March 5, 1946. O. E. DEMPSEY 2,396,162

MEANS FOR FLOWING WELLS

Filed Aug. 24, 1942 5 Sheets-Sheet 1

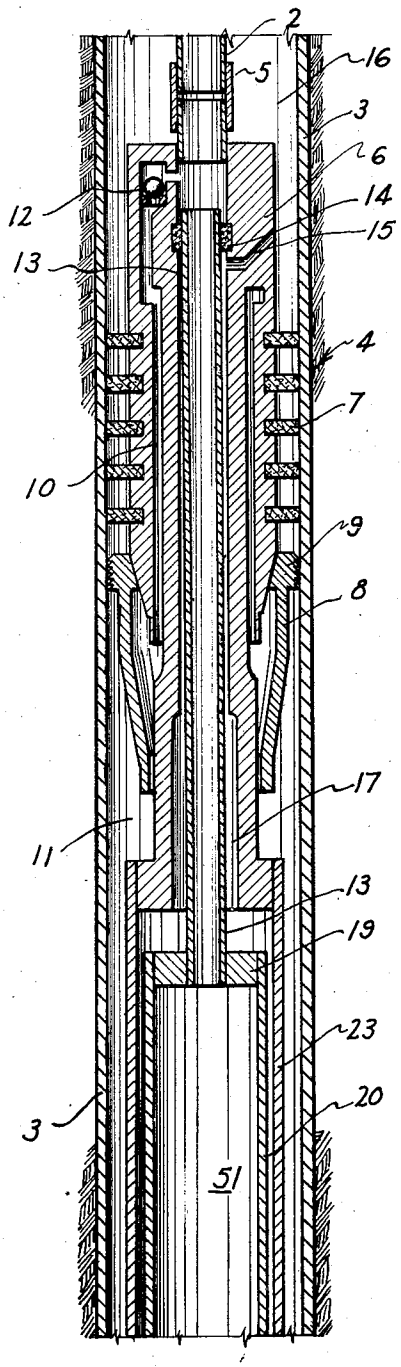


Fig 1.

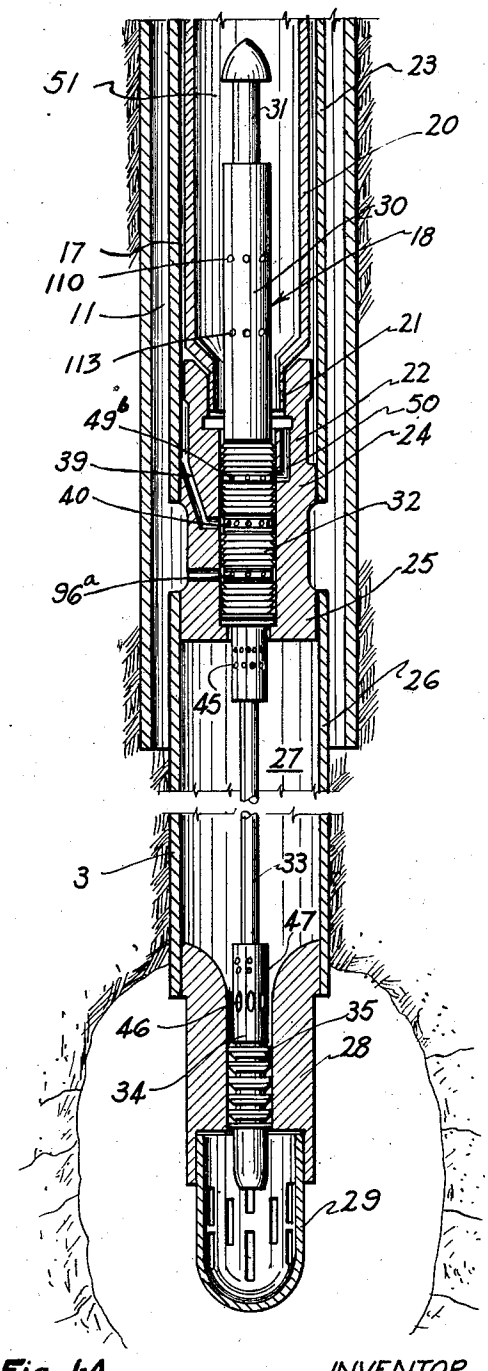


Fig. 1-A

INVENTOR.
Oscar E. Dempsey
BY E. M. McKnight
ATTORNEY.

