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H. J. NICHOLS

2,620,040

CONTROLLABLE REVERSIBLE PITCH PROPELLER

Filed Jan. 19, 1948

3 Sheets-Sheet 1

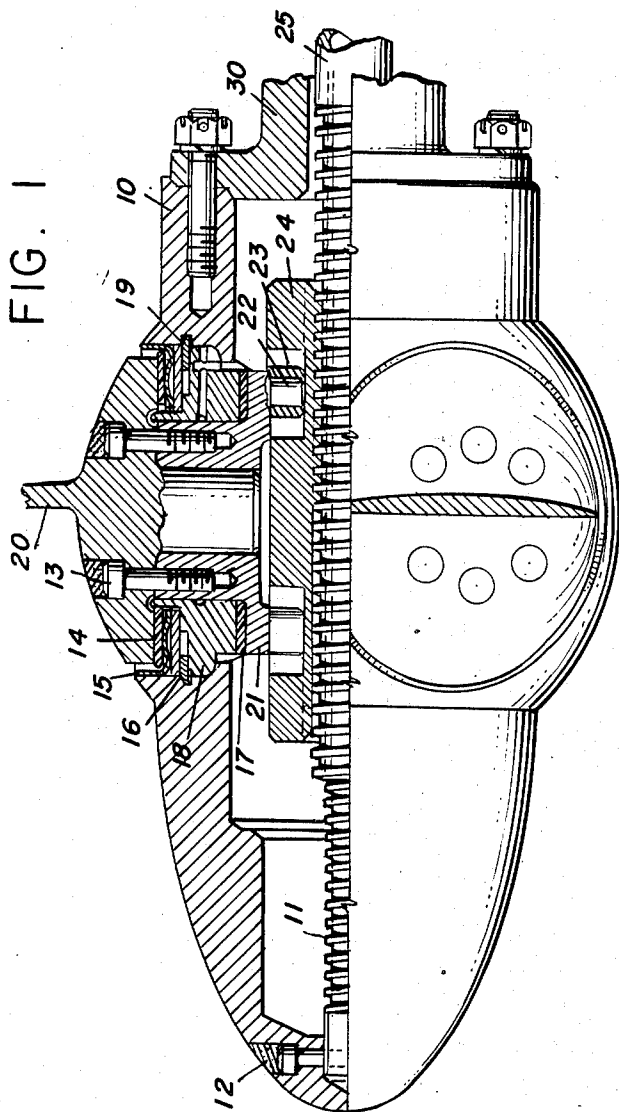


FIG. 3

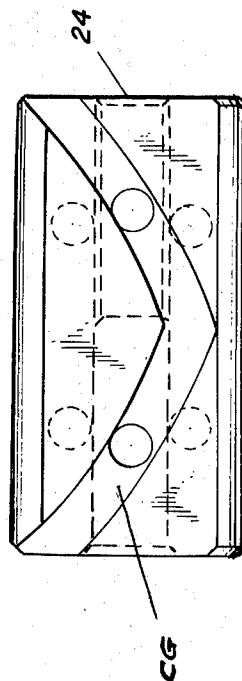
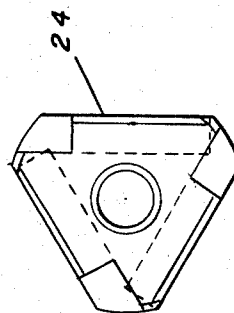


FIG. 2



Inventor
HARRY J. NICHOLS,

By *Marcel Keeseepe*
Attorney

Dec. 2, 1952

H. J. NICHOLS

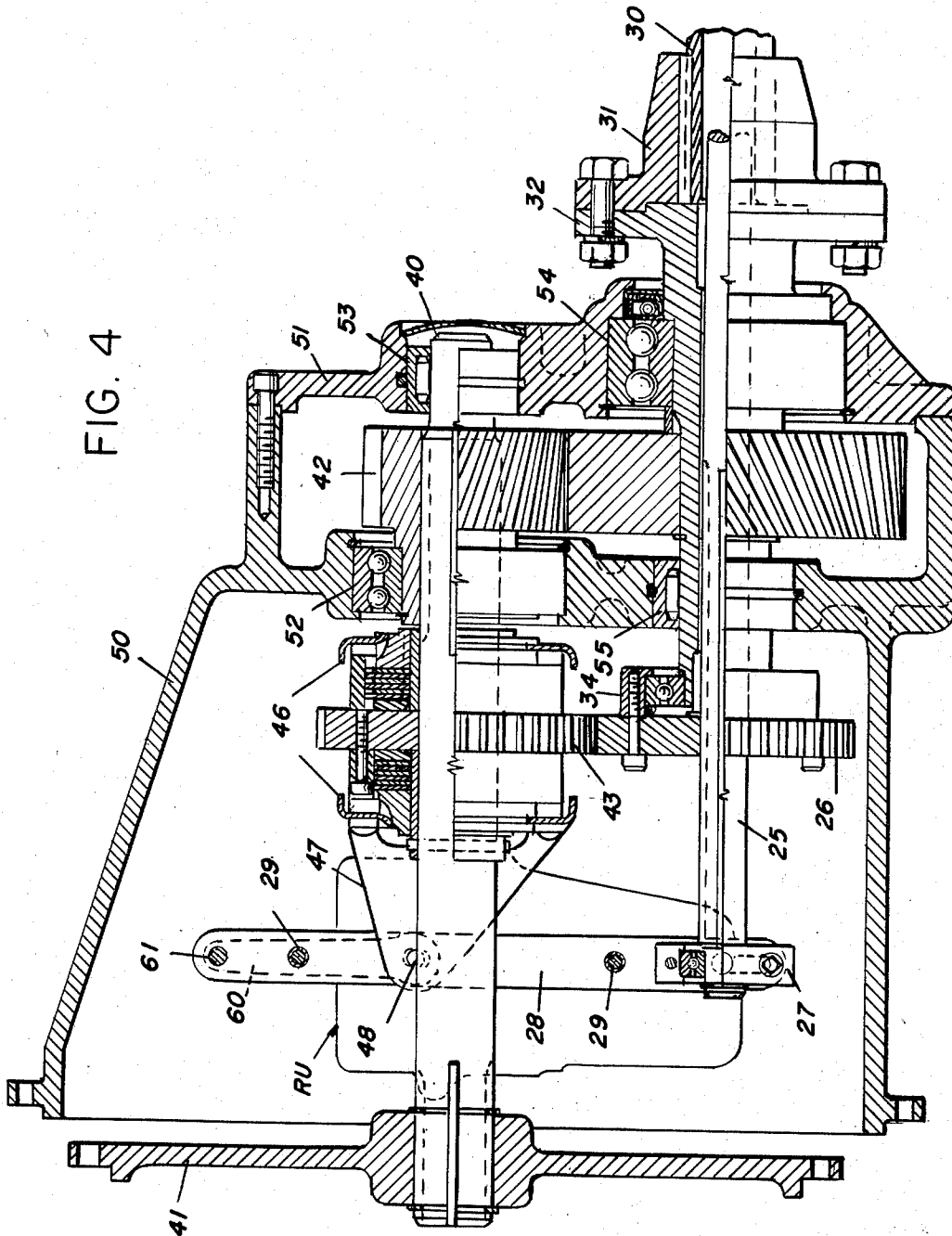
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CONTROLLABLE REVERSIBLE PITCH PROPELLER

