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Marine propulsion device power steering system

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(56) Documents cited
GB 0634334 A
GB 0692086 A
GB 0751890 A
GB 0817830 A
GB 1576699 A
US 3631833 A

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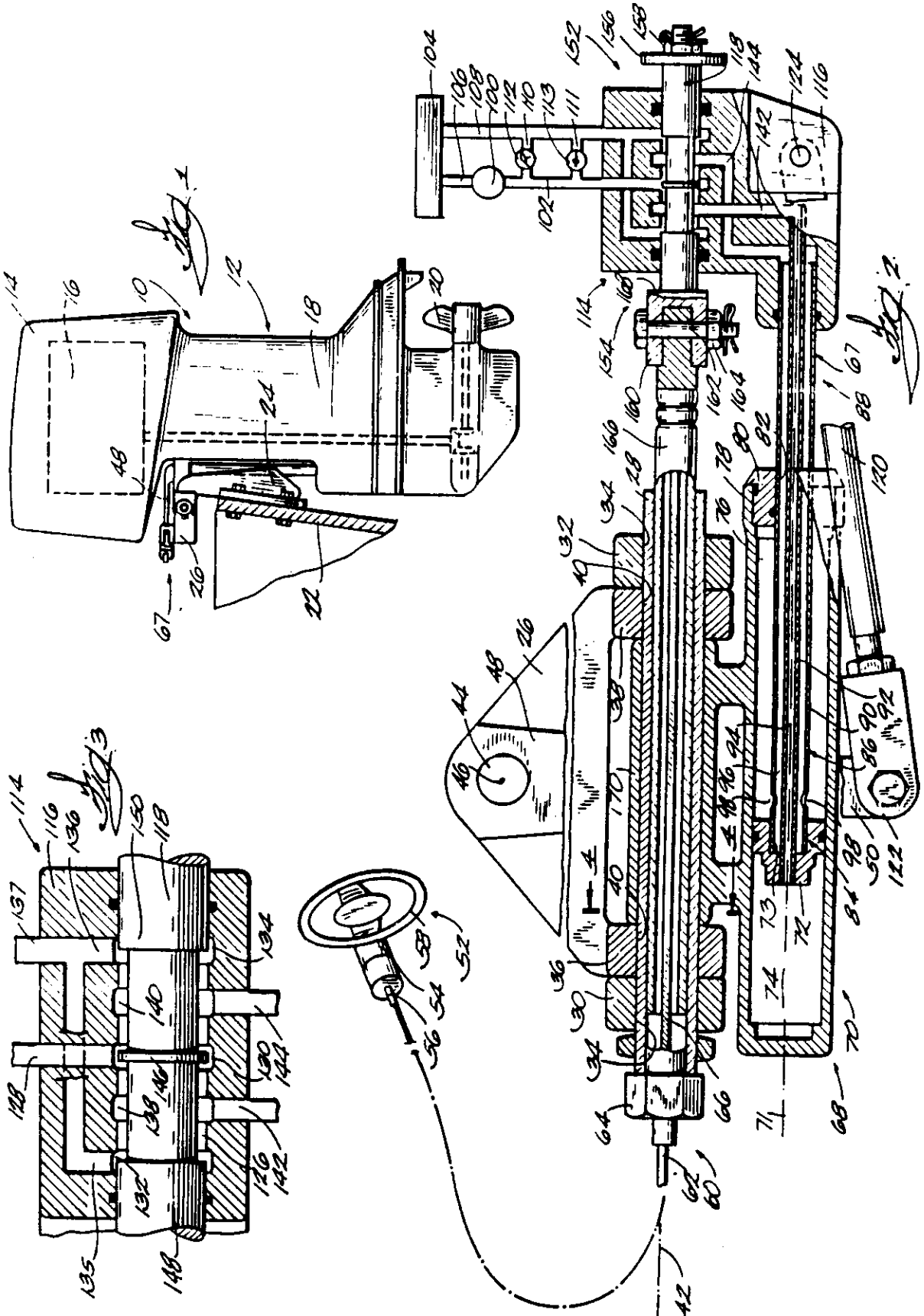
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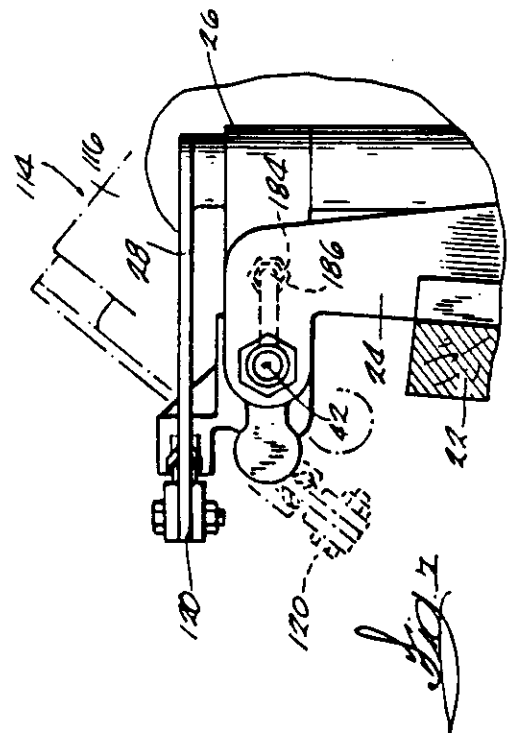
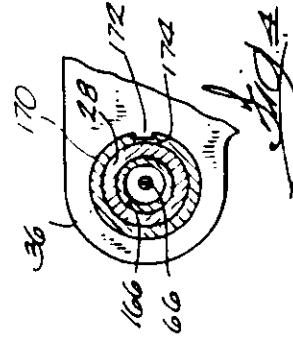
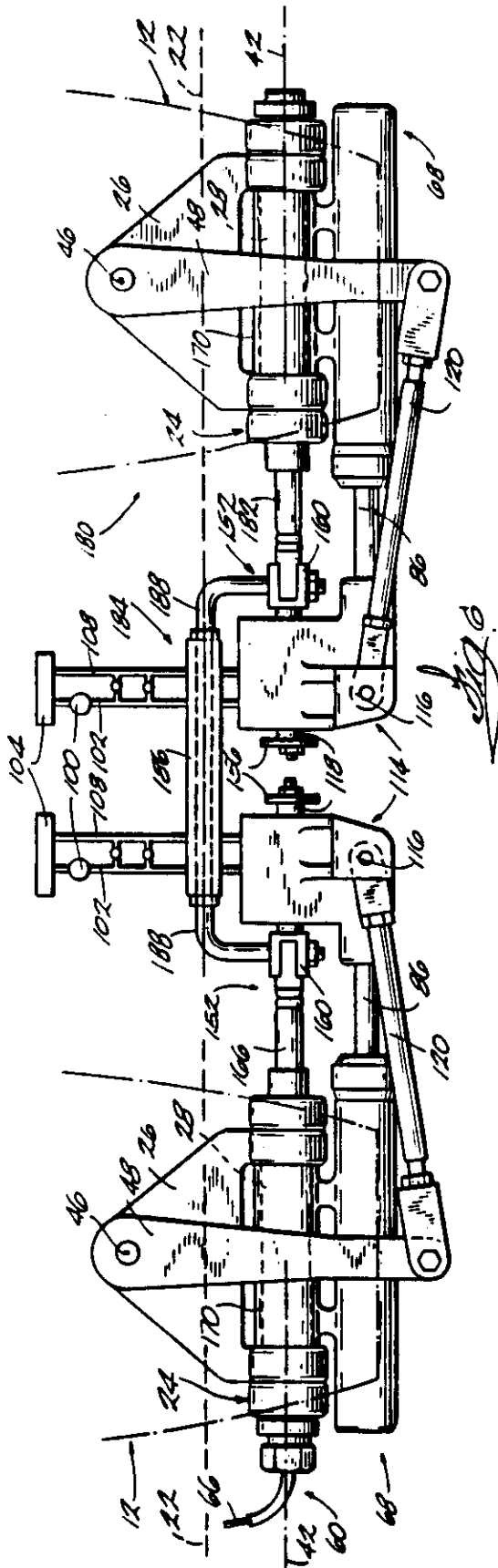