March 5, 1946. O. E. DEMPSEY 2,396,162

MEANS FOR FLOWING WELLS

Filed Aug. 24, 1942 5 Sheets-Sheet 2

Fig. 2

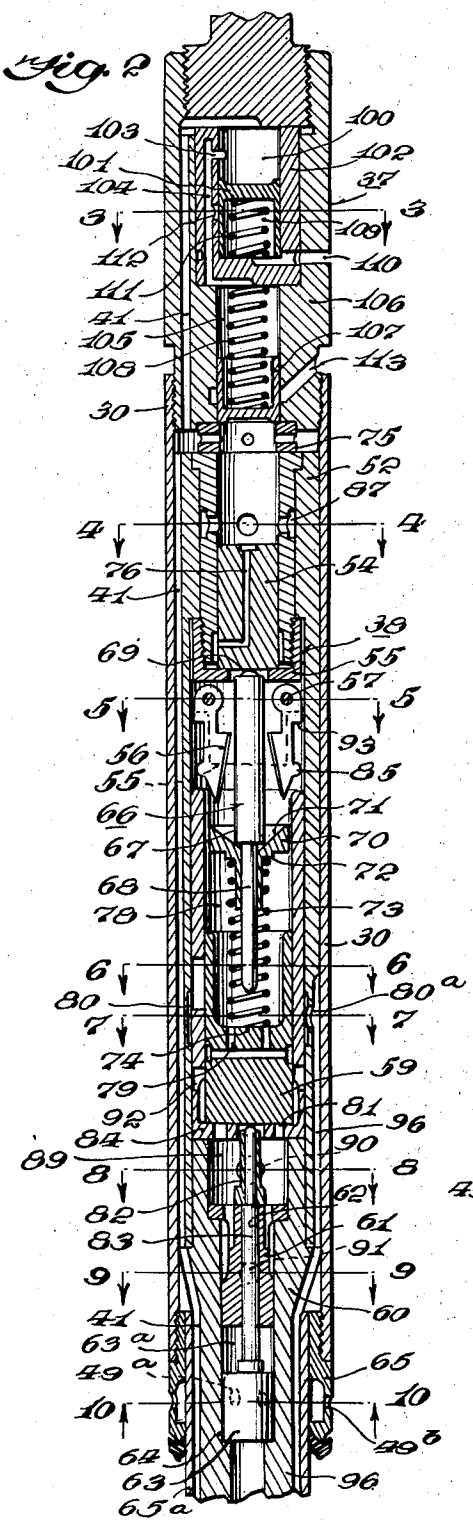


Fig. 3

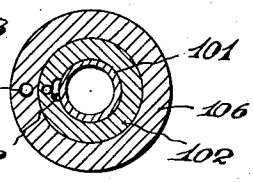


Fig. 4

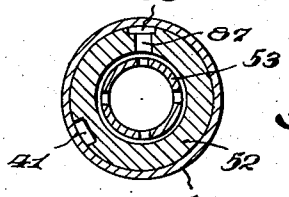


Fig. 5

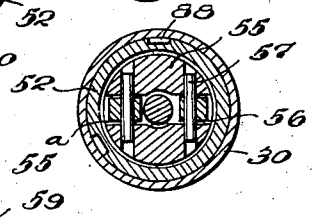


Fig. 6

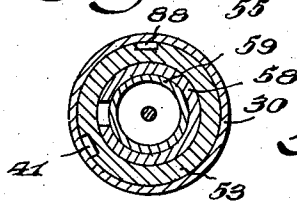


Fig. 7

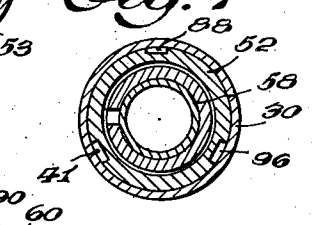


Fig. 8

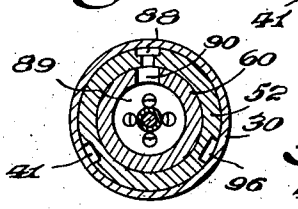


Fig. 9

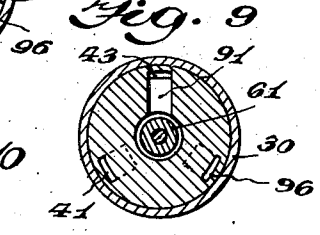
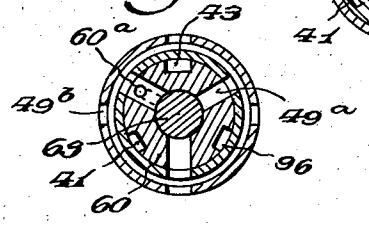


Fig. 10



Inventor

Oscar E. Dempsey

By Barry + Cyr

Attorneys

March 5, 1946. O. E. DEMPSEY 2,396,162

MEANS FOR FLOWING WELLS

Filed Aug. 24, 1942 5 Sheets-Sheet 3

Fig. 11

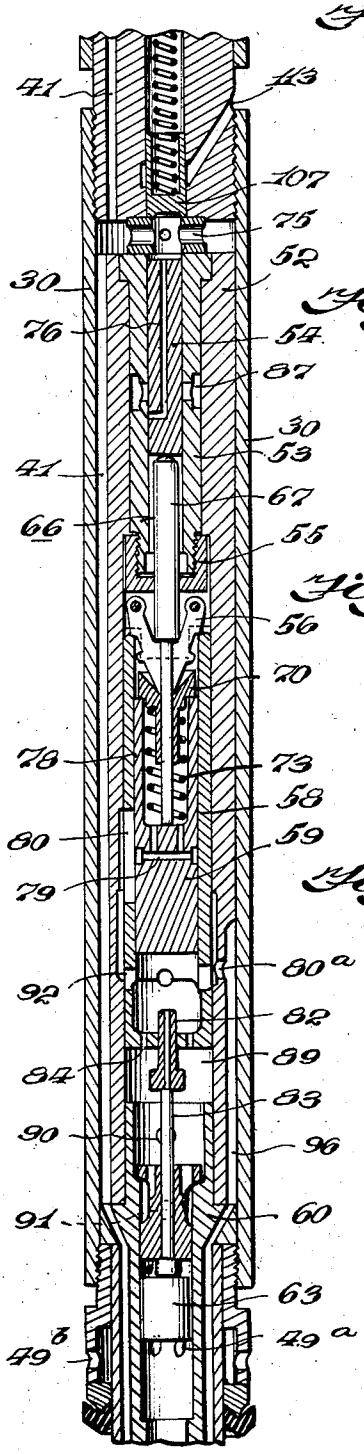


Fig. 13

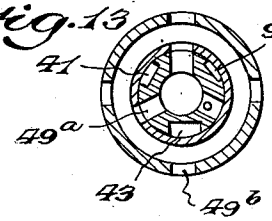


Fig. 14

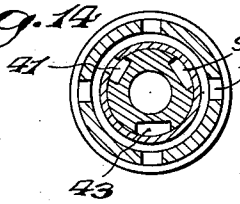


Fig. 15

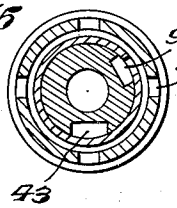


Fig. 16

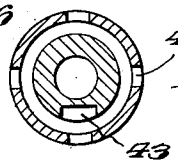
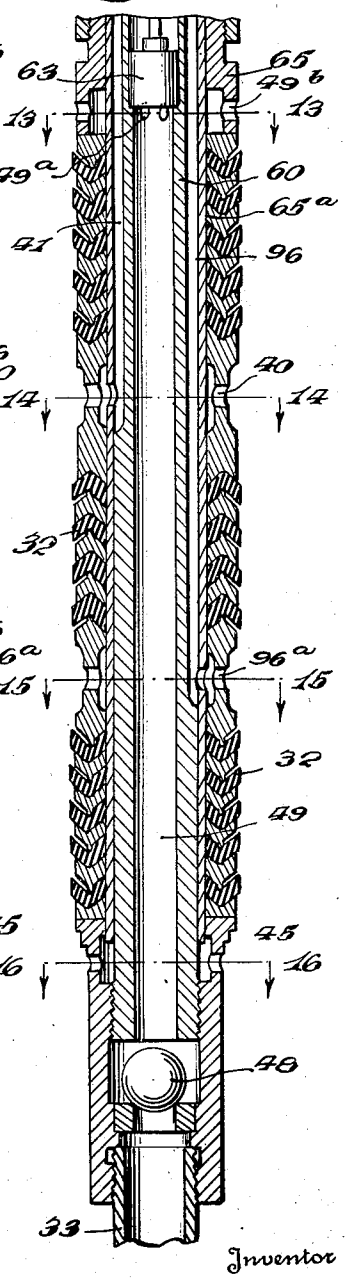


