Feb. 16, 1932. J. PENROD 1,845,181

HEAD FLOWING FLUID LIFT

Filed May 26, 1927 3 Sheets-Sheet 1

Fig. 1.

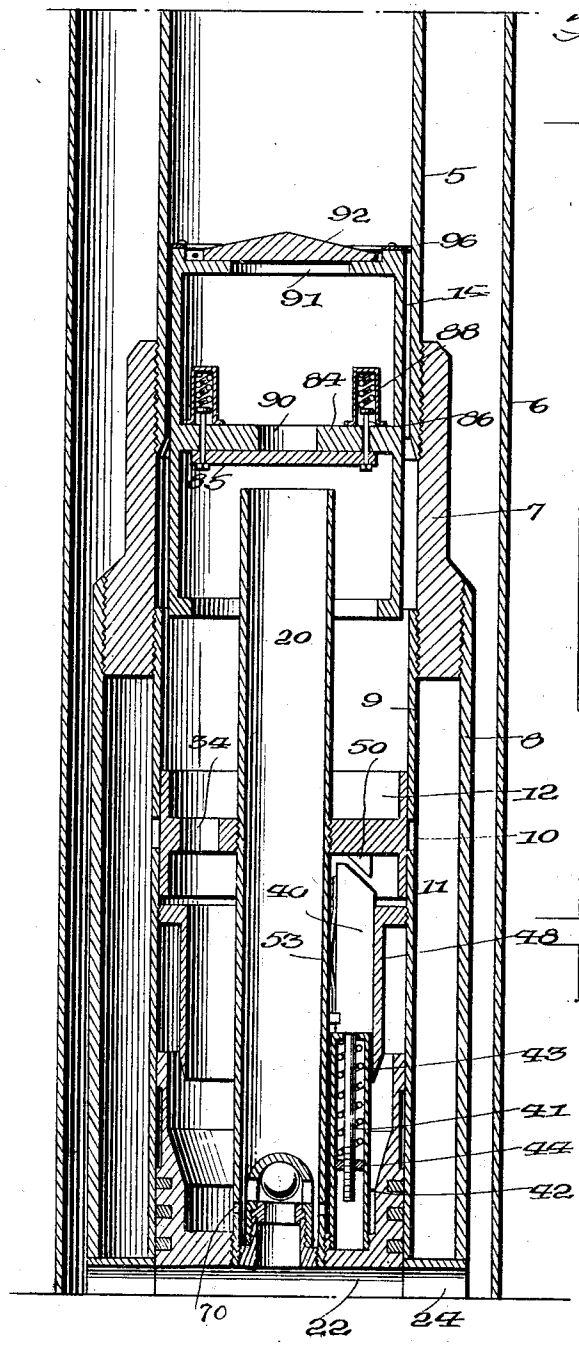
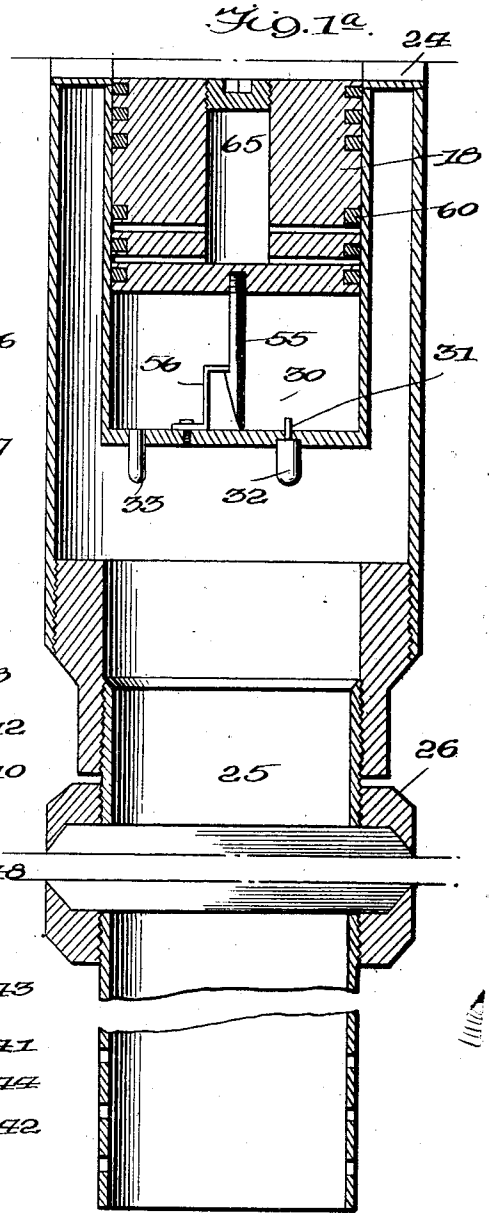


