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OUTBOARD DRIVE UNIT FOR WATERCRAFT

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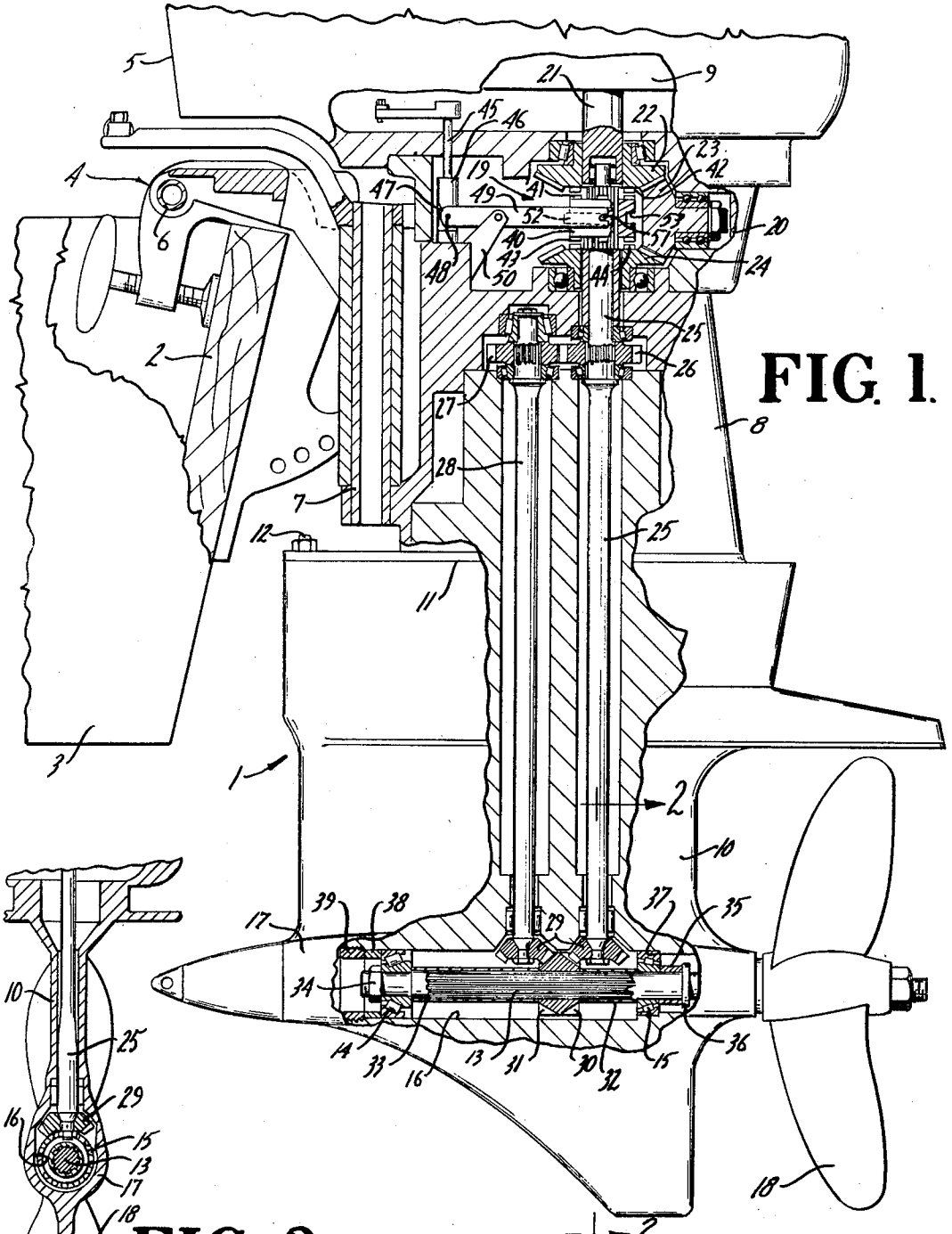


FIG. 1.



FIG. 2.

