May 3, 1949. O. E. DEMPSEY 2,469,225

MEANS FOR FLOWING WELLS

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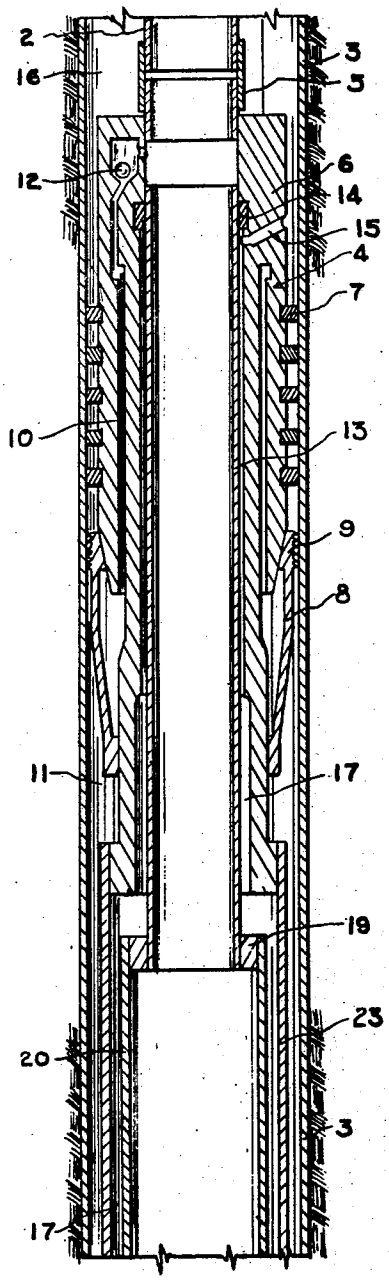


FIG. 1

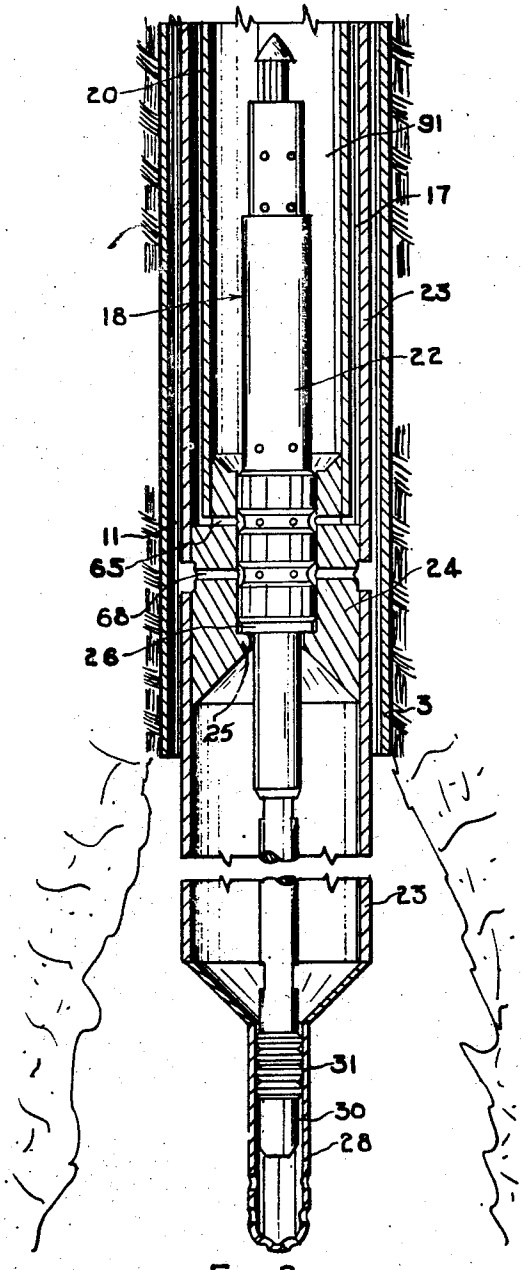


FIG. 2

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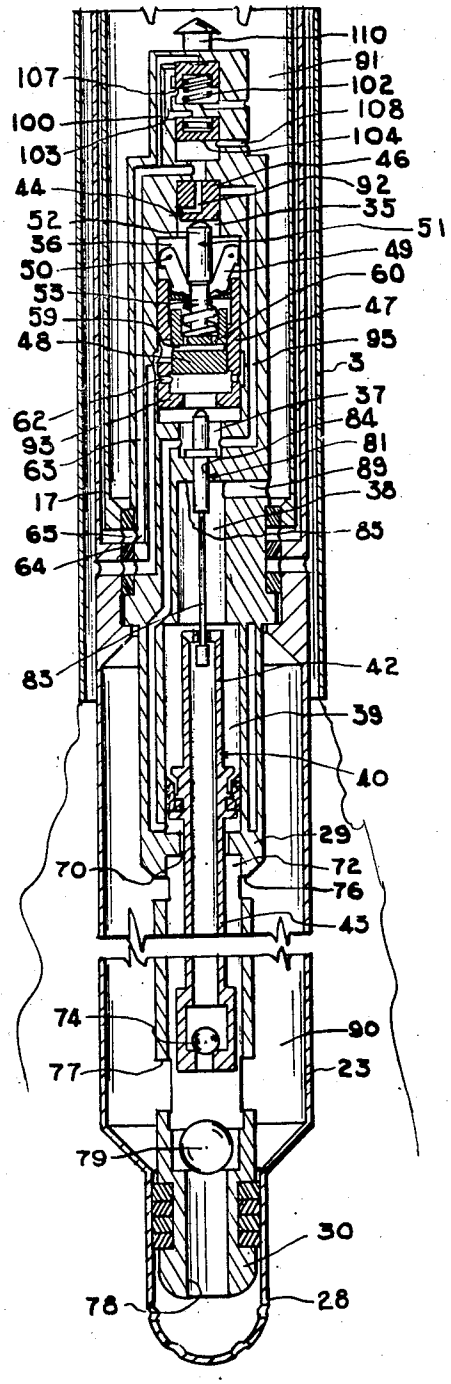


