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HYDRAULIC PUMP

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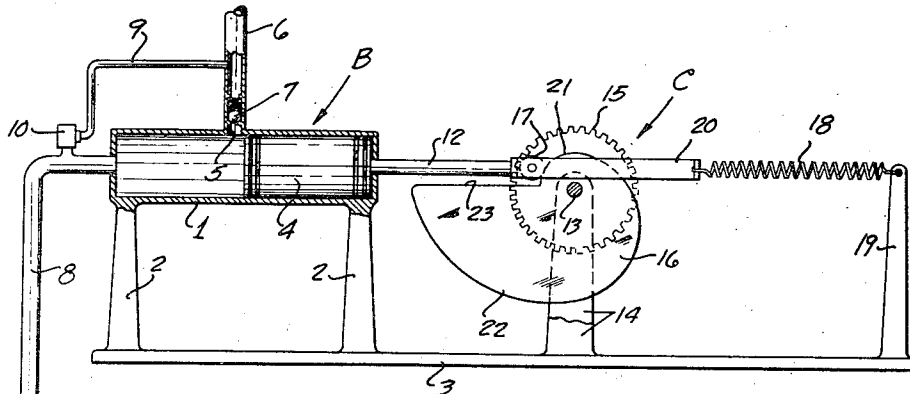


FIG. 1

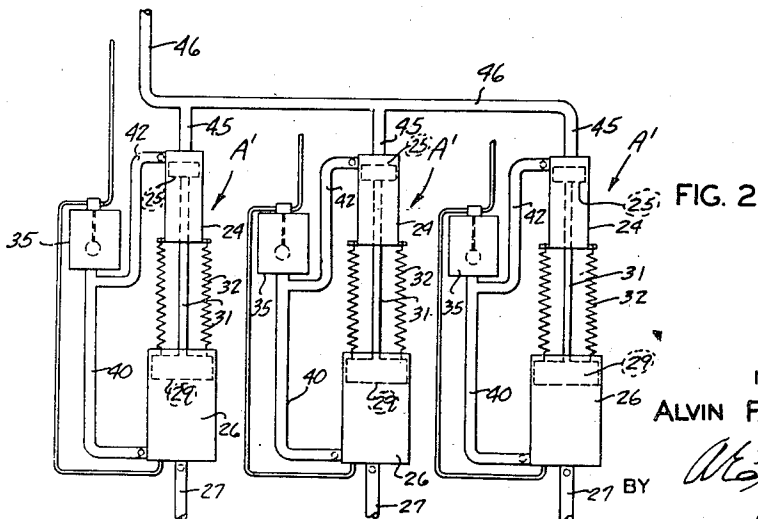


FIG. 2

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HYDRAULIC PUMP

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1 Claim. (Cl. 103—44)

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This invention relates to fluid pumps generally, and is more particularly directed to improvements in pumps of the hydraulically actuated character.

An important object of the invention resides in the arrangement of an inexpensive and relatively simple hydraulically actuated fluid pump which is not limited as to size or fluid pumping capacity and may be applied to the pumping of fluid from deep wells or wherever fluid is to be moved considerable distances and against relatively high head pressures in order to reach a point of delivery and consumption.

Another important object of the invention may be found in the provision of a simple and inexpensive fluid pump including a pressurized fluid reservoir for receiving fluid during each pumping stroke and for assisting in the delivery of reservoir fluid with each suction stroke, and means both in fluid flow and hydraulic operating relation therewith for effecting a predetermined cyclic operation of the pump in its pumping and suction strokes such as will initiate a flow of fluid toward the delivery line under a materially reduced head pressure, and such that the full effect and advantage may be had of the pressure in the fluid reservoir for assisting the lifting of fluid from a low level to a higher level.

Other objects of the invention reside in the arrangement of an hydraulically actuated pump of the reciprocatory and fluid cycling character, and in the construction, form, arrangement and operating features of the various parts and components of the fluid pump assembly.

