Dec. 27, 1938. C. R. McDANIEL 2,141,957

DEEP WELL PUMP

Filed April 17, 1937 3 Sheets-Sheet 1

FIG. 1.

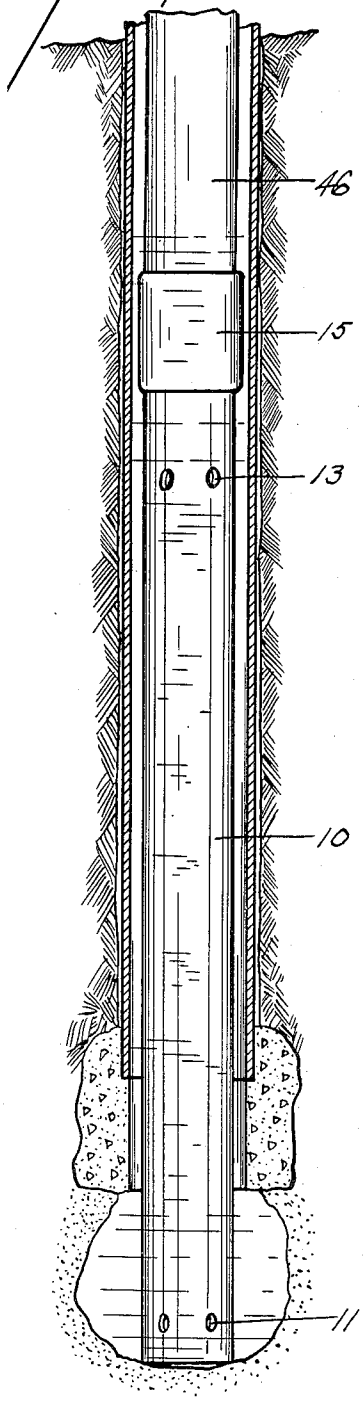


FIG. 2.

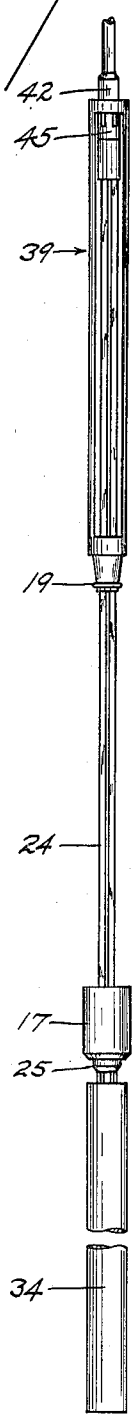
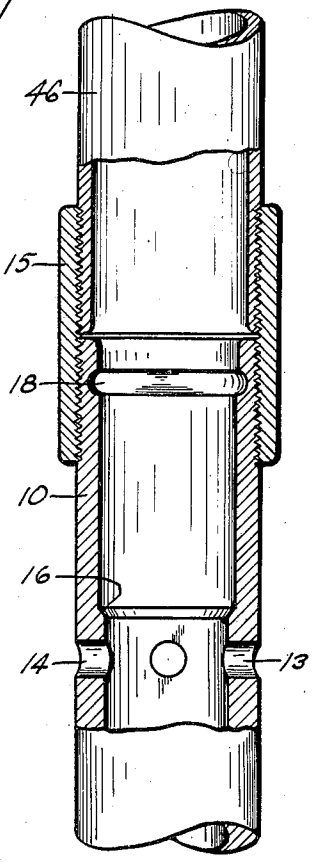


FIG. 8.



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Filed April 17, 1937 3 Sheets-Sheet 2