Fig. 12



Inventor

Oscar E. Dempsey,

By Barry & Cyr

Attorney

March 5, 1946. O. E. DEMPSEY 2,396,162

MEANS FOR FLOWING WELLS

Filed Aug. 24, 1942 5 Sheets-Sheet 4

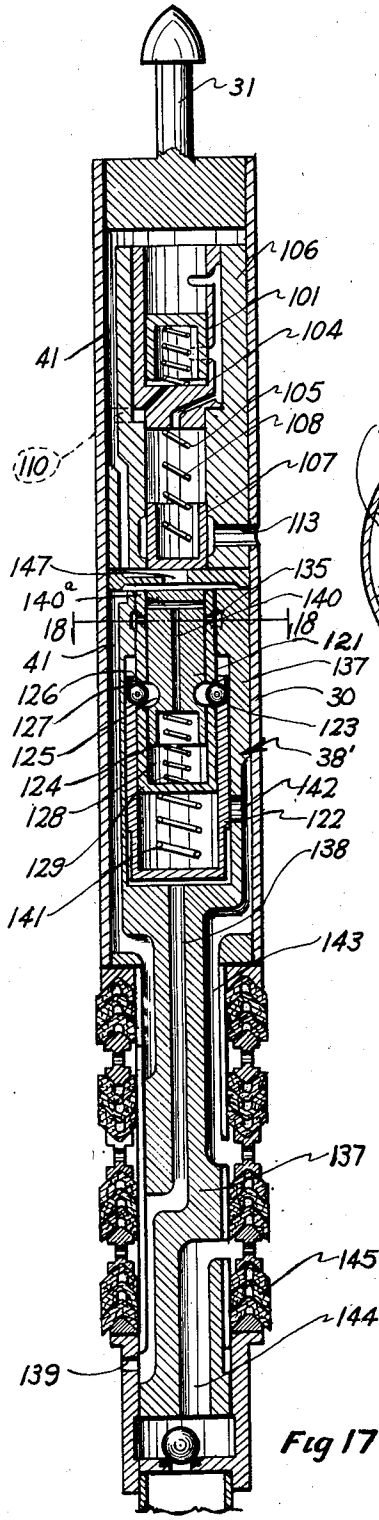


Fig 17

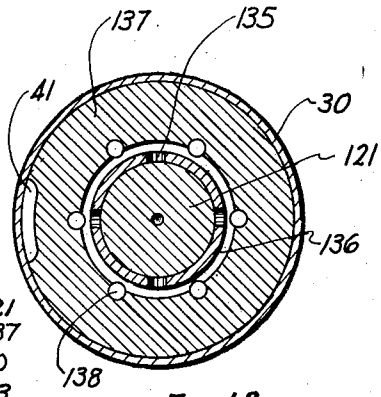


Fig 18

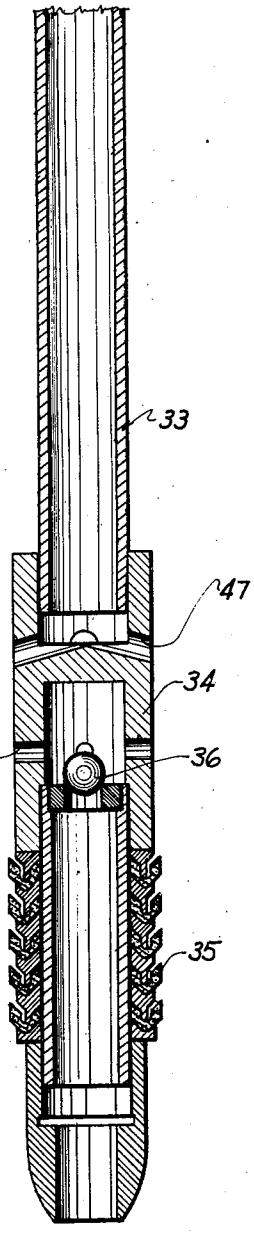


Fig 19

INVENTOR.
Oscar E. Dempsey
BY. L. M. McKnight
ATTORNEY.

