Sept. 20, 1971 K. A. BERGSTEDT 3,605,677

BOAT DRIVE ARRANGEMENT

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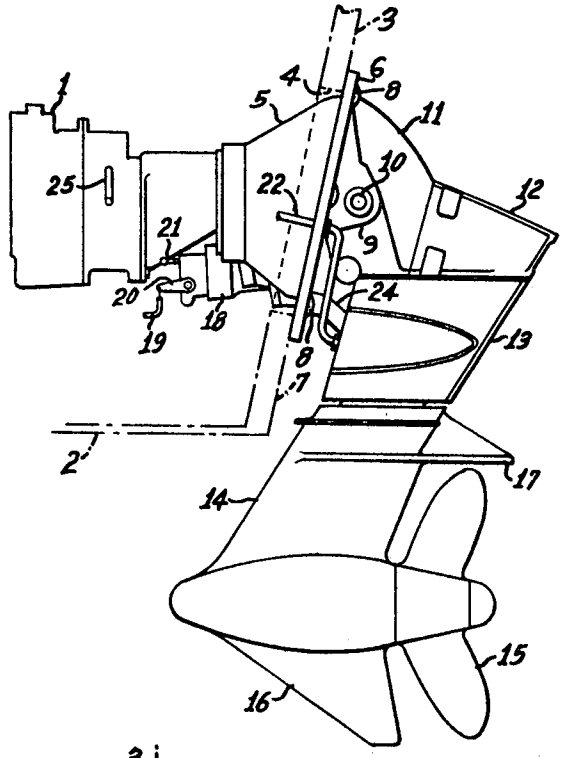


