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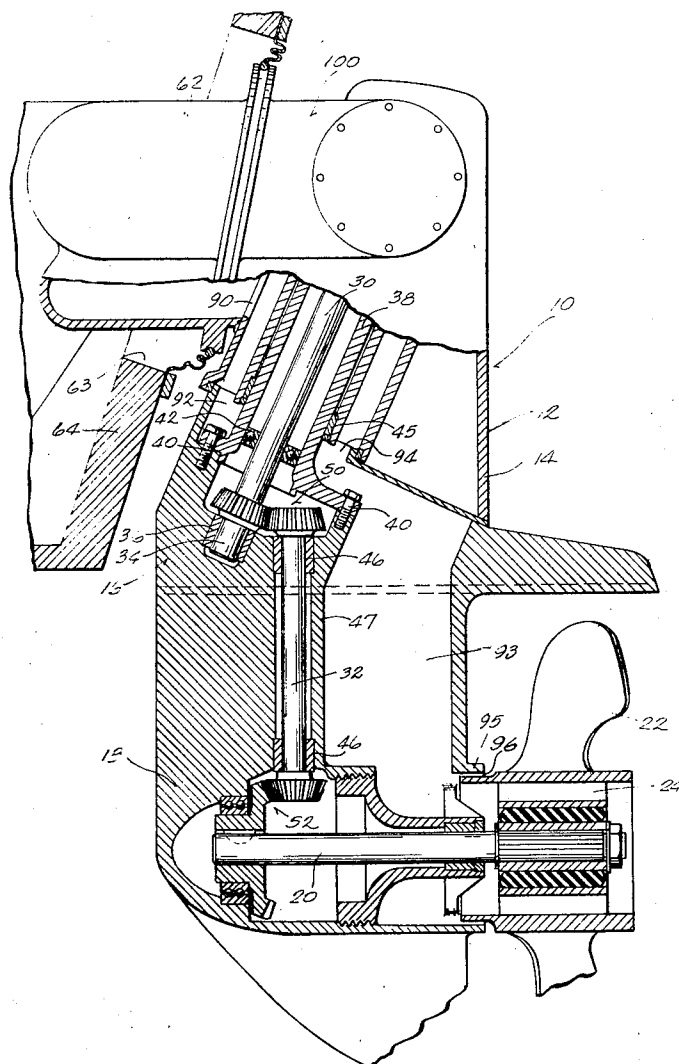
[54] **MARINE PROPULSION DEVICE WITH SPLIT DRIVE SHAFT**
 13 Claims, 4 Drawing Figs.

