June 9, 1964 I. W. NORTH 3,136,287

INBOARD-OUTBOARD DRIVE FOR WATERCRAFT

Filed March 23, 1962 3 Sheets-Sheet 1

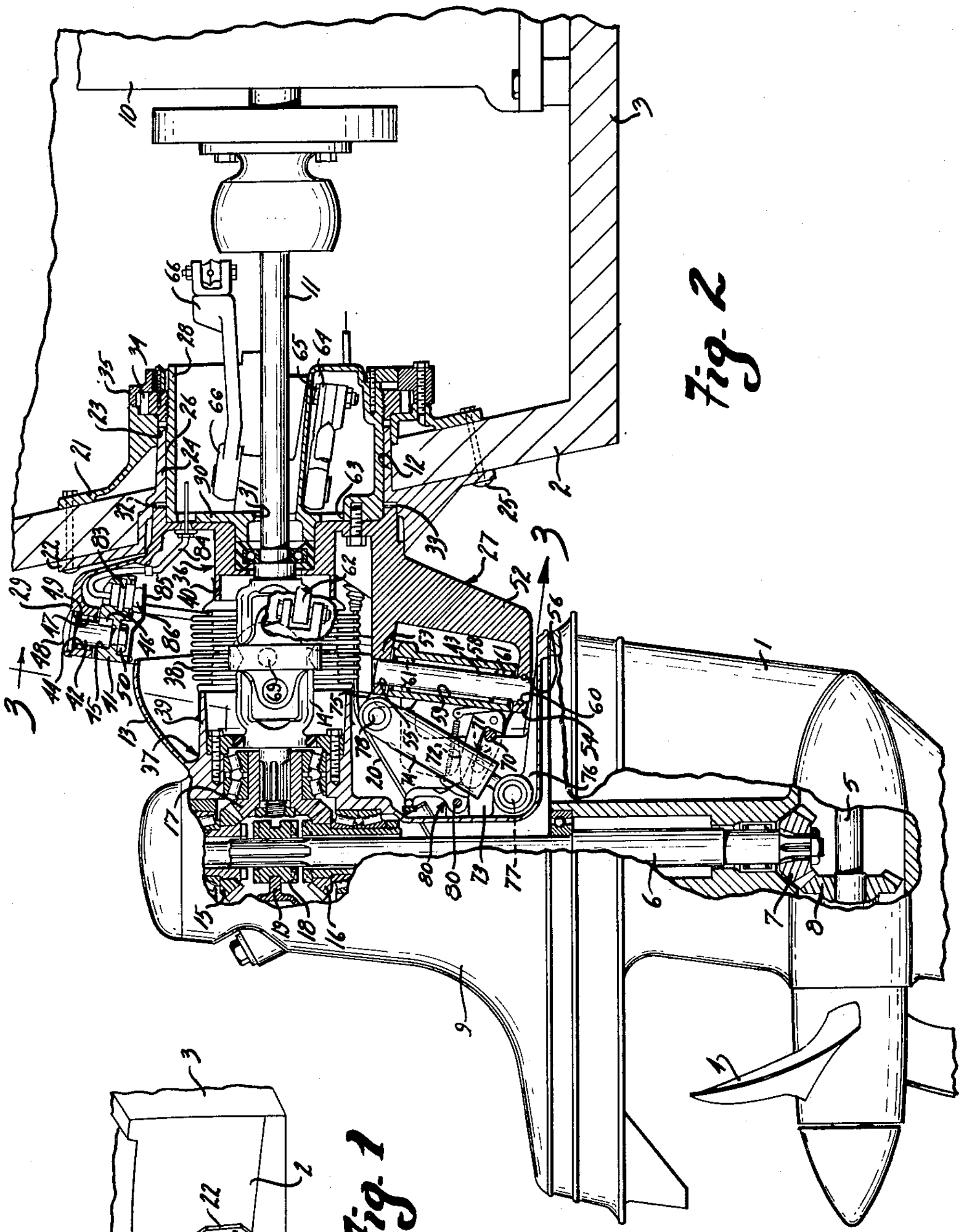

Fig. 2

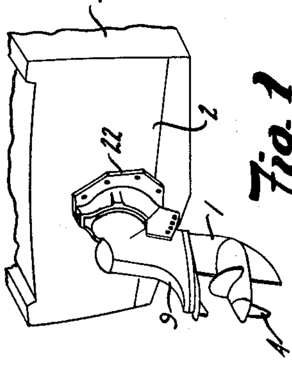

Fig. 1

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INBOARD-OUTBOARD DRIVE FOR WATERCRAFT