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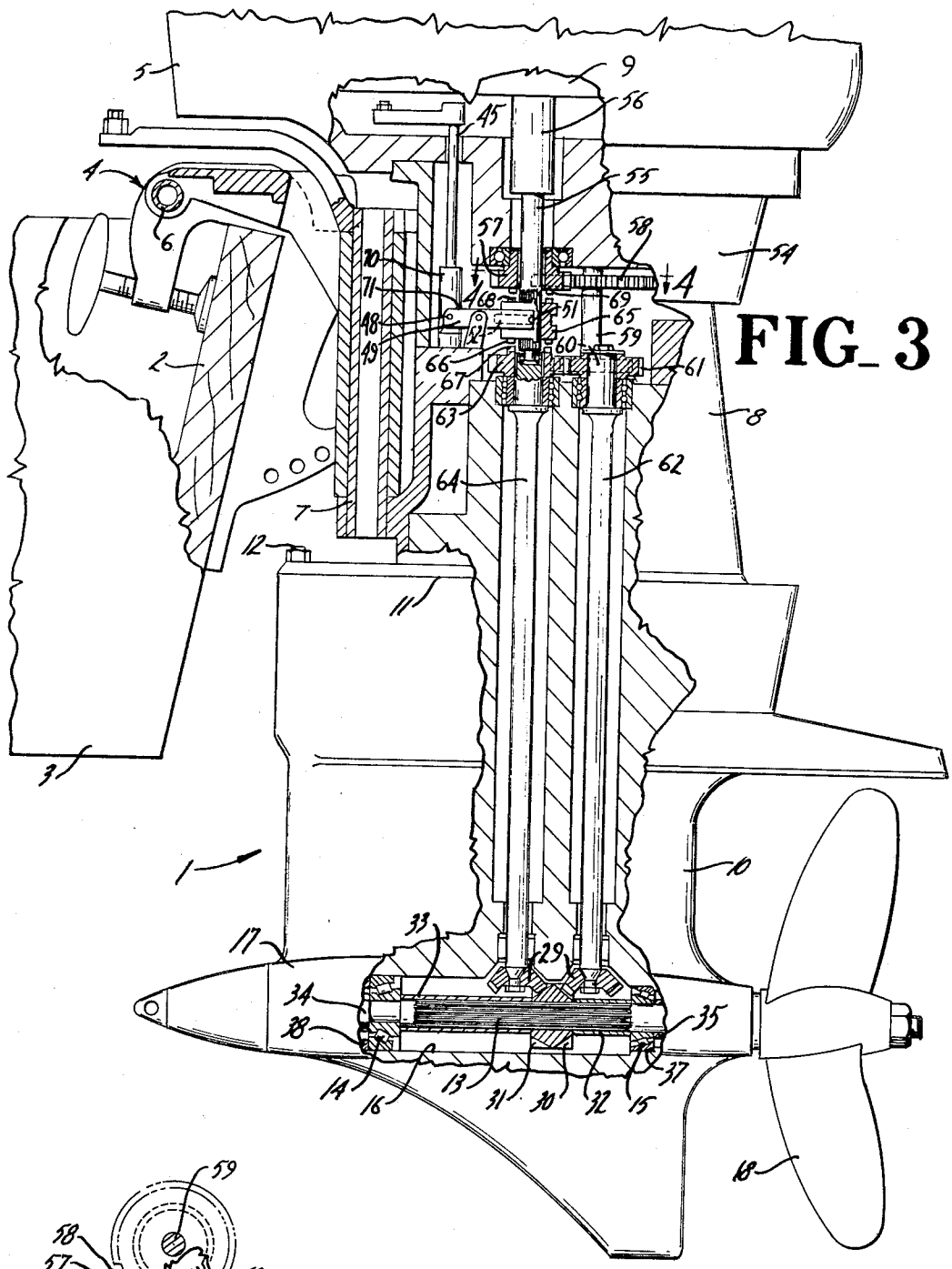



FIG_3

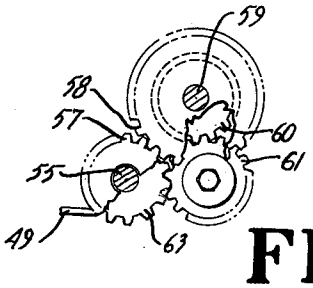



FIG_4

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# OUTBOARD DRIVE UNIT FOR WATERCRAFT

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## ABSTRACT OF THE DISCLOSURE

The transmission for an outboard drive unit includes a generally horizontal propeller shaft mounting a propeller, a relatively short generally vertical drive shaft spaced vertically above the propeller shaft, and a plurality of generally vertical driven shafts interposed between the drive shaft and propeller shaft and being drivingly connected to the propeller shaft. Reversing gear means connect the drive shaft to the driven shafts to provide for propeller rotation selectively in the forward and reverse directions.

