June 23, 1964 H. J. NICHOLS 3,138,136

CONTROLLABLE REVERSIBLE PITCH PROPELLER

Filed May 13, 1959 5 Sheets-Sheet 1

FIG. I

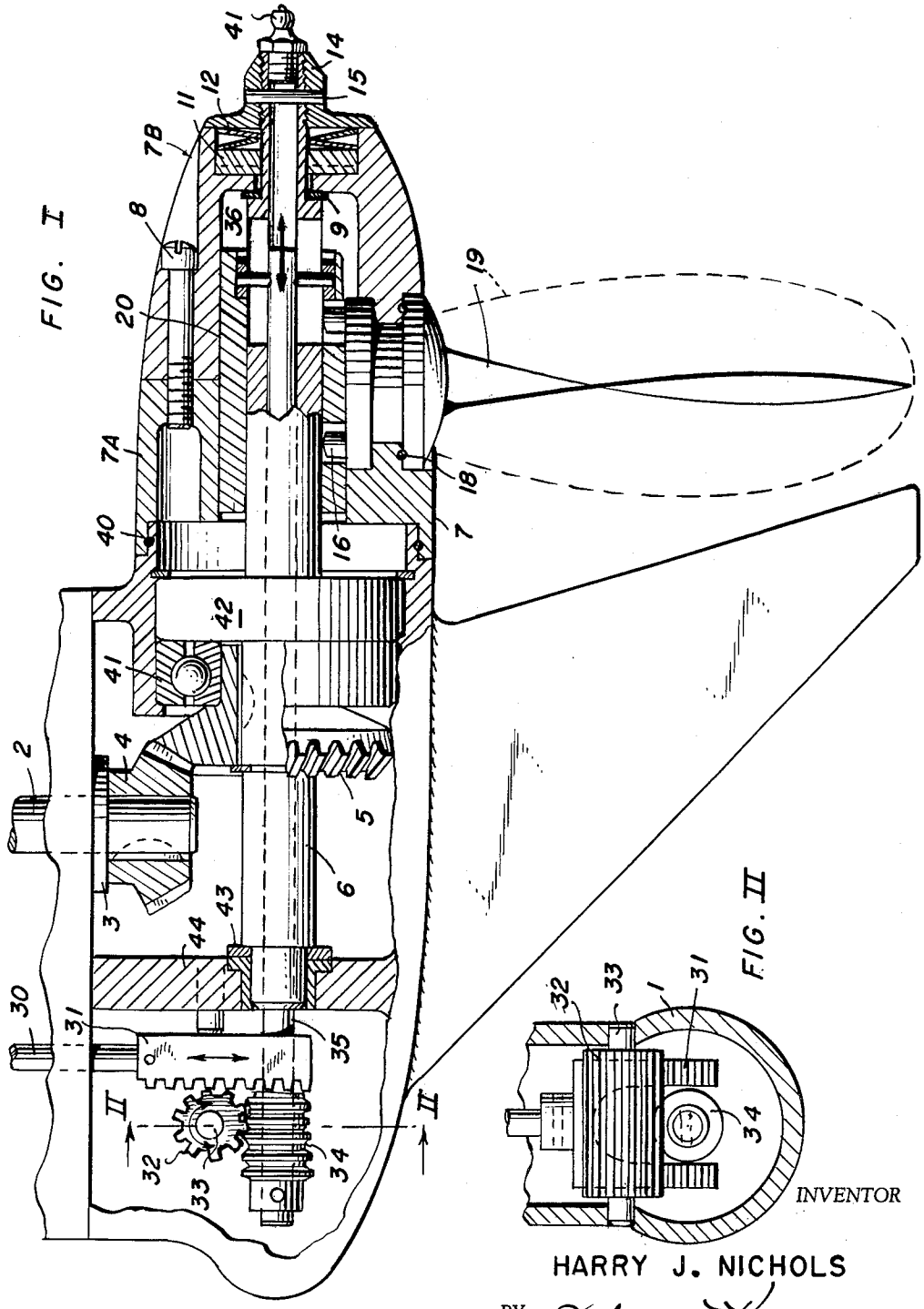


FIG. II

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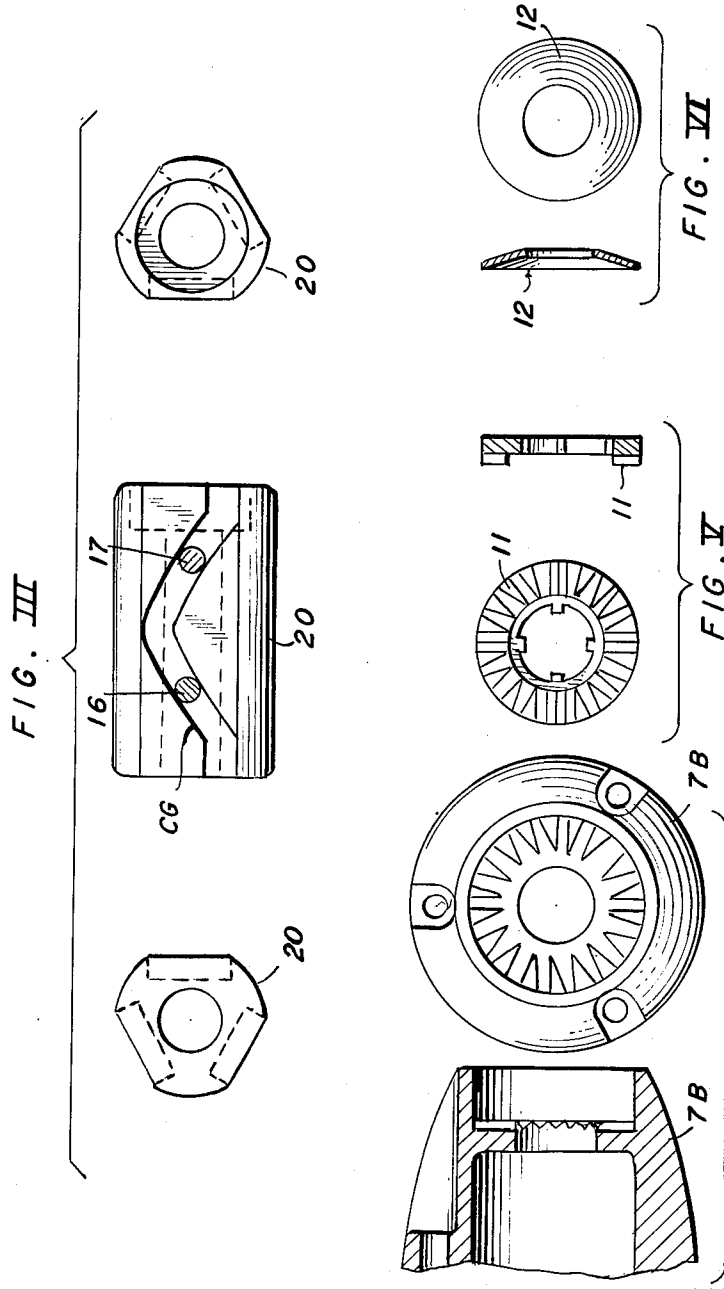
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June 23, 1964 H. J. NICHOLS 3,138,136

