March 28, 1950 H. J. NICHOLS 2,501,908

CONTROLLABLE PITCH MARINE PROPELLER SYSTEM

Filed Sept. 29, 1943 4 Sheets-Sheet 1

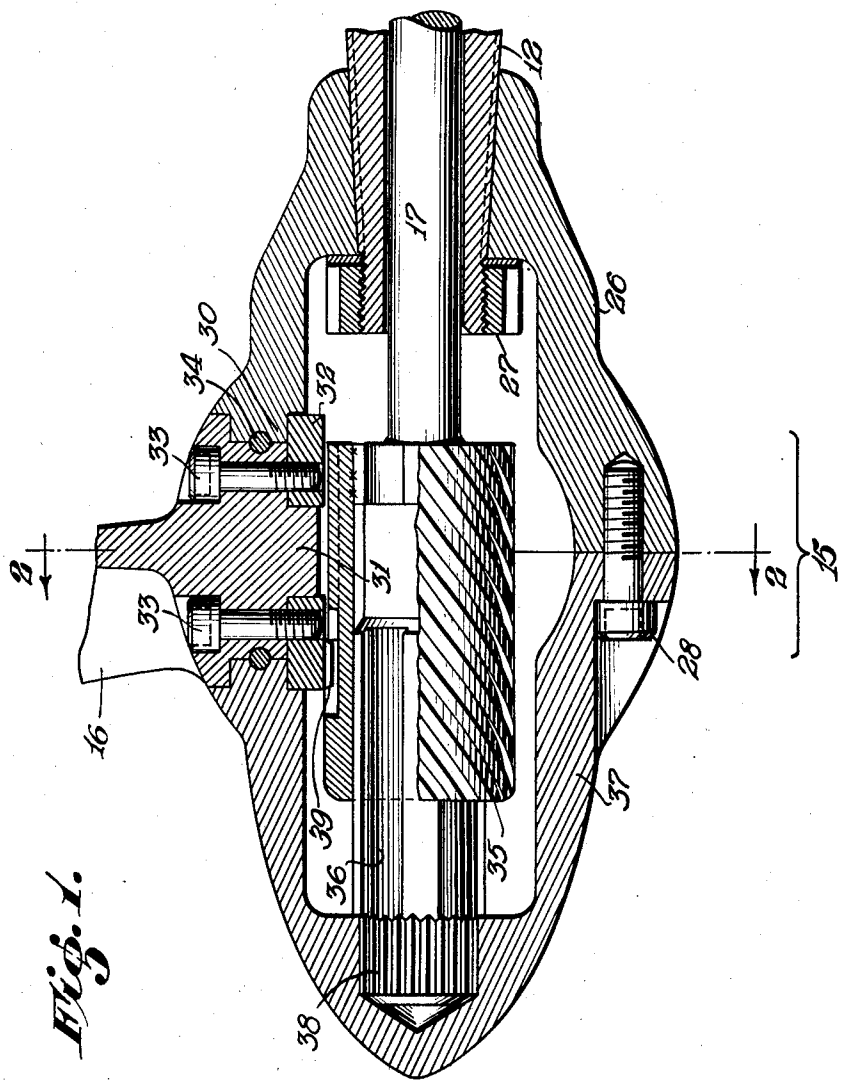


Fig. 1.

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CONTROLLABLE PITCH MARINE PROPELLER SYSTEM

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Fig. 9.

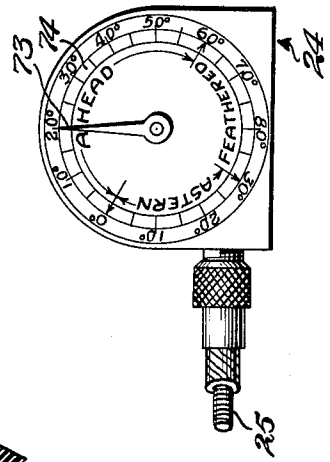
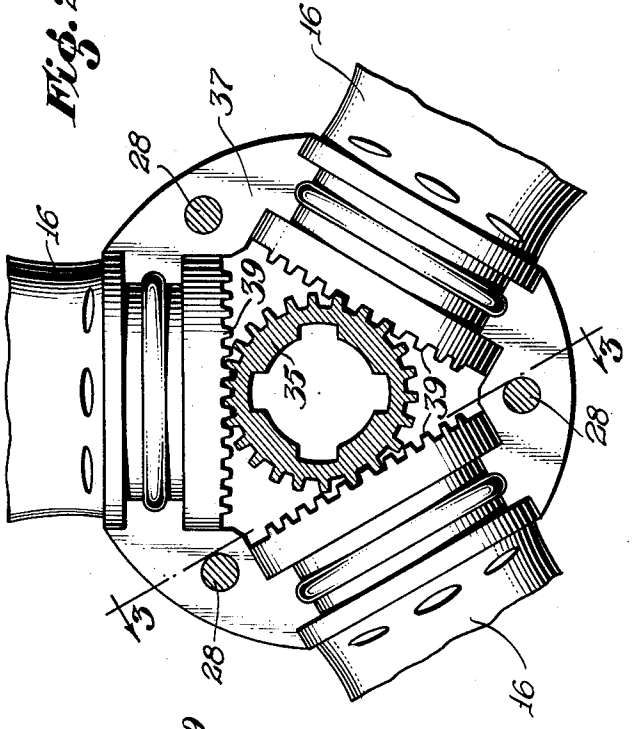


Fig. 2.



