March 3, 1953 L. DAVIS 2,630,071

DOUBLE-ACTING PRESSURE FLUID LIFT PUMP FOR OIL WELLS

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Fig. 1

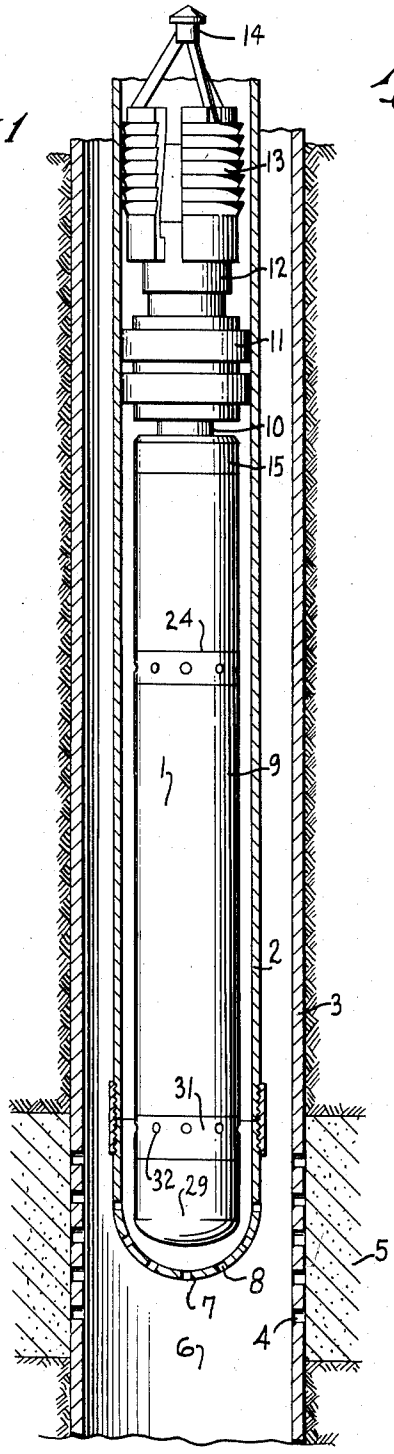

Fig. 2

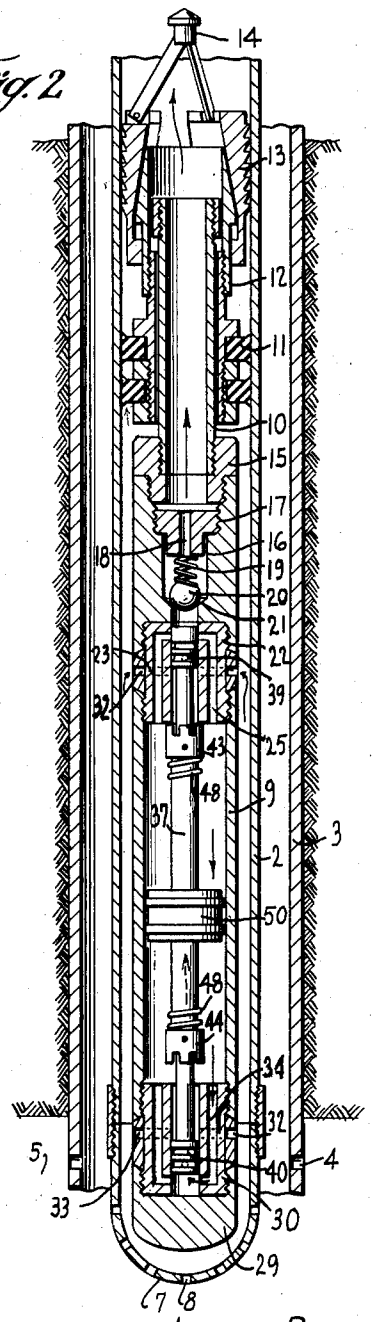

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Fig. 3

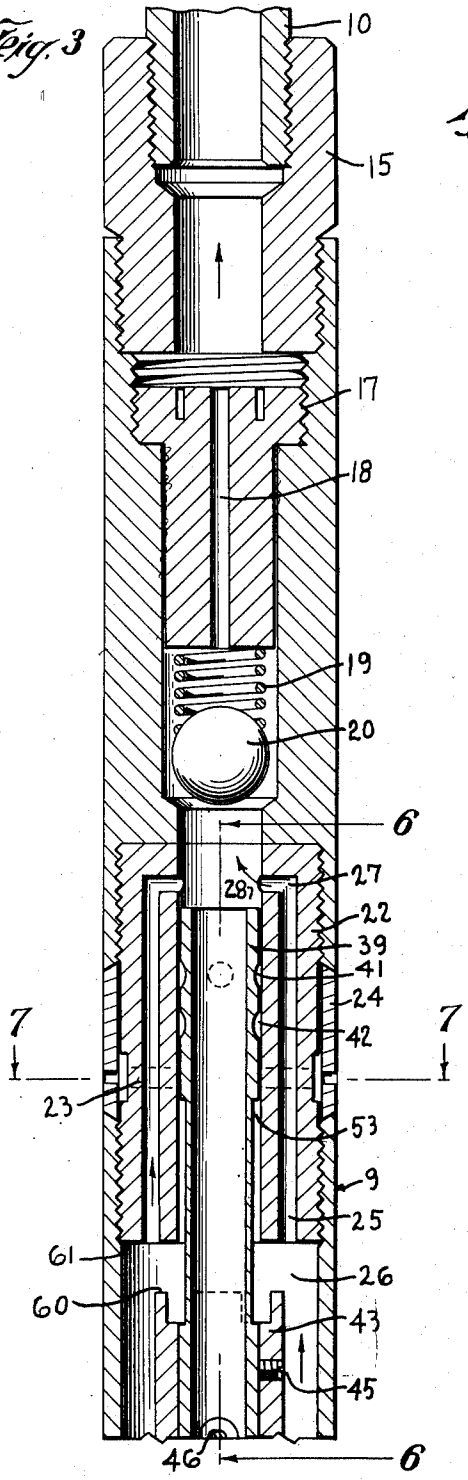

Fig. 4

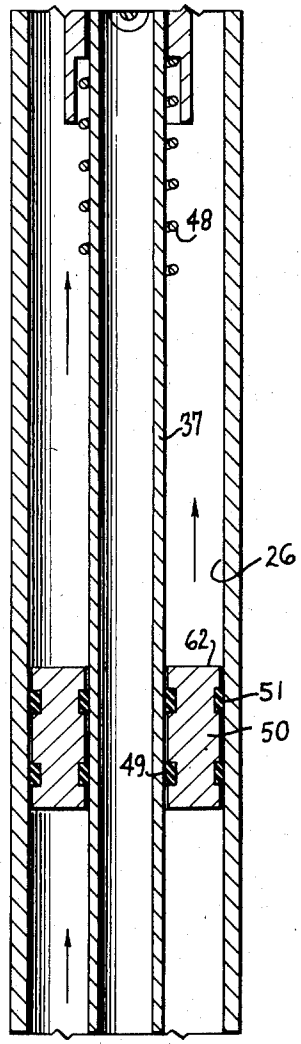

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Fig. 5

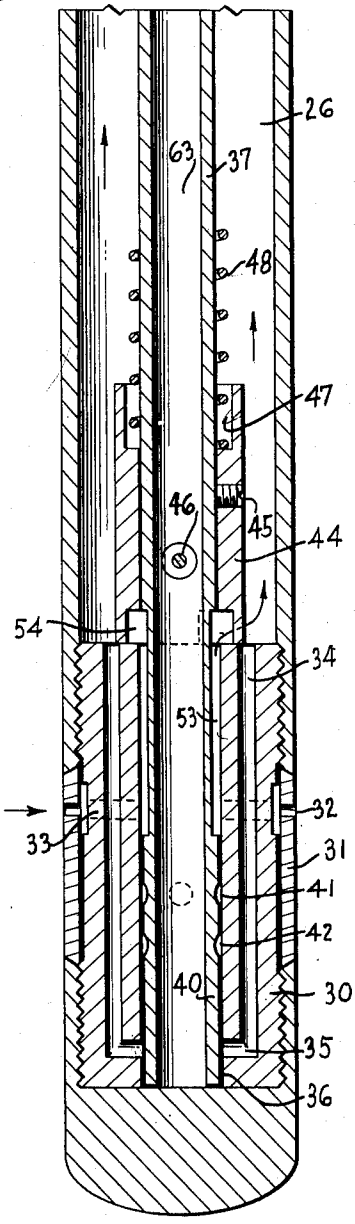


Fig. 6

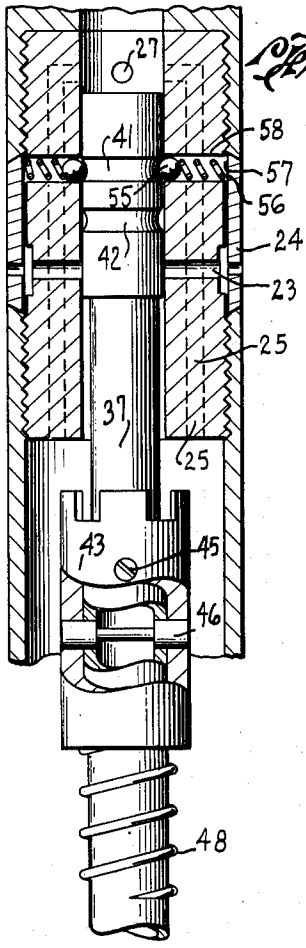
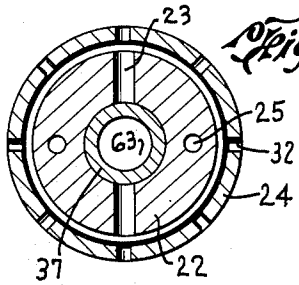


Fig. 7



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2,630,071

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DOUBLE-ACTING PRESSURE FLUID LIFT PUMP FOR OIL WELLS

Louis Davis, Corpus Christi, Tex., assignor of twenty-seven and one-half per cent to George W. Harris, Bay City, Tex.

Application October 18, 1950, Serial No. 190,823

4 Claims. (Cl. 103—46)

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This invention relates to a well pump which is adapted to be lowered into the tubing string of a cased well pump; the lowering means being a conventional wire line. Such invention is an improvement over my refiled application Serial No. 177,467, filed August 3, 1950, but differs therefrom in that the well pump is double acting.

It is an object of this invention to provide a well pump which is adapted to be lowered into the tubing string of a cased well bore by a wire line; such pump being assembled with a packer and slips so that the packer may be set above the pump when in lower position and so that the slips may be set to retain the pump in such position. In such assembly the annulus between pumping assembly and tubing string is sealed off when the packer is set with the result that the fluid pressure below the packer operates to move fluid upwardly into the tubing string and into communication with the pump which transfers it upwardly through the tubing string thereabove.