CONTROLLABLE REVERSIBLE PITCH PROPELLER

Filed May 13, 1959 5 Sheets-Sheet 2



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CONTROLLABLE REVERSIBLE PITCH PROPELLER

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FIG. VIII

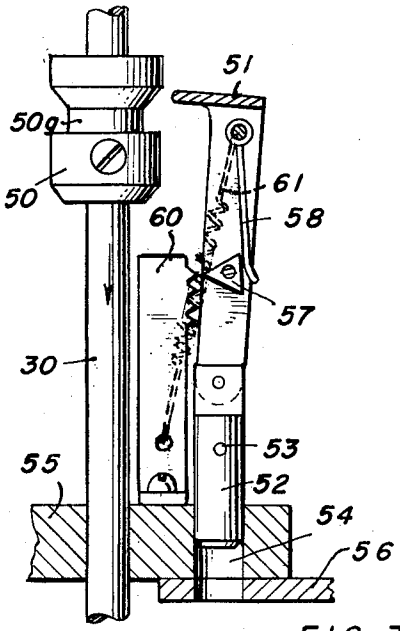


FIG. XII

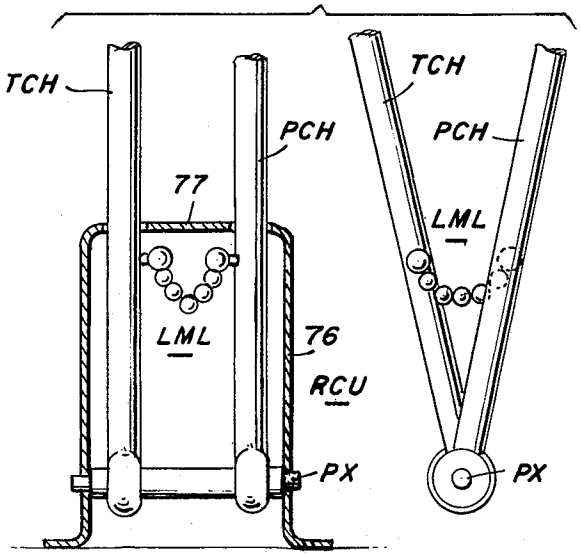
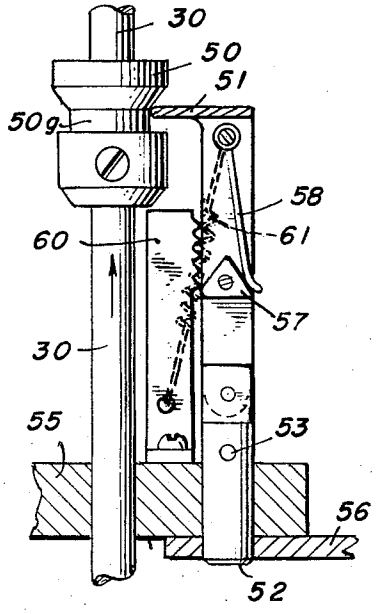
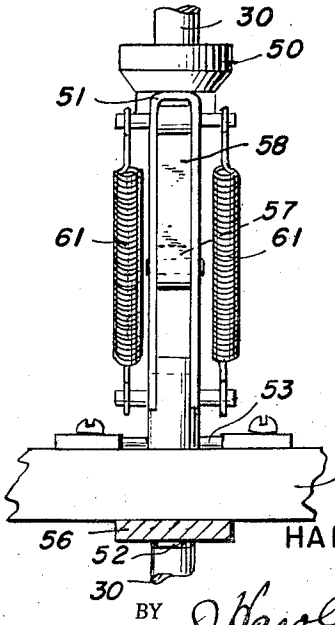


FIG. VII





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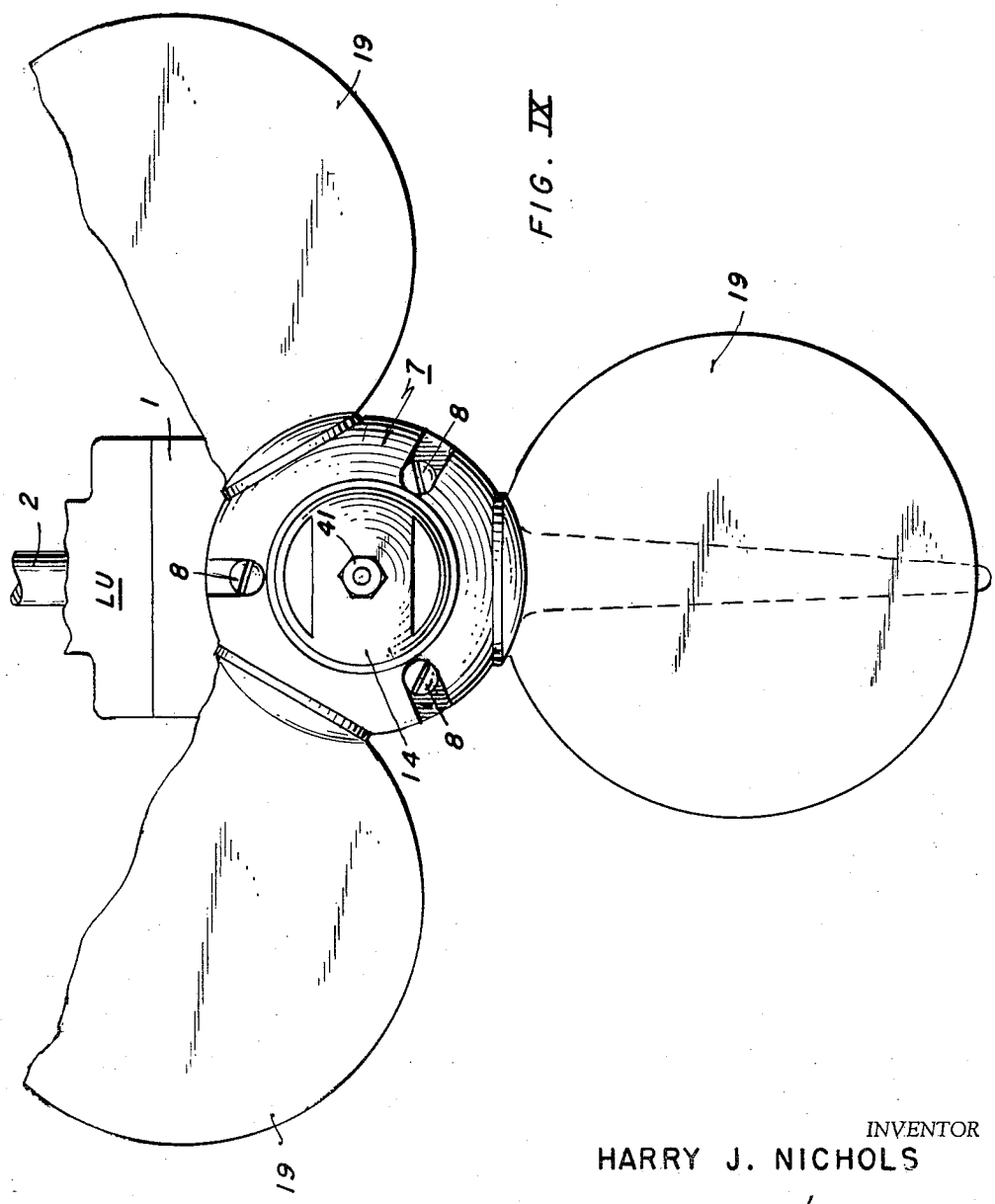


FIG. IX

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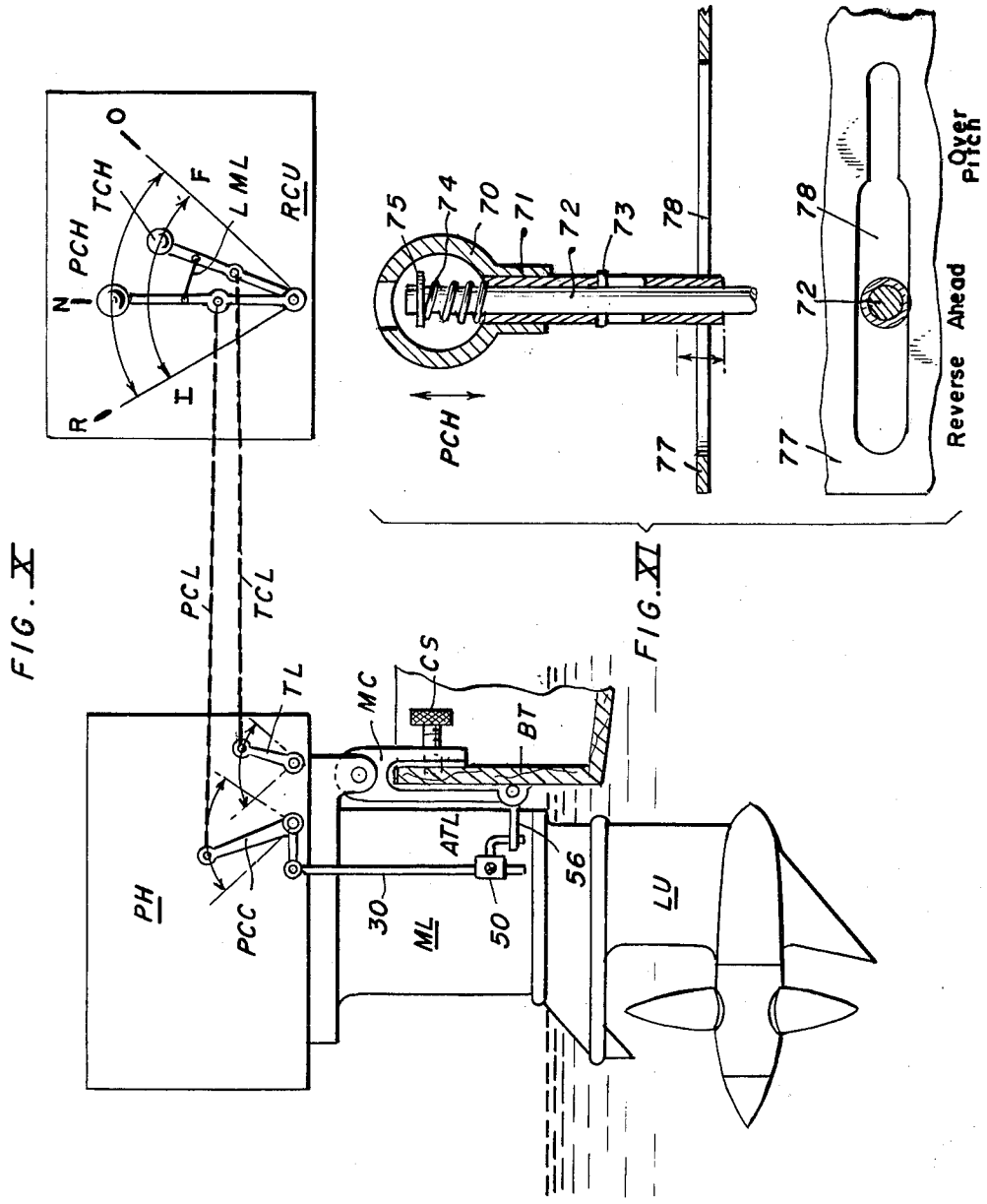
BY

