ABSTRACT: Disclosed herein is a marine propulsion unit steering mechanism which includes a double-acting hydraulic piston and cylinder assembly having a piston rod supporting a piston, a cylinder mounted for movement on the piston rod and piston. One of the piston rod and the cylinder is connected to a steering arm provided on the marine propulsion unit and the other of the piston rod and cylinder is connected to the transom of a boat. Also included is a hydraulic fluid control with a spool valve connected through the piston rod to a remote actuator to control the flow of a continuous supply of hydraulic fluid to and from the assembly.
MARINE PROPULSION POWER-ASSIST STEERING MECHANISM

BACKGROUND OF THE INVENTION

Steering mechanisms for marine propulsion units generally are mechanically connected to the steering arm of the marine propulsion unit to impart mechanical steering forces to the marine propulsion unit. These mechanisms can include a friction lock or positive lock to restrain steering movements which originate in the propulsion unit.

SUMMARY OF THE INVENTION

The marine propulsion steering mechanism of this invention provides a power assist for steering forces originating from a remote actuator as well as a power assist for restraining steering forces originating from the propulsion unit. This is accomplished by connecting a double acting hydraulic piston and cylinder assembly between the steering arm of a marine propulsion unit and a steering cable connected to a remote actuator. The specific arrangement includes a fixedly mounted piston and a cylinder mounted for movement relative to the piston. Hydraulic fluid is continuously supplied to the assembly to assure immediate availability of hydraulic force to either assist or restrain the steering forces. A control valve is provided in the assembly to control the flow of hydraulic fluid to the cylinder and is operatively connected through the piston to a remote actuator. The assembly is pivotally connected to the boat and to the marine propulsion unit to accommodate steering and to allow for vertical pivotal movement of the marine propulsion unit to clear obstacles in the water and for repair.

Other objects and advantages will become apparent from the following description when read in connection with the accompanying drawing in which:

FIG. 1 is a top view of a marine propulsion unit mounted on the transom of a boat.

FIG. 2 is a section view of the steering mechanism with the hydraulic fluid system shown diagrammatically.

FIG. 3 is a view of a portion of the steering mechanism showing the neutral position of the control valve.

FIG. 4 is a section view of a portion of the steering mechanism showing the position of the spool valve in the valve housing for moving the cylinder to the right.

FIG. 5 is taken on line 5-5 of FIG. 3 showing the inlet port and outlet port in the valve housing.

DESCRIPTION OF THE INVENTION

The steering mechanism 10 of this invention is shown in FIG. 1 pivotally connected to a steering arm 12 for a marine propulsion unit 14 and to a steering actuator 16 operable from a remote point in a boat. The marine propulsion unit 14 is mounted rearwardly of a transom 18 on a boat on a swivel bracket for steering movement about a vertical axis. The swivel bracket is connected to a clamp bracket for pivotal swinging movement about a horizontal axis. The steering actuator 16 can be of various forms and in the disclosed construction is of a push-pull or Bowden wire type having a cable sheath 20 having a threaded end 21 secured to the transom 18 by means of a bracket assembly 22. The actuator 16 also includes a steering cable 24 mounted for movement within the sheath 20 to provide steering movements for the propulsion unit 14. The bracket assembly 22 includes a retainer 23 fixedly secured to the transom 18 and a ball-socket swivel connector 25 supported for pivotal movement by the retainer 23 and having a threaded bore 27 to threadingly receive the threaded end 21 of the sheath 20. Although the propulsion unit 14 is shown as part of an outboard motor, the steering mechanism 10 is also adaptable for use with a propulsion unit of a stern drive unit.

In accordance with the invention, means are provided for supplying a hydraulic power assist steering force to the propulsion unit 14 to increase the steering forces originating in the steering cable 24 and for supplying a hydraulic power assist steering force to the propulsion unit 14 to restrain or counter the steering forces originating in the propulsion unit 14. In this regard hydraulic means are operatively connected to the propulsion unit 14 and to the remote actuator through the steering cable 24. Such means comprises the steering mechanism 10 which includes a hydraulic piston and cylinder assembly 26 connected at one end to the steering arm 12 and at the other end to the steering cable 24.

