

June 23, 1925.

1,543,488

W. O. TODD

DEEP WELL PUMPING APPARATUS

Filed Jan. 15, 1924

Fig. 1.

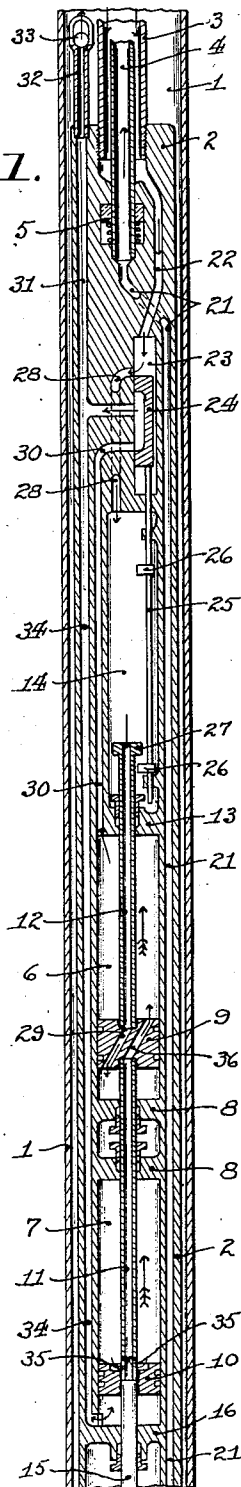


Fig. 2.

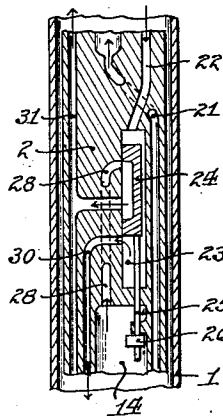


Fig. 3.

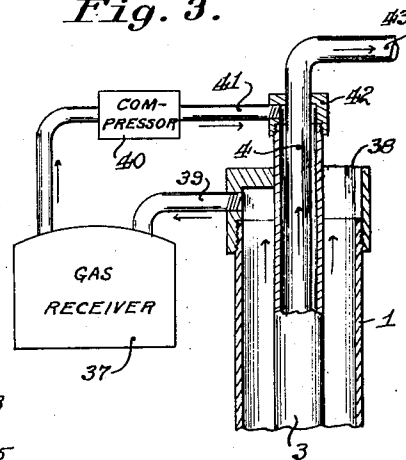
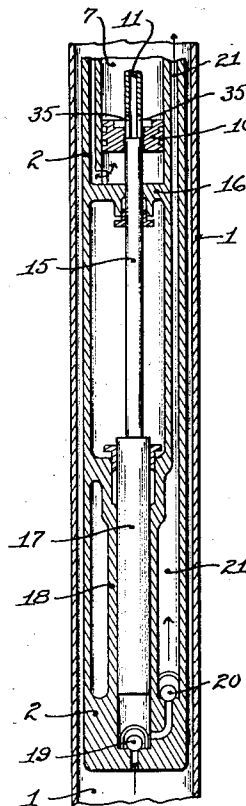


Fig. 4.



INVENTOR
William O. Todd
BY
Booth & Booth
ATTORNEYS

Patented June 23, 1925.

1,543,488

UNITED STATES PATENT OFFICE.

WILLIAM O. TODD, OF LOS ANGELES, CALIFORNIA.

DEEP-WELL PUMPING APPARATUS.

Application filed January 15, 1924. Serial No. 686,413.

To all whom it may concern:

Be it known that I, WILLIAM O. TODD, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented certain new and useful Improvements in Deep-Well Pumping Apparatus, of which the following is a specification.

My invention relates to deep well pumping apparatus applicable to either oil or water wells.

The principal object of my invention is to provide a deep well pump which can be successfully operated by fluid supplied under suitable pressure from the surface, thereby doing away with the sucker rods and eliminating the friction losses caused thereby. Another object of my invention is to provide a pumping apparatus which, when used in oil wells, can make use of the natural gas produced by the well for the power fluid, said gas being drawn from the casing-head, compressed, and forced down into the well to operate the oil pump in a manner to be fully described hereinafter. Inasmuch as it is common practise to compress the gas produced by oil-wells for the purpose of extracting the lighter liquids therefrom, the use of such compressed gas for operating the well pump results in a decided economy. Moreover, the gas so used is not wasted, but is returned to the well casing, as will be later set forth, to be used over again, so that, after the amount of gas required for operating the pump has been drawn off, the further gas production of the well can be used for other purposes, as at present.

