

June 3, 1930.

H. L. CRULL

1,761,876

OIL WELL PUMP

Filed April 16, 1928

3 Sheets-Sheet 1

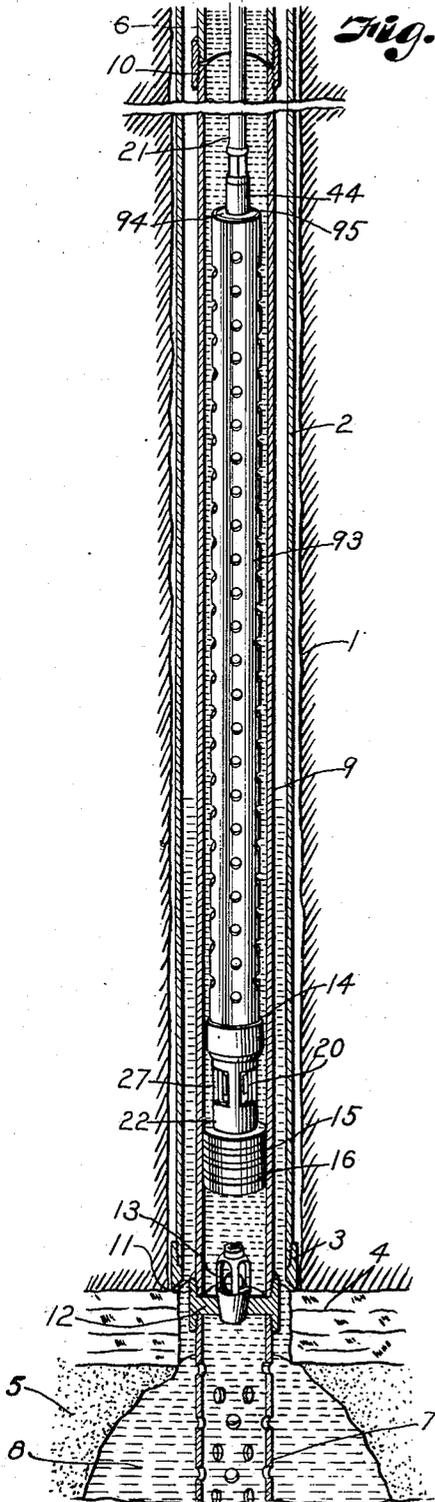


Fig. 1.

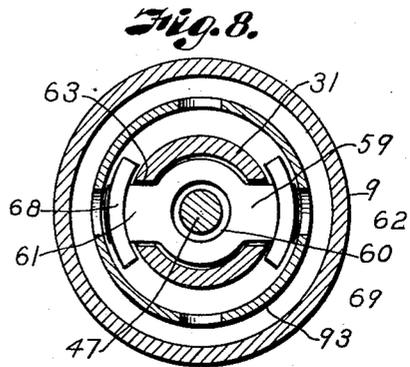


Fig. 8.

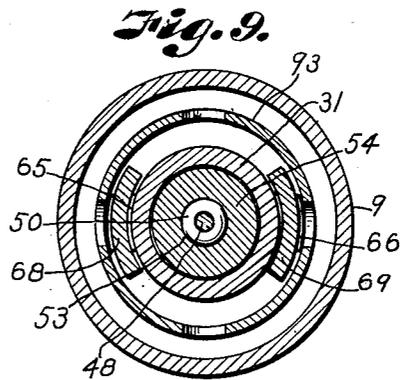


Fig. 9.

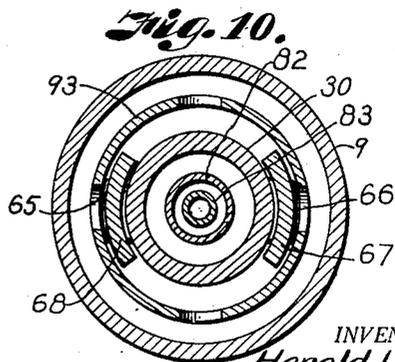


Fig. 10.