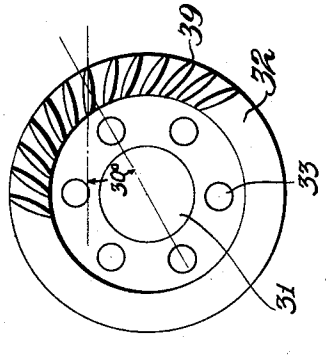


Fig. 3.

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CONTROLLABLE PITCH MARINE PROPELLER SYSTEM

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Fig. 5.

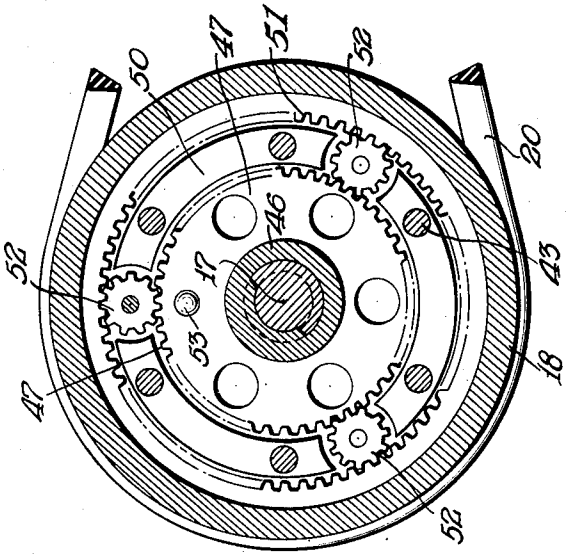
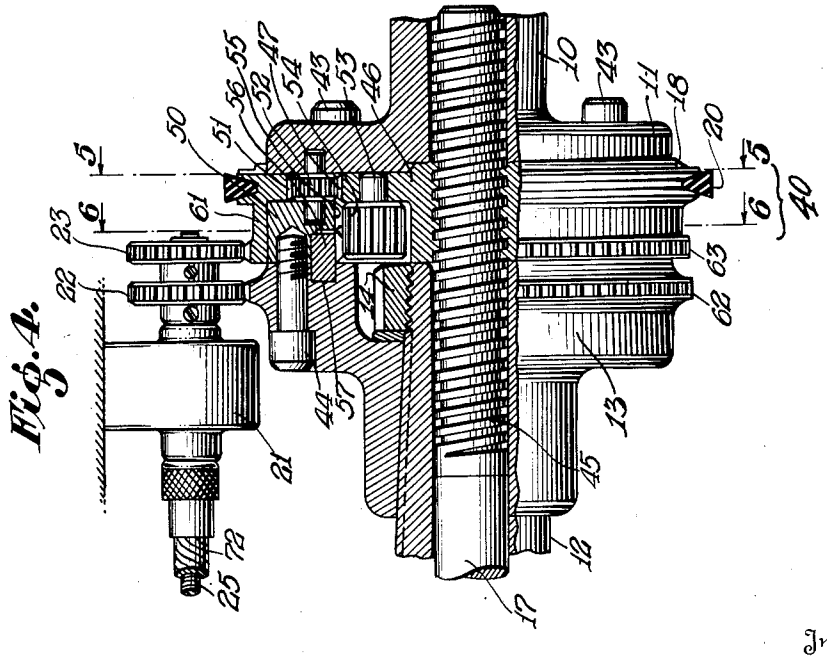


Fig. 4.



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CONTROLLABLE PITCH MARINE PROPELLER SYSTEM

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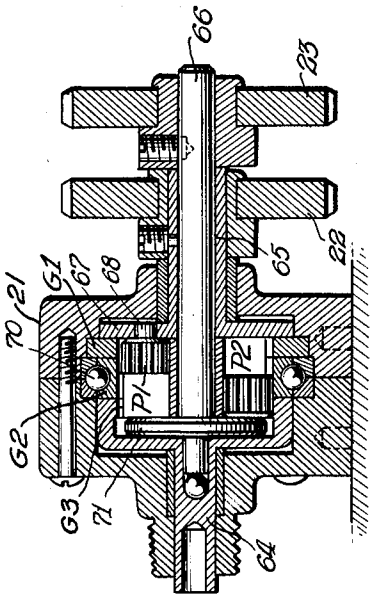


Fig. 7.