FIG. 3

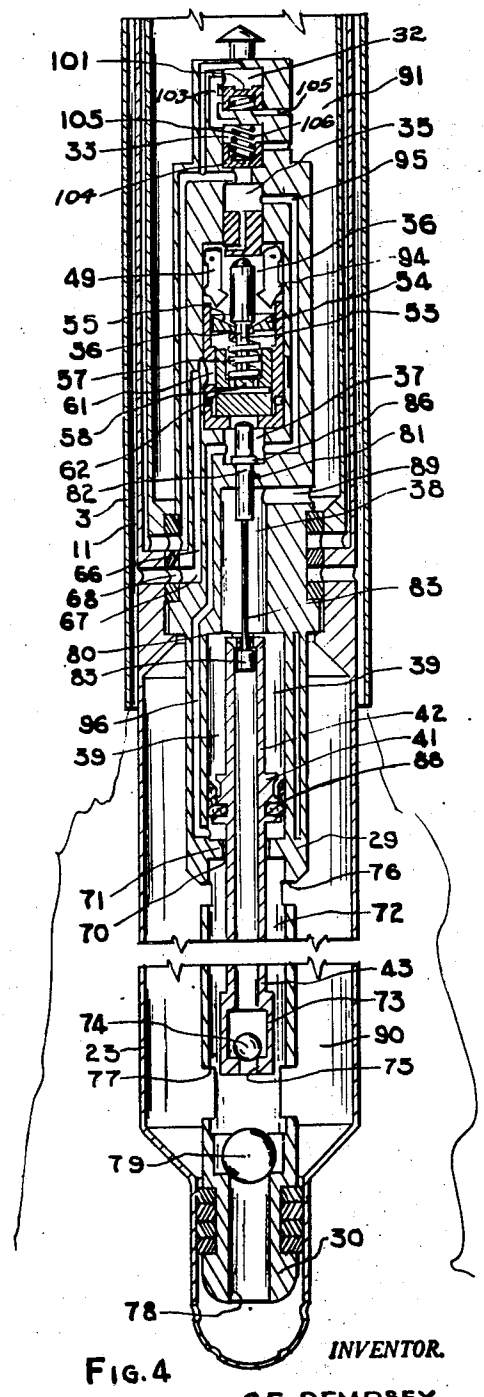


FIG. 4

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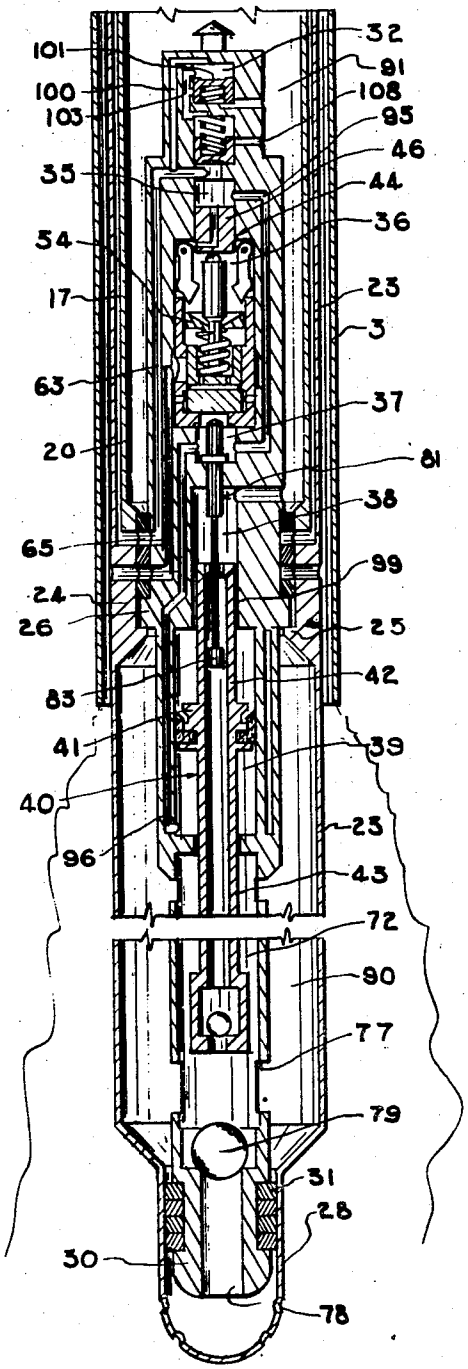