Fig. 1a.



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HEAD FLOWING FLUID LIFT

Filed May 26, 1927 3 Sheets-Sheet 2

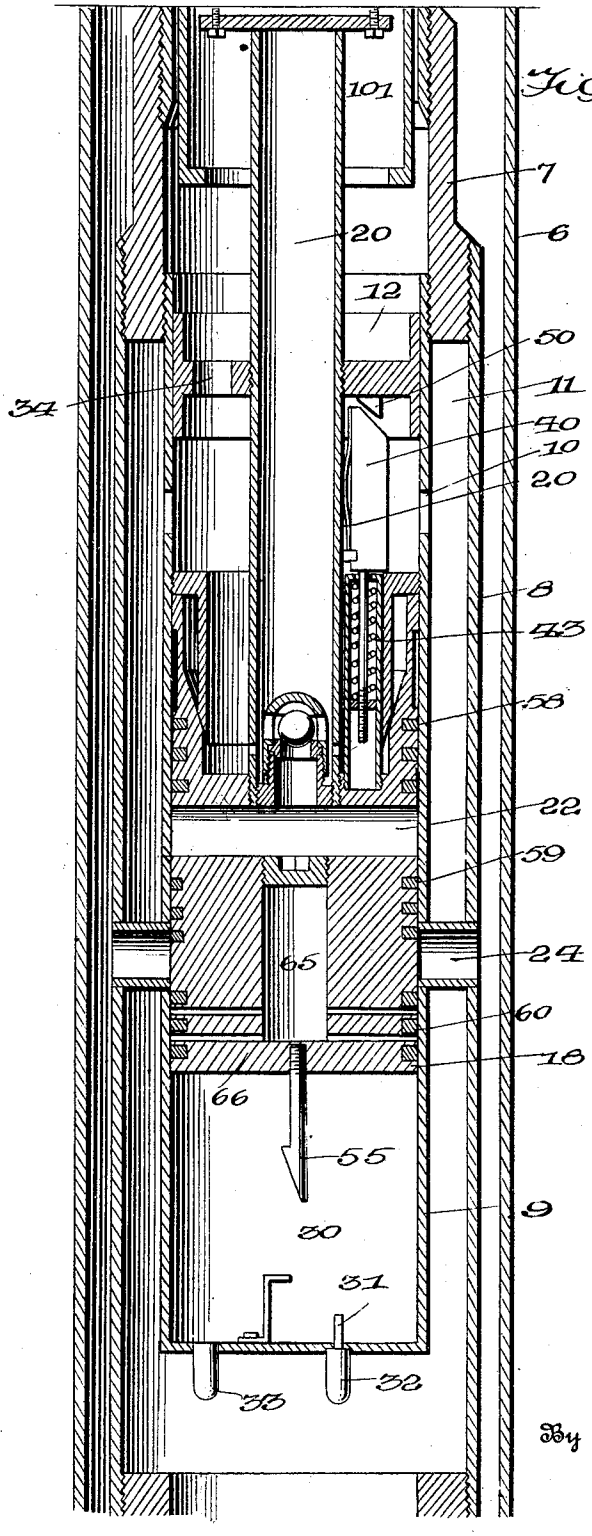

Fig. 2.

