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OIL WELL PUMP

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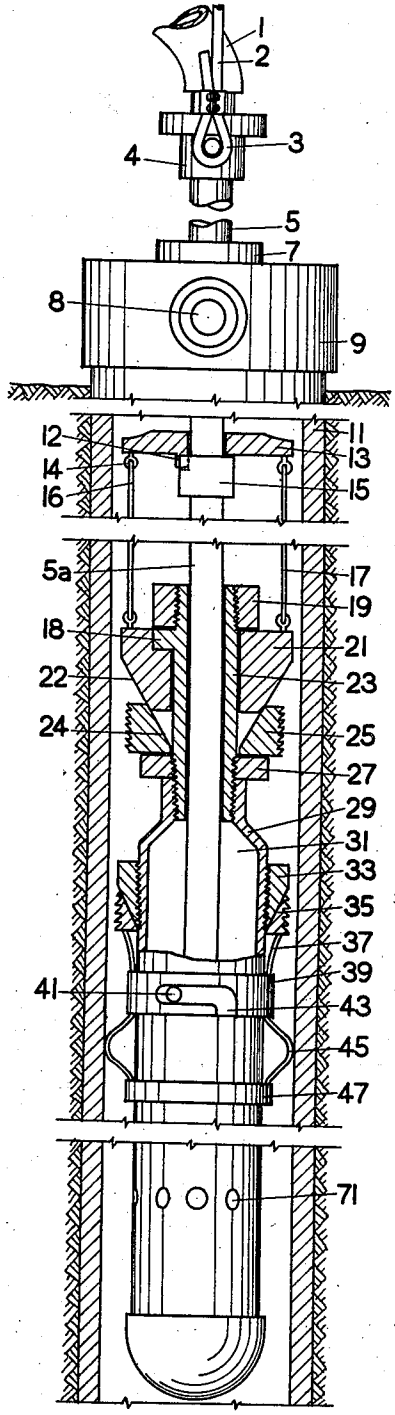


Fig. I

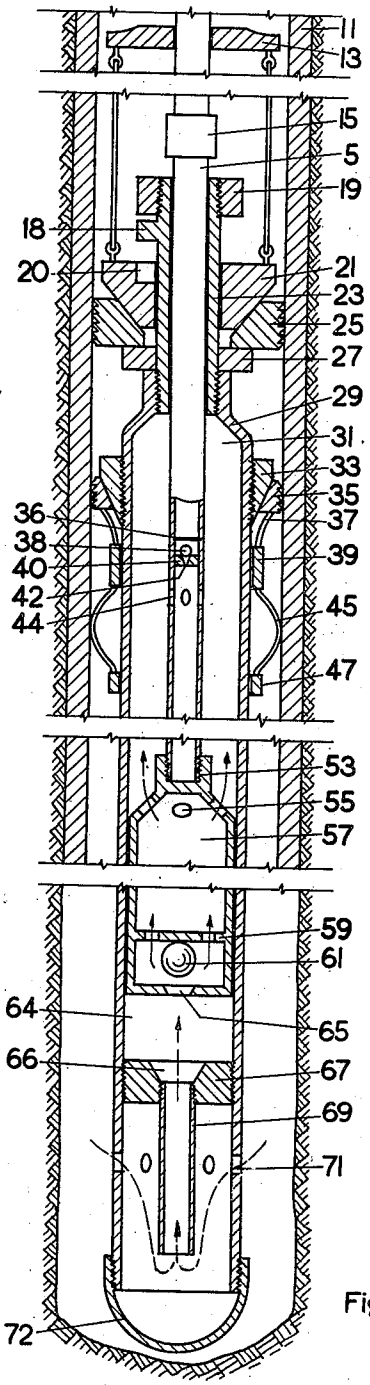


Fig. 2

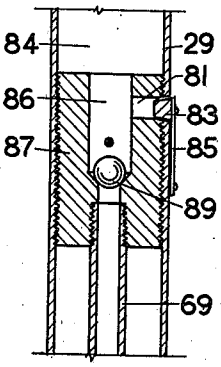


Fig. 3

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2,383,934

OIL WELL PUMP

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4 Claims. (Cl. 103—219)

This invention pertains to the art of producing hydrocarbon materials from underground formations, and relates more particularly to an improved oil well pump adapted to be actuated by the reciprocation of the tubing string.