March 5, 1946. O. E. DEMPSEY 2,396,162

MEANS FOR FLOWING WELLS

Filed Aug. 24, 1942 5 Sheets-Sheet 5

Fig. 20

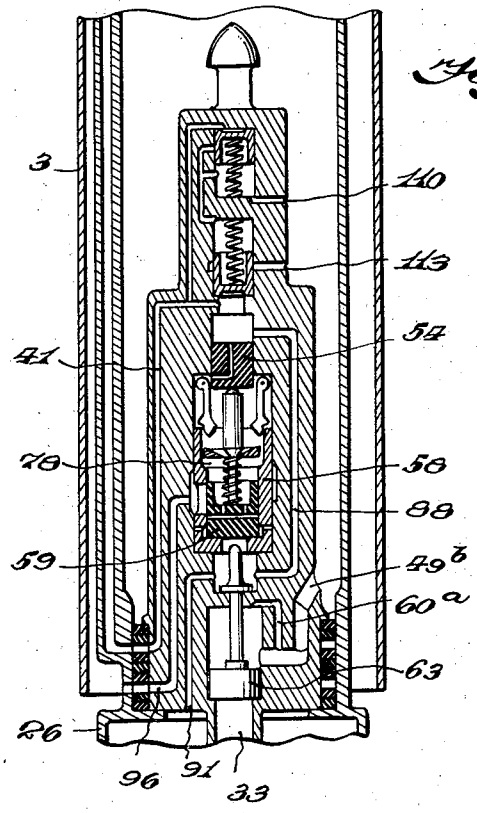


Fig. 21

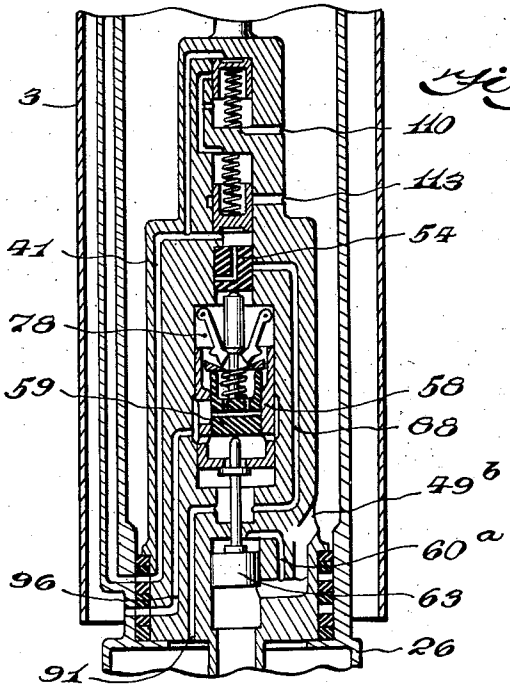
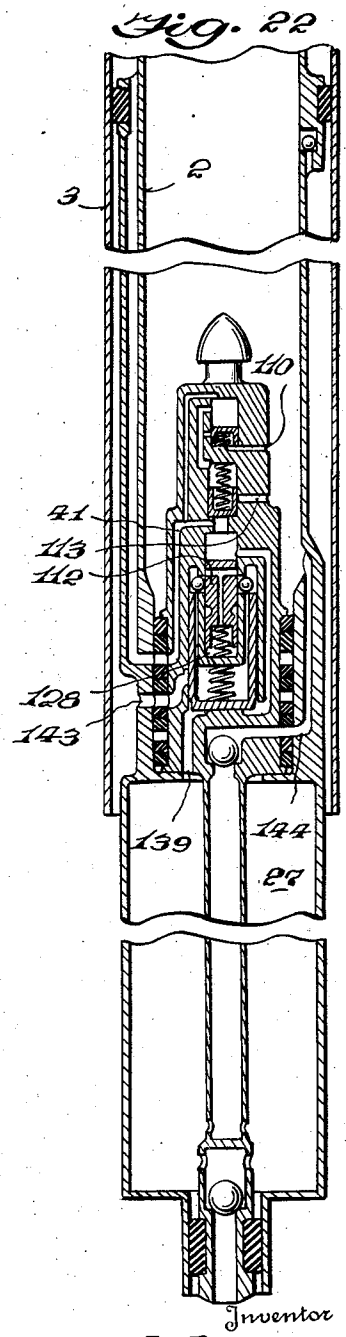


Fig. 22



Inventor

Oscar E. Dempsey,

By Barry & Cyr

Attorney

Patented Mar. 5, 1946 2,396,162

UNITED STATES PATENT OFFICE

2,396,162

MEANS FOR FLOWING WELLS

Oscar E. Dempsey, Tulsa, Okla.

Application August 24, 1942, Serial No. 456,107

11 Claims. (Cl. 103—231)

This invention relates to improvements in means for flowing wells, and more particularly but not by way of limitation, to maintain a substantial continual flow of well fluid from the production strata without interference from the lifting medium.

Many present day automatical intermitting units such as wire line plumb bob types move the valve to open position to allow motive pressure fluid to slug the hydrostatic head of oil to the top of the well, and the motive pressure fluid remains in the eduction tubing as a counteracting pressure against the bottom hole pressure of the well which must necessarily be bled off to the top of the well prior to an efficient emission of oil from the production strata into the eduction tubing. Furthermore, in intermitting units having a one step slugging operation for the hydrostatic head of oil, all the oil is not displaced from the eduction tubing, but due to friction, condensation and other losses, part of the oil falls back into the eduction tubing and cooperates with the residue motive fluid to counteract against the sand pressure of the well. Consequently there are intervals of time between slugging operations to allow for bleeding residue motive fluid, in addition to the entrapped oil remaining in the eduction tubing, which intervals of time can only be determined by wasteful trial and error methods as well as considerable waste of supply pressure fluid. The detriment of such a counteracting pressure against the production strata pressure is to decrease the differential pressure across the production strata thereby dissipating the pressure of the well, which in turn decreases the emission of the oil into the eduction tubing.

It is therefore an important object of this invention 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 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 repetition 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, eliminating any back pressure or sand pressure.

And still another object of this invention is a substantially continuous operation for displacing oil from a well by progressively lifting small quantities from a lowermost collection chamber to a reservoir disposed above, which upon a predetermined quantity received would be intermittently slugged therefrom by the same inlet pressure gas in greater quantities but at the same pressure.

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 unit disposed in a well bore.

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

Fig. 2 is a vertical sectional view of the lifting unit removed from the well annulus.

Fig. 3 is a view taken on lines 3—3 of Fig. 2.

Fig. 4 is a view taken on lines 4—4 of Fig. 2.

Fig. 5 is a view taken on lines 5—5 of Fig. 2.

Fig. 6 is a view taken on lines 6—6 of Fig. 2.

Fig. 7 is a view taken on lines 7—7 of Fig. 2.

Fig. 8 is a view taken on lines 8—8 of Fig. 2.

Fig. 9 is a view taken on lines 9—9 of Fig. 2.

Fig. 10 is a view taken on lines 10—10 of Fig. 2.

Fig. 11 is a view similar to Fig. 2 showing a closed position of the lower valve unit.

Fig. 12 is a vertical sectional view of the lowermost portion of the lifting unit housing.

Fig. 13 is a view taken on lines 13—13 of Fig. 12.

Fig. 14 is a view taken on lines 14—14 of Fig. 12.

Fig. 15 is a view taken on lines 15—15 of Fig. 12.

Fig. 16 is a view taken on lines 16—16 of Fig. 12.

Fig. 17 is a vertical sectional view of a modified form for the lower valve intermitting unit.

Fig. 18 is a view taken on lines 18—18 of Fig. 17.

Fig. 19 is a vertical sectional view of the lowermost portion of the lifting unit shown in Fig. 1A.

Fig. 20 is a schematic view showing the flow passageway of the unit with the valves in one position.

Fig. 21 is a similar view with the valves arranged in another position.

Fig. 22 is a schematic view for the modification shown in Fig. 17.

Referring to the drawings in detail particularly Figs. 1 and 1A reference character 2 represents a string of tubing disposed in spaced relation to the well casing 3 extending to the subsurface 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 tubing 2 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 motive fluid into the lifting unit 18 as will be hereinafter explained. The tubing 13 is connected by collar 19 to a lower tubing string 20 of larger diameter extending into a seating cavity 21 of housing 22 for the unit 18. 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 to the housing 22 and is welded to a shoulder 24 thereof, in order to support the housing 22 and lifting unit 18 in the well casing. An annular flange or projection 25 is provided on housing 22, and has secured thereto by welding, or the like, a tubing 26 extending below the casing into the well bore in proximity of the shot hole. The interior of tubing 26 acts as a filling chamber 27 for oil or fluid to be lifted from the well as will be hereinafter referred to. The lowermost portion of tubing 26 is provided with a seating nipple 28 welded thereto, which in turn is provided with a perforated hollow plug or gas anchor 29 for a purpose as will be hereinafter referred to.

