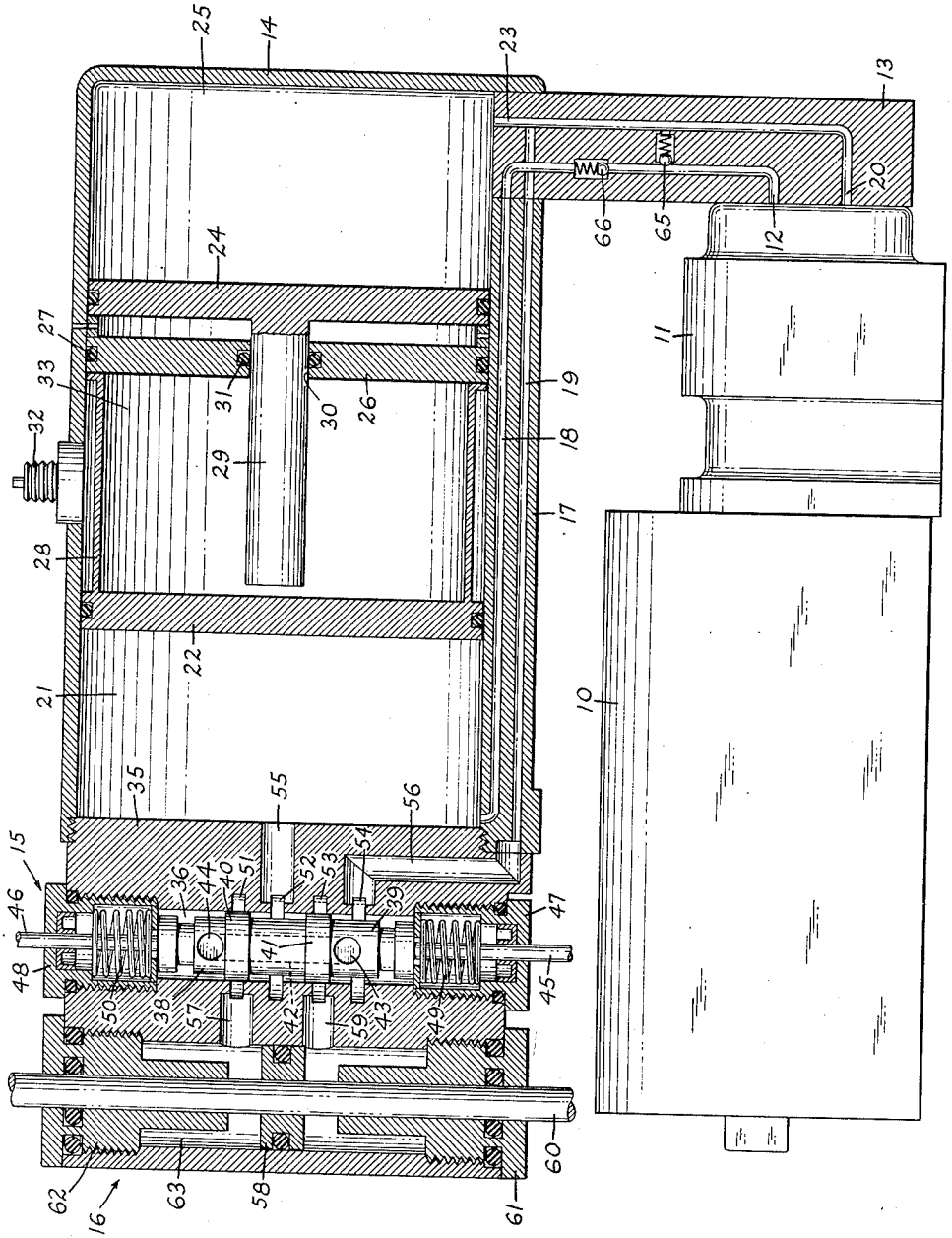
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HYDRAULIC POWER UNIT

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HYDRAULIC POWER UNIT

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This invention relates to hydraulic power units and it relates particularly to a unitary hydraulic system for generating, accumulating and supplying hydraulic power which is useful in installations, such as for example, guided missiles and the like requiring compact and lightweight hydraulic power systems.

In accordance with the present invention, such a unit may include a motor-driven pump which delivers liquid under pressure to a reservoir and accumulator structure from which it may be supplied under the control of a suitable selector valve to a hydraulic jack or other hydraulic motor forming a part of the unit.

A particular feature of the system is a reservoir and accumulator unit for the liquid which is effective to maintain a high liquid pressure therein after the manner of an accumulator and at the same time serve as a reservoir for supplying liquid to the intake port of the pump. This reservoir and accumulator unit is so constructed and arranged that it always affords a supply of liquid to the intake of the pump, and, regardless of its position or inclination, delivers the liquid therein to the intake of the pump so that there is little or no danger of the pump drawing in air from the system and delivering it to the accumulator.