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June 23, 1964 H. J. NICHOLS 3,138,136

CONTROLLABLE REVERSIBLE PITCH PROPELLER

Filed May 13, 1959 5 Sheets-Sheet 5



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United States Patent Office 3,138,136 Patented June 23, 1964

3,138,136

CONTROLLABLE REVERSIBLE PITCH PROPELLER

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Filed May 13, 1959, Ser. No. 812,904
19 Claims. (Cl. 115—17)

This invention relates to controllable reversible pitch propeller systems for marine use, and more particularly to such propellers for use on outboard motors; and has for its general object the provision of an improved propeller system of the character described in which the effective pitch of the propeller blades can be readily and accurately varied and also reversed, while the propeller is being rotated under load.

It is evident that outboard motors for motor boats are rapidly growing in size and power, as well as in numbers of models and applications. The field of application is also increasing with respect to the size of boats propelled by outboard motors. In some rather extreme cases, two to four outboard motors of upwards of fifty horse-power are mounted on the transom of a cabin cruiser—or even a slow cruising houseboat—to provide propulsion in lieu of the powerful single or twin inboard motors heretofore used. In another direction, the same model outboard motors used on recreational boats are also used for arduous commercial applications, such as fishing, hunting, transportation, rental services, etc. where utmost dependability is demanded. In yet another direction, super-power outboard motors of highest speed are used to push speed records of racing runabouts and hydroplanes to extraordinary figures. Thus, a single production model of an outboard motor may be used for racing craft, recreational boats and work boats; hence the propeller must provide efficient propulsion under quite diverse operating conditions. Since the efficient range of operation for any propeller having fixed blades is strictly limited, the need for a versatile and entirely practical controllable pitch propeller for large outboard motors is growing apace.

For outboard motors of medium power range, the practice has been to provide a two-way positive clutch coupling in the power transmission bevel gearing in the lower unit, whereby the propeller shaft can be disconnected from, or selectively coupled to, the vertical drive shaft for rotation in one or the other direction. Such clutches are of jaw-type and must be engaged abruptly in order to avoid chipping-off the corners of the jaws. But the sudden engagement of positive clutch couplings when the engine is running at idling speed is likely to stall the engine, hence the tendency on the part of the operator to speed up the engine before shifting the clutch into engagement. But if the engine is speeded up, upon shifting the clutch, the engine and propeller are rudely jerked, hence the torsional impact at clutch engagement may become damaging if not disabling—the clutch may be damaged and fail, gears may be stripped, drive shafts twisted or broken, etc. Hence, it has become evident that the increase in the power and speed of outboard engines renders the conventional two-way positive clutch inadequate and dangerous. The controllable and reversible pitch propeller provides a complete and satisfactory solution to this problem, since the shift clutch is entirely eliminated, and propulsion power can only be applied gradually by the operator.

Because of the aforesaid diverse applications of the larger outboard motors, it has become customary to fit each model with a variety of fixed-pitch "custom" propellers, commonly called "wheels" of different pitches and number of blades. For example, the same model may be fitted with two-bladed "racing wheels," three-bladed "standard wheels" and four-bladed "heavy-duty wheels." Each of these "wheels" may require several pitches.

Thus, as outboard motors have increased in power and range of applications, the limitations of fixed pitch propellers have entailed complications and excessive costs in providing a wide variety of "wheels" for the multitude of users. The controllable pitch propeller provides a technical and economical solution to this problem, since a single "wheel" provides all needed pitches. However, it is highly desirable that the design of the variable pitch propeller per se will enable two, three or four bladed "wheels" to be produced with only minor modifications of structure. This calls for a basic mechanical design of unusual versatility.

It is well known that craft propelled by outboard motors are often used in lakes, rivers, creeks, harbors, coves, shallow waters, etc. where the chances of the propeller striking a submerged object are high. Hence, propellers for outboard motors are usually protected by either a shear-pin or an impositive driving clutch, such as a multi-disc friction clutch or rubber-block slip clutch, utilized as the means for coupling the propeller hub to the propeller shaft. The use of shear pins provides a positive drive but entails the disadvantage that once the pin is sheared, the boat is disabled until the pin can be replaced. The use of slip clutches entails the disadvantage of an impositive drive which may slip prematurely under load, and the limitation of requiring a substantial space at or in the hub. Thus, while it is highly desirable to include an adequate safety clutch in the hub mechanism of a controllable pitch propeller for outboards, the space limitations are severe and difficult to overcome.

It seems generally obvious that a controllable pitch propeller for use on outboard motors must also be extremely compact and rugged, dependable and durable, made of the best materials, yet economical to produce; but just how such complex and conflicting requirements can be met is far from obvious. Thus when devising and designing controllable pitch propellers for outboard motors, the inventor or mechanician is confronted with the paradox of combining miniaturization with ruggedness, squeezing powerful mechanism into rigidly restricted spaces, and combining simplicity of elements with complex functions. Further, adequate safety and protective devices must be incorporated, and the material, strength and cost of each piece must be carefully considered. It is therefore quite evident that the diverse and conflicting requirements for a controllable reversible pitch propeller system for outboard motors are unusually complex and difficult to meet. It follows that elementary ideas and obvious mechanical devices and designs do not provide an adequate solution to this problem, hence more sophisticated devices and designs must be devised. Accordingly, the inventor and designer in this art is greatly limited and restricted with respect to devising practical devices and selecting components utilizable for his manifold purposes.

For efficient and "fool-proof" operation of controllable and reversible pitch propeller systems, coordinated means are required to control the pitch-changing mechanism, so as to set the effective blade pitch in a proper range of settings conforming to engine speed and power, and to the maneuvring or running conditions, boat resistance, boat speed, etc. It is also highly desirable to provide, in the pitch control system, means for indicating positionally and visually the status of the propeller pitch, at one or more remote control positions. For controllable pitch propellers for outboard motors, such features may be regarded as essential, since such propellers are used for quick maneuvring, braking and stopping purposes; often under emergency conditions where the pilot must act quickly and intuitively with possibly a quick glance at the pitch controls.

It is also highly desirable that the pitch controls be

coordinated in a logical manner with the engine throttle controls, thereby properly to coordinate engine and boat operation for best results without overtaxing the engine. Thus, when starting the engine, the propeller blades should be at "Neutral" (no thrust) pitch, while the engine throttle should be set at a somewhat advanced position; followed by retarted throttle when the engine starts and runs under idling conditions. When a boat is being accelerated to full or planing speed, the throttle should be moved to "Full" position, while the pitch control should be at "Ahead" position, i.e. at less than full pitch, in order to obtain maximum thrust. After the boat is brought up to planing speed, which requires running the motor at substantially full throttle, the pitch control should be advanced to "Over-Pitch," i.e. to full pitch, thereby increasing the speed of the propeller jet relative to propeller speed and thus obtaining maximum boat speed when planing at reduced hull resistance. Again, the requirements for an adequate control system are complex rather than simple.

When a reversible pitch propeller is used for braking and "crash" stopping the boat with the engine running at full throttle, shortly after the pitch is reduced there is a sudden and powerful reversal of the dynamic forces acting on the blades and pitch-changing mechanism, commonly called "kick-back." Unless preventive measures are designed into the pitch changing mechanism, "kick-back" may be transmitted back to the manual pitch control handle, with adverse consequences to the operator. Hence it is essential to incorporate an "anti-kick back" feature in manually operated controllable reversible pitch propeller systems.