FIG. 3

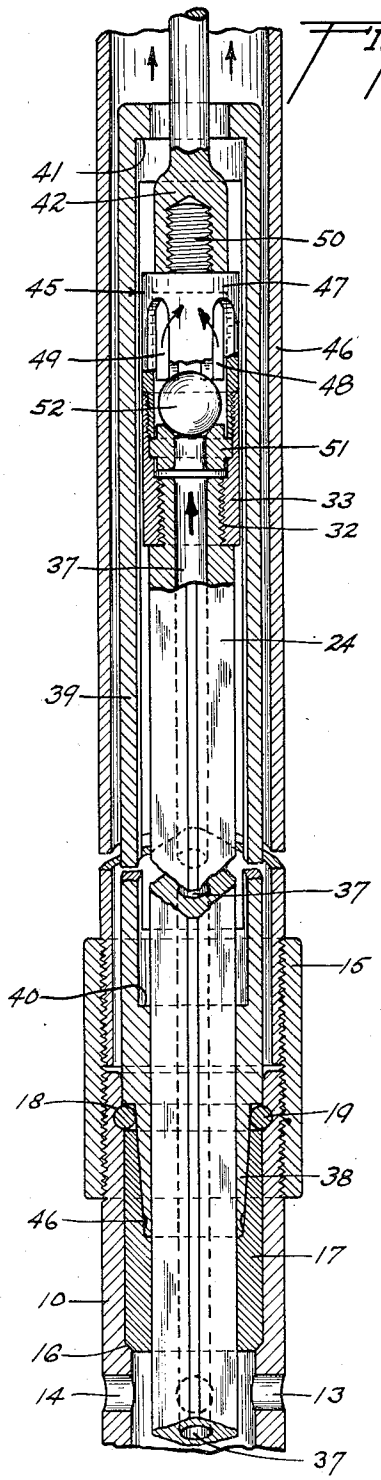


FIG. 4

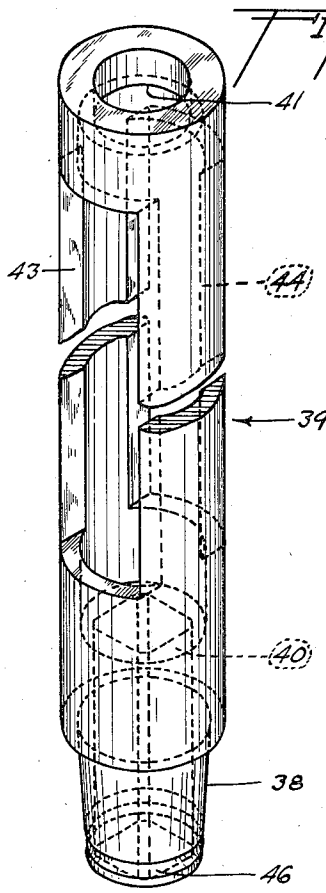
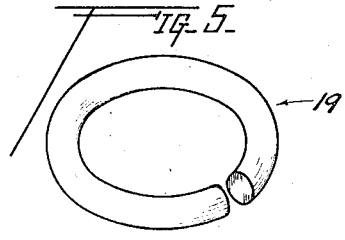


FIG. 5



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Filed April 17, 1937 3 Sheets-Sheet 3