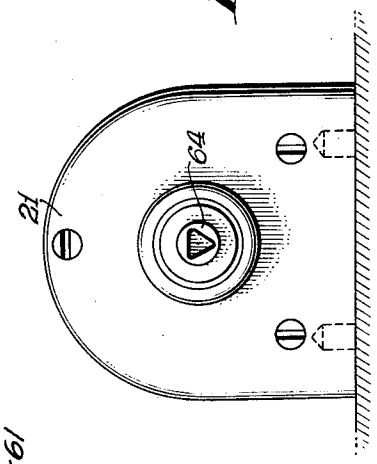


Fig. 8.

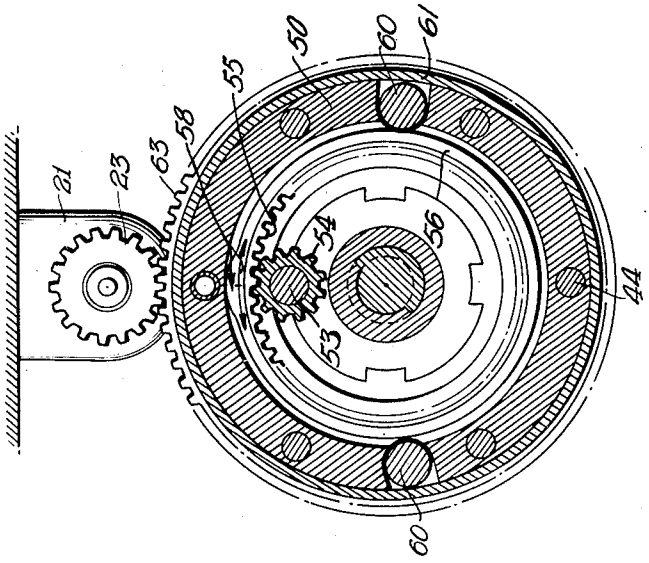


Fig. 6.

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Patented Mar. 28, 1950 2,501,908

UNITED STATES PATENT OFFICE

2,501,908

CONTROLLABLE PITCH MARINE PROPELLER SYSTEM

Harry J. Nichols, New York, N. Y.

Application September 29, 1943, Serial No. 504,333

20 Claims. (Cl. 170—160.22)

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This invention relates to controllable pitch propeller system, and more especially to such a system adapted for use on motor boats, and has for its principal object the provision of a propeller system of the character described in which the pitch of the blades can be easily and accurately adjusted while the propeller is in motion under load and in which the blades will be automatically locked against displacement after such adjustment.

A further object is to provide an exceptionally simple, compact, and durable propeller hub and blade actuating mechanism which is economical to manufacture, easy to install and service, and provided with automatic controls, pitch block and pitch indicating devices and other practical features to facilitate operation by unskilled and non-technical operators.

Another object is to provide a strong and rigid pitch varying mechanism which avoids any possibility of flutter or vibration of the blades in operation due to excessive elasticity or back-lash.

A further object is to provide a construction in which the gears of the primary actuating mechanism are relieved of any strain except when the pitch is being varied, thus reducing wear on the gear teeth and enabling relatively light gears to be employed.

A further object is to provide a pitch varying system of adequate angular range, including reversing and forward feathering of the blades, which is capable of changing the pitch in micrometric increments, yet also is capable of changing the pitch at a rapid rate for maneuvering and emergencies.

A further object is to provide a mechanical pitch limiting device to prevent the pitch being varied beyond the desired operating range, and a mechanical remotely indicating precision device to indicate to the operator at all times, the relative angle of the blades.

With these and other objects in view, as well as other advantages incident to the improved construction, the invention consists in the various parts and combinations thereof set forth and claimed, with the understanding that the several necessary elements constituting the same may be varied in proportions 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 comprehend the several 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—

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Fig. 1 is a side elevation in partial axial section of a marine variable pitch propeller and drive shaft therefor embodying certain features of the invention.

Fig. 2 is a transverse sectional view taken substantially on lines 2—2 of Fig. 1.

Fig. 3 is a detail view of the inner end of a blade root taken substantially on lines 3—3 of Fig. 2.

Fig. 4 is a side elevation in partial axial section of the gear mechanism and flange coupling forming part of the invention.

Figs. 5 and 6 are transverse sectional views taken substantially on lines 5—5 and 6—6, respectively, of Fig. 4.

Figs. 7 and 8 are axial sectional views in part and exterior end views, respectively, of the planetary differential device forming the transmitting end of the remote pitch indicator.

Fig. 9 is a schematic showing of typical pitch indicator instrument driven by the transmitter shown in Figs. 7 and 8.

Considering the invention as a whole, and referring particularly to Figs. 1, 2, and 4, a preferred construction of a variable pitch propeller system embodying the invention is shown as comprising a tubular main drive shaft 10 having a collar or annular flange 11 upset or otherwise provided thereon at its driving end, and driving a tubular propeller shaft 12, having a demountable flange 13, by means of a special flange coupling 40 in which is housed a gear-driven screw-jack mechanism and other mechanism to be described in detail hereinafter. A propeller hub 15 having rotatable blades 16 is mounted on the outboard end of propeller shaft 12, the latter housing thrust rod 17 which operatively connects the screw-jack mechanism in the coupling with the blade actuating mechanism within propeller hub 15.