The lifting unit is anchored in the housing 22 by packing 32 surrounding a cylindrical housing 30 having a fishing neck 31. A string of tubing 33 of decreased diameter extends from the lowermost portion of housing 30 into threaded connection with a cylindrical housing 34 anchored by packing rings 35 in the nipple 28. As shown in Fig. 19, a standing valve 36 is provided in housing 34 for a purpose as will be hereinafter referred to. A differential valve unit 37 is arranged in the housing 30, while a second valve unit 38 is arranged immediately below unit 37 for a purpose as will be hereinafter referred to.

Motive fluid pressure is constantly maintained in the well from a surface compressor or like equipment (not shown) into chamber 16, through apertures 15, passageway 17, and into lifting unit 18 through a plurality of annularly spaced ports 39 in housing 22, said ports 39 communicating with complementary ports 40 provided in cylindrical housing 30. From ports 40 motive fluid is discharged into conduit 41 in communication with valve units 37 and 38 (see Figs. 1A and 12).

Oil or fluid flowing from the production strata through the member 34 is discharged into chamber 27 through ports 46. Motive fluid discharging into the chamber 27 from ports 45 forces oil therefrom through ports 47 upward through tubing 33. Check valve 36 in housing 34 prevents retrograde flow of oil back into the producing strata as well as prevents any pressure of input fluid on the bottom hole pressure of the well. Oil being displaced through tubing 33 passes through a ball check valve 48 (Fig. 12) provided in housing 30 and upward therein through a passageway 49. Referring to Figs. 1A and 12 passageway 49 is in communication through ports 49*a* and 49*b* with a passageway 50, Fig. 1A in housing 22 allowing displacement of fluid from chamber 27 into chamber 51 provided by tubing 20 and acting as a reservoir for storing the well fluid. It will be apparent that the length of tubing providing reservoir chamber 51 is much longer than the tubing providing filling chamber 27 in order to create an increased storage chamber as compared to the lower chamber 27. In practice it has been found that a ratio of 10 to 1 is satisfactory.

Referring now to the valve unit 38 (Figs. 2 to 11 incl.) confined within the outer cylindrical housing 30, a cylindrical manifold 52 is disposed within the housing and extends substantially throughout the valve unit 38. In the upper portion of manifold 52 is a valve housing 53 in which is loosely disposed an elongated main valve 54. The lower end of the housing 53 received a threaded collar 55 carrying a pair of latch members 56 secured therein by studs 57. The collar 55 has a pair of diametrically opposed slots 55*a* (Fig. 5) to allow free movement of the lower ends of the members 56 toward and away from the manifold 52 for a purpose as will be hereinafter explained. A cylindrical slide valve 58 is disposed in the manifold 52 below the members 56. Slideable in the valve 58 is a cylindrical piston valve 59 wholly confined within the outer valve 58. Below the lowermost end of the valve 58 and manifold 52 is a stationary housing 60 in which is fixedly arranged a cylindrical sleeve 61 having a bore 62. Immediately below the sleeve 61 is a liquid discharge valve 63 adapted to travel between the bottom of sleeve 61 and shoulders 64 provided in housing 60. A nut 65 is secured to the lower end of the housing 30 to secure the unit 38 immediately below the unit 37 in complete assembly (as shown). A cylindrical member 65*a* supported by the nut extends downwardly therefrom and receives the packing 32.

Referring to the upper portion of the unit 38, immediately below the valve 54 is a valve push rod 66 having an upper shaft 67 and a lower shaft 68. The push rod 66 extends loosely through an aperture 69 of collar 55 and downwardly between the latch members 56 into the interior of the cylindrical valve 58. A sleeve 70 loosely surrounds the lower shaft 68 and is provided at its top with a V-shaped groove 71 for a purpose as will be hereinafter described. The sleeve 70 is provided with shoulders 72 for anchoring one end of a spring 73 having its opposite end resting on a surface 74 of valve 58.

Figs. 2 and 11 show the different operating positions of the valve unit with Fig. 2 showing the upper valve 54 in open position while Fig. 11 shows how such valve in closed position along with the complementary positions of the auxiliary valves. In the operation of the valve unit, motive pressure fluid is directed through conduit 41 from passageway 17 upward to the top of the valve unit 38 through an apertured baffle member 75 interposed between top valve unit 37 and lower unit 38.

As shown in Figs. 2 and 11, particularly Fig.

11, supply pressure fluid passes through the apertured baffle 75 into a bleed port 76 in valve 54 and leaks between the valve 54 and its bore through aperture 69 into chamber 78 provided by manifold 52 between valves 54 and 59. It is to be understood that the fit of the valve 54 in its bore, especially the short periphery of the valve below the horizontal leg portion of the port 76 is such that supply pressure fluid discharging from port 76 is allowed to leak between the outer periphery of valve 54 and its bore through the aperture 68 and into the chamber 78. It will be apparent that a small amount of the pressure fluid may leak through port 87 and into the pump chamber, however such leakage is not sufficient to warrant any displacement of liquid whatsoever. In this position the differential pressure across the valve 59 has been decreased (as will be hereinafter explained) so that the pressure aided by tension spring 73 causes movement of piston valve 59 downward until valve port 79 moves past a port 80 provided in slide valve 58 thereby preventing escape of the fluid therefrom. Leakage pressure flowing into chamber 78 will continue the movement of the valve 59 downward to where the bottom face 81 contacts the top of valve sleeve 82 which in turn contacts follower rod 83 to move pilot valve 63 downward past ports 49*a* and 49*b* providing communication between passageways 49 and 50. Continued downward movement of valve 59 causes it to contact the apertured base 84 of valve 58 thereby moving valve 58 downward out of contact with the latch members 56. The valve 58 is held by friction and does not move downward of its own weight during the preliminary movement of the valve 59. During initial downward movement of valve 59, the sleeve 70 is prevented from moving downward by the tension of the spring 73. As soon as the top of valve 58 moves below the shoulders 85 of the latches 56 (Fig. 2), the latch members are free to swing outward toward the manifold 52 thereby allowing downward movement of the shaft 67 of the push rod 66. Push rod 66 is then moved downward by valve 54 actuated by supply pressure fluid. Downward movement of valve 54 to open position (as shown in Fig. 2) opens ports 87 to supply pressure fluid which is directed from ports 87 downward through a passageway 88 (Fig. 4) in manifold 52 to be discharged into a chamber 89 below the base 84 of slide valve 58 (see Figs. 2 and 8), said passageway 88 communicating with chamber 89 through port 90 provided in manifold 52 (Figs. 8 and 11). From chamber 89 supply pressure fluid is discharged through port 91 communicating with a passageway 43 provided in manifold 60 and extending downward (see Figs. 13 to 16) into communication with ports 45 and discharged into the bottom chamber 27.