FIG. 6

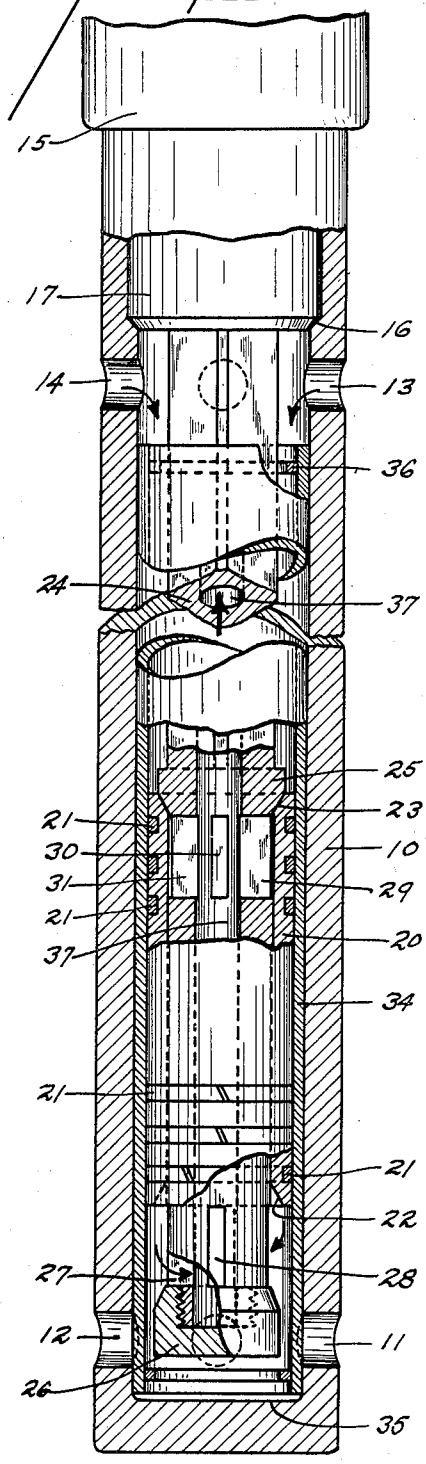
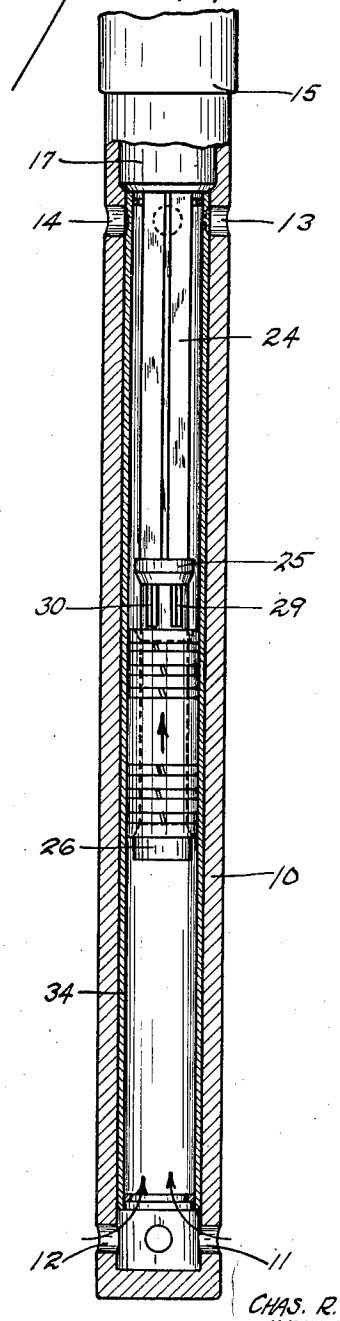


FIG. 7



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UNITED STATES PATENT OFFICE

2,141,957

DEEP WELL PUMP

Charles R. McDaniel, Oklahoma City, Okla.

Application April 17, 1937, Serial No. 137,444

6 Claims. (Cl. 103—192)

The invention relates to pumping apparatus for deep wells wherein the pump is located within the well, and the power unit is at the earth's surface, and it is particularly adapted for pumping oil.

An extremely expensive feature in pumping oil wells, where sand is mixed with the fluid, is the replacing of worn cups and valves, and the consequent loss of production incident to the pulling of rods to replace these worn parts. It is known that the greatest damage is done after the "sandy fluid" passes to the upper or high pressure side of the traveling valve, where it is in direct contact with the plunger, and where, when the well is shut down, the sand may settle on top and around the valve and plunger, causing them to "stick" when an effort is made to resume pumping.

One important object of the present invention, therefore, is to eliminate the above difficulty by providing a pump which discharges the sandy fluid into the production tubing above the plunger, where it cannot possibly again reach the plunger and cause wear on the plunger parts.

Another important defect in present pumping equipment is the inability of present pumps to deliver on both the upstroke and the downstroke of the plunger because of the weight of the fluid in the production tubing above the plunger, and due to the fact that this fluid is in direct contact with the plunger, which makes possible only the transfer of fluid from below the plunger into the tubing above the plunger on the downstroke. The only delivery stroke is the upstroke.

It is another important object of my invention, therefore, to eliminate this difficulty, and I do so by providing a pump which prevents the fluid in the production tubing above the plunger from coming into contact with the plunger on its downstroke, thereby allowing the plunger to force the fluid below it in the barrel into the production tubing above it and not simply into the pump barrel on the other side of the plunger, thus actually delivering oil on the downstroke as well as on the upstroke. This feature alone increases the efficiency of the entire pumping operation by approximately 40%.

Other objects of the invention are to provide a simple compact pumping unit with few working parts; which does not make use of the usual ball check standing valves and traveling valves, and thus eliminates the necessity of constantly replacing such valves due to wear; which because of the substantial elimination of sand wear in the working barrel utilizes metal plunger rings instead of the usual cup leathers; which is so constructed as to eliminate the settling of foreign matter on and around the plunger when the pump is shut down, thus eliminating the "sticking" of the plunger when the pumping operation is resumed; which is so constructed that all its working parts may be inserted or removed from the well as a complete unit; and which will deliver a greater quantity of fluid in proportion to the cross sectional area of the well tubing than pumps of present design.