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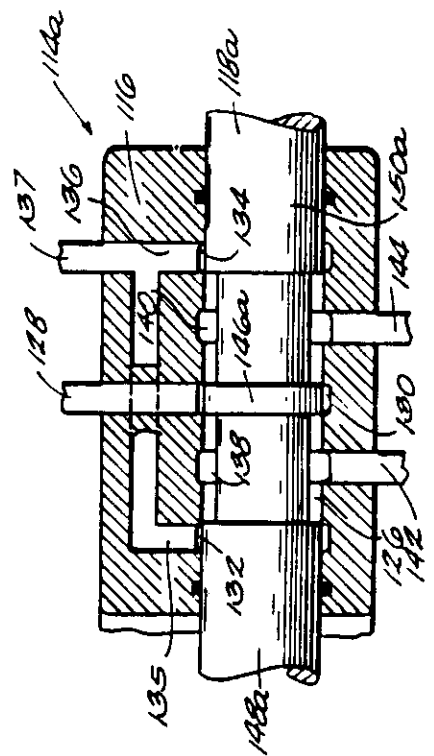
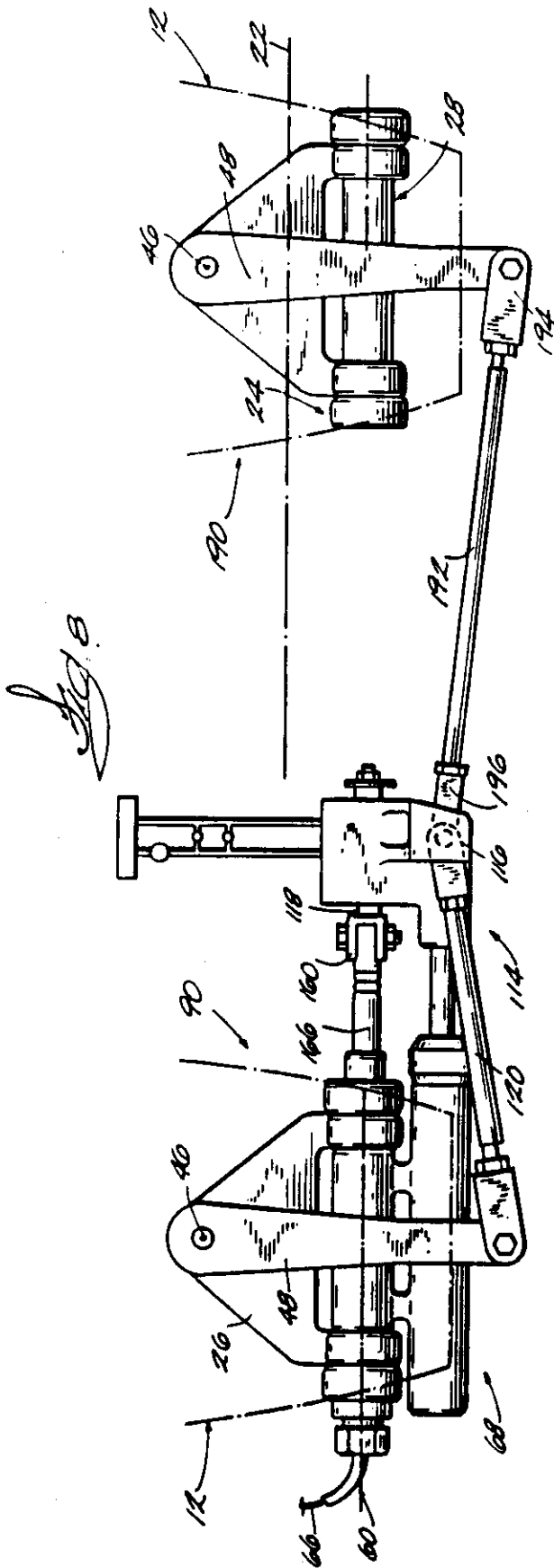
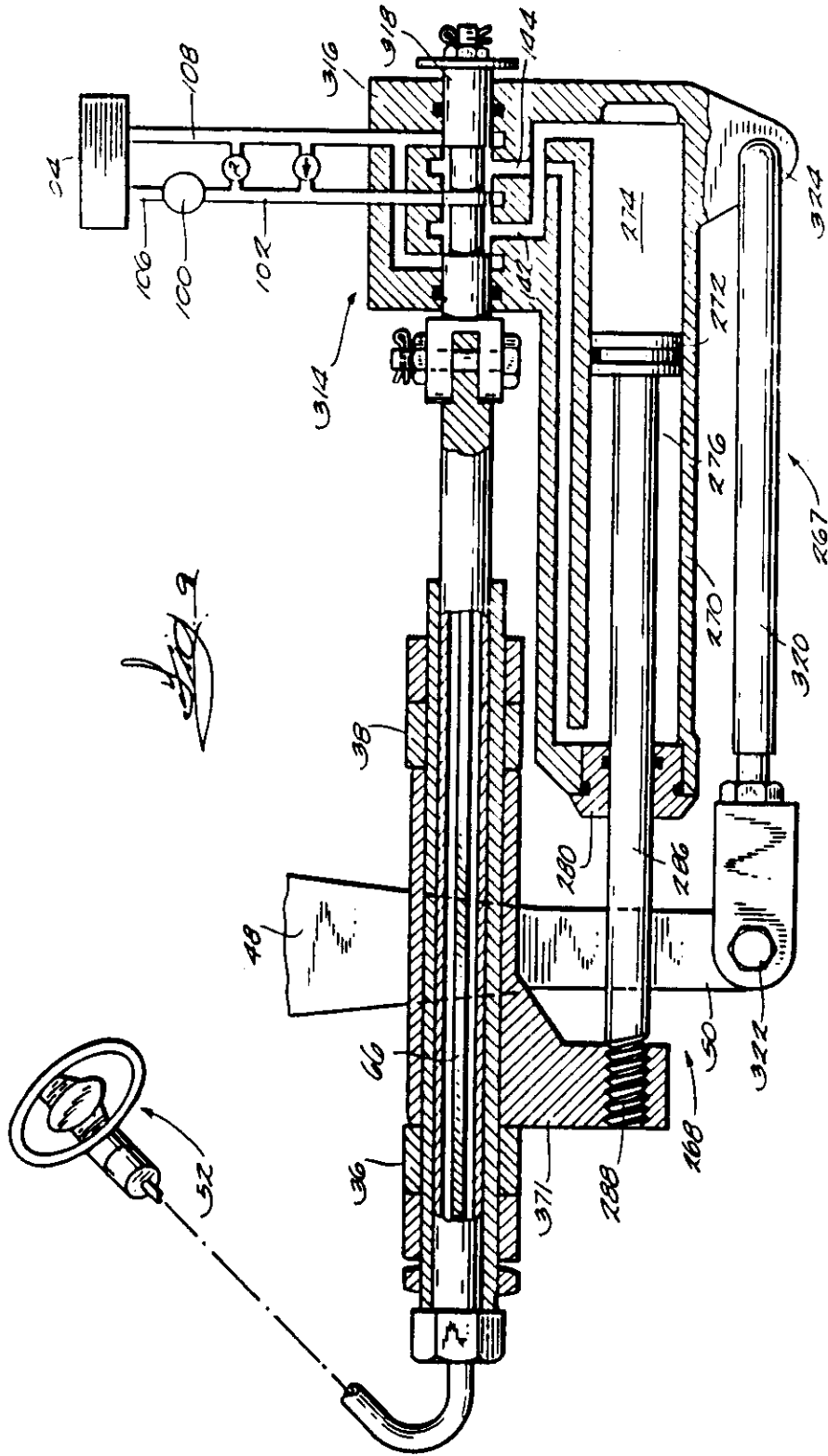
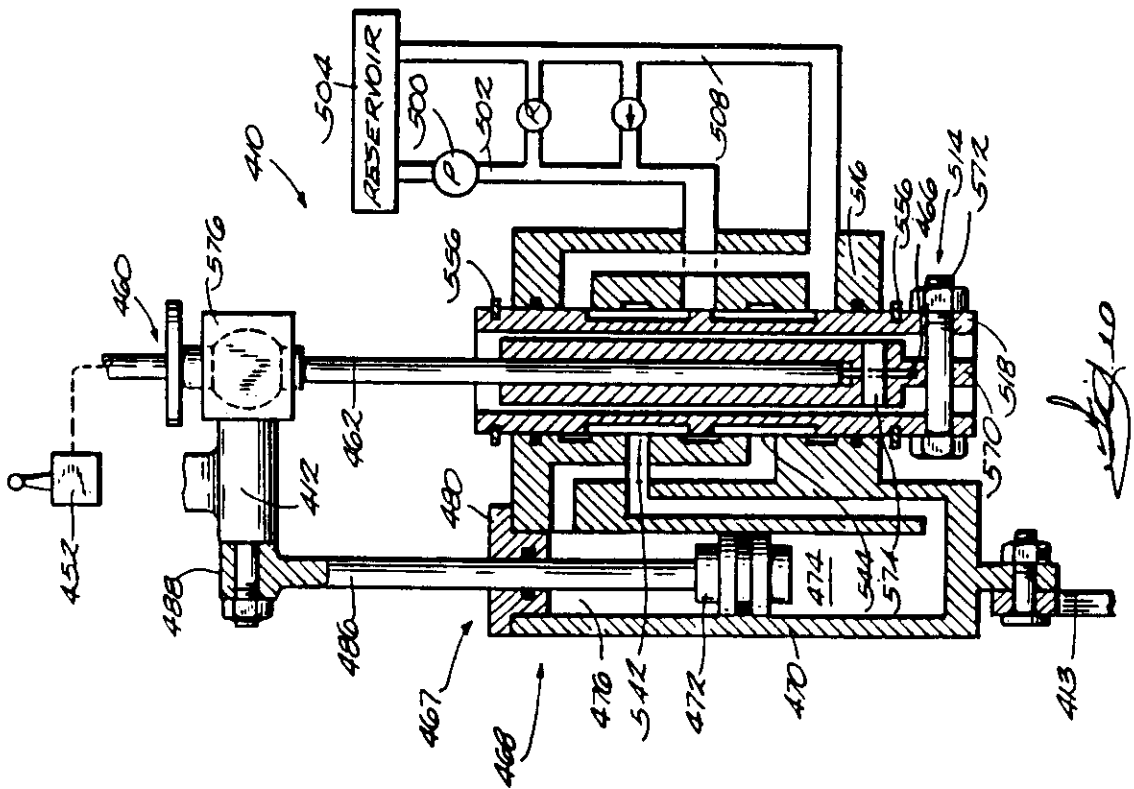
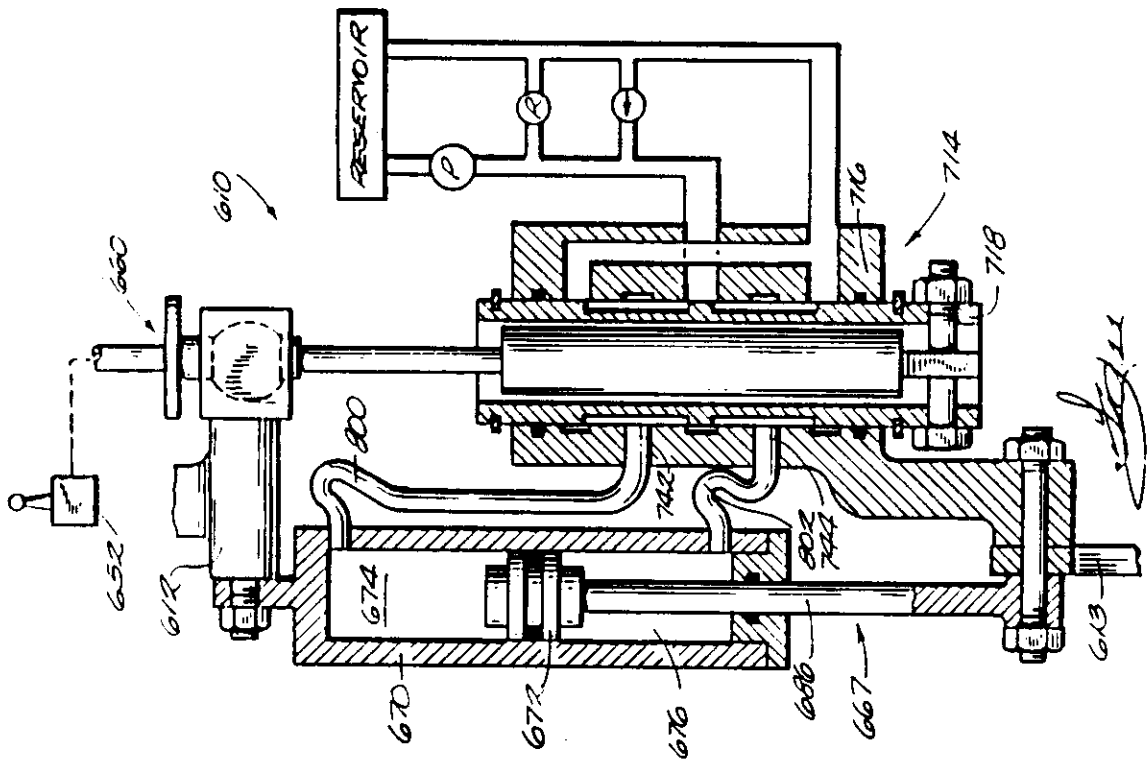