The piston and cylinder assembly 26 includes a piston 28 and a cylinder 30 mounted for movement axially of the piston 28. One end of the piston 28 and cylinder 30 is attached to the boat and the other is attached to the propulsion unit. The piston 28 is provided with a central aperture 29 to which a threaded portion 40 and is sealed with respect to the cylinder 30 by means of an O-ring 32 provided in an annular groove 34.

The piston 28 is retained in a relatively fixed position (i.e., ignoring some pivotal movement relative to the boat transom) by means of a tubular piston rod 36 pivotally secured to the transom 18 of the boat by means of the bracket assembly 22. The piston rod 36 is threaded at one end to the threaded bore 27 in the swivel connector 25 and at the other end for connection to the threaded portion 40 of the aperture 29 in the piston 28. For purposes to be mentioned later, a number of ports 42 are provided in the piston rod 36 adjacent to the piston 28.

Means are provided for closing the ends of the cylinder 30 in the form of an end wall 44 at one end of the cylinder to form a pressure chamber 46 on one side of the piston 28 and a plate 48 at the other end of the cylinder to form a pressure chamber 50 on the other side of the piston 28. The end wall 44 includes a central aperture 52, a port 54 and a threaded annular flange 56. The plate 48 is retained on the cylinder 30 by means of a snap ring 60 and includes an aperture 58 through which the tubular piston rod 36 extends. The plate 48 is sealed to the cylinder 30 and to the piston rod 36 by means of O-rings 62 and 64 positioned to sealingly engage the inner surface of the cylinder 30 and the outer surface of the piston rod 36, respectively.

The hydraulic means also includes a continuously available source of hydraulic fluid connected to the assembly 26. The hydraulic fluid is supplied to the assembly by means of a pump 66 which can be driven directly off of the marine propulsion unit 14 to supply hydraulic fluid whenever the unit is operating or by an independent power source such as an electric motor. The pump 66 is connected to the assembly 26 by a supply conduit 68 and to a reservoir or sump 70 by a conduit 72. Hydraulic fluid from the assembly 26 is returned to the reservoir or sump 70 through a return conduit 74.

The flow of hydraulic fluid to the pressure chambers 46 and 50 in the cylinder 30 is controlled by means of a control valve 76 mounted on the end wall 44 of the cylinder 30 and operatively connected to the remote actuator by the cable 24. The control valve 76 includes a valve housing 78 secured to the cylinder 30 and is provided with a central cavity 82 threaded at 84 for connection to the threaded flange 56 provided on the end wall 44 and is sealed to the cylinder 30 by means of an O-ring 85. The control valve also includes a spool valve 80 mounted for movement axially within the cavity 82 between a centered no-force position to second and third positions on opposite sides of the centered position as explained later in greater detail.

Hydraulic fluid is admitted to the central cavity 82 in the valve housing 78 through an inlet port 86 connected to the supply conduit 68 and is discharged from the cavity 82 through an outlet port 88 connected to the return conduit 74. The central cavity 82 is coaxial with the aperture 52 in the end wall 44 and is connected to the port 54 by means of a first axially extending bore 90 and a port 90’. The central cavity 82 is also connected to the outlet port 88 by means of a second axially extending bore 92 connected to the cavity 82 by internal annular grooves 94 and 96 located adjacent the ends of the central cavity 82.
In order to allow the steering mechanism 10 to move freely with respect to the steering arm 12, means are provided for interposing the valve housing 78 to the steering arm 12. Such means includes a flange or ear 85 which extends from the valve housing 78 and has an aperture 87. This means also includes a bifurcated lever arm 89 pivotally connected to the steering arm 12 and having apertures 91. The lever arm 89 is positioned to straddle the flange 85 and a pivot pin 93 is inserted through the apertures 91 and the aperture 87.