FIG. 1

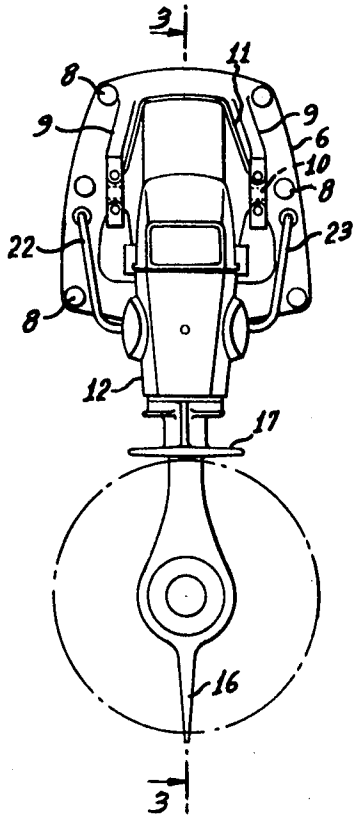


FIG. 2

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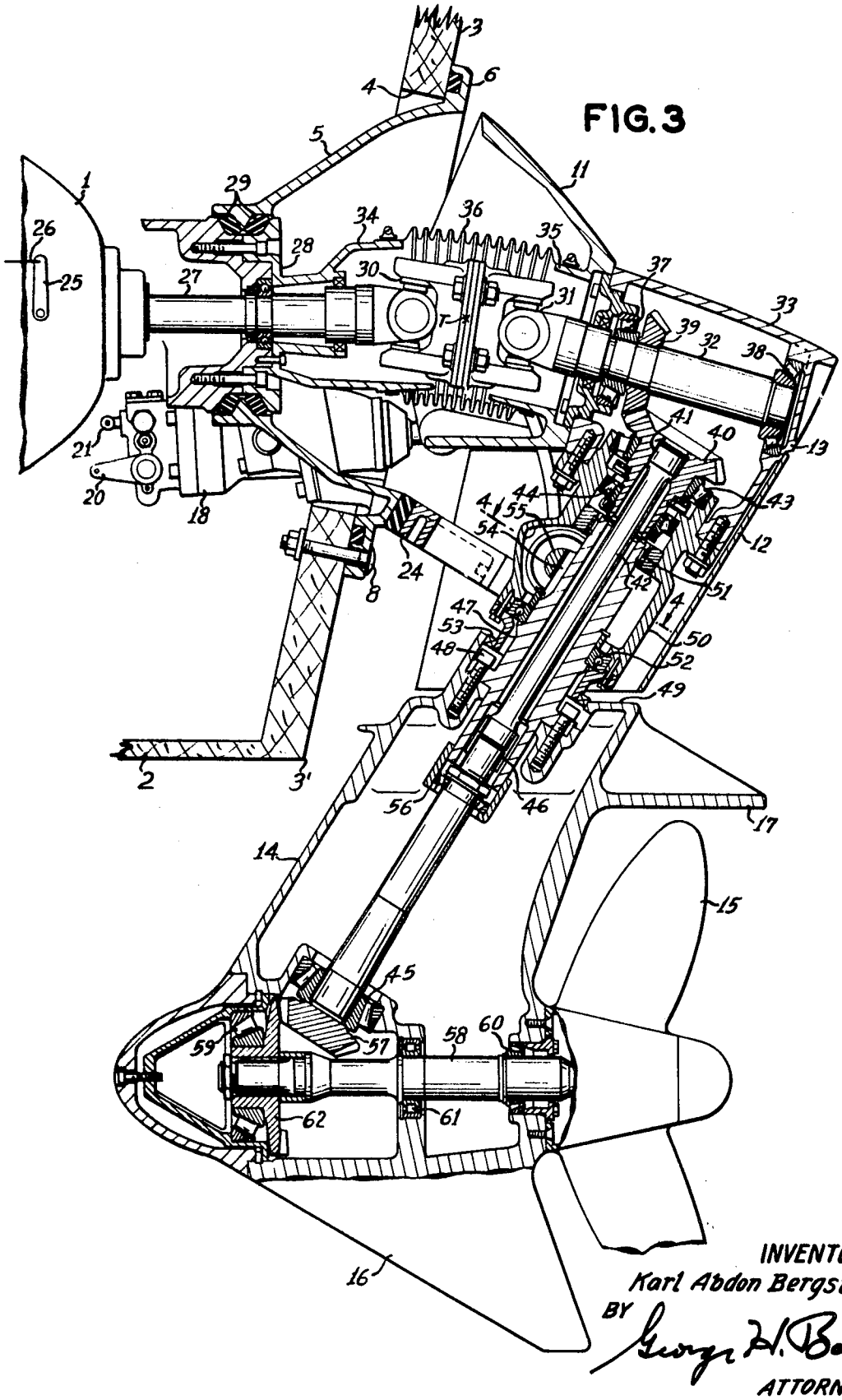
FIG. 3

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BOAT DRIVE ARRANGEMENT

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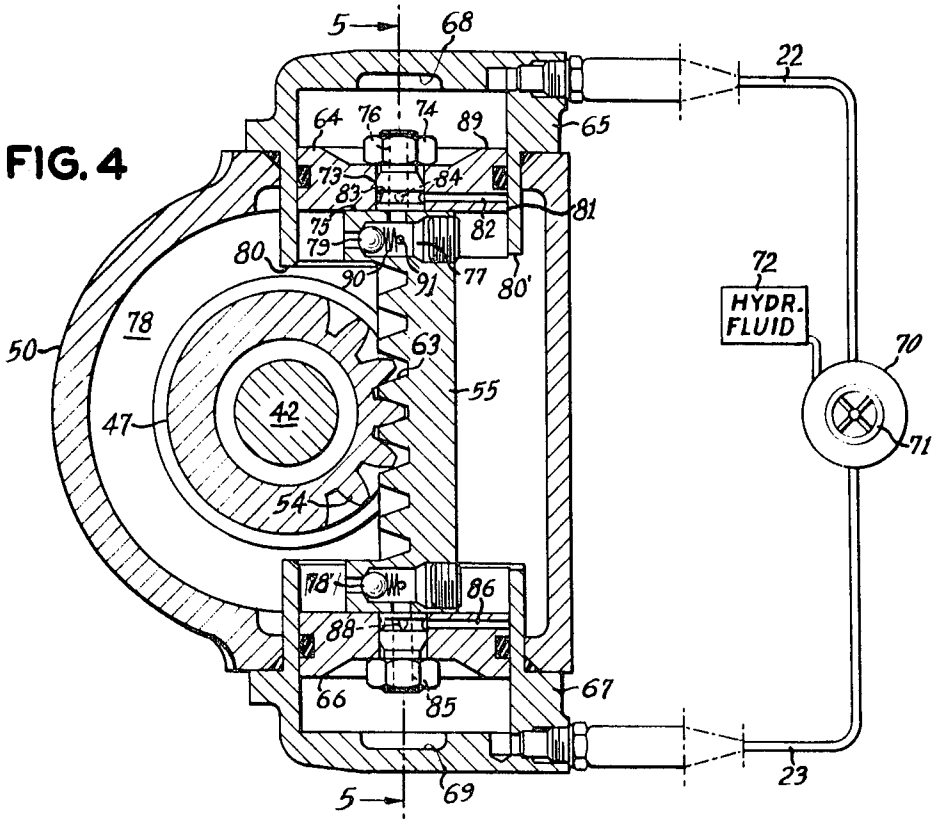
FIG. 4