Other objects of the invention will be fully understood from a consideration of the following detailed description when read in connection with the accompanying drawings which from a part of this application. The drawings are to be considered illustrative only.

Referring to the drawings:

Figure 1 is a sectional view of the lower end of a cased well, and shows my pump in operating position connected to the lower end of the production tubing;

Figure 2 is a side perspective view of the various working parts of my pump assembled as a complete unit ready for insertion into the production tubing;

Figure 3 is a sectional view of the upper portion of my pump connected to the production tubing;

Figure 4 is a perspective view of the traveling valve yoke;

Figure 5 is a perspective view of the locking ring;

Figure 6 is a sectional view of the portion of the pump below the portion shown in Fig. 3;

Figure 7 is a sectional view of the pump illustrating the action of the plunger, its valves, and the liner on the upstroke; and,

Figure 8 is a partial sectional view of the pump barrel attached to the lower end of the production tubing and illustrates clearly the seat for the sealing element and the seat for the locking ring which locks the sealing element on its seat.

Like characters of reference designate like parts in all the figures.

Referring more particularly to Fig. 6, my pump includes a barrel 10 which is preferably of the same outside diameter as the diameter of the production tubing, but whose inside diameter is somewhat smaller than the inside diameter of the production tubing. The barrel is preferably closed at its lower end and is provided with a plurality of lower inlet ports 11 and 12 and a plurality of upper inlet ports 13 and 14. The barrel may extend any distance below the lower inlet ports but in case it is extended a greater

distance than as shown in the drawings it must be provided with an interior annular shoulder adjacent the lower ports. Its upper end is adapted for connection to the lower end of the production tubing by means of a suitable coupling 15. Immediately above the upper inlet ports 13 and 14 the bore of the barrel is enlarged forming an annular seat 16 which is adapted to seat a sealing element 17 (Fig. 3), the outside shape of which is substantially cylindrical, and which is of a size to fit tightly within the enlarged upper bore of the barrel. Immediately adjacent its upper end the barrel is provided with an annular groove 18, which is more clearly shown in Fig. 8, which serves as a seat for a lock ring 19 (Fig. 5).

Again referring to Fig. 6, I will now describe the plunger assembly. The plunger is composed of a hollow casing 20 which has a plurality of spaced external grooves near its upper and lower ends which serve as seats for metal plunger rings, all of which are designated by the numeral 21. It is provided with annular valve seats 22 and 23 at its lower and upper ends respectively, and with a cylindrical central bore, within which is adapted to reciprocate the lower end of a hollow plunger operating rod 24 whose lower end is round in cross section to tightly fit within the bore of the casing 20. A short distance above its extreme lower end the rod 24 is provided preferably with an integral valve 25 which is adapted to seat on the seat 23. The lower end of this rod is threaded to receive a lower valve 26 which is adapted to seat on the seat 22 on the upstroke of the piston. A short distance above the valve 26 the lower portion of the rod 24 is provided with a plurality of through ports 27 and 28 which afford communication between the interior bore of the rod and the interior of the barrel. Likewise, immediately adjacent and below the valve 25 the rod is also provided with a plurality of through ports 29, 30 and 31. The distance between the valves 25 and 26 is substantially equal to the length of the casing 20 plus the length of the ports 27 and 28, thus permitting limited relative movement between the hollow plunger rod 24 and the casing 20. Immediately above the valve 25 the rod 24 is substantially square in cross section throughout the remainder of its length, and its upper end is threaded as at 32 (Fig. 3) for connection to the lower half 33 of a traveling valve 45, which will later be described. As previously mentioned this rod is hollow throughout its length but the bore at its extreme lower end is closed by the valve 26. The rod is square throughout most of its length to prevent it from accidentally becoming disconnected from the valve cage, and also to facilitate its connection to the valve cage and to the lower valve 26. The plunger is adapted to reciprocate within a liner 34 which is of a size to fit snugly but slidably within the bore of the barrel 10 below the seat 16. The length of this liner is less than the distance between the upper ports 13 and 14 and the lower end 35 of the barrel. The plunger is of such size that its rings 21 fit tightly within the bore of the liner 34, so that as the plunger begins its upward travel the frictional contact of the rings with the interior wall of the liner causes the liner to slide upwardly within the barrel, causing its upper end to close the upper ports 13 and 14 of the barrel. The upward movement of the liner is limited by the contact of its upper end with the lower end of the sealing element 17. The downward movement of the liner is limited by the contact of its lower end with the end 35 of the barrel, or with the annular shoulder previously mentioned, in case the barrel is extended. Inside its upper end the liner is provided with a ring 36, which is welded or otherwise rigidly secured to the liner, and which serves to contact the upper end of the plunger as the rod 24 and the plunger are withdrawn from the barrel, thus withdrawing the liner at the same time. From the construction thus described it will easily be seen that when the rod 24 moves upward the valve 26 seats on the seat 22 closing the ports 27 and 28 and forcing all liquid above the plunger through the ports 29, 30 and 31 into the bore 37 of the rod 24 and upward through the rod. When the direction of travel of the rod 24 is reversed the valve 25 seats on the seat 23 closing the ports 29, 30 and 31 and opening the ports 27 and 28, and as the plunger moves downward within the liner all liquid below the plunger is likewise forced upward through the bore 37 of the hollow rod 24.