The prior art discloses numerous attempts at devising a controllable pitch propeller especially adapted to meet the diverse and complex requirements of outboard motors, but the devices and designs employed have been generally inadequate and characterized by mechanical complications, such as staggered blades and complicated but weak blade-turning movements and pitch changing mechanisms. Complicated mechanisms naturally complicate production and assembly, thus running up the overall cost.

In view of the foregoing, a major object of the present invention is to provide an exceptionally simple, rugged, well-protected, safe and dependable pitch-changing mechanism, which is economical to manufacture, easy to assemble, install and service; and which embodies pitch indicating and pitch range adjusting means, and other practical operating features; thereby to promote safe and dependable operation even by inexperienced and unskilled motorboat operators.

Another object is to provide a powerful and rugged blade-turning movement adapted to be housed in a propeller hub of minimum diameter relative to the required wheel diameter, which movement will have a minimum of working parts, which will hold the blades rigidly, thereby avoiding any possibility of flutter or vibration of the blades while in high speed operation due to back-lash or elasticity in the pitch-changing mechanism; and which will also automatically lock the blades against re-active displacement at any position of pitch adjustment, thus providing an inherent "anti-kickback" feature.

Another object is to provide a pitch-changing mechanism of adequate angular range, including "Reverse" and "Over-Pitch" ranges; and which enables the pitch to be manually controlled from operating positions remote from the motor.

Yet another object is to provide a pitch-changing mechanism in which the operating mechanism is relieved of any strain except when the pitch is being changed, thus reducing wear and enabling relatively light mechanical parts to be employed in the linkage and control-force transmitting mechanism.

Yet another object is to provide the propeller hub assembly with a compact, semi-positive, safety-clutch which will enable the propeller shaft to drive the propeller normally, but which will permit the propeller to slip freely around its drive shaft should it strike an obstruction.

A further object is to provide means for avoiding damage to the pitch-changing mechanism, even tho the propeller strikes an obstruction with sufficient force to slip the safety-clutch.

Yet another object is to provide a propeller construction which enables individual blades and other mechanical components to be readily and quickly replaced in event of their becoming unserviceable due to accident or wear.

Yet another object is to provide a novel mechanism for angularly transferring translatory movement of a vertical rod to proportionate movement of an axially reciprocatable horizontal rotary rod.

A further object is to disclose a mechanical organization, design and construction of a propeller assembly of unusual versatility which can, by proper proportioning of the component parts, be adapted to a range of sizes to suit a series of outboard motors; and which can moreover be adapted, by simple variations in the hub and cam block, to provide "wheels" with two, three and four blades.

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 comprehend the underlying features of this invention so 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. I is a principal view in partial axial section of a marine variable pitch propeller, with driving and pitch-changing means therefor, embodying certain features of the invention.

FIG. II is a fragmentary view of the front portion of the motor lower unit, showing details of the mechanism of the invention for converting vertical translatory motion of a stationary rod to proportional horizontal motion of a rotating rod.

FIG. III shows details of the axially slidable, prismoidal cam block which constitutes a major feature of the invention.

FIG. IV shows details of the portion of the hub which houses the safety clutch assembly shown in FIG. I.

FIG. V shows detail views of the crown-toothed disc element of the safety clutch assembly shown in FIG. I.

FIG. VI shows similar views of a Belleville spring element of the safety clutch assembly shown in FIG. I.

FIG. VII shows typical details of the novel automatic tilt lock mechanism of the invention, shown in the locked position.

FIG. VIII shows a view of the same mechanism in the unlocked position.

FIG. IX is a partial transverse view which shows the general arrangement of the propeller of FIG. I as viewed from astern.

FIG. X is a schematic diagram showing the general arrangement of the various major elements of the marine propulsion system of the invention.

FIG. XI shows detail views of the pitch range limiting device operatively associated with the pitch control handle.

FIG. XII shows detail views of a typical combination remote control unit provided with a lost-motion linkage for coordinating the engine throttle control with the pitch control.

General Description

Considered as a whole and referring generally to the drawings, the general organization of the invention combines a complete outboard motor with a coordinated controllable pitch propeller system. The outboard motor construction comprises the power head PH, which includes the engine E and its accessories; the lower unit LU which houses a bevel-gear power transmission and mounts the controllable pitch propeller and associated mechanism; and the motor leg ML which serves to unite and support the upper and lower units, and to house the vertical power drive shaft. Motor leg ML also carries hinged means for mounting the motor on the boat. The controllable pitch propeller system includes a propeller assembly or "wheel" having a hub mounting axially rotatable propeller blades, a unique blade turning mechanism and a novel semi-positive driving clutch; a novel reciprocatory motion transfer device housed in the lower unit; a vertical pitch control rod and operatively associated automatic tilt lock mounted on the motor leg; a pitch control converter device mounted on the power head; a remote control unit LCU having coordinated pitch control and throttle control functions and presumably located at the piloting position; and independent pitch control and throttle linkages for operatively connecting the remote control unit with the pitch control and throttle control devices on the power head.

Motor Lower Unit

Referring to FIGS. I and X, the motor lower unit LU is assembled to the motor leg ML by means of several screws in customary manner. Motor leg ML houses and operatively mounts vertical drive shaft **2** rotating in stationary lower bearing **3**; while drive shaft **2** carries at its lower end bevel drive pinion **4** keyed thereon. Motor leg ML also houses and mounts reciprocatory vertical pitch control rod **30**. Drive shaft **2** is driven by the outboard motor engine E (see FIG. X), while pitch control rod **30** can be displaced axially through a limited distance by pitch-control linkage means described hereinafter. A driven bevel gear **5** is fast on horizontal propeller shaft **6**, which latter is rotatably mounted in lower unit LU and held against axial displacement by means of a combination two-way thrust-and-radial ball-bearing **41** secured in the horizontal main bore of lower unit LU against axial displacement, by conventional means. A steady bearing **43** is mounted in a wall **44** in lower unit LU for the purpose of maintaining the axis of propeller shaft **6** in proper alignment. A commercial shaft seal **42** is secured tightly in the main bore of lower unit LU and tightly around propeller shaft **6**; thus serving to keep lubricant within and water without lower unit LU, in conventional manner. Propeller shaft **6** is hollow, and has a splined-and-threaded outboard end portion adapted for mounting the propeller assemblage, as described hereinafter.

The propeller assemblage comprises mainly a unitary screw propeller, or "wheel," having a hub **7** with projecting rotatable propeller blades **19**. Hub **7** consists of two matched and abutting hollow castings (**7A**, **7B**) clamped rigidly together at assembly by cap screws **8**, which screws are inserted in longitudinal holes located symmetrically between the co-planar radial blades **19**; the latter having double-flanged root portions or journals mounted in the round radial sockets formed in the abutting faces of the hub castings, so as to be rotatable about their radial axes. It may be noted here that anyone or all of blades **19** can be readily dismounted merely by removing cap screws **8** and releasing and unscrewing nut **14**. Hub **7** has a central axial bore in which cam block **20** slides axially to turn blades **19** about their axes. Hub **7** is clamped on propeller shaft **6** against axial displacement, and normal angular displacement, by means of thrust washer **9** and a novel, semi-positive safety-clutch **10** assembled in an axial blind counterbore in hub piece **7B** near the outboard end of propeller shaft **6**. The inner face of this

counter-bore in hub part **7B** has cast therein an annular series of serriform radial indentations obverse to the serriform crown-teeth of a mating clutch disk. Thus, hub part **7B** constitutes the fixed driven member of the safety clutch (see FIG. IV).

Semi-Positive Safety Clutch

This safety clutch, of crown coupling type, also includes a hard metallic driving-disk **11** having a central bore splined complementally to propeller shaft **6**, so as to be slidable but non-rotatable thereon. Driving-disk **11** also has an inner face with an annular series of serriform radial crown-teeth, obverse to the said indentations, and a flat outer face (see FIG. V). A clutch compression spring **12**, consisting of two identical Belleville springs (see FIG. VI) mounted back-to-back on propeller shaft **6**, and a special clutch-adjusting nut **14**, screwed on the threaded-and-splined outboard end of shaft **6**, provide adjustable means for setting the torque at which the clutch will slip. When adjusting nut **14** is properly tightened, hub **7** is clamped on propeller shaft **6** in a semi-positive manner by reason of the spring force exerted by Belleville springs **12** against clutch-disk **11**, whereby the clutch elements are held firmly together, but can be forced to slip angularly without damage in event a certain propeller torque is exceeded; as for example in event the propeller strikes a submerged object while running.

