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Johnson

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[54] **VARIABLE PITCH PROPELLER**

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[52] **U.S. Cl.** **416/152,** 416/160

[51] **Int. Cl.** **B63h 3/04**

[58] **Field of Search** 416/152, 160

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Primary Examiner—Everette A. Powell, Jr.

[57] **ABSTRACT**

This disclosure pertains to novel means whereby the blade pitch in a propeller may be varied by employing uni-directional rotation of a propeller shaft, a portion of the power driving the propeller, and a pair of braking means. A propeller hub having a plurality of pivotally mounted blades is mounted on the propeller shaft. A blade pitch actuator member having a hub-end and a brake-end extends through the propeller shaft into the propeller hub. An eccentric slider block secured to the hub-end of the actuator member is interconnected to each of the propeller blades. An actuator gear is screw-mounted on the brake-end of the actuator member. Three pairs of planetary each pair secured to a common shaft, are mounted on the propeller shaft in substantially parallel spaced relation to the axis of rotation of the propeller shaft. One of each pair of planetary pinions is meshed with the actuator gear and further meshed with an outer sun gear secured to a first brake actuated member. The other of each pair of planetary pinions is meshed with an inner sun gear secured to a second brake actuated member. Each brake actuated member has a brake actuator means. Application of the first brake means causes the actuator gear to rotate in one direction and application of the second brake means causes the actuator gear to rotate in the other direction. Rotation of the screw-mounted actuator gear causes movement of the actuator member and eccentric slider block, thus altering the propeller blade pitch.

10 Claims, 9 Drawing Figures

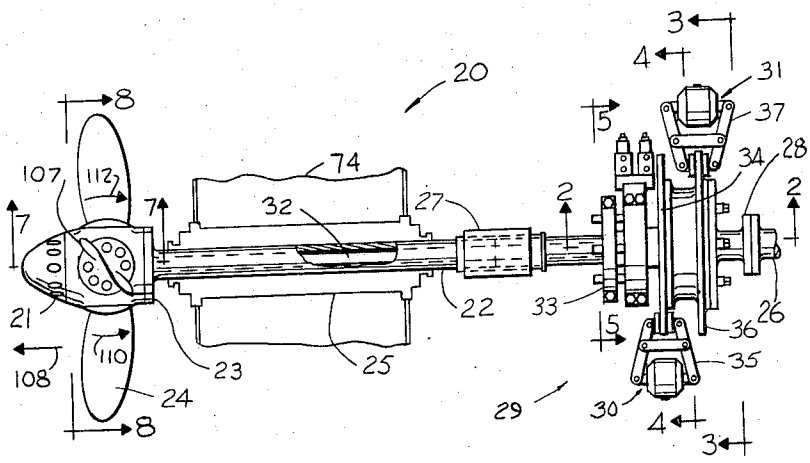
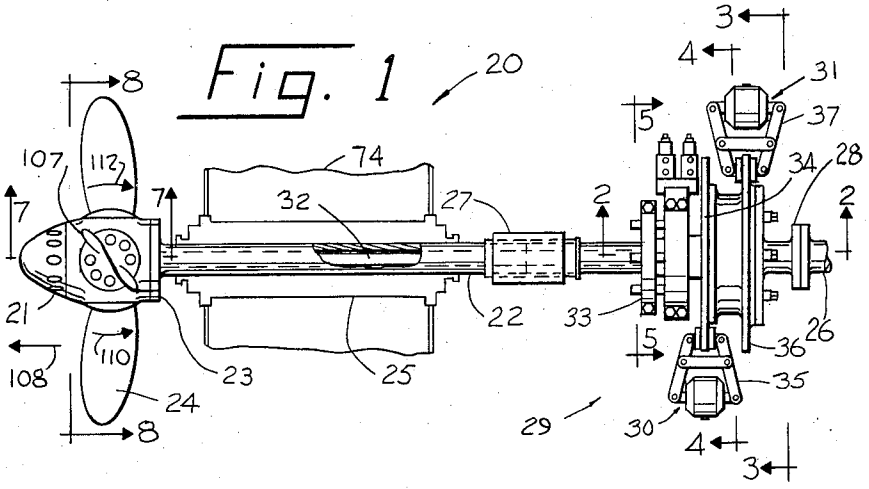


Fig. 1


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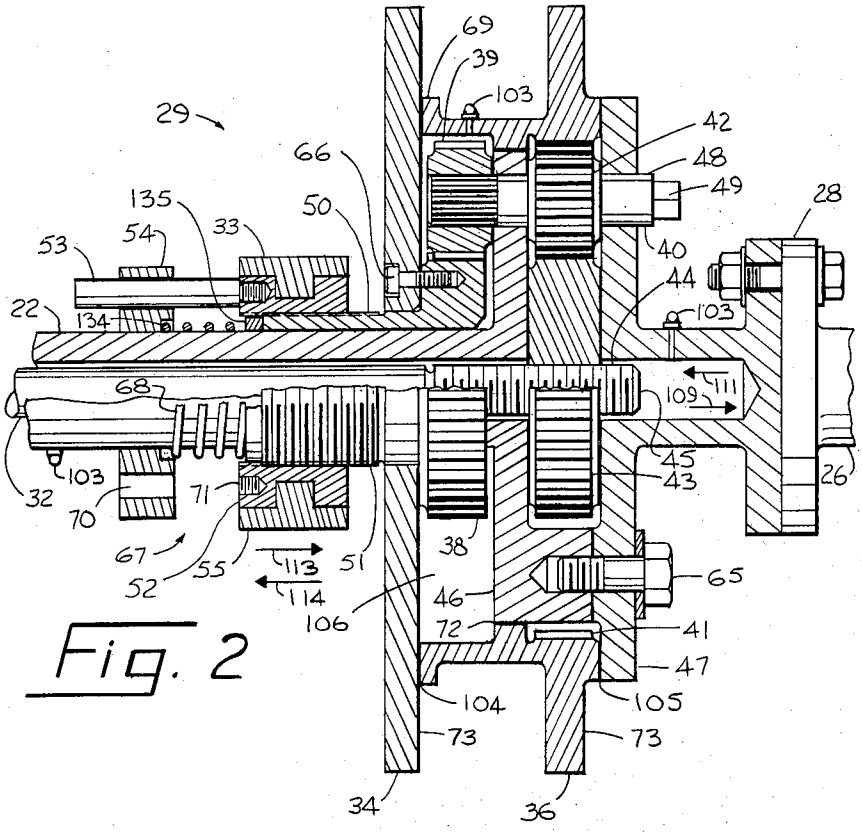