Above the plunger in the barrel is the sealing element 17, which has a substantially square internal bore which fits tightly about the substantially square rod 24 but permits the rod to slide therethrough. While I have not illustrated it, this sealing element may be provided both exteriorly and interiorly with packing to pack against the upper wall of the barrel and against the exterior surface of the rod if desired. This sealing element 17 is provided with a substantially frusto-conical seat which extends longitudinally of the element from its upper end to a point substantially midway between its ends, and serves to seat the similarly shaped lower end 38 of a yoke 39, which is shown in detail in Fig. 4. Above its lower end this yoke is substantially cylindrical, has an internal annular shoulder 40 near its lower end, and an internal annular shoulder 41 near its upper end. The bore in the yoke between these two shoulders is also cylindrical. The distance between the shoulders 40 and 41 is preferably greater than the stroke of the pump. The bore from the shoulder 40 to the extreme lower end of the yoke is substantially square in cross section to permit the rod 24 to slide therethrough. From the shoulder 41 to its extreme upper end the yoke has a circular bore which is sufficiently large to permit the entrance of a sucker rod joint 42 (Fig. 3). Intermediate the two shoulders 40 and 41 the yoke is provided with two oppositely disposed slots 43 and 44 which not only serve as ports to permit the passage of fluid into the production tubing, but also serve to permit the insertion of the traveling valve, designated as a whole by the numeral 45, and which will hereinafter be described. The outside diameter of the yoke 39 is substantially smaller than the inside diameter of the production tubing 46. Near its extreme lower end, and on the portion 38, the yoke is provided with an annular groove 46 which serves to seat the ring 19 in its contracted form. The interior diameter of the lock ring 19 in its contracted form is slightly smaller than the exterior diameter of the extreme lower end of the yoke 39 below the groove 46, so that after the sealing element 17 is seated on its seat 16 and the yoke is lowered into the frusto-conical seat in the upper end of the sealing element 17, its lower frusto-conical end 38 forces the lock ring 19 to expand into the groove 18 as shown in Fig. 3, the annular shoulder immediately above the frusto-conical end 38 of the yoke fitting tightly within the upper bore of the barrel 10 and seating on top of the lock ring 19.

thus holding the ring tightly in position. This arrangement affords a positive lock for the sealing element 17, which lock may be easily unlocked simply by raising the yoke 39 which permits the ring 19 to contract and as the end 38 of the yoke passes upward the ring seats on the annular seat 46, which prevents the ring from dropping off the end of the yoke, and holds it in position for the next locking of the sealing element 17.

The traveling valve 45 comprises a lower half 33 which is adapted to be connected to the upper end of the hollow rod 24 as previously described, and an upper half 47 which is provided with a plurality of slots 48 and 49 to form a valve cage, and which is provided with a screw-threaded shank 50 to which the sucker rod joint 42 is connected. The lower half 33 of the valve is provided with an internal annular shoulder which serves as a seat for a removable valve seat 51, which seat is impinged between the shoulder just mentioned and the lower end of the upper half 47. The usual ball valve 52 is caged within the upper half 47 and controls the passage of fluid through the bore 37 of the rod 24.

