

Feb. 7, 1961

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2,970,546

FLUID PRESSURE SYSTEMS

Filed April 23, 1958

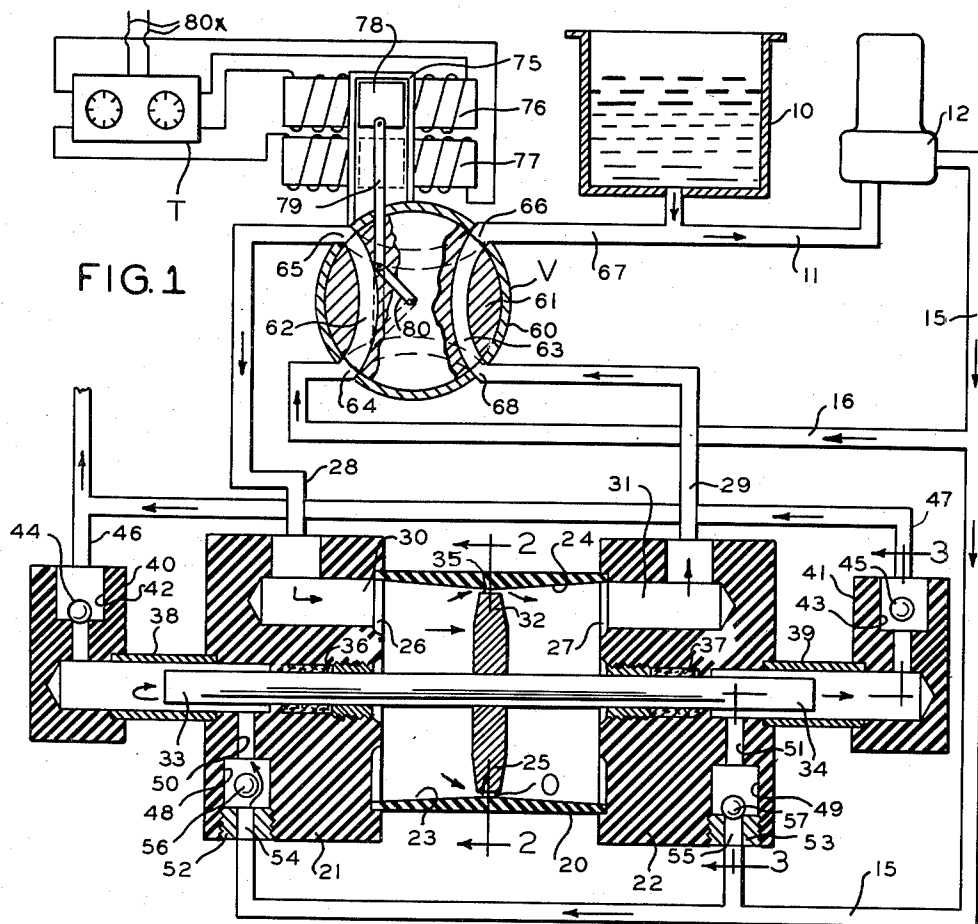


FIG. 2

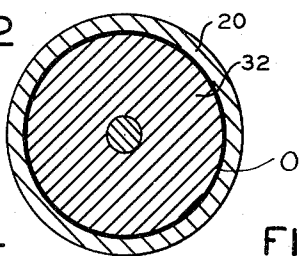


FIG. 3

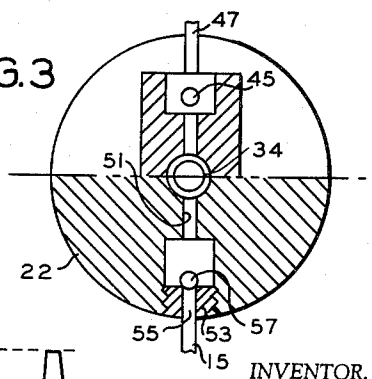


FIG. 4

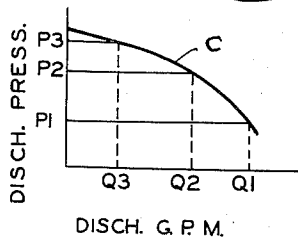
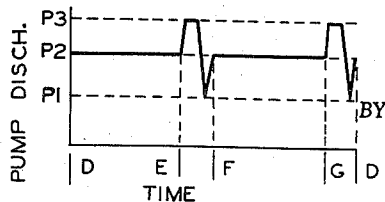