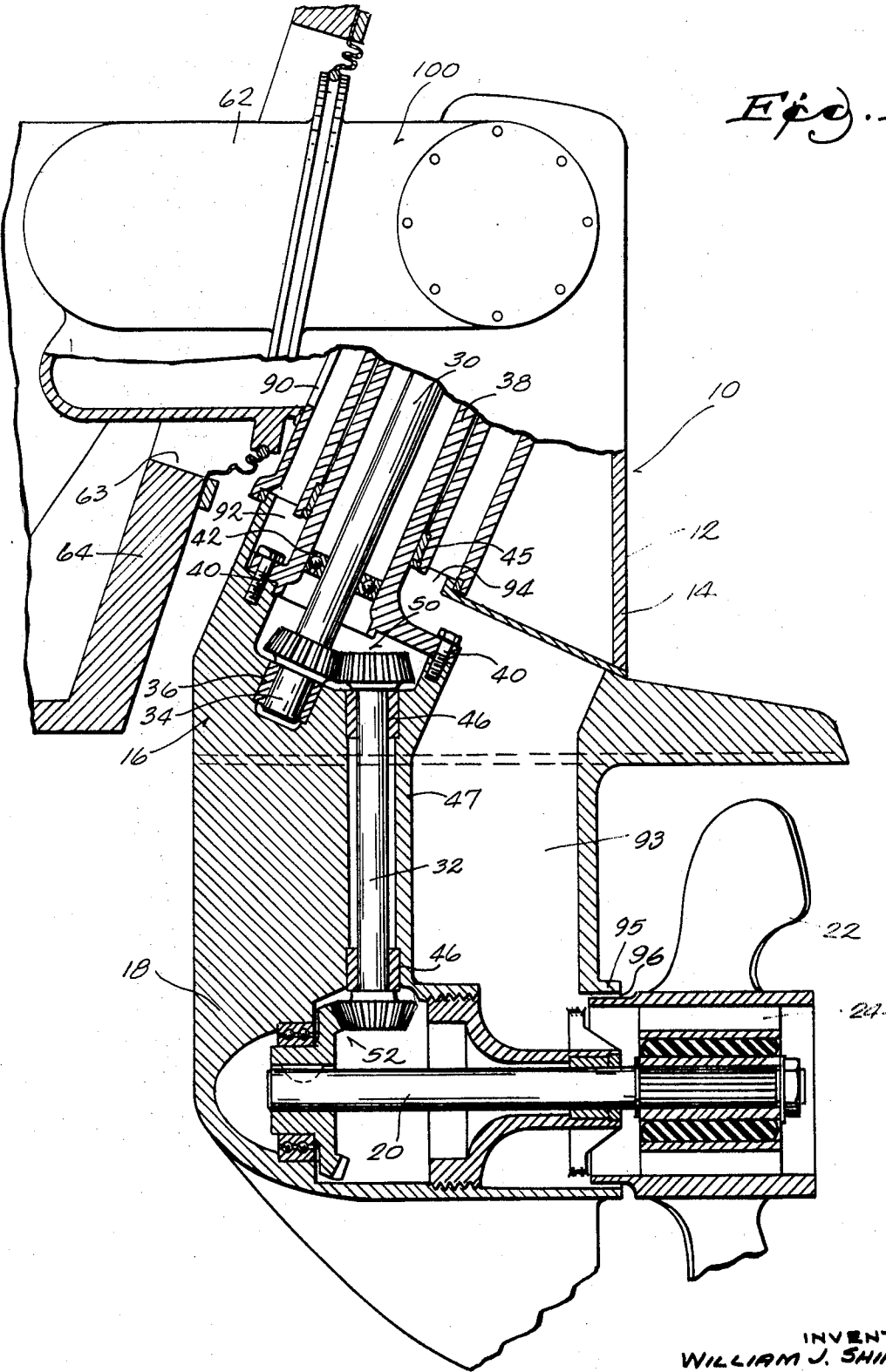
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 [50] Field of Search **115/35, 41,**
41 (HT), 34

[56] **References Cited**
UNITED STATES PATENTS
 2,499,339 2/1950 Wanzer **115/35**
 3,447,504 6/1969 Shimanckas **115/17X**

ABSTRACT: Disclosed herein is a marine propulsion unit which includes a drive shaft housing having upper and lower housing sections with the upper housing section rotatably supported for vertical swinging movement about a horizontal tilt axis. The drive train connecting the propeller shaft to engine output shaft includes first and second drive shafts. The first drive shaft is rotatably supported and extends through the upper drive shaft housing and into the lower housing section. The lower housing section is rotatably connected to the upper housing section for rotation about the axis of the first drive shaft to afford steering of the boat hull. The second drive shaft is connected by gears to the first drive shaft and is rotatably supported in the lower housing section for rotation about an axis transverse to the axis of the first drive shaft and at right angles to a propeller shaft.

The transfer of power from the engine to the first drive shaft includes a horizontal cross shaft located in coaxial relation to the horizontal tilt axis. Steering of the lower housing section is afforded by a steering drive or linkage.