However, with the upper valve 54 in open position (Fig. 2) the lower valve 63 has been moved downward to close port 49*a*. In order for the supply pressure fluid to displace well fluid from chamber 27 and through ports 49*a*, it is necessary to move the unit 38 upward into a position shown in Fig. 11. In order that valve 63 will be moved upward, the differential pressure maintained on both sides of the valve 63 must be greater than the differential pressure between chambers 78 and 89. It will be understood that the relationship of pressures are commensurate with the areas of the various pistons or piston valves and the ratio between them is a matter of choice dependent upon a particular well. The manifold 60 has a small port 60*a* providing communication between port 49*a* (Fig. 10) and the chamber 63*a*. These ports measure the reservoir pressure in order to determine the differential across the valve 63. With the valve 63 closed and valve 54 opened (Fig. 2) it is to be noted that the latch members 56 are swung outwardly and prevent any upward movement of valve 58 as long as valve 59 remains in its lowermost position. With an increase of differential pressure across valve 63 pressure fluid and liquid in chamber 27 moves valve 63 upward to allow displacement of liquid through discharge ports 49*b*. Simultaneous with upward movement of valve 63, rod 83 (Fig. 2) and follower 82 are moved upward to move piston valve 59 upward to a point where port 79 moves into communication with port 80 (Fig. 11), which in turn communicates with passageway 96 through ports 80*a*. It will be apparent that with motive pressure fluid imposing a downward thrust across the top of valve 59, a similar upward thrust must be produced to overcome the first mentioned thrust if the valve parts are to move upwardly. As the chamber 89 assumes greater pressure, the pressure differential across the valve 59 between the chambers 78 and 89 is decreased. Furthermore, the pressure at 89 corresponds with the pressure within lower chamber 27, and said pressure influences the bottom face of valve 63 either through the medium of entrapped liquid or by direct correspondence. As heretofore stated, since the input pressure is to be greater than the pressure existing at 63*a*, a pressure condition will be approached and quickly passed in chambers 89 and 27 enabling the increasing upward thrust against pilot valve 63 to overcome the diminishing downward thrust against valve 59. With the valve 59 moved to this position pressure fluid within the chamber 78 is bled or discharged to passageway 96 thereby decreasing the differential between chambers 78 and 89. The upward movement of piston valve 59 simultaneously moves push rod 66 upward which in turn moves valve 54 to an up or closed position thereby blocking off ports 87 and 88. The closing of valve 54 moves the large diameter shaft 67 of rod 66 out of contact with the latches 56, so that the latches are swung inwardly by sleeve 70 (Fig. 11) to release and allow movement of valve 58 upwardly. This is caused by a reversal of pressure differential wherein the top portion of valve 58 contacts the shoulders 93 of latches 56. In this position of the unit 38 (Fig. 11) well fluid has been displaced through the outlet ports 49*b* to the reservoir 50, and immediately subsequent the valve 59 has been moved upwardly to bring port 92 in communication with ports 80*a* and allow a predetermined rate of exhausting or bleeding off of the residue motive pressure fluid which caused the displacement of the well fluid. It will be apparent in this operation that the upper valve 54 is closed and locked by the latch members 56.

With substantially all the well fluid displaced from the filling chamber 27, it is necessary to bleed off residue motive pressure fluid from the chamber in order that the bottom hole pressure of the well will continue to discharge well fluid into the chamber. With the exhaust of supply pressure fluid from chamber 27, the differential between chamber 78 and chamber 89 is decreased to such an extent that tension spring 73 exerts force to cause downward movement of valve 59 thereby closing off port 79 from passageway 96. In this condition the constantly maintained supply pressure through apertured baffle 75 dis-

charges through bleed port 76 and leaks between the valve 54 and its bore into chamber 78, and with the closing off of port 79 immediately builds up pressure to cause continued downward movement of piston valve 59 as heretofore explained. This increase of pressure in chamber 78 likewise acts against the top portion of slide valve 58 to start its movement downward in conjunction with piston valve 59 contacting the top face of base 84 thereof, thereby unlocking the latches 59 from a position shown in Fig. 11 to a position shown in Fig. 2, and thus allowing downward movement of piston valve 54 to open position and discharge of pressure fluid into passageways 88 and 43, as heretofore described.

The formation gas from the sand strata is liberated from the well through chamber 11 along with the used or residue supply pressure fluid exhausting through passageway 96. These gases are discharged into the tubing 2 through the check valve 12. From Fig. 2, it will be apparent that supply pressure fluid during the operation of the valve unit 38 simultaneously flows through passageway 41 to be constantly maintained at the top of the valve unit 37. In this manner inlet pressure fluid is maintained in chamber 100 to keep valve 101 disposed in a lowermost position of valve housing 102. Housing 102 is provided with a port 103 communicating with a passageway 104 which in turn communicates with a chamber 105 arranged in the unit housing 106, and in which is disposed a lower valve 107. With pressure fluid acting against the underface of valve 107 from apertured baffle 74, and simultaneously, flowing through passageway 104 into chamber 105, it will be apparent there is an equal pressure on both sides of the valve 107 whereby tension spring 108 maintains it in a lowermost position. With the valve unit 37 maintained in this position, motive fluid is continually directed through unit 38 to displace oil from chamber 27 into the reservoir chamber 51 which communicates with a chamber 109 below valve 101 through a passageway 110.

With a sufficient increase in hydrostatic head in the reservoir chamber 51 complementary with an increase in chamber 109 and assisted by the tension spring 111, the motive pressure fluid at the top of the valve 101 is overcome causing the valve to move vertically upward and close off the port 104, and open a lower port 112 communicating with passageway 104. With the valve 101 moved to an upward position supply pressure fluid in chambers 105 is allowed to bleed off through the passageway 104 into chamber 109 thereby unbalancing valve 107 by relieving pressure on one side thereof. With the unbalancing of valve 107, supply pressure fluid flowing through apertured baffle 75 is directed through ports 113 into chamber 51 for displacing or slugging the well fluid present in the chamber upward to the top of the well.

