Aug. 26, 1941. A. M. GURLEY 2,253,780

HYDRAULIC PUMPING UNIT FOR DEEP WELLS

Filed Oct. 30, 1939 2 Sheets-Sheet 1

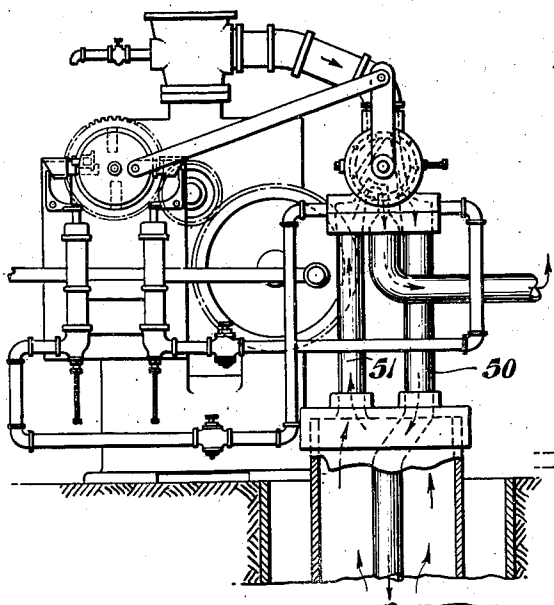
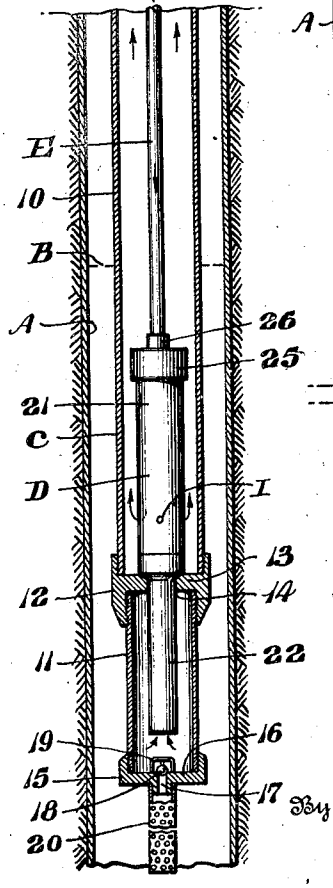
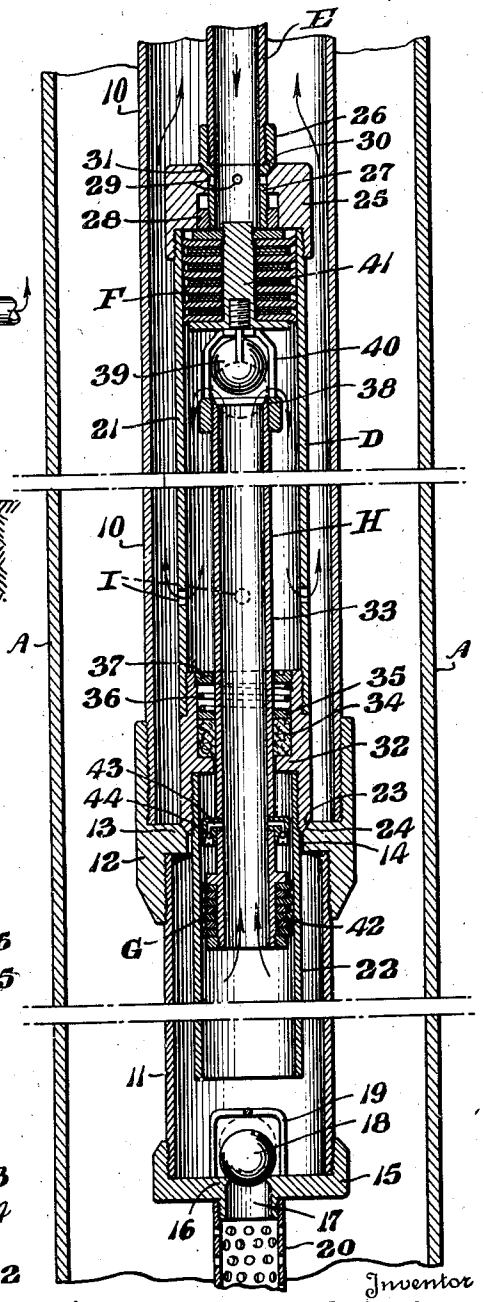


Fig. 1.