Fig. 5





"Marine Propulsion Device Power Steering System"

This invention relates to power steering systems for marine propulsion devices, such as outboard motors and stern drive units.

5 Attention is directed to the following U.S. patents which disclose prior art power steering systems for marine propulsion devices:-

	<u>Patentee</u>	<u>Patent No.</u>	<u>Issue Date</u>
	Hammock	2,939,417	June 7 1960
10	Shimanckas	3,631,833	January 4 1972
	Borst	3,774,568	January 27 1973
	Cox et al.	4,227,481	October 14 1980
	Borst	4,295,833	October 20 1981
	Hall et al	4,373,920	February 15 1983
15	Borst	4,419,084	December 6 1983

Attention is also directed to the following pending U.S. patent applications: Ferguson Application Serial No. 293,324, filed August 17, 1981; Hall et al Application Serial No. 485,028, filed April 14, 1983; Hall 5 Application Serial No. 484,900, filed April 14, 1983; and Hall Application Serial No. 558,041, filed December 5, 1983.

According to the present invention, there is provided power steering apparatus for a marine propulsion device having a propulsion unit and a propulsion unit mounting means adapted to be fixed to a boat hull and connected to the propulsion unit to afford steering and tilting movement of the propulsion unit relative to the propulsion unit mounting means about respective steering and tilting axes, the apparatus comprising a movably mounted steering member adapted to effect steering of the propulsion unit in response to movement of the member, a hydraulic cylinder-piston assembly including a cylinder having an axis, and a piston mounted in the cylinder and dividing the cylinder into opposite sides, support means attached to one of the cylinder and the piston and adapted

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to mount the cylinder-piston assembly on the propulsion unit mounting means such that the axis of the cylinder is parallel to the tilting axis and such that the one of the cylinder and the piston is fixed against movement in the direction of the tilting axis, the other of the cylinder and the piston being movable in the direction axially of the cylinder relative to the one of the cylinder and the piston and connected to the steering member, a valve assembly including a valve housing adapted to be connected to a source of pressurised hydraulic fluid and being hydraulically connected to the opposite sides of the cylinder, the valve assembly also including a valve member movable relative to the valve housing to control flow of hydraulic fluid from the source thereof to the cylinder, and connector means connecting one of the valve housing and the valve member with the other of the cylinder and the piston for common movement, the other of the valve housing and the valve member being adapted for connection to actuating means for displacing the other of the valve housing and the valve member relative to the one of the valve housing and the valve member in response to operator activity, whereby steering movement of the propulsion unit is effected in response to movement of the other of the cylinder and the piston incident to the application of hydraulic fluid to the cylinder by the valve assembly in response to the actuating means.

In one embodiment the apparatus further includes the actuating means which comprises a push-pull cable including an outer sheath adapted to be fixed to the propulsion unit mounting means and an inner core movable
5 relative to the outer sheath, the other of the valve housing and the valve member being fixed to the inner core for common movement therewith and for movement relative to the one of the valve housing and the valve member.

In one embodiment the support means is attached
10 to the cylinder and is adapted to mount the cylinder piston assembly on the propulsion unit mounting means such that the cylinder is fixed against movement in the direction of the tilting axis, the piston being movable in the direction axially of the cylinder.

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In one embodiment the connector means comprises a piston rod which is connected to the piston for common movement therewith and which includes an axial passageway for flow of hydraulic fluid between the valve assembly and
5 the cylinder.

In a development of this embodiment the piston rod includes an inner tubular portion forming an axial first passageway for flow of hydraulic fluid between the valve assembly and one side of the cylinder, and an outer
10 tubular portion coaxial with the inner tubular portion and forming an annular second passageway for flow of hydraulic fluid between the valve assembly and the other side of the cylinder.

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In one embodiment the connector means connects the valve housing to the other of the cylinder and the piston for common movement therewith, and the valve member is adapted to be connected to the actuating means for displacing the valve member relative to the valve housing in response to operator activity.

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In one embodiment the valve assembly is a spool valve assembly, the valve housing has an inlet port adapted to be connected to the source of pressurised hydraulic fluid and a return port adapted to be connected to a hydraulic sump, and the valve member is movable by the actuating means between first and second positions relative to the valve housing such that, when the valve member is moved into the first position, one side of the cylinder is placed in fluid communication with the inlet port and the other side of the cylinder is placed in fluid

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communication with the return port to effect steering
movement of the propulsion unit in one direction, and,
when the valve member is moved into the second position,
the one side of the cylinder is placed in fluid
5 communication with the return port and the other side of
the cylinder is placed in fluid communication with the
inlet port to effect steering movement of the propulsion
unit in the opposite direction.

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Reference is also made to the Applicants'
British Patent Specification No. 2,159,483.

In order that the invention may be more fully understood, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a side view of an outboard motor embodying various of the features of the invention.

Figure 2 is an enlarged, partially sectioned and partially schematic, top view of the power steering system in the outboard motor shown in Figure 1.

Figure 3 is an enlarged, fragmentary and schematic view of the control valve of the power steering system shown in Figure 2.

Figure 4 is a sectional view taken generally along line 4-4 in Figure 3.

Figure 5 is a view similar to Figure 3 of an alternate construction for the control valve in the power steering system.

Figure 6 is a top view of a power steering system for two outboard motors mounted in side-by-side relationship.

Figure 7 is an end view taken generally along line 7-7 in Figure 6 showing the relative position of certain parts when one propulsion unit is in a tilted position and the other is in an operating position.

Figure 8 is a view similar to Figure 6 except the steering mechanism includes a single power steering system for steering both outboard motors.

Figure 9 is a top view similar to Figure 2 showing an alternative embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Illustrated in the drawings is a marine propulsion device, such as an outboard motor or stern drive unit incorporating various of the features of the invention. In the specific construction illustrated, the marine propulsion device 10 is the form of an outboard motor including a propulsion unit 12 having an upper power head 14 housing an internal combustion engine 16 and a lower unit 18 carrying a rotatably mounted propeller 20 which is connected to the engine 16 via a conventional transmission.

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Means are provided for mounting the propulsion unit 12 on a boat transom 22 for vertical tilting movement about a generally horizontal axis and for pivotal movement in opposite directions about a steering axis generally transverse to the tilt axis. While various mounting means can be used, in the specific construction illustrated, such means includes a support or transom bracket 24 mounted on the boat transom 22 and a pivot or swivel bracket 26 pivotally connected to the transom bracket 24 via a horizontally extending pivot or tilt tube 28. More specifically, the transom bracket 24 has a pair of laterally spaced arms 30 and 32 including a bore 34 pivotally receiving the tilt tube 28.

The swivel bracket 26 has a pair of lugs 36 and 38 located adjacent the transom bracket arms 30 and 32 and including an aperture 40 receiving the tilt tube 28. The swivel bracket 26 tilts or pivots in a generally vertical plane relative to the transom bracket 24 about the horizontal axis 42 of the tilt tube 28, herein referred to as the tilt axis.

The propulsion unit 12 is connected to the swivel bracket 26 by a king pin 44 which affords pivotal swinging movement of the propulsion unit 12 in a generally horizontal plane relative to the swivel bracket 26 and in opposite directions about the generally vertical axis 46 of the king pin 44, herein referred to as the steering axis.

Means are provided for causing steering movement of the propulsion unit 12 about the steering axis 46. While various steering means can be used, in the specific construction illustrated, such means includes a tiller or steering arm 48 having a rearward portion affixed to the king pin 44 and the

propulsion unit 12 and a forwardly extending arm portion 50 providing a lever arm for pivoting the king pin 44 and the propulsion unit 12 about the steering axis 46.

The steering means also includes a remotely located steering actuator or device 52 including a housing or frame 54 mounted on the boat hull and a shaft 56 rotatably carried by the frame 54 and supporting a steering wheel 58. The steering device 52 is connected to the arm portion 50 of the steering arm 48 via a steering cable assembly 60 to effect pivotal steering movement of the propulsion unit 12 in response to rotation of the steering wheel 58. In the specific construction illustrated, the steering cable assembly 60 includes an outer cable sheath 62 having one end secured to one end of the tilt tube 28 by a threaded member 64 and an inner flexible member or push-pull cable 66 which is movable relative to the sheath 62. One end of the push-pull cable 66 is operably connected to the steering wheel shaft 56.