This invention relates to an outboard drive unit for watercraft and more particularly to a multiple shaft transmission for such a unit.

The lower unit and particularly the propeller shaft housing of an outboard drive unit is a drag imposing structure as the drive unit moves across the water. Conventionally reversing gear means are provided in the propeller shaft housing to provide for propeller rotation in accordance with forward and reverse operation of the drive unit and a long control linkage or actuating means is required to selectively actuate the reversing gear means. Generally, as the power of the drive unit is increased, the drag imposing frontal wetted area of the lower unit must also increase. The increased frontal wetted area results primarily because the size of the propeller shaft housing must be increased to accommodate not only the larger gears required for the increased torque load but perhaps also increased space requirements for the actuating means. Thus, the advantage of increased power is partially offset by increased drag. It is generally an object of this invention to provide a transmission including reversing gear means for an outboard drive unit and which provides for a more efficient lower unit having a lesser drag imposing frontal wetted area in operation.

Generally, according to the invention, the transmission for an outboard drive unit includes a generally horizontal propeller shaft which carries the propeller. A relatively short generally vertical drive shaft is spaced vertically above the propeller shaft. A plurality of generally vertical driven shafts are interposed between the drive shaft and propeller shaft and are drivingly connected to the latter. And reversing gear means connect the drive shaft to the driven shafts to provide for propeller rotation selectively in the forward and reverse directions.

The accompanying drawings illustrate the best mode presently contemplated for carrying out the invention.

In the drawings:

FIGURE 1 is a partial side elevation of an outboard motor with parts broken away and sectioned to show a transmission arrangement according to this invention;

FIG. 2 is a sectional view taken generally on line 2—2 of FIG. 1;



FIG. 3 is a partial side elevation generally similar to that of FIG. 1 and shows a further embodiment of the invention; and

FIG. 4 is a sectional view taken generally on line 4—4 of FIG. 3.

Referring to the drawings, an outboard drive unit such as an outboard motor 1 is shown mounted on the transom 2 of a watercraft 3 by means of a bracket assembly 4. The bracket assembly 4 supports the power unit 5 for tilt movement in a generally vertical plane about the horizontal tilt pin 6 and for pivotal steering movement in a generally horizontal plane about the generally vertical steering post 7.

The power unit 5 comprises an intermediate housing assembly 8 which supports the engine 9 at the upper end thereof and carries the lower unit 10 at its lower end. The lower unit 10 is joined to the housing assembly 8 along the generally horizontal parting line 11 by a plurality of bolts 12, only one of which is shown.

A propeller shaft 13 is rotatably supported by a pair of axially spaced and aligned bearing units 14 and 15 disposed in the generally horizontal, fore-and-aft extending bore 16 in the torpedo-shaped propeller shaft housing 17 of lower unit 10. The propeller shaft 13 projects from the bore 16 rearwardly of lower unit 10 and carries the propeller 18 thereon.

The power transmission means connecting the engine 9 to the propeller shaft 13 includes the reversing gear means 19 enclosed within the gear case 20 provided in the upper portion of the intermediate housing assembly 8 immediately beneath the engine.

A relatively short, generally vertical input or drive shaft 21, which is generally the engine crank shaft, extends downwardly into the gear case 20 and carries the bevel gear 22 on the lower end thereof. The bevel gear 22 is meshingly engaged with the bevel gear 23 rotatably supported in the gear case 20 on an axis normal to drive shaft 21. Bevel gear 23 serves as an idler and is meshingly engaged with the bevel gear 24 which is axially aligned with the bevel gear 22 and spaced therebeneath. The bevel gear 24 is disposed on the upper end of the generally vertical driven shaft 25 and is freely rotatable relative thereto and in the direction opposite to the bevel gear 22.