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Fig. 2. A.M.Gurley,

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HYDRAULIC PUMPING UNIT FOR DEEP WELLS

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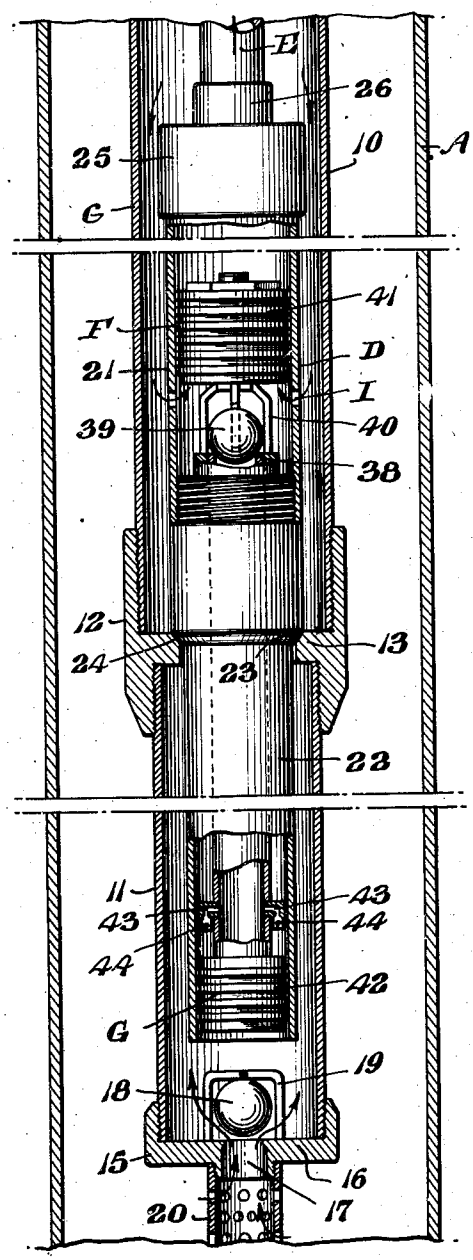


Fig. 3.

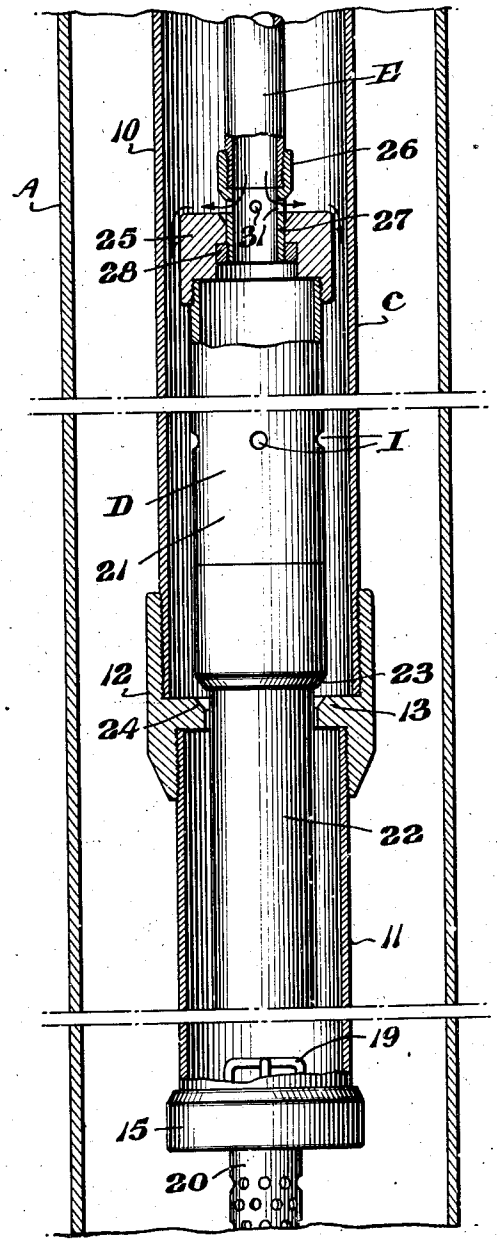


Fig. 4.