This safety clutch is designed to transmit the maximum propeller shaft torque when properly adjusted at assembly; whereupon a cross-hole is drilled thru propeller shaft **6** to receive cotter pin **15**, as indicated. Thus, whenever adjusting nut **14** is screwed on until cotter pin **15** can be inserted in its cross-hole, the safety-clutch is properly re-set to carry the required shaft torque; but a greater torque will cause the hub assembly to slip around the shaft.

When the mating clutch surfaces are made as shown in the detailed drawings (see FIGS. IV–V) the driven disk has radially widened clutch teeth, whereby, when the two sets of clutch teeth are in relative rotation, they cannot positively engage; hence when the clutch slips, the clutch disks slide with relatively light frictional drag. This feature thus provides the main advantage of shear pin drives.

Consequently, the novel design and construction provides a driving semi-positive safety-clutch, with adjustable torque transmitting capacity, which operates reliably to protect the propeller blades and hub assembly against excessive damage from impact with an obstruction, without consequently disabling the boat. As compared with a conventional slip-clutch holding only by friction, the safety clutch of the invention has greater torque transmitting capacity in relation to size, less critical adjustment, less drag after slipping, and permits the clutch driving surfaces to be lubricated; so that this is virtually a "wet-clutch," which while guarded against premature slipping also minimizes wear of the driving parts. Thus this novel and exceptionally compact and rugged safety clutch secures a unique combination of distinct practical advantages which can be fairly characterized as an advance in the art.

Propeller Blades

The construction of the propeller invention provides "wheels" having two, three or four identical propeller blades **19**, each having an integral boss and end-flanged journal, rotatably mounted in evenly spaced combination radial and two-way thrust bearings formed in the abutting faces of the hub castings. Blades **19** may have any usual form and section. Each journal flange mounts a pair of inwardly projecting diametral twin crank-pins **16**, these pins having roots pressed tightly into under-size holes drilled perpendicularly into the face of the flange. Each crank-pin is fitted with a sleeve roller **17**, which rolls in a co-acting cam groove CG milled in the opposite lateral face of sliding cam block **20**, described hereinafter. (See

FIGS. I and III.) Each blade mounting is made watertight by an O-ring seal **18**, seated under compression in half-grooves in the blade boss and hub socket faces, respectively, as shown. Seals **18** also serve to exclude sand from the journal bearings, and to retain lubricant within these bearings and the hub spaces.

Blade Turning Mechanism

The blades **19** are swung about their journals so as to vary their effective pitch by a special blade-turning mechanism mounted within an axial central counter-bore in hub **7**, said counter-bore being closed at the outboard end, as shown in FIGS. I and IV. The load-driving member of the blade-turning movement consists of axially slidable prismoidal cam block **20** loosely fitting on propeller shaft **6** and in the bore of hub **7**. Cam block **20** has flat lateral faces, one for each blade, each face having a pair of intersecting symmetrical two-edge cam grooves CG. Each pair of these grooves resemble a chevron in plan, whence they are termed "chevron grooves" (see FIG. III).

Upon axial translation of cam block **20** by the pitch-changing mechanism, each pair of crank pins are forced to swing about the blade axis of rotation as followers in their "chevron grooves"; whereby a torque couple is applied to turn each blade about its journal. The actual geometric forms of the "chevron grooves" are those of conjugate trochoids, and the curvatures are such that the angular rotation of the blades is in direct relation to the axial travel of cam block **20** from its mid position. The twin crank-pin and "chevron-groove" movement provides a mechanical advantage of approximately 4:1; and is self-locking in any position to which it is set, thus providing the highly desirable "anti-kickback" characteristic in the blade-turning movement per se.

It should be noted that the twin-crank pins **16** are disposed radially in the cam groove towards and along the axis of propeller shaft **6**. In event a blade strikes a heavy obstruction, cam block **20** rotates freely on propeller shaft **6** together with hub **7**, while the blade roots bind in their sockets, hence there is no material tendency to shear-off the crank-pins. This unique blade-turning mechanism is considered to combine the substantial advantages of ultimate compactness and simplicity, maximum ruggedness and reliability, high mechanical efficiency and manifold over-all advantages. For further details, reference is made to my U.S. Patent No. 2,675,084 dated April 13, 1954.

Pitch Changing Mechanism

In all mechanically operated controllable pitch propeller systems, a special mechanical problem is encountered due to the fact that the propeller is carried on a rapidly rotating shaft, while the mechanism for applying a controlling or operating force to change the blade pitch must be stationary in part.

Cam block **20** is moved axially to set the pitch of the blades by pitch changing mechanism including a novel device for angular transmission of motion of translation of a stationary rod to a rotating axially reciprocatable rod; comprising vertical pitch control rod **30**, having fixed to its lower end "fork-rack" **31**, long pinion **32** mounted rotatably on fixed pintle **33** (having its ends supported in two bearing holes drilled crosswise in lower unit body **1**), and round rack **34** mounted upon rotary reciprocatable horizontal connecting rod **35** and held against translation thereon by suitable means such as cotter pin **36**. (It should be noted here that long pinion **32** can be assembled in place by inserting pintle **33** thru a pair of opposite bearing holes in lower unit body **1**; whereupon those holes can be sealed.) Round rack **34** resembles a worm pinion, except that the circular teeth are not inclined to the axis, i.e. they have zero pitch; hence round rack **34** can rotate freely without driving pinion **32**. Thus, upon axial translation of vertical pitch control rod **30** (by operation of the "Pitch Control Lever" and interconnecting mechanical linkage) fork-rack **31** rocks pinion **32**, which in turn translates round rack **34**, thence rotary horizontal connecting rod **35** coaxial with propeller shaft **6**.

Horizontal connecting rod **35** is mounted slidably in the bore of hollow propeller shaft **6**, which latter has a pair of diametral cross-slots **6***s* near its outboard end, while connecting rod **35** is provided with a diametral cross-hole in which is assembled cross-pin **36**. Cam block **20** has at its outer end a shallow counter bore **20***c*, in which a thrust ring **38** is loosely retained by removable snap-ring **39**. The projecting ends of cross-pin **36** are seated in fitting holes in thrust ring **38**. The purpose of this construction is to connect cross-pin **36** so as to translate cam block **20**, while providing for free rotation of cam block **20** upon propeller shaft **6**. Thus, in event the propeller strikes a submerged object causing the safety-clutch to slip, cam-block **20** can turn freely on propeller shaft **6**, thereby eliminating any probable damage to the pitch control mechanism.

Automatic Tilt Lock

A special mechanical problem is encountered in the application of controllable reversible pitch propellers to outboard motors because, for reasons of safety, such motors are usually mounted on the stern of the boat by hinged means, so as to swing freely astern and upwardly in event the lower unit strikes an obstruction or the boat runs aground. But should the propeller driving thrust be reversed, the motor must be locked against swinging away from the boat, else the propeller will pull the lower unit out of the water, with loss of braking effect and possible damage to propeller or engine.

As indicated diagrammatically in FIG. X, a mounting clamp MC is horizontally hinged to motor leg ML of the motor. Clamp MC is hung over the boat transom BT and clamped tightly by clamp screws CS. The automatic tilt lock ATL functions to lock or unlock mounting clamp MC with respect to motor leg ML under partial control of vertical pitch control rod **30**.

In the case of conventional outboard motors having a gear shift transmission with a shift handle having mid "Neutral," "Forward" and "Reverse" positions, if a controlled tilt lock mechanism is provided such mechanism is ordinarily arranged to be locked in the "Reverse" and "Neutral" positions, and to be unlocked while the shift handle remains in the "Forward" position. However, in the case of outboard motors having a reversible pitch propeller, as here, it is necessary to lock mounting clamp MC to motor leg ML not only in "Reverse" and "Neutral" ranges, but also anywhere in the "Ahead" range whenever the pitch is decreased. This follows from the fact that when a controllable pitch propeller is running with positive pitch to drive the boat ahead, a small decrease in pitch may cause the propeller to reverse its thrust and to exert a braking action which tends to check the boat's speed. Thus, a relative reverse force is produced, tending to swing the propeller out of the water. Hence, it becomes necessary to provide a special automatic tilt lock device which will function to produce locking action upon merely decreasing the pitch, rather than actually reversing the pitch.

Referring now to FIGS. VII and VIII which show typical details of the novel automatic tilt lock device of the invention for meeting the requirements of outboard motors when equipped with a controllable reversible pitch propeller, vertical pitch control rod **30** is provided with a coaxial grooved sleeve, herein termed the adjustable trip **50**, which can be fixed along vertical rod **30** by means of a set screw, as indicated. A slidable bolt **52** is arranged in parallel relation to vertical rod **30**, so as to work longitudinally in a fitting hole **54** in frame member **55**. A stop pin **53** or equivalent is provided to limit the projection of bolt **52** from frame member **55**. The locked member of the locking device, herein termed lock link **56**, is mounted so as to slide transversely underneath frame member **55**, said lock link **56** being provided with a hole or stop;

whereby bolt **52** when extended locks link **56** and releases same when withdrawn.