The flow of hydraulic fluid through the outlet port 86 and the outlet port 88 in the valve housing 78 to the cylinder 30 is controlled by means of the spool valve 80 which is connected to the actuator for movement from the first or no-force position to the second and third positions in the central cavity 82. The spool valve 80 is provided with an axially extending bore 98 having an internally threaded section 99, a first passage or annular groove 104 having a discharge port 106 in end wall 108, a second axially elongated passage or annular groove 110, and a third passage or annular groove connected to the bore 98 by a port 102.

Means are provided for connecting the spool valve 80 to the steering cable 24 to transfer steering movements originating from the remote actuator to the propulsion unit. Such means includes a tubular member or extension 112 which projects axially through the aperture 52 in the end wall 44. The aperture 29 in the piston 28, and the bore of the piston rod 36. O-ring seals 51 and 53 are provided in the apertures 52 and 29, respectively, to sealingly engage the tubular extension 112. The tubular extension 112 is externally threaded at one end for connection to the internally threaded section 99 in the spool valve 80 and connected at the other end to the cable 24 by means of a cable connector 114 positioned for movement axially in the piston rod 36. The cable connector 114 is sealed within the bore of the piston rod 36 by and O-ring 116. A fluid flow path is provided between the bore of the extension 112 and the bore of the piston rod 36 by means of a number of ports 118 provided adjacent to the connector 114.

A hydraulic power assist steering force from forces originating in the steering cable 24 is provided to the propulsion unit by moving the spool valve 80 from the first or no-force position to either the second position or the third position within the valve housing 78. When the spool valve is in the first position, FIG. 3, means including the first passage 104 provide a connection between the inlet port 86 and the outlet port 88 for the continuous flow of hydraulic fluid through the valve 76. Such means is more specifically defined by a flow path which includes the inlet port 86, the first passage or groove 104 in the spool valve 80, the port 106 in the end wall 108, the internal annular groove 96 at the end of the second bore 92 and the outlet port 88. The cylinder 30 will not move with respect to the piston 28 under hydraulic actuation whenever the spool valve 80 is in the first position or no-force position because the fluid in the pressure chambers 46 and 50 is trapped in the cylinder 30.

The cylinder 30 is moved to the right with respect to the piston 28 by pressurizing the chamber 46 and relieving pressure in the chamber 50. In this regard, the spool valve 80 is moved axially to the right or to the second position in the valve housing 78 as shown in FIG. 4. When the spool valve is in the second position, means including the second passage 110 provide a connection between the inlet port 86 and the pressure chamber 46 for flow of hydraulic fluid to the pressure chamber 46 in the cylinder 30. Such means is more specifically defined by a flow path which includes the inlet port 86, the second passage or annular groove 110 in the spool valve 80, the first bore 90 and the port 54 in the end wall 44. Also, when the spool valve is in the second position, means including the third passage 100 provide a connection from the other chamber 50 to the outlet port 88 for the discharge of fluid from the chamber 50. Such means is more specifically defined by a flow path which includes the ports 42 in the piston rod 36 affording flow through the piston rod bore, the ports 118 in the tubular extension 112 affording flow from the bore of the piston rod to the bore of the tubular extension, the axial bore 98 in the spool valve 80, the port 102 to the third passage or annular groove 100, the internal annular groove 96 to the second bore 92 and the outlet port 88. Hydraulic fluid flowing through the ports 118 in the extension 112 is confined in the space in the bore of the piston rod 36 between the cable connector 114 and the piston 28 by means of the O-ring seals 116 and 53, respectively.

The cylinder 30 is moved to the left with respect to the piston 28 by pressurizing the chamber 50 and relieving pressure in the other chamber 46. In this regard, the spool valve 80 is moved to the left or to the third position in the valve housing 78 as shown in FIG. 2. When the spool valve is in the third position, means including the third passage 100 provide a connection between the inlet port 86 and the pressure chamber 50 for the flow of hydraulic fluid to the pressure chamber 50 in the cylinder. Such means is more specifically defined by a flow path which includes the inlet port 86, the third passage or annular groove 100, the port 102 to the axial bore 98, the bore of the tubular extension 112, the ports 118 to the bore of the piston rod 36 and the ports 42 to the chamber 50. Also, when the spool valve 80 is in the third position, means including the second passage 110 provide a connection between the pressure chamber 46 and the outlet port for the discharge of hydraulic fluid from the other chamber 46. Such means is more specifically defined by a flow path which includes the port 54 to the first bore 90, the second passage or annular groove 110, the internal annular groove 94, the second bore 92 and the outlet port 88.