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Fig. 2

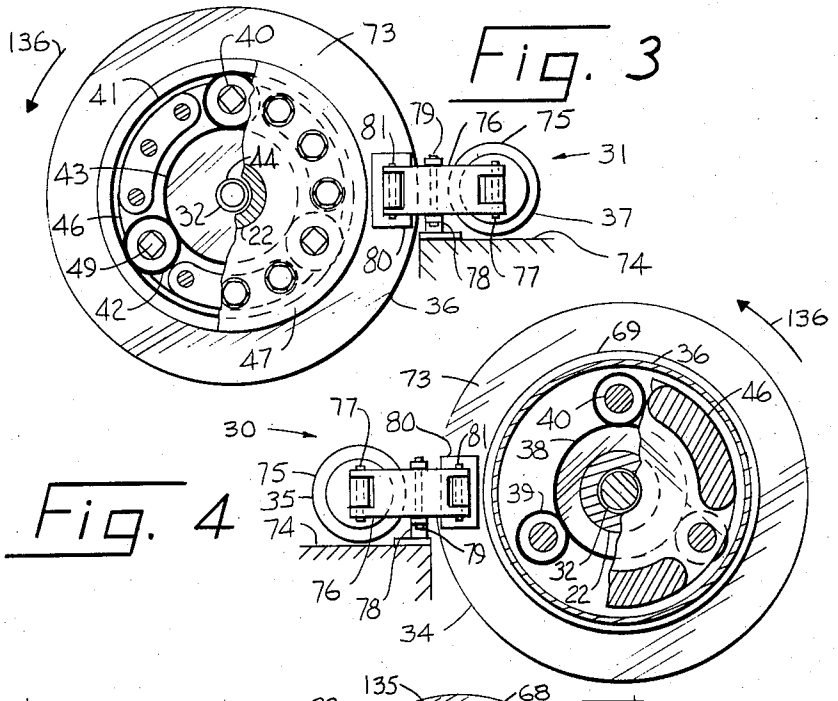


Fig. 3

Fig. 4

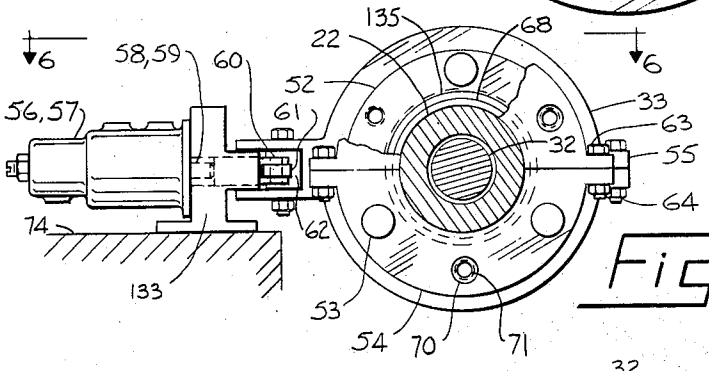


Fig. 5

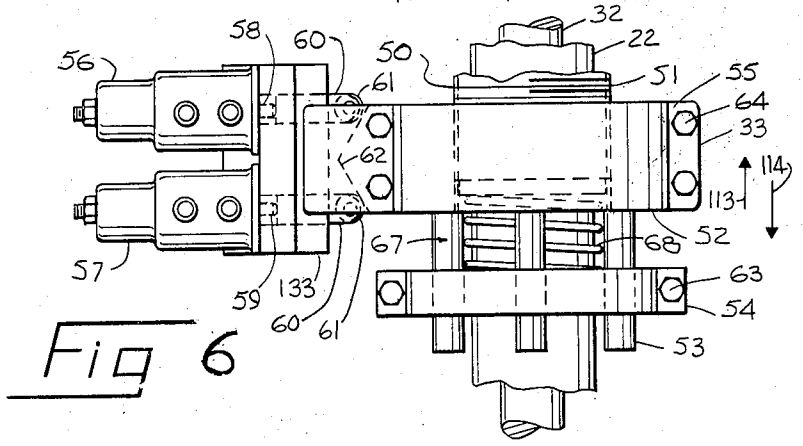


Fig 6

Fig. 7

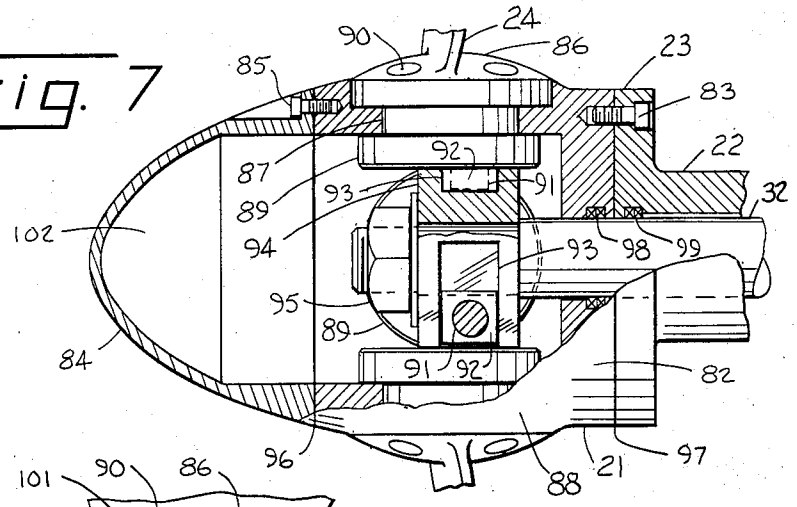


Fig. 8

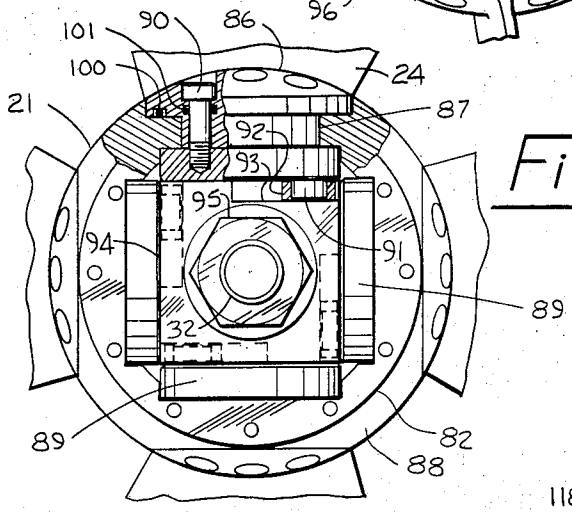
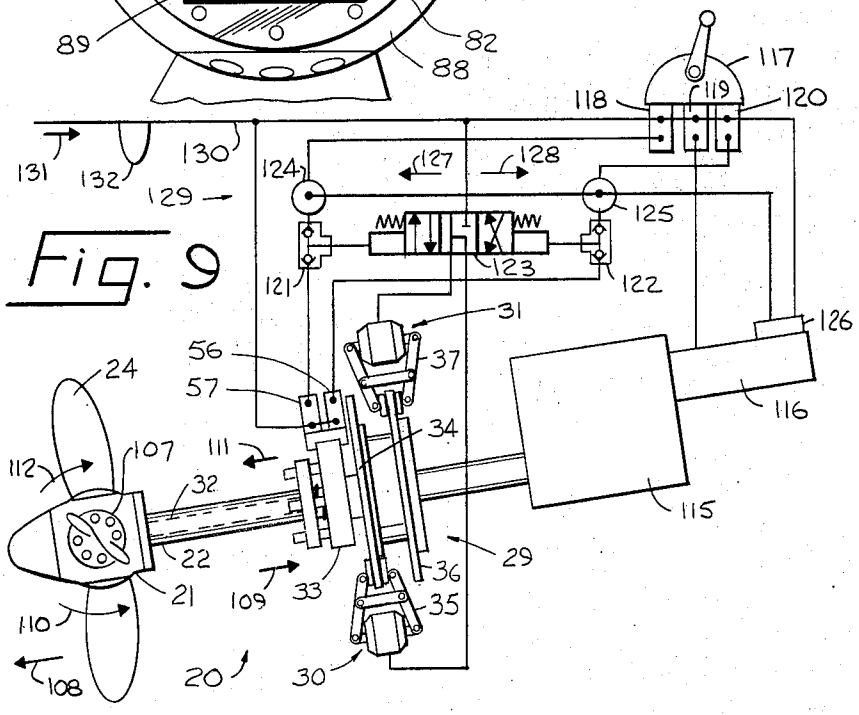


Fig. 9



VARIABLE PITCH PROPELLER

This invention relates to a novel structure in devices which are known in the art to which they pertain as controllable pitch propellers, reversible controllable pitch propellers, fluid propulsion devices which rotate in one direction but may change the direction of fluid propulsion, fluid propulsion devices which rotate in one direction and at a substantially constant speed but may vary the direction and rate of fluid propulsion, and other such devices which are of the general character of variable pitch propellers.

The primary function of variable pitch propellers is to permit ships and boats to operate at maximum efficiency under two or more operating conditions. For example, tugs and trawlers must operate efficiently under free-running and towing conditions; submarines must operate efficiently either on the surface or submerged; pipe and cable laying vessels, mine sweepers, and target-towing craft must operate at different speeds; virtually all vessels must operate under conditions varying from heavy swell to calm seas, high winds to no wind, and open water sailing to harbor manoeuvering. A secondary function of variable pitch propellers is to provide reversability of propulsion with a uni-directional shaft rotation, thus eliminating clutches, reverse gears, need to stop the propeller when reversing, and high starting forward loads on engine and transmission equipment. A tertiary function of variable pitch propellers, particularly where the prime mover is a deisel engine or a turbine, is to match propeller blade pitch with optimum engine fuel-speed characteristics for all load conditions. Further accepted advantages of variable pitch propellers are the provision of smoother speed control, higher acceleration, faster stopping, improved maneouvering, fuel economy, less engine wear, and avoidance of vibration caused at critical engine speeds.