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FIG. 4



Inventor

HARRY J. NICHOLS,

By

Charles K. Kieckhefer
Attorney

Dec. 2, 1952

H. J. NICHOLS

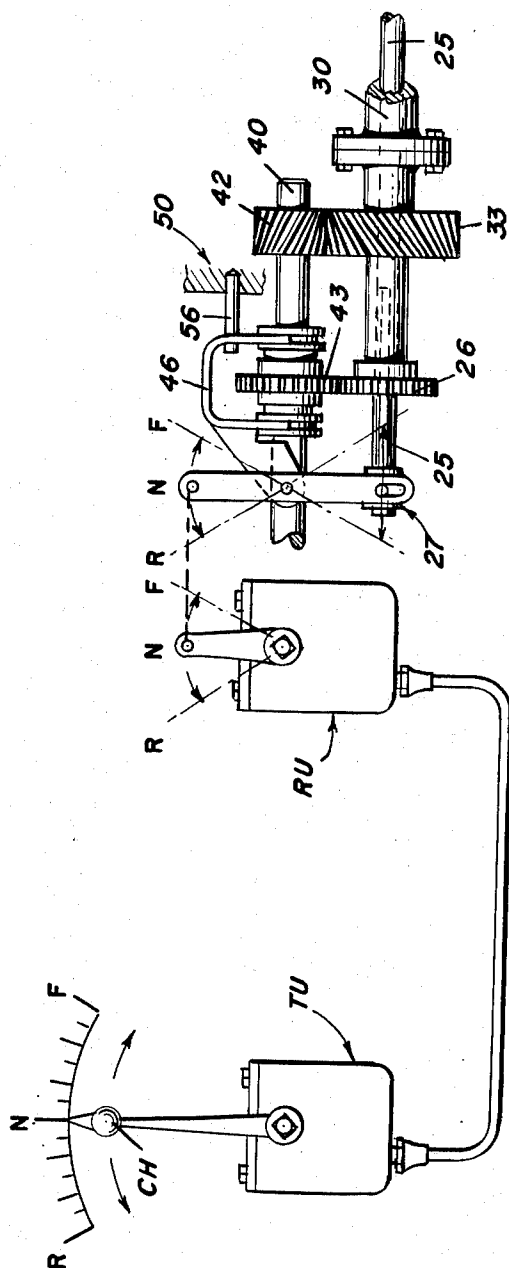
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CONTROLLABLE REVERSIBLE PITCH PROPELLER

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3 Sheets-Sheet 3

FIG. 5



Inventor
HARRY J. NICHOLS,
By *James H. Nichols*
Attorney

UNITED STATES PATENT OFFICE

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CONTROLLABLE REVERSIBLE PITCH
PROPELLER

Harry J. Nichols, Point Pleasant, N. J.

Application January 19, 1948, Serial No. 3,026

12 Claims. (Cl. 170—168.28)

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This invention relates to a controllable reversible pitch propeller system and more particularly to such propellers for use with marine vessels, and has for its main object the provision of a propeller system of the character described in which the pitch of the blades can be readily and quickly varied, and also reversed, by remote control, while the propeller is in rotation under full load.

Another object is to provide an exceptionally simple, compact, powerful and durable pitch changing mechanism which is economical to manufacture and easy to install, and the moving parts of which are readily accessible for re-conditioning or replacement in event of damage by accident.

Another object is to provide a strong and rugged blade turning and torque multiplying mechanism adapted to be housed within a propeller hub of relatively small diameter which will have a minimum of working parts and which will hold the blades rigidly, thereby avoiding any possibility of flutter or vibration of the blades in operation due to excessive back-lash or elasticity.

Another object is to provide a novel combination power take-off and reduction gear unit particularly adapted for attachment to various commercial marine engines without alteration thereof, thereby to provide the well-known advantages of reduction gearing in marine propulsion, and at the same time to provide readily controllable power means for actuating the pitch changing mechanism.