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Fig. 4

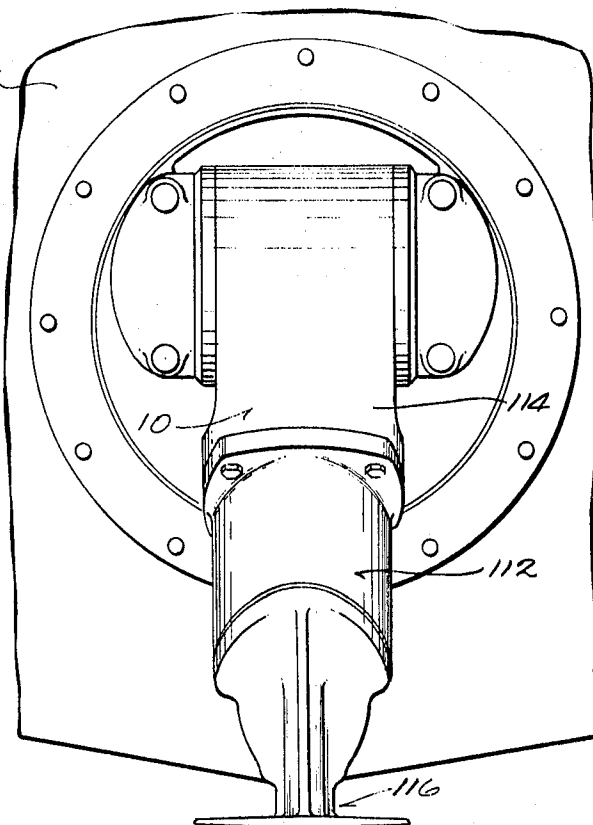
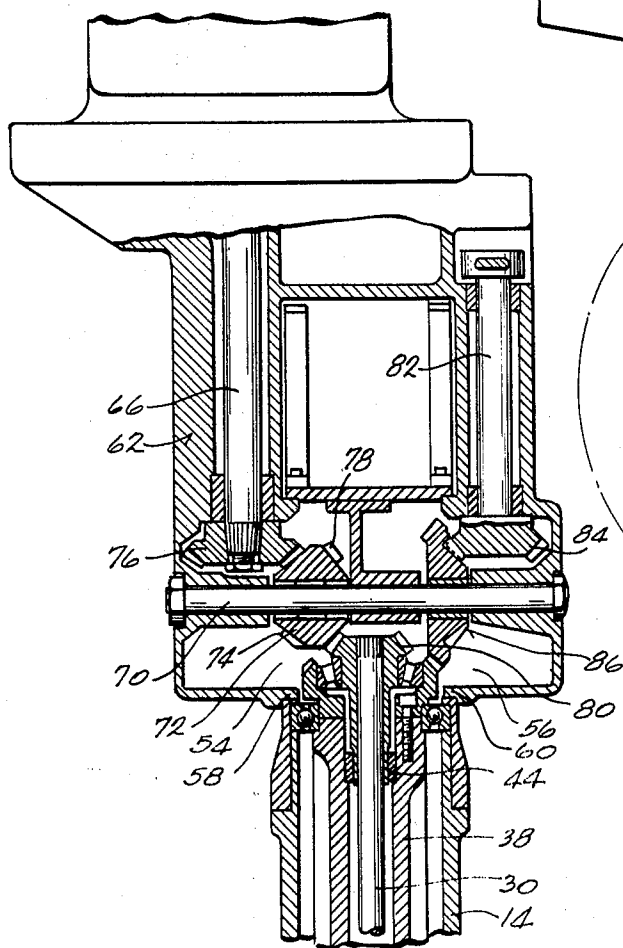
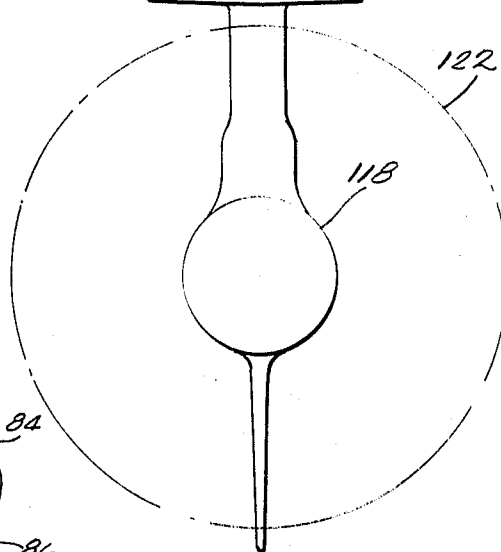