The earliest approaches to a variable pitch propeller were devices which unshipped or feathered a propeller. Many such devices were developed in the middle of the nineteenth century. One variable pitch propeller was devised wherein the base of each blade was a short cylindrical spindle which fitted into the propeller hub; attached to each spindle was a short eccentric lever pinned to a collar mounted around the propeller shaft forward of the propeller and exposed to sea water, a bell-crank arrangement operated by a push-rod moving the collar fore and aft, thus varying the blade pitch. Another variable pitch propeller employed blades attached to segments of spur gears which meshed whereby rotation of one blade caused a corresponding rotation of the others; rotation of the gears was achieved by a collar sliding on the propeller shaft inside the propeller hub and protected from sea water. Still another controllable pitch propeller was devised wherein worm gears mounted on the bases of the propeller blades were rotated by a sleeve around the drive shaft; a variation on this arrangement was a rack passing through the center of the propeller shaft actuating pinions on the bases of the propeller blades.

The current art in variable pitch propellers incorporates many of the foregoing features. The most common variable pitch propellers now employ hydraulically operated servo-mechanisms. One type incorporates the servo-mechanism inside the propeller hub, fluid flow passing either through a hollow propeller shaft or through a rotating sleeve outside the propeller shaft. Another type incorporates the servo-mechanism inside or outside the propeller shaft at a location within the vessel; actuation of the propeller blades is achieved by either a push-rod inside a hollow propeller shaft or by a sleeve outside the propeller shaft. Such devices employing hydraulic servo-devices require continuous auxiliary power, are complex in structure and operation, require troublesome dynamic fluid distribution systems, are difficult to override mechanically, do not permit easy visual inspection, and are often dangerously unreliable.

My invention herein disclosed overcomes many of the short-comings of hydraulically operated servo-mechanisms by its structural and operational features. It employs positive mechanical structure whereby propeller blades pivotally mounted in a hub are pivotally actuated by a blade pitch actuator member which may be either a rod inside a hollow propeller shaft or a sleeve outside the shaft. Rotation of the actuator members in either direction or slidable movement of the member fore and aft may be used to pivotally actuate the propeller blades. A pair of brake actuated members mounted on a propeller power shaft having uni-directional rotation are interconnected to the blade pitch actuator member whereby the actuator member may be either rotated or moved in one direction by a first brake actuator means applying a brake force to one of the pair of brake actuated members' and rotated or moved in the other direction by a second brake actuator means braking the other of the pair of brake actuated members. In this way the propeller prime mover is used directly to alter the propeller blade pitch and energy is required only at the time a pitch change is made. Movement of the blade pitch actuator member with respect to the propeller shaft provides a direct positive mechanical measure or read-out of propeller blade pitch. The power of the propeller prime mover is used directly by the pair of brake actuator means and actuated members to alter propeller blade pitch. The pitch varying mechanism is enclosed within the vessel. A gearing system comprising an actuator gear, a pair of planetary pinions, an inner sun gear and an outer sun gear is disclosed herein whereby the movement of the brake actuated members may be modified or reduced in transmission to the blade pitch actuator member; the pinion shaft provides a positive means for mechanically overriding the brake actuated members to set the propeller blade pitch in the event of a control failure or failure of the brake actuator means. Structure is provided whereby an axial force means creates friction between at least two of the parts of my invention which rotate with the propeller shaft and move with respect to one another, thereby maintaining a propeller blade pitch setting when neither of the brake actuator means are energized. A means is devised whereby the various components of the disclosed embodiment of my invention may readily be moved with respect to one another axially along the propeller shaft thus permitting visual inspection of the primary components thereof. Further structure has been provided whereby the fluid power of a control circuit may be used directly to operate the brake actuator means, the positive mechanical pitch read-out directly operating a pair of feed-back pressure varying valves.

Therefore it is one object of my invention to provide a variable pitch propeller wherein uni-directional rota-

tional energy of a propeller shaft is employed to effect a change in propeller blade pitch.

It is another object of my invention to provide structure embodying a pair of brake means, each having a brake actuated member and a brake actuating means, whereby the uni-directional rotational energy of a propeller power shaft is expended only when a change in propeller blade pitch is required, one brake means producing forward pitch and the other brake means producing reverse pitch.

It is yet another object of my invention to provide structure whereby a blade pitch actuator member interconnects a plurality of propeller blades pivotally mounted in a hub means to a pair of brake means, actuation of one of the pair of brake means producing either rotation or axial movement of the actuator member in one direction and actuation of the other of the pair of brake means producing either rotational or axial movement of the actuator member in the other direction.

A further object of my invention is to provide gearing structure comprising an actuator gear, a pair of planetary pinions, an inner sun gear and an outer sun gear, whereby rotational movement of a pair of brake actuated members may be modified in transmission to a blade pitch actuator member.

Still a further object of my invention is to provide mechanical structure which provides a positive measure and readout of propeller blade pitch.

Another object of my invention is to provide means wherein an axial force means forces together at least two of the structural components of the invention which rotate with the propeller shaft and move with respect to each other, thereby creating mechanical friction which maintains propeller blade pitch when neither of a pair of brake actuator means is energized.

Still another object of my invention is to provide means whereby several components of the invention may be moved axially along a propeller shaft thereby to expose the internal structure of the invention to visual insepection.

It is a further object of my invention to provide means whereby the brake actuator means of the invention may be actuated directly by fluid power in a fluid control circuit, positive mechanical pitch read-out means actuating feed-back pressure varying valves in the control circuit.