A special device, herein termed the "ladder rachet device," is provided to control the motion of bolt **52** in conjunction with adjustable trip **50**. The ladder rachet device comprises pawl **51** hinged to bolt **52** as shown, and carrying a tiltable detent **57** of triangular section and detained in operating position by spring finger **58**. A toothed piece, adapted to be engaged by detent **57**, herein designated as rachet ladder **60**, is mounted on frame **55** between control rod **30** and bolt **52**.

A pair of coiled retractive springs **61** are connected between the upper part of pawl **51** and the lower part of rachet ladder **60**, so as to provide a stored force tending to pull pawl **51** towards and downwardly along rachet ladder **60**.

The operation of the ladder rachet device is as follows: Assuming control rod **30** to be at the lower end of its travel, as shown in FIG. VII, which corresponds to the "Reverse" position of the pitch controls and the propeller blades, bolt **52** locks link **56** while pawl **51** is retained in liftable position in catch groove **50***g* in adjustable trip **50**.

Assuming next that control rod **30** is raised by the pitch controls as the operator moves the pitch control handle to the "Neutral" position, pawl **51** is lifted somewhat, but not enough to unlock link **56**. As rod **30** continues to rise, as in moving the pitch control handle towards "Ahead" position, detent **57** crawls up rachet ladder **60** towards the position shown in FIG. VIII.

At a certain intermediate position, according to the setting of adjustable trip **50**, bolt **52** clears and frees link **56**; thus unlocking the restraining connection between middle unit MU and hinged mounting clamp MC. But if the pitch setting were reduced by a minor degree, pawl **51** would be retained in lifted position by rachet co-action of detent **57** and rachet ladder **60**.

Referring now to FIG. VIII and VII, when trip **50** moves downwardly, the sloping top edge of trip groove **50***g* will soon push pawl **51** outwardly. Thereupon detent **57** slips off the rachet tooth with which it has been engaged, as shown in FIG. VIII whereupon pawl **51** and bolt **54** are driven back to the lowest position shown in FIG. VII. Thus, link **56** is fully relocked at once upon operation of the pitch control means to reduce the pitch, even though the propeller pitch remains in the positive range. Consequently, this automatic tilt lock enables the propeller while in the positive pitch range to be utilized for braking action on the boat, while avoiding danger of the lower unit being pulled out of the water due to reversed thrust.

In some conventional tilt lock mechanisms, the means for locking the motor against tilting may comprise or include a pivoted hook element or the like, which performs the same general functions as link **56** in the typical example shown herein, for purposes of illustrating the features and principles of the automatic tilt lock of the invention. It is therefore to be expressly understood that "link **56**" represents the symbol for the locked element, whatever its form, of the tilt lock mechanism comprehended herein.

Remote Pitch and Throttle Controls

Since outboard motors in the higher power ranges are now being used to propel runabouts, cruisers, and even house-boats, in which the convenient location for the pilot is usually remote from the motor, it is essential that the motor operating controls, comprising in this case the propeller pitch control and the engine throttle control, be of remote control type. It is also highly desirable that special provisions be made for a certain degree of automatic coordination of the pitch control and throttle control.

In the case of outboard motors equipped with a controllable reversible pitch propeller as contemplated by the present invention, for ordinary applications the pitch controls should permit continuous variation of the pitch within certain ranges, while indicating the effective pitch setting by the visible relative position of the master control element, herein termed the pitch control handle PCH. Four main positions of pitch control handle PCH should be indicated visually, as by suitable markings as indicated, namely the "Reverse" (full astern), "Neutral" (mid) "Ahead" (forward) and "Overpitch" (extreme) positions. When pitch control handle PCH is in indicated "N" position, the blades of the propeller are designed to be turned to such a pitch angle that the outer portion of each blade moves the water ahead, while the inner portion moves the water astern; thus the water is stirred or circulated without producing any effective thrust, hence the wheel is said to be in "neutral." When in neutral, the wheel absorbs very little torque at low engine speeds; but the absorbed engine torque increases as the square of the rotary speed, hence the wheel, even in neutral, prevents the engine from running wild, and even with fully advanced throttle. It should be noted that the operating situation with ordinary outboard motors having a gear-shift transmission with a free clutch is quite different; because when the gear shift is thrown into "neutral," the wheel is uncoupled and the only load on the engine is its own friction; hence the engine can easily run away, even at part throttle, and particularly at starting. It follows that one of the substantial advantages of the controllable pitch propeller of the invention is greater safety of operation, by reason of elimination of the danger of overspeeding the engine.

When the pitch control handle PCH is moved from "Neutral" towards "Ahead," the change in effective pitch increases the ahead thrust, while the astern thrust diminishes and disappears. When pitch control handle PCH is moved from "Neutral" towards "Reverse," the reactions and thrusts are in reversed direction. Hence, a motor boat equipped with a controllable reversible pitch propeller can be propelled at various speeds in either direction merely by pitch control; without or with variation of the throttle setting.

Overpitch Operation

Under certain typical outboard boat operating conditions, it is highly advantageous to operate the controllable pitch propeller beyond its normal ahead pitch range, herein termed "overpitch." Two typical examples of overpitch operation will be considered here, keeping in mind that the torque and thrust of a wheel depend upon the effective pitch, as well as upon engine and boat speeds. In the case of relatively light boats designed to plane at a certain speed (with a certain load), as the engine and boat speed are pushed up to elevate the boat to planing aspect in the water, strong thrust is needed, which requires a low or medium pitch wheel. As the boat planes, the hull resistance is reduced, but the wheel must now deliver thrust at increased velocity in order to increase the boat speed. Hence, it is advantageous to use overpitch after planing, whereby the engine can be operated to develop full power and the propeller pitch regulated to propel the boat at maximum speed obtainable at that power. With a fixed-pitch wheel, if full throttle were required to cause the boat to plane, very little speed increase would be available thereafter, because the thrust velocity would be restricted by the pitch.

As a second example, the requirements for maximum fuel economy at cruising speeds will be considered. It is of course elementary that in order to gain best engine efficiency and maximum fuel economy, the engine must be loaded to its full power rating at any particular engine speed. With a fixed pitch wheel, the engine can be loaded to its full power rating at only one engine speed, this speed being determined by the propeller pitch, among other variable factors. At less than this particular speed, the engine will be underloaded, and above this speed the engine will be overloaded. It follows that with a fixed-pitch wheel, when the engine speed is reduced for cruising, the engine efficiency and fuel economy are materially reduced. But with a controllable pitch propeller, at reduced engine speed the optimum pitch can be set to load

the engine properly for maximum efficiency and economy. This optimum pitch setting extends beyond the pitch range for full-speed ahead operation, hence the pitch control handle PCH must be set in the overpitch range for fuel economy at cruising speeds.

Selective Overpitch Device

In the pitch control system of the invention, the pitch control handle PCH is provided with a special device, termed a "selective overpitch device," for restricting the normal pitch setting to a certain operating range, while enabling the operator to select at will an extended forward range; that is the "overpitch" range.

Referring now to FIG. XI, the pitch control handle PCH is provided with a liftable round knob **70**, say a hollow ball, having an integral sleeve **71** fitting and axially slidable along pivoted lever **72**. Sleeve **71** is provided with a cross-slot **71***s*, and lever **72** with a complemental stop-pin **73** retained in a diametral hole, for the purpose of limiting the traverse of sleeve **71** along lever **72**. Knob **70** is spring-biased towards its lower position by means of a coaxial compression spring **74**, bearing at its lower end against sleeve **71** and at its upper end against a retainer ring **75** on lever **72**. Thus, knob **70** can be lifted by the operator to slide sleeve **71** upwards along lever **72**, but upon release of that knob, spring **74** will move sleeve **71** back to its normal position.

Referring to FIGS. XI and XII, pitch control handle PCH is pivotally mounted in a stationary structure or frame **76**, including a fixed guide piece **77** having a guide slot **78**, a wide portion of which guide slot fits sleeve **71** and a narrow portion fits lever **72**. The wide portion of the slot coincides with the range of pitch control handle PCH between "R" and "A," i.e. the normal "reverse" to "ahead" range; and the narrow portion with the range "A" to "O," i.e. the "overpitch" range.