In its broad aspects, the preferred form and arrangement which the fluid pump may have will be understood to include a fluid suction unit operatively related with a fluid displacement responsive unit such that the actuation of the latter unit will effect a desired operating response in the fluid suction unit to move fluid from its source into a pressurized fluid reservoir and transfer system connected in fluid delivery relation with the responsive unit. The above noted units and fluid reservoir may be assembled as a composite member of the pump and are suitably housed and arranged for location at or closely adjacent to the source of fluid to be pumped. In operative association with this composite member of the pump, there is arranged at an elevated position relative thereto, for example at the ground level or top of a well or other source of fluid, a power operated hydraulic unit which is arranged to open and close a fluid delivery line opening therefrom and to regulate the displacement of fluid toward the responsive unit through a connecting fluid line, as well as the reverse movement or flow of

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fluid from the pressurized fluid reservoir through the responsive unit and the connecting fluid line to the ultimate discharge thereof from the delivery line at the hydraulic unit. The operation of the hydraulic unit is constrained to movement in a predetermined cyclic manner by mechanical cycling means of a type and character developing a relatively uniform or progressive drive for a portion of its operating cycle, a rapid or relatively quick reversal of this drive followed by a period in which the hydraulic unit is inactive or non-operative.

According to this preferred arrangement, a volume of fluid initially filling the hydraulic unit and the fluid line leading therefrom to the responsive unit of the composite pumping member is displaced by the hydraulic unit, during the period of uniform drive operation of the mechanical means, into the responsive unit and is by this latter unit translated into operation of the suction unit in a direction to move fluid into the fluid reservoir where it is accumulated under a pressure proportional to the volume of fluid so accumulated. This action is followed by a rapid reversal of the hydraulic unit such as will cause a drop in pressure of the initially displaced fluid and as a result, cause the fluid in the responsive unit to flow in a reverse direction. The fluid pressure drop at the latter unit is therefore accompanied by a flow of accumulated fluid from the pressurized reservoir into and through the responsive unit and to the hydraulic unit for delivery at the discharge line leading therefrom. The period of inoperativeness of the hydraulic unit is timed to permit a full reverse fluid flow toward the discharge line and thereby effective utilization of the reservoir pressure in assisting fluid flow therefrom. As this reverse flow of fluid from the low level location of the pumping member to the discharge line at the high level location of the hydraulic unit is retarded by the gravitational effect on the fluid column, restoring means operatively connected with the responsive unit and the suction pumping unit becomes operative to re-set the responsive unit for subsequent cyclic operation and to move the pumping unit in its fluid suction stroke whereby a volume of fluid will be drawn up for subsequent delivery to the pressurized fluid reservoir.

With these broad principles in mind, it will be apparent that the present fluid pump of hydraulically actuated character possesses features of simplicity, may be applied in a variety of fluid pumping systems and may be utilized in multiple units where a greater volume of fluid is desired.

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In the accompanying drawing:

Figure 1 is a schematic arrangement of the fluid pump herein preferred, and in which the several units and operating parts have been shown in sectional elevation, and

Figure 2 is a schematic plan view of a multiple arrangement of composite pumping members adapted to deliver fluid to a common line connected with the hydraulic unit of the system.

With more specific reference to the drawing, the present invention, as disclosed in Figure 1, comprises the composite pumping member A adapted to be located at a low level relative to the hydraulic unit B and the mechanical operating means C. It will be observed that the fluid pump has been illustrated in a generally schematic arrangement such as will enable a complete understanding of the principles of its operation. However, the invention may be carried out with means other than that specifically disclosed herein, and it is the intention to include all such equivalent arrangements within the scope hereof.

In Figure 1, the hydraulic unit B includes the cylinder 1 suitably supported by legs 2 from a base structure 3, and a piston 4 movable in the cylinder between the inactive or "at rest" position shown and the opposite limit of the cylinder chamber. The cylinder 1 is provided with a fluid outlet port 5 which is opened and closed by the piston 4, and which port leads to the fluid delivery line 6 through a suitable ball check valve 7. As will appear presently, the cylinder 1 is placed in fluid communication with the member A of the pump through line 8. A by-pass line 9 is including a pressure responsive safety valve 10 is provided between line 8 and the delivery line 6.