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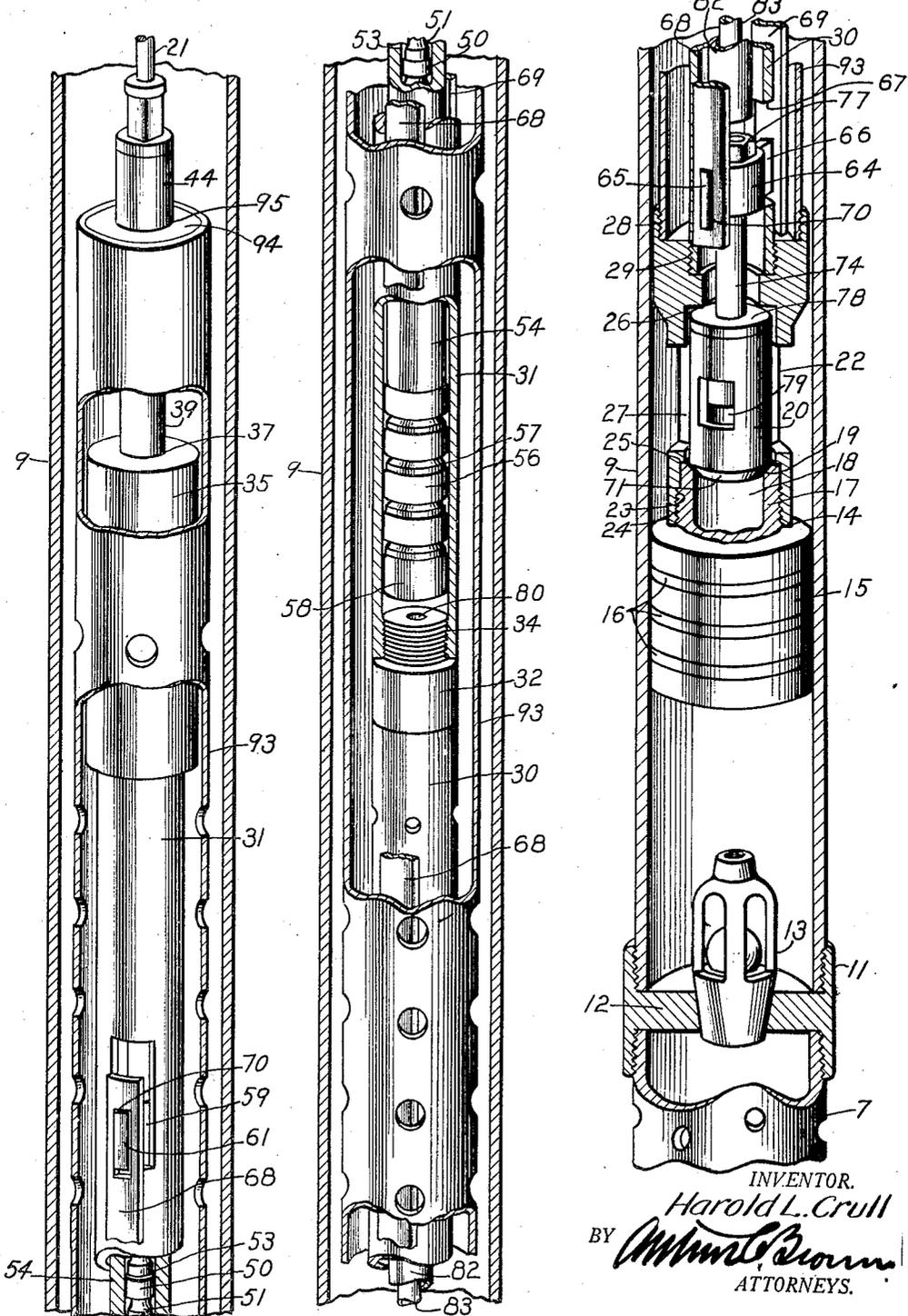
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Fig. 2.

