

Sept. 30, 1952

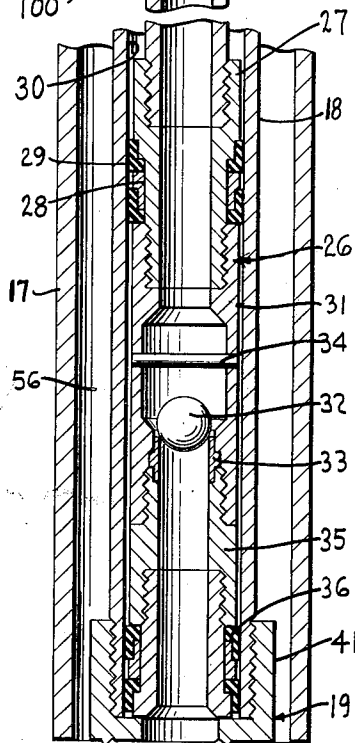
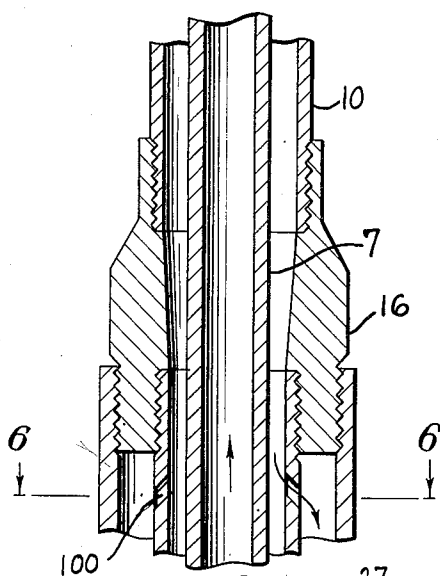
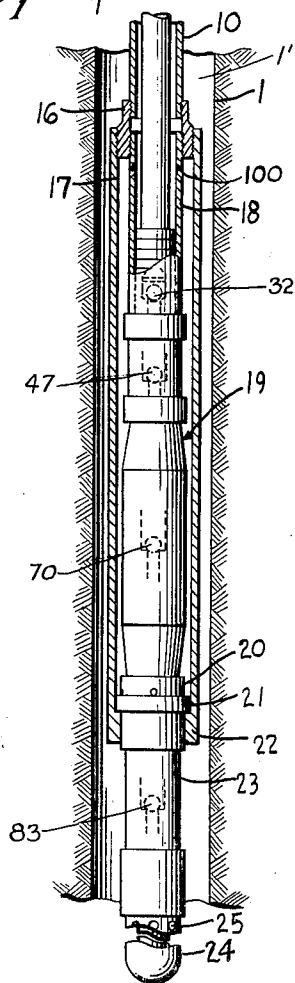
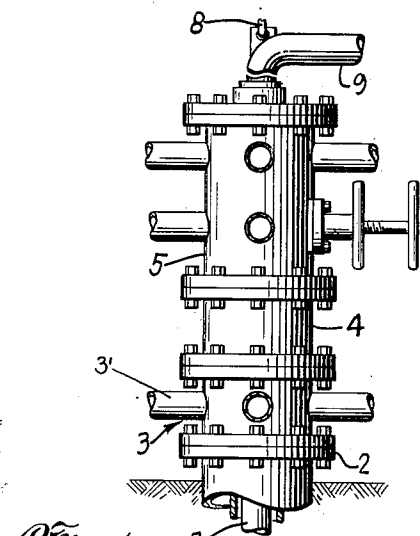
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2,612,111