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UNITED STATES PATENT OFFICE

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HYDRAULIC PUMPING UNIT FOR DEEP WELLS

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Application October 30, 1939, Serial No. 302,035

12 Claims. (Cl. 103—46)

The invention relates to pumps for oil or water wells, particularly of the drilled well type, the pump being of the type wherein the usual pump rod is eliminated and fluid pressure is employed for operating a floating piston located within a working barrel at the bottom of the well.

The invention is illustrated by reference to a pumping unit of the single acting type, although in its broadest aspects the invention is not limited to this particular type of apparatus.

One of the objects of the invention is to provide a form of apparatus which may be adapted for wells of different depths, while using a standard surface pumping apparatus for supplying the necessary fluid pressure. This is accomplished according to the present invention by properly regulating the respective areas of the power piston, of the hollow piston rod therefor and of the recovery piston. It is also possible to have the power piston of a standard size and vary the areas of the tubular piston rod, and of the recovery piston, according to the requirements of a particular installation.

Another object of the present invention is to provide means whereby the entire working assembly may be drawn to the surface for reconditioning or replacement simply by drawing up a single line of pipe.

A further object is to provide means whereby the fluid will be automatically drained from the tubing and working assembly when the same is being withdrawn, so as to reduce the weight, and will be restored when the assembly is lowered, so that the apparatus is ready for immediate use.

Other features and objects of the invention will become apparent from the following detailed description and drawings which are intended as illustrative only:

In the drawings:

Fig. 1 is a view partly in section and partly in elevation, showing the complete pump unit, portions being broken away and the surface pumping apparatus being shown in larger scale than the lower portion of the apparatus.

Fig. 2 is a detail vertical sectional view showing the parts in a position with the power piston about to begin its downward stroke.

Fig. 3 is a view partly in section and partly in elevation showing the power piston at the beginning of the up-stroke.

Fig. 4 is a view illustrating the manner in which the fluid from the inside pipe line flows into the casing as the string of tubing and work assembly are being withdrawn from the well.

Referring to the drawings, the reference character A denotes the outer wall of a water, oil, or other well containing fluid to a level B, and C denotes generally a casing which is lowered into the well and after being placed remains relatively fixed. D denotes a working barrel supported within the casing and adapted to be removed if necessary for the repair of the working parts, the working barrel being attached at the lower end of a pipe E. F denotes a power piston adapted to be reciprocated within the working barrel on the application of fluid pressure, and G denotes a pump piston secured at the opposite end of the hollow piston rod H of the power piston F. A plurality of openings located intermediate the ends of the working barrel are designated at I. Briefly stated, working fluid is supplied initially through pipe E above the power piston F, forcing the same downwardly and forcing the fluid trapped in the lower part of the working barrel upwardly, thence outwardly through the openings in the working barrel and then upwardly through the casing C toward the surface. At the end of a piston stroke the supply of power fluid is automatically reversed by any suitable means, such as that described in the companion application of A. M. and J. M. Gurley Serial No. 200,763, filed April 7, 1938, now Patent No. 2,183,560 dated December 19, 1939, whereupon pressure fluid is supplied from above through casing C and thence through the openings I into the working barrel D beneath the piston F forcing the same upwardly together with the pump piston G and at the same time drawing more oil or the like into the lower portion of the casing from the well itself. This operation will be more clearly apparent from the more detailed description which follows:

As shown, the casing C comprises an upper portion 10 extending from the top of the well nearly to the bottom thereof. This portion may be composed of any desired number of sections and at the lower portion thereof there is provided an extension 11 secured thereto by a coupling 12 having a septum 13 provided with a central opening 14 which forms a seat adapted to cooperate with a shoulder formed on the working barrel. At the lower portion of the extension there is provided a second coupling member 15 having a septum 16 provided with an opening 17 for admission of gain fluid, adapted to be closed by means of a ball valve 18 having a cage 19. A suitable strainer element 20 is provided below the coupling 15 and in communication with the opening 17.