Fig. 3.

Fig. 4.



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3 Sheets-Sheet 3

Fig. 5.

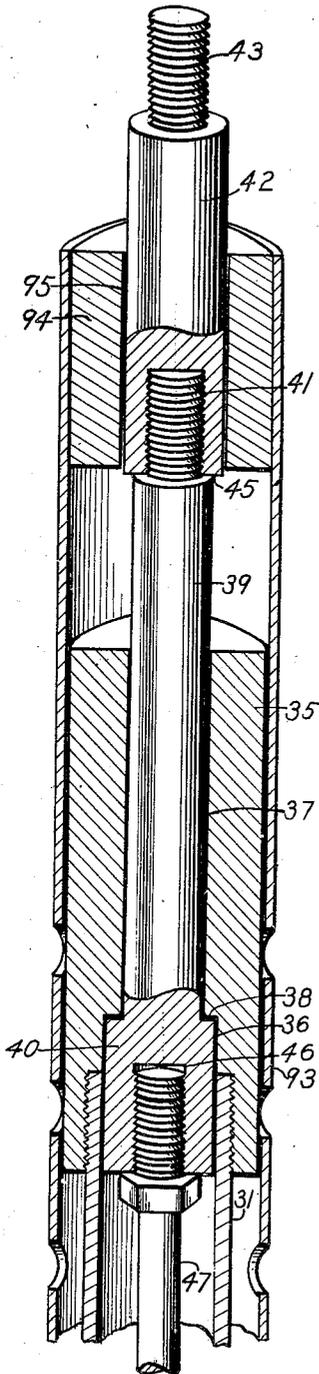


Fig. 6.

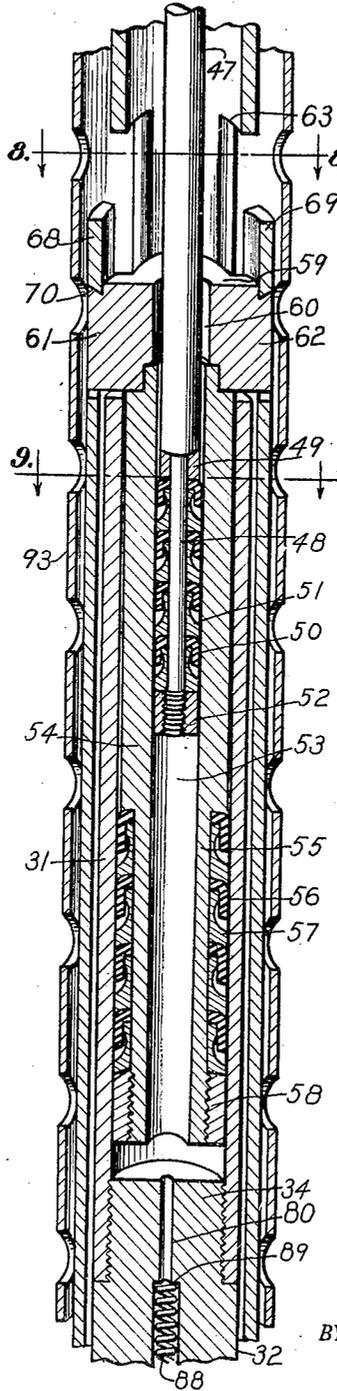
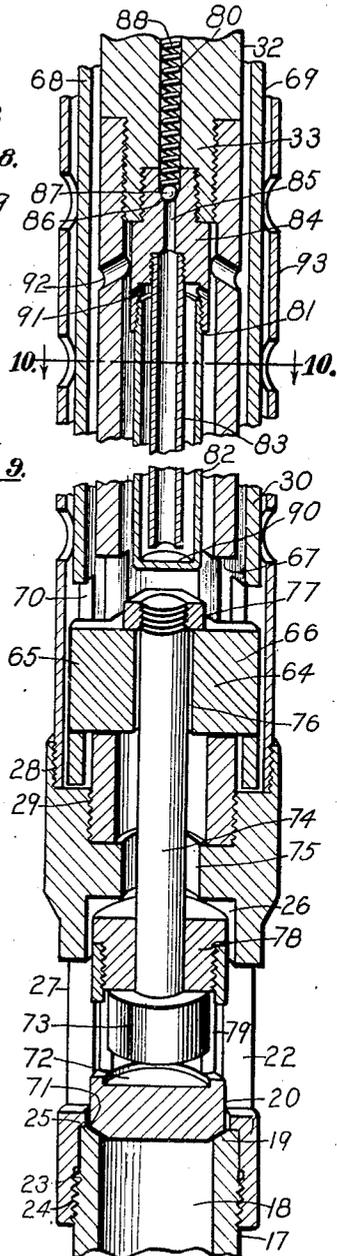


