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2,464,095

PUMP

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2 Sheets-Sheet 1

Fig. 1.

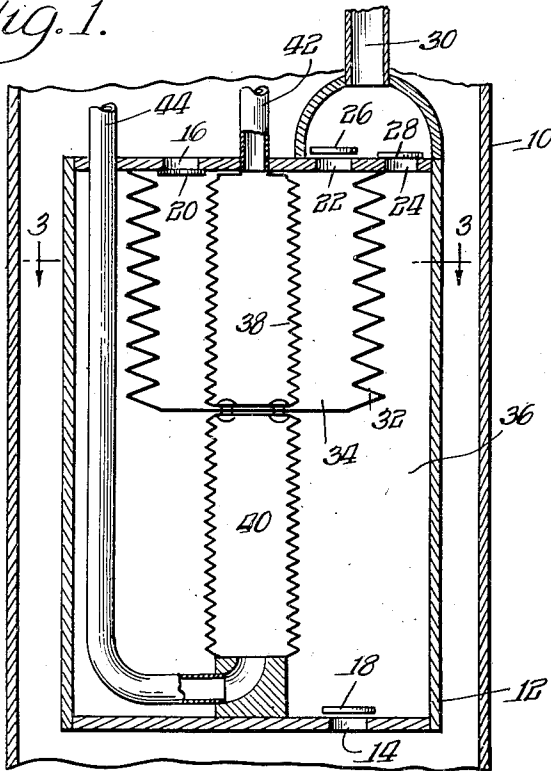


Fig. 2.

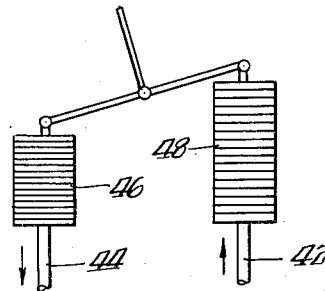


Fig. 3.

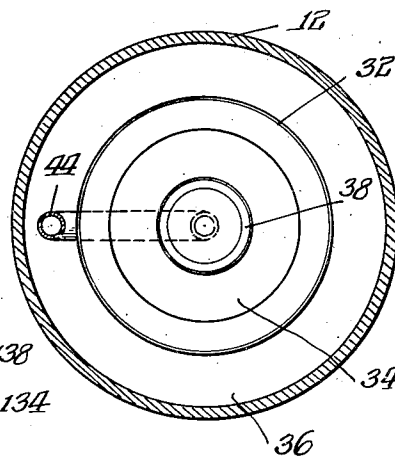
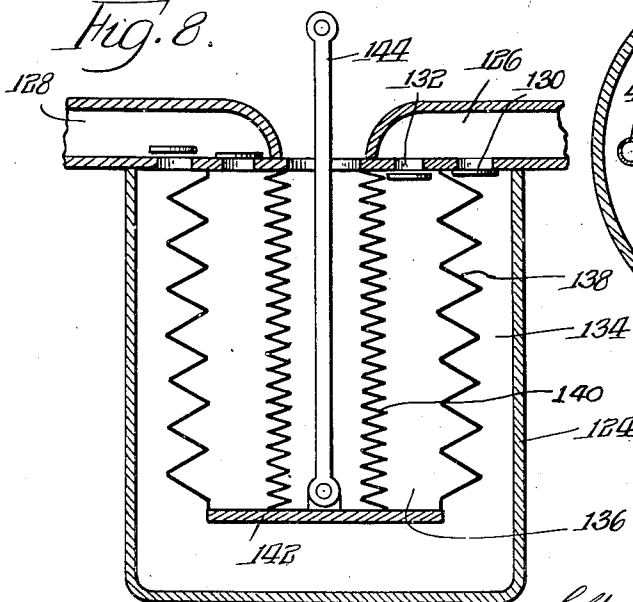


Fig. 8.