Power assist means 67 operably connecting the steering device 52 to the propulsion unit 12 are provided for increasing the steering force applied to the steering arm 48 by the push-pull cable 66. In the specific construction illustrated, such power assist means or power steering system 67 is wholly supported on the swivel bracket 26 and includes a hydraulic cylinder-piston assembly 68 having an extendable and retractable steering link which is connected between one end of the push-pull cable 66 and the arm portion 50 of the steering arm 48 and which, when it extends or retracts, effects pivotal movement of the propulsion unit 12. The

power steering system 67 also includes a control means for selectively extending and retracting the steering link in response to rotation of the steering wheel 58 and, thus, to axial movement of the push-pull cable 66.

The hydraulic cylinder-piston assembly 68 includes a cylinder 70 having a fixed, longitudinal axis 71 located in spaced parallel relationship to the tilt axis 42 and a piston 72 mounted inside the cylinder 70 for axial reciprocative movement. This piston 72 has a central aperture 73 and divides the cylinder 70 into opposite sides or first and second pressure chambers 74 and 76.

One end 78 of the cylinder 70 is closed by an end wall 80 including a central aperture 82. The inner end 84 of a tubular piston rod 86, slidably extending through the end wall aperture 82 and forming the steering link, is fixably connected to the piston 72 and the outer end 88 of the piston rod 86 extends outwardly from the cylinder 70. The piston rod 86 includes an outer tubular portion 90 and an inner tubular portion 92 which extends through the piston aperture 73 and forms a first flow passageway 94 communicating with the first pressure chamber 74. The inner tubular portion 92 is concentric with the outer tubular portion 90 and cooperates therewith to define an annular second flow passageway 96 which communicates with the second pressure chamber 76 through apertures 98 in the outer tubular portion 90 near the piston 72.

The piston 72 is operated by a pressurized hydraulic fluid continuously supplied by a pump 100 which can be driven directly by the engine 16 or by another power source such as an electric

motor (not shown) operated by a battery or by a generator driven by the engine 16. The pump 100 is connected to a sump or reservoir 104 by a conduit 106 and to the piston and cylinder assembly 68 by a supply conduit 102. Hydraulic fluid from the cylinder-piston assembly 68 is discharged to the reservoir 104 through a return conduit 108. In the event of excessive pressure, hydraulic fluid flows from the supply conduit 102 to the return conduit 108 via a conduit 110 and a vent or relief valve 112. The return conduit 110 is connected to the supply conduit 102 via a bypass conduit 111 and a check valve 113.

Control means are provided for selectively controlling the the flow of hydraulic fluid to and from the first and second pressure chambers 74 and 76 to extend and retract the piston rod 86. In the specific construction illustrated, such means includes a control valve 114 including a first member or valve housing 116 and a second member or spool valve 118 movable relative to each other. The spool valve 118 is connected to the push-pull cable 66 and is axially movable relative to the valve housing 116 in response to movement of the push-pull cable 66. Axial movement of the piston rod 86 relative to the cylinder 70 is transmitted to the steering arm 48 to effect pivotal movement of the propulsion unit 12 about the steering axis 46 by rigid connection of the piston rod 86 and the valve housing 116 and by a steering member in the form of a rigid connecting link 120 having one end 122 pivotally connected to the arm portion 50 of the steering arm 48 and the opposite end 124 pivotally connected to the valve housing 116.

The valve housing 116 has an axially extending, generally cylindrical bore or cavity 126 in which the spool valve 118 is mounted for axial movement between a first or turn-left position and a second or turn-right position on the opposite sides of a third, center or no-steering change position best illustrated in Fig. 3. Hydraulic fluid is admitted to the cavity 126 through an inlet port 128 connected in communication with the supply conduit 102 and a central annular groove 130 in the valve housing 114. Hydraulic fluid is discharged from the cavity 126 through annular end grooves 132 and 134 in the valve housing 114 spaced on opposite sides of the central groove 130 and through respective return ports or passages 135 and 136 which merge into a single passage or combined return port 137 connected in communication with the return conduit 108.

Hydraulic fluid flows from the cavity 126 to the cylinder 70 and from the cylinder 70 to cavity 126 through intermediate annular grooves 138 and 140 and respective steering passages or ports 142 and 144 in the valve housing 116. The steering port 142 is connected in communication with the first passageway 94 of the piston rod 86 (i.e., the interior of the inner tubular portion 92) and the steering port 144 is connected in communication with the second flow passageway 96 of the piston rod 86 (i.e., the annular passage between the inner and outer tubular portions 92 and 90).

The spool valve 118 includes an enlarged, cylindrical central portion or land 146 and enlarged, cylindrical end portions or lands 148 and 150 spaced from the opposite sides of the central land 146. The lands 146, 148 and 150 slidably and

sealingly engage the interior wall of the cavity 126 during axial movement of the spool valve 118.

Shoulder means are provided on the spool valve 118 for engaging the opposite ends of the valve housing 116 and mechanically connecting the push-pull cable 66 with the valve housing 118 in the event the power steering system fails. In the specific construction illustrated, the spool valve 118 includes opposite end portions 152 and 154 projecting outwardly from the opposite ends of the valve housing 116. One end 152 carries a washer 156 which is engageable with the valve housing 116 and is spaced therefrom a sufficient distance to accommodate axial movement of the spool valve 118 from the illustrated no-steering change position to a turn-left position described in more detail below. The washer 156 is held in place by a nut 158 threaded onto an outermost portion of the spool valve end 152.

The other end 154 of the spool valve 118 has a clevis 160 which is pivotally connected, by a bolt 162 and a nut 164, to a hollow member or ram 166 connected to the end of the push-pull cable 66 and guided for relative axial movement inside the tilt tube 128. Axial movement of the push-pull cable 66 and the ram 166 in response to rotation of the steering wheel 58 causes axial movement of the spool valve 118 relative to the valve housing 116. Similar to the washer 156, the outer surface 168 of the clevis 160 is engageable with the end of the valve housing 116 and is spaced therefrom a sufficient distance to accommodate axial movement of the spool valve 118 from the no-steering change position to a turn-right position described in more detail below.

When the spool valve 118 is in the no-steering change position, the central land 146 partially covers or blocks the central groove 130 and the end lands 148 and 150 partially cover or block the respective end grooves 132 and 134. Pressurized hydraulic fluid flows into the central groove 130 from the inlet port 128 and past the opposite edges of the central land 146 into the cavity 126. The first pressure chamber 74 is in fluid communication with the cavity 126 via the first passageway 94, the steering port 142 and the intermediate groove 138. The second pressure chamber 76 is in fluid communication with the cavity 126 via the apertures 98, the second passageway 96, the steering port 144 and the intermediate groove 140. Thus, both sides of the piston 72 are exposed to pressurized fluid when the spool valve 118 is in the no-steering change position.

When the push-pull cable 66 is not being moved, extension or retraction of the piston rod 86 causes the valve housing 116 to move axially relative to the spool valve 118. The area of the piston side facing the first pressure chamber 74 is larger than the area of the side facing the second pressure chamber 76 by virtue of the space occupied by the piston rod 86. Thus, when the spool valve 116 is moved to the center or no-steering change position, the piston rod 86 tends to extend and move the valve housing 116 to the right as viewed in Fig. 3 until the pressures acting on the opposite sides of the piston 72 are balanced to produce substantially equal pressure forces on both sides of the piston 72. That is, the size of the opening between the left edges of the central land 146 and the central

groove 130 is reduced, thereby reducing the hydraulic pressure supplied to the first pressure chamber 74, while the size of the opening between the right edges of the central land 146 and the central groove 130 is increased, thereby increasing the hydraulic pressure applied to the second pressure chamber 76.