Fig. 7.



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OIL-WELL PUMP

Application filed April 16, 1928. Serial No. 270,227.

My invention relates to oil well pumps of the plunger type wherein a traveling valve is opened against hydrostatic pressure on the down stroke of the plunger.

5 With the ordinary pump of this type downward pressure on the rods must be sufficient to put under pressure the liquid confined in the lower part of the pump barrel for opening the traveling valve against hydrostatic pressure of the column of fluid in the well which, due to the slow opening of the valve and to the thrust on the rods necessary to overcome the resistance against their downward movement, causes the rods to buckle and bend and thereby reduce capacity of the pump in proportion to the shortening or buckling of the rods.

10 It is the principal object of this invention to secure maximum capacity of such a pump by reducing strain on the rods and resistance to the downward travel of the plunger by reducing the force required in lifting the valve through intensification of the power applied for opening the valve.

15 In accomplishing this and other objects of the invention I have provided improved details of structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

20 Fig. 1 is a central vertical section of part of an oil well equipped with a pump constructed according to my invention.

25 Figs. 2, 3 and 4 are enlarged perspective views of the upper, middle and lower portions of the pump, parts being broken away and in vertical section.

30 Figs. 5, 6 and 7 are central vertical sections of parts of the pump illustrated in Figs. 2, 3 and 4.

35 Fig. 8 is a cross section on the line 8—8, Fig. 6.

40 Fig. 9 is a cross section on the line 9—9, Fig. 6, and

45 Fig. 10 is a cross section on the line 10—10, Fig. 7.

Referring more in detail to the drawings: 1 designates the lower portion of a well hole; 2 well casing, including the shoe 3, whereby the casing is supported on cap rock 4 above the oil sands 5; 6 well tubing which

extends through the casing and terminates in the usual perforated strainer 7, within the well pocket 8, and 9 a pump barrel which may consist of a section of tubing of the same diameter as the well tubing 6, interposed between the strainer section 7 and next upper tubing section, and coupled thereto by the usual threaded collar 10 above the pump and a special fitting 11 below the pump, including a diaphragm 12 for separating the pump barrel from the strainer section 7. Mounted on the diaphragm of the lower coupling 11 is a standing valve 13 for admitting fluid to the pump upon the up-stroke of the plunger.

14 designates the pump plunger including a piston 15 adapted to reciprocate in close relation to the pump barrel and provided with the usual packing rings 16 and neck 17, the piston and neck having a bore 18 through which oil is transferred from the lower to the upper portion of the cylinder upon down stroke of the plunger. The neck 17 is provided with a tapered valve seat 19, seating a traveling valve 20 which is unseated on the down stroke to permit passage of oil through the bore but is seated on the up stroke to trap and lift the oil previously admitted through the valve.

The plunger is operably connected with sucker rods 21 which are actuated from the top of the well as in common oil field practice.

The pump thus far described is substantially of standard construction so that oil drawn into the lower end of the working barrel through the standing valve on the up stroke is transferred through the piston upon the down stroke through lifting of the working valve, which seats on the beginning of the next up stroke to trap the oil above the piston and during the stroke lifts the entire column of oil in the tubing and discharges the capacity of the pump out of the well.