It is an object of this invention to provide a pump of this class which acts to transfer fluid both on the down stroke and up stroke of the piston.

It is a further object of this invention to provide a pump of this class which has a floating piston operable on a valve stem between two resilient elements, one of which is compressed near the end of the up stroke and the other near the end of the down stroke to build up axially acting forces upon the valve stem to transfer it between seating positions.

It is yet a further object of this invention to provide a pump of this class which is adapted to maintain a continuous delivery of liquid into the tubing string thereabove, thereby avoiding slippage of the fluid, as happens in conventional production methods whereby gas pressure is employed to transfer a liquid.

It is yet another object of this invention to provide a pump of this class which operates at the inherent pressure of the reservoir of fluid therebelow and therearound and which does not require the pressurizing of the casing annulus by admitting gas thereinto from the top of the well.

It is still a further object of this invention to provide a pump of this class which is adapted to be lowered into a tubing string, as by a wire line, thereby obviating the conventional method which requires the lowering of a complete tubing string and pump assembly to producing level.

Other and further objects will be apparent

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when the specification is considered in connection with the drawings in which:

Fig. 1 is an elevation of the assembled pumping unit in position at the bottom of the tubing string in a cased well, and in which position the slips have not been set.

Fig. 2 is a sectional elevation through the pumping unit shown in Fig. 1 and in this elevation the slips are shown set in the tubing string and the packer expanded to seal off the space therebelow.

Fig. 3 is an enlarged sectional elevation of the upper portion of the pump shown working on the up stroke.

Fig. 4 is an enlarged sectional elevation of the central portion of the pump shown working on the up stroke.

Fig. 5 is an enlarged sectional elevation of the lower portion of the pump shown working on the up stroke.

Fig. 6 is an enlarged sectional elevation of the upper portion of the pump showing details of the valve stem locking means, valve head, and bumper construction, such elevation being taken along lines 6—6 of Fig. 3.

Fig. 7 is a sectional plan view taken along line 7—7 of Fig. 3.

It is well known that in wells, as oil wells, a producing formation may produce fluid under excessive subsurface pressures. If the pressure of this fluid can be converted into the force to lift it from the well, and if this conversion can be accomplished through the medium of a pump lowered into, anchored in and sealing off around the tubing string to isolate the space therebelow adjacent such formation, then the necessity of employing a force actuated from the top of the well, as the injection of gas, may be obviated.

Consequently, this invention sets out to accomplish this purpose, and a preferred type of pump therefor, as disclosed in the drawing, will be hereinbelow described.