FIG. 5



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2,970,546

FLUID PRESSURE SYSTEMS

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Filed Apr. 23, 1958, Ser. No. 730,487

9 Claims. (Cl. 103—51)

This invention relates to fluid pressure systems, and more particularly to apparatus by which the output, under pressure, of a centrifugal pump can be employed for obtaining a force for delivering pressure fluid at a higher pressure, and for other purposes.

It is the principal object of the present invention to provide apparatus for applying pressure fluid from a centrifugal pump for supplying a portion of the pressure fluid in metered quantities, or at increased pressures, without leakage to the atmosphere.

It is a further object of the present invention to provide apparatus for applying pressure fluid from a centrifugal pump for purposes as aforesaid, and which is particularly suited for the handling of corrosive, erosive, toxic or radio-active liquids.

It is a further object of the present invention to provide apparatus for applying pressure fluid from a centrifugal pump for reciprocating a motor piston or the like against an appreciable pressure.

It is a further object of the present invention to provide apparatus for applying pressure fluid from a centrifugal pump for delivering a portion of the pressure fluid at increased pressure.

It is a further object of the present invention to provide apparatus for applying pressure fluid from a centrifugal pump in measured quantities at increased pressure.

It is a further object of the present invention to provide apparatus for applying pressure fluid from a centrifugal pump with a timed control of the application of the pressure fluid.

It is a further object of the present invention to provide apparatus for applying pressure fluid from a centrifugal pump for operating a positive displacement reciprocating pump having a higher output pressure.

Other objects and advantageous features of the invention will be apparent from the description and claims.

The nature and characteristic features of the invention will be more readily understood from the following description, taken in connection with the accompanying drawings forming part thereof, in which:

Figure 1 is a view partly diagrammatic and partly in longitudinal section of a preferred form of apparatus of the present invention;

Fig. 2 is a transverse sectional view taken approximately on the line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view taken approximately on the line 3—3 of Fig. 1;

Fig. 4 is a chart showing a typical performance curve of a centrifugal pump employed in connection with the invention; and

Fig. 5 is a chart showing the relation of the discharge pressures of the centrifugal pump to time as applied with the apparatus of the invention.

It should, of course, be understood that the description and drawings herein are illustrative merely, and that various modifications and changes can be made in the

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structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

Referring now more particularly to the drawings, the fluid pressure system in accordance with the present invention preferably includes a source of liquid to be pumped, such as a supply tank 10 which is connected by a fluid connection 11 to the intake of a motor driven centrifugal pump 12 of any preferred type. One suitable type of pump 12 is that shown in my prior Letters Patent No. 2,741,990, and can have performance characteristics of the type illustrated in Fig. 4. In Fig. 4 a typical performance curve C is plotted with the discharge indicated as abscissas, for a plurality of increasing quantities, such as quantities Q_0 , Q_2 , and Q_1 , expressed in gallons per minute, and corresponding discharge pressures expressed in p.s.i., indicated as ordinates for increasing pressures P_1 , P_2 and P_3 . The performance curve at C shows the inter-relationship between the discharge pressures and the quantities for different values.

The delivery side of the pump 12 has a fluid connection 15 extending therefrom with a branch connection 16.

Reciprocating mechanism is provided to which the fluid from the pump 12 is delivered and preferably includes a central cylinder 20 having heads 21 and 22 closing the ends thereof. The interior wall of the cylinder 20 is preferably formed of two tapered or substantially frusto-conical surfaces 23 and 24 of minimum diameter at the meeting portion 25 thereof, and of increasing diameters toward the outer ends thereof.

The heads 21 and 22 are provided with annular clearance spaces 26 and 27 with which fluid connections 28 and 29 are in communication through passageways 30 and 31.