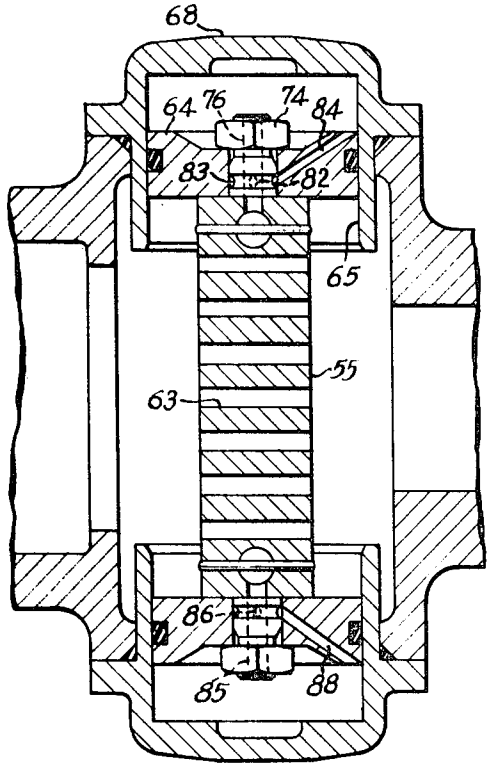




FIG. 5

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3,605,677

# BOAT DRIVE ARRANGEMENT

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Int. Cl. B63h 1/14, 5/06
U.S. Cl. 115—35 11 Claims

## ABSTRACT OF THE DISCLOSURE

An inboard-outboard drive for a boat wherein the outboard leg is of a generally Z configuration, is mounted on a horizontal tilt axis rearwardly adjacent to the transom and includes a downwardly and forwardly inclined drive shaft coupled at its lower end to a generally horizontal propeller shaft. The connection between the drive shaft and the propeller shaft is through gearing having a ratio equal to substantially the cosine of the angle between the drive shaft and propeller shaft. The lower portion of the outboard housing is arranged to rotate for steering about the axis of the drive shaft. Hydraulic steering means are provided for rotating the lower housing, including a double acting hydraulic cylinder and piston means, the piston means being provided with ports and check valves which open automatically at each extreme of the steering movement to permit a flow of hydraulic fluid through the piston means to scavenge air from the system.

This invention relates to inboard-outboard drive units for boats of the type wherein the lower propeller-carrying portion of the outboard housing is steerable about the axis of an upwardly extending drive shaft in the housing and wherein the steering torque is minimized by providing a gear ratio between the drive shaft and the propeller shaft substantially equal to the cosine of the angle between said shafts. A drive unit in which steering torque is so minimized is shown and claimed in my U.S. Pat. No. 3,382,838 issued May 14, 1968, entitled "Device on the Propeller Installation for Boats." The present invention further relates to hydraulic steering means for such drive units.

It is a general object of this invention to provide an improved drive unit of the aforesaid type. It is a more specific object of this invention to provide a compact drive of such type, wherein the propeller is located adjacent to the boat transom. It is a further object of the invention to provide an improved hydraulic steering system for rotating an outboard housing portion which carries the propeller and which is mounted for rotation on a steering axis. Other and further objects will be apparent from the following description when taken in connection with the drawings, in which:

FIG. 1 is a side elevational view of an inboard-outboard drive unit for a boat embodying my invention, portions of the boat being represented in phantom;

FIG. 2 is a rear elevational view thereof;

FIG. 3 is a sectional side view of the unit on an enlarged scale taken generally along line 3—3 of FIG. 2;

FIG. 4 is a sectional detail view on a further enlarged scale of a portion of the hydraulic steering system taken generally along line 4—4 of FIG. 3; and

FIG. 5 is a sectional view of parts of the portion shown in FIG. 4 taken along line 5—5 and on the scale of FIG. 4.



In the drawings, an inboard-outboard drive unit is shown in FIGS. 1 and 2 comprising an inboard engine, generally represented at 1, which is mounted in a boat 2 having a stern transom 3 with an opening 4 therethrough. The opening is closed by a shell 5 including a flange 6 engaging and sealed against the outer face 7 of the transom and bolted, such as by means of bolts 8, to the transom. The shell 5 includes arm portions 9 which project rearwardly of the transom and which journal pivot pin projections 10 from a hood-like portion 11 of outboard housing or leg 12. Housing 12 comprises an upper portion 13 and a lower steerable portion 14 which carries propeller 15 and which is provided with a skeg 16 and anticavitation plate 17, the propeller being shown in FIG. 2 by a representation of its turning circle.