Yet another object is to provide a novel controllable reversible pitch propeller organization in which the remote control means also inherently provides means for indicating the pitch and for limiting the pitch range, thereby eliminating the need for separate means to perform these functions.

A further object is to provide a controllable reversible pitch propeller organization particularly adapted for the replacement of fixed blade propellers already installed for purposes of modernization, without requiring any substantial alteration of the existing propulsion arrangements.

With these and other objects in view, as well as other advantages incident to the improved construction, the invention consists in various novel features and combinations thereof set forth in the claims with the understanding that the several necessary elements constituting the same may be varied in proportion and arrangement without departing from the nature and scope of the invention as defined in the appended claims.

To enable others skilled in the art to com-

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prehend the underlying features of this invention that they may embody the same by suitable modifications in structure and relation to meet the various practical applications contemplated by the invention, drawings showing a preferred embodiment of the invention form part of this disclosure, and in such drawings like characters of reference denote corresponding parts in the several views in which:

Fig. 1 is a side elevation in half-axial section of a marine propeller assembly according to the invention.

Figs. 2 and 3 are detail views of the novel combined nut-and-wedge element shown in the prior figure.

Fig. 4 is a side elevation in axial section of the novel combination power take-off and reduction gear unit of the invention in which various circular components are shown in half-axial section.

Fig. 5 is a schematic diagram showing the elements of and illustrating the operation of the remote control system of the invention.

General description

Considered as a whole, and referring generally to the drawings, the construction of the invention constitutes a complete controllable pitch propeller organization comprising in the main a propeller assembly as shown in Fig. 1, which includes novel mechanism characterized by its compactness and great torque amplifying power housed within the propeller hub for turning the propeller blades axially in unison to vary the pitch; a novel combination power take-off and reduction gear unit, as shown in Fig. 4, which is bolted to the flywheel housing of the engine in practice and which includes reduction gearing and means for powering the pitch actuating mechanism; an intermediate tubular propeller shaft containing a coaxial screw shaft which drivingly connects the reduction gearing and power take-off mechanism to that of the propeller assembly; and a remote control system including a transmitter device located at the remote control station in practice and a receiver device located in the power unit.

Propeller assembly

Referring now to the drawings in detail and particularly to Fig. 1, the propeller assembly of the invention, which is of water tight construction, is shown by way of example as comprising a hollow one-piece hub 10 secured tightly to the outboard end of propeller shaft 30 by means of

stud bolts extending longitudinally through an upset flange formed on the outboard end of the propeller shaft into threaded holes in the hub, in conventional manner. The hub is formed with stepped radial blade sockets and a stepped cylindrical axial bore extending from the inboard end.

Radial propeller blades 20, each having a circular boss and a cylindrical concentric root as shown, are rotatably journaled in the radial sockets of the hub by a blade mounting assembly which also provides an externally sealed combination two-way thrust and radial bearing. The parts of the blade mounting assembly, considered in the order and manner of assembly, are as follows: Blade journal 21, having an axial bore adapted to fit the blade root and an inner thrust flange is provided with two diametral crank pins 22 extending from the outer face of said flange. These crank pins are shown provided with loose roller sleeves 23 which for purposes of assembly can be retained on the crank pins by a coating of grease. However, the crank pins can be provided with slipper blocks instead of roller sleeves if so desired. Journal sleeve bearing 18, preferably provided with a non-metallic thrust washer 17 cemented to the inner face thereof, is dropped over the journal into position as shown. The journal with assembled parts is then placed in the hub socket with the crank pins engaged in the oppositely inclined grooves of wedge 24, described in detail hereinafter, as shown. Beveled retainer ring 19, of well-known commercial type, is next sprung into closed position and inserted in the hub socket and allowed to spring out into the annular groove cut in the bore of the blade socket, as shown. The retainer ring thus locks the journal sleeve bearing in place against the shoulder provided for it in the hub socket.

Cover washer 16 is placed in position over the retainer ring as shown, and resilient metallic sealing ring 15, which has an arched section and cupped oversize rim, is then pushed into the hub socket, the cupped rim of this ring being a tight spring fit to provide a rim seal with the bore of the hub socket, and to prevent rotation of the ring.

Outer thrust washer 14 is next cemented to the circular seat provided for it on the blade boss to provide a seal therewith and prevent relative movement therebetween. The blade root is then entered into the bore of the journal, the bolt holes in the blade boss being properly registered with the threaded holes in the journal. The blade 20 is then secured to the journal by cap screws 13. When the latter are tightened, the arched middle portion of sealing ring 15 is compressed tightly against outer thrust washer 14, thus preloading both thrust bearings and also providing a tight seal between the two outer thrust bearing surfaces. The screw head recesses in the blade boss are then sealed and filled flush with soft solder in the conventional manner.

Each blade mounting is thus sealed by a combination metallic seal and outboard thrust bearing. The special element of this combination is the resilient metallic sealing cup—preferably formed from a thin sheet of non-corrosive metal—which has an outwardly springing lip and an arched-spring web section. By thus combining the spring seal element with the outboard thrust bearing, the thrust bearing can be preloaded to eliminate any wobble or shake of the blades and

to provide take-up for wear, while keeping the starting friction under load to a minimum. Moreover, the preloaded resilient sealing ring has the effect of distributing the thrust bearing pressure due to the tilting force of the blade thrust on the blade. This spring loaded, combination outboard seal and thrust bearing is thus an important practical feature of the blade mounting construction of the invention.

The interior of the hub is preferably provided with a supply of lubricant, such as heavy oil or light grease, for the purpose of lubricating the working parts.