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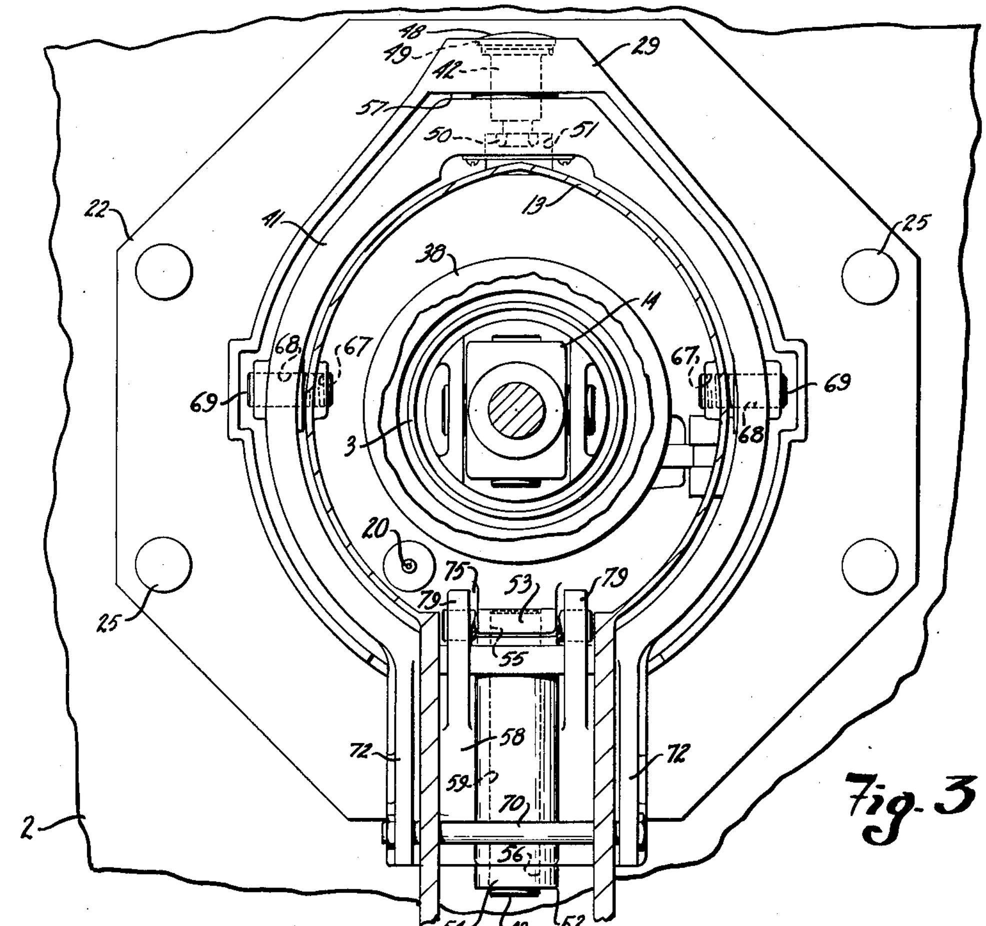

