Dec. 3, 1957 G. A. HUMASON 2,814,992

COMBINATION GAS LIFT AND WELL PUMP

Filed July 26, 1954 3 Sheets-Sheet 1

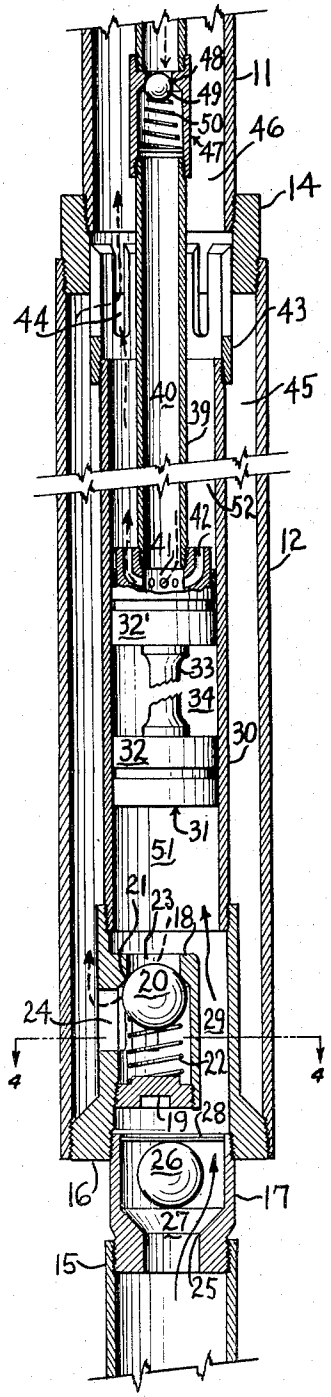


FIG. 1

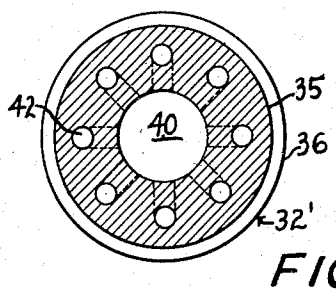


FIG. 3

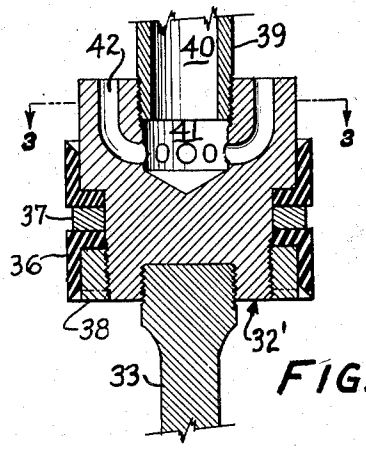


FIG. 2

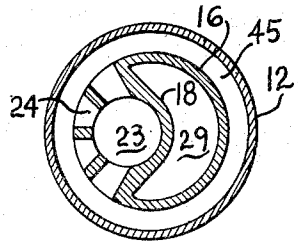


FIG. 4

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Dec. 3, 1957 G. A. HUMASON 2,814,992