A hydraulic trimming and tilting cylinder arrangement is provided at 18 to adjust the trim angle of the outboard housing, which is shown in position for normal straight ahead drive in the drawing. The hydraulic trim arrangement is operated from a suitable remote station through a flexible push-pull cable means 19 connected to valve lever 20, the arrangement being provided through the valve controlled by lever 20 with hydraulic fluid under pressure from a suitable source represented by and including conduit 21. Conduits 22 and 23 extend from a suitable pump connected with a steering wheel to provide hydraulic fluid under pressure to the hydraulic steering mechanism embodied within the upper portion 13 of the outboard housing 12 as hereinafter more particularly described. It will be understood that the conduits 22 and 23 are flexible between the transom and the outboard leg, whereby tilting of the leg on the horizontal axis of pivot pins 10 is permitted. The conduits 22 and 23 extend inwardly through the transom, and they preferably extend and are sealed through the flange 6 of the mounting bell 5 and pass into the boat through opening 4. Bumper means 24 is arranged to limit the forward tilting movement of the outboard housing or leg so as to prevent the leg from tilting forward under any circumstances into a position in which the lower housing 13 would contact the lower edge of the transom. Maximum extension of the hydraulic cylinder and piston arrangement 18 tilts the leg about axis T preferably sufficiently to raise the propeller 15 above water.

The drive unit is shown in section in FIG. 3, several parts as there shown being identified by the reference numerals as described above in connection with FIGS. 1 and 2.

The inboard engine 1 is provided with a forward and reverse transmission (not shown) which is operated by a lever 25 controlled by a suitable linkage mechanism 26 from the usual operator's station in the boat, from which station the steering and tilt and trim arrangements are also operable. The engine drive shaft 27 is journalled in a hollow ring member 28 which is externally connected and sealed by means of suitable compressed rubber or the like rings 29 to shell 5. The shaft 27 terminates rearwardly in a universal joint 30 which is in turn connected to universal joint 31 and therethrough to a countershaft 32. It will be understood that suitable spline connections (not shown) are provided between at least one of the shafts and one of the joints to accommodate the necessary movement imposed by the geometry when the out-

board leg is tilted. Joints **30** and **31** together comprise an assembly commonly referred to as a double universal joint. The tilt axis for the outboard leg is identified by the letter T in FIG. 3, and it will be understood that this corresponds to the horizontal axis of the pivot pins **10** shown in FIGS. 1 and 2. The tilt axis, which extends laterally of the boat center line, will be seen to substantially intersect the axis, if extended, of engine shaft **27** and to be substantially midway between the universal joints **30** and **31**. The position of the tilt axis with respect to the joints is selected to establish an appropriate working axis of the joints. It will further be seen that the countershaft **32** is at a small downward angle of substantially 15 degrees with respect to shaft **27**. It has been found that operation of double universal joints at a slight angle, such as an angle of 15 degrees, does not adversely affect the performance of the joints, while the downward inclination of the counter shaft **32** permits improved geometry of the upper end **33** of the upper housing portion **13** and increases the maximum permissible tilt angle for the leg, in that there is greater clearance between the upper end **33** and the flange **6** or the transom **3**, and, since there is a maximum permitted angle for operation of universal joints, in that the greater angle of tilt does not exceed such maximum angle for the joints. Specifically, for example, the double universal joint **30**, **31** may be designed for satisfactory operation up to a maximum angle of approximately 60 degrees, and, since the countershaft is inclined downwardly by approximately 15 degrees with the outboard leg in normal trim position, the joints would then accommodate rearward and upward tilting of the leg up to about 75 degrees from its normal trim position. It is to be noted that the top of the upper housing inclines downwardly along and adjacently above the countershaft to provide optimal transom clearance upon tilting up, as well as a pleasing external configuration of the outboard leg.

The hood or bell-like portion **11** of the outboard housing, which has been previously described as carrying pivot pins **10**, is arranged to swing into the bell **5** with tilting of the outboard housing. The ring member **28** includes a unitary, rearwardly extending, hollow, generally cylindrical inner portion **34**, and the member **11** has a similar inner hollow cylindrical portion **35** extending forwardly toward portion **34**. A flexible corrugated cylindrical boot **36** is clamped to and extends between portions **34** and **35** to enclose the universal joints **30**, **31** in a watertight compartment.