Fig. 2



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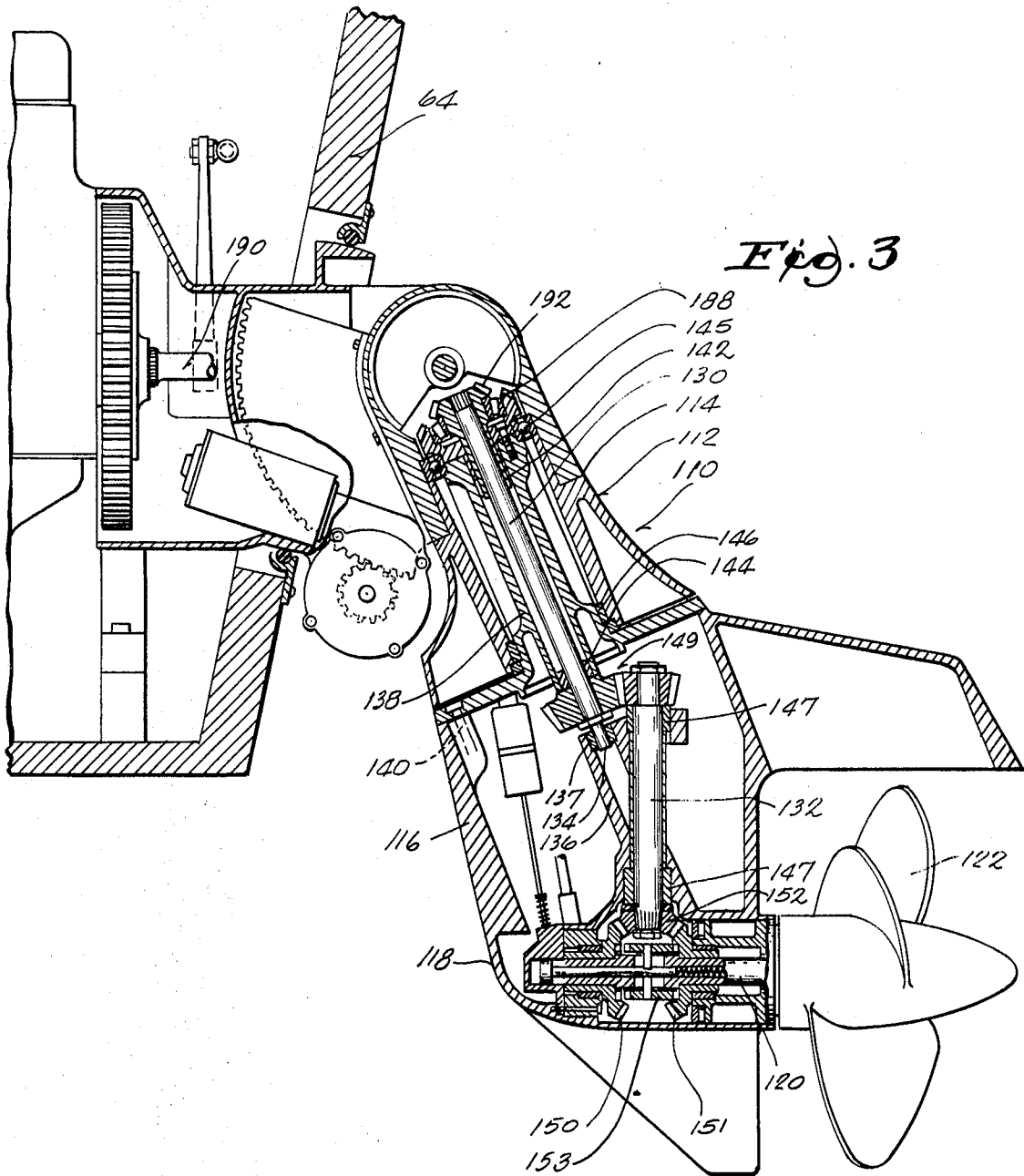


Fig. 3

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MARINE PROPULSION DEVICE WITH SPLIT DRIVE SHAFT

BACKGROUND OF THE INVENTION

The invention relates to marine propulsion devices of the in-board/outboard type, and is a further development of the subject matter disclosed in my copending application Ser. No. 844,457, attorney's docket No. 4402.