COMBINATION GAS LIFT AND WELL PUMP

Filed July 26, 1954 3 Sheets-Sheet 2

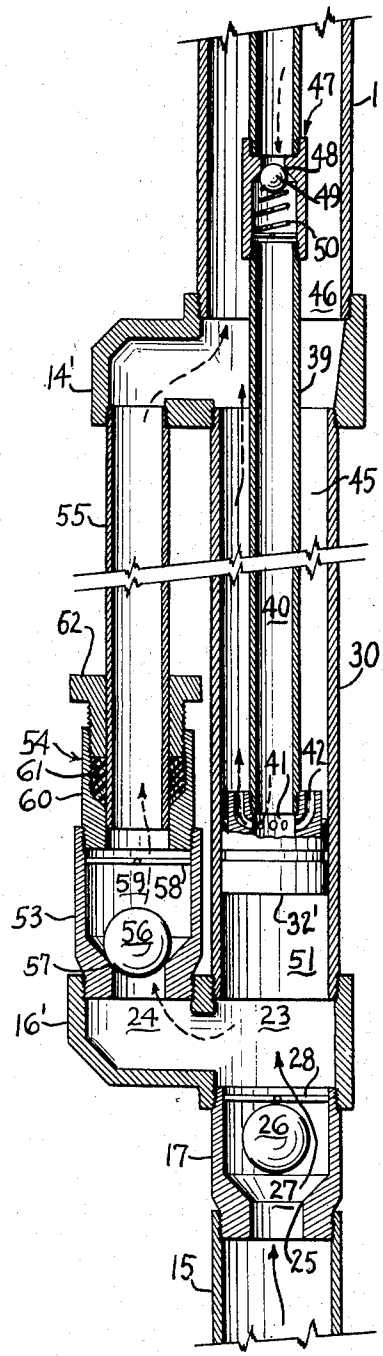


FIG. 5

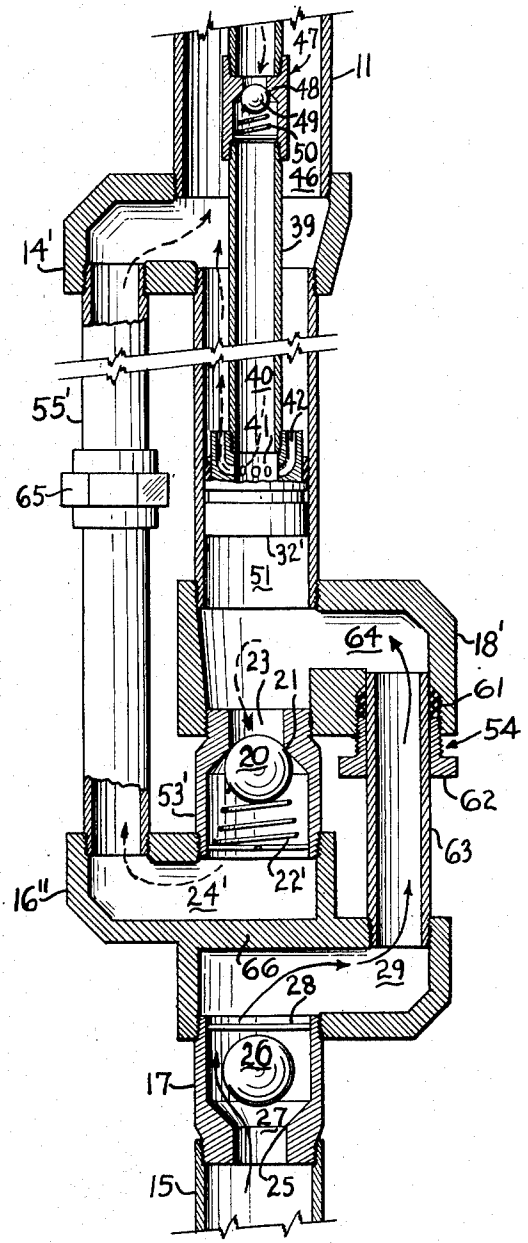


FIG. 6

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COMBINATION GAS LIFT AND WELL PUMP