Operation

In operation of the preferred embodiment, it will be apparent that motive fluid discharges through ports 39 to cause actuation of the valve unit 38 to flow motive fluid through passageway 88 and 43 through ports 45 into the filling chamber 27 for displacing oil therein that has emitted from the production strata. The oil is displaced through ports 49b by movement upward of the valve 63. From 49b oil flows through passageway 50 into the reservoir 51 and builds up a hydrostatic head sufficient to overcome the static pressure acting on intermitting unit 37 which functions to slug the oil onto the top of the well. The upward movement of valve 58 allows discharge of residue motive fluid in chamber 27, passageway 43 and chamber 89 through passageway 96 and ports 96a outward to the top of the well thereby maintaining the production pressure to provide continual emission of oil from the strata into the chamber 27. Furthermore, during discharge of motive fluid into chamber 27, valve 58 is locked by the latch members 56 (Fig. 2) to prevent bleeding off of motive fluid before displacement of oil from chamber 27. Similarly, valve 54 is locked by the latch members (Fig. 11) to prevent flow of motive fluid through unit 38 during the bleeding operation.

From the foregoing, it will be apparent that the invention contemplates the lifting of small quanties of oil from a lower filling chamber to a higher reservoir to be intermittently slugged to the surface of the well. The lifting unit functions in such manner to prevent any motive fluid counteracting the bottom hole pressure of the well and assuming a high differential across the strata to provide constant emission of well fluid from the production strata. Furthermore, the lifting apparatus will operate successively in deep wells having considerable production pressure, or with shallower wells having a minimum amount of production pressure to displace the oil with a minimum of motive fluid in a most efficient and economic manner.

In Figs. 17 and 18 is shown a modification of the lifting unit and more particularly the lower valve intermitting apparatus. It will be apparent from inspection of Fig. 17 that the numerous fluid inlet and outlet ports are disposed in different positions from those disclosed in Fig. 1A of the preferred embodiment. Referring now to Fig. 17, the valve unit 38' receives supply pressure fluid from passageway 41, for maintaining the piston valve 121 in a lowermost or open position (not shown), and in this position, a lower piston valve 122 is prevented from moving upwardly by a plurality of annular spaced balls 123 arranged between the valves 121 and 122. A valve housing 124 separates valves 121 and 122. Valve 121 is provided with an annular groove 125 complementary to an annular groove 126 on valve 122. Housing 124 is provided with a plurality of apertures 127 in which the balls 123 are disposed.

With input pressure fluid acting against the valve 121 to move it downward the balls are moved out of groove 125 through apertures 127 and partially into the groove 126 of valve 122. Ir this position, valve 122 is locked by the balls to prevent any upward movement thereof. It will be apparent as will be hereinafter referred to, that the balls operate in similar manner to prevent downward movement of piston valve 121 during an up position of valve 122 (Fig. 17). During the open position of valve 121 motive fluid is directed through ports 135 (Fig. 18) in housing 124 communicating with an annular groove 136 provided in manifold 137 which in turn communicates with a plurality of axially arranged passageways 138 extending through the manifold 137 to a position below the valve for discharging supply pressure fluid through ports 139 into the filling chamber 27 as in the preferred embodiment. With the valve 121 in open position (not shown) motive fluid pressure due to the fit of the valve 121 and its bore is allowed to leak there between to be discharged into the port 140—A communicating therewith, and then to a communicating port 140 which in turn communicates

with a chamber 128 below the valve. When the pressure in chamber 128 becomes equivalent to the pressure acting on top of the valve 121, the valve is moved upwardly as shown in Fig. 17, through the assistance of a tension spring 129. The fit of the valve 121 and its bore as well as the ports 140 and 140—A can be constructed so that the bleeding into chamber 128 is substantially commensurate with the flow of supply pressure fluid into chamber 27 for substantially displacing all the entrapped oil therein. In exhausting residue input fluid from chamber 27 after displacement of the oil therefrom, the valve 121 has moved to an up position thereby unlocking valve 122 and allowing pressure fluid in passageway 138 to overcome the tension of spring 141 to raise valve 122 and open port 142 whereby residue pressure fluid is exhausted through a passageway 143 communicating with the chamber 11 shown in Fig. 1A of the preferred embodiment. It will be apparent that with valve 122 in up position, the balls 123 have been moved into grooves 125 (not shown) to lock valve 121 as heretofore explained to prevent any downward movement thereof until exhaust pressure is relieved from valve 122 allowing spring 141 to move it downward and unlocking valve 121. The residue pressure fluid discharges from passageway 143, it being understood that the oil was displaced from chamber 27 through a passageway 144 provided in manifold 137. Packing 145 surrounds the manifold 137 as shown in the preferred embodiment. With the residue pressure exhausted from chamber 27 pressure is relieved against the valve 122 whereby tension spring 141 moved it to a lower position closing port 142 simultaneously with unlocking valve 121 and opening of ports 135 to discharge supply fluid into passageway 138 and filling chamber 27 for again displacing the well fluid therein. It will be apparent that during the upward movement of valve 121 pressure fluid in chamber 128 will be bled off through port 140 and port communicating with annulus 136.

From Fig. 17, it will be apparent that motive pressure fluid during the operation of valve unit 38' simultaneously flows through an aperture 147 into the continued passageway 41 to cause operation of valve unit 37 when the hydrostatic head of fluid increases sufficiently in chamber 51 as previously described in the preferred embodiment.

From Fig. 1A, it will be apparent that the intermitting unit can be run into the well bore and seated in housing 22 on a wire line and set down with a set of conventional jars (not shown). The fish neck 31 allows for connection with a wire line. Furthermore, in the event of any repair or adjustment of the intermitting unit can be pulled from the well through the tubing 2 by means of the wire line and jars without necessarily pulling the tubing itself. The tubing 13 is of sufficient diameter to pass the unit. This invention contemplates a removeable bottom hole intermitting unit for displacing oil.

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 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 with the reservoir, means for introducing constantly maintained motive pressure fluid from the casing into the filling chamber for displacing well fluid therein into the reservoir, said means permitting immediate bleeding off of residue motive fluid from the filling chamber, said means so constructed and arranged to prevent introduction of motive pressure fluid into the filling chamber during the bleeding off of the residue fluid therefrom, and means responsive to the hydrostatic head of well fluid in the reservoir to direct motive fluid from the casing into the reservoir for slugging the well fluid from the well.

