UNITARY HYDRAULIC SHOCK ABSORBER AND ACTUATOR

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7 Claims

ABSTRACT OF THE DISCLOSURE

A hydraulic device driven by a reversible electric motor having a hydraulic jack which is extensible or retractable by controlling the direction of rotation of the electric motor with all the active parts of the device being integrated, except for the electric motor controls, into a sealed casing with smooth outer contours to enable the device to be used in exposed ambient conditions.

It is a principal object of this invention to provide a hydraulic device for projecting or retracting a member wherein all of the active parts are encased in a sealed housing including a reversible electric motor for driving a pump which is the source of pressure for the extensible and retractable hydraulic device.

It is a further object of this invention to provide a hydraulic device, the active parts of which are housed in a sealed casing including a reversible electric motor, a gear pump, valve assemblies and a hydraulic jack so that it can be used under adverse ambient conditions.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction to combinations of parts and to economies of manufacture will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is an elevational view of an outboard motor in operative position on a boat to which the invention has been applied;
Fig. 2 is a perspective view in elevation of the motor shown in Fig. 1 in raised inoperative position;
Fig. 3 is an elevational view of the hydraulic device incorporating the invention taken broadside;
Fig. 4 is an elevational view of the device shown in Fig. 3 taken at right angles thereto;
Fig. 5 is an elevational view partly in section taken along line 5—5 of Fig. 3;
Fig. 6 is an elevational view partly in section taken along line 6—6 of Fig. 3;
Fig. 7 is a sectional elevational view taken along line 7—7 of Fig. 4;
Fig. 8 is a plan view in section taken along line 8—8 of Fig. 6;
Fig. 9 is a plan view in section taken along line 9—9 of Fig. 3; and
Fig. 10 is an enlarged view in elevation partly in section superimposing in phantom the parts of the device.

The device is shown as comprising two castings 22 and 23 from castings A and C which are fastened together by suitable mechanical means such as screws 40 and provided with suitable gaskets 46 for sealing as is well known in the art. The connections for the hydraulic circuits are all positioned within the castings so that the unit is extremely and not subjected to disruption by breakage or the like, due to its smooth outer contours. The reversible electric motor M is mounted against the casting C by means of throughbolts B and provided with gaskets 48 at the

the water to drive the boat forward. The brackets 24 are provided with a pivotal connection 30 which allows the motor to be tilted upwardly to remove the propeller from the water as shown in Fig. 2, either by manual manipulation or by the use of a unitary hydraulic tilt mechanism of H which may, but does not necessarily include a shock absorbing action. The mechanism H incorporates the invention as shown cooperating with the outboard motor and its mounting means for application to a boat. The shock absorber action of the device H is effective when the propeller of the outboard motor 20 and a submerged object when the boat is traveling at a high rate of speed, which propels the motor upwardly about the pivot point 30, often giving rise to dangerous conditions for the motor or for the occupants of the boat. The shock absorber aspect of the invention will be further described hereinafter.

In order to tilt the motor upwardly about its pivot 30, the device H incorporating the invention is provided with hydraulic cylinder (Fig. 3) 31 integrally incorporated in the device H which is capable of expanding by its movable piston and piston rod assembly 31a and applying a force to the outboard motor between a fixed pivot 32 on the outer lower end of an auxiliary bracket 24a and an intermediate pivot point 34 above it which will create the necessary mechanical arrangement to cause the motor to move upwardly. The motor is shown in raised position in Fig. 2 as pointed out hereinafore. The lower end of the jack 31 is provided with an integral anchor block 36 which is pierced by an aperture through which a pin projects to form the fixed pivot 32, the pin also projecting through suitable ears 38 on the lower outer end of the auxiliary bracket 24a attached to bracket 24. In a similar manner, the piston rod assembly 31a of the hydraulic jack 31 is provided with an eye 42 through which a pin projects to form the intermediate pivot 34, a second set of integral ears 44 being provided at a central location of the bracket 124 having apertures aligning with the eye to cooperate with the pin to form the pivot.

The hydraulic cylinder 31 is so arranged in its pressure connections with a source of controllable pressure, as will be further described hereinafter, that the movable piston assembly 31a can be expanded or retracted at the will of an operator. By controlling the application of pressure to the cylinder, the motor can either be raised to the position shown in Fig. 2 or to an intermediate position for partial tilt operation, or can be retracted from either position to the normal operation position shown in Fig. 1.

