June 9, 1964 R. L. CHENAULT 3,136,256

SUBSURFACE PUMP AND DRIVE

Filed Oct. 12, 1962

FIG. 1.

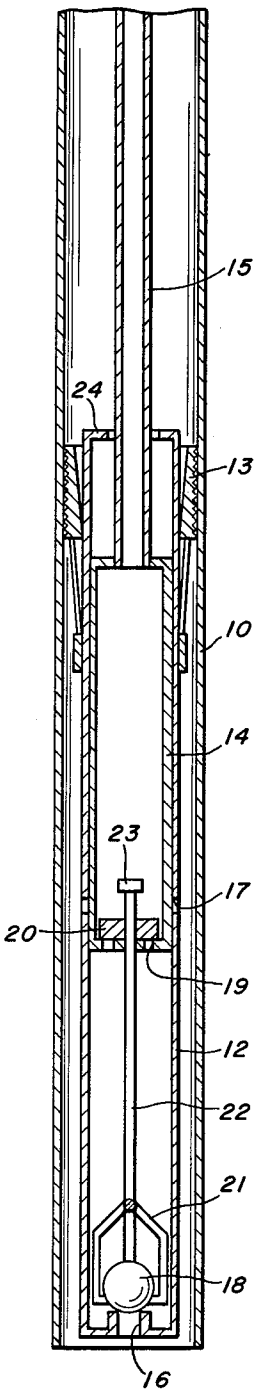


FIG. 2.

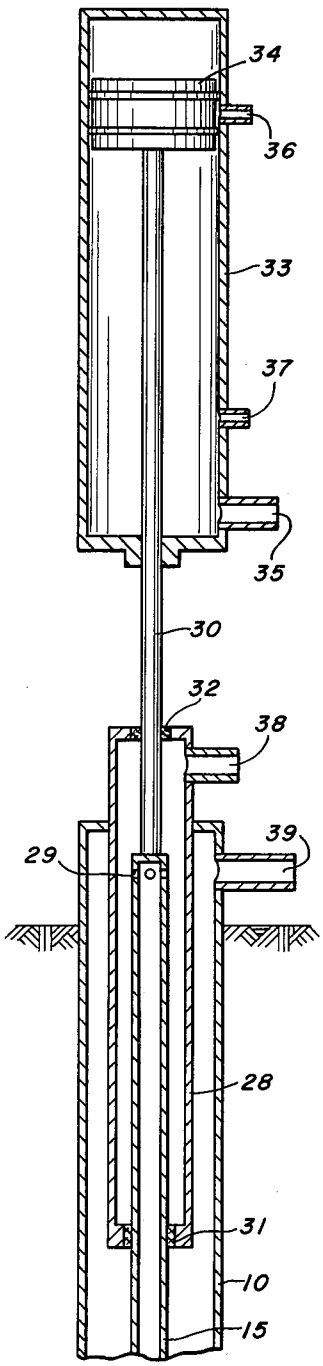
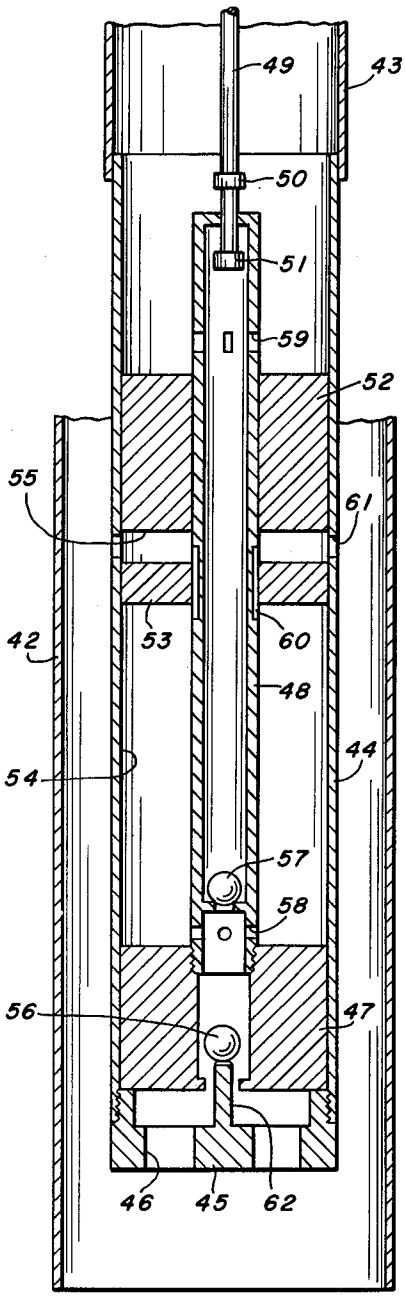