In order to prevent movement of the cylinder 30 with respect to the piston 28 when the remote actuator is released by the operator, means are provided for biasing the spool valve 80 to the first or no-force position in the cavity 82 of the valve housing. Such means comprises a pair of springs 81 provided in the cavity 82 on each side of the spool valve 80.

In the event the pressure of the fluid in the supply conduit becomes excessive, means are provided for bypassing fluid from the supply conduit 68 to the return conduit 74 in the form of a bypass conduit 73. Means are provided in the bypass conduit for restricting flow until the pressure exceeds a predetermined maximum. Such means is in the form of a relief valve 71 positioned in the bypass conduit 73. The relief valve 71 can be set to allow for the flow of fluid from the supply conduit to the return conduit when the predetermined pressure is reached.

A hydraulic power-assist restraining or backlash force is supplied to the propulsion unit to counteract steering forces originating in the propulsion unit when the remote actuator is held fixed by the operator by means of the connection of the cylinder 30 to the steering arm 12 and the connection of the spool valve 80 to the temporarily stationary steering cable 24. In this regard, any movement of the cylinder 30 and valve housing 78 with respect to the spool valve 80 from steering movements originating in the propulsion unit 14 will result in the establishment of a flow path from the inlet port 86 to one of the pressure chambers 46 and 50 and from the other of the pressure chambers 46 and 50 to the outlet port 88.

More specifically, as the cylinder 30 moves to the right, as seen in FIG. 2, the spool valve 80 will be moved to the third position in the valve housing 78. A flow path will be established from the inlet port 86 to the pressure chamber 50 and from the pressure chamber 46 to the outlet port 88 through the spool valve 80 as described above. The increase in hydraulic pressure in chamber 50 will cause the cylinder 30 to move to the left contrary to the steering movement originating in the propulsion unit. If the cylinder 30 moves to the left, as seen in FIG. 4, the spool valve 80 will be moved to the second position in the valve housing 78. A flow path will be established from the inlet port 86 to the chamber 46 and from the chamber 50 to the outlet port 88 as described above. The increase in pressure in chamber 46 will cause the cylinder to move to the right contrary to the force of the steering movement originating in the propulsion unit.
The propulsion unit 14 can be steered manually in the event the pump 66 is turned off or becomes inoperative. In this regard, the spool valve 80 is manually moved to the right or to the left by the movement of the cable 24 in response to actuation of the remote actuator by the operator until the spool valve 80 seats against the valve housing 78, thereby establishing a mechanical connection between the valve housing and the remote actuator. More specifically and referring to FIG. 2, when the spool valve 80 is moved to the left or third position into engagement with the valve housing 78, the cylinder 30 will start to move with the spool valve 80 reducing the size of the pressure chamber 46 and increasing the size of the pressure chamber 50. The fluid in the pressure chamber 46 will be forced out through the port 54 into the axially extending bore 90, through the annular groove 110 in the spool valve 80 and the annular groove 94 into the second bore 92 and out through the outlet port 88 into the return conduit 74 to the sump 70. Fluid in the return conduit 14 is supplied to the supply conduit 68 by means of a bypass conduit 67 connected between the return conduit 74 and the supply conduit 68. The flow of fluid through the supply conduit is restricted by means of a one-way check valve 69 provided in the conduit 67. Fluid will be drawn from the supply conduit 68 into the other chamber 50 through the one-way check valve 69, the annular groove 104 through the port 102 into the axial bore 98, through the bore of the tubular extension 112 and the ports 118 into the bore of the piston rod 36 and through the ports 42 into the chamber 50. Since the chamber 50 is smaller than the chamber 46 due to the presence of the piston rod 36, any excess fluid from the chamber 46 will flow directly through the return conduit 74 to the sump 70.