Referring now to Figs. 3 and 7, it will be noted that the hydraulic tilt and shock absorber H is divided into three portions, A, C and M, which cooperate together to form an integrated unit which includes the hydraulic jack 31, a source of pressure with its controls, and a power source consisting of a reversible electric motor M which is energized and controlled from a remote point inside of the boat by means of a cable K. The three portions are integrated together into a sealed casing, which protects the parts of the mechanism from ambient conditions such as weather and water to which the device is exposed due to its position on the exterior of the boat body where it may also be subjected to submersion in the water in a following sea. The sealed casing is fabricated from castings A and C which are fastened together by suitable mechanical means such as screws 40 and provided with suitable gaskets 46 for sealing as is well known in the art. The connections for the hydraulic circuits are all positioned within the castings so that the unit is extremely and not subjected to disruption by breakage or the like, due to its smooth outer contours. The reversible electric motor M is mounted against the casting C by means of throughbolts B and provided with gaskets 48 at the
joints to form seals. The shaft 50 of the motor (FIG. 7) extends in normal relation through the casting C through a seal 52 to drive a gear pump P as will be described further hereinafter.

The hydraulic jack 31, with its piston and piston rod assembly 31a is housed in an integral portion of the casting A and consists of a cylinder bore 31b in which the assembly 31 reciprocates under the controllable pressure regulations above and below the piston by communication through an upper inlet 31c and a lower inlet 31d. The bore 31b is fitted with a threaded cap 54 through which the piston rod moves being sealed by a gasket 56 as is well known in the art. The cap 54 is sealed to the cover head by an "O" ring 58.

The upper inlet 31c to the upper end of the bore 31b is in communication with a pump feed chamber F by passageway 60 which is bored from the chamber F in a longitudinal boss 62 projecting upwardly from the floor 64 of a reservoir R formed in part in the casting A and in part in the cover C to which the cover is fastened by the screws 40 and sealed by gasket 46 as already described. The boss 62 adjacent the chamber F is enlarged at 62a as shown in FIG. 5 and is provided with a flat front face 62b flush with the edge 64a of the integral circumambient wall 64b of the main casting A which forms part of the reservoir R in part. The front faces 62a and 62b are parallel and smooth and cooperates with a similar flat front face 66 of like dimension formed on a boss 67 on the inner side of the cover casting C the two faces being held in contact with each other by suitable means such as bolts 66b to fasten the metal seal with gaskets. The front face 66 on the cover casting C projects a slight distance beyond the plane of the edge 67a of the wall portions of the cover casting C cooperating with the gasket 46 to form the reservoir R, so that when the screws 40 are pulled home to compress the gasket 46, the front faces 62a and 66 are pressed together into close cooperative relation (FIG. 9). Tolerances in manufacture are compensated by the compression of the gasket 46. The cooperative relation of the cover C with the main casting A, forms the reservoir R and the feed chamber F.

The upper inlet 31c to the upper end of the bore 31b is in communication with the valve 68 through a pressure regulating valve 68 which is resiliently pressed against its seat by resilient means 70 anchored on the cover casting C as shown in FIG. 7. The lower inlet 31d is also in communication with the reservoir R by means of a manually controllable relief valve 72 (FIG. 7) which includes an actuator 172 for the re-located, closable, sealing, which closes lateral passageway 74 which communicates with the valve seating cavity 76 which in turn communicates with the reservoir R by passageway 78. The relief valve 72 is resiliently biased to its seat by a helical spring 80, the bias of which is manually controllable by a screw member 82 which forms an anchor thereon, the screw member’s position being controlled by the manual manipulation thereof by a tool inserted in kerf 82a. Seal O is provided for the member 82 in a well known manner and its removal from the relief valve cavity is prevented by a compressible seal 81 positioned above a spring washer 82b seated in an annular groove 82c in the main casting A. By unscrewing the member 82, the spring bias on the relief valve 72 is reduced, whereby the pressure in the lower side of the bore 31b under the piston is released to allow the motor to be manually lowered, assisted by gravity from the tilted position shown in FIG. 2 to the operative position shown in FIG. 1, in the event there is a power failure to prevent the operation of the electric motor M.

The reversible electric motor M, is connected by its drive shaft 50 to the driver gear 84 of the gear pump P (FIGS. 6 and 7) by a non-circular portion as shown, the driver gear 84 driving the idler gear 86, both being positioned in a cavity 87 in the flat face 66, the idler gear 86 being mounted on a stud 88, press fitted into a bore in the floor of the cavity 87 to freely rotate thereon, if desired, a shallow bore 50b may also be provided in the flat face 62a to form a clearance for the projecting end of the drive shaft 50a extending beyond the forward face of the motor 50 as shown in FIG. 7, to allow for manufacturing tolerances. The cavity 90 behind the gear pump and concentric with the shaft 50, communicates with the reservoir R by passageway 92, which relieves the seal 52 for the shaft 50 from a pressure build up arising from leakage from the gear pump and also supplies lubrication for the shaft at that point. A pair of passageways 94 and 96 communicating with passageway 92 are provided terminating at the flat face 66, each being provided with a ball check valve 94a and 96a respectively acting against a seat. Their purpose will be described hereinafter.