FIG. 3.



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SUBSURFACE PUMP AND DRIVE

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This invention relates to improved subsurface pumps for handling oils which have volatile constituents.

Oil in some wells has a high content of readily volatile constituents, such as propane or butane. When these constituents boil within a well, they may cause a vapor lock in a subsurface pump. The pump cannot bring oil to the surface, and the well appears to have "pumped off." For example, the vapor pressure of propane at 110 F. is about 213 p.s.i. In many wells the fluid column has a density such that about 3 feet of fluid head represents one pound per square inch of pressure. Under these conditions a fluid column of about 630 feet is required to prevent propane from boiling at the bottom. Thus a well may appear to pump off when it has up to 630 feet of fluid remaining above the pump inlet.

An object of the present invention is to provide improved subsurface pumps whch automatically allow vapors to escape, thereby enabling the pump to raise oil to the surface despite a high content of volatile constituents.

A further object is to provide improved subsurface pumps which automatically vent the barrel to the casing near the end of each intake stroke, allowing oil to replace vapors.

A further object is to provide improved subsurface pumps which automatically equalize the pressure inside and outside the pump barrel at the end of each intake stroke, thereby assuring that the pump picks up a representative sample of well fluid.

In accomplishing these and other objects of the invention, I have provided improved details of structure, preferred forms of which are shown in the accompanying drawing, in which:

FIGURE 1 is a diagrammatic vertical section of a casing-type subsurface pump constructed in accordance with my invention;

FIGURE 2 is a diagrammatic vertical section of surface equipment which I can use for actuating the pump shown in FIGURE 1; and

FIGURE 3 is a diagrammatic vertical section of a tubing-type subsurface pump constructed in accordance with my invention.

FIGURE 1 shows the lower portion of an oil well which contains a conventional casing 10. The pump of my invention includes an elongated tubular barrel 12 and conventional slips 13 or equivalent which anchor the barrel in the casing. The barrel contains a vertically movable reciprocable hollow plunger 14, the upper end of which is attached to a tubular rod string 15. The lower end of the barrel has an intake opening 16 and the side walls have vent ports 17 located intermediate the length of the barrel. A standing valve 18 is mounted at the lower end of the barrel over the intake opening 16. The lower end of the plunger has ports 19. A traveling valve 20 is mounted at the lower end of the plunger over the last-named ports. I mount the standing valve 18 in a cage 21. A rod 22 is attached to the top of cage 21 and extends upwardly therefrom through openings in the bottom of plunger 14 and traveling valve 20 into the interior of the hollow plunger. The upper end of rod 22 carries a knob or shoulder 23. The upper end of the pump barrel has a shoulder 24 to limit upward travel of the plunger.