FIG. 5

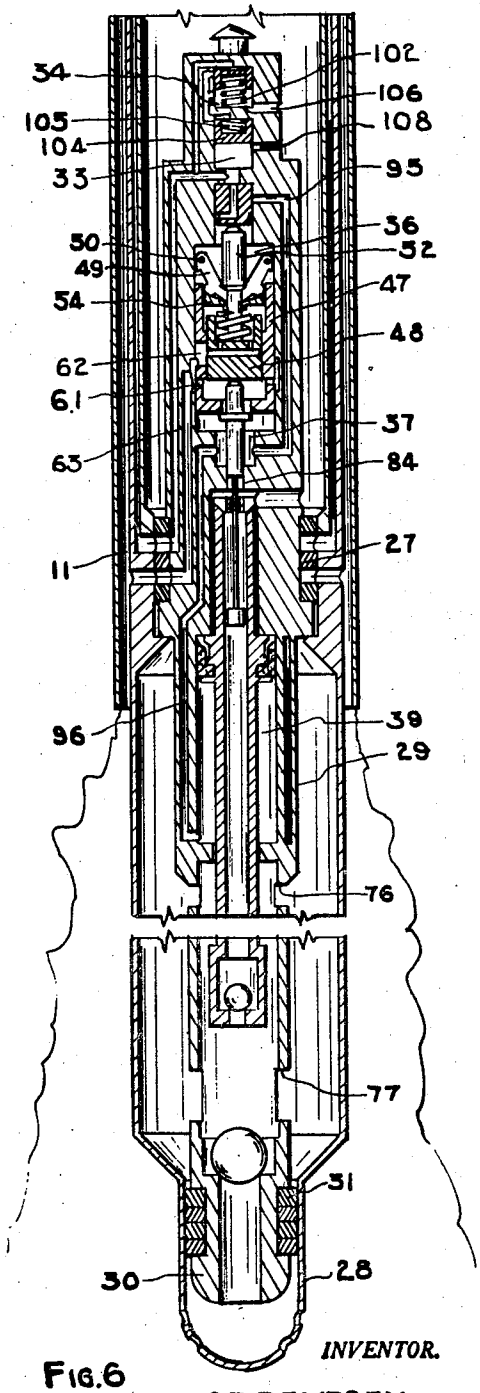


FIG. 6

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UNITED STATES PATENT OFFICE

2,469,225

MEANS FOR FLOWING WELLS

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Application February 4, 1946, Serial No. 645,305

11 Claims. (Cl. 103—46)

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This invention relates to improvements in means for flowing wells, and more particularly, but not by way of limitation, in means to maintain a substantially continuous flow of well fluid from the production strata without interference from the lifting medium. This invention is a continuation in part of applicant's co-pending application, Serial No. 456,107, filed on August 24, 1942, said application having issued into Patent No. 2,396,162, dated March 5, 1946.

In applicant's co-pending application, Serial No. 456,107, the oil flows from the production strata into a lower filling chamber and is displaced by input pressure fluid controlled through the operation of a valve mechanism in the lifting unit. The displacement operation is dependent upon overcoming a differential pressure across a lower liquid discharge valve which is moved relative to an outlet passageway for allowing discharge of fluid from the filling chamber to a reservoir located at a higher level. Movement of the liquid discharge valve is through the full length of its stroke or travel which in turn will effect an operation of the valve controlling mechanism to close off the supply pressure fluid regardless of whether all of the production fluid in the lower filling chamber is displaced or not. Furthermore, actuation of the valve mechanism by the discharge valve to shut off supply of pressure fluid simultaneously provides for the exhaust for all residue supply pressure fluid present in the filling chamber and connecting passageways to eliminate any counteracting pressure against the sand pressure of the production fluid. This provides for a constant emission of fluid into the filing chamber except for the momentary interruption during the displacement operation.

The present invention differs from applicant's co-pending application supra in that the structure in the lower portion of the lifting unit controlling the discharge of the production fluid from a lower filling chamber to the reservoir has been improved to assure a more positive and substantially complete displacement of the production fluid present in the lower filling chamber prior to actuation of the valve controlling mechanism for closing off the motivating supply pressure fluid as well as the bleeding off of the exhaust pressure.

It is, therefore, an important object of this invention to provide a lifting unit for the displacement of fluid from a well which progressively lifts quantities of the fluid from a lower collection chamber to a reservoir disposed at a

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higher level, said lifting unit having a valve mechanism for controlling the discharge of supply pressure fluid into the lower chamber wherein a portion of the displaced fluid acts as a snubber to maintain said valve mechanism in an open position for the discharge of the input pressure fluid until substantially all of the production fluid from the lower chamber is displaced.

Still another object of this invention is to provide a lifting unit for displacing oil from a well by progressively lifting quantities of fluid from the lower collection chamber to a reservoir disposed at a higher level, said lifting unit having a valve mechanism controlling the input of supply pressure fluid into the lower chamber for displacing the fluid as well as the exhausting of the residue supply pressure fluid after displacement of the fluid from the lower chamber.

And still another object of this invention is to provide a lifting unit for displacing fluid from a well having an automatic valve mechanism controlling the discharge of supply pressure fluid into the well for displacing the well fluid and the exhaust of residue supply pressure fluid after displacement of the fluid, wherein the control mechanism prevents exhaust of supply pressure fluid during the displacement of the well fluid and similarly prevents the supply pressure fluid from displacing the well fluid during exhaust of residue supply fluid after displacement.

Another object of this invention is to displace oil from a well in such a manner to conserve the bottom hole pressure of the well in order to maintain a substantially constant emission of well fluid from the sand strata whereby oil can be continually emitted into the eduction tubing without regard to intervals of time.