Filed July 26, 1954 3 Sheets-Sheet 3

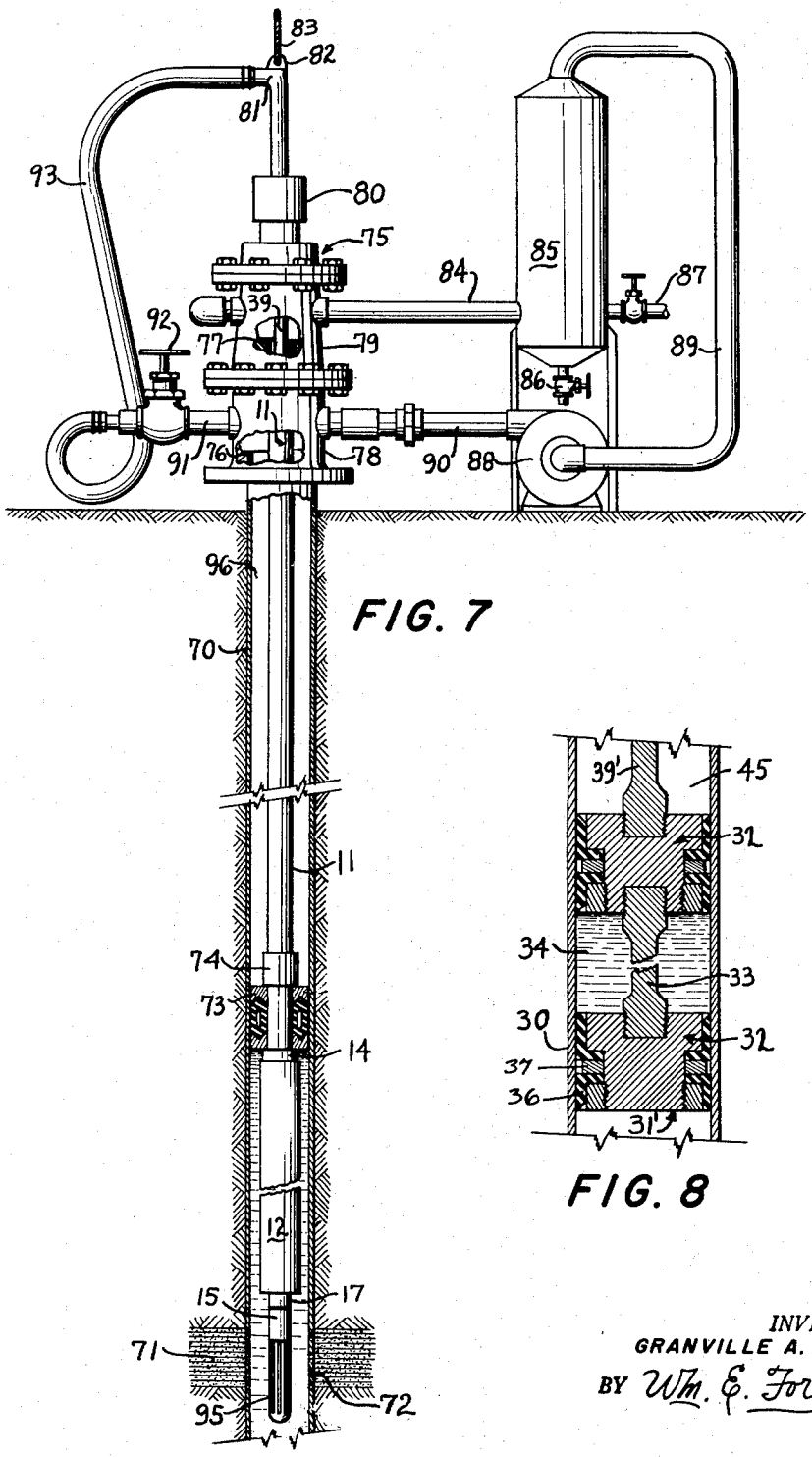


FIG. 7

FIG. 8

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United States Patent Office

2,814,992

Patented Dec. 3, 1957

2,814,992

COMBINATION GAS LIFT AND WELL PUMP

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Application July 26, 1954, Serial No. 445,720

5 Claims. (Cl. 103—5)

This invention relates to a combination gas lift and well pump of the type which employs the well tubing space surrounding the conventional pumping or sucker rod as a conduit for oil and gas transferred upwardly by reciprocation of a piston in a barrel or cylinder connected to the lower end of the tubing; such transfer being abetted by the gas which is separated from the oil at the top of the well and compressed in the well bore space packed off above the barrel or its lowermost extension until directed down the pumping rod to rise upwardly above the upper face of the piston and carry the upwardly rising oil and gas along therewith.