When the spool valve 80 is moved to the right or second position into engagement with the valve housing 78, fluid is supplied to the pressure chamber 50 from the supply conduit 68 through the tubular extension 112 and piston rod 36. Fluid in the chamber 46 is discharged through the bore 90, annular groove 110, bore 92 to the return conduit 74. The fluid in the return conduit 74 will flow directly through bypass conduit 67 and check valve 69 into supply conduit 68. Since the fluid from the chamber 50 will not be sufficient to fill the chamber 46, the fluid from the chamber 50 is augmented by the addition of fluid from the sump 70.

It is within the contemplation of this invention to include the bypass conduits 67 and 73 within the valve housing 78 and to mount the pump 66 directly on the valve housing 78. Various of the features of the invention are set forth in the following claims:

What is claimed is:

1. A marine propulsion device including a marine propulsion unit mounted for pivotal steering movement in opposite directions rearwardly of a boat, an actuator operable from a point in the boat remote from said propulsion unit to pivot the propulsion unit in opposite directions, and means operatively connected to said unit and to said actuator for hydraulically increasing the force causing propulsion unit steering movements in opposite directions and for locking said propulsion unit against steering movements originating in said propulsion unit, said means including a piston, a tubular piston rod fixedly secured to the boat and to said piston, a cylinder mounted for movement axially of said piston rod, means for closing the ends of said cylinder to form pressure chambers on each side of said piston, a valve housing fixedly secured to said cylinder and having an inlet port and an outlet port, a spool valve mounted for movement between first, second and third positions in said valve housing, means for connecting said spool valve to said actuator, means including a first passage in said spool valve providing a connection between said inlet port and said outlet port and preventing communication with said chambers when said spool valve is in the first position, means including a second passage in said spool valve providing, when said spool valve is in the second position, a connection between said inlet port and one of said chambers in said cylinder and providing, when said spool valve is in the third position, a connection between said one chamber and said outlet port, and means including a third passage providing, when said spool valve is in the second position, a connection between the other of said chambers and said outlet port, and providing, when said spool valve is in the third position, a connection between said inlet port and said other chamber.

2. A marine propulsion device in accordance with claim 1, including means for biasing said spool valve to the first position.

3. A marine propulsion device in accordance with claim 1, including means for constantly supplying pressure fluid to said inlet port, said means including a pump communicating with a sump, a supply conduit between said inlet port and said pump, a return conduit between said outlet port and said sump, and means for bypassing fluid from said return conduit to said supply conduit.

4. A marine propulsion device in accordance with claim 3, wherein said bypass means includes a pressure relief valve.

5. A steering arrangement comprising a propulsion unit mounted relative to a boat for pivotal movement about a horizontal axis to afford steering movement of said propulsion unit, a steering control actuator operable from a remote point in the boat, a piston, a tubular piston rod fixedly secured to the boat and to said piston cylinder fixed to said propulsion unit and mounted for movement between first, second and third positions in said valve housing, means for closing the ends of said cylinder to form pressure chambers on each side of said piston, a valve housing fixedly secured to said cylinder and having an inlet port and an outlet port, a spool valve mounted for movement between first, second and third positions in said valve housing, means for connecting said spool valve to said actuator, means including a first passage in said spool valve providing a connection between said inlet port and said outlet port when said spool valve is in the first position, means including a second passage in said spool valve providing, when said spool valve is in the second position, a connection between said inlet port and one of said chambers in said cylinder and providing, when said spool valve is in the third position, a connection between said one chamber and said outlet port, and means including a third passage providing, when said spool valve is in the second position, a connection between the other of said chambers and said outlet port, and providing, when said spool valve is in the third position, a connection between said outlet port and said one chamber, and a continuously available source of hydraulic fluid operatively connected to said inlet port.

6. A marine propulsion device in accordance with claim 5, including means for biasing said spool valve to said first position.