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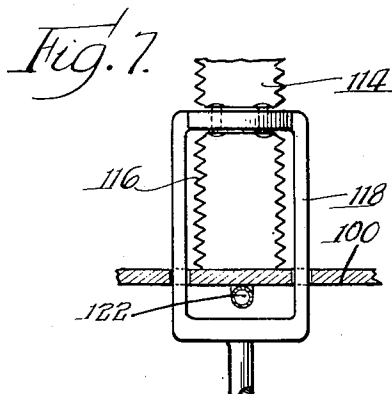
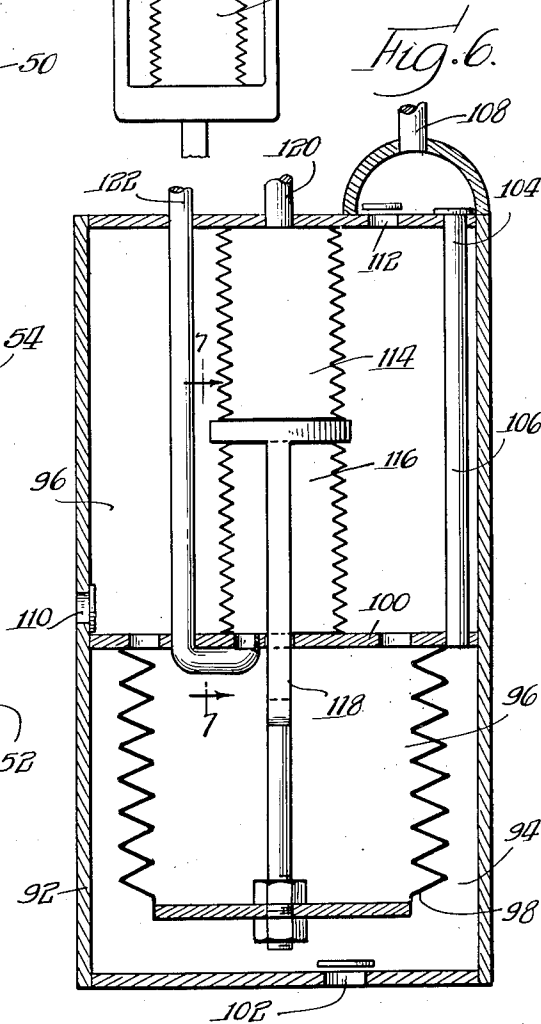
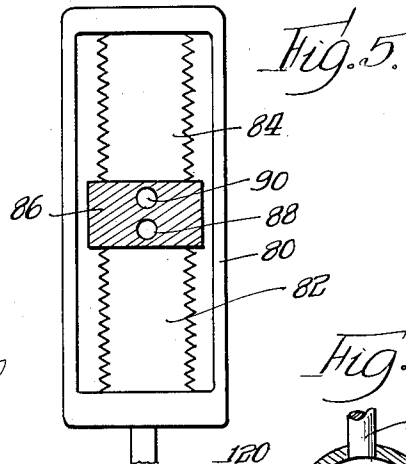
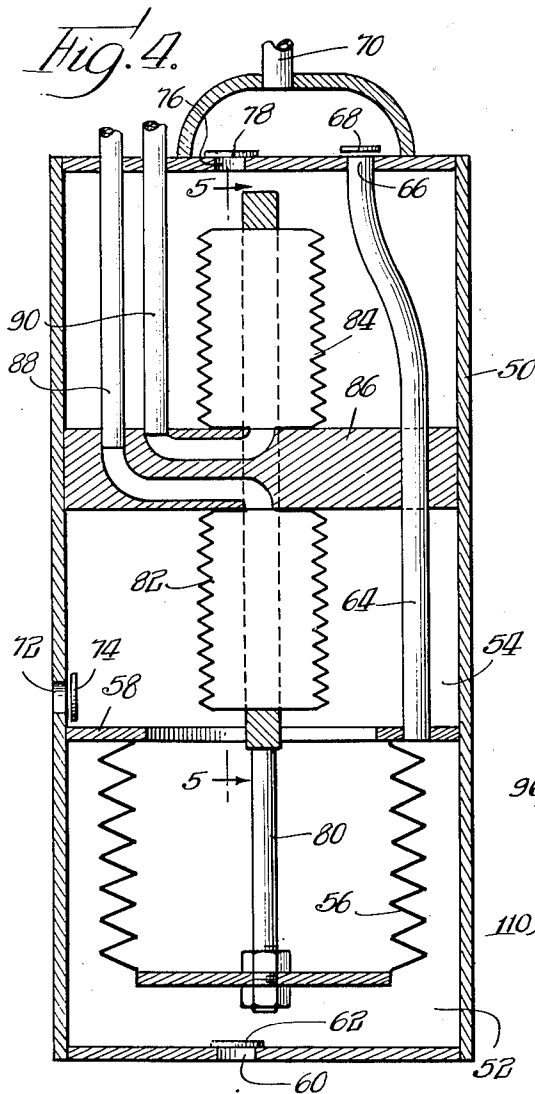
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2 Sheets-Sheet 2