A typical unit of the type described generally above may be of a suitable size to be used in guided missiles and other small aircraft, boats and the like, and because of its unitary self-contained construction, it can be readily installed and replaced in the device without extensive connections between the several elements making up the system.

For a better understanding of the present invention, reference may be had to the accompanying drawing, in which:

The single figure illustrates in elevation and partially in longitudinal section a hydraulic system of the type embodying the present invention.

While the invention will be described with reference to the use of the unit with a reciprocating hydraulic jack and a slide type of selector valve, it will be understood that the invention may be practiced with equal facility with a reversible rotary hydraulic motor and other types of selector valves without departing from the invention.

Referring now to the drawing, a typical unit may include an electric motor 10, preferably of small size and high energy output, which is utilized to drive a pump 11 of the gear or lobe type so as to provide pressure at the pressure port 12 of the pump. The motor and pump may be connected by means of a bracket 13 to the casing 14 of a combined reservoir and accumulator. The casing 14, as illustrated, is provided at one end with a valve member 15 which is adjacent to and connected with a hydraulic jack 16 for controlling the operation of the latter, as will be described hereinafter.

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The casing 14 of the combined reservoir and accumulator is of generally cylindrical shape in end view and is provided with a thickened wall portion 17 in which the liquid passages 18 and 19 are formed. The passages 18 and 19 extend through the bracket 13 and are connected, respectively, to the pressure or discharge port 12 of the pump and the intake port 20 of the pump. The port 12 is connected by means of the passage 18 to the interior of the casing 14 near the left-hand end thereof so that the liquid under pressure is forced into the compartment 21 between the left-hand end of the casing and the piston 22 which is movable axially of the casing 14.

The return passage 19 is connected to the interior of the casing 14 by means of a return passage 23 on the right-hand side of the piston member 24 which is reciprocable lengthwise of the casing. The passage 19 is further connected to a port in the selector valve 15 as described hereinafter.

The piston members 22 and 24 are adapted to reciprocate axially of the casing 14 and are utilized to keep the compartment 25 to the right of the piston 24 completely full of liquid by varying the size of the compartment. Likewise, the compartment 21 is kept full of liquid under pressure by the movement of the piston 22. The casing 14 is divided by means of a fixed partition 26 sealed to the wall of the casing by means of a suitable sealing ring 27. The partition 26 is keyed or otherwise secured to the casing.

The piston 22 is provided with an annular spacing sleeve 28 which engages against the partition 26 when the piston has moved to its limit position to the right.

The piston 24 is provided with a plunger rod 29 which is slidable in an aperture 30 in the partition 26. The rod 29 is maintained in sealing relation to the partition 26 by means of the sealing ring 31 mounted in the partition and engaging the plunger 29.

The space between the piston 22 and the partition 26 receives gas under pressure which is introduced through an air check valve 32 mounted in the wall of the casing 14 and communicating with the compartment or space 33. The pressure of the air or gas in the compartment 33 is related to the liquid pressure on the pressure side of the pump so that as the pressure and volume of liquid in the compartment varies, the piston will move to the right or left, thereby keeping the compartment 21 full of liquid at substantially the desired pressure. Thus, if the pressure in the gas or air chamber 33 is in the vicinity of 700 pounds per square inch, the liquid in the chamber 21 will be maintained under the same pressure as the air. In this way, the com-

partment 21 serves as an accumulator for the liquid under pressure.

Inasmuch as it is desired to maintain liquid at the intake 20 of the pump 11 at all times, the liquid in the reservoir or compartment 25 is also maintained under pressure by means of the air or gas pressure in the compartment 33. It is unnecessary to maintain the liquid in the compartment 25 under as high a pressure as the liquid in the compartment 21 and it is for this reason that the plunger 29 is provided. This plunger is acted upon by the air pressure, and, by regulating the cross-sectional area of the piston, a desired pressure may be applied to the liquid in the reservoir 25. In a typical example, the air pressure in the chamber 33 may be 700 pounds per square inch while the area of the plunger 29 is such that the pressure on the liquid in the reservoir 25 is in the vicinity of 20 pounds per square inch. Due to the pressure exerted on the plunger 29, the piston 24 will be moved to the right or left depending upon the volume of the liquid in the compartment to keep the latter full of liquid under the desired pressure. Regardless of the position of the unit as a whole, liquid will at all times be supplied to the intake or suction port 20 of the pump.

The liquid from the reservoir 21 may be supplied to any desired type of hydraulic motor under the control of a selector valve. In the form of valve and motor illustrated the selector valve 15 is of the slide type while the motor 16 is of the hydraulic jack type.