GAS LIFT

Filed March 6, 1950

3 Sheets-Sheet 1



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Fig. 3

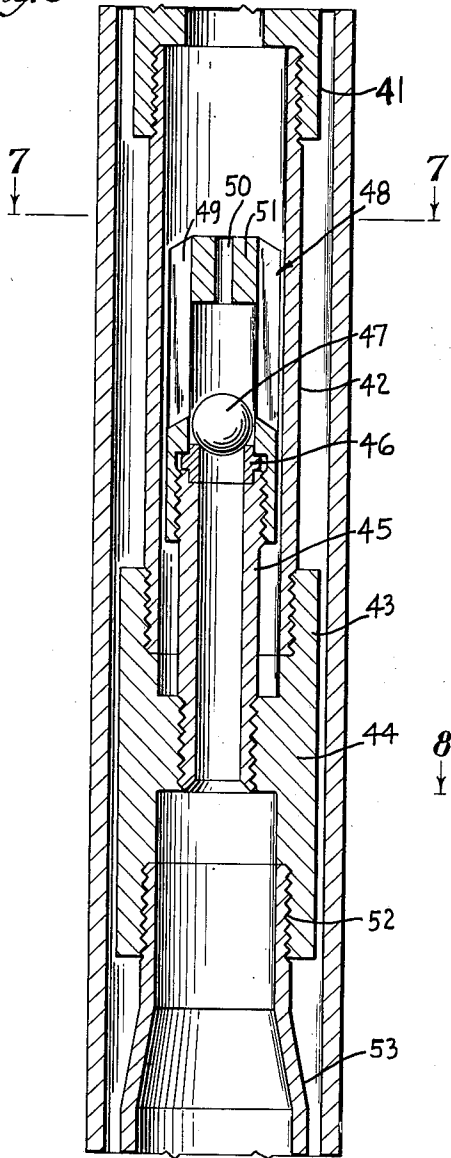
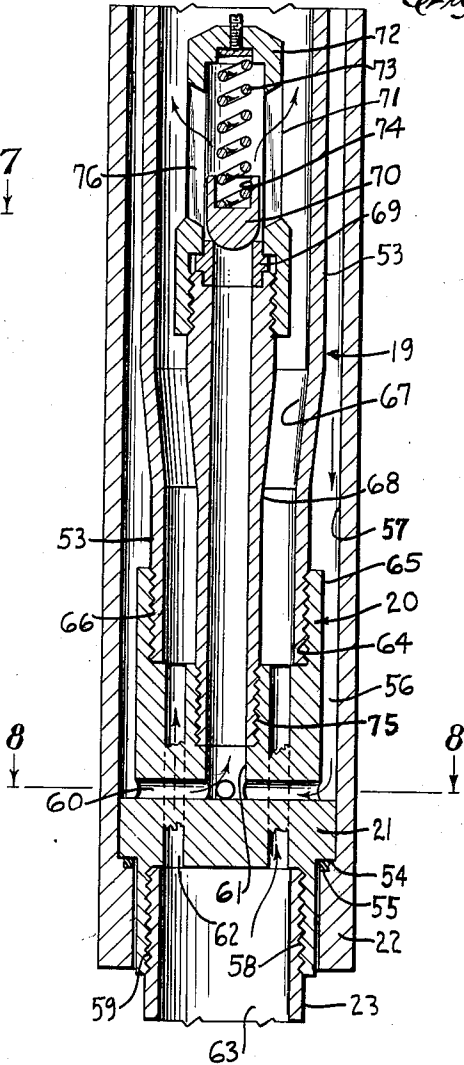