A piston 32 of disc type is provided, longitudinally axially movable within the cylinder 20 and is carried on opposed plungers 33 and 34, longitudinally axially aligned therewith and with the longitudinal axis of the cylinder 20. The periphery 35 of the piston 32 is in spaced relation with respect to the interior surfaces 23 and 24 of the cylinder 20 so as to provide an orifice O therearound variable in area from the minimum area thereof when the piston 32 is at the meeting portions 25 to a maximum at the outer ends of surfaces 23 and 24.

The plungers 33 and 34 extend outwardly through the heads 21 and 22 and through stuffing boxes 36 and 37 carried in the heads 21 and 22 for preventing fluid leakage therealong.

The heads 21 and 22, longitudinally axially aligned with the cylinder 20, have additional cylinders 38 and 39 connected thereto in fluidtight relation. The cylinders 38 and 39, at their outer ends, have end heads 40 and 41 secured thereto in fluid tight relation. The end heads 40 and 41 are preferably provided with bores 42 and 43 within which ball check valves 44 and 45 are provided, seating as hereinafter explained at the inner ends of the bores 42 and 43. Fluid connections 46 and 47 are provided connected to the bores 42 and 43 and connected together for fluid delivery.

The heads 20 and 21 are preferably each provided with bores 48 and 49 in communication with the interiors of the cylinders 38 and 39 through passageways 50 and 51. Seating plugs 52 and 53 in threaded engagement in the heads 21 and 22 and having passageways 54 and 55 therein provide seats for ball check valves 56 and 57 in the bores 48 and 49. The passageways 54 and 55 are respectively in communication with the connection 15.

A control valve V is provided which preferably includes a valve body 60 within which a plug 61 is rotatably mounted. The plug 61 is provided with a pair

of passageways 62 and 63. The valve body 60 is provided with a fluid port 64 to which the fluid connection 16 is connected, a port 65 which is connected by the fluid connection 28 to the passageway 30, a port 66 which is connected by a fluid connection 67 serving as a return line to the supply tank 10, and a port 68 which is connected by the fluid connection 29 to the passageway 31.

The valve plug 61 is adapted to be moved from the position in which the passageways 62 and 63 are as shown in full lines to the position shown in broken lines for controlling the fluid flow. In one position the passageway 62 connects the ports 64 and 65 while the passageway 63 connects the ports 68 and 66, and in the other position the passageway 62 connects the ports 64 and 68 and the passageway 63 connects the ports 65 and 66.

In order to actuate and position the valve plug 61, a push-pull solenoid 75 is provided having windings 76 and 77, one of which, upon energization, actuates an armature 78 in one direction, and the other of which actuates the armature 78 in the opposite direction.

The armature 78 is connected by a link 79 to a lever 80. The lever 80 is connected to the valve plug 63 for moving the same to either of the two different controlling positions referred to above.

An electrically operated timer T of adjustable type is provided for continuously determining the timed energization of the windings 76 and 77 and so as to maintain the valve plug 61 in a predetermined position for a selected length of time, and to energize the other winding for positioning the valve plug 61 at its other selected location for a selected length of time which can be the same as or different from that of the other winding.

The timer T can be provided with supply leads 80X connected to any suitable source of electrical energy.

The mode of operation will now be pointed out.

Upon energization of the centrifugal pump 12, fluid from the supply tank 10 is delivered through the fluid connection 11 and to the fluid connection 15. The timed positioning of the valve V, and the valve plug 61 thereof, is determined by the energization of the windings 76 and 77 by the timer T. Assuming the valve plug 61 at the position shown in full lines in Fig. 1, a portion of the fluid from the fluid connection 15 passes through the fluid connection 16, the port 64, the passageway 62, the port 65, the fluid connection 28 and the passageway 30, and is delivered against the piston 32 for moving the same towards the right as seen in Fig. 1. At the same time, a portion of the fluid is delivered through the fluid connection 15 and the check valve 56 and the passageway 33 to the cylinder 38, the check valve 56 opening for this purpose.

As the piston 32 moves to the right, the fluid in the cylinder 39 is urged by movement of the plunger 34 past the check valve 45 and through the fluid connection 47 for delivery.