External forces acting upon the propulsion unit 12 tending to pivot it about the steering axis 46 are resisted in a similar manner. For example, a force tending to pivot the propulsion unit 12 counterclockwise as viewed in Fig. 2 would tend to move the valve housing 116 to the right and increase the opening between the right edges of the central land 146 and the central groove 130 while decreasing the opening between the left edges of the central land 146 and the central groove 130. This would increase the pressure in the second pressure chamber 76 for resisting extension of the piston rod 86.

The pump 100 operates continuously during operation of the propulsion unit 12. Consequently, when the spool valve 118 is in the no-steering change position, a portion of the hydraulic fluid flows from the cavity 126 out through the return ports 135, 136 and 137 and is returned to the reservoir 104 through the return conduit 108.

As the spool valve 118 is moved to the right relative to the valve housing 116, or to the turn-right position, by a pushing movement on the push-pull cable 66, the left end land 148 covers the left end groove 132, the right end land 150 completely uncovers the right end groove 134, and the central land 146 completely uncovers and moves to the right of the central groove 130. A first passage

means comprising the central groove 130, the cavity 126, the steering port 142 and the first flow passageway 94 in the piston rod 86 connects the first pressure chamber 74 in fluid communication with the inlet port 128. This first passage means further comprising the return port 136, the right end groove 134, the cavity 126, the steering port 144, the second flow passageway 96 in the piston rod 86, and the apertures 98 connect the second pressure chamber 76 in fluid communication with the combined return port 137.

As a consequence of the above connections, the piston rod 86 is extended and the valve housing 116 is moved to the right, causing the propulsion unit 12 to be pivoted in a counter clockwise direction about the steering axis 46 via the connecting link 120 and the steering arm 148. As the piston rod 86 extends, the valve housing 116 is moved axially to the right relative to the spool valve 118 and continues to move to the right until it reaches the no-steering change position, at which time the pressure force acting on the opposite sides of the piston 72 are balanced as described above. The piston 86 is maintained in a position corresponding to the turned position of the steering wheel 58 until the steering wheel is subsequently rotated to change the direction of boat travel.

When the spool valve 118 is moved to the left relative to the valve housing 116 to the turn-left position by a pulling movement on the push-pull cable 66, the right end land 150 covers the right end groove 136, the left end land 148 completely uncovers the left end groove 132, and the central land 146 uncovers and moves to the left of

the central groove 130. A second passage means comprising the central groove 130, the cavity 126, the steering port 144, the second flow passageway 96 and the apertures 98 connect the second pressure chamber 76 in fluid communication with the inlet port 128. This second passage means further comprising the return port 135, the left end groove 132, the cavity 126, the steering port 142 and the first passageway 94 connects the first pressure chamber 74 in fluid communication with the combined return port 137.

As a consequence of the above connections, the piston rod 86 is retracted and the valve housing 116 is moved to the left, causing the propulsion unit 12 to be rotated in a clockwise direction about the steering axis 46 until the valve housing 116 reaches the no-steering change position relative to the spool valve 118 as described above.

When the spool valve 118 is in the no-steering change position, a third passage means comprising the central groove 130, the cavity 126, the intermediate groove 136, the steering port 142 and the first passageway 94 and also comprising the intermediate groove 140, the steering port 144, the second passageway 96 and the apertures 98 connect both the first and second pressure chambers 74 and 76 in fluid communication with the inlet port 128 and produce substantially equal pressure forces on the opposite sides of the piston 72 as described above.

Means are provided for mounting the piston cylinder assembly 68 for common tilting movement with the propulsion unit 12 about the tilt axis 42 and for preventing or restraining axial movement in a direction parallel to the tilt axis

42. While various suitable arrangements can be used, in the specific construction illustrated, the piston and cylinder assembly 68 includes an integral cylindrical part 170 rotatably receiving the tilt tube 28 and disposed between the swivel bracket lugs 36 and 38. Common tilting movement of the piston-cylinder assembly 68 can be obtained by dimensioning the part 170 so that it provides a press fit with the swivel bracket lugs 36 and 38.

Alternatively, interengaging means can be provided on the part 170 and the swivel bracket lugs 36 and 38. For example, as illustrated in Fig. 4, one or both of the swivel bracket lugs 36 and 38 can be provided with a protuberance 172 which is received in a groove 174 on one side of the part 170 when the part 170 is fitted between the swivel bracket lugs 36 and 38 during assembly.

In operation, with the steering wheel 58 centered and the propulsion unit 12 in a straight ahead position, pressurized hydraulic fluid is supplied to both the first and second pressure chambers 74 and 76 and the piston rod 86 is maintained in a no-steering change position as described above. When the steering wheel 58 is turned to the left, the push-pull cable 66 and the ram 166 is pulled to the left and the spool valve 118 is moved to the left to the turn-left position to connect the second pressure chamber 76 in fluid communication with the inlet port 128 and to connect the second pressure chamber 76 in fluid communication with the return ports 135 and 137 as described above.

Consequently, the piston rod 86 is retracted, causing the valve housing 116 to move to the left relative to the piston and cylinder assembly

68 and thereby pivoting the propulsion unit clockwise about the steering axis 46 to turn the boat to the left. At the same time, the valve housing 116 moves axially relative to the spool valve 118 until it reaches a position corresponding to the third or center position of the spool valve 118. The steering action is then terminated and the propulsion unit 12 is maintained in the turned position as described above until the steering wheel 58 is again turned.

When the steering wheel 58 is turned to the right, the push-pull cable 66 and the ram 166 is pushed to the right and the spool valve 118 is moved to the right to the turn-right position to connect the first pressure chamber 74 in fluid communication with the inlet port 128 and to connect the second pressure chamber 76 in fluid communication with the outlet ports 136 and 137 as described above. Consequently, the piston rod 86 is extended, causing the valve housing 116 to move to the right relative to the piston and cylinder assembly 68 and thereby pivoting the propulsion unit 12 to turn the boat to the left. The valve housing 116 moves to the centered position and the propulsion unit 12 is maintained in the turned position until the steering wheel 58 is again turned as described above.

If the piston 72 bottoms against the cylinder in either direction, the relief valve 112 opens to limit the hydraulic pressure supplied to the power assist or steering system to a predetermined level.

The propulsion unit 12 can be steered manually in the event the power steering system fails. As the push-pull cable 66 is moved to the left, the washer 156 will eventually engage one end

of the valve housing 116 and cause it to be mechanically moved to the left in a manner similar to movement of the spool valve 118 by the push-pull cable 66 and the ram 166. This movement of the valve housing 116 causes the propulsion unit 12 to be pivoted clockwise via the connecting link 120. Similarly, the outer surface 168 of the clevis 160 will engage the valve housing 116 and cause the propulsion unit 12 to pivot counterclockwise as the spool valve 118 is moved to the right by the push-pull cable 66 and the ram 166.

Hydraulic fluid displaced from the cylinder 70, as the piston rod 86 is extended or retracted in response to movement of the valve housing 116, is discharged from the control valve 114 through the combined return port 137 and flows through the bypass conduit 111 and the check valve 113 back to the supply conduit 102.

It should be understood that the cylinder-piston assembly 68 can be arranged so that the piston 72 is fixed against movement axially of the cylinder-piston assembly axis and the cylinder 70 is axially movable relative to the piston 72. Also, the control valve 114 and the connections between the cylinder-piston assembly 68 and the propulsion unit 82 can be arranged so that the spool valve 118 is connected to the piston rod 86 or the cylinder 70 and the valve housing 114 is connected to the push-pull cable 66.