As shown in Fig. 2 the liner 34, the plunger, the sealing element 17, the rod 24, the yoke 39, and the traveling valve 45 may all be assembled as a unit and connected to the sucker rod joint 42 for insertion into the barrel 10. The diameter of the traveling valve 45 is such that it cannot pass the upper shoulder 41 of the yoke, and the ring 36 in the upper end of the liner prevents the plunger from passing out of the liner, as previously described. In assembling the device, the casing 20 is slipped over the lower cylindrical end of the rod 24 and the valve 26 is then screwed tightly into position. The liner 34 is then slipped over the upper end of the rod 24 and down over the plunger, and its ring 36 is permitted to come into contact with the upper end of the casing 20. The sealing element 17 is then slipped over the upper end of the rod 24, the lock ring 19 is placed in position in the groove 46 of the yoke, and the yoke is then also passed over the upper end of the rod 24, and the traveling valve 45 is then inserted through one of the slots in the yoke and screwed on to the upper end of the rod. The sucker rod is then screwed on to the shank 50 of the traveling valve and the unit is completely assembled and ready for insertion into the barrel 10, which, of course, has already been lowered into the well on the lower end of the production tubing.

Operation

As the completely assembled unit, shown in Fig. 2, is inserted through the production tubing 46 into the barrel 10 the lower end of the liner contacts the lower end 35 of the barrel, the plunger passes downward within the liner, the sealing element 17 slides on to its seat 16, the lower end 38 of the yoke slides into its seat in the upper end of the sealing element 17 and forces the ring 19 into its groove 18 as previously described, thus locking the sealing element 17 tightly into position. Naturally, the proportionate lengths of the various elements of this pump are such that when the plunger is at the lower end of its stroke the traveling valve is located somewhat above the shoulder 40 of the yoke; and when the plunger is at the upper end of its stroke the traveling valve is located somewhat below the shoulder 41 of the yoke. It is understood, of course, that the sucker rod, the traveling valve, the plunger operating rod 24, and the plunger, all travel together, and that as the plunger reciprocates the contact of its rings with the liner causes the liner to move with the plunger until it reaches the limit of its movement in either direction.

As the sucker rod moves the plunger upward, as shown in Fig. 7, all liquid above the plunger and below the sealing element 17 is forced through the ports 29, 30 and 31 and upward through the bore of the rod 24, and through the valve 52 into the production tubing 46, due to the fact that the valve 26 has completely closed the lower end of the bore of the rod. During the upward travel of the plunger liquid is, of course, free to be drawn into the barrel through the ports 11 and 12 because the liner 34 is at the upper end of its limited movement. As the direction of the plunger is reversed the liner 34 immediately slides downward in the barrel 10, closing the ports 11 and 12, and trapping the liquid below the plunger. At the same time the ports 13 and 14 are opened and as the plunger moves downward fluid is drawn through these ports into the space above the plunger. The valve 25 is, of course, closed on the down stroke and the liquid cannot possibly pass downward through the plunger. The valve 26 is open and the fluid below the plunger is forced through the ports 27 and 28 and upward through the bore of the rod 24 and through the valve 52. It will be noted that the sealing element 17 serves as a partition between the operating barrel and the production tubing and that this sealing element carries a great percentage of the weight of all the fluid in the tubing above it, and that the plunger is therefore comparatively free of hindrance from this weight and pressure. It will also be noted that sand setttling out of the fluid in the production tubing will be trapped above the sealing element and thus prevented from causing the plunger to stick when the pumping operation is resumed.

While I have described and illustrated a specific embodiment of my invention I am aware that numerous alterations and changes may be made in its construction and I do not wish to be limited except by the prior art and the scope of the appended claims.

I claim:

1. A deep well pump comprising: a barrel having inlet ports near each of its ends; a liner slidable within said barrel for controlling the flow of fluid through the inlet ports of said barrel; a plunger within the liner adapted to move said liner to control said inlet ports; a hollow rod for reciprocating said plunger extending through said plunger and out through one end of said barrel and having a limited movement with relation to said plunger; a valve in each end of said plunger operable by said rod and each adapted to control the passage of fluid from its respective end of the barrel through adjacent ports in said rod into the bore of said rod; and a check valve carried by said rod outside said barrel for preventing the passage of fluid through the bore of said rod into said barrel.