These and further objects of my invention, which reside in the details of its structure and operation, will be evident from a study of the following disclosure and accompanying drawings which illustrate a preferred embodiment of the invention. This embodiment is merely exemplary and is not intended to detract from the full scope of the invention as set out in the annexed claims.

In the drawings wherein like numerals refer to like parts:

FIG. 1 is a plan view of my invention in a vessel depicting a propeller shaft means mounted in a stern tube, a propeller hub means outside the vessel, and a pitch varying mechanism inside the vessel;

FIG. 2 is a sectional elevation of the pitch varying mechanism taken substantially along line 2—2 in FIG. 1;

FIG. 3 is a partial sectional elevation of the pitch varying mechanism taken substantially along line 3—3 in FIG. 1;

FIG. 4 is a partial sectional elevation of the pitch varying mechanism taken substantially along line 4—4 in FIG. 1;

FIG. 5 is a partial sectional elevation of a pitch read-out mechanism taken substantially along line 5—5 in FIG. 1;

FIG. 6 is a plan view of the pitch read-out mechanism taken substantially along line 6—6 in FIG. 5;

FIG. 7 is a sectional elevation of the propeller hub means taken substantially along line 7—7 in FIG. 1;

FIG. 8 is a sectional elevation of the propeller hub means taken substantially along line 8—8 in FIG. 1;

FIG. 9 is a schematic fluid power control circuit depicting one mode of operation of my invention.

Turning now to the drawings, FIG. 1 shows a variable pitch propeller, generally denoted by the numeral **20**, having a propeller hub means **21** secured to propeller shaft means **22** by bolted flange **23**. Pivotally mounted in hub means **21** are a plurality of propeller blades **24**. Propeller shaft means **22** is rotatably mounted in a vessel by means of stern-tube **25** of conventional design and structure. End **26** of shaft means **22** is interconnected to the output shaft of a prime mover such as a deisel engine or gas turbine. Incorporated in propeller shaft **22**, by means of oil-injection friction coupling **27** and bolted flange coupling **28**, both couplings of conventional design, is propeller blade pitch varying mechanism generally indicated by the numeral **29**. Pitch varying mechanism **29** comprises a pair of brake means **30** and **31**, propeller blade pitch actuator member **32** operatively mounted inside and substantially concentric with propeller shaft **22** and interconnecting blades **24** to brake mechanism **29**, and blade pitch indication means **33**. Brake means **30** comprises brake actuated member **34** and brake actuator means **35**; brake means **31** comprises brake actuated member **36** and brake actuator means **37**.

FIGS. **2**, **3**, **4**, and **5** illustrate several views of pitch varying mechanism **29**. Brake actuated members **34** and **36** of brake means **30** and **31** are interconnected to pitch actuator member **32** by gearing means comprising an inner sun gear **38** secured to member **34** by bolts **66** and operatively meshed with a first planetary pinion **39** spline-mounted on common shaft means **40**, an outer sun gear **41** forming an integral structural part of member **36** and operatively meshed with a second planetary pinion **42** secured to common shaft means **40**, and an actuator portion comprising actuator gear **43** operatively screw-mounted on screw thread **44** at brake-end **45** of actuator member **32** and operatively meshed with pinion **42**. While a single pair of planetary pinions **39** and **42** are operative, three such pairs of pinions substantially equally spaced about shaft **22** are herein disclosed whereby to improve transmission force distribution between sun gears **38** and **41** and actuator gear **43**. Planetary pinions **42** and actuator gear **43** are situate between internal coupling flange **46** and external coupling flange **47** which form integral structural parts of propeller shaft means **22** and are bolted together by bolts **65**. Common shaft means **40** is rotatably mounted in flanges **46** and **47** and has at one end a mechanical propeller blade pitch overriding means **48** comprising squared end **49** which may be turned by a manual or power wrench. Inner sun gear **38** is rotatably mounted on shaft **22** and outer sun gear **41** is rotatably mounted on internal coupling flange **46**.

Extending axially from and forming an integral part of inner sun gear 38 is blade pitch indication actuator member 50. Screw-mounted on screw thread 51 is blade pitch indication actuated member 52. Indication actated member 52 is forced to rotate with shaft 22 by guide members 53 slidably mounted in guide collar 54 clamped to shaft 22 by bolts 63. Therefore, when inner sun gear 38 is caused to rotate with respect to shaft 22 by either brake actuated member 34 or 36, then indication actuated member 52 moves axially along shaft 22 thereby providing a positive measure of propeller blade pitch. A non-rotating follower 55 is clamp-mounted by means of bolts 64 upon indication actuated member 52 and moves axially therewith. In FIG. 6, follower 55 actuates a pair of fluid power feed-back or read-out pressure varying valves 56 and 57 mounted in valve bracket 133; one valve indicates forward pitch while the other indicates reverse pitch. valves 56 and 57 increase fluid pressure output proportionately as valve spools 58 and 59 are depressed; cam follower means 60, slidably mounted in valve bracked 133 and having rollers 61, depress either spool 58 or spool 59, depending on which way cam 62 is moved by follower 55.

Axial force means 67 comprising mechanical compression spring means 68, bearing between recess 134 of guide collar 54 and bearing 135 operatively connected to indication actuator member 50, forces brake actuated member 34 to bear axially upon friction flange 69 of brake actuated member 36 at friction junction 104, member 36 bearing axially upon external coupling flange 47 at friction junction 105. Whereas the rotary moments of inertia of members 34 and 36 should whenever possible be such that their inertial forces on pinions 39 and 42 are substantially equal, the friction between members 34 and 36 and between member 36 and flange 47 caused by axial force means 67 will maintain a given pitch setting in spite of changes in rotational speed of shaft 22. Further, this friction combined with the inherent friction forces in screw thread 44 will resist pitch changing forces eminating from an eccentric or changing center of propulsion pressure at propeller blades 24. Still further, this friction will determine the amount of energy expended by brake means 30 and 31 as well as the rate at which propeller blade pitch is altered by brake means 30 and 31.