Conventional oil well pumps are usually operated by reciprocating a string of sucker rods within a tubing or flow string which is, in turn, run within the well casing. The pump is installed at the lower end of the tubing string, and is supported thereby, the pump plunger being reciprocated through said sucker rod string by suitable prime-mover means at the surface. The sucker rod string is furthermore used, in well known fashion, to install and to withdraw the plunger and travelling valves of the pump.

A modification of this system is to be found in so-called casing pumps, wherein the pump is anchored directly in the well casing at the desired depth, and the tubing string is eliminated, the sucker rods reciprocating directly within the casing. The casing pump depends for its operativeness on the feature of packing off the casing above the pump, whereby the casing itself serves as a tubing string. This type of pump is however not suitable for wells having low fluid levels and producing large or even normal quantities of formation gas, because the gas can be produced to the surface only through the pump, and causes frequent failures of the pump due to gas lock.

It is therefore an object of this invention to provide an improved and simplified pump installation wherein the sucker rod string is eliminated, and the pump is installed, reciprocated during operation, and removed solely by means of the tubing string.

It is also an object of this invention to provide a pump system wherein the tubing string is used, during operation, both as actuating means for supplying motive power to the pump, and as conduit means for conveying the liquid output of the pump to the surface.

It is another object of this invention to provide a pump which is installed in the well casing in such manner that the formation gas can pass around the pump and escape through the annular space between the tubing and the casing strings, as in conventional well-pumping systems, whereby the possibility of gas lock is eliminated or minimized.

It is also an object of this invention to provide an oil well pump having an outer housing adapted to lock with the well casing against upward or downward movement during operation, and to be released by simple vertical movement of the tub ing string.

It is also an object of this invention to provide a well pump having a precompression chamber which increases the efficiency of the pump in wells having a relatively high gas-oil ratio.

These and other objects of this invention will be understood from the following description taken with reference to the attached drawing wherein:

Figure 1 is a vertical view, partly in cross-section, showing the present pump as it is lowered into the well;

Figure 2 is a similar view showing the pump of Figure 1 locked in place within the casing strings;

Figure 3 is a partial view in cross-section of a modification of the present pump provided with a precompression chamber.

Referring to Figure 1, the present pump is shown as being lowered into a well having a casing 11 and a casinghead 9, provided with suitable conduit connections 8 for the removal of gases entering the casing in the well. The pump is attached to the end of a tubing string 5 which passes into the casing through a suitable lubricator device 7. The tubing 5 serves for imparting a reciprocating motion to the pump, as will be described hereinbelow, and is for this purpose connected at 3 to a cable or similar means 2 leading to prime mover means such as a walking beam, not shown. The tubing 5 also serves as a flow or eduction tube for the oil being pumped, and is connected, through a swivel head 4, to an output conduit 1.

One of the coupling joints 15, used to connect together the tubing string 5, serves as a support for a yoke or plate 13. An upper slip bowl 21 is supported from the yoke 13 by means such as tubular or linear reins or link means 17, attached to said bowl and said yoke by hooks and eyelets 14 and 16, as shown in the drawing. The upper slip bowl 21 surrounds the upper pump barrel 23, and is free to move slidingly therealong between an upper flange 19 of said barrel, and a lower coupling 27 connecting the upper pump barrel 23 to its lower enlarged portion, shown at 29.

Slips 25 are slidably attached to the slip bowl 21, and have tapered inner faces 24 adapted to co-act with the outer tapered faces 22 of the upper slip bowl, whereby said slips are forced out and into contact with the casing 11 by the weight of the bowl 21 when said bowl is lowered relative to barrel 23, as shown in Figure 2.

The enlarged pump barrel 29 has outwardly and fixedly mounted thereon a lower tapered slip bowl 33. Slips 35 are slidably attached to bowl 33, and are connected by actuating arms 37 to a latch ring or collar 39, slidably mounted around the pump barrel 29. The latch ring 39 is connected by guide or friction springs 45 to a second ring 47, likewise slidably mounted around the pump barrel 29. The latch ring 39 has formed therein a J-slot 43, adapted to receive a pin 41, fixedly carried on the periphery of the pump barrel, the slips 35 being maintained in retracted position, as shown in Figure 1, when the pin 41 is within the slot 43.