The casing in which the valve 15 and the jack 16 are housed may be a block of metal of any desired shape having an end portion 35 threaded into and closing the left-hand end of the casing 14.

The valve 15 includes a bore 36 extending through the block 37 for receiving the slide valve plunger 38. The slide valve may consist of a cylindrical portion 39 having a pair of spaced apart flanges 40 and 41 and an axial bore 42 therein communicating with apertures 43 and 44 disposed outside the flanges 40 and 41. The plug 38 may be provided with actuating rods 45 and 46 at opposite ends which extend through closure caps 47 and 48 threaded into enlarged opposite end portions of the bore 36. The plunger is normally urged toward a neutral position corresponding to the position shown in the drawing, by means of coiled springs 49 and 50 bearing against washers which are loosely mounted on the rods 45 and 46 and engage the ends of the plunger when the latter is centered. Upon movement of the plunger 38 in one direction or another, the washer at one end is restrained by engagement with a shoulder in the end of the bore 36 and the spring at the opposite end is compressed, tending to return the plunger to centered position.

The casing 37 is provided with a series of four grooves 51, 52, 53 and 54 circumferentially of the bore 36 which form the ports of the valve. The port 52 is connected to a passage 55 communicating with the interior of the chamber 21. The port 54 communicates with a passage 56 in the block 37 which is connected to the return conduit 19.

The port 51 is connected by means of a passage 57 to the interior of the jack 16 on one side of the piston 58 in the jack. The other port 53 is connected by means of a passage 59 to the interior of the jack cylinder on the opposite side of the piston 58. The piston 58 may be fixed

to a reciprocable shaft 60 which is guided for axial movement in closure plugs 61 and 62 at opposite ends of the bore 63 in the jack cylinder.

In the neutral or centered position of the plug 38 of the selector valve 15, the rings or flanges 40 and 41 cover completely the ports 51 and 53 so that the fluid under pressure at the port 52 cannot pass into either end of the jack 16. If the valve plug 38 is moved downwardly from the position shown, the ports 51 and 53 are completely or partially uncovered so that liquid under pressure flows thrcugh the port 52, past the plunger 38 into the port 53 and then into the cylinder 63 below the piston 58, forcing it upwardly. At the same time, the port 51 is uncovered and the flange 40 is interposed between the ports 51 and 52 so that the liquid above the piston 58 flows through the passage 57, port 51, aperture 44, passage 42, aperture 43, port 54 and through the return passages 56 and 19 to the suction or intake side of the pump and to the compartment 25.

If the valve plug 38 is moved upwardly, the ports 51 and 53 are again uncovered but communication is established between the port 52 and the port 51 so that liquid under pressure is delivered to the cylinder 63 above the piston 58 to force it down. At the same time, liquid flows out through the passage 59, port 53 around the outside of the plunger to the passage 54 and to the return lines 56 and 19.

Liquid cannot flow through the valve passage 42 for the valve flange 40 is disposed above the passage 51 and prevents short circuiting of the liquid.

In order to avoid the accumulation of too high a pressure in the compartment 21, a relief valve 65, set to open under a pressure corresponding to the pressure in the air chamber, may be interposed between the pressure and return lines 18 and 19. Likewise, in order to prevent back flow of liquid from the accumulator compartment 21 to the pump, a check valve 66 may be interposed in the pressure line 18.

The above-described apparatus provides a complete hydraulic pressure generating and actuating mechanism which is usable in any position so that it is especially adapted for use in installations which may assume many different positions in operation. Also, because of the arrangement of the reservoir and the accumulator unit, a most compact system may be provided which is completely self-contained requiring no other hydraulic connections than those described above. Such an arrangement greatly facilitates its installation in many types of devices and affords a simple, yet highly effective hydraulic system for controlling the operation of rudders, wing flaps and the like in guided missiles and other similar devices.

It will be understood, of course, that the size of the devices may be varied as the purpose demands and that other arrangements and relations, than those disclosed, may be utilized as required. Therefore, the form of the invention described above should be considered as illustrative and not as limiting the scope of the following claims.

We claim:

1. In a hydraulic power unit, the combination of a motor-driven pump having an intake port and a discharge port; and a reservoir and accumulator unit having an expansible and contractile accumulator chamber connected to said discharge port for receiving liquid under pressure from said

pump, a reservoir for receiving liquid and connected to said intake port for supplying liquid to said pump, and separate piston means moveable relative to each other in said chamber and said reservoir, means to apply pressure against said piston means to move them in said chamber and said reservoir to maintain them full of liquid under pressure, said pressure applying means including means for applying a lower pressure to the liquid in said reservoir chamber than to the liquid in said accumulator chamber.