In the conventional methods of flowing wells heretofore the produced fluid has been raised in general by two methods. In one method the produced fluid rises through a hollow rod connected to a piston having a valve connected thereto which opens on the downstroke of the piston to let the produced fluid pass through the piston head and up the hollow rod. In the other generally employed method valve termed flow valves are installed at vertically spaced apart intervals on the well tubing and set to open at pressure gradients from the bottom to the top of the well, and gas under pressure is forced into the casing or well bore annulus around the tubing to open the flow valves upon attaining the opening pressures so that the gas may enter the tubing and lift the produced fluid, the valves at successively lower levels opening successively to force the produced fluid upwardly. This invention sets out to avoid the use of low valves and the required large volume of gas employed therewith with attendant large gas losses, and also to avoid the use of the pumping rod with its limited capacity as a transferring medium.

It is therefore an object of this invention to provide a combination gas lift and pump in which a piston reciprocates in a cylinder or barrel at the lower end of the tubing string and draws fluid as oil and gas from the well bore therebelow on the upstroke and on the downstroke delivers such fluid to the tubing space surrounding the piston rod above the piston.

It is also an object of this invention to separate the gas from the oil or liquid thus raised and compress it in the upper, packed off portion of the well and then employ it as needed to flow down the pumping rod and up into the tubing space above the piston to abet the upward transfer of oil and gas by the piston.

It is another and broader object of this invention to provide a combination gas lift and pump adapted to continually separate, compress, and recirculate the gas from the oil raised in the tubing so as to employ it in expansion to lift the gas and oil being upwardly transferred by the piston.

It is still another broader object of this invention to provide a combination gas lift and pump adapted to draw produced fluid, as gas and oil, into an entrapment space below the piston on its upstroke, and deliver such fluid therefrom to the tubing space above the piston on the downstroke.

It is also an object of this invention to provide a combination gas lift and pump of this class requiring a minimum working space and a minimum number of light working and structural parts while adapted to deliver produced fluid with a high degree of efficiency.

Other and further objects will be apparent when the attached drawings are considered in connection with the description hereinbelow; like reference numerals being applied to similar elements in the embodiments shown in the drawings of which:

Fig. 1 is a sectional elevation through the lower working end of one embodiment of the invention;

Fig. 2 is an enlarged sectional elevation of the upper head of the piston shown in Fig. 1;

Fig. 3 is a sectional plan view taken along line 3—3 of Fig. 2;

Fig. 4 is a sectional plan view taken along line 4—4 of Fig. 1 with the spring and closure plug therebelow not shown;

Fig. 5 is a sectional elevation through the lower working end of another embodiment of the invention;

Fig. 6 is a sectional elevation taken through the lower working end of still another embodiment of the invention;

Fig. 7 is an elevation, part in section, through a well bore having the structure of the embodiment of Fig. 1 operative therein and this figure also shows operating equipment at the top of the well which may be employed with any of the embodiments shown in the above described figures; and

Fig. 8 is a sectional elevation of modified form of the piston assembly.

Referring to the drawings, in the embodiment of the invention shown in Figs. 1–4, and 7, the lower working part of such embodiment includes a tubing string or stem 11 for operation in a well bore and a jacket or cylinder 12 connected to the lower end thereof by means of a coupling 14. The lower end of the jacket 12 is connected to an open ended plug or similar terminal member 15 by means of a casting 16 which closes such lower end and a coupling member 17 between such closure 16 and terminal member 15.

The closure casting 16 has formed therein a tubular delivery valve 18 having a lower closure plug 19 therein and a check ball element 20 urged upwardly against a seat 21 by a spring 22 confined between such ball 20 and the plug 19 and thus normally the ball closes the bore 23 of the valve 18 which when open provides flow passage through the valve to communicate with passages 24 provided in the casting wall which open into the interior of the jacket 12.