It is to be noted that the bearing surfaces between the resilient sealing ring and the outer thrust washer are lubricated in operation on the outer margin by water, and on the inner margin by grease or oil. Hence the need of a combination of materials for these parts which is especially adapted for such lubricating conditions. Moreover, the combination of materials should be such that the thrust washer is softer than the sealing ring and will not score the latter. A Monel sealing ring of hard temper and a laminated phenolic or other suitable plastic thrust washer meets these requirements. Moreover, any reasonable wear on the plastic thrust washer will be compensated for by the spring effect of the sealing ring, hence will not result in leakage.

Blade turning movement

Referring now to Figs. 1 to 3, the blades are turned axially in unison in their sockets to change their pitch by a novel mechanical movement characterized by utmost simplicity, compactness and large torque-multiplying power. It combines the principles of two basic mechanical powers, namely the screw and the wedge. The combined nut-and-wedge element 24 of the movement, herein termed the wedge, consists of a prism having a threaded bore, rounded edges bearing against the bore of the hub and equilateral faces, one for each blade. Each face is provided with a pair of oppositely inclined conjugate grooves CG (see Fig. 2) operatively engaging a pair of crank pins 22, which latter are forced to move, as followers, in the same rotary direction upon axial translation of the wedge, thereby applying a torque couple to each blade. The wedge is translated in operation by a torque shaft 25 mounted for rotation and axial translation in the propeller shaft 30 and having an externally and internally screw-threaded portion which extends into the hub 10 and through the wedge, the external threads mating with internal threads in the wedge bore and the external threads mating with external threads on a fixed coaxial screw 11. Said external and internal threads of the torque shaft 25 are of the same hand but of slightly different pitch whereby, when rotated, the torque shaft translates itself along screw 11 in one direction while translating wedge 24 in the opposite direction, thus producing differential movement of the wedge. The screw-threaded portion of the torque shaft, the coaxial screw 11, and wedge 24 in combination therefore constitute a differential screw movement.

The wedge, shown in detail in Figs. 2 and 3, is of prismatic form and has a cross-section bounded by a circle and equal straight sides adapted to fit closely between the inner faces of the blade journals. Thus for a three-bladed propeller, as shown, the cross-section of the wedge is a triangle with rounded corners, as shown in Fig. 3;

while for a four-bladed propeller, the cross-section would be a square with rounded corners. The diameter of the circumference is only slightly less than the diameter of the axial bore in the hub, so as to be sliding fit therein, thus avoiding any possibility of transverse wedging action against the journals. The wedge has an axial bore screw-threaded in part to mate with corresponding threads on screw shaft 25; the shaft and nut in combination thus constituting a screw-and-nut pair. Preferably the screw threads are of Acme form of self-centering type.

Each lateral face of the wedge is provided with oppositely inclined conjugate wedge-grooves as shown in detail in Fig. 2. These wedge-grooves are preferably symmetrically disposed with respect to the center plane of the wedge as shown, and have a curvature such that the angular displacement of the crank pins is proportional to the travel of the wedge. The wedge-grooves, of course, have a width and depth adapted to fit the crank pin rollers 23, or the slipper blocks when used. The pitch line and contours of the curves of the grooves can be determined graphically in any specified case in the well-known manner for determining cam contours, and can be precisely defined mathematically as a pair of conjugate curves as more particularly described in my copending application Ser. No. 770,640, filed Aug. 26, 1949.

The screw shaft 25 is provided at the outboard end with a threaded axial bore adapted to mate with the threads of coaxial screw 11 which is fixed coaxially in the bore of the hub in any desired manner, as for example by means of a cross-screw 12 set in the hub as shown. The pitch of the mating threads of the fixed screw and the screw shaft is slightly different from the pitch of the mating threads of the screw shaft and the wedge, preferably being of somewhat lesser pitch. The two screw-threaded pairs thus constitute a differential screw movement whereby the travel of the wedge per turn of the screw shaft can be made quite small, while at the same time the threads on the threaded parts can be made relatively large and strong. For example, assuming the internal and external threads of screw shaft 25 to have pitches of 6 and 5 threads per inch, respectively, the differential pitch would be

$$\frac{6 \times 5}{6 - 5} = 30$$

per inch. Assuming further that when the wedge travels 2 inches the blades will be turned through an angle of 45°, the overall speed-reduction ratio of the blade turning movement would be

$$\frac{30 \times 2 \times 360^\circ}{45^\circ} = 480$$

The torque multiplying ratio would of course be equal to the speed reduction ratio times the mechanical efficiency, or say $480 \times .50 = 240$. Because of this large torque-multiplying ratio, other forms of torque-multiplying devices are eliminated and the pitch actuating mechanism simplified in the present invention.

Another important advantage gained from the construction described is that the axial thrust of the screw shaft is supported by the fixed axial screw, hence no separate thrust bearing is required for the screw shaft. Moreover, all the major working forces are confined to the hub, relieving the working and structural parts out-

side the hub of the support of such forces, thus permitting lighter parts to be employed.

The novel mechanical movement described applies a torque couple to turn each blade axially, thereby eliminating the radial load component which would be produced by the turning effort if only a single crank pin were used. Further, since the turning effort is exerted on two crank pins instead of one, the crank pins can be made proportionally smaller, yet provide adequate strength. The movement also provides a large mechanical advantage in turning the blades, according to the well-known inclined plane principle thereby reducing the working force necessary to slide the wedge against the load reaction. As a direct consequence the screw shaft or its equivalent can be relatively much smaller than would otherwise be necessary. Furthermore, the movement provides a rigid mechanical connection to the blades which can be fitted in practice with virtually no back-lash, thus avoiding the possibility of shake and consequent blade vibrations. Since the axial thrust component on the screw shaft due to the reaction of the wedge is supported inside the hub by reason of its threaded connection to the fixed screw, the portion of the screw shaft outside the hub transmits torque only and is therefore kinematically a torque shaft. Moreover, the wedge is slidingly supported so that it cannot turn in the bore, hence no separate wedge guide means are necessary.