Thus, with the selective pitch limiting device of the invention, the operator can move pitch control handle PCH between the limits "R" and "A" without hindrance, but to move PCH into the "overpitch" range towards "O," the operator must sensibly lift knob **70** to its top position: whereupon sleeve **71** is raised above and can slide along the top of guide piece **77** at the narrow slot position. But when the operator moves pitch control handle PCH back out of the "overpitch" range, when sleeve **71** reaches the wide slot spring **74** will restore sleeve **71** to its barring position. Thus, the selective overpitch device requires the operator to consciously manipulate the pitch controls to pass into the "overpitch" range, but automatically bars that range when returning back to normal operating range.

Co-Ordinated Pitch and Throttle Control Device

In the case of outboard motors equipped with a controllable pitch propeller system, while a controllable pitch wheel with properly designed blades inherently absorbs sufficient torque to prevent the engine from running wild, even with the wheel in "neutral" pitch position, yet under certain operating conditions it is desirable that the positions of the pitch controls and throttle controls be co-ordinated.

For example, upon starting the engine, it is desirable that the pitch controls be set at or near "neutral," while the throttle controls should be set somewhat beyond the idling position; thereby to facilitate starting while avoiding putting way on the boat.

As another example, before the pitch control is thrown into the "reverse" range, the throttle should be retarded; thus to avoid jerking the boat, or gaining fast sternway, which is unnecessary if not dangerous. Further, if the boat is running ahead and the engine is slowed down for braking purposes, the pitch controls and throttle controls should be pulled back simultaneously, to cause actuation of the automatic tilt lock device. Furthermore, there is the consideration that when running full speed ahead, reducing the pitch and throttle controls together provides smooth and effective braking action with safety.

In view of these and other considerations, means are provided, in the propulsion system of the invention, for coordinating the throttle controls with the pitch controls.

Referring to FIG. XII, which shows in elementary form, for illustrative purposes, preferred means for co-ordinating the throttle and pitch controls; pitch control handle PCH and throttle control handle TCH are shown as being hinged on a common axis or pintle PX mounted transversely in the frame **76** of remote control unit RCU. The preferred device for loosely co-ordinating the movements of pitch control handle PCH and throttle control handle TCH is a "lost-motion" linkage LML, here taking the form of the short length of bead chain, swivel fastened at its ends to each control handle. This "lost-motion" linkage permits a certain degree of independent movement of each handle; but as either handle is moved away from the other towards the limits of their operating range, they are constrained to move together. Thus, if it is assumed that the pitch control handle PCH is moved to "neutral," throttle control handle TCH will be pulled back, if fully advanced, so as to limit the running speed of the engine. Likewise, if pitch control handle PCH is moved to its "reverse" position, throttle control handle TCH will be pulled back to its middle range. Conversely, if throttle control handle TCH is pulled far back towards idling position when pitch control handle PCH is in the "overpitch" range, the pitch will be reduced, thus preventing overloading or stalling the engine at low throttle.

It is to be expressly understood that "lost-motion" linkage LML may take other forms, such as a slotted link, or a hinged pair of links, and may be installed in other locations in the motor control system, as for example in the power head. Whatever coordinating device is used should permit a certain degree of independent movement of throttle and pitch controls, so that in the running range the pitch control can be set to load the engine to rated output at the desired engine or boat speed.

Having now described and illustrated one form of my invention, I wish it to be understood that my invention is not limited to the specific form or arrangement of parts herein described and shown, or specifically covered by the appended claims.

I claim:

1. A marine propulsion system having, in combination, an outboard motor comprising: a power head including an internal combustion engine, a motor leg housing a vertical power drive shaft driven by said engine, a structural lower unit mounting a rotatable horizontal hollow propeller shaft, said lower unit also mounting and housing a bevel-gear power transmission connecting said drive shaft in driving relation to said propeller shaft; and a cooperative controllable reversible pitch propeller system including a propeller assemblage having a hub fixed on said propeller shaft and mounting radial blades journaled in said hub for pitch changing movement, pitch changing mechanism including an axially reciprocatable rotary connecting rod carried by said propeller shaft for turning said blades each about its axis, and pitch control means including a remote control unit having a master pitch control handle, a pitch control lever mounted on said power head, linkage means operatively connecting said master pitch control handle to said pitch control lever, a vertical reciprocatory pitch control rod mounted on said motor leg and operatively connected to said pitch control lever, and rack and pinion gearing mounted in said lower unit for operatively connecting said vertical control rod to said connecting rod of the pitch changing mechanism.

2. A marine propulsion system having, in combination, an outboard motor comprising: a power head including an internal combustion engine, a motor leg

housing a vertical structural lower drive shaft driven by said engine, a power unit mounting a rotatable horizontal hollow propeller shaft, said lower unit also mounting and housing a bevel-gear transmission connecting said drive shaft in driving relation to said propeller shaft; and a co-operative controllable reversible pitch propeller system including a propeller assemblage having a hub fixed on said propeller shaft and mounting radial blades journaled in said hub for pitch changing movement, pitch changing mechanism including an axially reciprocatable rotary connecting rod having a round rack at the input end carried by said propeller shaft for turning said blades each about its axis, and pitch control means including a remote control unit having a master pitch control handle, a pitch control lever mounted on said power head, linkage means operatively connecting said master pitch control handle to said pitch control lever, a vertical reciprocatory pitch control rod mounted on said motor leg and operatively connected to said pitch control lever, and toothed gearing comprising two racks and a pinion mounted in said lower unit for operatively connecting said vertical control rod to said round rack of said pitch changing mechanism.

3. A marine propulsion system having, in combination: an outboard motor comprising, a power head including an internal combustion engine, a motor leg housing a vertical power drive shaft driven by said engine, a structural lower unit mounting a rotatable horizontal hollow propeller shaft, said lower unit also mounting and housing a bevel-gear power transmission connecting said drive shaft in driving relation to said propeller shaft; and a co-operative controllable reversible pitch propeller system including a propeller assemblage having a hub fixed on said propeller shaft and mounting radial blades journaled in said hub for pitch changing movement, pitch changing mechanism carried by said shaft for turning said blades each about its axis including a horizontal reciprocatable rotary connecting rod coaxially slidable in said propeller shaft; pitch control means including a remote control unit having a master pitch control handle, a pitch control lever mounted on said power head, linkage means operatively connecting said master pitch control handle to said pitch control lever, a vertical pitch control rod mounted on said motor leg and operatively connected to said pitch control lever, and a motion translating device comprising a train of three gears mounted within said lower unit for operatively connecting said vertical control rod to said horizontal rod in said propeller shaft.

4. A marine propulsion system having, in combination: an outboard motor comprising, a power head including an internal combustion engine, a motor leg housing a vertical power drive shaft driven by said engine, a lower unit mounting a rotatable horizontal hollow propeller shaft, said lower unit also mounting and housing a bevel-gear power transmission assemblage connecting said drive shaft in driving relation to said propeller shaft; and a co-operative controllable reversible pitch propeller system including a hub assemblage fixed on said propeller shaft and mounting radial blades journaled in said hub for pitch changing movement, pitch changing mechanism carried by said shaft or turning said blades each about its axis including a reciprocatable rotary connecting rod coaxially slidable in said propeller shaft; pitch control means including a remote control unit having a master pitch control handle, a pitch control lever mounted on said power head, linkage means operatively connecting said master pitch control handle to said pitch control lever, a vertical reciprocatory pitch control rod mounted on said motor leg and operatively connected to said pitch control lever, and rack and pinion gearing comprising a train of three gears including a round rack housed within said lower unit for transmitting reciprocatory motion between said rods.

5. In a controllable pitch propeller system for outboard motors, the combination of: a lower unit mounting and housing a pair of power transmitting bevel-gears and mounting a rotatable horizontal hollow propeller shaft driven by said gears; a propeller assemblage mounted on said propeller shaft including a hub fastened coaxially on said shaft and mounting radial blades journaled in said hub for pitch changing movement, and pitch changing mechanism carried by said shaft for turning said blades each about its axis, said mechanism including a reciprocatory horizontal connecting rod having a round rack rotating with and slidable coaxially in said propeller shaft; and pitch control means including a reciprocatory vertical pitch control rod, and rack and pinion gearing including said round rack, a long pinion and a fork-rack housed within said lower unit for operatively connecting said vertical pitch control rod to said horizontal pitch change rod; whereby reciprocatory motion is transferred from one rod to the other.

6. In a controllable pitch propeller system; pitch changing mechanism including a reciprocatory stationary control rod, and a reciprocatable rotating connecting rod; and rack and pinion gearing for operatively connecting said rods, said gearing comprising a toothed long pinion mounted rotatably with its axis crosswise to the axes of said rods, a fork element fixed to the end of said stationary rod and having rack teeth engaging the teeth of said pinion, and a round rack on said rotating rod having circular rack teeth engaging the teeth of said pinion; whereby said pinion transmits reciprocatory motion from one rod to the other.