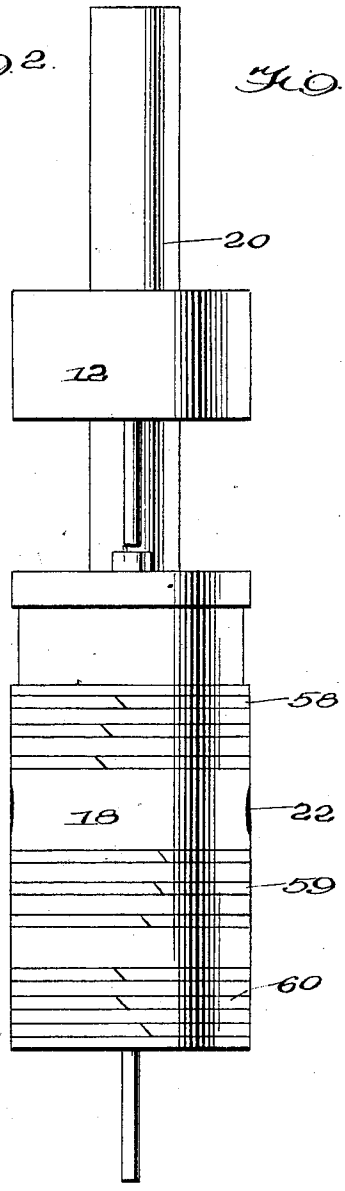

Fig. 3.

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Feb. 16, 1932. J. PENROD 1,845,181

HEAD FLOWING FLUID LIFT

Filed May 26, 1927 3 Sheets-Sheet 3

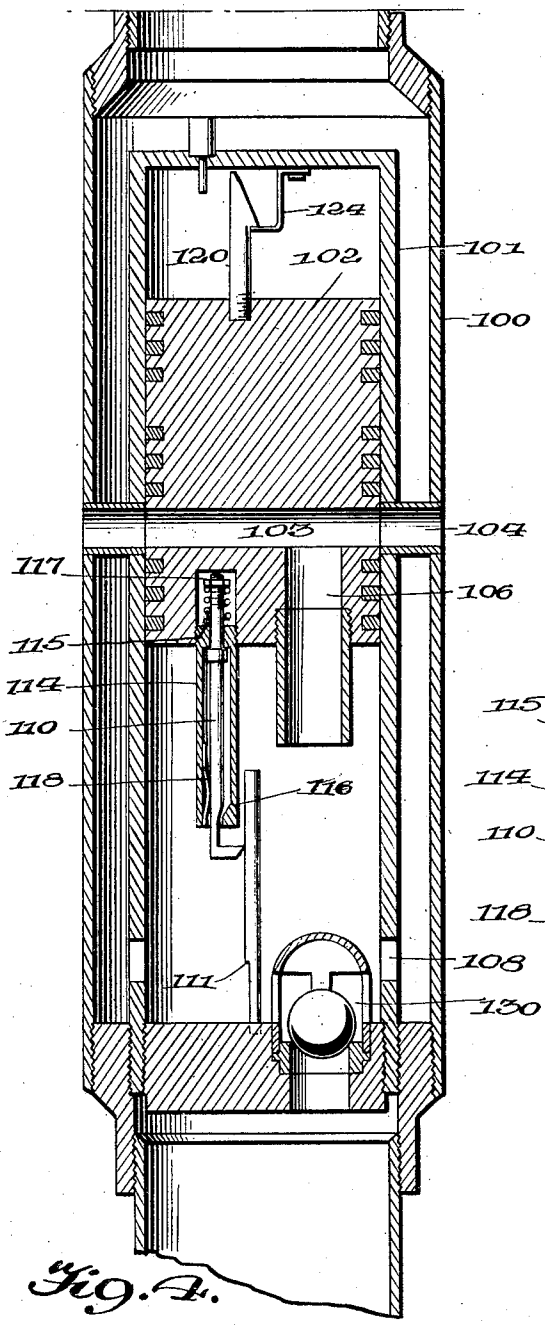

Fig. 4.