It is thus thought evident that the novel blade turning mechanism of the invention provides outstanding advantages in combination with other features of the construction by combining several essential functions in a few parts of simple construction, and also in enabling other functional parts of the mechanism to be made lighter in construction than would otherwise be possible.

The power unit

Referring now to Fig. 4 which shows the novel power unit of the invention, this unitary assembly of mechanism serves as a combination speed-reduction gear between the engine and the propeller shaft, and as a power take-off for driving the pitch changing mechanism.

The main structural element of the power unit is the main housing 50 in the form of a hollow casting open at one end and adapted to be bolted to the engine, usually at the fly-wheel end, according to well-known practice. This housing serves to mount and house all the mechanism of the power unit. The main drive shaft 40 is preferably provided with a demountable disc flange 41, as shown, adapted to be secured demountably by screws to the engine fly-wheel, not shown. Alternatively, the main shaft can be coupled to the projecting end of the engine crank-shaft by a suitable coupling in cases where the engine is suitably designed. The main housing is formed with a vertical blackwall, and a hollow overhang to which an end plate 51 is tightly but demountably secured by screws, as indicated. Anti-friction bearings are mounted in the housing wall and end plate for purposes of providing a "straddle mounting" for the reduction shafts and gears, in well-known manner. The reduction gearing consists of a drive pinion 42 mounted non-rotatably on the main shaft, and a driven bull-gear 33 fast on the reduction output shaft 32, these gears preferably having helical teeth. The pinion is preferably provided with a splined bore mating with a splined outboard portion of the

main drive shaft and is secured to the inner race of a double-row ball bearing 52 mounted in the housing wall, as shown. The outboard end of the main drive shaft is supported by a roller bearing 53 mounted in the end plate.

The bull-gear 33 is provided with a splined bore mating with the splined portion of the hollow output shaft 32, which latter is provided with an integral coupling flange and is straddle-mounted by means of a double-row ball bearing 54 mounted in the end plate, and a roller bearing 55 mounted in the wall of the main housing. The propeller shaft 30 is coupled to the output shaft 32 by means of a conventional demountable coupling 31.

Throughout the construction, the outer bearing race is preferably held in its mounting by an internal retainer ring, while the inner race when used is held in place on its shaft by an external retainer ring, thereby to facilitate quick assembly and disassembly.

It is to be understood that for the purposes of the invention, the details of the design and construction of the main housing shafts, reduction gears, and their mountings can be varied according to circumstances, provided good engineering practices are maintained, the construction shown and described being merely by way of example. The construction shown however, is thought to be characterized by simplicity and ease of manufacture and assembly, and is considered preferable to other alternative constructions on that account.

Pitch actuating mechanism

The mechanism now to be described relates particularly to the pitch changing function and comprises in the main a floating gear 43 mounted loose on the main drive shaft, a duplex or double-acting clutch assembly DC mounted partly on the floating gear and partly on the main drive shaft, a gear 26 termed the screw-shaft gear mounted loose on the output shaft 32 and having a splined bore in which the inboard splined portion of screw-shaft 25 is adapted to slide, a trunnion pivot assembly 27 loosely secured to the inboard end of the screw-shaft, and a floating shift lever 28 operatively connecting the trunnion pivot assembly to the clutch assembly.

A telemotor receiver unit RU, forming part of the remote control system described hereinafter and of well-known commercial type, is preferably mounted inside the main housing back of the main shaft as viewed, and is provided or connected with a crank arm 60 which is operatively connected by a crank pin 61 to the floating shift lever 28.

Considering now the details of pitch actuating mechanism, the floating gear 43 is mounted loose on the main drive shaft 40 in meshing relation with screw-shaft gear 26 which is loosely but non-slidably mounted on the output shaft 32, preferably by means of a ball-bearing yoke mounting 34 as shown.

The duplex clutch assembly DC is of the driving and braking type, and is arranged so as to provide a normal neutral position, as shown, in which the floating gear 43 is free to turn loosely on the main drive shaft 40; also alternative driving and braking positions, respectively. The preferred type of duplex clutch comprises a double-acting friction brake and clutch of the well-known Weston multiple-disc type, as shown, altho it is to be understood that other types of

double-acting clutches can be used for the purposes of the invention. The two clutch throw-out collars are rigidly connected by an axially slidable yoke assembly 46 which holds these collars at a fixed distance and also prevents them from turning. The yoke assembly is slidably mounted on two stud pins 56 (one being shown in Fig. 5) fixed in the back wall of the housing

50, and is thus prevented from turning. The yoke assembly 46 includes two brackets 47 (one of which is shown) upon which are mounted fixed trunnions 48 which act as floating pivots for floating shift lever 28. The shift lever 28 has two lever members (the back one being shown) 15 which are connected rigidly by separator sleeves and bolts 29, the two members being assembled so as to straddle the main shaft. The shift lever is carried at the upper end by the crank pin 61 of crank arm 60.

When the yoke assembly is shifted by the shift lever axially to the right from neutral position, the floating gear is driven by the main drive shaft; when shifted axially to the left, the floating gear is braked and stopped.