The screw-jack mechanism, preferably rotatably driven by a pulley 18, flexible belt 20, and a reversible motor (not shown), is preferably mounted inside the vessel at an accessible location, say at the driving end of the engine. The entire pitch changing mechanism rotates bodily with the shafts at shaft speed, the gears and other parts of the mechanism being normally at rest relative to each other, while the motor turns idly. When the blade pitch is to be changed, the reversible motor is energized to rotate relatively in one direction or the other and drives the pulley 18

in one direction or the other relative to the shafts, thereby actuating transmission gearing and the screw-jack to produce a change of pitch as described hereafter in detail. The stationary planetary spur gear differential 21, having two independent drive gears 22 and 23, is driven by suitable gearing on pulley 18 and flange 13 and in turn drives pitch indicating instrument 24 (see Fig. 9) by a flexible shaft 25, or other suitable means, to provide remote precise indication of the pitch angle.

The controls for the reversible motor are not part of the present invention, and are described in detail in my copending application Serial No. 433,991, filed March 9, 1942, now U. S. Patent No. 2,363,191.

Referring now to the drawings in detail and particularly to Fig. 1, the propeller of the invention is shown as comprising a sectional hub 15 comprising a forward portion 26 which is fixed to the tubular propeller shaft 12 by a tapered, splined connection and nut 27, as shown, or by other suitable construction; and an after portion 37 which is secured to the forward portion 26 by longitudinally extending bolts 28. This structure mounts the blades and houses the blade actuating mechanism.

The two portions of the hub are provided with a plurality of radially extending bores formed with inner and outer seats and an intermediate annular shoulder 30. Blades 16, each having a root portion spindle 31, are journalled for axial rotation in the radial bores for the purpose of angular pitch adjustment, each blade having an annular toothed ring 32 mounted on and secured to its inner end by means of screws 33. A packing gasket 34 of any preferred type is assembled between the blade root 31 and shoulder 30 to prevent leakage of lubricant and entrance of water into the hub.

The blades 16 can be rotated in the hub to vary their pitch from the full forward (feathered) position to a negative pitch (reversed) position by means of novel mechanism including a toothed cylinder wedge 35 having external helical teeth, which is fixed on the outboard end of thrust rod 17 by a tight splined connection, as shown, or in any desired manner. Wedge 35 has a splined internal bore adapted to slide without turning on a splined guide stud 36 secured axially in rear hub portion 37, preferably by pressing the knurled end 38 of the stud into a hole bored axially in the hub portion 37. This construction enables the wedge 35 to be reciprocated by the thrust rod 17, but neither the wedge nor the thrust rod can turn relative to the hub. The rings 32, each attached to a blade root or spindle, are each provided with a toothed annular segment projecting from the face of the ring and adapted to engage jointly the teeth of wedge 35. (See Fig. 2.) Each ring thus constitutes a crown gear.

Referring to Fig. 3 the toothed segment of ring 32 is provided with skewed teeth 39 similar to those of a skew crown gear, these teeth being preferably formed by a reciprocating generating cutter having helical teeth similar in form to those of the cylinder wedge 35. As is well understood, the shape of the sector teeth will be conjugate to that of the wedge teeth at each point of contact.

The cavity of hub 15 is provided with a supply of lubricant which provides lubrication for the working parts of the hub mechanism.

It will be evident that with the construction shown, the blades 16 will be rotated in unison as the wedge 35 is reciprocated by thrust rod 17.

Referring now to Fig. 4, which shows the details of the driving mechanism for reciprocating thrust rod 17, this mechanism comprises a unitary assembly 40 including the coupling connecting propeller shaft 12 to drive shaft 10, as for example the drive shaft of a prime mover. The drive shaft 10 is shown as being provided with a conventional upset flange 11, while the propeller shaft 12 is preferably provided with a demountable flange 13, fixed on the propeller shaft by a tapered, splined connection and nut 14, thereby to enable the propeller shaft to be withdrawn rearwardly through the propeller shaft bearings (not shown) when flange 13 is dismounted. The flanges 11 and 13 are strongly clamped to the coupling ring 50 by plural bolts 43 and 44 in well known manner.

The inner end of thrust rod 17 is provided with strong threads 45 and is mounted so as to be slidable coaxially in the bore of shafts 10 and 12. A rotary nut 46 is journalled freely on threaded portion 45 of thrust rod 17 between flange 11 and the end of the thrust rod, nut 46 being the hub of an external spur gear 47. This gear is driven for the purpose of varying the blade pitch by transmission gearing comprising a plurality of stationary pinions 52 journalled in recesses in the coupling ring 50 and flange 11, and meshing with an internal ring gear 51 cut in the inner perimeter of floating pulley 18, which is rotatably mounted between flange 11 and ring 50. (See Fig. 4.)