It will be apparent from the following specification that fluids other than the natural gas of the well can be used for operating the pump. In water wells, for example, air could be used satisfactorily, but for pumping oil, the use of air would in most cases be unsatisfactory, not only because of the ensuing dilution of the natural gas by the air exhausted from the pumping apparatus, but also because of the possibility of explosive mixtures being formed by the air and the natural gas or volatile constituents of the oil. My invention will be described, therefore, with particular reference to its application to oil wells, with the understanding that fluids other than the natural gas of the well may be used to operate the pump. It is also to be understood that the form and construction of the apparatus may

be varied, within the limits of the claims hereto appended, without departing from the spirit of the invention.

My invention will now be fully described with reference to the accompanying drawings, wherein—

Fig. 1 is a longitudinal section of the upper, or power end of my pump.

Fig. 2 is a sectional detail showing the slide valve in a position opposite to that shown in Fig. 1.

Fig. 3 is a part sectional view of the casing head showing diagrammatically the means for applying power to the pump.

Fig. 4 is a longitudinal section of the lower or pumping end of the apparatus whose upper portion is shown in Fig. 1.

In the drawings, the reference numeral 1 designates the well casing. 2 is a body member, which is suspended within the well, partly or wholly submerged in the oil, by a tubing string 3, to which said body 2 is attached by threading or other suitable means. Within the tubing 3 is a second and smaller tubing string 4, whose end is removably secured to the body 2 by any suitable means capable of making a gas tight joint, a common form of packer being indicated at 5 for this purpose. The inner tubing string 4 may, therefore, be detached from the body 2 and pulled, to facilitate the subsequent pulling of the outer tubing string 3 and the body 2 when occasion requires. The inner tubing string 4 conducts the pumped oil from the well to the surface, and the outer tubing string 3 conducts gas under pressure from the surface for the purpose of operating the pump in a manner to be presently described.

The body 2 contains one or more power cylinders. In Fig. 1 of the drawings, two such power cylinders are shown, an upper cylinder 6 and a lower cylinder 7, separated by a head 8. Pistons 9 and 10 are operable respectively in the cylinders 6 and 7, and are connected by a hollow rod 11 passing through suitable packing in the central head 8. A similar hollow rod 12 extends upwardly from the upper piston 9, passing through suitable packing in the upper head 13 of the upper cylinder 6, and having an open end within a chamber 14 formed in the body 2 above said upper cylinder. The lower piston 10 is connected by a downwardly extending rod 15, passing through suitable packing in the lower head 16 of the

lower cylinder 7, with the pump plunger 17, Fig. 4. Said plunger 17 operates in a barrel 18 formed in the lower end portion of the body 2. An inlet check valve indicated at 19 admits the oil from the well to the barrel 18 on the up stroke of the plunger 17, and said oil is forced out, on the down stroke, through a check valve 20 into a passage 21 which extends upwardly through the body 2 and communicates with the inner tubing string 5 as shown in Fig. 1.

The gas which is forced under pressure into the outer tubing string 3 at the surface, passes through a duct 22 in the body 2 to a valve chamber 23, in which is a movable valve 24. For the sake of illustration, I have shown this valve as a simple slide valve, operated directly by the pistons in a manner to be presently described, but it is to be understood that any suitable form of valve may be used. As a matter of mechanical practice, some form of valve should be used which would be non-stalling, as for example, a main valve operated by the gas pressure and controlled by a pilot valve, but as such valves are well known, and are not necessary to a full understanding of my invention, I have illustrated only the simplest form of operable valve.

The slide valve 24 is operated by a rod 25 which extends into the chamber 14 and has two spaced lugs 26 adapted to be engaged by a shoulder or head 27 formed upon the hollow upper piston rod 12, when the pistons approach each end of their stroke. With the valve 24 in the position shown in Fig. 1, the compressed gas passes from the valve chamber 23 through a duct 28 into the chamber 14, thence through the hollow upper rod 12 and a communicating passage 29 in the upper piston 9, and enters the upper cylinder 6 below its piston 9, thereby moving said piston, with the rods 11 and 15 and the pump plunger 17, upwardly, as indicated by the feathered arrows in Fig. 1. The exhaust or spent gas from the upper end of the cylinder 6 passes out through a duct 30, the valve 24, and a duct 31, which leads into an exhaust pipe 32 extending upwardly from the body 2 to a point above the level of the oil in the well. Said exhaust pipe 32 is provided with a check valve 33 to prevent oil from entering it in case its end is submerged.

The lower piston 10 is not utilized for power purposes during the up-stroke, the power of the upper piston being sufficient to lift the pump plunger 17. The lower end of the lower cylinder 7 is, therefore, vented, by a passage 34 leading into the exhaust duct 31. The exhaust gas from the upper end of said lower cylinder 7 passes into the lower hollow rod 11 through ports 35 in its lower end, as shown by the plain arrows, thence through said rod and a communicat-

ing passage 36 formed in the upper piston 9, into the upper end of the upper cylinder 6, and thence out to the exhaust pipe 32 as hereinbefore described.