Fig. 4



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Fig. 5

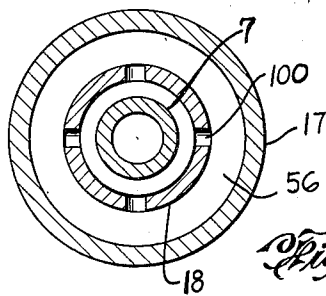
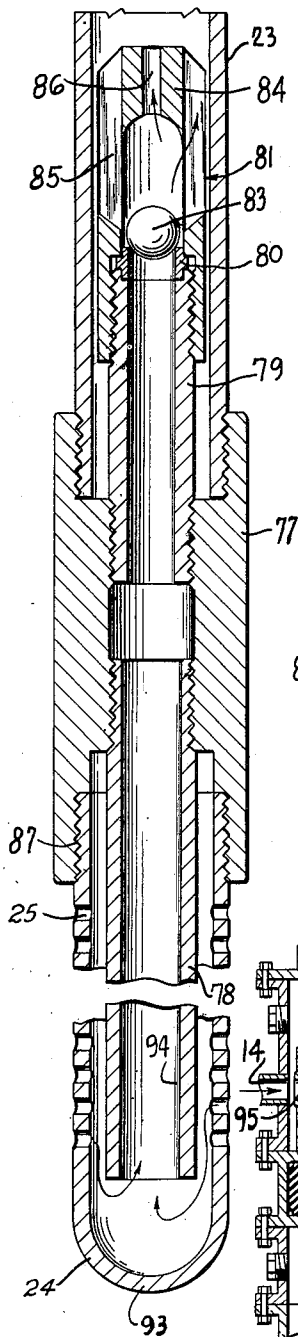


Fig. 6

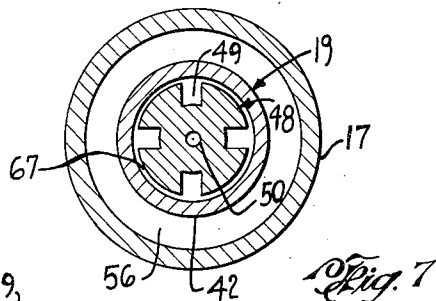


Fig. 7

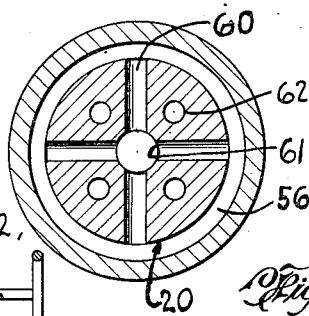


Fig. 8

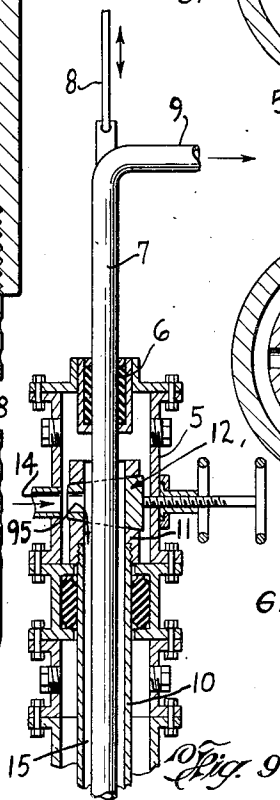


Fig. 9

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UNITED STATES PATENT OFFICE

2,612,111

GAS LIFT

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Application March 6, 1950, Serial No. 147,989

2 Claims. (Cl. 103-5)

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This invention relates to apparatus for lifting fluid, as oil, from a well by injecting gas into the apparatus externally of a hollow pumping string therein so that the gas may then flow upwardly into a center sleeve of the apparatus, and into a position from whence the pumping string may lift the fluid to the top of the well.

It is an object of this invention to provide an apparatus adapted for connection to the end of the tubing string in which the pumping string operates in such a manner that gas under pressure may be injected into the tubing string externally of the pumping string from whence it may pass upwardly within the sleeve centrally within the apparatus to create the suction which will draw fluid upwardly therein and into a position from which the pumping string may then operate to withdraw the fluid to the top of the well.

It is another object of this invention to provide an apparatus of this class in which gas, under pressure, is forced downwardly through an annular space between an outer housing and an inner sleeve member and then upwardly past a gas lift valve within the sleeve member and through a standing valve thereabove, thereby creating the suction which will draw fluid, as oil, through a ported plug closing the bottom of the housing, and into the space around the gas lift valve.