Thus it is apparent that on the down stroke the traveling valve must lift against the hydrostatic head of oil in the tubing and the downward force of the rods must be great enough to put under pressure the fluid trapped below the piston to lift the valve.

Since the effective area above the traveling

valve, acted upon by the fluid and tending to hold the valve closed, is greater than the effective area below the valve upon which the trapped fluid acts to open the valve, it is necessary that the unit pressure of fluid below the traveling valve be greater than the unit pressure above the valve before the valve can open. Therefore, the total force required of the rods to start the valve is equal to the difference in pressure times the unit area of the bottom side of the traveling valve plunger and, as before stated, the required resultant force of the rods is, in deep wells, occasionally so great as to cause the rods to buckle and fracture and the tubing or casing to part. In any event the burden of overcoming such hydrostatic head reduces efficiency of the pump.

With my invention I convert a part of the fluid above the plunger into a working force by so diverting it against the valve as to supplement and intensify the force exerted by the sucker rods and assist the rods in overcoming the hydrostatic pressure normally resisting opening of the valve.

Threaded to the neck 17 of the piston 15 is a valve cage comprising a tubular connector 22 of smaller diameter than the working barrel and having internal threads 23 for engaging complementary threads 24 on the neck and an inwardly projecting shoulder 25 for seating against the neck so that when the cage is screwed thereon, it is firmly secured in position.

Extending upwardly within the cage is a recess 26 of sufficient depth to freely receive the valve member 20, the walls of the recess being slotted as at 27 to permit passage of oil discharged through the valve. The cage is also provided at its upper end with stepped, internally threaded recesses 28 and 29 and threaded into the inner recess 29 is a tube 30 supporting a valve actuating, or intensifier cylinder 31 at its upper end through a coupling 32 of the same external diameter as the tube and cylinder and provided with reduced extensions 33 and 34, which are threaded into upper and lower ends of the tube support and the intensifier cylinder to firmly secure the intensifier cylinder to the tube.

The intensifier cylinder 31 extends upwardly within the pump barrel, and threaded onto the upper end of the cylinder is a sleeve 35 of larger diameter than the cylinder and having a recess 36 in its lower end corresponding to the inner diameter of the cylinder and a reduced through bore 37 opening from the recess forming a stop shoulder 38 for a reciprocating rod 39 that is slidable in the bore and provided with an enlarged head 40 at its lower end, slidable in the cylinder 31 and engageable with the shoulder upon upward movement of the rod.

The rod extends upwardly through the sleeve and is provided at its upper end with a reduced threaded extension 41 to which is

threaded a sucker rod connector 42 having a threaded pin 43 on its upper end to receive the box 44 of the sucker rods 21, the connector being preferably of larger diameter than the rod to provide a stop shoulder 45 for contact with the sleeve 35 on downward movement of the sucker rods.

Thus it is apparent that when the rods move on the down stroke the rod 39 will move through the sleeve until the shoulder 45 contacts the sleeve, when continued downward movement of the rods will force the sleeve downwardly, causing the piston to move downwardly in the working barrel. On return movement of the sucker rods, the rod 39 will move idly through the sleeve until the head 40 engages the shoulder 38 in the sleeve 35, whereupon continued upward movement of the rods lifts the sleeve and the piston, the sucker rods moving independently of the piston at the beginning of both the up and down stroke.

Such free movement of the rods is an important feature of my invention in that such movement is utilized to actuate power intensifier mechanism for lifting the traveling valve from its seat.

Threaded into an internally threaded socket 46 in the bottom of the head 40 of the rod 39 is an intensifier piston rod 47 of relatively small diameter and sleeved on a reduced extension 48 at the lower end of the rod is an adapter ring 49 and a plurality of downwardly facing leather cups or the like 50, spaced by cup followers 51 and retained on the rod by a nut 52, as in common piston practice. The cups 50 are substantially the diameter of the rod and snugly engage the inner surface of a cylindrical bore 53 formed in a valve actuating piston 54.