Operation of pitch changing system

The principle of operation of the pitch changing system is as follows: Let it be assumed by way of example that the reduction gear ratio is 2:1 and the ratio of the two pitch-changing gears is 1:1. Normally, that is when the pitch is not being changed the duplex clutch will be in neutral position and the floating gear, being free to rotate on the main drive shaft, will be driven idly by the screw-shaft gear at the same speed as the output shaft. Consequently, the floating gear will be driven idly at one-half the speed of the drive shaft. Then if the crank arm 60 is caused to turn clock-wise, as viewed in Fig. 4, the floating shift lever causes the driving section of the clutch (on the left of the floating gear) to become operative and it clutches the drive shaft to the floating gear. The speed of the drive shaft being twice that of the output shaft, the screw-shaft gear will accordingly be rotated at twice the speed of the output shaft, thereby causing the screw-shaft to rotate in leading relation to the propeller shaft. The differential screw movement in the hub thereupon causes the wedge in the hub to traverse axially, as before described, thus producing a change of pitch; and at the same time the screw shaft is caused by the fixed differential screw 11 to travel outwards, or to the left as viewed. This axial travel of the screw-shaft turns the floating shift lever in the same angular direction as the crank arm, and thus tends to relieve the clutch pressure. Accordingly, if the turning effort of the crank arm is not maintained, the clutch will be released and the pitch-change thereupon terminated.

In this connection, it should be noted that the fly-wheel effect of the pitch changing gears and connected parts will tend to cause a slight overrun of the pitch-changing action, thus freeing the clutch of pressure after it has been actuated by the crank arm. In the event the fly-wheel effect of the gears is insufficient to relieve the clutch pressure, sufficient fly-wheel mass must be added to the gears or connected parts to produce this result.

Angular movement of the crank arm in the opposite (counterclockwise) direction initiates a pitch-changing cycle in the opposite direction by applying pressure via the floating shift lever and yoke assembly to the braking section of the clutch

(on the right side of the floating gear), thereby braking and stopping the rotation of the latter. Slowing down or stopping the floating gear has a like effect on the screw-shaft gear, which latter thus causes the screw-shaft to rotate in lagging relation to the propeller shaft, thereby energizing the differential screw movement in the opposite direction. The wedge in the hub is thus caused to traverse axially so as to reverse the pitch. The pitch changing cycle is terminated by the axial follow-up movement of the screw-shaft consequent to the change of pitch, in the same manner as before.

Considering now the kinematics of the pitch changing mechanism, it is to be noted that to produce reversible pitch changing action the speed ratios of the reduction gearing and pitch changing gearing must be different; the reduction ratio of the reduction gearing being always greater than that of the pitch changing gearing. Otherwise stated, the gear ratios must be such that the screw-shaft can be rotated faster than the propeller shaft. Further, the operating crank arm, screw-shaft, and floating shift lever in combination constitute a differential device by means of which the relative angular positions of the crank arm and the propeller blades are automatically compared. These elements in combination thus constitute a differential follow-up movement.

It follows from the action and principles described above that the degree of pitch change will be controlled by the angular position of the crank arm when it comes to rest, since the differential follow-up movement always immediately returns the clutch to neutral position after it has been actuated and thus terminates the pitch changing cycle initiated by the crank arm in definite relation to the rest position of the crank arm.

It is further to be noted that the duplex clutch constitutes a torque amplifier device whereby a relatively small control torque is enabled to control the application of a larger torque derived from the power source, in this case the prime mover. Further, there is a proportionality between the control torque and applied torque up to a certain maximum, since the larger the braking force, the larger the applied torque. Moreover, there is some correspondence in the rate of application of the two torques, as in all friction brake systems.

Control system

Considering now the control system for the foregoing mechanism and referring particularly to Fig. 5, which illustrates the control system of the invention in a schematic manner, this system as a whole constitutes a servo system by means of which the pitch can be caused to follow accurately the angular position of a control member, which latter may be remotely located.

For purposes of local control, that is at the power unit, the control system may be considered as comprising the crank arm 60, which can be manually operated, the floating shift lever 28, the duplex clutch DC, and the screw-shaft 25.

For purposes of remote control the system comprises the foregoing; a telemotor receiver unit RU at the power unit and operatively connected to crank arm 60, a telemotor transmitter unit TU having an operating handle CH shown in neutral pitch position, and a connecting link CL operatively connecting the telemotor transmitter unit to the telemotor receiver unit.

Since various commercial telemotor systems, either electrical, mechanical, or hydraulic, can be used in carrying out the present invention according to its teaching, detailed description of any particular telemotor system is deemed unnecessary.

The principal features for present purposes comprise a control handle CH angularly displaceable through a limited range and preferably calibrated as to angular position as indicated, the controlled crank arm 60, and means connecting these members whereby the crank arm is moved angularly in proportion to the angular displacement of the control handle. Having shown that the pitch angle of the blades is directly related to the angular position of the crank arm, it follows that the pitch angle is also directly related to the angular position of the control handle. Consequently, the angular position of the control handle indicates directly the pitch of the blades, hence there is no need for any other pitch indicating system. Moreover, since the range of angular movement of the control handle (and crank arm) is definitely limited, by proper selection of such range the range of pitch change can be limited as desired. Accordingly, there is no need for separate pitch limiting means.

Considering now the remote control system shown as a servo control system, its operation is as follows: When the control handle CH, which constitutes the master or input control member of the system is displaced angularly, the crank arm 60 is likewise displaced angularly by the connecting means and moves the floating shift lever 28 angularly about the trunnion pivot assembly 27 as a fulcrum. The duplex clutch assembly DC is thereby caused to apply driving or braking torque, as the case may be, to the screw-shaft gearing and screw-shaft 25, thereby causing the latter to drive the blade turning mechanism in the hub and to traverse axially, thereby moving floating shift lever 28 angularly about crank pin 61 as a fulcrum in the same direction as the crank arm, thus tending to move the clutch assembly DC to its neutral position. Consequently, when control handle CH is operated to continue the pitch change, the mechanism just described continues in action to effect a change of pitch, the differential follow-up movement continually tending to terminate the pitch change; but if the control handle is brought to rest, the differential follow-up movement thereupon terminates the pitch change.