The coupling member 17 provides a seat 25 therein to receive thereon a check ball 26 which closes passage 27 through the coupling. A stop pin 28 extends across the top of the coupling 17 to stop upper travel of the ball 26 in response to pressure from below. The passage 29 communicates with an annular passage 29 through the closure casting 16 to the top of which is connected a barrel or cylinder 30 in which operates a piston or piston assembly 31.

The piston assembly 31 includes piston heads 32 and 32' which are spaced apart by a connecting rod 33 to provide a space 34 thereinbetween to contain lubricant for lubricating the inner wall of the barrel 30 in which the piston 31 reciprocates.

In detail, as best shown in Figs. 2 and 3, the piston head 32' has mounted on a body 35 outwardly facing rubber cups 36 spaced apart by a spacer ring 37 and bound in assembly by a hold down ring 38 threadable upon the body 35. A tubular rod 39 is threadable into the upper end of the body 35 to place the bore 40 of the rod in communication with a recess 41 within the body 35. The body

35 provides therein passages 42 which extend from the recess to the upper face of the body 35 to establish fluid communication with the space thereabove.

The barrel or cylinder 30 is held rigid by means of a guide tube 43 connected to the upper end thereof and fitted within the coupling 14. Such guide has slots 44 therein to establish communication between the annular jacket space 45 and the annular space 46 within the tubing 11 surrounding the pumping rod 39. For a purpose to be hereinafter described a coupling valve 47 connects the upper and lower sections of the rod 39 and provides a seat 48 against which a check ball 49 is urged by a spring 50 which seats upon the upper end of the lower section of the rod 39.

It is obvious that, upon reciprocation of the rod 39 and piston 31, upward movement of the piston will create a force which can lift the check ball 26 and draw a fluid, as for instance a combination of oil and gas, into the terminal member 15 and up through the passages 27 and 29 into the barrel space 51, as indicated by the full arrow headed flow lines in Fig. 1. Also, it can be seen that downward movement of the piston 31 thereafter will exert a force on such fluid which will cause the check ball 26 to seat and thereafter increased pressure on the trapped fluid will unseat check ball 20 and force the fluid out through the passages 23 and 24 and up the space 45 within the jacket and through the slots 44 into the annular space 46 within the tubing 11 and surrounding the pumping rod 39. The arrow headed broken lines shown in Fig. 1 indicate this path of fluid flow.

It can also be seen that the injection of a pressurized gas down the rod 39 will unseat the check ball 49 and permit such gas to pass down the rod bore 40 and through the recess 41 and passages 42 into the space 52 above the piston 31. The upward direction of such gas and the force therein will cause it to abet the upward passage of fluid, as gas and oil, which has been delivered to the spaces 45 and 46 by the downstrokes of the piston 31, as a venturi effect will be created by the passage of the gas up through the space 52 into the tubing space 46.

Referring to Fig. 7 a producing well is shown in which the well bore has been cased by a casing 70 which extends downwardly through a producing formation 71; such casing having been perforated at the level of the producing formation so that the fluids from such formation flow through the perforations 72 into the well bore and rise therein. A conventional packer 73 has been installed on the tubing 11 in the well bore to rest upon the coupling 14 of the form of invention shown in Figs. 1–4, and to be held in place by the collar 74 affixed to the tubing on the upper side of a packer.

The casing 70 extends to the top of the well and is connected into the lower section of a conventional braden head 75 as indicated at 76. The tubing 11 extends upwardly through the casing 70 and is connected at 77 to an upper section of the braden head. The pumping rod 39 extends upwardly through the tubing 11 and passes outwardly from the braden head 75 through the stuffing box 80 and terminates at its upper end in an elbow 81 extending at right angles from the longitudinal axis of the rod. A connection flange 82 is connected to the elbow 81 and a means 83 to reciprocate the rod in the well bore is fastened thereto. Any means which may lower and raise the rod 39 will serve but the means best employed is the conventional walking beam actuated by an oil well pumping unit.