It is yet a further object of this invention to provide an apparatus of this class in which the fluid passes upwardly through the travelling valve operable in a working barrel of the apparatus, and from thence through a hollow sucker rod or pumping string to the top of the well.

It is yet another object of this invention to provide an apparatus of this class equipped with a closure plug for the lower end of the housing, which plug has passage means therein to place the annular space between housing and sleeve means in communication with a standing valve connected centrally to the plug; and which plug also has axial port means therein for placing the space within the sleeve means surrounding the gas lift valve in communication with space within a tubular member connected to the plug and extending therebelow.

It is yet another object of this invention to provide an apparatus of this class in which the plug which closes the housing has a tubular member connected therebelow having a standing valve therein and terminating downwardly in a bull plug having radial ports through the

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walls thereof for receiving fluid, as oil, from the bottom of the well.

It is yet another object of this invention to provide apparatus of this class which is operated in conjunction with means at the top of the well for closing the well bore around the tubing string; for permitting the pumping string to move vertically therethrough, in sealed engagement therewith; and for permitting gas under pressure to be injected into the annular space between tubing string and pumping string.

Other and further objects will be apparent when the specification is considered in connection with the drawings, in which:

Fig. 1 is an elevation of the apparatus, part in section.

Fig. 2 is a sectional elevation of the apparatus showing the connection of the gas lift to the tubing string.

Fig. 3 is a sectional elevation of the central portion of the gas lift.

Fig. 4 is a sectional elevation showing details of the gas lift valve and the terminal plug of the gas lift.

Fig. 5 is a sectional elevation showing the lower end of the gas lift.

Fig. 6 is a sectional plan view taken along line 6-6 of Fig. 2.

Fig. 7 is a sectional plan view taken along line 7-7 of Fig. 3.

Fig. 8 is a sectional plan view taken along line 8-8 of Fig. 4.

Fig. 9 is a sectional elevation taken through the apparatus at the top of the well.

As shown in Fig. 1, a well bore 1 is closed at the top thereof by the casing head 2, which has the head 3 connected on thereabove to which connections may be made, as the connections 3' to establish fluid communication between the exterior of the head 3 and the annular space 1' between the well bore 1 and the tubing 10. The seal containing member 4 is installed on top of the head 3 to connect it with the Christmas tree 5. As shown in detail in Fig. 9 the Christmas tree 5 has the seal 6 at the top thereof, through which may operate the pumping string 7, which is connected thereabove by the member 8, to the walking beam of a pumping unit, not shown. Fluid drawn upwardly through the pumping string 7 is discharged outwardly therefrom through an elbow 9.

The pumping string 7 operates within a tubing string 10, which is connected into the valve member 11 of the Christmas tree 5. With the plug valve 12 in the position shown in Fig. 9, gas may

be injected under pressure through the ports 14 to pass downwardly through the annular space 15 between pumping string and tubing string.

As shown in Fig. 1, the tubing string 10 terminates downwardly in a coupling 16, which has connected outwardly thereon the housing 17, and inwardly thereinto the working barrel 18. The working barrel has connected thereto the sleeve means, or sleeve assembly 19, which terminates downwardly in the plug 20, which has the shoulder 21 thereon to bear against the end 22 of the housing 17 in assembly. The tubular member 23 is connected into the plug 20 and extends therebelow and terminates in the bull plug 24, which is positioned in the bore 1 to receive fluid, as oil, thereinto through the radial ports 25.

The pumping string, or hollow sucker rod string 7, terminates downwardly within the working barrel 18 in the travelling valve 26. This travelling valve 26 has the connection member 27 which connects directly to the pumping string 7, and which has a turned down portion 28 thereon to receive the sealing member 29, which contacts the bore 30 of the working barrel 18. The valve body 31 is connected to extend below the connection member 27, and has therein the check valve or ball 32, which normally seats by gravity upon the valve seat 33, and which is restrained from upward motion above the step pin 34. The terminal member 35 of the travelling valve has the sealing member 36 confined therearound to also seal with the working barrel bore 30.