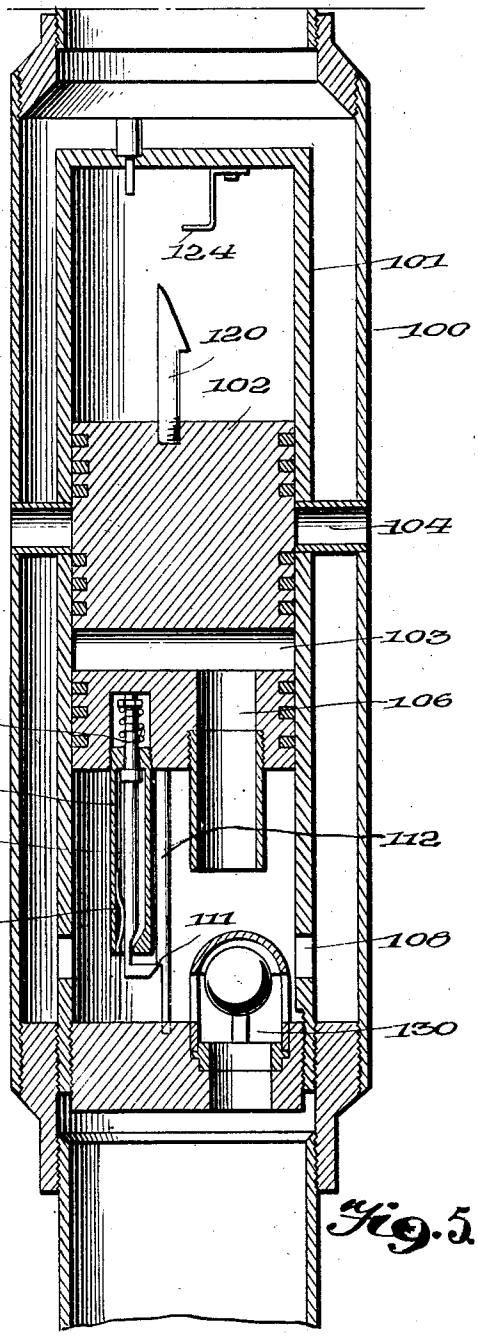

Fig. 5.

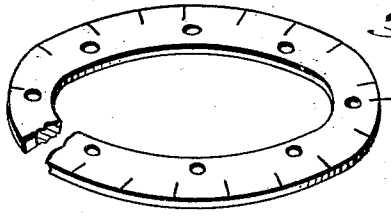

Fig. 6.

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HEAD FLOWING FLUID LIFT

Application filed May 26, 1927. Serial No. 194,370.

This invention relates to fluid lifts of the type which employ compressed air or gas as a lifting medium.

Briefly stated an important object of the invention is to provide a fluid lift for wells having a novel form of valve adapted to be controlled by the hydrostatic pressure to allow the lifting medium, such as compressed air or gas, to assume lifting relation to the column of fluid at the intervals when the compressed air or gas may be most advantageously employed, this feature of the invention being calculated to flow the well by heads and to conserve the supply of lifting medium.

Another and equally important object of the invention is to provide a fluid lift embodying an air or gas actuated swab having means to minimize the mingling of the products of the well with the lifting medium, such as compressed air or gas, the improved swab also having means whereby the paraffin which attaches itself to the wall of the tubing is removed each time the well is flowed.

Another object is to provide a control valve for a fluid lift having automatic means by which the movement of the same to an extreme position in response to pressure variations is delayed slightly to allow sufficient pressure to be built up to cause the valve to move to an extreme position with the suddenness desired to bring about the rapid opening and closing of the separate ports by which the oil and the lifting medium enter.

The invention forming the subject of the application also contemplates the admission of native well fluid to the space immediately below the lifting medium as the oil above the lifting medium approaches the limit of its ascent whereby the rock pressure is permitted to accelerate the flowing of the well.