Spring means 68 may be compressed, for setting and assembly purposes, between collar 54 and indicator member 52 by means of collar holes 70 and studs or bolts threaded into holes 71 of actuated member 52. Once collar 54 is clamped in place on shaft 22 by bolts 63, the bolts or studs in holes 71 must be slacked off or removed to permit operative indication movement of member 52 with respect to collar 54.

It should be noted that for assembly purposes and for visual inspection of inner sun gear 38 and pinions 39, collar 54 may be loosened from shaft 22 and brake actuated member 34 and sun gear 38 moved axially along shaft 22 away from internal flange 46. Brake actuated member 36 bearing rotatably upon internal flange 46 at junction 72 and the internal diameter of surface 72 on member 36 being less than the internal diameter of outer sun gear 41, brake actuated member 36 may be moved axially along shaft 22 away from external flange 47, thereby exposing pinions 42 and actuating gear 43 to visual inspection.

FIGS. 3 and 4 illustrate brake means 30 and 31 wherein each of brake actuated members 34 and 36 include a disc portion 73. Brake actuator members 35 and 37 are caliper means adapted to discs 73. Each caliper comprises fluid operated linear actuator 75 pivotally interconnected to one end of each of a pair of actuating levers 76 by means of pins 77. Each of levers 76 is pivotally mounted in mounting bracket 78 by pin 79 and pivotally interconnected to a brake shoe 80 by pin 81.

Caliper mounting bracket 78 is fixed with respect to shaft 22, being mounted on a portion of a ship hull schematically denoted by the numeral 74. Hence, energization of linear actuator 75 causes shoes 80 to squeeze and thus brake the disc 73 therebetween. In this way, an external braking torque may be applied at will to either brake actuated members 34 and 36, thereby producing propeller blade pitch altering rotation of members 34 and 36 with respect to shaft 22.

The braking force or torque which brake actuator means 37 imparts to brake actuated member 36 may be the same or different from that imparted to brake actuated member 34 by brake actuator means 35, depending upon the forces required in blade pitch actuator member 32 to effect a change in propeller blade pitch, the magnitude of friction forces created by axial force means 67, the transmission or gearing and screw thread speed change ratio between members 34 and 36 and blade pitch actuator member 32, and the required rates of pitch change into forward pitch and reverse pitch. These braking forces or torques will be operatively determined by the fluid pressures employed in linear actuators 75 and the leverage ratio of levers 76.

Turning now to the structural details of the propeller hub means 21, FIGS. 7 and 8 show two sectional views of the hub blade portion 82 secured to propeller shaft flange 23 by a plurality of bolts 83. The aft-end of hub means 21 comprises a streamlined cover 84 secured to hub blade portion 82 by a plurality of bolts 85; cover 84 permits access to the inside of hub means 21 for assembly and inspection purposes.

Each of our propeller blades 24 comprises a base portion 86 having a spindle or pilot portion 87 pivotally mounted in spherical portion 88 of hub portion 82; spherical portion 88 permits blades 24 to pivot without disturbing the streamlined contour of hub means 21. Blades 24 are secured to a blade actuator plate 89 by a plurality of bolts 90. Each actuator plate 89 has on its underside an eccentrically located pin 91 pivotally mounted in a substantially rectangular slider 92. Slider 92 is slidably mounted in slots 93 in blade actuated portion 94 of blade pitch actuator member 32. Actuated portion 94 is secured to actuator member 32 by threaded nut 95. It will be evident to one skilled in this art that movement fore and aft of actuated portion 94 will carry sliders 92 and pins 91 in an arc described about the pivotal axis of each of blades 24, thereby pivotally actuating and operatively varying the pitch of propeller blades 24.

Whereas stern-tube 25 of conventional design is adapted to prevent water entering a vessel around the periphery of propeller shaft 22, means should be provided to prevent water entering hub means 21 and thereby passing into shaft 22 around actuator member 32. Therefore, sealing compound, packing, or seals should be used in the cover-hub junction 96 at bolts 85 and flange-hub junction 97 at bolts 83. Further, pack-

ing or seals **98** and **99** between actuator member **32** and hub portion **32** and shaft **22** may be employed. Dynamic sealing means **100** should be employed to prevent sea water entering hub means **21** around base **86** of blades **24**. Static seals or packing **101** should be used around bolts **90**, depending on the location of sealing means **100**.

Lubrication in hub means **21** may be provided in a variety of ways including continuous pressurized oil flow through actuator member **32** or shaft **22**. However, for most practical applications where the materials employed in hub means **21** and shaft **22** are not subject to corrosion, chamber **102** of hub means **21** should be packed with a suitable marine grease or lubricant. Likewise, gearing chamber **106** of pitch varying mechanism **29** may be lubricated by initial and periodic grease packing, circulating oil, or periodic greasing by means of grease fittings **103**. It will be evident to one skilled in this art that lubriation of hub means **21** and pitch varying mechanism **29** will most often be a choice in design dictated in large measure by the circumstances in which my invention is employed. It is worth noting however, that friction generating surfaces at junctions **104** and **105** of pitch varying mechanism **29** (FIG. **2**) should be either compatible with the lubricant used in gearing chamber **106** or operatively sealed therefrom.