The hydraulic unit B is operated in a predetermined cyclic manner by the mechanical drive means C which is operatively connected through rod 12 with the piston 4. In its preferred construction, means C includes a shaft 13 rotatably carried in spaced bearing stands 14 on base 3, a drive element or gear 15 fixed on the shaft in position to be connected with a motor or other prime mover (not shown), a cycling drive cam 16 also fixed on the shaft to engage a follower roller element 17 on piston rod 12, and a retracting or return spring element 18 which is fixed at one end to a base stand 19 and at the opposite end to a yoke connector piece 20. This yoke is, in turn, attached to the piston rod 12 and through the spring 18 normally urges the piston 4 to the position shown in Figure 1. The cycling drive cam 16 is peripherally shaped to provide an arcuate portion 21 of constant radius, a progressively rising surface 22 of substantial arcuate extent, and a radially directed cut-off edge 23. It will thus appear that for counterclockwise rotation of the cycling cam 16 the piston 4 will remain at rest during the period of contact of roller 17 on the constant radius cam surface 21. This is the so-called "dead spot" of the cam 16 as the piston 4 will have no motion in cylinder 1 and consequently will remain at rest for the duration of cam rotation through this arcuate extent. Continued cam rotation will bring the progressively rising surface 22 into driving contact with the rod follower 17 for displacing the piston 4 to the opposite limit of its stroke. When the cut-off edge 23 is rotated past the roller 17, the retracting spring 18 will immediately act to return the piston 4 to the position shown in Figure 1. When this occurs the sudden and rapid reverse piston motion effects a desired reduction in the fluid pressure of line 8 such as will impart a

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correspondingly rapid reversal of fluid flow in line 8 to cause a fluid delivery impulse past the check valve 7 and outwardly through line 6 leading from cylinder 1.

5 The composite pumping member A which is responsive to the cyclic operation of the hydraulic unit B is seen to include: a fluid displacement responsive unit comprised of the cylinder 24 which communicates with line 8 at its closed end, and a piston 25 movable therein from and to this closed end; and a fluid suction unit also comprised of a cylinder 26 having the fluid suction line 27 connected at its closed end through a line check valve 28, and a piston 29 movable in the cylinder from and to this closed end. These last described units are suitably carried on a base structure 30 in a generally tandem or axially aligned relation such that a single rod 31 may be used to couple the pistons 25 and 29 for simultaneous movement. 10 These pistons 25 and 29 are normally urged to one limit of their stroke by the provision of one or more spring elements 32 (two being shown here) each of which may be adjustably secured by threaded elements 33 to the cylinder 24 and attached to the rear side of the piston 29, in the manner indicated. In the example of Figure 1, the springs 32 act to retain the piston 29 at the end of its suction stroke thereby charging cylinder 26 with a volume of fluid drawn in through the suction line 27 and past the check valve 28. At the same time, piston 25 is at the inner or closed end of the cylinder 24 and in position to respond to the inflow fluid from line 8 under the hydraulic driving impulse imparted thereto by the piston 4 of the hydraulic unit B. 15

Before describing the pump operation, it will be noted that the composite pumping member A includes a pressurized fluid reservoir arranged in uni-directional flow communication between 24 and 26. In a preferred form, this means comprises an air bell or dome 35 having a dual-purpose air valve 36 in the top surface which is controlled by the float 37. The float 37 has a predetermined degree of rise and fall before actuating the valve 36. The valve 36 communicates with the atmosphere through an open end line 38, so that during periods of excess high liquid level in the air bell or dome 35, the float 37 rises and operates the valve 36, allowing air to be drawn into the cylinder 26 through the uni-directional line 39, which air is then forced into the air bell or dome 35, through the line 40, thus lowering the excess liquid level. This is to compensate for the absorption of air by the liquids. When the liquid level falls below the desired level in the air bell or dome 35, the float 37 descends and operates the valve 36, so that air will escape from the dome 35, thus allowing the liquid level to rise to the desired height. This is for the purpose of bleeding off such air therefrom as is normally entrained with the incoming volume of suction fluid. The air dome 35 receives a quantity of pumped fluid from the cylinder 26 through the feed line 40, and this fluid is prevented from reverse flow by means of the check valve 41 located close to the line connection at the cylinder 26. The liquid to be expelled from the dome 35 under the impulse of the air trapped therein, flows through an outlet line 42 and into the cylinder 24 past the check valve 43 adjacent thereto. 20

Operation of the pump is as follows: Rotation of the cyclic drive cam 16 causes displacement of piston 4 in a direction first to close the outlet port 5 in cylinder 1 and then to move or displace a volume of fluid through line 8 and into 25