In operation, a drive mechanism at the surface alternately raises and lowers the tubular rod string 15 and plunger 14. Preferably the drive is of a type which produces a long stroke on the order of 20 to 30 feet and is equipped with a timer which automatically stops the rod string for several seconds at the end of each intake stroke. One example of a suitable drive is described hereinafter. During an upstroke of the plunger, the standing valve 18 opens and the traveling valve 20 closes. The plunger draws well fluid into barrel 12 through the intake opening 16 in the usual way. The plunger covers the vent ports 17 until it approaches the top of its upstroke. When the plunger moves past these ports and uncovers them, the interior of the barrel is vented to the casing. Continued upward movement of the plunger lifts rod 22 and cage 21 to hold the standing valve open. Thus gas which accompanies oil in the well, along with vapors which form as volatile constituents boil, escape into the casing. The pause in movement of the plunger allows sufficient time. During a downstroke the standing valve closes and the traveling valve opens. Well fluid is forced from the pump barrel through ports 19 into the plunger, and up the bore of the tubular rod string 15 to the surface.

FIGURE 2 shows one form of mechanism I can use for delivering well fluid at the surface from the pump shown in FIGURE 1 and also actuating the pump. A cylindrical chamber 28 is fixed within the upper end of the casing 10. The tubular portion 15 of the rod string terminates within chamber 28 and has discharge ports 29 therein. A polished rod 30 is attached to the upper end of the rod string 15. Chamber 28 has stuffing boxes 31 and 32 at opposite ends through which the tubular rod string and the polished rod extend. A single-acting drive cylinder 33 is positioned above the top of tubing 10. A piston 34 is attached to the upper end of the polished rod and housed in cylinder 33. The lower portion of the cylinder has a connection 35 for admitting and discharging hydraulic fluid. This connection leads to a motivating pump and valve (not shown). Cylinder 33 has spaced upper and lower pressure taps 36 and 37 for actuating timing and reversing mechanism (not shown). Reference can be made to my earlier Patent No. 2,665,551 for a showing of a motivating pump and associated mechanisms suitable for this purpose. The circuit which energizes the motivating pump can be equipped with a conventional timer for producing a pause in movement of the rod string at the end of each intake stroke. Chamber 28 has a discharge opening 38, and the casing 10 a vent opening 39.

In operation, hydraulic fluid is forced into the drive cylinder 33 through the connection 35 to raise piston 34 and thus produce an upstroke of the rod string 15 and pump plunger 14. In the embodiment of my pump shown in FIGURE 1, the upstroke is the intake stroke; hence the force required is only that needed to lift the rod string. During the downstroke the rod string moves by gravity. The weight of the rods thus furnishes the force needed to deliver well fluid to the surface. In this manner I avoid the need to counterbalance the weight of the rods, although of course I can use a counterbalance as shown in my aforementioned patent to diminish still further the force required for an upstroke.

FIGURE 3 shows a modification in which I apply my venting principles to a tubing-type pump. The figure shows the lower portion of an oil well which contains a conventional casing 42 and tubing 43. An elongated tubular barrel 44 is fixed to the lower end of the tubing and has a lower head 45 which contains intake openings 46. The barrel contains a reciprocable plunger 47, the upper end of which is attached to a finished tube 48. I connect the upper end of tube 48 to a rod string 49, the lower end of which has spaced shoulders 50 and 51 to provide a lost-motion connection between the rod string

and the plunger. I mount vertically spaced upper and lower liners 52 and 53 within barrel 44. These liners closely receive the outside of tube 48 and they divide the interior of the pump barrel into chambers 54 and 55. The plunger 47 contains an intake valve 56, and tube 48 a check valve 57. Tube 48 has ports 58 and 59 near its lower and upper ends respectively, and a series of vertical grooves 60 in its outer surface intermediate its length. The barrel 44 has vent ports 61 which afford communications between chamber 55 and casing 42. The lower head 45 has an upstanding stem 62 for holding the intake valve 56 open at the bottom of a downstroke.