Operation of my invention will be understood from a study of FIGS. **1** through **8**. Consider that the propeller shaft is driven by a prime-mover in direction **136** of FIG. **3** and **4**, that is, in a counter-clockwise direction looking aft along shaft **22**. Therefore, looking at typical blade **107** in FIG. **1**, it is clear that water is propelled in direction **108**, propeller blades **24** thus having forward pitch. Consider further that actuator member thread **44** and pitch indicator member thread **51** are both conventional right-hand screw threads. Still looking aft along propeller shaft **21**, actuation of brake means **30** causes inner sun gear **38** to rotate in a clockwise direction with respect to shaft **22**, pinions **39** and **42** to rotate in a counter-clockwise direction, and actuator gear **43** to rotate in a clockwise direction with respect to actuator member **32**. Therefore, actuator member **32** is moved in direction **109** and blades **24** are pivoted typically in direction **110** of blade **107**, thus increasing propeller blade forward pitch. Actuation of brake means **31** causes outer sun gear **41** to rotate in a clockwise direction with respect to shaft **22**, pinion **39** and **42** to rotate in a clockwise direction, and actuator gear **43** to rotate in a counter-clockwise direction with respect to actuator member **32**. Therefore, actuator member **32** moves in direction **111** and blades **24** are pivoted typically in direction **112** of blade **107**, thus decreasing propeller forward pitch and ultimately producing reverse pitch.

As to pitch indication, rotation of inner sun gear **38** in a clockwise direction with respect to shaft **22** causes pitch indication actuated member **52** to move in direction **113**. Rotation of outer sun gear **41** in a clockwise direction causes, through pinions **39** and **42**, counter-clockwise rotation of inner sun gear **38**. Counter-clockwise rotation of inner sun gear **38** causes pitch indication actuator member **50** to move indicator actuated member **52** in direction **114**. The position of indicator member **52** with respect to shaft **22**, collar **54**, or the ship hull **74** provides a positive mechanical measure or read-out of propeller pitch. This positive measure of propeller blade pitch may be transmitted to a remote location by various electrical, pneumatic, hydraulic, or mechanical control means; as previously described, movement of indicator member **52** and follower **55** may be adapted to actuate fluid pressure varying control valves **56** and **57**, as shown in FIGS. **5** and **6**.

FIG. **9** schematically illustrates my invention incorporated in a pneumatic control circuit **130**. Shaft **22** is driven by engine **115** having engine speed governor and automatic load control **116**. The control circuit employs a duct network **129** wherein air enters the system in direction **131** and first passes through filter-lubricator **132**. A single lever engine and propeller pitch control **117** comprises fluid pressure varying control valves **118, 119,** and **120,** respectively controlling forward propeller blade pitch, engine throttle and speed, and reverse propeller pitch.

Pressure varying control valves **56** and **57** provide control feed-back signals respectively as to forward and reverse propeller blade pitch; these signals may be transmitted to a control station for a visual read-out and are shown interconnected by means of two-way check valves **121** and **122** to pilot-operated spring-centered four-way control valve **123**. Control valves **118** and **120** set the maximum allowable propeller pitch setting by means respectively of pressure regulating relay valves **124** and **125**; the maximum pressures established by valves **118** and **120** are modifed or overridden by a pressure signal from pressure varying control valve **126** on engine load control **116**. Hence, when the propeller blade forward pitch setting pressure signal from valve **56** is substantially equal to the pressure signal from valve **118,** subject to modification in valve **124** by a signal from valve **126,** then the spool of valve **123** is spring centered and both brake actuator means **35** and **37** are de-energized. If the pressure signal from valve **124** drops below that produced by valve **56,** then the spool of valve **123** shifts in direction **127,** brake actuator means **37** is energized and propeller blade pitch is reduced. If the pressure signal from valve **124** is greater than that from valve **56,** then the spool of valve **123** shifts in direction **128,** brake actuator means **35** is energized and propeller blade pitch is increased. Likewise it can readily be shown that reverse propeller blade pitch is operatively controlled and modified by valves **57, 120, 123, 125,** and **126.** Moreover, it will be evident to one skilled in this art that when the pressure signal from valve **118** is equal to zero, a forward pitch pressure signal from valve **56** actuates valve **123** whereby to energize brake actuator means **37** and reduce propeller blade pitch to zero; conversely, for a zero pressure signal from valve **120,** a reverse pitch pressure signal from valve **57** actuates valve **123** whereby to energize brake actuator means **35** and reduce propeller blade pitch to zero.

It is believed that my invention of a variable pitch propeller will have been clearly understood from the foregoing detailed description of my now preferred illustrated embodiment. Various modifications, changes, additions, and equivalents may be resorted to in view of these teachings by one skilled in this art without departing from the spirit of my invention. For instance, blade pitch actuator member **32,** while illustrated in the drawings as being a rod slidably mounted inside hollow shaft **22,** it might instead be rotatably mounted and may be either a sleeve outside shaft **22** or one or more rods mounted adjacent and substantially parallel to