And still another object of this invention is to bleed off residue supply pressure fluid from a small section of the well depth from which oil from the sand strata is displaced therefrom, said bleeding allowing expeditious and repetitious flow of oil from the strata into said displacement chamber, thereby eliminating considerable intervals of time which oil may be displaced.

And still another object of this invention is to allow escape of formation gas to the well surface at all times except a momentary period when oil is being displaced or slugged to the top of the well.

And an additional object of this invention is the economic use of small volumes of gas in cubic feet for progressively lifting small amounts of fluid into a reservoir to be intermittently slugged in predetermined quantities, thereby eliminating

the use of large volumes of gas to slug small amounts of entrapped oil all the way through the tubing string.

Other objects and advantages of the invention will be evident from the following detailed description read in conjunction with the accompanying drawings which illustrate my invention.

In the drawings:

Fig. 1 is a fragmentary sectional view showing part of the lifting unit disposed in a well bore.

Fig. 2 is an extension of Fig. 1 showing in elevation the lower portion of the lifting unit disposed in the well bore.

Fig. 3 is a fragmentary sectional elevational view shown schematically and slightly enlarged for clarity of the lifting unit disposed in the well casing with the valve mechanism shown in one position before displacement of the well fluid.

Fig. 4 is a view similar to Fig. 3 showing the position of the valve mechanism of the lifting unit in a stage of operation.

Fig. 5 is a similar view showing another position of the valve mechanism for the lifting unit during the displacement of the well fluid.

Fig. 6 is a similar view to Fig. 5 showing the final position of the valve mechanism for the lifting unit upon completing the operation of displacing the well fluid.

Referring to the drawings in detail particularly Figs. 1 and 2 reference character 2 represents a string of tubing disposed in spaced relation to the well casing 3 extending to the sub-surface producing strata of the well. A packing assembly 4 is connected to the tubing 2 by a collar 5, and comprises an outer cylindrical housing 6 having its outer periphery provided with a plurality of spaced annular packing glands 7. Below the packing glands the housing 6 is provided with a pair of diametrically opposed belly springs 8 having serrated slips 9 securing the assembly in the well casing. The springs are secured to the housing 6 by welding or the like. The cylindrical housing is provided with a longitudinal port 10 providing communication with the chamber 11 between the housing 6 and casing 3 for the discharge of production and formation gas as will be hereinafter explained. A ball check valve 12 is provided in the upper portion of passageway 10 for formation gas discharging therethrough to the interior of the tubing 2. A string of tubing 13 is disposed in the housing 6 in spaced relation thereto. Packing 14 is interposed between the tubing 13 and inner periphery of housing 6.

A plurality of annular spaced apertures 15 provide communication between a chamber 16 containing motive fluid, and a chamber 17 between the inner tubing 13 and the inner periphery of the housing 6. The chamber 17 acts as a passageway providing communication for supply pressure fluid into the lifting unit 18 as will be hereinafter explained. The tubing 13 is connected by a collar 19 to a lower tubing string 20 of larger diameter extending downwardly and secured to a supporting member 24 as will be hereinafter set forth. Extending from the lowermost portion of housing 6 is an intermediate string of tubing 23 arranged in spaced relation between casing 3 and tubing 20. The tubing 23 extends downwardly from the housing 6 to the bottom of the well bore. The tubing 23 at a predetermined position is provided with an inwardly projecting flange or supporting member 24 having upstanding shoulders 25 adapted to cooperate with an outwardly projecting flange 26 provided in the central portion of the cylindrical housing 22. Packing rings 27 surround the housing 22 at the jointure of the tubings 20 and 23 with the member 24. The lowermost end of the tubing 23 is provided with a perforated plug or gas anchor 28 for a purpose as will be hereinafter set forth. A cylindrical tubing 29 extends downwardly from the lowermost portion of the housing 22. An apertured plug 30 is secured to the lower end of tubing 29 and is anchored in the gas anchor 28 by packing rings 31.

The upper portion of the housing 22 is provided with a plurality of vertical bores 32 and 33 for receiving a differential valve unit 34 as will be hereinafter set forth. The housing 22 is further provided with a valve bore 35 communicating with a chamber 36 which in turn communicates with chamber 37. The valve bores and chambers contain an automatic valve mechanism similar to the valve mechanism disclosed in applicant's co-pending application heretofore-mentioned. The lowermost portion of the housing 22 is provided with a bore 38 communicating with a lower chamber 39 which houses a cylindrical piston 40 having a main body portion or circular flange 41 provided with oppositely extending cylinders 42 and 43.

Referring now to the main valve unit 44 (Figs. 3 to 6, inclusively), a loosely disposed elongated valve 46 is disposed in the bore 35. A substantially cylindrical slide valve 47 is disposed in chamber 36. Wholly confined within the slide valve, and movable therein, is a piston valve 48. A pair of latch members 49 are loosely secured on studs 50 anchored in the chamber 36. A valve locking pushrod 51 is disposed in the chamber 36 immediately below the valve 46 and comprises an upper shaft 52 and a lower shaft 53. The rod 51 extends between the latch members 49 and into the interior of valves 47 and 48. A sleeve 54 loosely surrounds the lower shaft 53 and is provided with a groove 55 for a purpose as will be hereinafter set forth. The lower face of sleeve 54 is provided with a shoulder 56 for anchoring one end of a helical spring 57 having its opposite end resting on a surface 58 of valve 48. The valve 48 is provided with a transverse port 59 communicating with vertical ports 60 in turn communicating with chamber 36. The outer valve 47 is provided with a port 61 and immediately below is a second port 62 for a purpose as will be hereinafter explained. The upper central portion of the housing 22 is provided with a passageway 63 communicating with an annulus 64 which in turn communicates with a plurality of circumferentially spaced apertures 65 providing communication with the inlet chamber 17. In similar manner a vertical passageway 66 communicates with an annulus 67 provided in housing 22, which in turn communicates with a plurality of circumferentially spaced apertures 68 communicating with the exhaust chamber 11.