Beneath bevel gear 24 the driven shaft 25 rotatably carries the spur gear 26 which is meshingly engaged with the spur gear 27 fixed on the companion driven shaft 28. The driven shafts 25 and 28 extend downwardly from the gear case 20 into the horizontal bore 16 of the lower unit 10 and carry bevel pinion gears 29 on the respective lower ends thereof. The pinion gears 29 are meshingly engaged with the corresponding opposed bevel gears 30 and 31, which may have a common hub, keyed on the propeller shaft 13. Driven shafts 25 and 28 generally divide the torque load transmitted to the propeller shaft and extending as they do from the gear case 20 downwardly into bore 16 of lower unit 10, they are necessarily relatively long and therefore able to deflect torsionally to equalize and distribute tooth pressures on the bevel gear connection to the propeller shaft 13.

The opposed bevel gears 30 and 31, shown mounted on a common hub, are confined against movement axially of the propeller shaft 13 by the sleeve 32 disposed on the shaft between the bevel gear 30 and bearing 15 and the sleeve 33 between bevel gear 31 and bearing 14. The

inner race of the bearings 14 and 15, gears 30 and 31, and sleeves 32 and 33 are all drawn up tightly on the propeller shaft 13 by the nut 34 against the opposed annular spacer element 35 confined by the radial shoulder 36 on the shaft and constitute the rotating assembly in the bore 16. Spacing for the rotating assembly to assure proper meshing of gears 30 and 31 with the corresponding bevel pinions 29 is provided by the inwardly projecting bore shoulder 37 against which the outer race of bearing 15 bears. Forwardly the rotating assembly is confined by the annular spacer element 38 which bears against the outer race of bearing 14 and is held in place by the member 39 threadedly engaged in bore 16.

To provide for rotation of propeller 18 selectively in the forward and reverse directions, a coupling or clutch element 40 is keyed on the upper end of driven shaft 25 intermediate the bevel gears 22 and 24. The clutch element 40 is movable axially on driven shaft 25 and is shown in its intermediate or neutral position between gears 22 and 24.

For forward drive operation the clutch element 40 is moved axially in the direction of bevel gear 22 to place the radially extending clutch teeth 41 on the clutch element into driving engagement with the corresponding clutch teeth 42 on gear 22. With engagement of the clutch element 40 with the forward drive gear 22, the driven shaft 25 is coupled to gear 22 and rotates therewith. The shaft 28 is simultaneously set in motion through the driving connection of the spur gears 26 and 27, and the counterrotating shafts 25 and 28 drive propeller 18 in the direction for forward drive operation.

In reverse drive operation the clutch teeth 43 on clutch element 40 engage with the clutch teeth 44 on the reverse drive bevel gear 24 when the cltuch element is moved axially downward. The engagement of clutch element 40 with gear 24 effects a coupling of shaft 25 with gear 24 for rotation together in the reverse drive direction. The shaft 28 is also set in motion and the counterrotating shafts 25 and 28 drive the propeller 18 in the direction for reverse drive operation.

The clutch element 40 is selectively actuated to assume its forward drive, reverse drive and neutral positions by a rotatable shift rod 45 which carries a cam 46 at the lower end thereof. The cam 46 is provided with a spiral cam groove 47 engageable by the follower pin 48 of the shift lever 49 which is pivotally supported intermediate its length by the projection 50. With selective rotation of shift rod 45, follower pin 48 assumes positions in the spiral cam groove 47 corresponding to forward, neutral and reverse and actuates the shift lever 49 correspondingly.

The end of shift lever 49 oppositely from cam 45 is adapted to carry the pin 51 which projects radially from the shifting collar 52. Collar 52 is slidably disposed in the peripheral recess 53 of the clutch element 40 to provide for rotation of the clutch element relative to its shifting lever 49. With selective actuation of the shifting lever 49 by the cam 46, the collar 52 carries the clutch element 40 axially into the forward, neutral and reverse positions.

In the embodiment of FIGS. 3 and 4, the gear case 54 in the intermediate housing assembly 8 of power unit 5 is disposed somewhat lower relative to engine 9 than was gear case 20 in the embodiment of FIG. 1 and a generally upright drive shaft 55 is coupled for rotation with the engine crank shaft 56 and extends downwardly into the gear case. A reverse spur gear 57 is mounted for relative rotation on the lower end of the drive shaft 55 and is meshingly engaged with the spur gear 58 carried at the upper end of the generally vertically disposed idler shaft 59.