A sleeve assembly 19 is connected to the working barrel 18 by means of the coupling 41, which has connected therebelow the sleeve member 42. This member 42, in turn, connects into the coupling member 43, which has the transverse wall 44 thereacross. The standing valve stem 45 is connected into the transverse wall 44 and extends upwardly within the sleeve member 42, and has the valve seat 46 at the top on which seats the ball or valve 47. The upper end of the stem 45 is threaded to receive thereon the standing valve body 48, which has the longitudinally extending slots 49 therein and also the axial port 50 within closure 51, which also acts as the stop for the ball 47.

The coupling 44 has the end 52 of the outwardly swedged sleeve 53 connected thereinto. This swedged sleeve 53 terminates downwardly in the terminal plug 20 connected thereonto so that the collar 21 thereof shoulders at 54 against the housing end 22 and the seal ring 55, to seal off communication between annular space 56 within the housing bore 57, and the sleeve assembly 19. The tubular member 23, which is externally threaded at 58, connects into the internally threaded lower portion 59 of the plug 20. As shown most clearly in Fig. 8, the plug 20 has the radially extending passages 60 therein, which terminate inwardly in the central bore 61. Spaced from the passages 60 are the longitudinally extending ports 62 which place the interior 63 of the tubular member 23 in communication with the internal threaded bore 64 within the upper plug portion 65. The swedged sleeve 53 is threaded at its lower end 66 into this upper plug portion 65 so that the space 67 is placed in communication with the ports 62. The tubular stem 68 is threaded at 75 into the plug bore 61 and has, at the upper end thereof, the valve seat 69, which is for the valve 70. The valve body 71 is threaded onto the stem 68 to restrain the valve seat 69, and the top 72 of the valve body 71 comprises the stop member for the spring 73, which

bears within the recess 74 of the valve 70 to normally maintain it seated against the valve seat 69. The valve body 71 has the longitudinally extending slots or openings 76 therein and the top 72 has therein the axial bore 72'.

The tubular member 23 which is connected into the lower portion of the plug 20, has as a part thereof the coupling 77, which has connected thereinto below the gas anchor 78, and which has connected thereinto above the stem 79, which has the valve seat 80 on the top thereof and the valve body 81 threaded thereinto. The ball or valve 83 seats normally against the valve seat, and the valve body 81 has the top 84, which acts as an upward stop for the ball 83. Slots, or longitudinal passages 85, are formed in the valve body to permit the passage of fluid there-through and the top 84 also has the axial port 86 therethrough.

Surrounding the gas anchor 78 and threaded into the coupling 77 at 87, is provided the bull plug 24. This plug 24 has radial ports 25 through the walls thereof and fluid, as oil, or oil having gas or air mixed therewith, passes through these ports so that the heavier fluid, as oil, will fall first to the bottom of the bull plug 93 to extend upwardly into the gas anchor bore 94.

In operation gas is forced under pressure through the inlets 14 into the Christmas tree 5, and such gas passes through the port 95 in the plug valve 12, and downwardly through the space 15 between pumping string 7 and tubing string 10. Upon reaching the working barrel 18 this gas passes outwardly through the ports 100 therein as its further downward passage is stopped by the upper travelling valve seal 29. The gas is thus deflected downwardly through the space 56 between the housing 17 and the sleeve assembly 19 and passes inwardly through passages 60 and upwardly through the plug bore 61, and through the stem 68 to lift the valve 70.