shaft 22. Whereas actuator member 32 includes actuator gear 43 screw-mounted on its brake-end 45 and actuated slider block 94 secured to its hub-end, block 94 might be screw-mounted on and gear 43 secured to member 32. A variety of power-transmission systems employing operatively meshed gears and screw threads might interconnect brake actuated members 34 and 36 to actuator member 32; both members 34 and 36 might be meshed with pinion 39 while pinion 42 actuates only gear 43; the pitch diameters of inner and outer sun gears 38 and 41, pinions 39 and 42, and actuated gear 43 may be reasonably varied to accommodate thrust requirements in actuator member 32 as well as the required rates of reverse and forward pitch change. Whereas brake means 30 and 31 comprise disc actuated portions 73 and brake actuator means 35 and 37 comprise caliper means adapted to discs 73, it is entirely feasible to employ band, block, plate, electromagnetic, and fluid friction brake means; moreover, brake means 30 and 31 may be actuated by pneumatic, hydraulic, electrical, mechanical, or manual means. Whereas a measure of propeller blade pitch is provided by inner sun gear 38, clearly such measure or pitch read-out might be obtained from outer sun gear 41 or directly be measuring the movement of actuator member 32 with respect to shaft 22. Whereas axial force means 67 comprises mechanical spring means 68, fluid operated linear actuator means, preset or controlled at will, might be employed; moreover axial force means 67 might be employed in combination with either outer sun gear 41, actuator gear 43, or pinions 39 and 42. Whereas a simple slider lock arrangement comprising block 94, slider 92, and blade actuator plate 89 is illustrated in the drawings as interconnecting blade actuator member 32 to propeller blades 24, a variety of bell-crank systems, linkage arrangements and gearing systems might likewise be employed. Whereas hub means 21 is flange mounted on shaft 22, other mounting means employing tapers, keyways, and screw threads are available. Therefore, whereas a choice between the foregoing variations, modifications, changes, additions, and equivalents falling within the true scope of my invention will depend largely upon the circumstancs in which my invention is used, it is my express intention that no limitations be implied and that the hereto annexed claims be given the broadest interpretation to which the language fairly admits.

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

1. A variable pitch propeller comprising a hub means secured to a propeller shaft means, a plurality of propeller blades pivotally mounted in said hub means and operatively connected to a blade pitch actuator member having a hub-end and a brake-end, a pair of brake means each comprising a brake actuator means fixed with respect to said propeller shaft means and a brake actuated member rotatably mounted on said propeller shaft means, an actuator gear operatively mounted on said brake-end of said blade pitch actuator member, a pair of planetary pinions operatively secured to a common shaft means, said common shaft means rotatably mounted on said propeller shaft means, an outer sun gear secured to one of said brake actuated members, an inner sun gear secured to the other of said brake actuated members, said pair of planetary pinions operatively meshed with said actuator gear and said inner and outer sun gears, whereby actuation of one of said brake means produces forward pitch in said plurality of propeller blades and actuation of the other of said brake means produces reverse pitch in said plurality of propeller blades.

2. A variable pitch propeller as defined in claim 1 wherein said blade pitch actuator member further comprises an actuated portion secured against rotation to said hub-end, said actuator gear screw-mounted on said brake-end, said plurality of propeller blades interconnected to said actuated portion.

3. A variable pitch propeller as defined in claim 1 wherein said blade pitch actuator member further comprises an actuated portion screw-mounted on said hub-end, said actuator gear secured against rotation to said brake-end, said plurality of propeller blades interconnected to said actuated portion.

4. A variable pitch propeller as defined in claim 1 wherein one end of said common shaft means extends outside said propeller shaft means and further comprises a mechanical propeller blade pitch overriding means.

5. A variable pitch propeller as defined in claim 1 wherein a blade pitch indication actuator member is interconnected to one of said sun gears, a blade pitch indication actuated member screw-mounted on said blade pitch indication actuator member for axial movement with respect to said propeller shaft means, said axial movement providing a measure of pitch of said plurality of propeller blades.

6. A variable pitch propeller as defined in claim 1 wherein friction between said propeller shaft means and said blade pitch actuator member maintains the pitch setting of said plurality of propeller blades when neither of said pair of brake means is actuated.

7. A variable pitch propeller as defined in claim 1 wherein at least one of said pair of planetary pinions and said inner and outer sun gears and said actuator gear and said brake actuated members is also a friction member, axial force means forcing together said friction member and said propeller shaft means producing friction, said friction maintaining the pitch setting of said plurality of propeller blades when neither of said pair of brake means is actuated.

8. A variable pitch propeller as defined in claim 1 wherein at least two of said pair of planetary pinions and said inner and outer sun gears and said actuator gear and said brake actuated members form a pair of friction members, axial force means forcing together said pair of friction members producing friction, said friction maintaining the pitch of said plurality of propeller blades when neither of said pair of brake means is actuated.

9. A variable pitch propeller as defined in claim 1 further comprising blade pitch indication means interconnected to said blade pitch actuation member, a pair of pressure varying control valves interconnected to said pitch indication means, said brake actuator means of each of said pair of brake means including a fluid powered caliper means, a fluid power control circuit including a single lever control and a pair of pressure regulating relay valves and a four-way spring-centered pilot-operated control valve.

10. A variable pitch propeller comprising a hub means secured to a propeller shaft means, a plurality of propeller blades pivotally mounted in said hub means and operatively connected to an actuated portion oper-

atively mounted on one end of a blade pitch actuator member, an actuator gear operatively mounted on the other end of said actuator member, a pair of planetary pinions operatively secured to a common shaft means, flange means operatively secured to said propeller shaft means, said common shaft means rotatably mounted on said flange means, an outer sun gear secured to a first brake actuated member, an inner sun gear secured to a second brake actuated member, each of said first and second brake actuated members having a brake actuator means fixed with respect to said propeller shaft means, said pair of planetary pinions operatively meshed with said inner and outer sun gears and said actuator gear, whereby actuation of one of said brake means produces forward pitch in said plurality of propeller blades and actuation of the other of said brake means produces reverse pitch in said plurality of propeller blades.

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