In Fig. 1 a pumping unit assembly 1 is shown when it has been lowered to approximately the bottom of a tubing or pumping string 2 in a cased well bore 3. Such a well bore has been perforated as at 4 to permit communication between a producing formation 5 and the interior 6 of the well bore. The tubing string 2 is closed by a perforated end member 7 through which perforations 8 the fluid may pass into communication with the pumping unit 1.

The pumping unit comprises the pump housing 9, the locking mandrel 10 connected into the top thereof, the packer elements 11 on the mandrel

10, the mandrel head 12, the slips 13, and the spear head 14, which is connected to the top of the slips. The packer and slips may be of conventional construction and any type of slip may be employed which can be set when the assembly is in desired position and which can be released when it is desired to withdraw the assembly. Also any type of packer may be employed which can be set when the assembly is at a desired elevation in the tubing string and which can be released by movement of the pumping unit in the tubing string.

The pump housing has a top cap 15 into which the mandrel 10 is threaded. Below the cap, in the pump 16, is positioned, as by threading, the seating element 17 which has the passage 18 therethrough and which has provided at its base the seat for a spring 19 which forces the ball 20 against the valve seat 21. Below the valve seat 21 is located the upper valve head 22 which has the lateral ports 23 therein to communicate with the port ring 24 which is incorporated as part of the housing 9. The valve head 22 also has axially extending ports 25 therein which communicate with the housing bore or interior 26 at the lower end of the valve head and which open at 27 into the bore 28 of the valve head near the upper end thereof.

The lower portion of the pump is of similar construction and has the bottom cap 29 connected to the lower valve head 30 which valve head has therearound the port ring 31 of the housing 9. The housing ports 32 in the port ring 31 communicate with the lateral ports 33 and the lower valve head 30. The axially extending ports 34 in the valve head 30 communicate at their upper ends with the housing interior 26 and at their lower ends they open at 35, into the bore 36 of the valve head near the lower end thereof.

The valve stem 37 extends from valve head bore 36 into valve head bore 28 and has the ends 39 and 40 which have thereon the vertically spaced apart locking rings 41 and 42. Between the ends 39 and 40, and within the housing bore 26, the valve stem 37 has fixed thereon the bumpers 43 and 44. Conventional means, as the set screw 45 and the pin 46, may be employed for such connection. The inner bumper ends are recessed at 47 to receive the springs 48. A piston 50, which has sealing rings 51 on its outer periphery to seal against the valve stem 37, is slidable upon the valve stem.

In operation, the valve stem 37, seated as shown in Figs. 3–5, permits communication of fluid, as oil, through the housing ports 32 and lateral ports 33 to the annular space 53 around the valve stem above the valve head 40. The liquid then passes upwardly and outwardly through the slots 54 in the bumper 44 and fills the housing bore 26 and exerts a pressure on the lower surface of the piston 50 to force the piston upwardly.

The piston moves upwardly until it contacts the spring 48 and begins compressing the string. During this time the axial ports 34 are blocked off from communication with the bore of the valve head 30. The groove 41 has the ball 55 seated therein, such ball being held thereagainst by the spring 56 which is confined in the bore 53 and between the port ring inner wall 57 and the outer ball surface.

As shown in Fig. 6 a similar arrangement locks the valve stem end 39 by employment of the groove 41. In this position the valve end 39 blocks off communication between the lateral ports 23 and the bore of the valve head 22. On the other hand, the axial ports 25 permit communication between the housing bore 26 and the bore 28 thereabove.

The oil continues to fill the space below the piston and increases the pressure on the spring 48 until this pressure is sufficient to unseat the valve stem by forcing outwardly the balls 55 from the upper grooves 41. The upper bumper end 60 is brought into contact with the lower surface 61 of the valve head 22 to stop further upward motion of the valve stem. The space between the bumper end 60 and surface 61 is equal to the distance between the grooves 41 and 42 and at the point of contact of bumper end with the valve head the lower grooves 42 are contacted by the balls 55 to hold the valve stem in upper locked position. This change of position places the lateral ports 23 in communication with the annular space 53 around the valve stem and within the valve head 22. The upper portion of the valve stem end 39, in such raised position, blocks off the axial ports 25.