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5 Claims. (Cl. 103-148)

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The present invention relates to pumps, and more particularly to a double acting pump having a high efficiency.

In deep well water pumps the conventional types are of relatively small capacity and are of such construction as to require frequent repair and replacement of certain parts such as packings and valves. Often times a deep well does not have a straight wall thus complicating the installation of a pump. It, therefore, would be desirable for deep wells, particularly water wells, to provide a pump which is simple in construction and installation, and which requires a minimum amount of maintenance.

In accordance with the present invention a pump, particularly adapted for deep wells for pumping water, oil and the like is provided which utilizes a plurality of bellows and which is double acting so as to provide a high degree of efficiency. The pump is fluid or liquid actuated by two conduits operating to supply alternate power. The two columns of propulsion liquid are balanced and the volume displaced by the pumping bellows is relatively small thereby minimizing the inertia losses. Such pump does not require attachment to the well wall nor does it have the high parasitic loss characteristic as in the plunger type pump. Such pump furthermore does not require high hydraulic pressures of the circulating losses of a jet type pump. It may be set at a greater depth than pumps of the types mentioned and is more readily installed or removed from the well since the connections may comprise semi-rigid tubing.

It, therefore, is an object of the present invention to provide an improved double acting pump particularly adapted for use in wells.

It is another object of the present invention to provide an improved double acting pump of the bellows type.

Still another object of the present invention is to provide an improved bellows type pump which does not require connection to the well tubing nor involve rigid mechanical connection between the top and bottom of the well.

Still another object of the present invention is to provide a pump structure which is readily installed or removed from a well and which is particularly adapted for deep well operation.

Still another object of the present invention is to provide an improved bellows type pump characterized by simplicity of construction and installation, a high operating efficiency, and a minimum amount of maintenance and repair.

Other and further objects of the present in-

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vention subsequently will become apparent by reference to the following description taken in connection with the accompanying drawing wherein

Figure 1 is a diagrammatic cross sectional view illustrating the construction of a pump in accordance with the present invention;

Figure 2 schematically illustrates the prime mover or power supply for the pump mechanism shown in Figure 1;

Figure 3 is a cross sectional view of the apparatus shown in Figure 1 as seen in the direction of the arrows along the line 3-3;

Figure 4 is a cross sectional view of a diagrammatic representation of another embodiment of a pump constructed in accordance with the principles of the present invention;

Figure 5 is a view of a portion of the pump mechanism shown in Figure 4 as seen in the direction of the arrows along the line 5-5;

Figure 6 is a cross sectional view of another diagrammatic representation of another pump embodiment utilizing the principles of the present invention;

Figure 7 is a view of a portion of the pump mechanism shown in Figure 6 as seen in the direction of the arrows along the line 7-7; and

Figure 8 is a cross sectional view of a further modification of the present invention which is more particularly adapted for use with shallow pumps.