2. In a hydraulic power unit, the combination of a motor-driven pump having an intake port and a discharge port for supplying liquid under pressure; and a reservoir and accumulator unit having an accumulator chamber connected to said discharge port for receiving liquid under pressure, a piston reciprocable in said chamber to vary its capacity, a reservoir chamber connected to said intake port to supply liquid to said pump, means to maintain liquid in said reservoir chamber, a piston reciprocable in said reservoir chamber to vary its capacity and means for applying unequal pressures to said pistons to keep said chambers full of liquid and the liquid in said accumulator under higher pressure than the liquid in said reservoir chamber.

3. In a hydraulic power unit, the combination of a motor-driven pump having an intake port and a discharge port for supplying liquid under pressure; and a reservoir and accumulator unit having an accumulator chamber connected to said discharge port for receiving liquid under pressure, a piston reciprocable in said chamber to vary its capacity, a reservoir chamber connected to said intake port to supply liquid to said pump, a piston reciprocable in said reservoir chamber to vary its capacity, means to maintain liquid in said reservoir chamber, a chamber interposed between said pistons for receiving gas under pressure for applying pressure to said pistons to displace them and keep said chambers full of liquid under pressure, and means for reducing the pressure applied to the liquid in said reservoir chamber to a lower value than the pressure applied to the liquid in said accumulator chamber.

4. In a hydraulic power unit, the combination of a motor-driven pump having an intake port and a discharge port; a reservoir and accumulator unit having an expansible and contractile accumulator chamber, an expansible and contractile reservoir chamber and means for applying pressure to said chambers tending to contract them, said pressure applying means applying less pressure to said reservoir chamber than to said accumulator chamber; a connection between said pump discharge port and said accumulator chamber; a connection between said pump intake port and said reservoir chamber; and a selector valve connected to said accumulator chamber, said pump and said reservoir chamber for controlling the flow of liquid to and from said pump, reservoir and accumulator.

5. An accumulator and reservoir unit for receiving liquid from and supplying it to a pump, comprising a substantially cylindrical casing, a partition in said casing adjacent to its mid-portion dividing it into an accumulator chamber and a reservoir chamber, pistons in said chambers movable lengthwise thereof on opposite sides of said partition, means for introducing gas under pressure into said casing between said partition and the piston in the accumulator chamber, and means for applying the pressure of said gas at

reduced value to the piston in said reservoir chamber.

6. An accumulator and reservoir unit for receiving liquid from and supplying it to a pump, comprising a substantially cylindrical casing, a partition in said casing adjacent to its mid-portion dividing it into an accumulator chamber and a reservoir chamber, said partition having a centrally located aperture in it, pistons in said chambers movable lengthwise thereof on opposite sides of said partition, means for introducing gas under pressure into said casing between said partition and the piston in the accumulator chamber, and means cooperating with said aperture and acting through the piston in said reservoir chamber to maintain the liquid in said reservoir chamber under a pressure less than the pressure in said accumulator chamber.

7. An accumulator and reservoir unit for receiving liquid from and supplying it to a pump, comprising a substantially cylindrical casing, a partition in said casing adjacent to its mid-portion dividing it into an accumulator chamber and a reservoir chamber, pistons in said chambers movable lengthwise thereof on opposite sides of said partition, means for introducing gas under pressure into said casing between said partition and the piston in the accumulator chamber, and a piston rod extending through said aperture and connected to the piston in the reservoir chamber and responsive to pressure of said gas to urge the last-mentioned piston in a direction to maintain the liquid in said reservoir chamber under a pressure less than the pressure on the liquid in said accumulator chamber.

8. An accumulator and reservoir unit for receiving liquid from and supplying it to a pump, comprising a substantially cylindrical casing, a partition in said casing adjacent to its mid-portion dividing it into an accumulator chamber and a reservoir chamber, pistons in said chambers movable lengthwise thereof on opposite sides of said partition, a sleeve on the piston in the accumulator chamber for maintaining the last-mentioned piston in spaced relation to said partition, means for introducing gas under pressure into said casing between said partition and the piston in the accumulator chamber, and means for applying the pressure of said gas at reduced value to the piston in said reservoir chamber.

9. An accumulator and reservoir unit for receiving liquid from and supplying it to a pump, comprising an expansible and contractile accumulator chamber, an expansible and contractile reservoir chamber, and means common to both chambers for applying gas pressure to said reservoir chamber and to said accumulator chambers to contract them and keep them full of liquid under pressure, said means having areas of different size exposed to the gas pressure and acting separately on said accumulator and reservoir chambers to maintain the liquid in said accumulator chamber under higher pressure than the liquid in said reservoir chamber.

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