Fig. 5 illustrates an alternative construction for the control valve 114a and components common with those in the control valve 114 illustrated in Fig. 3 are designated by the same reference numerals. In this alternate construction,

the spool valve 118a is arranged so that the central land 146a completely covers the central groove 130 and the end lands 148a and 150a completely cover the respective end grooves 132 and 134 when the spool valve 118a is in the third or no-steering change position. The power steering system operates in substantially the same manner when the spool valve 118a is in the turn-left and turn-right positions and the first and second pressure chambers 74 and 76 are alternately connected to the inlet port 128 and the combined return port 137 by passage means like the first and second passage means described above.

When the spool valve 118a is in the non-steering change position illustrated in Fig. 5, the central groove 130 communicating with the inlet port 128 and the end grooves 132 and 134 communicating with the combined return port 137 are blocked. Thus, communication is prevented between the first and second pressure chambers 74 and 76 and either the inlet port 128 or the combined return port 137. Consequently, hydraulic fluid from the pump 100 flows through the relief valve 112 and through the return conduit 108 to the reservoir 104. Hydraulic fluid is trapped in the cavity 126, the steering ports 142 and 144, the first and second passageways 94 and 96, and the first and second pressure chambers 74 and 76. The substantially incompressible hydraulic fluid prevents the piston 72, and thus the propulsion unit 12, from being moved until the spool valve 118a is moved from the no-steering change position toward either the turn-left position or the turn-right position.

In the embodiment illustrated in Figs. 6 and 7, a plurality, e.g., two, of outboard motors

180 are mounted on a boat transom 22 in side-by-side relationship. Each outboard motor 180 includes a propulsion unit 12 like that described above supported from the boat transom 22 by a transom bracket 24 and a swivel bracket 26 for tilting movement about a generally horizontal tilt axis and steering movement about a generally vertical steering axis.

Each propulsion unit 12 includes a power steering system similar to that described above. More specifically, each power steering includes a cylinder-piston assembly 68 having a part 170 rotatably receiving a tilt tube 28, a control valve 114 having a valve housing 116 connected to a piston rod 86, a connecting link 120 connecting the valve housing 116 to a steering arm 48 on the propulsion unit 12, and a spool valve 118 for controlling the flow of hydraulic fluid to the piston and cylinder assembly 68 in response to relative axial movement of the spool valve 118 and the valve housing 116.

The power steering systems are oppositely arranged so that both can be operated by a single actuator or steering device. One end of the spool valve 118 for the left propulsion unit 12 is connected to a boat steering device, such as a steering wheel like that shown in Fig. 2, by a steering cable assembly 60 including a push-pull cable 66 and a ram 166 extending through the tilt tube 28 and connected to a clevis 160 on the spool valve 118. Axial movement of the push-pull cable 66 and the ram 166 in response to operation of the steering device moves the spool valve 118 to selectively extend and retract the piston rod 86 as described above.

One end 152 of the spool valve 118 for the right propulsion unit 12 is connected, via the respective clevis 160, to a rod 182 slidably received in the respective tilt tube 28.

Means are provided for interconnecting the spool valves 118 so that they move in unison in response to movement of the push-pull cable 66 and the ram 166 and both the propulsion units 12 are pivoted in the same direction. While various arrangements can be used, in the specific construction illustrated, the spool valves 118 are mechanically connected together by a rigid connecting link or tie bar assembly 184 including a horizontally extending bar or rod 186 and a pair of L-shaped leg members 188. Each leg member 188 has one end connected to the respective spool valve clevis 160 and the other end connected to the rod 186.

In operation, when the push-pull cable 66 and the ram 166 is pulled to the left in response to rotation of the steering wheel, the spool valve 118 for the left propulsion unit is moved to the left to the turn-left position as described above. The spool valve 118 on the right propulsion unit is also moved to the left via the tie bar assembly 184. However, it is moved to the second position described above because the control valve 114 is oppositely arranged or oriented 180° from the control valve 114 on the left propulsion unit. Consequently, the piston rod 86 on the right propulsion unit 12 is extended and each propulsion unit is pivoted in clockwise direction about the respective steering axis 46. The opposite action of the piston rod 86 occurs to provide opposite pivotal movement of the propulsion units when the push-pull cable 66 and the ram 166 are moved to the right.

In the event either power steering system fails, the washers 156 and the clevises 160 on the spool valves 118 permit the propulsion units 12 to be steered manually as described above.

The power steering systems are provided with means permitting the propulsion units to be tilted independently of each other, even though the spool valves are mechanically linked together to steer the propulsion units in unison. In the specific construction illustrated, each valve housing 116 and spool valve 118 is rotatable relative to each other, in addition to being axially movable relative to each other, and the longitudinal axis of each spool valve 118 generally coincides with the tilt axis 42. Thus, a valve housing 116 can rotate about the respective spool valve 118 when one of the propulsion units 12 is tilted relative to the other as illustrated by the dashed lines in Fig. 7.

The leg members 188 of the tie bar assembly 184 preferably are adjustably connected to the rod 186, for example, threaded into the rod 186, so that the length of the tie bar can be adjusted to accommodate variation in lateral spacing between the propulsion units and to adjust the amount of toe-in and toe-out between the two propulsion units 12.

Fig. 8 illustrates an alternate arrangement of a power steering mechanism for a plurality, e.g., 2, of outboard motors 190 mounted on a boat transom 22 in side-by-side relationship similar to the embodiment shown in Figs. 6 and 7, but steered with a single power steering system. In this embodiment, the spool valve 118 for the left propulsion unit 12 is connected to the steering device and operates like that for the left propulsion

unit in the embodiment illustrated in 6 and 7. Means are provided for connecting adjacent propulsion units together for common steering movement of all the propulsion units in response to movement of the push-pull cable 66. In the
5 specific construction illustrated, the right propulsion unit 12 is mechanically connected to the left propulsion unit 12 by a link 192 pivotally connected at one end 194 to the steering arm 48 on the right propulsion unit 12 and pivotally connected at the other end 196 to the valve
10 housing 116 on the left propulsion unit 12, so that, during steering movement of the left propulsion unit 12, the right propulsion unit 12 is moved in unison therewith. Alternately, a similar link can be connected between the steering arms of adjacent propulsion units.

15 Whilst the preferred embodiment utilises a push-pull cable to axially displace the spool valve 118, other means, such as for example a hydraulically operated mechanism, can be employed.

 The power assist means 67 of the preferred
20 embodiment can, as mentioned previously, have alternative constructions.

 Illustrated in Figure 9 is an alternative
construction of the power steering system of the preferred
embodiment. Components common with those of the preferred
25 embodiment are designated by the same reference numerals. Power assist means 267 operably connects the steering device 52 to the propulsion unit 12 for increasing the steering force applied to the steering arm 48 by the push-pull cable.

66. As in the preferred embodiment, the power assist means or power steering system 267 is wholly supported on the swivel bracket 26 and includes a hydraulic cylinder-piston assembly 268 having an extendable and retractable steering link which is connected between one end of the push-pull cable 66 and the arm portion 50 of the steering arm 48 and which, when it extends or retracts, effects pivotal movement of the propulsion unit 12.

The hydraulic cylinder-piston assembly 268 includes a cylinder 270 and a piston 272 mounted inside the cylinder 270 for axial reciprocative movement of the cylinder 270 relative to the piston 272. The piston 272 divides the cylinder 270 into opposite sides or first and second pressure chambers 274 and 276.