SUMMARY OF THE INVENTION

The invention provides a marine propulsion device in which fore and aft length of the propulsion device in which fore and aft length of the propulsion device is minimized by a construction which includes upper and lower rotatably connected housing sections and first and second drive shafts. In one embodiment, the first drive shaft extends downwardly and forwardly through the upper housing section into the lower housing section. The lower housing section is rotatably connected to the upper housing section for rotation about the axis of the first drive shaft to afford steering of the boat hull. The second drive shaft is rotatably supported in the lower housing section for rotation about an axis transverse to the axis of said first drive shaft and transverse to the steering axis of the lower housing section.

The propeller shaft is at right angles with the second drive shaft to enable the use of a shifting mechanism in the gear case to provide for forward and reverse propeller rotation.

The invention also provides a drive train and steering arrangement which further minimizes the size of the propulsion device. The connection between the engine output shaft and the first drive shaft is provided by a compound idler gear rotatably carried by a horizontal cross-shaft supported in coaxial relation with the horizontal tilt axis which can conveniently be provided by intumed annular flanges or trunnions on a fixed housing, which trunnions extend into coaxial apertures in the upper end of the drive shaft housing. The compound gear meshes with a gear on the engine output shaft and a gear on the upper end of the first drive shaft. The steering drive for rotating the lower housing section about the steering axis of the first drive shaft also utilizes an idler gear rotatably carried by the horizontal cross-shaft. A steering shaft which is connectable to conventional remote steering apparatus is mounted in the fixed housing in parallel relationship to the engine output shaft. The steering idler gear meshes with a gear on the steering shaft and a gear connected to a projecting portion which extends from the lower housing section through the upper housing section.

It is an object of the invention to provide a marine propulsion device with upper and lower drive shafts rotatably supported in a drive shaft housing having upper and lower housing sections and in which the lower housing section is rotatably connected to the upper housing section for rotation about the axis of the upper drive shaft.

It is a further object of the invention to provide a marine propulsion device which utilizes upper and lower drive shafts have transverse axes to minimize the fore and aft length of the propulsion device.

It is an additional object of the invention to provide a propulsion device which has upper and lower drive shafts and a propeller shaft connected at right angles to the lower end of the lower drive shaft to afford the use of a shifting mechanism in the lower unit gear case.

Further objects and advantages of the present invention will become apparent from the following description and accompanying drawings. **DRAWINGS**

FIG. 1 is a side elevational view in fragmentary section of a marine propulsion device in accordance with the invention.

FIG. 2 is a fragmentary plan view in partial section of the marine propulsion device shown in FIG. 1.

FIG. 3 is a side elevational view in fragmentary section of a further embodiment of the marine propulsion device of the invention.

FIG. 4 is an end view of the marine propulsion device shown in FIG. 3. **DESCRIPTION OF THE DRAWINGS**

Referring to the drawings, FIG. 1 shows a marine propulsion device which is generally designated 10 and which includes a drive shaft housing 12 having upper and lower housing sections 14 and 16, respectively. The lower housing section 16 is steerable as hereinafter described, and includes a gear case 18 which rotatably supports a propeller shaft 20 and a propeller 22. The propeller 22 can be provided with an axial passage 24 for underwater discharge of the exhaust, as generally described in my earlier application Ser. No. 844,457, (attorney's Docket No. 4402).

In accordance with the invention, the marine propulsion device 10 is provided with an upper or first drive shaft 30 and a lower or second drive shaft 32. The first drive shaft 30 extends through the upper housing section 14 and into the lower housing section 16 with the lower end 34 of the first drive shaft 30 supported in a bearing 36 located in the lower housing section 16. The first drive shaft 30 is also rotatably supported in a portion 38 which projects upwardly from and is secured to the lower housing section by bolts 40 and which extends through and is supported in the upper housing section 14 by bearings 42 and 44 (FIG. 2).

To afford steering, the lower housing section 16 is rotatably supported in the upper housing section 14 by a bearing 45 for rotation about the axis of the first drive shaft 30. The second or lower drive shaft 32 is rotatably supported in the lower housing section for rotation about an axis transverse to the steering axis and the axis of the first drive shaft 30 by bearings 46 supported by a wall portion 47 (FIG. 1).