The oil and gas which is forced up the tubing 11 by the operation of the piston in the barrel 30 passes from the upper section 79 of the braden head through the connecting pipe 84 into a separator 85 wherein the oil is separated from the gas. The interior structure for such separation is conventional and therefore is not shown. After separation takes place the oil may be taken from the separator 85 through the valved outlet 86 and the gas may be taken therefrom through the valved outlet 87. In the employment of this invention a pump 88 is provided to draw gas through the suction line 89 from the top of the separator 85 and to discharge such gas through the discharge line 90 into the lower section 78 of the braden head. An outlet 91 is shown extending from the lower braden head section 78 on the opposite side therefrom from the discharge line 90 and such outlet 91 has a valve 92 as a control and closure therefor. A flexible conduit 93 connects the valve 92 and elbow 81 and is of length to maintain such connection at uppermost piston travel.

In operation, fluid is drawn in through the perforations 72 and slots 95 in the terminal member or bull plug 15, and on the up stroke of the piston 31 such fluid is drawn into the barrel space 51 and trapped therein as the piston begins to move downwardly and seats the check ball 26. Then as the piston moves further downwardly the check ball 20 is unseated and the fluid is forced upwardly through the barrel space 45 into the annular space 46 within the tubing 11. Continued pumping in this manner fills the space 46 to the top of the well and forces the produced fluid, as oil and gas, into the interior of the upper section of the braden head section 79 to pass therefrom through the pipe 84 to the separator for separation.

The gas thus separated from the oil is drawn into the suction line 89 by the operation of the pump 88 and discharged through the discharge line 90 into the upper braden head section 78 and into the casing 70. When the valve 92 is closed the casing space above the packer 73 and the space within the lower braden head section 78 and within the pipes 90 and 91 combine to form a compressed gas reservoir 96 in which gas pressure may be built up to a desired value by the continued operation of the pump 88. Whenever it appears that the operation of the piston 31 alone is not sufficient to deliver fluid, as oil and gas, to the top of the well, or when it is desired to increase speed of its delivery, the valve 92 may be opened and compressed gas within the space or reservoir 96 can pass therefrom through the valve 92 and flexible conduit 93 into the pumping rod 39. When sufficient pressure has been developed the check ball 48 will be unseated against the urging of the spring 50 and the compressed gas may then flow down the pumping rod bore 40 and through the recess 41 and passage 42 to pass upwardly through the space 45 and into the space 46 with force and velocity sufficient to produce a substantial venturi effect to draw upwardly the gas and oil from within the jacket space 45 to discharge it up the tubing 11 to the top of the well.

In this invention there is no waste of gas in this type of flow abetting operation since the produced gas may be recirculated over and over again in the producing of the well. Furthermore it is easily possible to adapt conventional well head equipment to the ends of this invention as the only additional items required are the pump 88 and its suction and discharge connections and the valve 92 and conduit 93 and their terminal connections. It is also easy to employ the structure with the types of hollow pumping rod now marketed, as each of the lower structure modifications shown in either Figs. 1–4, Fig. 5, or Fig. 6 may be installed simply through connecting the section pumping rod 39 to which the piston 32 or 32′ is connected to the lower end of the conventional hollow pumping rod 39 while also connecting the coupling 14 or 14′, as the case may be, to the lower end of a conventional tubing string 11.

In detail, the modification shown in Fig. 5 comprises a casting or machined part 16′ providing a lower opening which communicates with the interior of the coupling member 17 in which seats the ball 26 as retained by the pin 28. The casting or fitting 16′ also provides a passage 24 spaced laterally from a bore 23 therein and a fitting 53 is connected with the fitting 16′ to communicate with the passage 24 and to provide a valve

seat on which a ball valve **56** may seat downwardly at **57** under the urging of fluid pressure from thereabove while stop pins **59**, **58** extend across the bore of the fitting **53** and has ends fixed in such fitting. Thus, when urged upwardly the check ball **56** places the passage **24** in communication with the bore of the fitting **16'** as designated by the reference numeral **59**.