At the same time the lateral ports 33 are closed, communication is opened between the axially extending ports 34 and the bottom of the bore 36. This position of the valve stem is shown in Fig. 2. Fluid, as oil, now flows downwardly through the annular space 53 within the valve head 22 and enters the housing bore 26 to exert pressure on the upper surface 62 of the piston 50. The oil below the piston is thus forced downwardly as the piston descends and passes through the ports 34 into the bore 36 and upwardly through the valve bore 63 to lift the check ball 20 against the pressure of the spring 19 to permit the fluid to flow up the bore 18 and through the mandrel 10 and on upwardly through the tubing string 2 to the top of the well. The piston continues moving downwardly until it contacts the lower spring 48 and compresses it to finally unseat the valve stem 37 and move it to the position originally described and shown in Figs. 3–5.

In a pump of this class it should be noticed that there is a continuous delivery of fluid upwardly into the tubing string so that the head of fluid is continuously increased until the whole tubing string is filled and delivery is being made at the top of the well. This is an efficient and novel method of oil delivery and compares more than favorably with the conventional method that requires a gas to be injected down the annular space around the tubing to intermittently force quantities of oil upwardly. This conventional method results in an admixture of gas and oil in the tubing string and there is a loss of efficiency due to downward slippage of the oil. The elimination of the requirement that gas be injected from the top of the well is also a considerable saving.

It is broadly pointed out that in this invention the pressures inherently occurring in the sealed off portions of the well below the packer are sufficient to operate the pump. In this regard it is pointed out that, of course, the annulus space between tubing string and casing must be closed at the top of the well.

The facility with which this type of pumping assembly can be positioned and removed is also a decided asset in operation. It is only necessary to attach a conventional wire line to the spear-head 14 to lower the assembly into position and to remove it from the well.

Broadly, this invention considers a double act-

ing pump adapted to be lowered into the tubing string of a well; the packing element assembly with the pump being adapted to seal off the annulus between the assembly and the tubing string, and the slips of the assembly being adapted to anchor the assembly in pumping position. Also it is broadly pointed out that this invention considers a pump of this class adapted to operate by fluid pressures inherent in the sealed off portion of the well.

What is claimed is:

1. A double acting pump comprising, a housing having upper and lower port means therein, a bored valve head in either end of said housing adjacent said housing port means, port means in each valve head for placing the adjacent housing port means and the bore of the valve head in communication, other port means in each valve head between the inner end thereof and the valve head bore outwardly of said first valve head port means, a hollow valve stem having ends operable in said valve head bores and having in succession inwardly from each end a bumper and a resilient member to seat thereon, a piston slidable on said stem between said resilient means, locking means on said valve heads and said stem ends adapted to retractably lock said stem to said valve heads in spaced apart positions, said upper valve stem end being adapted in lower locked position to close said upper valve head first port means while said lower valve stem end is adapted to close said lower valve head other port means, said upper valve stem being adapted in upper locked position to close said upper valve head other port means while said lower valve stem end is adapted to close said lower valve head first port means and to place said valve stem interior in communication with said lower valve head other port means.

2. In a pumping assembly adapted to be lowered by a wire line into the lower end of a tubing string in communication with fluid in the surrounding well bore, the combination of, a pump, packing means and slip means connected thereabove, when in desired position said packing means being adapted to seal the annulus between said assembly and said tubing string and said slips being extendable to grasp the wall of said tubing string to anchor said assembly, said pump including a housing having upper and lower port means therethrough and upper and lower valve means including a hollow valve stem operable therein and a piston slidable on said valve stem between said valve means, said valve means being adapted alternately to admit fluid through said lower port means and below said piston to force fluid above said piston through said upper valve means and to admit fluid through said upper port means to force said piston downwardly and to force fluid below said piston upwardly through said valve stem interior.

3. A double acting pump comprising, a housing having upper and lower port means therethrough and upper and lower valve means therein including a hollow valve stem operable in said valve means, a piston slidable on said valve stem, said valve means being adapted to operate alternately to admit fluid through said lower port means and below said piston to force said piston upwardly and fluid thereabove through said upper valve means, and to admit fluid through said upper port means above said piston to force said piston downwardly and fluid below said piston up through said valve stem interior.

4. A double acting, reciprocating pump for a well having a tubing therein and a pressure fluid in communication with the lower end of the tubing, said pump comprising, a housing having a tubular stem upstanding therein and reciprocably movable between two pre-determined positions, means to seal between said barrel and said tubing, a piston operable to slidably seal between said housing and said stem, a check valve in said housing above said piston, means in said housing to yieldably urge said piston axially of said stem, and valve means around said stem, said stem and said valve means being adapted to admit said pressure fluid into said housing to force said stem reciprocably between said positions and to urge said piston reciprocably upwardly and downwardly against said yieldably urging means, and to discharge fluid into said housing from said conduit and said valve means, and above said piston and said valve means.

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