7. A marine propulsion device including a propulsion unit mounted relative to a boat for pivotal movement about an axis to afford steering movement of said propulsion unit, and hydraulic means for controlling pivotal movement of said propulsion unit including a cylinder connected to one of the boat and said propulsion unit, a piston movable in said cylinder and dividing said cylinder into opposing pressure chambers, a rod extending through one end of said cylinder and connecting said piston to the other of the boat and said propulsion unit, and a valve connected to said pressure chambers and including a pressure fluid supply port, a pressure fluid outlet port, and a valve member movable relative to said supply and outlet ports and between a first position communicating said supply and outlet ports independently of said chambers and preventing fluid flow relative to said chambers, whereby to allow fluid flow from said supply port to said return port and to lock said propulsion unit against pivotal movement originating in said propulsion unit, a second position communicating one of said chambers with said supply port and the other of said chambers with said return port, whereby to pivot said propulsion unit in one direction in response to the application of pressure fluid to said pressure fluid supply port, and a third position communicating said other of said chambers with said supply port and communicating said one of said chambers with said outlet port.
8. A marine propulsion device in accordance with claim 7, including a steering control actuator operable at a location remote from said propulsion unit and wherein said valve means includes a valve housing fixed relative to one of said cylinder and said piston rod and said valve member comprises a spool valve movably mounted in said housing and connected to said actuator.

9. A marine propulsion device in accordance with claim 7, and further including a continuously available source of pressure fluid including a pump communicating with a sump, a supply conduit between said inlet port and said pump, and a return conduit between said outlet port and said sump.

10. A marine propulsion device including a propulsion unit mounted relative to a boat for pivotal movement about an axis to afford steering movement of said propulsion unit, a steering control actuator operable at a location remote from said propulsion unit, hydraulic means for controlling pivotal movement of said propulsion unit including a cylinder closed at both ends and connected to one of the boat and said propulsion unit, a piston movable in said cylinder and dividing cylinder into opposing pressure chambers, a piston rod extending through one end of said cylinder and connecting said piston to the other of the boat and said propulsion unit, said piston rod including a hollow interior, and valve and conduit means connected to said pressure chambers and including a valve housing connected to the other end of said cylinder and a spool valve movably mounted in said housing, said valve and conduit means being selectively operable for preventing fluid flow relative to said chambers, whereby to lock said propulsion unit against pivotal movement originating in said propulsion unit, for permitting pressurization of one of said chambers and venting of the other of said chambers, whereby to pivot said propulsion unit in one direction, and for pressurizing said other of said chambers and venting said one of said chambers, whereby to pivot said propulsion unit in the other direction, and a member extending through said hollow interior of said piston rod and through said piston and connected between said actuator and said spool valve for operating said valve and conduit means.

11. A marine propulsion device in accordance with claim 10 wherein said valve housing includes a pressure fluid inlet port and a pressure fluid outlet port and further including a continuously available source of pressure fluid including a pump communicating with a sump, a supply conduit between said inlet port and said pump, and a return conduit between said outlet port and said sump.

12. A marine propulsion device in accordance with claim 10 wherein said valve housing includes a pressure fluid inlet port, wherein said spool valve includes an axial bore communicating with said hollow interior of said piston rod, and wherein said piston rod includes a port communicating between said hollow interior thereof and said chamber adjacent said one cylinder end, and wherein said spool valve is selectively operable to connect and disconnect said spool valve bore with said pressure fluid inlet.

13. A marine propulsion device in accordance with claim 12 wherein said spool valve has a radial bore communicating with said axial bore and communicable with said pressure fluid inlet port depending upon the location of said spool valve in said housing.
UNIVERS STATES PATENT OFFICE
CERTIFICATE OF CORRECTION


Inventor(s) William J. Shimankas

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 24 "Fur" should be --- For ---;
Column 3, line 19 after "groove", insert --- 100 ---;
Column 3, line 25 "44. The" should read -- 44, the --.
Column 3, line 67 "annual" should be --- annular ---;
Column 7, line 7 delete "means";
Column 7, line 24 after "dividing", insert --- said ---.

Signed and sealed this 18th day of July 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCALK
Attesting Officer Commissioner of Patents