In operation, a drive mechanism (not shown) at the surface alternately raises and lowers the rod string 49. The drive can be similar to that already described, except that preferably it is equipped with a counterbalance, since in this instance the upstroke is the delivery stroke. During a downstroke the intake valve 56 opens, while the weight of the fluid column in the tubing holds valve 57 closed. Well fluid enters the chamber 54 within the pump barrel through openings 46, the open valve 56, and ports 58. The close fit of the finished tube 48 in liner 53 blocks flow of fluid from chamber 54 to chamber 55 until the plunger approaches the end of its downstroke. When the finished tube reaches a position near the end of the downstroke, grooves 60 establish communication between chambers 54 and 55, whereby chamber 54 is vented to the casing. On continued downward movement of the plunger, stem 62 holds the intake valve 60 open. Thus gas which accompanies oil in the well, along with vapors which form as volatile constituents boil, escape into the casing. The pause in movement of the plunger allows sufficient time. During the upstroke the intake valve 56 closes and the check valve 57 opens. Well fluid is forced from chamber 54 through ports 58, the open valve 57 and ports 59 into the tubing 43 and thence to the surface.

From the foregoing description, it is seen that either embodiment of my subsurface pump allows free circulation of well fluid through the intake opening 16 or 46 and out the vent ports 17 or 61 during the pause at the end of an intake stroke. Consequently the pump picks up a representative sample of fluid under conditions identical with those in the well outside the barrel. Even though a liquid is boiling violently, the volume of vapor is relatively small. Hence I obtain a high volumetric efficiency by admitting a truly representative sample of well fluid to the barrel. However, even a slight pressure drop in a boiling liquid causes a flashing into vapor which may completely fill the pump barrel on the intake stroke and recondense with only a small pressure increase on the delivery stroke to form an insignificant volume of liquid. Both arrangements I have shown avoid this vapor lock condition by assuring that the pressure inside the pump barrel is exactly the same as that outside.

While I have shown and described certain preferred embodiments of my invention, it is apparent that other modifications may arise. Therefore, I do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

I claim:

1. A subsurface pump comprising an elongated tubular barrel, a vertically movable reciprocable element housed within said barrel and adapted to make intake and delivery strokes as it travels in opposite directions, a first valve which closes during a delivery stroke but opens during an intake stroke to admit fluid to said barrel, a second valve which closes during an intake stroke but opens during a delivery stroke to enable said element to force fluid from said barrel, said barrel having a vent port intermediate its length, said element reaching a position near the end of its intake stroke in which said port affords communication between the interior of said barrel and the exterior but otherwise closing said port, and means for holding said first valve open when said element reaches the end of its intake stroke to allow volatiles to escape from said barrel through said port and liquid to enter the barrel through said first valve to replace escaped volatiles.

2. A pump as defined in claim 1 in which said element travels upwardly as it makes its intake stroke and downwardly as it makes its delivery stroke, said first valve is a standing valve mounted in said barrel below said element, and said second valve is a traveling valve mounted in said element.

3. A pump as defined in claim 2 in which the means for holding said first valve open includes a cage in which said first valve is mounted, a rod extending upwardly from said cage and into said element, and a knob on the upper end of said rod for lifting said cage.

4. A pump as defined in claim 1 in which said element travels downwardly as it makes its intake stroke and upwardly as it makes its delivery stroke, said first valve is an intake valve mounted in said element near the lower end thereof, and said second valve is a check valve mounted in said element above said first valve.

5. A pump as defined in claim 4 in which the means for holding said first valve open includes an upstanding stem fixed to the lower end of said barrel.

6. A subsurface pump comprising an elongated tubular barrel, a vertically movable hollow reciprocable plunger housed within said barrel and adapted to make an intake stroke as it travels upwardly and a delivery stroke as it travels downwardly, a standing valve which is mounted in said barrel below said plunger and closes during a delivery stroke but opens during an intake stroke to enable said plunger to draw fluid into said barrel, a traveling valve which is mounted in said plunger and closes during an intake stroke but opens during a delivery stroke to enable said plunger to force fluid from said barrel, said barrel having a vent port intermediate its length, said plunger reaching a position near the end of its intake stroke in which said port is uncovered and affords communication between the interior of said barrel and the exterior but otherwise covering said port and preventing communication therebetween, and means connecting said plunger and said standing valve for holding said standing valve open when said plunger reaches the end of its intake stroke to allow volatiles to escape from said barrel through said port and liquid to enter the barrel through said first valve to replace escaped volatiles.