Referring now to FIG. 10, where the gears 84 and 86 of the gear pump P are superimposed in phantom in an enlarged view looking at the flat face 62a, it will be seen, that when the driver gear 84 is rotated clockwise, the idler gear 86 driven thereby will rotate counterclockwise and hydraulic fluid will be displaced from the chamber F via a groove F through the pump cavity 87 to the groove 98 on the lower side to build up a hydraulic pressure in the cavity 100 with which the groove 98 is in communication. The cavity 100 has a laterally extending passage 102 which is axially extended on the front face of the floor 104. Referring to FIG. 6, a closure of ball check valve 96a (FIG. 8) which effectively closes the passageway 96 to hold the hydraulic pressure allowing it to increase in cavity 100 and not to escape back to the reservoir R. The cavity 100 communicates with a bore 102 in which is seated valve block 104 (FIGS. 7 and 8) and being sealed therein by an "O" ring 106, the valve block having a serrated forward face 104a to allow the pressure to enter a flared inner hole 108 and also to cooperate with the flat face 66 on the cover C to hold the block in position in the bore 102 (FIG. 9).

The cover C has its flat face 66 pierced by a smaller bore 110 concentric with the bore 102 in the opposite casting A, in which is slidable positioned an actuator 112 sealed by an "O" ring 114, the actuator having a concentric nose 112a extending into the flared central opening 108 to contact the head 116 of a moveable hexagonal valve member 118, mounted in counterclockwise when the valve actuator is retracted and in which direction by pressure acting in an annular channel 118a on the rear side of the actuator 112, about a stop member 110b. When pressure is building up in chamber 100, the pressure is zero or negative in chamber 110a.

The valve member 118 of hexagonal outer configuration is disclosed and is for use in the hydraulic jack 31, Ser. No. 682,247, filed Nov. 13, 1967, assigned to the same assignee. Below the head 116 of the valve member 118, an elastomeric sealing member 120 is seated in a forward cavity 122 of the valve member, the flange 124 of the cavity being serrated to allow pressure in the counterbore to flow into the region of the sealing member 120. The sealing member has a projecting land 126 beneath the head 116 which coacts with a small annular lip 128 positioned about the converging opening of the flared hole 108 into which the head 116 slidably fits with minimum tolerance, all as described in the aforementioned copending application. The elastomeric member 120 is urged toward the lip 128 by helical bias spring 130 positioned in and seated against the undercut of a second counterbore 132 concentric with passageway 31a and bores 102, 119 and 110. Stops 134 are provided in the bore 119 to prevent the bore from being closed by the valve member 118 when it is retracted.

As the pump P builds up pressure in the cavity 100 (FIG. 10), the fluid moves into the flared hole 108 past the head 116 into the bore 119, thence into bore 132 and into passageway 31a, where it passes into the cylinder 31b on the lower side of the piston, which moves upwardly in response thereto, to lift the outboard motor upwardly about the pivot 30. The upward movement of the piston expels fluid above it, which must be relieved
either by passing into the pump feed chamber F or into the reservoir R. This action will now be described.

The fluid expelled from the upper end of the cylinder 31b, passes through the passageway 31c and into the bore 60 which terminates in the chamber F (FIG. 7) from which the fluid again passes into the gear pump P by the groove f (FIG. 10) to be pumped to the lower side of the piston by the mechanism already described. The chamber F is in communication with the reservoir R via the ball checked passageway 94, which is positioned between a groove g in the flat face 62b at the lower end of the chamber F (FIGS. 6 and 10) which terminates in bore 92 to communicate with the reservoir R. The ball valve 94a is so arranged that when the chamber F is feeding fluid to the pump P and therefore is substantially zero pressure, the valve will be open to allow fluid to flow from the reservoir R to the chamber F to make up for piston rod volume. However, when the pump P has its direction of rotation reversed so that the driver gear 84 rotates in a counterclockwise direction (FIG. 10), fluid will be pumped into chamber F to build up a pressure therein, which will cause the ball valve 94a to close to cut off further communication between the chamber F and the reservoir R. The situation and interaction of the parts of the mechanism when the pump rotation is reversed will now be described.