By referring to Fig. 5, it is seen that when belt 20 drives pulley 18 in one direction or the other relative to ring 50, ring gear 51 drives pinions 52 in the same direction and external gear 47 in the opposite direction, thereby turning nut 46 on screw 17.

For the purposes of limiting the pitch change to a predetermined operating range, a pitch block mechanism is provided, although of course this feature can be omitted without detriment to the other features of the invention. Referring again to Fig. 4, the web of gear 47 mounts a fixed stud 53 on which is journalled a planetary pinion 54 which meshes in common with a stationary internal gear 55 cut in the internal bore of ring 50, and with a floating internal ring gear 56 rotatably mounted inside ring 50. Gears 55 and 56 are preferably cut to the same pitch circle, but differ slightly as to the numebr of teeth, say by one tooth. A portion of ring gear 56 works in an annular groove 57 cut in the face of flange 13, and the outer perimeter of that gear is provided with a cam rise or traveling stop member 58 which forms part of the pitch block device (see Fig. 6). Two hardened steel rollers 60 are journalled loosely in ring 50 at suitable positions to be intercepted by stop member 58 when the latter has travelled the predetermined angular limits made permissible by the limitations of the blade actuating mechanism. One of the stop rollers 60 is preferably set to the limit where the blades would be fully feathered forward, while the other roller would preferably be set at the desired maximum reverse blade position, say at a pitch of (—) 30°.

Referring to Fig. 6, the operation of the pitch block device is as follows: When pulley 18 drives the pitch changing gearing, planetary pinion 54 which is carried by gear 47 rolls around in internal gears 55 and 56 and due to the differential number of teeth in these gears, ring gear 56 is

caused to creep gradually relatively to gear 55, hence cam rise 58 moves away from the mid-position shown in Figure 6. In the event the pitch change is carried to either limit, the cam rise 58 encounters one of the rollers 60 which, as it ascends the cam rise, jams between the outer rim of gear 56 and the inner surface of drum 61, thereby stopping rotation of drum 61 which is integral with pulley 18. The action is similar to that of well-known roller clutches and overdrive devices, and checks the relative motion of pulley 18 in a positive manner without undue shock. The torque of the pitch drive motor is overcome by the braking action on pulley 18 until such time as the rotation of the motor is reversed, whereupon the motor is able to unlock the clutch and set the gearing in rotation in the opposite direction towards the alternate pitch stop. It will be apparent to those skilled in the art that the construction described provides an exceptionally simple, effective and practical pitch block device.

Referring now to Figs. 4, 7, 8, and 9, for the purposes of providing remote precise indication of the pitch angle by mechanical means, additional mechanism is provided as follows: Flange 13 is provided with an external spur gear 62, while the drum portion 61 of pulley 18 is provided with an equal external spur gear 63, these gears meshing respectively with equal gears 22 and 23, which drive planetary differential gear unit 21. Referring particularly to Figs. 7 and 8, the differential gear unit comprises a split casing 21, comprising two portions bolted together as shown, housing planetary spur gear mechanism driving a shaft 64 which turns proportionally to the difference in angular relation between gears 22 and 23, which latter are mounted fixed on independent coaxial drive shafts 65 and 66, respectively. Hollow shaft 65 is provided with a flange 67 having a stud 68 on which is journalled first planetary pinion P1 meshing with stationary internal gear G1 and floating internal ring gear G2 mounted in a ball bearing 70, these latter gears being cut to the same pitch circle, but differing slightly, say by one tooth. Shaft 66 is provided with a flange 71 carrying a stud similar to stud 68 on which is journalled second planetary pinion P2 meshing with gear G2 and driven internal gear G3, the latter gear having the same number of teeth as the stationary gear G1. Gear G3 is preferably integral with driven shaft 64. The casing 21 and shaft 64 are adapted for connection to a flexible drive shaft 25 and flexible casing 72 therefor in well known manner.

The operation of the planetary differential spur gearing is as follows: Assuming first that gears 22 and 23 are being driven at the same speed, the first and second planetary pinions P1 and P2 roll around in unison in the internal gears G1, G2, G3. For each planetary revolution of these pinions, due to the difference in the number of teeth, gear G2 gains (or loses) one tooth pitch over gear G1, while gear G3 loses (or gains) one tooth pitch over gear G2. The net result is that gear G3 rotates at the same rate as gear G1, that is, it remains stationary. Now assume that gear 22 rotates faster than gear 23, so that pinion P1 revolves faster than pinion P2, then when P1 gains one planetary turn relative to P2, gear G3 will have gained one tooth pitch relative to gear G1. This is apparent if it is considered that gear 22 is rotated one turn while gear 23 is held stationary, whereupon pinion P1 meshes with all the teeth of gear G1 and with

the same number of teeth of gear G2 that is, with one more (or less) of the teeth of gear G2, whereby gear G3, which is coupled to gear G3 by pinion P2, gains (or loses) one tooth pitch relative to gear G1. It is readily seen that if gear 22 is held while gear 23 is rotated one turn the result will be equal but opposite to that obtained in the previously assumed case. It is to be noted that in order to obtain the result just described, the product $G1/G2 \times G2/G3$ must equal one, where the gear designations represent the number of teeth in those gears.