A stuffing box assembly **54** is threaded in to the top of the fitting **53** to protect against leakage about a pipe **55** and such stuffing box assembly **54** includes a housing **60** which engages with the fitting **53**, a packing **61** therein to seal about the pipe **55**, and a nut **62** which threadedly engages within the housing **60** to exert pressure on the packing **61**. The pipe **55** is connected at its upper end to a fitting **14'** which places it into communication with the bore **46** of the pipe string **11** as such fitting threadedly engages the lower end of the pipe string **11**. It also has an opening spaced from its connection to the pipe **55** which threadedly engages the upper end of the barrel **30**. In other respects the structure of Fig. 5 duplicates the structure of Fig. 1 and like reference numerals are applied to like parts, the lower opening of the fitting on part **16'** being connected to the top of the coupling **17**. In such a tool the jacket **12** of Fig. 1 is eliminated and a single short pipe **55** substituted in place thereof. Also a downwardly seating ball check valve **56** which is not spring urged carries out the function of the spring urged, upwardly seating check ball **20** in Fig. 1.

In the modification of Fig. 6 a casting or machined part or fitting **16''** is provided having a lower connection to the coupling **17** and providing a receiving chamber **29** for the upwardly urged fluid under hydrostatic pressure from the well bore therebelow. A connection pipe **63** is threadedly engaged at the top of the chamber **29** and extends upwardly into a casting, machined part, or fitting **18'** thereabove and a stuffing box assembly **54** extends around the pipe **63**, such assembly including a packing **61** and a gland nut **62** to be threaded into the fitting **18'** to tighten the packing **61** around the pipe **63**.

A valve body coupling **53'** connects the lower end of the fitting **18'** with the upper end of the fitting **16''** to place the chamber **64** in communication with the bore **21** therethrough and such bore **21** in communication with the chamber **24'** therebelow, a spring **22'** urging the check ball **20** to seat upwardly at **21** in the coupling **53'**. A pipe **55'** having a union **65** therein connects the upper end of the fitting **16''** outwardly of the coupling **53'** with the lower end of the fitting **14'** thereabove and this fitting **14'** in turn, at its upper end establishes fluid communication with the bore **46** of the pipe string **11** and spaced from the pipe **55** it establishes connection at its lower end to the barrel **39**. In other respects this structure of Fig. 6 duplicates the structure of Fig. 1 and like reference numerals are applied to like parts. In such a tool the jacket **12** of Fig. 1 is eliminated and a single short pipe **55'** substituted therefor. At the same time an upwardly seating check valve is spring urged as in Fig. 1.

In cases where lifting pressures obtainable in the well bore by piston operation can effectively lift the fluid without the additional injection of gas from the reservoir **96**, it is possible to eliminate the packer **73**, the pump **88**, and the connection **93** between lower braden head section **78** and pumping rod **39** while still providing a very effective device which may utilize all of the tubing space **46** as the barrel through which the gas and oil pass upwardly under such developed pressure rather than utilizing the pumping rod or sucker rod space **40** for such passage, as is generaly done with conventional well pumping units.

Such a pumping rod assembly **31'** for a modification of the invention not employing conventional hollow rod but solid rod **39'** is shown in Fig. 8 in which two piston heads **32** are spaced apart by a connecting rod **33**, each piston head being of solid construction and surrounded by rubber cups **36** separated by spacer rings **37**. A lubricant **34** fills the space surrounding the connecting rod **33** between the piston heads **32** and the solid pumping rod **39'**.

This invention is not limited to the details shown in the structures at the top of the well and in the various lower working portion embodiments, but other structures fall within the broad spirit of the invention, and claim is also made to various combinations and subcombinations of structure as shown in the various embodiments and upper operating equipment, and as claimed in the appended claims for which it is deemed a broad interpretation is merited.