From the foregoing, it will be apparent that the above-described structure is similar to that of applicant's co-pending application heretofore-mentioned; however, the lower portion of the housing 22 is constructed as to provide the piston unit 40 and complementary structure which forms the novel aspect of this application. The circular piston flange 41 is disposed in chamber 39 with the upper cylinder 42 capable of extending into the bore 38 in spaced relation thereto. The lower extending cylinder 43 extends in spaced relation through an aperture 70 provided by inwardly projecting shoulders 71 of the cylinder 29 to a position below the shoulders

and into a chamber 72 provided in the lowermost portion of cylinder 29. The lower end of cylinder 43 is provided with a cage 73 in which is disposed a ball check valve 74 cooperating with an aperture 75. The cylinder 29 is provided with a plurality of circumferentially spaced apertures 76. A second set of circumferentially spaced apertures 77 are provided in the cylinder 29 in vertically spaced relationship to apertures 76. The plug 30 is provided with a ball check valve 79 cooperating with an aperture 78.

The upper end of piston cylinder 42 is provided with a plurality of apertures 80 for a purpose that willl be hereinafter explained. A piston extension rod 81 comprising an upper shaft 82 and a lower shaft 83 cooperates with piston cylinder 42. The lower shaft 83 extends through a centrally disposed aperture 80 of cylinder 42 and is provided with a projection 83 of increased diameter confined within the interior of piston cylinder 42. The upper shaft 82 extends through an aperture 84 provided by inwardly projecting shoulders 85 of housing 22. The shaft 82 is provided with a circular flange 86 adapted to contact the shoulders 85 and maintain the upper portion of shaft 82 in chambers 37 and 36. The flange 41 is provided with a plurality of circular packing cups 88 preventing leakage past the piston flange into the chamber 39.

It will be apparent that the sand pressure of the well will cause fluid from the production strata to flow through the plug 28, aperture 78, past valve 79, and through apertures 76 and 77, thereby filling chambers 72 and 90 with production fluid. It will be apparent from Fig. 3 that the oil builds up in these filling chambers for displacement to a reservoir located at a higher level.

Motive fluid pressure is constantly maintained in the well from a surface compressor or like equipment (not shown) into the chamber 16 and discharges into the inlet passageway 17, port 63, into constant communication with upper valve units 34 and 44. Referring now to the valve unit 44, with production fluid standing in the lower filling chambers 72 and 90, Fig. 3, it will be understood that production fluid is also present above the piston flange 41 in chambers 39, bore 38, and the reservoir due to a previous displacement operation of fluid from the lower filling chambers as will be more fully set out. The input motive pressure discharges from port 63 into a bleed port 92 provided in main valve 46 and leaks between the valve 46 and its bore into the chamber 36. It is to be understood that the fit of the valve 46 in its bore 35, especially the lowermost end of the valve below the horizontal leg portion of the bleed port 92, is such that the input pressure fluid discharging from port 92 is allowed to leak between the outer periphery of valve 46 and its bore into the chamber 36. The small amount of pressure fluid constantly leaking through port 92 into the chamber 36 is not sufficient to warrant any displacement of liquid in the filling chambers 72 and 90. With the mechanism of the lifting unit 18 in the position as shown in Fig. 3, the leakage pressure flowing into chamber 36 with the aid of tension spring 57 will cause downward vertical movement of valve 48 until the port 59 moves past the port 61, thereby closing off the chamber 36 from exhaust passageway 66. The downward movement of valve 48 contacts the base 93 of valve 47 and continued leakage of supply pressure fluid into chamber 36 will build up the pressure therein, moving valve 47 downward out of contact with the locking latches 49. The valve 47 is held by friction and does not move downward of its own weight during the preliminary movement of valve 48. Furthermore, during the preliminary movement of valve 48, the sleeve 54 is prevented from moving downward by the tension of spring 57. As soon as the top of valve 47 moves below the shoulders 94 of the locking latches 49, the latches are free to swing transversely outward in the chamber 36 (Fig. 4), thereby releasing the locking pushrod 51. The rod 51 is then moved downward by valve 46 actuated by input pressure fluid. Movement of valve 46 downwardly (Fig. 4) opens passageway 95 to input pressure fluid which is directed therethrough and into chamber 37 below the chamber 36.