A portion of tubing 5 forming the upper polished plunger 5a extends through the upper barrel 23 into the enlarged pump barrel 29, an annular chamber 31 being formed therebetween, as shown in Figure 2. Attached to the lower end of tubing 5, as shown at 53, is a hollow plunger 57, having an outside diameter larger than that of tubing 5 and adapted for a sliding fit within the pump barrel 29. The plunger is provided with a passage or orifice 65, opening to the space within the pump barrel below the plunger and forming a valve seat for an upwardly opening ball valve 61, held in place by a baffle plate 59. The plunger has also ports 55 in communication with the space within the pump barrel above the plunger.

The tubing 5 is provided, at a suitable distance above the plunger, with lateral ports 44 in communication with the chamber 31. Mounted within the tubing 5 above these ports is a valve structure comprising an orifice 42, a valve seat 40, an upwardly opening ball valve 38, and a baffle pin 36.

The pump barrel 29 is closed at the lower end by a transverse member or plate 67, having therethrough an orifice 66 in register with a downwardly extending tube 69 depending from said plate. Ports 71 are formed in the walls of the pump barrel above the lower end of the tube 69 to permit the inflow of the fluid from the well, and the pump barrel or housing 29 is closed at the bottom by a bull plug 73, and arrangement 67—69—71 forming in effect a pump anchor.

The operation of the present tubing-actuated pump is as follows:

The pump is lowered into the well as shown in Figure 1, the pump barrel comprising the elements 23 and 29 being supported by the abutment of flange 19 against the upper face of slip bowl 21, suspended on links 17 from the yoke 11 which is in turn supported on the coupling 15 of the tubing 5.

When the pump has been lowered to the desired level in the well, the supporting tubing 5 is rotated from the surface. Since the key 18, forming a part of the pump barrel is at this time engaged within the keyway 20 of the slip bowl 21, and a key 12 on the yoke 13 is engaged within the keyway 14 on the coupling joint 15, the rotation of the tubing 5 causes the whole pump to rotate. Guide springs 45 are however in frictional engagement with the casing, and the rotation of the latch ring 39 is therefore prevented or retarded until the pins 41, rotating with the pump, are free of the J-slot 43. A further downward movement of the tubing 5 with the springs 45 still in frictional engagement with the casing will result in the slips 35 being moved upwardly with regard to the slip bowl 33 and along its tapered faces into engagement with the casing 11, as shown in Figure 2. The pump barrel 29 together with barrel 23 and flange 27 being thus anchored within the casing against downward movement, a further lowering of the tubing 5 will result in applying the weight of the suspended upper slip bowl 21 to the tapered faces of slips 25, forcing these slips out into engagement with the casing, and thus anchoring the pump against upward movement, as likewise shown in Figure 2.

The pump is now installed and anchored within the casing 11 against either downward or upward motion, and is ready for operation by the reciprocation of the tubing 5, the dimensions of the barrels 23 and 29, plunger 57 and tubing 5 below the coupling 15 being selected so that the plunger 57 and coupling 15 do not strike plate 67 and flange 19, respectively, at the end of the lower stroke, and coupling 15 does not strike yoke 13 at the end of the upper stroke of the pump.

As the plunger 57 is reciprocated within the pump barrel by means of tubing 5 and suspending elements 2 and 3 from a prime-mover element such as a walking-beam, the flow of the well liquid proceeds to the surface as follows:

During the downward stroke, valve 38 is closed by the column of fluid in tubing 5 and the well fluid entering the pump barrel through ports 71 and tube 68 passes into the plunger 57, valve 61 being open, and hence into chamber 31 through ports 55 due to the vacuum created in chamber 31 above the plunger 57 by the downward displacement of said plunger. On the upward stroke, the valve 61 is closed, and the fluid displaced from chamber 31 by the rising plunger is forced through ports 44 and upwards into the tubing 5, opening the valve 38.

Figure 3 illustrates the use of an additional ball valve 89 installed in a fitting 87, which may be used instead of the transverse member or plate 67 of Figures 1 and 2. The use of this ball valve converts the space within the pump barrel below the plunger into a second enclosed chamber 84 similar to chamber 31, which chamber 84 is filled to its full volume on the upstroke. On the downstroke, valve 89 being closed, fluid is sucked upwards through valve 59 in a volume equal to the inner volume of the pump barrel minus the volume of the tubing 5. This leaves said last volume of fluid to be disposed of during said downward stroke, which is accomplished by relieving said fluid from said chamber by means of relief valves 83, actuated by springs 85 to close lateral ports 81 in said chamber. Springs 85 may be set to give a desirable precompression in said chamber, for example about 20 lbs. per square inch, which reduces the volume of any gas which may have been sucked together with the liquid into chamber 84 during the upstroke, and increases the volumetric efficiency of the pump in wells making considerable quantities of gas.

