control rod, a plurality of openings connecting the hollow portion of said shaft with said bored passageways and with the areas formed in said cylinder by the forward and after sides of said piston and said cylinder walls.

3. The combination according to claim 2 wherein the valve lands of said control rod are adapted to align with the openings in the after end of said shaft leading to said bored passageways, a source of fluid supply, means selectively supplying fluid from said source through said control rod and bored passageways to either side of said piston, means attached to said control rod for controlling longitudinal movement thereof, whereby oil is caused to flow through said control rod to either side of said piston according to the direction of movement of said control rod.

4. The combination according to claim 2 wherein means are provided for preventing rotation of said cylinder in said housing, said means comprising a slot in the outer side of said cylinder, a like mating slot in the inner wall of said housing adapted to align with the slot in said cylinder, a key for said slots whereby relative rotational movement between said cylinder and said housing is precluded.

5. The combination according to claim 2 wherein means are provided for supplying a fluid pressure to the hub cavities, said means comprising a hollow propeller shaft connected to the forward end of said hub, a bored opening in said hollow shaft, a bushing in said opening, a circular ring extending around said shaft and holding said bushing in said opening, a pair of circular rubber seals respectively positioned on each side of said ring, means for securing said seals to said shaft and means enclosing and holding said bushing to said shaft whereby a fluid is adapted to be supplied through said bushing through said hollow shaft to said hub.

6. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of said blades, said means comprising a hub casting having a plurality of openings around its periphery and having a longitudinal bore therein, means securing said blades to said hub casting, a first guide having a plurality of arms positioned adjacent to the after side of said hub casting, a closed cylinder, means connecting the walls of said cylinder to the first guide, a piston in said cylinder, a second guide, a hollow shaft connected at one end to said piston and extending forwardly in said longitudinal bore and connected at its other end to said second guide, means positioning said cylinder and enclosed piston in spaced relation to said casting, means connected at one end to said guides and at the other ends to said blades, fluid pressure means connected with said cylinder and piston for moving said piston and said cylinder relatively to one another whereby such movement is transmitted through said guide arms to said blades for changing the pitch thereof.

7. In combination, a controllable pitch propeller having blades and a hub, means for changing the pitch of said blades, said means comprising a hub casting having a plurality of openings around its periphery and a longitudinal bore therein, a crank pin ring secured in each of said openings, a propeller blade secured in each of said crank pin rings, a hollow cylindrical housing secured to the after side of said hub casting and adapted to be aligned with said longitudinal bore, a cylinder having a plurality of arms, a cap closing the after end of said cylinder, a wall having an aperture forming the forward side of said cylinder, means securing said cylinder to said housing for preventing relative rotational movement therebetween, a piston in said cylinder thereby forming a first chamber and a second chamber on opposite sides of said piston in said cylinder, a guide having a plurality of arms extending radially therefrom, a hollow shaft positioned in said longitudinal bore having its after end extending through said cylinder aperture and its forward end secured to and extending through said guide, means connecting said after end of said hollow shaft to the forward end of said piston, first connecting means secured at one end to said cylinder arms and at its other end to one side of said crank pin rings, second connecting means secured at one end to said guide arms and at its other end to the other side of said crank pin rings, a control unit, a source of fluid supply for said control unit, means connecting said source of fluid supply with said

first and second chambers in said cylinders, control means for controlling said fluid to said chambers whereby fluid pressure acting in said chambers moves said cylinder and piston relatively to one another for changing the pitch of said blades.

8. The combination according to claim 7 wherein said connecting means comprises a plurality of crank arms, clevis means on each end of said crank arms, and means respectively securing said crank arms at one end to said cylinder arms and guide arms and at their other ends to said crank pin rings.

9. The combination according to claim 7 wherein said fluid pressure means comprises a hollow propeller shaft secured to the forward end of said hub, a fluid pressure control unit, means connecting said control unit with said propeller shaft, a hollow control rod having valve lands on the after end thereof, means positioning said control rod in said hollow shaft and said propeller shaft and terminating in said control unit, a first set of bored passageways, a second set of bored passageways, said bored passageways extending longitudinally in said hollow shaft and positioned between said inner and outer walls of said hollow shaft, a first set of openings connecting said hollow shaft through a first set of passageways with said first chamber, a second set of openings connecting said hollow shaft through a second set of passageways with said second chamber whereby said openings alternately serve to supply and return fluid from said chambers to said hollow shaft, means positioning said valve lands on said control rod a space equal to the distance between said first and said second sets of openings whereby movement of said control rod selectively allows fluid to flow through either set of said openings to its respective chamber for moving said piston and chamber and thereby changing the pitch of said blades.

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