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cylinder 24 of the responsive unit. This volume of fluid is initially admitted to the pump for the purpose of priming the same, but once operation has completed the first full cycle, the pump will then continue working automatically. The hydraulic action of this fluid is to force piston 25 outwardly against the return springs 32 and to drive the pumping piston 29 inwardly of its cylinder 26, thereby forcing fluid into reservoir means through line 40 by the directing action of valves 28 and 41. The air valve 36 will close upon rise of the float actuated needle 37 and air in the top zone of the dome 35 will be compressed. However, no fluid can pass through line 42 into the cylinder 24 as the hydraulic pressure in this latter cylinder will maintain valve 43 closed. The above cycle occurs during the time cam surface 22 is operative on the piston rod 12. When the cut-off cam edge 23 moves past the rod follower 17, return springs 18 will immediately and rapidly return the piston 4 to the position shown in Figure 1, thus opening outlet port 5 and reducing the pressure in line 8 to a sub-atmospheric value. Consequently, the hydraulic column in line 8 is reversed in its direction of flow and the fluid in the pressurized reservoir will be released by opening of valve 43 such that the compressed air in the air bell or dome 35 can act forcibly to discharge the fluid upwardly in line 8. The reversal of fluid flow in the cylinder 24 is not necessarily accomplished by a material drop in pressure at first, but as such pressure does begin to fall off, piston 25 will be enabled to return to its starting position (Figure 1) under the forcing action of springs 32. Thus the piston 25 will for a time materially aid in the upward flow of fluid for eventual delivery in line 8.

During the period when the fluid is flowing outwardly of the reservoir and upwardly in line 8, the cycling cam 16 is moving in its "dead spot" and piston 4 is at rest. This latter condition of cam operation will permit the composite pumping member A to attain its original piston setting and effect a pumping suction stroke of piston 29 such as will recharge cylinder 26 for each subsequent cycle of operation. Thus the cycling cam effects a period of hydraulic actuation of the pumping member A through unit B, a sudden and rapid period of reverse fluid flow accompanied by a quiescent or "dead spot" period to enable a maximum discharge from line 8 of the fluid in the pressurized reservoir system 35, 40 and 42, and a fluid charging or suction stroke of the member A.

Figure 2 illustrates a multiple arrangement of pumping members A', each of which is constructed in the manner described in connection with Figure 1 and the like parts are indicated by similar reference numbers. In this arrangement each of the members A' is connected by a branch line 45 with a common flow line 46 which leads upwardly to a common hydraulic unit, such as the one shown and described at B in Figure 1. The operation of the multiple pumping assembly conforms to that already noted and therefore no further discussion is believed necessary.

In constructing the present fluid pump, there are certain relations of parts which, if observed, will contribute to the success of its operation. It is preferred that the cylinder 26 be somewhat larger than the cylinder 24, and that the effective volume of the cylinder 1 of unit B be substantially equal to the volume of cylinder 24 (Figure 1), or in the multiple pump of Figure 2 equal to the combined volume of all of the cylinders 75

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24. Where the pumping member A is located below or at a lower level relative to the unit B, the inter-connecting line 8 should be arranged to be free of reverse bends such as would cause an air lock. Moreover, the return or retracting springs 32 for displacing the pistons 25 and 29 should be tensioned according to each installation so as to offset the weight of fluid in the line 8 (Figure 1) or lines 45 and 46 (Figure 2). When constructed in the manner described and with due regard to accepted hydraulic practices, it is believed that this fluid pump will have an advantageous efficiency comparable to other pumps capable of performing the same work. It will also appear that the size and pumping capacity may be varied over a wide range and that the pump can be applied to many and varied uses, especially where the fluid to be pumped has both distance and head.

The above description has referred to a preferred construction of hydraulically actuated fluid pump, but it should be understood that the scope of the invention is intended to include equivalent arrangements and variants such as will come within the spirit of the appended claim.

I claim:

In a fluid pump, the combination of a fluid suction unit having a cylinder provided with valve controlled fluid inlet and outlet connections and a piston movable in the cylinder alternately for sucking fluid through the inlet connection and pumping the same through the outlet connection, a fluid responsive unit having a cylinder provided with a valve controlled fluid inlet connection and a piston movable in the cylinder, means operatively connecting said pistons for simultaneous movement, resilient means connected to one of said pistons for urging the piston of said suction unit to the limit of its fluid suction movement, a fluid reservoir connected between the respective fluid outlet and inlet connections of said first and second mentioned cylinders, a float controlled air admission valve in said reservoir which is operative to retain air therein such as will pressurize the reservoir fluid pumped therein by said suction unit, an hydraulic actuating unit connected in fluid flow relation with the cylinder of said responsive unit, said hydraulic unit being provided with a fluid delivery line, and means for actuating said hydraulic unit alternately to effect hydraulic movement of the piston in said responsive unit against said resilient means and in a direction to pump fluid into said reservoir, and to effect a rapid reversal of hydraulic actuation thereof whereby the fluid in said reservoir is suddenly released and effectively forced under reservoir pressure toward said hydraulic unit for flow through said delivery line.

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