A passageway 96 provides communication between chamber 37 and chamber 39 at a position below the piston flange 41. With the production fluid displaced by a previous operation to a position above the piston flange 41 as shown in Fig. 4, discharge of input pressure fluid below the flange at a greater pressure than the static pressure of the production fluid in chamber 39, bore 38, and reservoir 91 will move the piston 40 vertically upward; however, upward movement of the piston is limited due to a decrease in volume of oil in chamber 39, whereby the oil present in chamber 39 acts as a snubber to momentarily retard upward movement of the piston 41 and prevent actuation of the valve mechanism until substantially all of the fluid is displaced from the filling chambers. With the snubbing action momentarily precluding further upward movement of the piston 40, the input pressure is then directed through port 70 and outlets 76 into contact with the well fluid in the chambers 72 and 90. As soon as the input pressure fluid increases sufficiently greater than the static pressure of the fluid in the filling chambers, it will cause displacement of the fluid from the chambers 72 and 90 through the ball check valve 74 and into the interior of piston 40. The production fluid being displaced through the interior of piston 40 discharges through apertures 80, bore 38, outlet aperture 89, and into the reservoir 91.

It will be apparent that simultaneous with the displacement of the fluid from the chambers 72 and 90, the input pressure fluid continues to act against the underface of piston flange 41. With the production fluid displaced through piston 40, the input pressure fluid discharging through annulus 70 also flows through the interior of piston 40, apertures 80 and into bore 38, causing a complete displacement of liquid into the reservoir 91. The diameter of outlet aperture 89 is greater than the annulus 70 formed by the spaced relation of cylinder 43 and shoulder 71, which provides for a faster discharge of the input pressure fluid through the outlet orifice 89 than the discharge thereof through the smaller annulus 70. This results in a decreased pressure condition in bore 38, allowing the oil in chamber 39 surrounding the piston cylinder 42 to be discharged into the annulus 99, bore 38, and the outlet 89. The annulus 99 is formed by the spaced relation of the cylinder 43 to the bore 38. The displacement of fluid from chamber 39 above the piston is due to input pressure fluid contacting the underface of piston flange 41 and it will be apparent that the snubbing action of the fluid above the piston flange

has been relieved, thereby causing the input pressure fluid to move the piston 40 to completion of its upward stroke as shown in Fig. 6. The final upward vertical movement of piston 40 causes the top portion of piston cylinder 43 to contact the larger shaft 82 of piston rod 81 (Fig. 6), thereby moving the rod 81 upwardly through the apertured base 93 to cause vertical upward movement of valve 48 and position ports 59 and 60 into communication with port 61, thereby exhausting the pressure in chamber 36 into passageway 66. Simultaneous with upward movement of valve 48, there is a vertical upward movement of pushrod 51, causing the upper shaft 52 to move out of contact with the locking latches 49 so they may swing transversely inward into the V-shaped groove 55 of sleeve 54, at which time the rod shoulder 86 and supply fluid pressure in chamber 37 contacts the underface of valve base 93 to move valve 47 vertically upward. The movement of rod 51 is assisted by tension spring 57. Vertical upward movement of rod 52 causes movement of valve 46 upward against the input pressure fluid to close off the passageway 95.

In this position (Fig. 6), the locking latches 49 have been swung inwardly to lock the rod 51 and valve 46 in closed position. The movement of the valve 47 vertically upward positions the port 62 into communication with exhaust passageway 66. The residue input pressure fluid in passageways 95, 96, and chamber 37, as well as chambers 72 and 90, is allowed to exhaust through the apertured base 93, port 62, to the exhaust passageway 63, chamber 11, passageway 10, valve 12, and tubing 2 to the top of the well. With the input pressure fluid cut off from passageway 95 and the oil displaced from the chamber 90, it will be apparent that the production strata can flow through the apertured plug 28 without interference from residue input pressure fluid. Furthermore, the static head of displaced fluid standing in reservoir 91 falls back through outlet port 89, bore 38, and this pressure with the assistance of gravity moves the piston 40 vertically downward in chamber 39 to a position shown in Fig. 3.

It will be understood that the relationship of pressures is commensurate with the areas with the various valves, pistons, and bores and the ratio between them is a matter of choice dependent upon a particular well. Furthermore, the length of tubing providing the reservoir 91 is much longer than the tubing for the filling chambers 72 and 90 in order to provide a larger storage chamber or reservoir. In practice it has been found that a ratio of 10 to 1 is satisfactory. It will also be understood that the formation gas from the production strata is liberated from the well through chamber 11 along with the exhaust or residue supply pressure fluid exhausting through the passageway 66.

The upper portion of housing 22 is provided with the differential valve unit 34 which functions to allow discharge of supply pressure fluid into the reservoir 91 for slugging the stored fluid onto the top of the well as will now be fully explained. The valve unit 34 communicates with the inlet passageway 63 through a conduit 100 so that the supply pressure fluid is constantly maintained in communication with the top of valve 101 disposed in the valve bore 32. In this manner supply pressure fluid maintains the valve 101 in a lowermost position (Fig. 4) against the action of tension spring 102. A vertical port 103 provides communication between bore 32 and bore 33 in which is disposed a lower valve 104. With pressure fluid acting against the underface

of valve 104 from passageway 63 and simultaneously flowing through passageway 100 into bore 32 and port 103, it will be apparent there is an equal pressure on both sides of valve 104 whereby a tension spring 105 maintains valve 104 in closed position as shown in Fig. 4. A passageway 106 provides communication between the reservoir 91 and the underface of valve 101. With a sufficient increase in hydrostatic head in the reservoir 91 complementary with an increase in pressure beneath the valve 101 assisted by the tension spring 102, the constantly maintained supply pressure fluid acting against the top of valve 101 is overcome, causing the valve to move vertically upward and close off port 103 and open a port 107 communicating between the port 103 and the underside of valve 101. With the valve 101 in upward position, supply pressure fluid in chamber 33 is bled off through the ports 103 and 107 into the chamber 32 below the valve 101, thereby unbalancing valve 104 by relieving pressure on one side thereof. With the unbalancing of valve 104, supply pressure fluid discharging from passageway 63 moves valve 104 upwardly to open a port 108, allowing discharge of supply pressure fluid directly into the reservoir 91 for displacing the fluid in the reservoir 91 upward to the top of the well.