The casing C is adapted to be lowered into the well and constitutes a relatively stationary part of the equipment normally remaining within the well. The casing being in place, the working barrel D is adapted to be lowered by means of the tubing E and may be withdrawn as a unit from the casing.

As shown, the working barrel D comprises an enlarged upper portion 21 and a reduced lower portion 22 with a shoulder 23 at the juncture between the portions 21 and 22, said shoulder being adapted to engage a corresponding seat 24 formed in the septum 13. In this manner, a fluid-tight connection or drop seat valve is provided separating the interior of the upper portion of the casing 10 from the interior of the extension 11. It will be obvious that the weight of the working barrel and the tubing insures the tightness of the valve joint.

According to my invention, a releasable valve connection is formed between the working barrel D and the tubing E such that when the tubing and the working barrel are in working position the tubing may be filled with fluid and no leakage takes place, but when it is desired to raise the tubing and working barrel to the surface the fluid is automatically drained out of the tube into the outer casing C where it remains until the tubing and working barrel are again lowered into the casing when the fluid again flows into the tubing and working barrel.

As shown, the working barrel D is provided with a collar 25 at the upper end thereof and the tubing E is provided with a coupling 26 at the lower end thereof. These parts are adapted to have limited sliding movement with reference to each other. The coupling 26 is shown as provided with a reduced portion 27 which slidably fits within the collar 25, a lock nut 28 being provided at the lower end thereof to limit the sliding movement. Openings 29 are formed in the reduced portion 27 of the coupling and just above these openings a shoulder 30 is formed which is adapted to fit against a shoulder 31 on the collar 25. When the parts are in working position the shoulders 30, 31 are in engagement and insure a fluid-tight fit owing to the weight of the tubing. When, however, the tubing is lifted the openings 29 are then exposed and any fluid within the tube E drains into the casing C. The releasable valve connection is most clearly shown in Figs. 2 and 4.

The interior of the upper portion 21 of the working barrel D is separated from the lower portion by a septum 32 having an opening through which passes the hollow piston rod 33, the piston rod being adapted to slide through said opening. Suitable packing 34 is provided just above the septum and a cup or packing ring 35 is placed above the packing with a spring 36 pressing downwardly upon the packing ring. A suitable packing nut 37 is adapted to be screwed down upon the spring so as to give the same the requisite degree of tension. The packing is designed to produce a leak-proof joint between the upper and lower sections 21 and 22 respectively of the working barrel.

At the upper end of the hollow piston rod there is provided a valve seat 38 with which a suitable ball valve 39 is adapted to engage when forced into position by fluid pressure. The valve is provided with a cage 40 and to the upper end of the cage is secured the power piston 41 (F) which is provided with suitable packing cups or rings.

At the lower end of the piston rod is located the pump piston 42 (G), the purpose of which is to operate upon the fluid pumped from the well, said piston comprising a plurality of packing rings surrounding the lower end of the hollow piston rod H, fluid being adapted to pass up through the center of the rod as the piston is lowered.

To prevent fluid lock, openings 43 are provided in the piston rod just above the piston 42, said openings being provided with relief valves 44 of any suitable construction which open on the up-stroke only of the piston rod, but close automatically at the beginning of the down stroke.

It will be obvious that by regulating the relative diameters of the pistons F and G (41 and 42) and of the hollow piston rod 33 (H), it will be possible to regulate the pressures necessary to operate against the static head, which in turn is dependent on the depth of the well. This allows great flexibility in operation and permits a given surface pumping apparatus to furnish fluid pressure sufficient for a well of any depth. It is also possible to provide a working piston F of standard size and merely to vary the size of the piston G and the internal diameter of the extension 22 in which the same works. This is obviously a great advantage from the practical standpoint since it standardizes the equipment.