Thus, the pitch of the blades follows the movement of the control handle, within the permitted limits, and is finally determined by the rest position of the control handle. However, due to the self-locking characteristic of the differential screw mechanism in the hub, the pitch remains set, upon termination of a control cycle, to whatever position it has been adjusted.

The servo system of the invention is thus of intermittent type wherein any pitch change can only be initiated by the master control handle CH, or by independent movement of crank arm 60 as an exceptional case. It is to be noted that it is unnecessary as a normal condition to latch the control handle CH in the rest position, because upon return of the duplex clutch DC to neutral position, there is no action tending to cause operative movement of the floating lever.

While I have described my invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art, after understanding my invention, that various changes and

modifications may be made therein without departing from the spirit or scope thereof. The appended claims are therefore intended to cover all such modifications and changes.

I claim is my invention:

1. A controllable pitch marine propeller system having, in combination; a tubular propeller shaft; a propeller assembly fixed to said propeller shaft comprising a hollow hub and radial blades mounted rotatably about their axes thereon, and a torque multiplying mechanical movement mounted within said hub for turning said blades axially in unison, including an axially slidable prismatic wedge having a pair of oppositely inclined conjugate grooves in each face mounted coaxially within said hub, two diametral crank pins projecting from each of said blades and adapted to move as followers in said grooves so as to turn said blades axially upon axial translation of said wedge, and a differential screw movement for translating said wedge axially in which said wedge constitutes the driven nut element; a rotatably and axially translatable torque shaft mounted coaxially in said propeller shaft and hub and constituting the driving element of said screw movement; a screw member fixed coaxially to said hub and coacting with the torque shaft to effect axial translation of said torque shaft upon rotation thereof; and controllable power driven mechanism operatively connected to said torque shaft for applying torque alternatively in one rotary direction or the other thereto, thereby to actuate said mechanical movement so as to change the pitch of said blades.

2. In a variable pitch propeller, the combination of a tubular propeller shaft, a hollow hub fixed to one end thereof, blades journaled in said hub so as to be capable of angular adjustment each about its own axis, a rotatable and axially translatable torque shaft extending coaxially through said propeller shaft and into said hub including an externally and internally screw-threaded part on said torque shaft extending into said hub, a nut element mounted on said screw-threaded part so as to be non-rotatable but axially movable therealong by rotation of said torque shaft, means operatively connecting said nut element to said blades so as to impart equal angular movement thereto by axial movement of said element along said screw-threaded part, and a screw-threaded member fixed coaxially in said hub and mated with the internally threaded portion of said screw-threaded part so as to impart axial movement to said torque shaft upon rotation thereof, thereby to produce a differential axial movement of said nut-and-wedge element.

3. In a mechanical operating mechanism for a variable pitch propeller having axially rotatable blades and including a mechanical movement for turning the said blades axially to change their pitch, in combination, a torque shaft for driving said movement, and controllable power means for applying driving torque to said torque shaft intermittently in either direction of rotation including a power driven main drive shaft, an output shaft coaxial with the torque shaft said shafts normally rotating at the same speed, speed reduction gearing connecting said main drive shaft in driving relation to said output shaft, torque transmission gearing having a ratio different from said speed reduction gearing and mounted in part loosely on said main drive shaft and in part non-rotatably on said torque shaft, double acting clutch means capable alternatively of connecting said torque transmission gearing in

driven relation to said main drive shaft or of braking said torque transmission gearing, control means for actuating said clutch means selectively, thereby to initiate rotation of said torque shaft relative to said output shaft thus to cause a change of pitch of said blades in one direction or the other, and a follow-up device actuated by said torque shaft for terminating the rotation of said shaft under certain conditions.

4. In a controllable pitch propeller organization including a torque multiplying mechanical movement for turning the blades thereof axially to change their pitch, in combination, a rotary operating shaft for driving said mechanical movement, controllable means for applying a relative torque to said operating shaft intermittently in either direction of rotation including a main drive shaft adapted to be coupled to a non-reversible source of power, torque transmission gearing operatively associated with said main drive shaft and said operating shaft, double acting clutch means operatively associated with said main drive shaft and said torque transmission gearing and capable alternatively of coupling said main drive shaft to said transmission gearing or of braking the latter, and control means including a follow-up device actuated by said operating shaft for actuating said double acting clutch means selectively and intermittently, thereby to cause a limited change of pitch of said blades in one direction or the other.

5. In a mechanical operating mechanism for a controllable pitch propeller including a tubular propeller shaft; means for changing the pitch of said propeller intermittently including, in combination, a main driving shaft adapted to be coupled to the prime mover for said propeller, a hollow output shaft coupled to said propeller shaft speed, reduction gearing connecting said main drive shaft in driving relation to said output shaft, an axially movable rotary operating shaft extending coaxially through said propeller and output shafts and operatively connected to change the pitch of said propeller, pitch changing torque transmission gearing operatively connected to said operating shaft, double-acting clutch means operatively associated with said torque transmission gearing and having neutral, driving, and braking positions respectively; and automatic follow-up control means for said clutch means including means for selectively moving said double acting clutch means to either the driving or braking positions, and a differential follow-up device actuated by axial movement of said operating shaft for returning said clutch means to neutral position subsequent to movement thereof to either the driving or braking position.