The upper drive shaft 30 is connected to the lower drive shaft 32 by gearing 50. The lower drive shaft 32 is connected to the propeller shaft 20 by gearing 52. To enable the use of a shifting mechanism as hereinafter described, the propeller shaft 20 can be rotatably supported at right angles to the lower drive shaft 32.

Means are provided for rotatably supporting the drive shaft housing 12 for vertical tilting movement about a horizontal tilt axis relative to a normal running position with the propeller shaft horizontal. As disclosed, the means includes a pair of coaxial spaced apertures 54 and 56 in the upper housing section 14 (FIG. 2). The apertures receive horizontally extending trunnions or intumed annular flanges 58 and 60 which are formed in a housing 62 which extends through an aperture 63 in the transom 64 of a boat hull and which can be fixed to the boat transom 64 as provided in FIG. 2.

In the embodiment of the invention disclosed in FIG. 1, in the normal running position, the upper drive shaft 30 and the upper drive shaft housing 14 extend downwardly and forwardly with respect to the horizontal tilt axis to thus afford some of the advantages of the marine propulsion device disclosed in my copending application Ser. No. 844,457, attorney's docket No. 4402, i.e., steering the boat hull by rotating the lower housing section about a forwardly inclined drive shaft axis to raise the bow of the boat hull on turns.

Means are provided for connecting the input shaft or engine output shaft 66 to the upper drive shaft 30. As disclosed in FIG. 2, the means includes a fixed horizontal cross-shaft 70 which is supported in the housing 62 and which rotatably carries a compound idler gear 72 which has teeth 74 in mesh with a bevel gear 76 carried by the input shaft 66. The teeth 78 on the gear 72 are in mesh with a gear 80 secured to the upper end of the upper drive shaft 30.

Means are also provided for connecting the lower housing section 16 to remote steering apparatus. As disclosed in FIG. 2, the means includes a steering shaft 82 which is provided with a bevel gear 84. The bevel gear 84 meshes with a steering idler gear 86 which is rotatably supported on the cross-shaft 70. The idler gear 86 engages a bevel gear 88 which is secured to the upper end of the projecting portion 38 of the lower housing section.

To convey the exhaust gases from the engine to the propeller, the upper drive shaft housing 14 is provided with an exhaust inlet 90 which can be connected to the engine exhaust manifold by a flexible conduit (not shown). The interiors of the upper and lower housing sections 14 and 16 are provided

with exhaust passages 92 and 93 which communicate through an opening 94. The lower housing section 16 or gear case 18 is provided with an annular wall portion 95 which defines a rearwardly open exhaust outlet 96 which communicates with the passage 24 in the propeller hub 22. Thus, the engine exhaust enters inlet 90, travels through passage 92 through opening 94 and passage 93 and through the outlet 96 and passage 24 in the hub 22.

Means can be provided for selectively varying the direction of rotation of the propeller shaft 20. The means can be located forwardly of the transom as disclosed in my copending application Ser. No. 844,457, attorney's docket No. 4402, and include a tiltable housing 100 which can be adjusted to change the angle of tilt. Alternatively, the means can be located in the gear case as shown in FIG. 3 and as hereinafter described.

Means can also be provided for selectively varying the angle of tilt of the drive shaft housing about the horizontal tilt of the drive shaft housing about the horizontal tilt axis. The means can be in the form disclosed in FIG. 3 and in my copending application Ser. No. 844,457, attorney's docket No. 4402.

FIG. 3 shows a further embodiment of the marine propulsion device 110 of the invention which includes a drive shaft housing 112 which has upper and lower housing sections, respectively 114 and 116. The lower housing section includes a gear case 118 which rotatably supports a propeller shaft 120 which carries a propeller 122.

In accordance with the invention, the marine propulsion device 110 is provided with an upper or first drive shaft 130 and a lower or second drive shaft 132, which is at right angles with the propeller shaft 120. The first drive shaft 130 extends through the upper housing section 114 and into the lower housing section 116 with the lower end 134 of the first drive shaft 130 rotatably supported by a bearing 137 in an upstanding boss 136 in the lower housing section 116. The upper drive shaft 130 is also rotatably supported in a projecting portion 138 which extends upwardly from the lower housing section 116 and is secured to the lower housing section 116 by bolts 140. The projecting portion 138 carries bearings 142 and 144 which rotatably support the upper drive shaft 130.