The gear system described operates according to the operational equation:

$$n=a_1(1-e_1)e_2+a_2(1-e_2)$$

in which

n=revolutions of driven gear G3
a_1=revolutions of first planetary carrier 67
a_2=revolutions of second planetary carrier 71
e_1=first train factor=G1/G2
e_2=second train factor=G2/G3

and in which

$$e_1 \times e_2 = G1/G2 \times G2/G3 = +1$$

Therefore, it follows that shaft 64 rotates proportionally to the angular difference between gears 22 and 23, which turn proportionally to the angular difference between gears 62 and 63, which latter difference in turn represents proportionately the pitch angle of the blades relative to the shaft. Thus the rotation of shaft 64 reflects proportionally the pitch angle of the propeller blades and the pitch measuring mechanism described constitutes a form of angle micrometer.

It is further to be noted that the planetary spur gear differential device described provides a relatively great speed reduction between the rates of relative rotation of the input shafts 65, 66, and the rotation of output shaft 64. For example, assume that gears G1 and G3 have 99 teeth, while gear G2 has 100 teeth. Then the speed ratio between shaft 65 and gear G2, and between shaft 66 and gear G2 will be 100:1; or otherwise stated, the input shafts will require a relative rotation of 100 turns for each turn of the output shaft. By comparison, the conventional bevel gear differential gearing disclosed by the prior art provides a speed reduction of 2:1 between the differential shafts. This large speed reduction ratio is a highly advantageous feature of the differential device of the invention, since it is evident that in order to provide the strong torque requisite to rotate the blades while under load, the pulley 18, which carries gear 63, must rotate a hundred or more turns relative to the shaft for each axial turn of the blade. Further, this large speed reduction ratio eliminates the need of the high ratio, speed reducing gear-trains preceding or following the differential shafts of the prior art, and yet enables the remote angle indicating instrument and its connecting link to operate at a low and favorable speed. An over all advantage in the apparatus and operation of pitch indicators is thus secured.

Referring now to Fig. 9, flexible shaft 25 operatively connects the differential unit 21 with the visual pitch indicating instrument 24. The construction of suitable angle indicating instruments being well known, and various types being suitable for the purposes of the present invention, detailed description is considered unnecessary. As a typical example, the flexible shaft 25 drives by means of suitable gears (not shown) a pointer

73 moving along an arcuate scale 74, suitably graduated to show the astern (or reverse), ahead, and feathered ranges as shown. The pointer indicates the pitch angle of the blades directly in degrees, so that the operator is constantly apprised of the pitch conditions. The pitch block device previously described prevents the blade pitch from exceeding the desired operating range, hence there is no danger of the pitch varying mechanism being deranged or damaged by careless or improper operation.

The motor control apparatus described in my copending application Serial No. 433,991, filed March 9, 1942, now abandoned, enables the pitch of the blades to be varied at will, or automatically by suitable control of instruments.

Without further description, it is believed evident that the mechanism of the invention provides a powerful, practical and efficient means for varying the blade pitch under all operating conditions. It is also to be noted particularly that the construction of variable pitch propellers provided by the invention is readily adaptable to equipping existing vessels with such propellers without extensive alteration of conventional propulsion arrangements.

I claim:

1. In a mechanical operating device for a variable pitch propeller blade mounted on a hollow hub on a hollow shaft, a hollow drive shaft, a mechanical coupling for said drive shaft, means mounted in said hub and shafts for varying the pitch of said blade while in rotation, including a reciprocating screw member slidable coaxially in said shafts, means mounted in said coupling for translating said screw member including a rotary free nut mounted on said screw member, power transmission gear means for rotating said nut, and external drive means for said gear member including a ring drive member rotatable concentrically on said coupling, a first drive means carried by said ring member, a second drive means carried by said coupling, and stationary differential means jointly driven by said first and second drive means for mechanically indicating the pitch of the aforesaid propeller blade.

2. In a mechanical operating device for a variable pitch propeller blade mounted on a hollow hub on a hollow propeller shaft driven by a mechanical coupling, means mounted in said hub, shaft, and coupling for varying the pitch of said blade while in rotation, including blade turning mechanism in said hub, a reciprocating member slidable coaxially in said shaft and extending from said coupling to said hub for actuating said turning mechanism, translating means assembled in said coupling for reciprocating said member including a ring drive member for said translating means rotatable concentrically on said coupling, a first drive member carried by said ring member, a second drive member carried by said coupling, and stationary means jointly driven by said first and second drive members for mechanically indicating the pitch of the aforesaid propeller blade.