It will be seen that outboard housing portion **11** and bell **5** serve to protect the boot **36** against damage from external objects, and it will be further seen that bell **5** together with member **28** completely close the opening **4** in transom **3** against the entrance of water into the boat, although water may reach the outside of boot **36**.

Countershaft **32** is supported on roller thrust bearings **37** and **38** within upper portion **13** of the outboard housing, and it has keyed thereon a bevel gear **39** meshing with bevel gear **49** keyed on the upper end **41** of a jointed drive shaft **42**. The drive shaft extends from its upper end in a downward and forwardly inclined direction. The drive shaft is supported for rotation or journalled by thrust bearings **43** and **44** in the upper housing portion **13** and by thrust bearing **45** in the lower housing portion **14**. Joint means **46** permit the shaft to be separated between its ends for convenience in assembling and disassembling the outboard leg and to provide for length adjustment of the shaft to accommodate it to the bearing positions.

The lower housing portion **14** has an upwardly extending hollow neck member **47** bolted thereto by bolts **48** at its upper end **49**. The hollow neck **47** extends upwardly into a downwardly opening generally tubular projecting portion **50** of the upper housing **13** and is rotatable therein on pin bearing **51** and on ball bearing **52** on an axis coincident with the axis of shaft **42**. A sealing ring **53** interposed between projection **50** and the upper end **49** of the lower housing prevents the escape of hydraulic fluid from and the entry of water up into the projection **50** and thus protects bearings **43**, **44**, **51** and **52**.

The outer surface of the hollow neck member **47** is provided between bearings **51** and **52** throughout a part of its periphery with pinion teeth **54** engaged with the teeth of a rack member **55**, as hereinafter more particularly described, permitting steering of the lower portion **14** of the housing with respect to the upper portion **13**. Movement of the rack **55** in a direction toward the viewer in FIG. 3 will cause the lower housing portion **14** to swing in a direction in which the propeller would move away from the viewer, that is to say, propeller **15** being a pusher propeller, in a direction to steer the boat to starboard.

The neck member **47** carries at its lower end, and at a location within lower housing portion **14**, a roller thrust bearing **56** which journals the drive shaft just below coupling **46**. The drive shaft **42** terminates downwardly in a bevel gear **57**. Propeller shaft **58** is mounted in the lower housing portion by roller thrust bearings **59** and **60** and roller bearings **61**, and it is provided with a crown gear **62** meshing with the bevel gear **57**. Propeller **15** is preferably a pusher propeller and is, accordingly, mounted on the propeller shaft exteriorly and rearwardly of the housing portion **14**.

The drive shaft **42** and propeller shaft **58** rotate in the same direction of rotation, that is, the teeth of gear **57** are in mesh with the teeth of gear **62** above shaft **42** and above shaft **58**, and the gear ratio between these shafts is substantially equal to the cosine of the angle between the shaft axes to minimize the steering torque effect of shaft **42** on the lower housing in accord with the teachings of my U.S. Pat. No. 3,382,838.

The angle between the axis of drive shaft **42** and the axis of propeller shaft **58** in the arrangement shown in FIG. 3 is 58 degrees, or 122 degrees, and the cosine of this angle is substantially 0.53, whereby the gear ratio between drive shaft **42** and propeller shaft **58**, or from gear **57** to gear **62**, is 1:0.53. As so arranged, gear **62**, being a crown gear, and gear **57**, a bevel gear, the teeth are in engagement perpendicularly above the point of intersection of the drive shaft and propeller shaft axes. It will be found normally desirable that the gear ratio should not be substantially greater than 1:0.53 for modern gasoline engines and modern high speed propellers, in that a substantially greater reduction from shaft **42** to the propeller would require excessive shaft speeds or a low speed propeller. If the angle between the shafts **42** and **58** were 70 degrees, for example, the gear ratio would be substantially 1:0.34, while at 75 degrees the ratio would be 1:0.26 or nearly 4:1, a ratio which would be under any usual circumstances unsatisfactory for a high speed planning boat or for a high speed propeller. Decreasing the angle to 50 degrees would permit a ratio of 1:0.64, while an angle of 40 degrees would permit a ratio of 1:0.77. While such gear ratios may be more desirable for a high speed propeller than a ratio of 1:0.53, the geometry of the outboard leg would be adversely affected by the smaller angle and, since the lower unit **14** steers about the axis of shaft **42**, the propeller shaft would tilt up at an undesirable angle when the lower unit was swung away from normal straight ahead drive position. Accordingly, the minium satisfactory angle between the shaft axes would be approximately 45 degrees and the maximum satisfactory angle would be approximately 70 degrees, although with a low speed propeller angles of as great as about 75 degrees might be employed.