2. In a pump, the combination of: a barrel having inlet ports near its upper and lower ends; a string of production tubing attached to the upper end of the barrel; a sealing element separating the interior of the barrel from the interior of the production tubing; a plunger in the barrel; valves carried by the plunger; a hollow plunger operating rod connected to said plunger and having a limited movement with relation thereto, extending from the interior of the barrel into the pro-

duction tubing, and reciprocable through said sealing element, its bore affording communication between said barrel and said production tubin; a traveling check valve carried by said hollow rod for preventing the passage of fluid downward through the upper end of its bore; the valves in said plunger being operable by said hollow rod for controlling the passage of fluid from the barrel into the bore of said rod; and a liner within the barrel operable by said plunger, as it reciprocates, to control the passage of fluid into the barrel through the ports at its upper and lower ends.

3. A device of the class described comprising: a plunger barrel adapted for connection to a string of production tubing, and having inlet ports near its upper and lower ends; a sealing element separating the interior of the barrel from the interior of the production tubing; a plunger reciprocable within the barrel; a liner within the barrel operable by the plunger as it reciprocates for controlling the passage of fluid through said inlets; a hollow rod for reciprocating the plunger, its bore affording communication between the interior of said barrel on both sides of said plunger and the interior of the production tubing; a check valve carried on the upper end of said rod for permitting passage of fluid upward through the bore of said rod and for preventing its passage downward therethrough; a valve in each end of said plunger operable by said rod and adapted to control the flow of fluid from said barrel into the bore of said rod from both sides of said plunger; and means for reciprocating said rod.

4. A deep well pump comprising: a barrel adapted to be attached to the lower end of a string of production tubing, said barrel having a plurality of through ports near its upper and lower ends; remotely controllable means for sealing the interior of the barrel from the interior of the production tubing; a liner which fits snugly but slidably within the barrel for controlling the passage of fluid through the ports at each end of the barrel; a plunger adapted to reciprocate within the liner and to move said liner to alternate ends of the barrel as it reciprocates; a hollow plunger operating rod extending through the plunger, through said sealing means, and into the production tubing, and carrying valves adapted to seat alternately on seats in each end of said plunger as the rod reciprocates; inlet ports in the hollow rod adapted to be controlled by said valves; and a traveling check valve at the opposite end of said rod within the production tubing for preventing the passage of fluid from said production tubing through said hollow rod into said barrel.

5. A pumping apparatus comprising: a string of production tubing; a pump barrel adapted to be secured to the lower end of said production tubing and having inlet ports near each of its ends; means for separating the interior of the barrel from the interior of the production tubing; a hollow plunger operating rod extending from the production tubing into the barrel through said first mentioned means and adapted to reciprocate therethrough; a hollow plunger mounted on the lower end of said rod for limited longitudinal movement with relation thereto, and having a valve seat in each of its ends; a pair of valves carried by the rod and adapted to seat on said valve seats; through ports in the lower end of said hollow rod near the adjacent ends of said valves adapted to afford communication between the bore of said rod and the interior of said barrel on both sides of said plunger when the valves are open; an upwardly opening check valve carried on the upper end of said rod within said production tubing, its cage adapted to serve as a coupling for attaching said hollow rod to a power driven operating rod; and means within the barrel operable by said plunger for controlling the passage of fluid through said inlet ports into said barrel.

6. In combination with a string of production tubing, a pump comprising: a barrel having inlet ports near its opposite ends; sealing means separating the interior of the barrel from the interior of the production tubing; a reciprocable liner within the barrel adapted to close the ports at each end of the barrel as it is moved to that respective end of the barrel; a plunger reciprocable within the liner and adapted to reciprocate said liner by frictional contact therewith; a hollow plunger operating rod reciprocably attached to said plunger and adapted to afford communication between the interior of said barrel on both sides of said plunger and the interior of said production tubing; a valve at each end of the plunger for controlling the flow of fluid from its respective end of the barrel into said hollow rod; and a check valve at the upper end of said hollow rod outside said barrel and inside said production tubing for preventing fluid from passing from the production tubing into the hollow rod and thence to the barrel.

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