6. In mechanical operating mechanism for a controllable pitch propeller organization including a hollow propeller drive shaft, a rotary operating shaft extending coaxially therethrough and arranged to produce a change of pitch upon rotation relative to said propeller drive shaft and an axial movement consequent to such rotation, means for causing intermittent relative rotation of said operating shaft including a main drive shaft adapted to be coupled to the prime mover for said propeller, speed-reduction gearing connecting said main drive shaft in driving relation to said propeller drive shaft, torque transmission gearing of different ratio than said speed-reduction gearing operatively associated with said main driving shaft and said operating shaft, a double-acting clutch mechanism having

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driving, neutral, and braking positions, respectively, operatively associated with said main drive shaft and said transmission gearing, and position control servo mechanism including actuating mechanism for moving said clutch mechanism to any of its positions and a differential follow-up device actuated by axial movement of said operating shaft for returning said clutch to neutral position from either the driving or braking position.

7. In an operating mechanism for a controllable pitch propeller organization including a tubular propeller shaft and an operating shaft extending coaxially therethrough, a power transmission unit comprising, in combination, a housing structure; speed reduction gearing operatively mounted in said housing structure including a main drive shaft adapted to be coupled to the prime mover for said propeller, a hollow output shaft adapted to be coupled to said propeller shaft, and speed reduction gears for drivingly connecting said main drive shaft to said output shaft; and an assembly of controllable servo mechanism for causing a change of pitch also operatively mounted in said housing structure including a duplex clutch operatively associated with said main drive shaft, torque transmission gearing operatively associated with said clutch and said operating shaft, a master control device, and follow-up clutch actuating means jointly controlled by said control device and said operating shaft said control device being capable of initiating a change of pitch and said operating shaft being capable of terminating automatically said change of pitch.

8. In an operating mechanism for a controllable pitch propeller organization including a tubular propeller shaft, a power transmission unit comprising, in combination; a housing structure adapted to be secured to the prime mover for said propeller; speed reduction gearing operatively mounted in said housing structure including a main drive shaft adapted to be coupled to the drive shaft of said prime mover, a hollow output shaft adapted to be coupled to said propeller shaft, and speed reduction gears connecting said main drive shaft in driving relation to said output shaft; an operating shaft mounted coaxially in said output shaft for rotation and axial movement therein and operatively connected to produce a change of pitch by rotation relative to said output shaft and axial movement consequent to such change of pitch; and an assembly of controllable servo mechanism for deriving power from said main drive shaft to cause intermittent reversible rotation of said operating shaft relative to said output shaft including double-acting clutch follow-up means, a control device, and differential means for actuating said clutch means jointly controlled by said control device and said operating shaft whereby a determinable limited change of pitch can be initiated by said control device and such change of pitch will be terminated by consequent follow-up axial movement of said operating shaft.

9. A controllable reversible pitch propeller system including a power driven shaft, a hollow output shaft, gearing connecting said power driven shaft in driving relation to said output shaft, a rotary operating shaft for effecting a pitch change extending coaxially through and beyond said output shaft, torque transmission gearing operatively associated with said power driven shaft and said operating shaft, double-

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acting clutch means operatively associated with said main drive shaft and said torque transmission gearing, and remote control means for actuating said clutch means intermittently including a telemotor system comprising a transmitter unit having a control handle calibrated with respect to angular position, a telemotor receiver unit having an output arm arranged for limited angular displacement, and link means connecting said handle and said output arm whereby said output arm is caused to be displaced angularly in direct relation to the angular displacement of said handle, and automatic differential follow-up means jointly actuated by said operating shaft and said output arm for initiating and terminating a pitch changing cycle.

10. In a controllable pitch propeller system having variable pitch blades, a position control servo system for varying, indicating, and limiting the pitch of said blades including, a master control member displaceable through a limited range of movement and calibrated with respect to position, a displaceable controlled member, means operatively connecting said master control member to said controlled member so that said controlled member follows the movement of said master control member, rotary power means capable of providing torque for changing the pitch of said blades, pitch changing mechanism operatively connected to said blades including a rotatable torque shaft movable axially in direct relation to the pitch of said blades, and torque amplifier means including a differential follow-up device jointly actuated by said controlled member and said torque shaft for connecting said rotary power means in intermittent driving relation to said pitch changing mechanism so as to effect a controlled pitch changing cycle, thereby to vary the pitch of the blades in determinable relation to the position of said master control member.

11. In a controllable reversible pitch propeller system including a hollow hub carrying adjustable pitch blades, constituting a servo system of the position-control type and comprising: a position-control device for controlling and indicating the pitch of said blades; a controlled device comprising a torque-multiplying mechanical movement within said hub for turning said blades to adjust their pitch, torque amplifier mechanism including a drive shaft, a duplex-clutch, torque transmission gearing, said mechanical movement, and a torque shaft operatively connecting said gearing to said mechanical movement; a differential follow-up device for comparing the positions of said position-control device and said blades including a differential screw, said torque shaft, and a differential lever for actuating said duplex-clutch; and a blade stabilizing device including the mechanical movement within said hub; whereby the pitch of said blades is caused to correspond to the position of said position-control device.

12. A variable pitch propeller assembly comprising a hollow hub provided with an axial bore and radial sockets; blades having journals axially turnable in said sockets and provided with a pair of diametral crank pins projecting from the inner end of each journal, a translatable blade turning element of prismatic form axially slidable in said bore and having equilateral faces each provided with a pair of oppositely inclined conjugate grooves engaging operatively with a pair of said crank pins so as to apply equal turning movements thereto, said element also

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having an axially disposed screw threaded opening therethrough; an axially disposed screw member fixed within said hub; and an axially translatable driving shaft having external threads meshing with said element and internal threads meshing with said screw member, said threads being of the same hand but of slightly different pitches, whereby upon rotation of said shaft it translates itself in one axial direction along said screw member and simultaneously translates the said element differentially in the other direction, thus turning the blades axially in unison.

HARRY J. NICHOLS.

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