Upon lifting the valve 70, the gas passes outwardly through the slots 76 into the interior of the swedged sleeve 53, and upwardly through the stem 45 to lift the check valve 47. This creates a low pressure area at least within the lower portion of the swedged sleeve 53 and therebelow, since the upward rush of the gas past the valve 70 operates upon the Venturi principle. The existence of this area above the check ball 83, against which the pressure of the well fluids acts from below results in the lifting of the ball 83, so that the fluid, as oil, standing in the gas anchor 78 and bull plug 90, may pass upwardly by its own pressure and/or the suction of the gas to pass through the ports 62, and upwardly into the swedged sleeve 53. As the gas passes upwardly through the swedged sleeve 53, and past the check ball 47 it carries the fluid, as oil and any air which may be mixed therewith, along upwardly toward the travelling valve 26.

On the downward stroke of the pump the pumping string 7 is forced downwardly in the tubing string 10 and the travelling valve 26 at the end thereof is moved downwardly in the working barrel 18. The mixture of air, gas and oil is thus compressed in the space above the check ball 47 and the check ball, or valve, is forced by the pressure thereabove to seat upon the valve seat 46. The pressure thus created is sufficient to lift the check valve 32 in the travelling valve 26 so that the mixture of fluid, gas and air is entrapped thereabove within the hollow pumping string 7, and the top part of the column of fluid within the pumping string is transferred

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outwardly through the elbow 9 at the top of the well.

On the downstroke, the column of fluid above the check valve 32 maintains this valve seated in the seat 33, so that none of the fluid thereabove is lost downwardly. This downward stroke of the travelling valve also tends to seat the check valve 47 against the gas pressure acting upwardly thereon from below and it also tends to seat the gas lift valve 70.

Broadly this invention considers a gas lift and apparatus in which gas under pressure passes outwardly from around a hollow pumping string through the working barrel in which the travelling valve at the end of the pumping string moves, and from thence the gas passes downwardly between an exterior housing and a sleeve means below the working barrel and then upwardly through suitable valving arrangements within the sleeve assembly below the travelling valve. This invention further considers employing the suction thus created to draw fluid, as oil, upwardly into the sleeve assembly, through suitable valves and ports, to be transferred further upwardly by the gas and through the travelling valve into the hollow pumping string to be lifted from the well.

I claim:

1. The combination of, a well tubing string including, a tubular sleeve assembly and a housing therearound connected thereto and radially spaced therefrom and having a closed lower end, a hollow pumping string in said tubing string radially spaced therefrom and including a downwardly travelling valve operable in said sleeve assembly, a check valve in said travelling valve, a gas lift valve below said travelling valve and upstanding within said sleeve assembly above said housing end and controlling fluid communication into the interior of said sleeve assembly, port means through said sleeve assembly wall completing fluid communication between the annulus between pumping and tubing string and the annulus between sleeve assembly and housing, port means in said sleeve assembly adapted to complete fluid communication between said second annulus and said gas lift valve so that gas may be injected into said first annulus to

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force against said gas lift valve, and a standing valve spaced in said sleeve assembly between said gas lift valve and said travelling valve and said port means in said sleeve assembly adapted to provide communication between the interior of the hollow pump string and a source of fluid being pumped.

2. The combination of, a well tubing string including, a tubular sleeve assembly and a housing therearound connected thereto and radially spaced therefrom and having a closed lower end, a hollow pumping string in said tubing string radially spaced therefrom and including a downwardly travelling valve operable in said sleeve assembly, a check valve in said travelling valve, a gas lift valve below said travelling valve and upstanding within said sleeve assembly above said housing end and controlling fluid communication into the interior of said sleeve assembly, port means through said sleeve assembly wall completing fluid communication between the annulus between pumping and tubing string and the annulus between sleeve assembly and housing, port means in said sleeve assembly adapted to complete fluid communication between said second annulus and said gas lift valve so that gas may be injected into said first annulus to force against said gas lift valve, a standing valve spaced in said sleeve assembly between said gas lift valve and said travelling valve, and a tubular member connected below said housing lower end and terminating in a ported plug and having a check valve above said plug, said last mentioned port means including means adapted to provide communication between the tubular member and the interior of the hollow pump string.

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