When it is desired to raise the pump from the well, this may be accomplished by simply pulling the tubing 5, which results first in retracting the upper slips 25, as soon as the upper slip-bowl is raised by the action of the coupling 15 lifting the yoke 13, and second in retracting the lower slips 35 as soon as the lower slip-bowl is raised, together with the body of the pump, by the lifting action of the upper bowl applied against the flange 19.

The reason for using two sets of slips, and spe-

cifically the upper slips anchoring the pump against upward motion, is that the force pushing the fluid into the tubing and up to the surface through valve **38** during the upward stroke tends to move the pump barrel upwards, said force being caused by the fluid head in tubing **5** plus the friction losses.

Although the present pump system may be installed in any oil well and in combination with casing and tubing of any diameter, its use is especially advantageous in wells producing small volumes of oil, such as stripper wells giving up to **50** barrels of fluid daily, wherein it may be operated in combination with small diameter tubing such for example as one inch, one and one quarter inch, or one and a half inch tubing.

I claim as my invention:

1. In well pumping apparatus, a string of tubing extending into the well, said tubing being adapted for reciprocation from the surface, a plunger affixed to the lower end of said tubing, a pump barrel slidingly fitting around said plunger, port means for admitting well fluid to said pump barrel below said plunger, passage means in said plunger for admitting fluid from the under to the upper side thereof within said pump barrel, said tubing being open to said pump barrel above said plunger, valve means adapted to close said passage during the upward stroke of the plunger, lower slip means outwardly carried by said pump barrel adapted to anchor said pump barrel against downward motion in the well, and upper slip means adapted to anchor said pump barrel against upward motion in the well, said upper slip means comprising a slip-bowl slidingly surrounding said pump barrel, stop members on said pump barrel to limit the upward and the downward motion of said slip-bowl with regard to said pump barrel, a yoke slidingly surrounding said tubing, a stop member on said tubing adapted to limit the downward motion of said yoke with regard to said tubing, and link means connecting said yoke to said upper bowl, whereby said upper slip means can be set to anchor said pump barrel against upward motion by lowering the tubing after the pump has been anchored by said lower slip means against downward motion.

2. In well pumping apparatus, a string of tubing adapted to extend into a well, a pump barrel enclosing the lower end of said tubing, a stop member carried by the tubing above said pump barrel, a yoke member slidably mounted around the tubing and adapted to rest on said stop member, a bowl member slidably mounted about the pump barrel, stop members on the pump barrel adapted to limit the axial movement of said bowl member with regard to the pump barrel, link means connecting said bowl member to said yoke member, first anchoring means mounted around the pump barrel, latching means actuated by tubing manipulation from the surface for setting said anchoring means in the well, second anchoring means mounted on said bowl, said means being adapted to be set by a downward motion of said tubing with regard to the pump barrel when the pump barrel is anchored in the well by said first anchoring means, and means for conveying well fluid to the surface through the tubing by reciprocating the tubing with regard to the pump barrel anchored in the well, said means comprising a valved plunger affixed to the end of the tubing and slidingly fitting within the pump barrel.

3. A well pump adapted to be positioned in a well at the end of a string of tubing and to be actuated by the reciprocation of said tubing, said pump comprising a valved plunger adapted to be affixed to the end of the tubing, a pump barrel slidably surrounding said plunger, first anchoring means mounted on said barrel, said first anchoring means being adapted to be set in the well in response to a rotational motion of said pump barrel, second anchoring means mounted on said barrel, said second anchoring means being adapted to be set in the well in response to an axial motion of tubing with respect to the pump barrel after the pump barrel has been anchored in the well by said first anchoring means.

4. A well pump adapted to be positioned in a well at the end of a string of tubing, said pump comprising a pump barrel, a valved plunger fitting for a limited stroke within said pump barrel, said plunger being adapted to be connected to said tubing, first anchoring means carried on said pump barrel in a normally retracted position, latching means for said anchoring means in frictional contact with the walls of the well, said latching means being adapted to release said anchoring means against the walls of the well in response to a rotational motion of the pump barrel, second anchoring means carried on said pump in a normally retracted position, and actuating means for said second anchoring means supported on said tubing, said actuating means being adapted to force said second anchoring means against the walls of the well in response to an axial motion of the pump barrel with regard to the pump barrel after the pump barrel has been anchored in the well by said first anchoring means.

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