Fig. 3

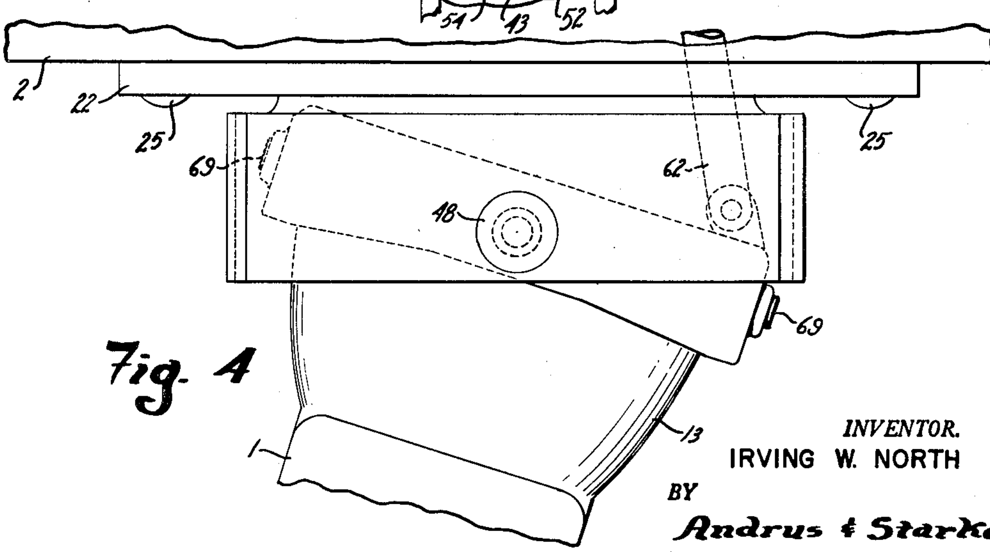

Fig. 4

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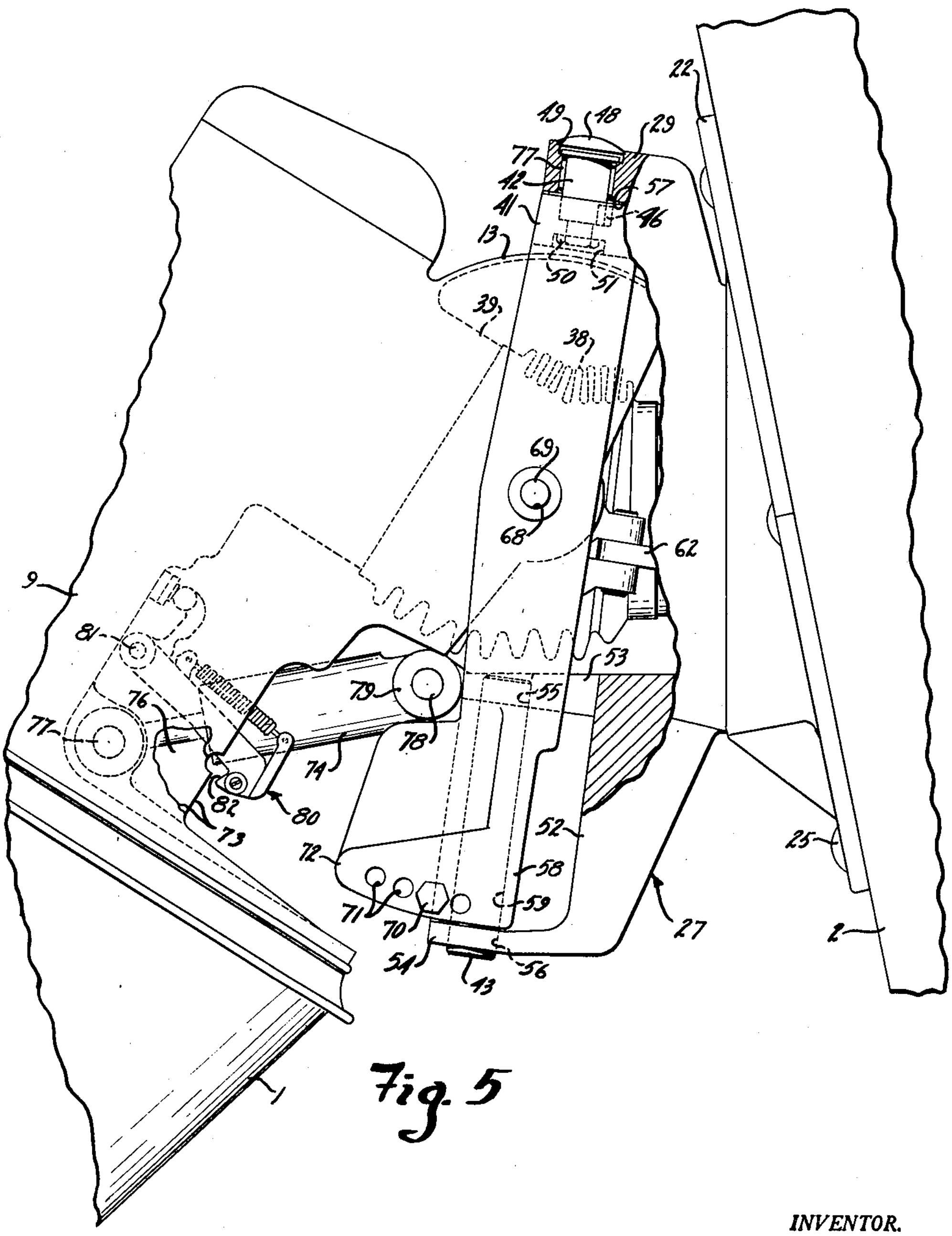