Referring to Figure 1 there is shown a well casing 10 which may be assumed to be adjacent the lower extremity of a relatively deep well. Within the casing 10 there is a housing 12 which contains a pump structure embodying the present invention. The housing 12 which is submerged below the level of the liquid, oil or water, in the well has two inlets 14 and 16 each provided with suitable valve means 18 and 20 diagrammatically illustrated as being of the flutter type construction. Any simple type of valve means may be employed, it being preferable to use a relatively simple type structure which will require a minimum of maintenance and repair.

The housing 12 also has two outlets 22 and 24 provided with suitable valve means 26 and 28. The outlets 22 and 24 are connected to a common conduit 30 through which the fluid is to be forced to the top of the well. The housing 12 has a bellows 32 so arranged as to provide the housing into two chambers 34 and 36. Therefore the chamber 34 is provided with the inlet 16 and the outlet 22 whereas the chamber 36 is provided with the inlet 14 and the outlet 24.

The bellows 32 is arranged to be actuated by two oppositely arranged coaxial bellows 38 and 40 connected to conduits 42 and 44 respectively. The oppositely arranged bellows 38 and 40 are mechanically connected to the bellows 32 so that the movement of the bellows 38 and 40 produces movement of the bellows 32. The bellows in Figure 1 are shown in a state of equilibrium when no pumping action is occurring, or when the bellows 38 and 40 are midway between their extreme positions.

The bellows 38 and 40 connected with the conduits 42 and 44 are hydraulically actuated by the liquid within the conduits which is compressed and released by a suitable prime mover or pumping mechanism schematically illustrated in Figure 2. From this figure it may be assumed that the conduit 44 is connected to a cylinder or bellows 46 which at the moment is being compressed or reduced in volume while at the same time the conduit 42 is connected to a cylinder or bellows 48, the volume of which is being increased. Thus the flow of liquid through the conduits 44 and 42 is such that the flow in the first conduit is downward and in the second conduit is upward. Thus it may be assumed that the bellows 40 is expanding and the bellows 38 of Figure 1 is contracting.

This, therefore, brings about a contraction of the bellows 32 so that the pressure applied to the liquid within the bellows closes the flap valve 20 and opens the valve 26 so that the liquid therein is forced upwardly through the conduit 30. At the same time that the internal volume of the bellows 32 is being reduced thereby reducing the size of the chamber 34, the size of the chamber 36 is being increased so that the valve 28 is closed, and the valve 18 is open. Due to the increase in the volume of the chamber 36, the liquid from within the well casing 10 is being drawn into this chamber so that when the flow of hydraulic power in the bellows 38 and 40 is reversed, the liquid then in the chamber 36 will be forced upwardly through the outlet 24 into the conduit 30. When this occurs, the volume of the chamber 34 will be increasing while the volume in the chamber 36 is decreasing. The increase in the volume of the chamber 34 causes the valve 26 to close and the valve 20 to open thereby again filling the chamber 34 with more liquid from within the well.

The arrangement thus far described does not utilize any piston or packing material nor is there any other delicate machinery in the well which might require frequent repair or maintenance. An arrangement such as shown in Figure 1 may be used in a well of relatively small diameter since the dimensions of the casing 12 and the components therein may be varied accordingly. A relatively high efficiency of operation is obtained since the liquids contained within the conduits 42 and 44 and the bellows 38 and 40 are equal and in balance so that all the energy supplied by the pumping mechanism at the top of the well, schematically illustrated in Figure 2, is devoted to useful work as the only losses are the slight losses due to the alternating flow of the transmission fluids in the conduits 42 and 44.

Preferably all liquid velocities are relatively low, and the mechanical losses are negligible since the energy stored in the compressed or expanded bellows is recovered to a substantial degree as is the case in a spring. The arrangement shown will operate against high pres-

ures without loss of capacity or efficiency since there is no theoretical limit to the depth at which it may operate dependent upon the limit of the strength of the materials. A pump of this sort having no leathers or other materials of organic origin does not require appreciable maintenance since the only wearing parts are the inlet and outlet valves. A semi-rigid tubing such as seamless copper, steel, or plastic tubing may be used for the conduits 30, 42, and 44 thus permitting easy installation or removal from the well and installation in wells which are not straight. No attachment to the well wall is required and the operating machinery need not be placed over the well. The pump requires no priming, and the propulsion systems may be filled with a non-freezing liquid for use in cold climates. In such instances the discharge conduit 30 may be insulated or otherwise suitably protected.