A downward and forward inclination of 58 degrees to the horizontal for shaft **42** provides an arrangement in which propeller **15** and anticavitation plate **17** may be desirably disposed close to the lower edge **3'** or the transom, with the plate aligned at the level of or slightly below edge **3'** and with the propeller sufficiently close

to the transom as to be in compacted water rather than in the turbulent wake further astern, and with the plate and propeller in positions in which they tend to remain at desired depth upon pitching of the boat.

The hydraulic steering system is best understood with reference to FIGS. 4 and 5. As seen therein, the upstanding neck member **47**, which is rigidly attached to lower housing **14**, is provided exteriorly throughout somewhat less than half of its periphery with teeth **54** meshing with teeth **63** of rack member **55**. The rack member carries a piston at each end, piston **64** being disposed in a cylinder **65** and piston **66** being disposed in a cylinder **67**. The cylinders have closed outer ends **68** and **69**, respectively, and are provided with suitable connections to respective hydraulic fluid lines **22** and **23**, whereby the piston and cylinders constitute a double acting hydraulic cylinder and piston mechanism for moving the rack member back and forth.

The hydraulic system includes a pump **70** connected to steering wheel **71** operable to force fluid into conduit **22** and to permit return of fluid from conduit **23** in response to rotation of the wheel in one direction and vice versa in response to rotation in the opposite direction.

A hydraulic fluid supply or sump **72** is connected to the pump **70** to supply fluid for the original filling of the system as the air is scavenged therefrom, and to supply make up fluid thereafter.

The rack member has motion in each direction limited when one or the other of pistons **64** and **66** meets the respective cylinder end wall **68** and **69**. The teeth **63** on rack **55** extend through a distance therealong, and the teeth **54** on neck member **47** extend around the periphery thereof, sufficiently to accommodate the full extent of the permitted movement of rack **55**. For example, the rack may be arranged to move sufficiently to rotate neck member **47** and lower housing **14** through a total of approximately 60 degrees, 30 degrees on each side of the dead center position corresponding to straight ahead steering position.

In the construction shown, rack member **55** is provided with a partially threaded reduced generally cylindrical end portion **73** which passes through piston **64** and onto which nut **74** is screwed up against the piston to hold the piston firmly against shoulder **75** of the rack member. The end portion is longitudinally bored at **76** into a cross-bored chamber **77** in the rack member. The projection **50** constitutes a fluid containing chamber and housing for the rack and pinion mechanism and the interior **78** of the housing chamber has communication through a check valve **79** into the chamber **77** within the rack member. The check valve **79** may include a light spring **90** seated on pin **91**.

The cylinder **65** terminates at an edge **80** which, at cutaway portion **80'**, exposes a small part of the wall **81** of piston **64** when this piston is fully extended, that is, with piston **66** stopped by or very close to end wall **69**. A port or passage **82** is drilled into this portion of the piston wall and communicates with the interior of cylinder **65** through groove **83** formed around portion **55** of the rack and through passage **84** drilled from piston face **89** to the grove.

The arangement associated with piston **66** will be seen to be identical to that associated with piston **64** as above described, including bore **85**, port **86**, check valve **87** and passage **88** corresponding, respectively, to bore **76**, port **82**, check valve **79**, and passage **84**.

The above described arrangement provides for self-bleeding and air scavenging of the system. Operation of pump **70** to force fluid through line **22** into cylinder **65** causes the piston **64** to move in a direction outwardly of the cylinder until piston **66** nearly meets wall **69**, whereupon port **82** is exposed, through cut-away portion or notch **80'**, to the chamber interior **78**. Whatever air may be in line **22** and cylinder **65** now passes together with hydraulic fluid into bore **76**, through passages **83** and **84** and through port **82** into the interior **78** of the housing chamber. The increasing pressure in the housing chamber opens the lightly loaded check valve **87** and first any entrapped air, and later hydraulic fluid, pass through the check valve and bore **85** into cylinder **67** and thence through line **23** and into sump **72**. Operation of pump **70** in reverse direction forces piston **66** in a direction outwardly of cylinder **67** until port **86** is uncovered, whereupon hydraulic fluid and any remaining trapped air pass through channels **88** and **86** into chamber **78** and thence through check valve **79** and bore **76** into cylinder **65** and finally through conduit **22** to the sump **72**. The pump is thus operated back and forth to and beyond its full steering effect in one and in the other direction a sufficient number of times to insure complete bleeding or scavenging of the air from the system.