Fig. 5

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INBOARD-OUTBOARD DRIVE FOR WATERCRAFT

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This invention relates to an inboard-outboard drive for watercraft and more particularly to an improved suspension for the propulsion unit of such a drive.

The propulsion units of inboard-outboard drives are commonly mounted on the stern transom of the watercraft and driven by engines mounted inboard of the watercraft. In drives of this type the suspension for the propulsion unit commonly includes provision for steering on a generally vertical axis and for tilting on a generally horizontal axis. It is generally an object of this invention to provide an improved suspension for the propulsion unit of such drives which includes provision for both steering and tilting.

According to this invention a propulsion unit of an inboard-outboard drive is mounted on the stern transom of a watercraft and is driven by a power source mounted within the watercraft. The suspension for the propulsion unit includes a support member which is adapted to be rigidly secured relative to the transom. An intermediate member is rotatably supported by the support member on a generally vertical axis for steering control of the propulsion unit. The propulsion unit in turn is rotatably supported by the intermediate member on a generally horizontal axis to accommodate vertical tilt movements of the unit. Since the intermediate member rotates with the propulsion unit relative to the support member for steering, tilt movements of the propulsion unit will not disturb the steering geometry of the unit.

The drawings furnished herewith illustrate the best mode for carrying out the invention as presently contemplated and set forth hereinafter.

In the drawings:

FIG. 1 is a perspective view of the outboard portion of an inboard-outboard drive shown mounted on the transom of a boat;

FIG. 2 is an enlarged partial side elevation of an inboard-outboard drive with parts broken away and sectioned and showing the propulsion unit suspension of this invention;

FIG. 3 is an enlarged partial sectional view taken generally on line 3—3 of FIG. 1 to show an end elevation of the propulsion unit suspension;

FIG. 4 is a partial top plan view showing the propulsion unit in a rotated position on its generally vertical steering axis; and

FIG. 5 is a partial side elevation with parts broken away and sectioned showing the propulsion unit in a tilted position on its generally horizontal tilt axis.

Referring to the drawings, the inboard-outboard drive includes a propulsion unit 1 suspended outboard from the transom 2 of a partially shown boat or other watercraft 3. The propulsion unit includes a propeller 4 which is carried by the horizontal propeller shaft 5 and is driven by the vertical drive shaft 6 through bevel gears 7 and 8 to propel the watercraft.

The vertical drive shaft 6 is totally supported within the propulsion unit housing 9 and is in turn driven by the engine 10 mounted inboard of watercraft 3 through the horizontal drive shaft 11 which extends rearwardly from the engine through the circular transom opening 12 and into the forwardly extending bell-shaped portion 13 of housing 9. Intermediate its length the horizontal drive shaft 11 is provided with a double universal joint 14 having its center substantially at the intersection of the generally vertical steering axis and generally horizontal tilt axis of the propulsion unit 1 as will be more fully described hereinafter.