It is apparent that the stroke of the piston rod 47 is equal to the independent movement of the sucker rods, as above described.

The valve actuating piston 54 comprises a tube having a reduced shoulder portion 55 at its lower end and sleeved on said extension is a plurality of cups 56 spaced by followers 57 and held in place by a nut 58 threaded on the lower end of the reduced portion.

The piston 54 is slidable in the cylinder 31 before described, under influence of the piston 47, through liquid contained in the cylinder 31 and bore 53 and since the effective area of the piston 54 is much greater than the effective area of the piston 47, force applied to the piston 54 is multiplied, which multiplied force is utilized in opening the working valve.

Connected with the upper end of the piston 54 is a yoke 59 having a central opening 60 through which the piston rod 47 extends and having laterally extending arms 61 and 62 projecting through slots 63 formed in the cylinder 31.

A similar yoke 64 slidable in the lower

end of the tube 30 is also provided with projecting arms 65 and 66 projecting through slots 67 in the tube 30 aligning with the slots 63 so that the arms 61 and 65 and the arms 62 and 66 may be connected by bars 68 and 69 which extend along the sides of the cylinder 31 and its supporting tube 30 and are provided with openings 70 to receive the arms. Thus as the upper yoke is lifted by the piston 54, the lower yoke is lifted accordingly, due to the bar connection.

The traveling valve 20 preferably comprises a cylindrical member having a beveled lower end 71 for seating on the seat 19 and a recess 72 containing a head 73 formed on the lower end of a valve stem 74 which extends upwardly into the tube 30 through an opening 75 in the valve cage and through an opening 76 in the yoke 64, the stem being suspended from the yoke by a nut 77 threaded upon the upper end of the stem.

The valve is retained on the head of the stem by a threaded bushing 78, sleeved on the stem and threaded into the recess of the valve as shown in Fig. 6, to provide loose mounting of the valve on the stem for insuring perfect seating of the valve when the piston is on the up stroke. The side wall of the valve is also preferably provided with openings 79 for a purpose presently apparent.

Fluid for supplying the intensifier cylinder and for replenishing fluid lost past the cups of pistons 54 is admitted into the cylinder through a port 80 extending centrally through the coupling 32 and opening from a sand and gas eliminator 81, including concentric tubes 82 and 83 screw threaded in a nipple 84 threaded into the connector and having a port 85 aligning with the port 80 and the inner tube 83, the nipple being provided with a valve seat 86 for seating an upwardly opening ball check 87, which is yieldingly urged to its seat by a spring 88, one end of which bears against the ball check and the other against a shoulder 89 formed in the port 80.

The tube 83 extends to a point adjacent the closed lower end 90 of the outer tube 82 and the nipple is provided at the upper end of the tube 82 with ports 91 slightly below ports 92 in the tubing 30 so that oil is admitted from the working barrel to the separator tubes through the ports 91 and 92 where it is compelled to pass downwardly between the tubes to enter the open lower end of the inner tube 83 and then pass upwardly past the check valve into the cylinder.

In order to protect the intensifier mechanism and retain the connecting bars on the arms of the yokes, a perforate tubing 93 is sleeved over the intensifier mechanism and screwed into the threaded recess 28 in the cage, the upper end of the tubing extending above the sleeve 35 and being provided with a guide member 94 having a central opening

95 for constituting it a bushing for the rod connector 42.

Operation of the device constructed and assembled as described is as follows:

Upon the beginning of a stroke of the sucker rods, the rod 21 moves idly through the sleeve as far as movement of the pump plunger is concerned, downward movement of the plunger being resisted by oil confined in the lower end of the working barrel between the working and standing valves, the sole purpose of the initial movement being to actuate the intensifier piston.