The lower housing section 116 is rotatably supported in the upper housing section 114 for steering movement and rotation about the axis of the upper drive shaft 130 by bearings 145 and 146.

The lower drive shaft 132 is rotatably supported in the lower housing section 116 by bearings 147 for rotation about an axis transverse to the steering axis or axis of the first drive shaft 130. The upper drive shaft 130 is connected to the lower drive shaft 132 by gearing 149.

The gear case 118 can also include means for selectively varying the direction of rotation of the propeller shaft 120. As disclosed, a pair of bevel gears 150 and 151 are rotatably carried by propeller shaft 120. A bevel gear 152 secured to the lower drive shaft 132 is in mesh with the gears 150 and 151. The bevel gears 150 and 151 are selectively connectable to the propeller shaft 120 by an axially shiftable clutch dog 153 which is splined to the propeller shaft 120 and which can be controlled by hydraulic or electrical means as disclosed in application Ser. No. 809,465, attorney's docket No. 4412.

The drive shaft housing 112 can be rotatably supported for vertical swinging movement about a horizontal tilt axis in accordance with the arrangement disclosed in FIG. 2 or as disclosed in my copending application Ser. No. 844,457, attorney's docket No. 4402.

As disclosed, means are provided for selectively varying the angle of tilt of the drive shaft housing about the horizontal tilt axis. The tilting means can be in the form of the arrangement disclosed in my copending application Ser. No. 811,829, attorney's docket No. 4071, or as disclosed in my U.S. Pat. No. 3,183,880.

Steering of the lower housing section 114 can be provided as shown in FIG. 2. A bevel gear 188 (FIG. 3) is connected to the projecting portion 138 of the lower housing section 116 and is engageable with the idler gear 86 which meshes with the

gear 84 on the steering shaft 82. The drive train connecting the engine output shaft 190 to the gear 192 at the upper end of the upper shaft 130 can be as disclosed in FIG. 2.

Various of the features of the invention are set forth in the following claims.

I claim:

1. A marine propulsion device comprising a drive shaft housing having upper and lower housing sections, means for rotatably connecting said lower housing section to said upper housing section to provide a steering axis for said lower housing section, a first drive shaft rotatably supported in said upper housing section, a second drive shaft rotatably supported in said lower housing section for rotation about an axis transverse to said steering axis of said lower housing section, and means for drivingly connecting said first and second drive shafts

2. A marine propulsion device in accordance with claim 1, including a propeller shaft rotatably supported in said drive shaft housing, means for rotatably supporting said drive shaft housing for vertical tilting movement about a horizontal tilt axis and means for selectively varying the angle of tilt of said drive shaft housing relative to a normal running position.

3. A marine propulsion device in accordance with claim 2, wherein said first drive shaft extends downwardly and forwardly from said horizontal tilt axis when said propeller shaft is in the normal running position.

4. A marine propulsion device in accordance with claim 2, wherein said second drive shaft rotates about an axis located forwardly of said horizontal tilt axis when said propeller shaft is in the normal running position.

5. A marine propulsion device in accordance with claim 2, wherein said first drive shaft extends downwardly and rearwardly of said horizontal tilt axis when said propeller shaft is in the normal running position.

6. A marine propulsion device in accordance with claim 2, wherein said second drive shaft rotates about an axis located rearwardly of said horizontal tilt axis when said propeller shaft is in the normal running position.

7. A marine propulsion device comprising a drive shaft housing having upper and lower housing sections, a first drive shaft, means for rotatably supporting said first drive shaft in said upper housing section, means for rotatably supporting said drive shaft housing for tilting movement about a horizontal tilt axis relative to a normal operating position in which said first drive shaft is inclined downwardly and forwardly of said horizontal tilt axis, means for rotatably connecting said lower housing section to said upper housing section for rotation about said axis of said first drive shaft, a second drive shaft, means for rotatably supporting said second drive shaft in said lower housing section for rotation about an axis transverse to said axis of said first drive shaft, a propeller shaft, means for drivingly connecting said second drive shaft to said first drive shaft, and means for drivingly connecting said second shaft to said propeller shaft.