7. A casing-type subsurface pump comprising an elongated tubular barrel, means for anchoring said barrel in a casing, a vertically movable reciprocable hollow plunger housed within said barrel and adapted to make an intake stroke as it travels upwardly and a delivery stroke as it travels downwardly, a tubular rod string connected to said plunger for driving it up and down, a standing valve which is mounted in said barrel below said plunger and closes during a delivery stroke but opens during an intake stroke to enable said plunger to draw fluid into said barrel, a traveling valve which is mounted in said plunger and closes during an intake stroke but opens during a delivery stroke to enable said plunger to force fluid from said barrel into said rod string, said barrel having a vent port intermediate its length, said plunger reaching a position near the end of its intake stroke in which said port is uncovered and affords communication between the interior of said barrel and the exterior but otherwise covering said port and preventing communication therebetween, and means connecting said plunger and said standing valve for holding said standing valve open when said plunger reaches the end of its intake stroke to allow volatiles to escape from said barrel through said port and liquid to enter the barrel through said first valve to replace escaped volatiles.

8. A subsurface pump comprising an elongated tubular barrel, a vertically movable reciprocable plunger housed within said barrel and adapted to make an intake stroke as it travels downwardly and a delivery stroke as it travels upwardly, a finished tube fixed to said plunger and ex-

tending upwardly therefrom, vertically spaced upper and lower liners fixed within said barrel and closely receiving said tube, said liners dividing the interior of said barrel into a first chamber below said lower liner and a second chamber between the two liners, said tube having ports which afford communication between the interior of the tube and said first chamber, an intake valve which is mounted in said plunger near the lower end thereof and closes during a delivery stroke but opens during an intake stroke to admit fluid to said tube and through said ports into said first chamber, a check valve which is mounted in said tube and closes during an intake stroke but opens during a delivery stroke to enable said plunger to force fluid from said first chamber through said tube, said barrel having a vent port leading to said second chamber, said tube having external grooves along a portion of its length, said tube reaching a position near the end of an intake stroke in which said grooves afford communication between said first and second chambers but otherwise preventing such communication, and means on said barrel for holding said intake valve open when said plunger reaches the end of its intake stroke to allow volatiles to escape through said vent port and liquid to enter the barrel through said intake valve to replace escaped volatiles.

9. A tubing-type subsurface pump comprising an elongated tubular barrel, a vertically movable reciprocable plunger housed within said barrel and adapted to make an intake stroke as it travels downwardly and a delivery stroke as it travels upwardly, a finished tube fixed to said plunger and extending upwardly therefrom, vertically spaced upper and lower liners fixed within said barrel and closely receiving said tube, said liners dividing the interior of said barrel into a first chamber below said

lower liner and a second chamber between the two liners, said tube having ports which afford communication between the interior of the tube and said first chamber and other ports which afford communication between the interior of the tube and barrel above said upper liner, an intake valve which is mounted in said plunger near the lower end thereof and closes during a delivery stroke but opens during an intake stroke to admit fluid to said tube and through said first-named ports into said first chamber, a check valve which is mounted in said tube and closes during an intake stroke but opens during a delivery stroke to enable said plunger to force fluid from said first chamber into said tube and through said second-named ports, a rod string connected to the upper end of said tube and having a lost-motion connection therewith, said barrel having a vent port leading to said second chamber, said tube having external grooves along a portion of its length, said tube reaching a position near the end of an intake stroke in which said grooves afford communication between said first and second chambers but otherwise preventing such communication, and means on said barrel for holding said intake valve open when said plunger reaches the end of its intake stroke to allow volatiles to escape through said vent port and liquid to enter the barrel through said intake valve to replace escaped volatiles.

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