In operation, the steering wheel now controls the movement of rack **55** between full starboard and full port steering positions of the lower housing up to the point at which port **82** or port **86** is uncovered, whereafter continued movement of the wheel will force a small flow of hydraulic fluid through the chamber interior **78**, as when the system is being bled. The lower housing may be turned slightly beyond the full normal port or starboard steering position by an external force until one or the other of pistons **64** or **66** meets the respective cylinder end wall **68** or **69**. Such end play in the system, with properly proportioned components, will be small, such as less than one degree of swing of the lower housing. Thus port **82** should become uncovered only when piston **66** has approached very close to wall **69** at the maximum steering to port position of the pistons, rack and lower housing portion, while port **86** should become uncovered at the maximum steering to starboard position.

What is claimed is:

**1.** An inboard-outboard drive unit for a boat comprising an outboard leg comprising an upper portion disposed rearwardly of the stern of the boat and a lower portion, means tiltably mounting said upper portion on the boat for tilting on a generally horizontal lateral axis, a drive shaft disposed in said leg extending from within said upper portion inclinedly downwardly and forwardly into said lower portion, means rotatably connecting said lower portion to said upper portion for rotation of said lower portion about the axis of said drive shaft, steering means for rotating said lower portion with respect to said upper portion about said axis, means having support in said upper portion for driving said drive shaft, a propeller shaft mounted in said lower portion disposed generally horizontally and parallel to the axis of the boat when said lower portion is oriented for normal forward propulsion, a water reaction propeller carried by said shaft exteriorly of said lower portion, driving means in said lower portion drivingly connecting said drive shaft to said propeller shaft, the angle between the axes of said shafts being between substantially 45 degrees and 70 degrees, said connecting means driving said propeller shaft in the same direction of rotation as the direction of rotation of said drive shaft and at a ratio from said drive shaft to said propeller shaft equal to substantially the cosine of said angle.

**2.** The combination according to claim **1** wherein said means for driving said drive shaft comprises an inboard engine, a drive train including a power shaft extending rearwardly from said engine, a counter shaft rearward of said power shaft and flexible drive means interposed between and drivingly connecting said power shaft and counter shaft, said drive train extending through an opening in said stern of the boat, and a gear connection from said counter shaft to said drive shaft, said upper leg portion having bearings mounted therein rotatably supporting said counter shaft, said flexible drive means having a working center at substantially said tilt axis, whereby said drive train is operative to transmit power from said

engine to said countershaft when said leg is in normal trim position and in upwardly tilted position.

3. The combination according to claim 1 wherein said propeller shaft projects rearwardly from said lower portion and said propeller is a pusher propeller.

4. The combination according to claim 1 wherein the engine is provided with a forward and reverse transmission operative to drive said drive train selectively in one and the other direction of rotation and thereby to drive said propeller selectively for forward propulsion and for backing down.

5. The combination according to claim 2 wherein said counter shaft extends from said flexible drive means rearwardly with a downward inclination with respect to said engine power shaft when said leg is in normal trim position and with an upward inclination with respect to said power shaft when said leg is in an upwardly tilted position.

6. An inboard-outboard drive for a boat having a transom with an opening therethrough and an inboard engine with a generally horizontal drive shaft extending rearwardly alignedly toward said opening, said shaft terminating in a rearward end, said drive having a countershaft with a forward end disposed rearwardly of said rearward end, a double universal joint connecting between said shaft ends, a gear keyed on said countershaft, a drive shaft, a propeller shaft, when said drive is in normal drive position, said drive shaft extending downwardly below said countershaft at an angle to the vertical of between substantially 20 and 45 degrees and said propeller shaft being generally horizontally disposed, gear means drivingly connecting said drive shaft to said propeller shaft for rotation in the same direction and having a gear ratio substantially equal to the cosine of the angle therebetween, an upper housing journalling said counter shaft and said drive shaft therein, a lower housing rotatably supported by said upper housing on a rotational axis coincident with the axis of said drive shaft, said drive shaft entering said lower housing, said drive shaft and said propeller shaft being journalled in said lower housing, said propeller shaft extending outwardly of said lower housing, a propeller exteriorly of said lower housing carried by said propeller shaft, pivot means establishing a horizontal tilt axis extending laterally of the boat and between said shaft ends tiltably mounting said upper housing to said boat whereby said housings may tilt upwardly from said normal drive position upon the lower housing striking a submerged or floating object, and steering means connected between said upper and lower housing operable to rotate said lower housing on its said rotational axis selectively from and to its straight ahead drive position.