When the boat operator wishes to lower the outboard motor from the position shown in FIG. 2 to the operative position shown in FIG. 1, he manipulates the electrical controls to reverse the rotation of the motor M (see FIG. 10) which also reverses the rotation of the driver gear 84 to counterclockwise rotation whereby fluid is withdrawn from the groove 98 and from the cavity 100 and pumped into groove f and into chamber F above it. This builds up pressure in the chamber F which is communicated to the upper side of the piston in cylinder 31b via bore 60 and inlet 31c, to cause the piston to move downwards. The pressure in chamber F is also communicated to annular chamber 110a (FIGS. 7 and 9) via groove g which communicates with bore 110d (FIGS. 6 and 10) and passageway 110c to the chamber 110a, where it acts against the valve actuator 112 to move it to the left (FIG. 9) to contact the end of the head 116 to open the valve and allow the fluid to flow from the lower side of the piston in the cylinder 31b into the cavity 100 by passing through the inlet 31d, the counterbores 132 and 119, through the open valve, past the head 116 into the flared hole 108 and thence into the cavity 100, where the fluid again is acted upon by the gear pump P through groove 98. As the pressure builds up on the upper side of the piston by the action of the pump, the piston moves downwardly to move the motor into operative position. Any excess fluid in the cavity 100 arising from the different displacements on the opposite sides of the piston due to the piston rod 31c will be passed through ball valve 96a by groove 100a (FIGS. 8 and 10) through bore 96 into the bore 92 in communication with the reservoir R.

When the outboard motor is subjected to shock arising from hitting a submerged object with the boat travelling at high speed, it will create an instantaneous high pressure on the upper side of the piston in the cylinder 31b, which will unset ball check valve 68 and allow fluid to flow back to reservoir R which will continue until the pressure is relieved and the shock absorbed by the mechanism. This action will slow the movement of the motor in an upward direction about the pivot 30 (FIGS. 1 and 2) and prevent disruptive forces from being created.

The reservoir R is provided with a screw-threaded filler opening 150 in the upper side of the casing C, whereby hydraulic fluid can be added to the system as required to maintain the level L in the reservoir as determined by the lower side of the opening with the piston in retracted position. A screw plug 150a is provided to close the opening.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its applications to the details of construction and arrangement of parts illustrated in the accompanying drawings since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the foregoing claims beyond the requirements of the prior art.

What is claimed is:

1. A hydraulic device for moving a load in at least two directions, comprising a sealed casing divided into a main portion and a second portion cooperating together, each provided with inner and outer planar surfaces facing each other in a cooperative relation to form the sealed casing, a cylinder with a piston assembly movable therein integrally formed in the main casing element with pressure connections for each side of the piston assembly to move the piston assembly in two directions by application of fluid pressure, a reversible gear pump positioned in a cavity in the inner planar surface of the main portion, aligned cavities in the inner planar faces of the main portion and the second portion, a control valve seated in the cavity in the main portion, a movable piston to open the control valve in the aligned cavity in the second portion, cooperating cavities between the inner and outer cooperating planar surfaces in both casing members to provide a reservoir for fluid, grooves formed in the inner planar surface of the main casing portion to cooperate with the gear pump to provide communication with the control valve, passageways in the casing portions to provide communication for fluid under pressure between the reservoir, the reversible pump, the control valve, and the cylinder, to allow the reversible pump to move the piston assembly in the desired direction, gasket means between the outer cooperating planar surfaces on both casing portions to contain the high pressures, and holding means to supply pressure on the inner cooperating planar surfaces on both casing portions to provide a metal-to-metal seal therebetween to contain the high pressures, and a second holding means to apply pressure on the gasket means between the outer cooperating planar surfaces of both casing portions to contain the relatively low pressure in the reservoir and adjacent portions of the casing.

2. The hydraulic device defined in claim 1 wherein a reversible electric motor is incorporated in the second portion of the sealed casing for driving the reversible pump.

3. The hydraulic device defined in claim 1 further characterized by having the passageways forming the connective communications between the reversible pump, the cylinder with its piston assembly and the reservoir formed by bores in the portions of the sealed casing means.

4. The device defined in claim 3 further characterized by having at least one valve in the bores of the casing portions which is directly controlled by the fluid pressure.

5. The device defined in claim 1 further characterized by having at least one valve under manual control in the main casing portion to change the predetermined position of the piston assembly.

6. The device defined in claim 4 further characterized by the control valves being adapted to be responsive to high pressures in the fluid system arising from shock movements of the piston assembly to absorb the shock sufficiently to prevent disruption of the elements of the device.

7. The device defined in claim 1 further characterized by providing the main casing portion with mounting
means at its lower end which allow limited rotation of the device about pivot means to provide a tilting action to a rotatable load.

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