The surface pumping apparatus shown at the top of Fig. 1 may be of any desired type and need not be described in detail, but as shown is of the general type described and claimed in the copending application of A. M. and J. M. Gurley Serial No. 200,763 filed April 7, 1938 now Patent No. 2,183,560. This mechanism is designed to automatically supply pressure fluid through pipes 50 and 51 leading to the pipe E and the casing C respectively, the direction of flow being automatically reversed at the end of each piston stroke, when a predetermined degree of pressure has been built up, whereupon pressure fluid is supplied through the pipe 51 instead of through the pipe 50. This operation continues as long as pressure fluid is supplied to the system.

The general operation of the apparatus will be apparent from the foregoing description but will be briefly described for the purpose of clarity.

Assuming the parts in the positions shown in Figs. 1 and 2, pressure fluid is passed down through the tube E forcing the piston F downwardly carrying with it the pump piston G, closing valve 18 and opening valve 39, and forcing any fluid within the extension of the working barrel upwardly through the hollow piston rod into the upper portion of the working barrel and thence through the apertures I therein into the casing C surrounding the working barrel, raising the level therein and forcing the surplus to a storage tank or the like not shown. When the piston reaches the limit of its stroke, back pressure is built up on the line E and automatic reversal of flow takes place as described in my Patent No. 2,183,560, whereupon downward pressure is supplied through casing C and openings I in the working barrel, thence beneath the piston F raising the same together with the gain piston G and drawing fluid into the lower portion of the working barrel past the valve 18. The operation of the present device differs from that described in my Patent No. 2,183,560, in that gain fluid is drawn off only during the down stroke of the piston F whereas according to my Patent

No. 2,183,560 the fluid may be drawn off during both strokes.

The apparatus is so designed that by pulling the single inside pipe E the entire working assembly may be drawn to the surface for reconditioning or replacement without the necessity of pulling two lines as is required in other systems of this general type.

The apparatus is also so designed that when the working parts are withdrawn as above described, any fluid contained in the pipe E will flow out through the openings 29 and any fluid within the working barrel above the openings I will flow into the casing thus materially reducing the weight to be lifted. Moreover, when the inside pipe and working barrel are replaced, the fluid displaced thereby returns to the working barrel and inside pipe line leaving both strings of pipes and tubing full of fluid ready for delivery of power to the piston F. This feature makes operation of the pump economical and also increases the efficiency of servicing and installation.

Other advantages of the improved system will be apparent to those skilled in the art and are considered as within the scope of the present invention. It will also be obvious that numerous modifications and variations in detail may be resorted to without departing from the spirit of the invention.

I claim:

1. A deep well pump for oil wells and the like, including a casing extending into the well, having a seat near the bottom thereof, a working barrel detachably mounted within the casing and resting upon the seat and having an extension projecting below the seat, said working barrel being provided with a fluid operated pumping member and having inlet and outlet means, an unobstructed string of tubing connected to said working barrel and communicating at all times with said pumping chamber and providing means for withdrawing the working barrel from the casing, and means whereby on the application of a lifting force to the tubing in the withdrawal of said tubing and working barrel from the well any fluid in said tubing is allowed to pass into the casing, thus reducing the lifting force required.

2. A deep well pump as set forth in claim 1, wherein a fluid-tight connection is provided between the working barrel and said seat, constituting a drop seat valve.

3. A deep well pump as set forth in claim 1, wherein said last named means comprises a releasable valve connection between the working barrel and said tubing.

4. A deep well pump as set forth in claim 1, wherein said tubing and said working barrel have a limited sliding movement relative to each other, and the application of a lifting force to the tubing exposes openings permitting fluid to drain from the tubing into the casing.