7. The combination according to claim 6 wherein said drive shaft, when said drive is in normal drive position, extends inclinedly downwardly and forwardly below said countershaft.

8. The combination according to claim 7 wherein said countershaft, when said drive is in normal drive position, extends rearwardly from its said forward end at a downward inclination of between substantially 10 and 30 degrees to the horizontal.

9. In an inboard-outboard drive unit for a boat comprising a generally upright outboard leg disposed rearwardly of the boat transom and having an upper housing portion attached to the boat, a lower housing portion and a drive shaft in said leg extending into and between said portions, said lower housing portion journalling a propeller shaft drivingly connected to said drive shaft, means rotatively mounting said lower housing portion to said upper housing portion on a steering axis coincident with the drive shaft axis, a double acting hydraulic piston and cylinder assembly, said assembly including cylinder means having opposed cylinder end chambers, means to apply pressure hydraulic liquid selectively into one and the other of said end chambers and to open the said end chamber opposite to the chamber being supplied with pressure liquid for the escape of fluid therefrom, piston means in said end chambers adapted to be forced back and forth inwardly of said one and outwardly of said other end chamber upon application of pressure fluid into said other end chamber and inwardly of said other and outwardly of said one end chamber in response to said application of pressure fluid to said one end chamber, said assembly being connected between said upper and said lower housing portions and operative, in response to movement of said piston means with respect to said cylinder means, to swing said lower housing portion between respective maximum steering positions, and scavenging valve means communicating between said end chambers, said valve means being opened in response to maximum steering travel of said piston means in the direction outwardly of said one cylinder end chamber thereby to provide fluid flow through said chambers in series.

10. In an inboard-outboard drive unit for a boat comprising a generally upright outboard leg disposed rearwardly of the boat transom and having an upper housing portion attached to the boat, a lower housing portion and a drive shaft in said leg extending into and between said portions, said lower housing portion journalling a propeller shaft drivingly connected to said drive shaft, means rotatively mounting said lower housing portion to said upper housing portion on a steering axis coincident with the drive shaft axis, a pair of spaced apart cylinders having open inner ends facing each other and closed outer ends, a piston in each cylinder, a rack connected between said pistons, a pinion engaged with said rack and having an axis coincident with said steering axis, said pinion being connected to one of said housing portions and said cylinders being connected to the other housing portion whereby back and forth movement of said pistons and rack with respect to said cylinders steeringly rotates said lower housing portion on said steering axis between opposite limit positions, a chamber located between said cylinders and pistons adapted to be filled with hydraulic fluid, a passage in one piston opening through the face thereof into the respective cylinder and opening through a portion of the side wall thereof which is covered by the cylinder wall when the piston is inwardly of the cylinder and exposed to said chamber when the piston has moved outwardly of the cylinder into a position corresponding to limit steering in one direction, a passage through said other piston opening into said chamber and through the face of the piston into the interior of its respective cylinder, a check valve for said last passage blocking flow of fluid therethrough in the direction from said cylinder interior into said chamber and freely passing flow in the opposite direction, and means to force pressure fluid into the cylinder for said one piston and to permit fluid flow from the other cylinder, said last means being operable to force said one piston into limit position thereby to uncover said passage opening in the wall of said one piston and thereafter to cause said fluid to flow through said chamber and into and through said other cylinder, thereby to scavenge air from said cylinders and chamber.

11. In an inboard-outboard drive unit for a boat comprising a generally upright outboard leg disposed rearwardly of the boat transom and having an upper housing portion attached to the boat, a lower housing portion and a drive shaft in said leg extending into and between said portions, said lower housing portion journalling a propeller shaft drivingly connected to said drive shaft, means rotatively mounting said lower housing portion to said upper housing portion on a steering axis coincident with the drive shaft axis, a steering system characterized in that said last means comprises a generally cylindrical neck portion of said lower housing portion extending upwardly therefrom into said upper housing portion and coaxial with said drive shaft, bearing means in said up-

per housing portion rotatively journalling said neck portion therein, gear teeth externally on said neck portion, a rack member in said upper housing portion engaged with said teeth, double acting hydraulic cylinder means fixed in said upper housing portion, piston means in said cylinder means connected to said rack member, and manually controlled hydraulic pressure fluid supply means connected to said cylinder means for reciprocating said piston means and said thereto connected rack member to provide steering rotation of said lower housing portion on said axis.



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TRYGVE M. BLIX, Primary Examiner