When the pistons reach the upper end of their travel, the valve 24 is shifted, as described above, to the position shown in Fig. 2. The gas, under pressure, then passes from the valve chamber 23, through the duct 30 into the upper end of the upper cylinder 6, and thence through the passage 36 and the hollow rod 11 into the upper end of the lower cylinder 7, so that the pressure is applied to the upper faces of both pistons 9 and 10, forcing them, and the plunger 17 down. This is the working stroke, the oil being forced up through the passage 21 and the inner tubing string 4 as described above. The exhaust or spent gas from the lower end of the upper cylinder 6 passes up through the passage 29, the hollow rod 12, the chamber 14, the duct 28, the valve 24, Fig. 2, and into the exhaust duct 31. The lower end of the lower cylinder is vented, as before, through the passage 34 and the exhaust duct 31. When the pistons reach the lower end of their stroke, the valve 24 is shifted back to the piston shown in Fig. 1, the cycle is repeated, automatically, as long as gas under the necessary pressure is supplied to the outer tubing string 3.

The exhaust gas discharged from the pipe 32 passes up through the casing 1 around the tubing string 3, and may be led into a suitable receiver 37, Fig. 3, at the surface, the casing 1 being suitably capped as indicated at 38, and connected by a pipe 39 with said receiver. From said receiver the gas is drawn into a compressor indicated at 40, and by it is forced through a pipe 41 into the outer tubing string 3, said string being suitably capped as shown at 42. The oil rising through the inner tubing string 4 is led off by a pipe line indicated at 43. Thus the same gas may be used over again. When the gas used is produced by the well itself, the compressor 40 may be utilized to extract the lighter liquids from such gas in the usual manner, before it is used for operating the well pump, and any gas in excess of that required to operate said pump may be drawn off and used for other purposes.

It should be noted that the construction of my apparatus permits the raising of the oil to be done by the down stroke of the plunger 17, instead of by the up stroke, as is necessary when sucker rods are employed. This enables me to use a solid plunger, as shown, and to position both inlet and discharge at the lower end of the barrel 18, thereby keeping sand and grit away from the pump packing, and materially reducing the wear caused by such sand and grit on the moving parts of the pump. It should

also be noted that, by increasing the number of working cylinders, arranged similarly to the two shown, I am enabled to obtain sufficient power to pump the deepest wells, without increasing the diameter of the device.

I claim:

1. A well pumping apparatus comprising a body adapted to be suspended within the well, and having a power cylinder and a pump barrel; a piston operable in said cylinder; a plunger, connected with said piston and operable within said barrel; a stationary tubing string communicating with said cylinder for conducting fluid under continuous pressure thereto, and a second stationary tubing string positioned within and spaced from the first tubing string, said second tubing string communicating with said barrel for conducting the pumped well fluid therefrom, one of said tubing strings being connected with said body for suspending the same; and a valve within said body for controlling the admission and discharge of the pressure fluid to said cylinder on each side of its piston to cause the latter to reciprocate.

2. A well pumping apparatus comprising a body adapted to be suspended within the well, and having a power cylinder and a pump barrel; a piston operable in said cylinder; a plunger, connected with said piston and operable within said barrel; a tubing string connected with said body for suspending the same, said tubing string communicating with said cylinder for conducting fluid under continuous pressure thereto; a second tubing string, positioned within and spaced from the first tubing string, said second tubing string communicating with said barrel for conducting the pumped well fluid therefrom; a separable connection between the second tubing string and the body whereby said second tubing string may be removed without disturbing the first tubing string; and a valve within said body for controlling the admission and discharge of the pressure fluid to said cylinder on each side of its piston to cause the latter to reciprocate.

3. A well pumping apparatus comprising a body adapted to be suspended within the well, and having a power cylinder and a pump barrel; a piston operable in said cylinder; a plunger, connected with said piston and operable within said barrel; a tubing string connected with said body for suspending the same, said tubing string communicating with said cylinder for conducting fluid under continuous pressure thereto; a second tubing string, positioned within and spaced from the first tubing string, said second tubing string communicating with said barrel for conducting the pumped well fluid therefrom; a packer for separably con-

necting the second tubing string with the body whereby said second tubing string may be removed without disturbing the first tubing string; and a valve within said body for controlling the admission and discharge of the pressure fluid to said cylinder on each side of its piston to cause the latter to reciprocate.