As is clearly shown in Figures 1 and 2, the housing in 22 is provided with a fishing neck 110, affording means for receiving any suitable hook and cable for lowering or lifting the lifting unit into and out of the well respectively. It will be apparent that the unit 18 is of such size to easily pass through the tubings 13 and 2.

From the foregoing, it will be apparent that the invention contemplates the intermittent lifting of small quantities of oil from a lower filling chamber to a higher reservoir, and functions in such manner to prevent any supply pressure fluid utilized for displacing the oil from counteracting the sand pressure of the well, so that there is always a constant emission of fluid from the production strata except for the momentary period during the displacement operation. Furthermore, the lifting unit comprises an automatic valve mechanism for controlling the supply pressure fluid into the displacement chamber, and assures that substantially all of the production fluid is displaced from the filling chamber prior to shutting off the supply pressure fluid. This is accomplished by utilizing a portion of the production fluid as a snubber against the supply pressure fluid in the displacement operation. The valve mechanism also functions to exhaust all the residue supply pressure fluid and formation gas remaining from the displacement of the production fluid in order to prevent a counteracting pressure against the sand pressure of the well. The lifting apparatus will operate successfully in either deep or shallow wells, providing either high or low sand pressure, and will displace the well fluid with a minimum of supply pressure fluid in the most economical and efficient manner.

Changes may be made in the combination and arrangement of parts as heretofore set forth in the specification and shown in the drawings, it being understood that any modification in the precise embodiment of the invention may be made within the scope of the following claims without departing from the spirit of the invention.

What is claimed is:

1. In an apparatus for lifting fluid from a

well including a filling chamber, means for introducing constantly maintained motive pressure fluid into the filling chamber for displacing the fluid emitting therein from the production strata, means for receiving the displaced fluid, means actuated by the motive pressure fluid to move the first mentioned means to a position preventing introduction of motive fluid into the filling chamber and permitting exhaust of residue motive fluid therefrom, said last mentioned means including a piston responsive to previously displaced well fluid disposed above the piston to provide a snubbing action to limit the actuation of the said means until substantially all the production fluid in the filling chamber is displaced, and means independent of the first mentioned means and responsive to the hydrostatic head of well fluid in the receiving means for introducing motive fluid thereto to slug the well fluid to the top of the well.

2. In an apparatus for lifting fluid from a well comprising an automatic valve unit communicating with an inlet passageway having a constantly maintained motive pressure fluid therein, an accumulation chamber for well fluid emitting from the production strata, a reservoir communicating with the valve unit and the accumulation chamber, a main valve in the unit and moveable by motive pressure fluid to open position for directing motive pressure fluid into the accumulation chamber for displacing well fluid therefrom, piston means operably connected with the valve unit and moveable in response to motive pressure fluid to close the main valve against motive pressure fluid after displacement of the well fluid from the accumulation chamber to the reservoir, said piston means having previously displaced well fluid standing on one side thereof to snubber the movement of said piston means and prevent closing of the main valve until substantially complete displacement of the well fluid from the accumulation chamber, and means independent of the main valve and responsive to the hydrostatic head of well fluid in the reservoir for introducing motive pressure fluid thereto to slug the well fluid to the top of the well.

3. In an apparatus for lifting fluid from a well having an eduction tubing and a well casing, said apparatus including a reservoir communicating with the eduction tubing, a filling chamber communicating with the well casing and the reservoir, an automatic valve mechanism operable in one position to direct constantly maintained motive pressure fluid from the casing into the filling chamber for displacing well fluid therefrom, said mechanism operable in another position to bleed off residue motive pressure fluid after displacement of well fluid from the filling chamber, fluid means for snubbing the movement of the mechanism in the last mentioned position until substantially all the well fluid is displaced from the filling chamber, and means independent of the valve mechanism and responsive to the hydrostatic head of well fluid in the reservoir for introducing motive pressure fluid thereto to slug the well fluid to the top of the well.

4. In an apparatus for lifting fluid from a well including a filling chamber, a main valve mechanism controlling the introduction of constantly maintained motive pressure fluid into the filling chamber for displacing the well fluid emitting therein from the production strata, a reservoir well receiving the displaced fluid, a cylindrical piston operably connected with the valve mechanism and responsive to supply pressure fluid for actuating the valve mechanism to shut off the supply pressure fluid from the filling chamber after displacement of the well fluid therefrom, said piston responsive to displaced well fluid standing above the piston for limiting the movement of the piston in one direction until substantially complete displacement of the well fluid from the filling chamber, and means independent of the main valve and responsive to the hydrostatic head of well fluid in the reservoir for introducing motive pressure fluid thereto to slug the well fluid to the top of the well.