The idler shaft 59 carries a second spur gear 60 at the lower end thereof which is meshingly engaged with the spur gear 61 keyed onto the upper end of the generally vertical driven shaft 62. Spur gear 61 is in turn meshingly engaged with the forward spur gear 63 carried at the upper end of the driven shaft 64 which parallels the driven shaft 62. The shafts 62 and 64 extend downwardly into the bore 16 of lower unit 10 and carry bevel pinion gears 29 at their respective lower ends to drive the propeller shaft 13 and propeller 18. As in the embodiment of FIG. 1, the driven shafts 62 and 64 generally divide the torque load and are able to deflect torsionally to equalize and distribute tooth pressures at the bevel gear connection to propeller shaft 13.

The coupling or clutch element 65 is keyed on the lower end of drive shaft 55 intermediate the forward and reverse gears 63 and 57 and is movable axially from the neutral position, as shown in FIG. 3, into forward and reverse drive positions selectively. For forward drive operation the clutch element 65 is moved axially downward placing the cltuch teeth 66 thereon in driving engagement with the corresponding cltuch teeth 67 on the forward drive gear 63. With forward gear engagement, the clutch element 65 couples the driven shaft 64 directly to the drive shaft 55 and the associated gearing also sets driven shaft 62 in motion while the idler shaft 59 and its gears 58 and 60 along with the reverse spur gear 57 simply idle or run free.

Reverse drive operation results when the clutch element 65 is moved axially upward placing the clutch teeth 68 thereon in driving engagement with the clutch teeth 69 on the reverse spur gear 57 which couples the gear 57 to the drive shaft 55. In reverse drive engagement the driven shafts 62 and 64 counterrotate in their reverse direction to drive the propeller shaft 13 and propeller 18 correspondingly as provided by the train of spur gears 58, 60, 61 and 63 when driven by the engaged reverse gear 57.

The clutch element 65 is actuated by a shifting lever 49 similarly as in the embodiment of FIG. 1. However, since the vertical disposition of the forward and reverse gears 63 and 57 is reversed from the disposition of forward and reverse gears 22 and 24 shown in the embodiment of FIG. 1, the actuation of shift lever 49 must be opposite of that for FIG. 1 for similar actuation of the shift rod 45. To provide for such opposite actuation of the shift lever 49, the shift rod 45 carries a cam 70 wherein the cam groove 71 spirals in a direction opposite to that of the groove 47 in cam 46 of FIG. 1.

The smaller bevel gear sizes in the propeller shaft housing resulting from the division of torque loads by the multiple shaft construction of this invention and the removal of reversing gear means from the propeller shaft housing provide for a more efficient outboard drive lower unit having a lesser drag imposing frontal wetted area in operation. As a consequence, other factors being equal, higher speeds are attainable for given power consumed. Furthermore, with the reversing gears disposed in the intermediate housing assembly or above the lower unit where space is somewhat less critical insofar as operation of the drive unit is concerned, such means and the actuating means therefor can be made more rugged. In the case of an outboard motor it is contemplated that the reversing gear means may be disposed in the vicinity of the engine.

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. An outboard motor comprising a power unit having an engine with a crank shaft, a vertical housing supporting said power unit, a lower unit secured to and depending from said housing and having an underwater portion including a torpedo-shaped propeller shaft housing of minimum frontal area accommodating only the diameter for the necessary bearings for the propeller shaft, a plurality of vertical shafts extending downwardly from said housing through the lower unit and geared directly to

the propeller shaft to drive the same, said vertical shafts dividing the load therebetween and being of smaller diameter than would be required for a single shaft carrying a corresponding load and being disposed in a fore-and-aft vertical plane whereby the underwater portion of the lower unit has a minimum frontal area accommodating the generally smaller shaft bearings and gears connecting the vertical shafts with the propeller shaft, and a forward and reverse transmission between said engine crank shaft and said vertical shafts to drive the latter with said crank shaft and one of said vertical shafts being directly coupled for forward propeller drive.

2. The construction of claim 1, in which the forward drive is effected through all of the said vertical shafts,



each taking a proportionate load, and the reverse drive is effected through less than all of said vertical shafts.

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