The pressure relationships between the discharge pressures and quantity outputs of the centrifugal pump 12 are illustrated in Fig. 4 as the curve C. From Fig. 4 it will be seen that as the pressure increases from P_1 to P_3 the flow decreases from Q_1 to Q_3 .

The pressure relationships with respect to the respective input sides of the cylinder 20 are shown in Fig. 5. The vertical distance from D to E represents the time of one stroke, from E to F represents the reversal period between the end of one stroke and the beginning of the next stroke in which the valve V is reversed, from F to G represents the return stroke, and from G to D represents the reversal period between the end of the return stroke and the beginning of the next forward stroke in which the valve V is restored to its original position.

From Fig. 5 it will be seen that upon the commencement of the stroke, indicated at D, the output pressure of the centrifugal pump 12 is at P_2 and the piston assembly comprising the piston 32 and plungers 33 and 34 will move towards the right in Fig. 1. The pressure

differential across the edge of the piston 32, minus the product of the suction pressure and the effective area of the piston 32, results in a force towards the right in Fig. 1 which is sufficient to overcome the drag due to the packing 36 and 37 and the force equal to the area of the plunger 34 times the pressure in the chamber in the cylinder 39.

It will be noted that an annular orifice O exists between the periphery of the piston 32 and the inner wall of the cylinder 20, and that this orifice O becomes smaller in area as the disc 32 reaches the middle of its stroke and then increases in area as the disc 32 reaches the end of its stroke in either direction. The area of this orifice O determines the distribution of the fluid discharged by the centrifugal pump 12 between that employed for actuation of the piston 32 and that returned to the supply tank 10. By varying the clearance between the piston 32 and the wall of the cylinder 20 over the full travel of the piston 32 any desired piston acceleration-deceleration characteristics can be obtained.

When the piston 32 stops at the right hand end of the stroke (Fig. 1) the pressure increases from P_2 to P_3 (see Fig. 5) between the lines E and F, since all the fluid discharged by the pump 12 must pass through the annular orifice O until the valve V has again been actuated. As can be seen in Fig. 4, while the pressure is increasing from P_2 to P_3 the flow is decreasing, but not to the point of shut off of the centrifugal pump 12.

Upon actuation of the valve V to position the passageway 62 to connect the ports 64 and 68, and the passageway 63 to connect the ports 65 and 66, the pressure will drop from P_3 to P_1 (as shown between the lines E and F on Fig. 5) and as the pressure is applied against the piston 32 to actuate it in the opposite direction the value of the pressure rises from P_1 to P_2 , as at F. During the return stroke, the pressure will remain at P_2 until at the end of the stroke, indicated at G, the pressure will change between G and D, as previously described with reference to the interval E—F.

The operations just described will be repeated so long as the valve V is operated.

The chambers in the cylinders 38 and 39, upon reciprocation of the plungers 33 and 34 therein provide positive displacement of fluid so that metered quantities of fluid can be delivered therefrom, or the pressure of the fluid delivered therefrom raised to a multiple of that available from the centrifugal pump 12. The reversal of the valve V is accomplished when the discharge from the centrifugal pump 12 is at a minimum so that the shock to the hydraulic system is at a minimum.

It will also be noted that the suction side, at the inlet valves 56 and 57 is supplied with fluid under pressure from the pump 12 so that the likelihood of starvation of the pump suction is avoided.

The materials from which the component parts are made can be readily adapted for avoidance of erosion or corrosion, and the escape of fluids such as toxic or radioactive fluids can be readily avoided.

I claim:

1. A fluid pressure system having a source of fluid under pressure, a motor cylinder, a motor piston mounted in said cylinder for reciprocation therein, the periphery of said motor piston and the interior wall of said cylinder having a fluid passageway therebetween at all positions of said piston, a valve connected by a fluid connection to said source, fluid connections from said valve to said motor cylinder for selectively applying said fluid at opposite ends of said cylinder, a timing mechanism for actuating said valve, and a plunger connected to and actuated by said motor piston.