The intensifier piston being attached rigidly to the rod 39 is moved downwardly in the cylinder bore 53 of the actuating piston 54, applying pressure to the liquid contained therein and exerting an upward force on said piston 54, which is transferred to the yoke 59 at the top of the barrel, to lift the yoke 64. The yoke 59 being connected with the yoke 64 at the bottom of the barrel through the bars 68 and 69, and the yoke 64 being connected with the working valve 20 through the stem 74, the upward force generated by the intensifier piston tends to lift the valve 20 against hydrostatic head of oil in the tubing. With the valve open and the shoulder 45 on the rod in contact with the head or sleeve 35, resistance to downward movement of the pump plunger within the working barrel is relieved through the opening of the valve as pressure of the fluid then acts over the entire area of the bottom of the valve to equalize the hydrostatic pressure acting on the top area.

Attention is here called to the fact that since the force exerted by fluid in the cylinder is equal in all directions, there is a force acting downwardly on the end of the connector which acts to part the valve seat from the valve.

When the sucker rods start on the up stroke they move free of the piston as on the down stroke until the head 40 engages the shoulder 38 in the sleeve 35. During this initial movement the piston is retained in its lower position by weight of the oil column above the piston.

The intensifier piston is lifted in its cylinder to relieve pressure on the actuating piston so that the actuating piston is permitted to return to its normal position, as shown in Fig. 5, to allow the traveling valve to seat and retain the oil above the piston. Continued upward movement of the rods carries the plunger piston 15 upwardly to lift the column of oil in the tubing and at the same time draw in a charge of oil through the standing valve.

Oil leaking past the intensifier or valve actuating piston cups on the down stroke will be replaced through the check valve on the up stroke, due to hydrostatic pressure in the tubing.

Thus by intensifying the downward thrust on the rods at a point adjacent to the traveling valve and utilizing the intensified force to lift the working valve, I relieve undue strain on the rods and overcome difficulties encountered in use of pumps of ordinary construction.

What I claim and desire to secure by Letters Patent is:

1. In combination with a working barrel, a plunger operable in the barrel, a valve subject to hydrostatic pressure of superimposed fluid and controlling admission of fluid to the plunger, means for actuating the plunger, and hydraulic means responsive to initial charging movement of the plunger actuating means for unseating the valve.

2. In combination with a working barrel, a plunger operable in the barrel, a valve subject to hydrostatic pressure of superimposed fluid and controlling admission of fluid to the plunger, means for actuating the plunger with initial slip movement at opposite limits of travel of the plunger, and means responsive to the plunger actuating means during its downward slip movement for unseating the valve.

3. In combination with a working barrel and a pump rod, a primary plunger member operable in the barrel, connected valve and piston members at opposite ends of the primary plunger member, and an intensifier plunger connected with the pump rod and operable to shift the piston against hydrostatic pressure on said valve on down stroke of the rod.

4. In combination with a working barrel and a pump rod, a plunger in the barrel, a downseating valve exposed to hydrostatic pressure in the barrel and controlling charging of the plunger, a primary piston operable by the rod, and a secondary piston connected with the valve and responsive to downward movement of the primary piston to lift the valve.

5. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve opening against hydrostatic pressure in the barrel to admit fluid through the plunger, and hydraulic means responsive on initial movement of the rod operable to open the valve.

6. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve opening against hydrostatic pressure in the barrel to admit fluid through the plunger, and means including pistons of differential diameter actuatable responsive to initial movement of the rod to open the valve.

7. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve opening against hydrostatic pressure in the barrel to admit fluid through the plunger, and means responsive to initial movement of

the rod to intensify force of the rod to open the valve.

8. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve controlling flow to the plunger, means on the rod for operating the plunger, having initial idle movement at opposite limits of its travel, and means responsive to idle movement of said operating means in one direction for shifting the valve.

9. In combination with a pump barrel and a pump rod, a reciprocating plunger in the barrel having a downseating valve controlling intake to the plunger and a piston chamber spaced from the valve, a yoke member operably connected with the valve, a secondary piston in said chamber operable on the yoke member to open the valve, and means connected with the rod including a primary piston operable to effect operation of the secondary piston upon initial movement of the rod and a member engageable with the plunger to move the plunger upon continued movement of the rod in the same direction.

10. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve controlling flow through the plunger, a cylinder anchored in the plunger, a coupling member floating in the plunger and connected with the valve, a secondary piston in the cylinder operable on the coupling member to open the valve, a primary piston operable on the secondary piston to shift the latter, and means directly connecting the pump rod with the primary piston and having delayed connection with the coupling member to actuate the plunger.

11. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve controlling flow through the plunger, a cylinder anchored in the plunger, a secondary piston slidable in the cylinder and having a bore therein, means connecting the valve to the secondary piston, and a primary piston reciprocable in the bore by the pump rod to effect movement of the secondary piston to move the valve.

12. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve controlling flow through the plunger, a cylinder anchored in the plunger, a secondary piston in the cylinder, a yoke on the piston, a complementary yoke connected with the valve, rods connecting the yokes, and a primary piston operable by the pump rod to effect movement of the secondary piston to move the valve through the yoke and rod connections.

13. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve controlling flow through the plunger, a tube carried by the plunger, a cylinder carried by the tube, the tube and cylinder having aligning slots, a secondary piston in the cylinder, a yoke slidable in the slots of the

cylinder and connected with the secondary piston, a yoke slidable in the slots of the tube and connected with the valve, rods connecting the yokes, and a primary piston operable by the pump rod to effect movement of the secondary piston to move the valve through the yoke and rod connections.

14. In combination with a pump barrel and a pump rod, a reciprocating plunger in the barrel having a downseating valve controlling flow through the plunger, a cylinder anchored to the plunger, a secondary piston in the cylinder having a bore therein, a primary piston slidable in the bore and actuated by the pump rod to effect movement of the secondary piston, means connecting the secondary piston with the valve and means for supplying a piston actuating fluid to the cylinder upon upward travel of the primary piston.

15. In combination with a pump barrel and a pump rod, a reciprocating plunger in the barrel having a downseating valve controlling flow through the plunger, a cylinder anchored to the plunger and having a fluid inlet, a secondary piston in the cylinder having a bore therein, a primary piston slidable in the bore and actuated by the pump rod to effect movement of the secondary piston, means connecting the secondary piston with the valve, and a sand and gas separator connected with the inlet comprising spaced tubes having oil inlets opening to the pump barrel for supplying liquid to the cylinder.

16. In combination with a pump barrel and a pump rod, a reciprocating plunger in the barrel having a downseating valve controlling flow through the plunger, a cylinder anchored to the plunger, a secondary piston in the cylinder having a bore therein, a primary piston slidable in the bore and actuated by the pump rod to effect movement of the secondary piston, means connecting the secondary piston with the valve, and a check valve connected with the cylinder to admit fluid from the working barrel upon upward movement of the primary piston.

17. In combination with a pump barrel and a pump rod, a plunger in the barrel, a valve controlling flow through the plunger, a cylinder anchored in the plunger, a secondary piston slidable in the cylinder and having a bore therein, means connecting the valve to the secondary piston, a primary piston reciprocable in the bore, a head for the cylinder, and a rod slidable in the head and connected with the primary piston and with the pump rod and having stop shoulders for engaging the cylinder head at the end of each stroke of the primary piston to connect the plunger with the pump rod.

18. In combination with a pump barrel, a plunger in the barrel, and a plunger actuator, a valve movable against pressure in the

barrel to admit fluid above the plunger, and a power intensifier operable upon actuation of the plunger actuator to move the valve.

19. In combination with a pump barrel, a plunger in the barrel and a plunger actuator, a valve movable against pressure in the barrel to admit fluid above the plunger, a hydraulic power intensifier operable upon actuation of the plunger actuator to move the valve, and a separator connected with the intensifier for separating foreign matter from liquid supplying the intensifier.

In testimony whereof I affix my signature.

HAROLD L. CRULL.

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