8. A marine propulsion device comprising a drive shaft housing having upper and lower housing sections, a first drive shaft, means for rotatably supporting said first drive shaft in said upper housing section, means for rotatably supporting said drive shaft housing for tilting movement about a horizontal tilt axis relative to a normal operating position in which said first drive shaft is inclined downwardly and rearwardly of said horizontal tilt axis, means for rotatably connecting said lower housing section to said upper housing section for rotation about said axis of said first drive shaft, a second drive shaft, means for rotatably supporting said second drive shaft in said lower housing section for rotation about an axis transverse to said axis of said first drive shaft, a propeller shaft, means for drivingly connecting said second drive shaft to said first drive shaft, and means for drivingly connecting said second shaft to said propeller shaft.

9. A marine propulsion device comprising a drive shaft housing having an upper housing section and a lower housing section swingable relative to said upper housing section for

steering, a first shaft having upper and lower ends and rotatably supported in said upper housing section, a second shaft having upper and lower ends and rotatably supported in said lower housing section for rotation about an axis transverse to the axis of rotation of said first shaft, means drivingly connecting said upper end of said second shaft to said lower end of said first shaft, a third shaft rotatably supported in said lower drive shaft housing section, a propeller carried by said third shaft, and means drivingly connecting said third shaft to said lower end of said second drive shaft.

10. A marine propulsion device comprising a drive shaft housing including a lower housing section with a projecting portion thereon, a gear connected to said projecting portion, a drive shaft rotatably supported in said drive shaft housing, a gear on said drive shaft, means for rotatably supporting said drive shaft housing for tilting movement about a horizontal tilt axis, a horizontal cross-shaft rotatably supported in coaxial relation with said horizontal tilt axis, an engine output shaft having thereon a gear, a compound idler gear rotatably carried by said horizontal cross-shaft and having a first set of teeth in mesh with said gear on said drive shaft and a second set of teeth in mesh with said gear on said engine output shaft, a steering idler gear rotatably carried by said cross-shaft and in mesh with said gear on said projecting portion, a steering shaft, means for supporting said steering shaft in parallel relation to said engine output shaft, and a gear on said steering shaft in mesh with said steering idler gear.

11. A marine propulsion device comprising a drive shaft housing having upper and lower housing sections, means for rotatably connecting said lower housing section to said upper housing section to provide a steering axis for said lower housing section, a first drive shaft rotatably supported in said upper housing section, a second drive shaft rotatably supported in said lower housing section for rotation about an axis trans-

verse to said steering axis of said lower housing section, means for drivingly connecting said first and second drive shafts, a propeller shaft rotatably supported in said lower housing section, said propeller shaft being at a right angle with said second drive shaft, and means for connecting said propeller shaft to said second drive shaft.

12. A marine propulsion device in accordance with claim 11, wherein said means for connecting said propeller shaft to said second drive shaft includes means in said lower housing section for selectively varying the direction of rotation of said propeller shaft.

13. A marine propulsion device comprising a drive shaft housing having upper and lower housing sections, said upper and lower housing sections having interiors including exhaust passages, said lower housing section being rotatably connected to said upper housing section for communication of said exhaust passage of said upper housing section with said exhaust passage in said lower housing section, an exhaust inlet in said upper housing section adapted to be connected to an engine exhaust conduit and to afford discharge of the exhaust into said exhaust passages of said drive shaft housing, a first drive shaft rotatably supported in said upper housing section, a second drive shaft rotatably supported in said lower housing section for rotation about an axis transverse to said steering axis of said lower housing section, means for drivingly connecting said first and second drive shafts, a propeller shaft rotatably supported in said lower housing section, a propeller carried by said propeller shaft, said propeller including a hub with an axial passage, and a wall portion in said lower housing section defining an exhaust outlet, said outlet communicating with said exhaust passage in said lower housing section and with said axial passage in said propeller to afford underwater discharge of exhaust gases.

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