A further embodiment of the principles of the present invention is disclosed in Figure 4 where in the outer casing 50 is divided into two chambers 52 and 54 by a bellows 56. The bellows is shown attached to an apertured support or wall 58 arranged transversely of the casing 50. The chamber 52 is provided with an inlet 60 and a cooperating valve structure 62. The chamber 52 is connected through a conduit 64 to an outlet 66 having a cooperating valve mechanism 68. The outlet 66 is associated with a common conduit 70 through which liquid is to be supplied to the top of the well. The chamber 54 is provided with an inlet 72 having a cooperating valve member 74, and an outlet 76 having a cooperating valve member 78. The bellows 56 is connected to a rod and frame 80 which, as may be seen from Figure 5, engages opposite extremities of a pair of bellows 82 and 84. Adjacent ends of the bellows 82 and 84 are secured to a cross member 86 extending between the side walls of a casing 50. The cross member 86 contains two conduits 88 and 90 respectively connected to the bellows 82 and 84. The conduits 88 and 90 extend to the top of the well where they are connected to a suitable reciprocating pump or prime mover to alternately supply liquid under compression to one of the bellows. Thus when one of the bellows 82 is expanded, the other bellows 84 is contracted thereby moving the pumping bellows 56. This movement of bellows 56 reduces or changes the capacity of the chamber 52 and changes the capacity of the chamber 54, thereby to bring about a pumping action of liquid similar to the pumping action described in connection with the embodiment in Figure 1.

It may be assumed that the conduit 88 is supplying liquid under pressure thereby causing the bellows 82 to become expanded so that the volume of the chamber 54 is increasing thus bringing about a closing of the valve 78 and an opening of the valve 74 so as to admit liquid from the well to this chamber. At the same time the chamber 52 is decreasing in volume thereby closing the valve 62 and opening the valve 68 bringing about a flow of liquid through the conduits 64 and 76 to the top of the well.

When the other bellows 84 is expanding the valve 74 is closed and the valve 78 is opened, and at the same time the valve 62 is opened and the valve 68 is closed. Thus the chamber 52 is receiving liquid from the well and the chamber 54 is forcing its liquid upwardly to the top of the well. The arrangement shown in Figure 4 provides for a greater displacement for a given linear motion

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of the end of the bellows 56 as compared to a similar motion of the bellows 32 of Figure 1.

A further arrangement of the present invention is shown in Figure 6 wherein the outer casing 92 is divided into two chambers 94 and 96 by a bellows 98. The bellows 98 is supported from a cross member or apertured partition 100 extending transversely of the housing 92. The chamber 94 has an inlet 102 and an outlet 104 interconnected by a pipe 106. The outlet 104 is connected to an upwardly extending conduit 108. The other chamber 96 has an inlet 110 and an outlet 112. Extending between the transverse apertured wall 100 and one end of the casing 92 is a pair of bellows 114 and 116 connected to a stirrup frame 118 at their common juncture. The stirrup frame 118 is connected to one end of the bellows 98. The bellows 114 is connected to a power conduit 120 and the other bellows 116 is connected to another power conduit 122. The conduits 120 and 122 are connected to the prime mover source which supplies alternating fluid power to the two bellows to bring about a double action motion to the bellows 98 so that a relatively constant stream of liquid is pumped from the well up to the top of the well by the conduit 108.