3. In remotely indicating pitch indicator means for variable pitch propellers, a differential planetary gear mechanism including two independent drive shafts each adapted to drive a rotary member carrying a planetary pinion, a stationary internal gear meshing with one of said pinions, an intermediate rotatable internal gear meshing with both pinions, and a driven internal gear meshing with the other pinion, whereby the rotation of the driven gear is proportional to the angular relation of the two drive shafts.

4. The mechanism of claim 3, in which the product of the number of teeth in the first pinion times those in the driven gear divided by the product of the number of teeth in the second pinion times those in the stationary gear equals one.

5. In remotely indicating pitch angle indicators, the combination comprising an instrument for indicating angles visually, a driving connection therefor, and a unitary planetary spur gear differential mechanism of large speed reduction ratio for actuating said driving connection comprising two independent coaxial drive members adapted to be driven in the same direction and each carrying a planetary pinion meshing with an individual internal gear and meshing in common with a floating internal gear having a slightly different number of teeth than said individual gears, one of the individual gears being stationary, while the other individual gear constitutes the driven gear of the gear mechanism and is caused to rotate by said drive members in diminished proportion to the differential angle of said drive members.

6. In mechanical operating mechanism for a variable pitch propeller blade mounted on a tubular shaft, the combination with blade actuating mechanism carried by said shaft for varying the blade pitch including a rotary drive member for driving said actuating mechanism, of a coupling for driving said shaft, and mechanical means housed in said coupling for limiting the pitch of said blade to a predetermined range of operation comprising traveling stop means adapted to be driven by said rotary drive member, gear mechanism operatively connected with said drive member for rotating said stop means in diminished proportion to the relative rotation of said drive member, and releasable locking means adapted to coact with said stop means and said drive member for preventing further rotation of said drive member in the same direction relative to the coupling at predetermined angular limits.

7. In mechanical operating mechanism for a variable pitch propeller blade mounted on a tubular shaft, in combination with a mechanical coupling for driving said shaft, of mechanism carried by said coupling for limiting the blade pitch to predetermined limits comprising a rotary drive member mounted concentrically on said coupling, rotary means operatively connected with said drive member and adapted to rotate in diminished proportion thereto, and clutch means actuated by said rotary means for stopping rotation of said rotary drive member relative to said coupling when the predetermined pitch limits are approached.

8. In a differential speed reducing device for angle indicators, a planetary differential spur gear train having a train factor of plus one and comprising, a stationary internal gear, an intermediate gear having one tooth more or less than said stationary gear rotatably mounted coaxially with said internal gear, a driven internal gear equal to said stationary gear and rotatably mounted coaxially therewith, a pair of planetary pinions each meshing with one of said equal gears and in common with the intermediate gear, and two independently rotatable driving carriers for said planetary pinions.

9. A mechanical differential movement comprising two independent input drive shafts, a driven output shaft, a stationary internal gear

mounted in concentric relation to at least one of said shafts, a rotary member carrying a planetary pinion having a driving connection to one of said input shafts and meshing with said stationary gear, an intermediate rotatable internal gear meshing with both pinions, and a driven internal gear meshing with the second planetary pinion and having a driving connection with said output shaft, whereby the rotation of the output shaft is proportional to the differential rotations of said input shafts when said shafts are in relative rotation.

10. A differential planetary spur gear mechanism comprising two independent rotary drive members each operatively connected with a rotary member carrying a planetary pinion, a stationary internal gear meshing with one of said pinions, an intermediate rotatable internal gear meshing with both pinions, and a driven internal gear meshing with the other pinion, whereby the rotation of said driven gear is proportional to the differential rotations of said drive members when in relative rotation.

11. A mechanical differential movement characterized by a large speed reduction ratio comprising two independently rotatable driving members, a stationary spur gear mounted in coaxial relation to one of said members, an equal driven spur gear rotatably mounted in coaxial relation to said stationary gear, an intermediate rotatable spur gear having a slightly different number of teeth than the aforesaid internal gears and mounted in coaxial relation thereto, a planetary pinion rotatably mounted on one of said driving members and meshing with said stationary gear and said intermediate gear, and a second planetary pinion rotatably mounted on the other of said driving members and meshing with said intermediate gear and said driven gear.

12. A planetary differential all spur gear mechanism having two epicyclic gear trains in differential combination comprising two independent driving planetary carriers, a stationary spur gear, a driven spur gear, an intermediate spur gear, and double planetary pinions carried individually by said planetary carriers and meshing in common with said intermediate gear and individually with said stationary and said driven gears respectively, wherein the epicyclic gear trains in combination operate according to the equation:

$$n=a_1(1-e_1)e_2+a_2(1-e_2)$$

13. In combination with pitch changing mechanism for a variable pitch propeller having means carried by the propeller shaft for adjusting the pitch of the propeller blades while said shaft is in rotation under load, including a driven rotary member mounted concentrically rotatable with respect to said shaft in angular coordination with the pitch angle of said blades; a rotary member concentrically fixed to said shaft, pitch measuring mechanism adapted to be driven jointly by said rotary members including a stationary unitary spur-gear differential angle reducing device, means operatively connecting said rotary members individually to said device, and a pitch angle indicating instrument connected to be driven by said device so as to indicate the pitch angle of the propeller blades.