One end of the cylinder 270 is closed by an end wall 280 including a central aperture through which a piston rod 286 slideably extends. The piston rod 286 is fixedly connected to the piston 272, and the outer end 288 of the piston rod 286 extends outwardly from the cylinder 270 and is fixed against axial movement by a piston rod bracket 371 rotatably receiving the tilt tube 28 and disposed between the swivel bracket lugs 36 and 38. The piston rod bracket 371 has the same function as the integral cylinder part 170 of the preferred embodiment.

The piston 272 is operated by pressurized hydraulic fluid continuously supplied by a pump 100. The pump 100 is connected to a sump 104 by a conduit 106 and to the cylinder-piston assembly 268 by a supply conduit 102. Hydraulic fluid from the cylinder-piston assembly 268 is discharged to the sump 104 through a return conduit 108.

Control means similar to those of the preferred embodiment are provided for selectively controlling the flow of hydraulic fluid to and from the first and second pressure chambers 274 and 276 to extend and retract the cylinder 270 relative to the piston rod 286. In the alternative construction illustrated, such means includes a control valve 314 including a first member or valve housing 316 and a second member or spool valve 318 movable relative to each other. The spool valve 318 is connected to the push-pull cable 66 in the same manner as in the preferred embodiment and is axially movable relative to the valve housing 316 in response to movement of the push-pull cable 66.

Axial movement of the cylinder 270 relative to the piston rod 286 is transmitted to the steering arm 48 to effect pivotal movement of the propulsion unit 12 about the steering axis 46 by rigid connection of the cylinder 270 and the valve housing 316 and by a rigid connecting link 320 having one end 322 pivotally connected to the arm portion 50 of the steering arm 48 and an opposite end 324 pivotally connected to the valve housing 316.

The valve housing 316 and spool valve 318 are similar to those of the preferred embodiment. The steering port 142 is connected in communication with the first chamber 274 of the cylinder 270 via a passageway in the valve housing 116, and the steering port 144 is connected in communication with the second chamber 276 of the cylinder 270 via a second passageway in the valve housing 116.

As the spool valve 318 is moved to the right relative to the valve housing 316, or to the turn-right position, the cylinder 270 is extended

relative to the piston rod 286 and the valve housing 316
is moved to the right, causing the propulsion unit 12 to
be pivoted in a counterclockwise direction about the
steering axis 46 via the connecting link 320 and the
5 steering arm 48.

When the spool valve 318 is moved to the left
relative to the valve housing 316, or to the turn-left
position, the cylinder 270 is retracted relative to the
piston rod 286 and the valve housing 316 is moved to the
10 left, causing the propulsion unit 12 to be rotated in a
clockwise direction about the steering axis 46.

Except for the fact that the cylinder 270 and
piston rod 286 of the alternative construction are
interchanged, so that the piston rod 286 is fixed and the
15 cylinder 270 moves relative to the piston rod 286, the
hydraulic cylinder-piston assembly 268 of the alternative
construction functions in the same manner as the hydraulic
cylinder-piston assembly 68 of the preferred embodiment.
Therefore, no further description of the operation of the
20 hydraulic cylinder-piston assembly 268 of the alternative
construction is necessary.

CLAIMS

1. Power steering apparatus for a marine propulsion device having a propulsion unit and a propulsion unit mounting means adapted to be fixed to a boat hull and
5 connected to said propulsion unit to afford steering and tilting movement of said propulsion unit relative to said propulsion unit mounting means about respective steering and tilting axes, the apparatus comprising a movably
10 mounted steering member adapted to effect steering of said propulsion unit in response to movement of said member, a hydraulic cylinder-piston assembly including a cylinder having an axis, and a piston mounted in said cylinder and dividing said cylinder into opposite sides, support means attached to one of said cylinder and said piston and
15 adapted to mount said cylinder-piston assembly on said propulsion unit mounting means such that said axis of said cylinder is parallel to said tilting axis and such that said one of said cylinder and said piston is fixed against movement in the direction of said tilting axis, the other
20 of said cylinder and said piston being movable in the direction axially of said cylinder relative to said one of said cylinder and said piston and connected to said steering member, a valve assembly including a valve housing adapted to be connected to a source of pressurised
25 hydraulic fluid and being hydraulically connected to said opposite sides of said cylinder, said valve assembly also including a valve member movable relative to said valve housing to control flow of hydraulic fluid from the source

thereof to said cylinder, and connector means connecting one of said valve housing and said valve member with said other of said cylinder and said piston for common movement, the other of said valve housing and said valve member being adapted for connection to actuating means for displacing said other of said valve housing and said valve member relative to said one of said valve housing and said valve member in response to operator activity, whereby steering movement of said propulsion unit is effected in response to movement of said other of said cylinder and said piston incident to the application of hydraulic fluid to said cylinder by said valve assembly in response to the actuating means.

2. Power steering apparatus according to claim 1, and further including the actuating means which comprises a push-pull cable including an outer sheath adapted to be fixed to said propulsion unit mounting means and an inner core movable relative to said outer sheath, said other of said valve housing and said valve member being fixed to said inner core for common movement therewith and for movement relative to said one of said valve housing and said valve member.

3. Power steering apparatus according to claim 1 or 2, wherein said support means is attached to said cylinder and is adapted to mount said cylinder piston assembly on said propulsion unit mounting means such that said cylinder is fixed against movement in the direction of said tilting axis, said piston being movable in the

direction axially of said cylinder.

4. Power steering apparatus according to claim 3, wherein said connector means comprises a piston rod which is connected to said piston for common movement therewith and which includes an axial passageway for flow of hydraulic fluid between said valve assembly and said cylinder.

5. Power steering apparatus according to claim 4, wherein said piston rod includes an inner tubular portion forming an axial first passageway for flow of hydraulic fluid between said valve assembly and one side of said cylinder, and an outer tubular portion coaxial with said inner tubular portion and forming an annular second passageway for flow of hydraulic fluid between said valve assembly and the other side of said cylinder.

6. Power steering apparatus according to any preceding claim, wherein said connector means connects said valve housing to said other of said cylinder and said piston for common movement therewith, and said valve member is adapted to be connected to the actuating means for displacing said valve member relative to said valve housing in response to operator activity.

7. Power steering apparatus according to claim 6, wherein said valve assembly is a spool valve assembly, wherein said valve housing has an inlet port adapted to be connected to said source of pressurised hydraulic fluid and a return port adapted to be connected to a hydraulic sump, and wherein said valve member is movable by the

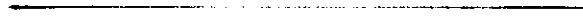
actuating means between first and second positions relative to said valve housing such that, when said valve member is moved into said first position, one side of said cylinder is placed in fluid communication with said inlet port and the other side of said cylinder is placed in fluid communication with said return port to effect steering movement of said propulsion unit in one direction, and, when said valve member is moved into said second position, said one side of said cylinder is placed in fluid communication with said return port and said other side of said cylinder is placed in fluid communication with said inlet port to effect steering movement of said propulsion unit in the opposite direction.

8. Power steering apparatus according to claim 6 or 7, wherein said steering member is a rigid connecting link pivotally connectable at one end to a steering arm of the propulsion unit and pivotally connected at the other end to said valve housing.

9. Power steering apparatus according to any preceding claim, wherein said support means comprises a tubular part adapted to surround a tilt tube of said propulsion unit mounting means.

10. Power steering apparatus according to claim 2 or any one of claims 3 to 9 when appended directly or indirectly to claim 2, wherein said outer sheath of said push-pull cable is adapted to be connected to a tilt tube of said propulsion unit mounting means and said inner core

of said push-pull cable is adapted to be connected to said valve member after passing through said tilt tube.



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FOR THE COMPTROLLER

NOTE RENEWALS FILED WITHIN THE LAST FEW DAYS MAY NOT APPEAR
IN THE RECORDS