The drive connection between the horizontal drive shaft 11 and vertical drive shaft 6 includes a pair of vertically spaced beveled gears 15 and 16, one of which is a forward gear and the other a reverse gear, which are supported for free rotation within suitable bearings on the upper end of shaft 6. The drive gear 17 carried on the horizontal shaft 11 drivingly engages gears 15 and 16 and causes the latter to rotate in opposed directions. A clutch element 18 disposed between beveled gears 15 and 16 is carried by shaft 6 and is slidable axially thereon to selectively engage gears 15 and 16 to complete the drive connection between shafts 6 and 11 and drive the propeller in the desired direction. As shown in FIG. 2, clutch element 18 also has an intermediate "neutral" position between gears 15 and 16 in which case the propeller 4 is inoperative. Axial movement of the clutch element 18 relative to shaft 6 is effected by the projecting member 19 which is vertically interlocked with the clutch element and is actuated by means not shown through the push-pull cable 20 controlled from within the watercraft and extending through the transom opening 12 into the propulsion unit housing 9.

The suspension means for the propulsion unit 1 includes an inner transom plate 21 and an outer transom plate 22. The inner plate 21 is provided with an opening 23 of substantially the same size as transom opening 12 and is secured in position with the openings in aligned relation. The outer plate 22 is provided with an inwardly extending annular flange 24 the outer diameter of which corresponds substantially in size with openings 12 and 23 of the transom and inner plate respectively. Flange 24 extends through transom opening 12 and is telescoped into opening 23 of the inner transom plate to properly seat plate 22 against the transom. A plurality of circumferentially spaced throughbolts 25 extend through the transom to secure the plates 21 and 22 to the transom. The opposed transom plate construction provides a rigid mounting for the propulsion unit and distributes the propulsion unit operating stresses over a wide transom area. With outer transom plate 22 secured in position, the annular flange 24 defines the effective cylindrical transom opening 26 extending therethrough.

The suspension means further includes a housing member 27 comprising a forwardly extending cylindrical portion 28 and a rearwardly extending bell-shaped portion 29. Housing member portions 28 and 29 are separated by a partition wall 30 having a cylindrical opening 31 centrally thereof through which the horizontal drive shaft 11 extends.

Cylindrical housing portion 28 is slidably received within opening 26 of the outer transom plate 22 and extends forwardly beyond the forward end of flange 24 into the watercraft as limited by the engagement between the interfering shoulders 32 and 33 provided on the outer transom plate 22 and housing member 27 respectively. The shoulders 32 and 33 are provided with radially extending spline grooves which are engaged when the shoulders are drawn together to lock housing member 27 against rotation within opening 26. Housing portion 28 is threaded beyond the end of flange 24 of transom plate 22 and a large nut 34 is threaded thereon to secure housing member 27 rigidly with respect to the transom. An annular cover plate 35 is secured to the inner transom plate 21 and extends over the peripheral portion of the forward face of nut 34 to confine the nut between the inner transom plate and the cover plate.

Interiorly of the bell-shaped portion 29 of support housing 27 there is provided a cylindrical shaft support structure 36 through which the horizontal drive shaft 11 extends. A cylindrical shaft support structure 37 is also provided interiorly of the bell-shaped opening 13 of the propulsion housing 9. In the assembled position of the propulsion unit, the shaft support structures 36 and 37 are generally aligned to receive shaft 11 and are spaced apart to accommodate the double universal joint 14. An annular flexible bellows connecting member 38 is disposed around the universal joint 14 and has its ends secured on the forwardly extending annular flange 39 and rearwardly extending annular flange 40 provided on support structures 37 and 36 respectively and serves to exclude water and other foreign matter from the drive mechanism.

The support housing 27 pivotally supports an intermediate gimbal ring member 41 on a generally vertical axis to provide for steering movement of the propulsion unit in a generally horizontal plane. The ring portion of member 41 is generally disposed rearwardly and within the bell-shaped portion 29 of housing 27 and extends around jointed shaft 11. The member 41 is pivotally supported within housing 27 by means of vertically spaced and aligned swivel shaft segments 42 and 43 the common axis of which extends generally through the center of the double universal joint 14 at the axis of shaft 11. For steering movements of member 41 within support housing 27, the shaft 11 simply bends correspondingly at the universal joint 14 and maintains the drive connection to the propulsion unit 1.