Where the requirements of the deep well operation are not to be met, a pump structure such as that shown in Figure 8 may be utilized. This structure involves a casing 124 having an inlet conduit 126 and an outlet conduit 128. The inlet conduit 126 has two valved openings 130 and 132 connected to two chambers 134 and 136 respectively. The chambers 134 and 136 are formed by a bellows member 138. The bellows 138 is connected to a coaxial bellows 140 arranged to provide a suitable mechanical connection to the common end plate 142 for both of the bellows. The common end plate 142 is connected by a suitable link or lever 144 to a source of power for actuating the bellows 138. Since the bellows 138 divides the housing 124 into two chambers 134 and 136 respectively, and one chamber is increased in size while the other chamber is being decreased in size, the pump shown in Figure 8 provides a relatively simple easy to manufacture double acting pump. It provides positive displacement without the use of a stuffing box or piston packing. It comprises a closed system thereby eliminating the possibility of leaks.

While for the purpose of illustrating and describing the present invention certain embodiments have been shown in the drawings, it is to be understood that the invention is not to be limited thereby since the various embodiments are intended to disclose the variations intended as is also indicated by the scope of the following claims.

The present invention is hereby claimed as follows:

1. A fluid actuated pump for liquid comprising a housing, a pair of coaxially arranged bellows mounted in said housing, said bellows each connected to a conduit for alternately receiving fluid power, a third coaxially arranged bellows arranged concentric to one of said first bellows and connected so as to be actuated by said pair of bellows, said third bellows separating said housing into two chambers, inlet valves, one for each of said chambers, and outlet valves, one for each of said chambers, said inlet valves being associated with a source of fluid and said outlet valves being connected to an output conduit.

2. A fluid actuated pump adapted to be located in a well comprising a housing, a pair of coaxial

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oppositely arranged bellows in said housing each of said bellows connected to a separate conduit for alternately receiving liquid power, a third coaxially arranged metal bellows arranged concentric to one of said first bellows and mechanically connected to said pair of bellows so as to be actuated thereby, said third bellows being mounted in said housing so as to separate said housing into two chambers, inlet valves, one for each of said chambers and outlet valves, one for each of said chambers, said inlet valves being associated with a source of fluid, said outlet valves being connected to an output conduit.

3. The combination comprising a source of power, means controlled by said source of power for alternately supplying energy through a pair of fluid conduits, a remotely located fluid actuated pump connected to said conduits, said pump comprising a housing having mounted therein a bellows arranged to divide said housing into two chambers, each chamber being provided with an inlet valve and an outlet valve, said inlet valves being associated with a source of liquid to be pumped, said outlet valves being connected to an output conduit, a pair of coaxially arranged oppositely positioned metal bellows members mounted within said housing and connected to said first bellows, each of said pair of bellows being connected to a different one of said first mentioned conduits, and one of said pair of bellows being arranged concentric to said first bellows.

4. A double acting pump unit for a well comprising a housing adapted to be positioned adjacent the bottom of the well, a metal bellows member mounted within said housing to form two chambers, each chamber being provided with an inlet valve for liquid from said well, each chamber being provided with an outlet valve, a common output pipe for said outlet valves, said output pipe being arranged to extend to the top of the well, a pair of coaxially arranged bellows each having one end thereof mounted fixedly relative to said housing, a hydraulic fluid conduit for each of said bellows adapted to extend upwardly to the top of the well for connection to a source of alternating hydraulic power, and a stirrup interconnecting the other end of each of said bellows with one end of said first mentioned bellows.

5. A double acting pump adapted to be submerged in a liquid comprising a housing, a bellows member mounted in said housing so as to separate said housing into two chambers, inlet valves, one for each of said chambers, and outlet valves, one for each of said chambers, said inlet valves being connected to a source of liquid, said outlet valves being connected to a common output pipe, a source of reciprocating power connected to said bellows, said source of reciprocating power including two similar oppositely arranged bellows mounted in said housing coaxially with said first bellows and connected thereto, said first bellows arranged so as to be concentric with one of said oppositely arranged bellows, and external means for alternately expanding and contracting said oppositely arranged bellows.

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The following references are of record in the file of this patent:

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