7. In a controllable pitch propeller system; a motion transmitting device for operatively connecting a reciprocatory stationary rod to a reciprocatable rotary rod whose axes intersect at an angle comprising; a toothed pinion mounted rotatably with its axis located near and transverse to the intersection of said axes, a fork element fixed to the end of one rod and having rack teeth engaging the teeth of said pinion, and a round rack fixed on the other rod and having circular rack teeth also engaging with the teeth of said pinion; whereby said pinion transfers reciprocatory motion from one rod to the other.

8. In a pitch changing mechanism; a motion transmitting device for angular transmission of reciprocatory motion between a stationary rod and a rotating rod whose axes intersect comprising; a fork rack on said stationary rod, a round rack on said rotating rod, and a pinion mounted rotatably with its axis transverse to said axes, so as to engage operatively with both said racks.

9. In a variable pitch propeller system for outboard motors including a lower unit mounting and housing a power transmitting bevel-gear set and mounting a horizontal hollow propeller shaft driven by said set: the combination of; a propeller assemblage adapted for mounting on said propeller shaft and including a hollow hub mounted on and coupled to said shaft and mounting turnable radial blades journaled in said hub, each blade having a flange at its inner end with at least one crank pin projecting inwardly therefrom; mechanism carried by said shaft for turning said blades each about its axis, said mechanism including a driving prismoidal cam element movable coaxially on said shaft within said hub and having a cam groove in each lateral face engaging a crank pin, and a reciprocatory horizontal connecting rod for moving said cam element rotating with and movable coaxially in said propeller shaft; and adjustable means for varying the axial position of said rod with respect to said propeller shaft.

10. In a variable pitch propeller for outboard motors including a lower unit mounting a power driven hollow propeller shaft: a propeller assemblage adapted for mounting on said propeller shaft and including a hollow hub coupled on said shaft and turnable radial blades each having a flanged journal at its root and at least one crank pin projecting inwardly therefrom, a driving prismoidal cam element slidable coaxially on said shaft in said hub and having a cam groove in each lateral face engaging a

crank pin, and means for positioning said element along said shaft including a connecting rod movable coaxially in said hollow shaft.

11. A propeller assemblage as set forth in claim 10 wherein said hub is coupled on said shaft by means of an adjustable semi-positive crown clutch.

12. In a variable pitch propeller system for outboard motors including a lower unit mounting a horizontal hollow propeller shaft driven by said motor: a propeller assemblage adapted for mounting on said propeller shaft and including a hollow hub coupled to said shaft and mounting radial blades journaled in said hub for pitch changing movement; pitch changing mechanism carried by said shaft for turning said blades each about its axis, said mechanism including twin crank pins projecting inwardly from each blade, a prismoidal cam slidable coaxially along said shaft within said hub and operatively engaging said crank pins, and a horizontal connecting rod rotating with and movable coaxially in said propeller shaft; and adjustable means for varying the axial position of said rod.

13. In a variable pitch propeller for outboard motors including a lower unit mounting a power driven hollow propeller shaft; a propeller assemblage mounted on said propeller shaft and including a hollow hub coupled on said shaft and mounting turnable radial blades each having a flanged journal at its root and at least one crank pin projecting inwardly therefrom, a prismoidal driving cam element slidable coaxially along said shaft within said hub and having a cam groove in each lateral face engaging a crank pin; adjustable means for positioning said cam element including a connecting rod movable coaxially in said hollow shaft, and safety means for coupling said hub on said shaft.

14. A propeller assemblage substantially as set forth in claim 13, wherein said hub is coupled on said shaft by means of an adjustable semi-positive crown clutch.

15. In a controllable pitch propeller system for marine motors of outboard drive type, the combination of: a structural lower unit mounting a motor-driven rotary horizontal hollow propeller shaft, a propeller assemblage mounted on said propeller shaft including a hub having a central bore fastened coaxially on said shaft and mounting radial blades each having a journal with an inner end flange turnable in said hub, and a mechanical device mounted entirely within said hub for turning said journals each about its axis including a least one crank pin projecting from the inner face of each said flange, a prismoidal cam-block having a two-edge cam-groove in each lateral face slidable axially in the bore of said hub, each said cam-groove engaging with and positively turning at least one of said crank pins; and mechanism for sliding said cam-block axially including a reciprocatable rotary connecting rod slidable coaxially in said hollow shaft and operatively connected to said cam-block, a vertical pitch control rod, and another mechanical device having rack and pinion gearing operatively connecting said rods so as to transmit motion from one to the other, whereby said pitch control rod controls the pitch of said blades.

16. In a controllable pitch propeller system for marine motors of outboard drive type, the combination of: a structural lower unit mounting a motor-driven rotatable horizontal hollow propeller shaft; a propeller assemblage mounted on said propeller shaft including a hub having an axial bore fastened coaxially on said shaft and mounting radial blades each having a journal with an inner end flange turnable in said hub, and a mechanical device carried by said shaft for turning said journals each about its axis including at least one crank pin projecting longitudinally from the inner face of each flange, a prismoidal cam-block slidable coaxially in said bore and having a two-edge cam-groove in each lateral face engaging with and positively driving at least one of said crank pins, and pitch changing mechanism for positioning said cam-block including a vertical pitch control rod, a reciprocatable rotary connecting rod slidable coaxially in said propeller shaft, and a motion transmitting device including a fork rack fixed on said control rod, a pinion, and a round rack fixed on said connecting rod for operatively connecting said vertical pitch control rod with said connecting rod, whereby the latter positions said cam-block and thereby adjusts the pitch of said blades.

17. In a marine propulsion system having a propulsion engine, the combination comprising a vertical motor leg housing a vertical power drive shaft driven by said engine and having hinged means for mounting said motor leg in tiltable relation to a supporting structure, a lower unit mounting a rotatable, horizontal hollow propeller shaft, said lower unit also mounting and housing a bevel-gear power transmission connecting said drive shaft in driving relation to said propeller shaft; and a cooperative controllable pitch propeller system including a controllable pitch propeller having a hollow hub mounting variable pitch blades mounted on said propeller shaft, means in said propeller shaft and said hub for changing the pitch of said blades, and means for controlling the pitch of said propeller including a vertical reciprocatory pitch control rod mounted along said motor leg, and automatic tilt-lock means mounted in part on said hinged means and in part on said motor leg, said tilt-lock means including a lock link connected to said hinged means and a ladder ratchet device mounted on said motor leg for unlocking said lock link during pitch increasing travel of said pitch control rod and for locking said lock link upon any pitch decreasing travel of said rod.

18. In a marine propulsion system having a propulsion motor comprising a power unit including an internal combustion engine; a vertical motor leg housing a vertical power drive shaft driven by said engine and having hinged means for mounting said motor leg in tiltable relation to a supporting structure, a lower unit mounting a rotatable horizontal propeller shaft, said lower unit also mounting and housing a bevel-gear transmission connecting said drive shaft in driving relation to said propeller shaft; and a cooperative controllable pitch propeller system including a controllable pitch propeller and associated pitch changing mechanism carried entirely by said propeller shaft, pitch control means including a vertical reciprocatory pitch control rod mounted on said motor leg and operatively connected to said pitch changing mechanism, and automatic tilt-lock mechanism mounted in part on said motor leg and in part on said hinged means, said mechanism including a lock link connected to said hinged means and automatic means including a ladder ratchet device mounted entirely on said motor leg; whereby said lock link is unlocked by pitch increasing travel of said pitch control rod and locked upon subsequent reverse travel of said rod.

19. A marine propulsion system having, in combination: an outboard motor including a power head mounting an internal combustion engine; a motor leg housing a vertical power drive shaft driven by said engine and having hinged clamping means for mounting said outboard motor in tiltable relation to a supporting structure; a lower unit mounting a rotatable, horizontal hollow propeller shaft, said lower unit also mounting and housing a bevel-gear power transmission connecting said drive shaft in driving relation to said propeller shaft; and a cooperative controllable pitch propeller system including a propeller having variable pitch blades mounted on said propeller shaft means for changing the pitch of said blades mounted in said propeller shaft, a pitch control lever mounted on said power head, a vertical reciprocatory pitch control rod mounted along said motor leg and operatively connected to said pitch control lever, a tilt-lock device, and automatic means for operating said tilt-lock device sequentially by said vertical pitch control rod, said device including a lock link connected to said clamping means, said automatic means including a ladder ratchet

device mounted on said motor leg and trippable by said pitch control rod upon pitch reducing movement.

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