What is claimed is:

1. In combination with a well bore having a casing therein, a braden head at the top of the well connected to said casing, a tubing connected to said braden head and extending therefrom downwardly into said casing, a closure positioned in said braden head to seal off between said braden head and said tubing, a piston in said tubing having a reciprocating hollow rod connected thereto and extending from said tubing and through said braden head, a first check valve closing said tubing below said piston, a conduit leading from said tubing between said first check valve and said piston to said tubing above said piston, a second check valve normally closing communication between said tubing and the lower end of said conduit, a packer sealing the well bore between said tubing and said casing above said first check valve, a separator at the top of the well connected to said braden head below said closure to deliver gas into said braden head and thence into said casing above said packer and connected to said braden head above said closure to receive gas and liquid therefrom, means to selectively deliver gas from said braden head below said closure into said hollow rod above said closure as said hollow rod is reciprocated, and an outlet from said hollow rod through which said selectively delivered gas may pass into said tubing above and adjacent to said piston and upwardly through said tubing, the upward movement of said piston drawing well gas and liquid through said first check valve and the downward movement of said piston forcing said gas and liquid to open said second check valve and to flow upwardly through said conduit and through said tubing, said tubing being solidly closed from conduit communication for a spaced distance above the vertical interval of piston travel and to the point of juncture of said conduit with said tubing above said piston whereby said selectively delivered gas abets delivery of the full volume of liquid and gas up said tubing and into said braden head above said closure and thence into said separator for separation.

2. In combination with a well bore having a casing therein, a braden head at the top of the well connected to said casing, a tubing connected to said braden head and extending therefrom downwardly into said casing, a closure positioned in said braden head to seal off between said braden head and said tubing, a piston in said tubing having a reciprocated hollow rod connected thereto and extending from said tubing and through said braden head, valve means connected into said tubing and effective upon the upstroke of said piston to permit gas and liquid to be drawn upwardly thereby to enter into said tubing below said piston, a conduit controlled by said valve means and extending upwardly to said tubing at a spaced distance above the interval of piston travel, on the downstroke of said piston said valve means being effective to permit gas and liquid to be forced thereby into said conduit and into said tubing above said piston, a packer sealing the well bore between said tubing and said casing above the point of gas and liquid entry into said valve means, a separator at the top of the well connected to said braden head below said closure to deliver gas into said braden head and thence into said casing above said packer and connected to said braden head above said closure to receive gas and liquid

therefrom, means to selectively deliver gas from said braden head below said closure into said hollow rod above said closure as said hollow rod is reciprocated, and an outlet provided from said hollow rod through which said selectively delivered gas may pass into said tubing above and adjacent to said piston and upwardly through said tubing, said tubing being solidly closed from conduit communication for a spaced distance above the vertical interval of piston travel and to the point of juncture of said conduit with said tubing above said piston whereby said selectively delivered gas abets delivery of the full volume of liquid and gas up said tubing and into said braden head above said closure and thence into said separator for separation.

3. The combination as claimed in claim 2 in which said valve means includes an entrapment chamber extending downwardly from said tubing coaxially therewith and having a bottom inlet and a side outlet below said piston, a downwardly seating check valve to control said inlet, and a spring urged, upwardly seating check valve to control said outlet.

4. The combination as claimed in claim 2 in which

said valve means includes an entrapment chamber extending downwardly from said tubing coaxially therewith and providing an inlet on one side thereof and an outlet on the other side thereof, a downwardly seating check valve to control said inlet and an upwardly seating, spring urged check valve to control said outlet.

5. The combination as claimed in claim 2 in which said valve means includes an entrapment chamber connected to said tubing and extending downwardly therefrom and providing an inlet portion coaxial with said tubing and an outlet portion extending sidewardly from said inlet portion, a downwardly seating check valve to control said inlet, and a downwardly seating check valve to control said outlet.

References Cited in the file of this patent

UNITED STATES PATENTS

270,789	Hamilton	Jan. 16, 1883
787,244	Watson	Apr. 11, 1905
2,016,433	Humason	Oct. 8. 1935