2. A fluid pressure system having a continuous source of fluid under pressure, a motor cylinder, a motor piston mounted in said cylinder for reciprocation therein, the periphery of said motor piston and the interior

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wall of said cylinder having a space therebetween providing an orifice at all positions of said piston, a valve connected by a fluid connection to said source, fluid connections from said valve to said motor cylinder for selectively applying said fluid at opposite ends of said cylinder, a timing mechanism for actuating said valve, a pump cylinder, a direct supply connection from said source to said pump cylinder, and a positive fluid displacement member in said pump cylinder and actuated by said motor piston.

3. A fluid pressure system as defined in claim 2 in which said motor cylinder has the interior wall thereof of varying diameter between the ends thereof, and said motor piston has the periphery thereof in spaced relation to said interior wall to provide said orifice therebetween.

4. A fluid pressure system as defined in claim 2 in which said motor cylinder has the interior wall thereof flaring towards the opposite ends thereof, and said motor piston has the periphery thereof in spaced relation to said interior wall to provide said orifice therebetween.

5. A fluid pressure system as defined in claim 2 in which the source of fluid under pressure has the delivered quantity of fluid therefrom decreasing with increase of pressure.

6. A fluid pressure system having a continuous source of fluid under pressure in which the delivered quantity of fluid decreases with increase of pressure, a motor cylinder, heads for closing the ends of said cylinder, a motor piston mounted in said cylinder for reciprocation therein, a valve connected to said source, fluid connections from said valve to opposite ends of said motor cylinder for selectively applying said fluid at one of the ends of said cylinder and returning fluid to said source from the other end of said cylinder, a timing mechanism for actuating said valve, opposed pump cylinders carried by said motor cylinder end heads in longitudinal axial alignment with the motor cylinder, supply connections connected directly to said source and to said pump cylinders, delivery connections connected to said pump cylinders, inlet valves for controlling the delivery of fluid to said pump cylinders, and discharge valves for controlling the discharge from said pump cylinders, said motor cylinder and said motor piston being in spaced relation to provide an orifice therebetween at all positions of said piston for the continuous return of fluid from said motor cylinder to said source.

7. A combined motor-pump for fluid pressure systems comprising a central motor cylinder, end closure heads for closing the outer ends of said cylinder, fluid connections in each of said heads in communication with the interior of said cylinder at opposite ends thereof,

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opposed pump cylinders extending from said heads in coaxial alignment with respect to said motor cylinder, opposite end heads for closing the outer ends of said pump cylinders, inlet valves for said pump cylinders

5 in said motor cylinder heads, delivery valves for said pump cylinders in said pump cylinder heads, a motor piston mounted in said motor cylinder for reciprocation therein, said motor cylinder having the interior wall thereof of varying diameter between the ends thereof, said motor piston having the periphery thereof in spaced relation to said interior wall at all positions of said piston to provide a variable orifice therebetween, said motor cylinder having opposed plungers extending longitudinally axially therefrom through said cylinder end closure heads and into said pump cylinders, and valve mechanism for supplying fluid under pressure selectively to opposite ends of said motor cylinder for reciprocating said piston.

8. A fluid pressure system as defined in claim 7 in which said motor cylinder has the interior wall thereof flaring toward the opposite ends thereof.

9. A combined motor-pump for fluid pressure systems comprising a central motor cylinder, end closure heads for closing the outer ends of said cylinder, fluid connections in each of said heads in communication with the interior of said cylinder at opposite ends thereof, opposed pump cylinders extending from said heads in coaxial alignment with respect to said motor cylinder, opposite end heads for closing the outer ends of said pump cylinders, inlet valves for said pump cylinders in said motor cylinder heads, delivery valves for said pump cylinders in said pump cylinder heads, a motor piston mounted in said motor cylinder for reciprocation therein, said motor cylinder having the interior wall thereof flaring toward the opposite ends thereof, said motor piston having the periphery thereof in spaced relation to said interior wall to provide an orifice therebetween at all positions of said piston, said motor cylinder having opposed plungers extending longitudinally axially therefrom through said cylinder end closure heads and into said pump cylinders, stuffing boxes in said motor cylinder end heads for preventing fluid leakage along said plungers, and valve mechanism for supplying fluid under pressure selectively to opposite ends of said motor cylinder for reciprocating said piston.

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