At the upper extremity of the swivel axis the swivel shaft segment 42 extends through the aligned bores 44 and 45 provided respectively in the support housing 27 and gimbal ring member 41. Shaft segment 42 is secured against rotation within gimbal ring member 41 by means of a key 46 and is disposed for rotation within bore 44 of housing 27 as provided for by needle bearing 47. The shaft segment 42 is vertically retained between a head 48 provided at the upper end thereof which is recessed within the stepped bore portion 49 of housing 27 and the nut 50 which is threaded onto the lower end of the shaft and recessed within the stepped bore portion 51 of ring member 41.

Support housing 27 includes a downwardly extending and rearwardly opening yoke portion 52 having vertically spaced, generally horizontal arms 53 and 54 with the upper arm 53 being spaced beneath the shaft support structure 36. Arms 53 and 54 are provided with bore openings 55 and 56 respectively which are aligned on the swivel axis and adapted to receive the swivel shaft segment 43. The downwardly disposed part of the bell-shaped portion 29 of housing 27 is provided with a forwardly extending recess 57 through which the gimbal ring member 41 extends. The ring member 41 includes a lower portion 58 which is adapted to be received between arms 53 and 54 of the yoke portion 52 and is provided with a bore opening 59 aligned with bore openings 55 and 56 on the swivel axis when in assembled relation. The swivel shaft segment 43 extends through the aligned openings 55, 59 and 56 and is vertically secured therein by the arcuate key member 60 between the shaft segment and the yoke arm 54. Because of the substantial vertical extent of shaft segment 43 a pair of vertically spaced needle bearings 61 in bore opening 59 rotatably support the lower portion 58 of ring member 41 on the shaft segment.

The gimbal ring member 41 may be pivoted on the generally vertical swivel axis in any number of ways for steering control of the propulsion unit. In the preferred form, which is the subject of an application by Charles F. Alexander, Serial No. 180,280, filed on even date herewith, entitled, Steering Arrangement for Inboard-Outboard Drive and assigned to the common assignee of this invention, a linkage member 62 extends through an opening 63 in the partition wall 30 from the cylindrical support housing portion 28 into the bell-shaped portion 29 and is pivotally connected to a forwardly extending bifurated projection 64 of the gimbal ring member 41 by the pin member 65. Linkage member 62 is connected to lever means 66 and is actuated by a remote control cable, not shown, from within the watercraft to effect steering control of the propulsion unit.

The propulsion unit 1 is also pivotable on a generally horizontal transverse axis to accommodate tilt movements of the unit in a generally vertical plane as when the underwater portion of the unit strikes an obstruction. The tilt axis is generally in the horizontal plane containing the axis of horizontal shaft 11 and extends generally through the center of the double universal joint 14. Thus, for vertical tilt movements of the propulsion unit the shaft 11 bends correspondingly at universal joint 14 to maintain the drive connection to the propulsion unit.

The tilt axis is also generally in the generally transverse vertical plane of the swivel axis. Since the gimbal ring member 41 contains both the tilt axis and swivel axis in a generally common plane, the gimbal ring member may be referred to as having generally planar pivot means extending radially therefrom on a generally vertical axis and generally transverse horizontal axis.

As shown in the drawings, the gimbal ring member 41 is adapted to receive the forward portion of the bell-shaped housing portion 13 of the propulsion unit therewithin. At the tilt axis and on opposite sides of shaft 11, housing portion 13 and gimbal ring member 41 are provided with aligned bore openings 67 and 68 respectively. The bore openings 67 in housing portion 13 are threaded to receive the threaded portions of pins 69 which are journaled within the corresponding ring member bore opening 68. Pins 69 thus provide for rotatable support of the propulsion unit within the gimbal ring member 41 on the tilt axis.

The propeller thrust is transmitted to the gimbal ring member 41 through the transversely extending tilt adjustment pin 70 which is supported in transversely aligned openings 71 provided in the transversely spaced flange members 72 extending rearwardly from the lower portion 58 of the ring member. The pin 70 is engaged by the transversely spaced flange members 73 which extend forwardly from the propulsion unit beneath the bell-shaped housing portion 13. The pin 70 is selectively movable for disposition in a corresponding pair of a series of openings 71 in flange members 72 to establish the desired operating position or trim for the propulsion unit. This adjustment of the trim of the propulsion unit provides a means for increasing or decreasing the leverage or moment arm as determined by the rudder effect of the propulsion unit relative to the steering axis. For instance, where high speed operation is desired, the trim adjustment will be obtained by placing pin 70 in the outermost holes 71 thereby increasing the rudder moment arm and stiffening the steering action, and when it is desired to operate at slow speeds the pin 70 will be disposed in the innermost holes 71 thereby decreasing the rudder moment arm and freeing the steering action. At slower speeds and with the pin 70 disposed in the innermost holes, however, the watercraft displaces more water so that a greater portion of the unit is disposed in the water to thereby increase the boat stability. As a net result, whether one places pin 70 in the outermost holes 71 for high speed operation or in the innermost holes for slower operation, stability about the steering axis will be adequately maintained and be more nearly constant.