2. 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 fluid emitting therein from the production strata, means for receiving the displaced fluid, said first mentioned means permitting bleeding off of the residue motive fluid from the filling chamber, 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.

3. In a well flowing apparatus including in combination with the well casing and tubing for directing constantly maintained motive fluid into the well, a reservoir communicating with the tubing, a filling chamber communicating with the casing and the reservoir, a valve unit communicating with the casing and filling chamber for periodically introducing motive fluid into the filling chamber for displacing well liquid emitting therein from the production strata, said valve unit responsive to the displacement of the well fluid from the filling chamber to allow exhaust of residue motive fluid and formation gas in the chamber to a passageway communicating with the tubing, and an independently operated valve unit responsive to the hydrostatic head of well fluid in the reservoir for directing the motive fluid into the reservoir and slugging the well fluid upward in the eduction tubing.

4. In an apparatus for lifting fluid from a well having an eduction tubing, said apparatus including a reservoir communicating with the eduction tubing, a filling chamber communicating with the well casing and with the reservoir, a lifting unit interposed between the reservoir and the filling chamber, said lifting unit comprising upper and lower valve units communicating with motive pressure fluid constantly maintained in the well casing, said lower valve unit having means movable to direct motive fluid therethrough into the filling chamber for displacing well fluid therein into the reservoir, and slide valve means in the lower valve unit movable in response to the displacement of well fluid from the chamber to provide communication between the filling chamber and the eduction tubing whereby residue motive fluid is allowed to bleed off immediately therefrom, means in the lower unit preventing movement of the first mentioned means for directing motive fluid to the filling chamber during the bleeding of the residue fluid, said upper valve unit responsive to the hydrostatic head in the reservoir to direct motive fluid thereto for slugging the well fluid to the top of the well.

5. In an apparatus for flowing wells including a filling chamber, means for periodically introducing a constantly maintained motive pressure

fluid into the filling chamber in the well for displacing fluid emitting therein from the production strata, a reservoir above the filling chamber for receiving the displaced fluid, said means comprising a valve movable in response to the displacement of the well fluid from the filling chamber to allow bleeding off of residue motive fluid therefrom, and means in the first mentioned means preventing introduction of motive fluid into the filling chamber during the bleeding off of the residue motive fluid, and means, operable independently of the first mentioned means and responsive to the hydrostatic head in the reservoir for directing motive 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 lifting unit for introducing a constantly maintained motive pressure fluid into the filling chamber in the well, 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 piston valve movable to direct motive fluid into the filling chamber, a valve in the lifting unit movable in response to the displacement of the oil from the filling chamber to allow bleeding off of residue motive fluid therefrom, means in the lifting unit preventing movement of the piston valve for introducing motive fluid during bleeding off of the residue fluid from the filling chamber, and means operable independently of the first mentioned means and responsive to the hydrostatic head of oil in the reservoir for directing motive fluid thereto for slugging the oil to the top of the well.

7. In an apparatus for flowing wells including a lifting unit for introducing a constantly maintained motive pressure fluid into a filling chamber in the well for displacing oil emitting therein from the production strata, a reservoir above the filling chamber and in communication therewith for receiving the displaced oil, said lifting unit interposed between the reservoir and the filling chamber and comprising a piston valve movable in response to motive fluid to direct motive fluid into the filling chamber, a valve in the lifting unit movable in response to the oil being displaced from the filling chamber to allow bleeding off of residue motive fluid therefrom, and means in the lifting unit preventing movement of the valve during the introduction of motive fluid through the lifting unit, and means operable independently of the first mentioned means and in response to the hydrostatic head of oil in the reservoir for directing motive fluid therein to slug the oil to the top of the well.

8. In an apparatus for lifting fluid from a well having an eduction tubing and well casing, said apparatus including a reservoir communicating with the eduction tubing, a filling chamber communicating with the well casing and with the reservoir, means for introducing constantly maintained motive pressure fluid from the casing into the filling chamber for displacing well fluid therein into the reservoir, said means permitting immediate bleeding off of residue motive fluid and formation gas from the production strata present in the filling chamber after displacement of the well fluid, latching means preventing introduction of the motive fluid during the bleeding off of the residue fluid, and means responsive to the hydrostatic head of liquid in the reservoir to direct motive pressure fluid from the casing into the reservoir for slugging the well fluid into the reservoir.

9. In an apparatus for flowing wells including a filling chamber, a removable lifting unit for introducing motive pressure fluid into the filling chamber in the well for displacing oil emitting thereto from the production strata, a reservoir above the filling chamber for receiving in the displaced oil, said lifting unit comprising a piston valve moveable to open a communicating passageway for directing motive fluid into the filling chamber, a liquid discharge valve in the lifting unit moveable in response to the displacement of the oil from the filling chamber to allow bleeding off of residue motive fluid therefrom, and means in the lifting unit preventing movement of the piston valve for introducing the motive fluid into the passageway during bleeding off of the residue fluid from the filling chamber, and means operable independently of the first mentioned means and responsive to the hydrostatic head of oil in the reservoir for directing motive fluid thereto for slugging the well fluid to the top of the well.

10. In an apparatus for lifting fluid from a well having an eduction tubing, a reservoir communicating with the eduction tubing, a filling chamber communicating with the well casing and with the reservoir, a valve unit interposed between the filling chamber and the reservoir for introducing constantly maintained motive fluid from the casing into the filling chamber for displacing well fluid therein upwardly to the reservoir, said valve comprising a main valve, means responsive to one position of the main valve for directing motive fluid into the filling chamber, a valve moveable in response to the flow of motive fluid against the liquid in the filling chamber to allow discharge therefrom, a piston valve moveable to bleed off residue motive fluid from the filling chamber, a slide valve, a rod, a plurality of latch members, said slide valve moveable in response to one position of the main valve to move the piston valve to a closed position relative to exhaust ports for bleeding residue fluid, said rod and latch members maintaining the piston valve in closed position during the introduction of motive fluid into the filling chamber, and means operable independently of the valve unit and responsive to the hydrostatic head of fluid in the reservoir to direct motive fluid from the casing into the reservoir for slugging the well fluid from the well.

11. 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 well fluid from the filling chamber and simultaneously preventing the introduction of motive pressure fluid during the bleeding off of the residue fluid, and means independent of the first mentioned means responsive to the hydrostatic head of well fluid in the reservoir for introducing motive pressure fluid thereto for slugging the fluid from the well.

OSCAR E. DEMPSEY.