5. A deep well pump for oil wells and the like including a casing extending into the well, a working barrel detachably mounted within the casing, a fluid operated reciprocating pump plunger within the working barrel, an unobstructed string of hollow tubing connected to said working barrel normally containing operating fluid for actuating said pump plunger in one direction, and in open communication therewith at all times, said tubing providing means for withdrawing the working barrel from the casing, and means whereby on the application of a lifting force to the tubing in the withdrawal of said tubing and working barrel from the well any fluid in said tubing is allowed to pass into said casing.

6. A deep well pump comprising a casing extending into the well, a working barrel detachably mounted within the casing having a fluid operated reciprocable pumping unit therein comprising a string of hollow tubing connected to said working barrel and in open communication with said pumping unit at all times, said pumping unit comprising a solid pumping piston working in the upper portion of the working barrel, a hollow pump piston working in the lower portion of the working barrel, and a hollow piston rod connecting the two, packing means for said piston rod intermediate the two pistons, a fluid inlet from the well communicating with said pumping piston below the same, a valved outlet from said hollow piston rod intermediate the two pistons, said working barrel having openings between said solid piston and said packing to permit passage of working fluid to said pumping unit in one direction and to permit withdrawal of pumped fluid when the unit is operating in the other direction, and means whereby on the application of a lifting force to the tubing any liquid in said tubing is allowed to pass into said casing, thus reducing the lifting force required.

7. A deep well pump for oil wells and the like, including a casing extending into the well and having a seat near the bottom thereof, a working barrel detachably supported within said casing upon said seat, tubing attached to said working barrel, a power piston operating within said working barrel, and a pump piston actuated thereby for drawing fluid from the well, valve controlled means for discharging fluid drawn from the well from the pumping means into the working barrel, said working barrel having openings intermediate its ends adapted to permit passage of fluid to or from said working barrel into said casing, and means for alternately supplying pressure fluid to one side or the other of said power piston, from the tubing or from the casing respectively, said tubing providing means for withdrawing the working barrel from the casing.

8. A deep well pump as set forth in claim 7, wherein the pump piston is hollow and is connected to the power piston by means of a hollow piston rod.

9. A deep well pump as set forth in claim 7, wherein the pump piston is hollow and is connected to the power piston by a hollow piston rod, and packing means within said working barrel intermediate the pistons.

10. A deep well pump as set forth in claim 7, wherein the pump piston is hollow and is connected to the power piston by a hollow piston rod, and packing means within said working barrel intermediate the pistons, and relief valve means to prevent fluid lock in the reciprocation of the pump piston.

11. A deep well pump for oil wells and the like comprising a casing extending from the ground level into the fluid within the well, a working barrel detachably supported within said casing near the bottom thereof, a string of tubing connected with said working barrel and providing means for withdrawing the working barrel from the casing, a reciprocable plunger within said working barrel comprising a solid power piston at one end, a hollow pump piston at the other

and a hollow rod connecting the two, packing means for said piston rod intermediate the two pistons, said working barrel having openings between said solid piston and said packing means adapted to permit passage of fluid to or from said working barrel into said casing, means including said tubing and casing for alternately supplying pressure fluid to one side or the other of said solid piston for operating the same, inwardly opening valve means at the bottom of said casing for admitting fluid from the well on the upstroke of the plunger, and a valved opening from said hollow piston rod into said working barrel to permit fluid to pass on the down stroke of the plunger.

12. A deep well pump for oil wells and the like, comprising a casing extending from the ground level into the fluid within the well, a working barrel detachably supported within said casing near the bottom thereof, a string of hollow tubing connected with said working barrel for supplying working fluid and providing means for withdrawing the working barrel from the casing, a fluid operated reciprocable pump plunger within said working barrel comprising a solid power piston at the upper end, a hollow pump piston at the other, and a hollow piston rod connecting the two, said solid piston being in open communication with said string of tubing, packing means for said piston rod intermediate the two pistons, said working barrel having openings between said solid piston and said packing providing means for alternately supplying pressure beneath the power piston and for withdrawing pumped fluid, valve means below the plunger for admitting fluid from the well on the upstroke, and a valve controlled opening from the hollow piston rod into said working barrel to permit fluid drawn from the well to pass thereinto on the down stroke of the plunger.

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