4. A well pumping apparatus comprising a body adapted to be suspended within the well and having a power cylinder in its upper portion, a pump barrel in its lower portion, and a duct leading through a side wall from said barrel to its upper end; a pair of tubing strings separably connected with the upper end of said body, one of said tubing strings communicating with said cylinder for conducting fluid under pressure thereto and the other communicating with said duct for conducting the pumped well fluid from said barrel; a piston operable in said cylinder; a valve for controlling the admission and discharge of the pressure fluid to said cylinder on each side of said piston; and a plunger operable in said barrel and connected with said piston.

5. A well pumping apparatus comprising a body adapted to be suspended within the well and having a pump barrel in its lower portion, a power cylinder in its central portion, and a chamber, separate from said cylinder, in its upper portion; a piston operable in said cylinder; a hollow rod connected with said piston and movably extending into said chamber, the upper end of said hollow rod being open to said chamber and its lower end communicating with said cylinder below said piston; a valve for controlling the admission and discharge of fluid under pressure to and from said chamber and the upper end of said cylinder to cause its piston to reciprocate; means for supplying the pressure fluid to said valve; a plunger operable in said barrel and connected with said piston; and means for conducting the pumped well fluid from said barrel.

6. A well pumping apparatus comprising a body adapted to be suspended within the well and having a pump barrel in its lower portion, a power cylinder in its central portion, and a chamber, separate from said cylinder, in its upper portion; a piston operable in said cylinder; a hollow rod connected with said piston and movably extending into said chamber, the upper end of said hollow rod being open to said chamber and its lower end communicating with said cylinder below said piston; a valve controlled by the movement of said piston for controlling the admission and discharge of fluid under pressure to and from said chamber and the upper end of said cylinder to cause its piston to reciprocate; means for supplying the pressure fluid to said valve; a plunger oper-

able in said barrel and connected with said piston; and means for conducting the pumped well fluid from said barrel.

7. A well pumping apparatus comprising
 5 a body adapted to be suspended within the well and having a pump barrel in its lower portion, a power cylinder in its central portion, and a chamber, separate from said cylinder, in its upper portion: a piston operable in said cylinder; a hollow rod connected with said piston and movably extending into said chamber, the upper end of said hollow rod being open to said chamber and its lower end communicating with said cylinder below said piston; a valve for controlling the admission and discharge of fluid under pressure to and from said chamber and the upper end of said cylinder to cause its piston to reciprocate; means for supplying the pressure fluid to said valve; means for discharging the spent pressure fluid from said valve into the well; a plunger operable in said barrel and connected with said piston; and means for conducting the pumped well fluid from said barrel.

8. A well pumping apparatus comprising a body adapted to be suspended within the well and having a power cylinder and a pump barrel; a piston operable in said cylinder; a valve for controlling the admission and discharge of fluid under pressure to and from said cylinder to cause the reciprocation of said piston; means for conducting the pressure fluid to said valve; a pipe extending upwardly from said body for discharging the spent pressure fluid into the well; a plunger operable in said barrel and connected with said piston; and means for conducting the pumped well fluid from said barrel.

9. A well pumping apparatus comprising a body adapted to be suspended within the well, said body having a pair of power cylinders positioned end to end and a pump barrel positioned below said cylinders; a piston operable in each cylinder; a member connecting said pistons; a valve for controlling the admission and discharge of fluid under pressure to and from said cylinders to cause said pistons to reciprocate; a plun-

ger operable in said barrel and connected with the lowermost piston; means for conducting the pressure fluid to said valve; and means for conducting the pumped well fluid from said barrel.

10. A well pumping apparatus comprising a body adapted to be suspended within the well, said body having a pair of power cylinders positioned end to end and a pump barrel positioned below said cylinders; a piston operable in each cylinder; a valve for controlling the admission and discharge of fluid under pressure to and from the upper cylinder to cause its piston to reciprocate; a hollow rod connecting said pistons, said rod conducting the pressure fluid between the upper cylinder and the lower cylinder; a plunger operable in said barrel and connected with the lowermost piston; means for conducting the pressure fluid to said valve; and means for conducting the pumped well fluid from said barrel.

11. A well pumping apparatus comprising a body adapted to be suspended within the well, said body having a chamber in its upper portion, a pair of power cylinders set end to end below said chamber, and a pump barrel below the lowermost of said cylinders; a piston operable in each cylinder; a hollow rod extending upwardly from the upper piston, its upper end lying within and being open to said chamber and its lower end communicating with the upper cylinder below its piston; a second hollow rod connecting the upper piston with the lower piston, and having its upper end communicating with the upper cylinder above its piston and its lower end communicating with the lower cylinder above its piston; a valve for controlling the admission and discharge of fluid under pressure to and from said chamber and the upper end of the upper cylinder; means for conducting the pressure fluid to said valve; a plunger operable in said barrel and connected with the lower piston; and means for conducting the pumped well fluid from said barrel.

In testimony whereof I have signed my name to this specification.

WILLIAM O. TODD.