To control and limit tilt movements of the propulsion unit upon striking an obstruction, an extendable shock absorber unit 74 is connected respectively to the gimbal ring member 41 and the propulsion unit. The shock absorber unit is disposed within the opposed recesses 75 and 76 formed by the corresponding pairs of flange members 72 and 73 on the gimbal ring member and propulsion unit respectively. The lower end of the shock absorber unit is rotatably mounted on the pin 77 carried by the spaced flanges 73 while the opposite end is rotatably mounted on pin 78 supported at a substantially higher position by transversely spaced projections 79 which extend rearwardly from lower portion 58 of ring member 41 between the spaced flange members 72.

A tilt lock mechanism 80 is pivotally supported between flanges 73 of the propulsion unit at 81 and is normally biased downwardly to place the latch hook 82 in engagement with the tilt adjustment pin 70 carried by ring member 41. Means, not shown, are provided to lock the tilt lock mechanism 80 in its latched position for reverse operation of the propulsion unit. While latch hook 82 remains in engagement with pin 70 during forward operation, the hook is disengageable from the pin when a predetermined pressure is exerted on the hook to permit tilting of the propulsion unit as when the unit strikes a submerged or floating obstruction. When an obstruction is passed beneath the unit and the unit returns to its normal operating position, the latch hook 82 is adapted to automatically re-engage with pin 70.

Adjacent to the upper swivel shaft segment 42, ring member 41 carries the safety tilt switch 83 which is connected in series with the electrical ignition circuit, not shown, of engine 10 through the partially shown lead wire 84. The switch 83 is normally closed so as to render the ignition circuit complete and the engine operable. During the upward movement of the propulsion unit the upper edge of bell-shaped housing 13 is adapted to engage the spring lever 85 and push the same upwardly to depress the switch button 86 and thereby open the switch 83 to break the engine ignition circuit. When the propulsion unit returns to its normal operating position and the bell-shaped housing 13 clears the spring lever 85, the switch 83 again closes to restore engine ignition. The provision of tilt switch 83 prevents a violent thrust surge which would otherwise occur when an over-speeding propeller returns to the water.

In the improved suspension for the propulsion unit of an inboard-outboard drive as here disclosed the spaced swivel shaft segments 42 and 43 effectively provide a long bearing arrangement better able to withstand the steering, propeller thrust and impact stresses. The long-span bearing arrangement eliminates or greatly reduces the extreme structural stresses and bearing loads encountered with the commonly employed short swivel shaft arrangements. It will be noted, too, that the improved suspension of this invention permits tilt movements of the propulsion unit without disturbing the steering geometry of the unit.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In an inboard-outboard drive for watercraft having a transom, a propulsion unit disposed outboard of the watercraft, a power source for said propulsion unit mounted within the watercraft, support means rigidly secured to the transom of the watercraft, an intermediate member pivotally supported by the support means on a generally vertical axis for steering control of the propulsion unit, said propulsion unit being pivotally supported by the intermediate member on a generally transverse horizontal axis to accommodate vertical tilt movements of the unit, movable abutment means on the intermediate member beneath the horizontal tilt axis and engageable by the propulsion unit to transmit propulsion thrust to said intermediate member and establish the operating trim for said unit providing a selective rudder effect for the propulsion unit, and means to move the abutment means to vary the rudder effect.

2. The invention set forth in claim 1 wherein the intermediate member is a gimbal ring which is pivotally supported from the support means on said generally vertical axis by a pair of vertically spaced and axially aligned shaft members.

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