14. A variable pitch marine propeller system including a hollow propeller shaft, a hollow hub fast coaxially thereon, a mechanical drive coupling therefor, and having, in combination, a plurality of blades each with a spindle journaled radially in said hub, mechanism mounted in said hub, shaft and coupling for varying the pitch of said blades including a blade turning movement mounted within said hub comprising a reciprocable cylinder wedge and a driven crown gear fast on each said spindle in mesh with said cylinder wedge, a reciprocable rod movable coaxially in said shaft and extending from said coupling to said hub and fast to said cylinder wedge, and mechanism mounted in said coupling for reciprocating said rod with respect to said shaft including a screw-jack mechanism and torque transmission gearing for actuating said screw-jack mechanism including a reversibly driven ring-gear drive member for said gearing mounted concentrically and rotatably on said coupling.

15. A controllable pitch marine propeller including a tubular propeller shaft having, in combination, a streamlined hollow hub fixed tightly on said propeller shaft and having an axial bore, a plurality of axially rotatable blades each having a spindle journaled radially in said hub, a cylinder wedge and crown gear movement for rotating said blades axially in unison for the purpose of varying their pitch comprising an individual segmental crown gear fixed rigidly to each of said spindles and having multiple skew teeth, a wedge member mounted in said bore for axial translation having the form of a right circular cylinder with external helical gear teeth adapted to mesh in common with successive teeth of said crown gears; and a reciprocable rod mounted coaxially within said shaft and extending into said hub connected so as to impart translatory movement to said wedge member, thereby to cause said wedge member to impart rotary movement to said crown gears by wedge action.

16. A controllable pitch marine propeller having, in combination, a streamlined hollow hub having an axial bore and angularly displaceable blades each having a spindle journaled radially in said hub, a wedge and gear movement mounted within said hub for displacing said blades in unison comprising an individual crown gear having multiple skew teeth fast to the spindle of each blade, a wedge member mounted in said bore for reciprocation therein and having the form of a cylinder of revolution provided with external helical gear teeth adapted to mesh successively with said skew teeth of said individual gears, and means for reciprocating said wedge member, thereby to impart a rotary movement to said crown gears by wedge action of said helical teeth on said skew teeth.

17. In a controllable pitch marine propeller including a streamlined hollow hub having an axial bore and blades with spindles journaled radially in said hub, a wedge and gear movement mounted entirely within said hub for varying the pitch of said blades comprising a segmental crown gear fast rigidly on each said spindle and having multiple skewed teeth, a coacting toothed wedge member axially reciprocable in said bore, and having the external form of a helical pinion, and guide means fixed in said hub and adapted to guide the movement of said wedge member.

18. A controllable pitch marine propeller system including a tubular propeller shaft, a drive shaft therefor, a hollow coupling assembly for said shafts, and a hollow hub mounting a plurality of radial, axially rotatable blades fast coaxially to said propeller shaft; in combination: a mechanical movement mounted in said hub for rotating said blades axially comprising a partial crown gear fixed on the root portion of each blade, and an axially translatable cylinder wedge

having external helical gear teeth meshing operatively with said crown gears mounted coaxially in said hub; and pitch changing mechanism mounted in said shafts and coupling comprising a reciprocable connecting rod extending coaxially through said propeller shaft to translate said wedge, power screw-jack mechanism mounted in said coupling for reciprocating said connecting rod including a rotary but non-translatable nut mounted in said coupling on a threaded portion of said rod, torque transmission gearing mounted in said coupling for rotating said nut while said shafts are in rotation including a ring-gear driving member for said gearing mounted concentrically and rotatably on said coupling, and power transmission means external to said coupling for driving said ring-gear reversibly.

19. In a controllable pitch marine propeller including a hollow hub having an axial bore mounting a plurality of axially rotatable blades each having a spindle journaled radially in said hub; a mechanical movement within said hub for rotating said blades axially in unison for purposes of varying their pitch comprising a segmental crown gear, having skew teeth on the face thereof, fixed rigidly on the inner end of each spindle, and a reciprocable wedge member having the general form of a cylinder of revolution with helical gear teeth cut in its periphery and adapted to mesh successively with said skew teeth.

20. The combination with a controllable pitch propeller including an axially rotatable blade mounted on a propeller shaft; of means for so rotating said blade including a rotary driven member rotatable concentrically with respect to said shaft and in coordination with the rotation of said blade; a rotary member fast concentrically on said shaft; a stationary unitary differential angle reduction device, characterized by compound differential spur gearing having a large speed reduction ratio, jointly driven by said rotary members for generating an angular motion in greatly reduced ratio in comparison with the differential rotations of said rotary members; and an angle indicating instrument operatively connected to said differential device, thereby to indicate the pitch of said propeller.

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