5. In an apparatus for lifting fluid from a well including a filling chamber communicating with an eduction tubing, a main valve mechanism communicating with constantly maintained motive pressure fluid in the eduction tubing and moveable in response thereto for directing the motive pressure fluid into the filling chamber for displacing well fluid therefrom, a cylindrical piston operably connected to the valve mechanism and responsive to the motive fluid pressure to move the valve to a position preventing introduction of motive fluid pressure into the filling chamber, said piston cooperating with previously displaced well fluid in the filling chamber and standing above the piston for retarding the action of the motive pressure against the piston until substantially all the well fluid therein is displaced from the filling chamber, means in the valve mechainsm permitting exhaust of residue supply pressure fluid after the displacement of well fluid from the filling chamber, and means independent of the main valve and responsive to the hydrostatic head of well fluid in the reservoir for introducing motive pressure fluid thereto to slug the well fluid to the top of the well.

6. In an apparatus for flowing wells including a filling chamber, a removable lifting unit for introducing constantly maintained motive pressure fluid into the filling chamber for displacing oil emitting thereto from the production strata, a reservoir above the filling chamber for receiving the displaced oil, said lifting unit comprising a main valve movable in one position to open a communicating passageway directing motive fluid into the filling chamber, means in the lifting unit movable in response to the displacement of oil from the filling chamber to allow bleeding off of residue motive fluid therefrom, fluid means for snubbing the movement of the last mentioned means until substantially all the well fluid is displaced from the filling chamber, and means independent of the valve means and responsive to the hydrostatic head of well fluid in the reservoir for introducing motive pressure fluid thereto to slug the well fluid to the top of the well.

7. In a lifting apparatus for lifting fluid from a well including a filling chamber and a reservoir, means for periodically introducing constantly maintained motive pressure fluid into the filling chamber for displacing fluid emitting therein from the production strata to the reservoir, said means allowing bleeding off of residue motive fluid utilized in the displacement of the well fluid from the filling chamber and simultaneously preventing the introduction of motive pressure fluid during the bleeding off of the residue motive fluid, and piston means cooperating with previously displaced well fluid to snub the action of said first mentioned means and prevent the bleeding off of the residue fluid until substantially all the production fluid in the filling

chamber is displaced therefrom, and means independent of the first mentioned means and responsive to the hydrostatic of well fluid in the reservoir for introducing motive pressure fluid thereto to slug the well fluid to the top of the well.

8. In a lifting apparatus for lifting fluid from a well including a filling chamber and a reservoir, means for periodically introducing constantly maintained motive pressure fluid into the filling chamber for displacing fluid emitting therein from the production strata to the reservoir, said means allowing bleeding off of residue motive fluid utilized in the displacement of the well fluid from the filling chamber and simultaneously preventing the introduction of motive pressure fluid during the bleeding off of the residue motive fluid, an apertured piston disposed in the filling chamber and permitting discharge of the well fluid therethrough, said piston having a flange co-operating with previously displaced well fluid standing thereabove for snubbing the action of the first mentioned means for preventing bleed off of the residue pressure fluid until substantially all the well fluid in the filling chamber is displaced therefrom.

9. In a lifting apparatus for lifting fluid from a well including a filling chamber and a reservoir, means for periodically introducing constantly maintained motive pressure fluid into the filling chamber for displacing fluid emitting therein from the production strata to the reservoir, said means allowing bleeding off of residue motive fluid utilized in the displacement of the well fluid from the filling chamber and simultaneously preventing the introduction of motive pressure fluid during the bleeding off of the residue motive fluid, an apertured piston disposed in the filling chamber and permitting discharge of the well fluid there-through, said piston having a flange co-operating with previously displaced well fluid standing thereabove for snubbing the action of the first mentioned means for preventing bleed off of the residue pressure fluid until substantially all of the well fluid in the filling chamber is displaced therefrom, and means independent of the first mentioned means and responsive to the hydrostatic head of well fluid in the reservoir for introducing motive pressure fluid thereto to slug the well fluid to the top of the well.

10. In a lifting apparatus for the intermittent lifting of fluid in a well to different stages of

elevation including a filling chamber and a higher reservoir chamber, means for directing constantly maintained motive pressure fluid into the filling chamber for displacing well fluid therefrom, said means allowing bleeding off of residue motive fluid utilized in the displacement of the well fluid from the filling chamber and simultaneously preventing the introduction of motive pressure fluid during the bleeding off of the residue motive fluid, an apertured piston operably connected with the first mentioned means and having a passageway for discharge of the displaced fluid from the lower portion of the filling chamber to an upper portion of the filling chamber above the piston, said piston co-operating with displaced fluid standing above the piston for retarding the action of the first mentioned means and preventing bleed off of the residue fluid until substantially all the well fluid in the lower portion of the filling chamber is displaced therefrom.

11. In a lifting apparatus for lifting fluid to different stages of elevation in a well including a filling chamber and a higher reservoir chamber, means for directing supply pressure fluid into the filling chamber for displacing well fluid therefrom, said means allowing bleeding off of residue motive fluid utilized in the displacement of the well fluid from the filling chamber and simultaneously preventing the introduction of motive pressure fluid during the bleed off of the residue fluid, control means operably connected with the first mentioned means, means for discharging the fluid from the filling chamber to a position above the control means, said control means co-operating with the displaced fluid above said control means for retarding the actuation of the first mentioned means and preventing bleed off of the residue fluid until substantially all the well fluid is displaced from the filling chamber.

OSCAR E. DEMPSEY.

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