Other objects and advantages will be apparent during the course of the following description.

In the accompanying drawings forming a part of this application and in which like numerals are employed to designate like parts throughout the same,

Figures 1 and 1*a* are vertical sectional views through the improved pump, the parts being in position to admit a lifting medium such as compressed air or gas,

Figure 2 is a fragmentary vertical sectional view through the pump, the parts thereof being positioned to cut off the admission of a lifting medium and to allow the admission of oil or other products of the well,

Figure 3 is a side elevation of a piston valve embodied in the invention,

Figure 4 is a vertical sectional view through a modification of the invention, the same being in position to admit air or gas as the case may be,

Figure 5 is a sectional view through the pump in position to admit oil or other products of the well,

Figure 6 is a perspective of a scraping element embodied in the invention.

In the drawings the numeral 5 designates a tubing positioned within a casing 6 and having connection with the improved fluid lift by way of a coupling 7.

Figure 1 clearly illustrates that the coupling has connection with a shell or casing 8 and a cylinder 9, the members 8 and 9 being positioned one within the other and in spaced relation to define an annular chamber 11 for the inflow of oil or other products of the well. At this point it might be stated that the cylinder 9 is provided near the upper end thereof with a suitable number of ports 10 communicating with the aforesaid chamber 11 and controlled by the upper section 12 of the piston valve fully illustrated in Figure 3. When the upper section 12 is in its lowermost position as suggested in Figure 1 the ports 10 are closed to prevent the admission of oil from the chamber 11 to the tubing by way of the ports 10 and 34. From the upper portion of the cylinder 9 the oil flows upwardly through and about a swab 14 to be fully hereinafter described. However, it might be stated at this point that when the lifting medium, such as compressed air or gas, is introduced into the tubing to lift the oil it contacts with the under side of the swab 14 to minimize the mingling of the lifting medium with the oil. In other words, the oil is elevated as a single column above the swab.

The upper section 12 of the piston valve is connected to the lower section 18 by a tubular conduit 20 which extends above the piston section 12 and discharges the compressed air or gas in lifting proximity to the swab.

Figure 1 clearly illustrates that the piston section 18 is provided with a transverse port 22 communicating with the tubular conduit 20 and adapted for registration with ports or passages 24 having constant communication with the space between the tubing and the casing. Therefore it is believed to be clear that when the piston section 18 is in its lower position as suggested in Figures 1 and 1*a* the lifting medium, such as compressed air or gas, may be allowed to enter the tubing from the casing. On the other hand when the piston section 18 is in the elevated position illustrated in Figure 2 the admission of compressed air or gas to the tubing is cut off.

As suggested in Figure 1 the inlet conduit or member 25 by which oil or other products of the well is supplied to the annular chamber 11 is provided with a packer 26 of conventional or other design. It is believed to be obvious that when the improved fluid lift is installed in the well the packer will establish a fluid tight connection between the casing and the member 25 so that the compressed air or gas supplied to the space between the tubing and the casing will be prevented from exercising a restraining influence on the oil or the like seeking to enter the pump. In other words, the packer 26 sets up an effective barrier between the compressed air and the producing stratum.

The piston valve is urged to the oil inlet position illustrated in Figure 2 by the air compressed within the chamber 30 in the lower portion of the cylinder 9. Figure 1 clearly illustrates that the lower end of the piston section 18 is exposed to air compressed within the chamber 30 so that when the hydrostatic pressure on the upper end of the piston section 18 is relieved to the required point the piston is moved upwardly to air excluding and oil inlet position.

In carrying out the invention a suitable valve 31 may be associated with the chamber 30 by which air under pressure may be admitted to the chamber 30. A cap 32 may be extended over the valve 31 to avoid leakage of air from the chamber and to prevent the supply of additional air or other fluid in case the pressure is greater exteriorly of the chamber than interiorly thereof.

A relief valve 33 may be employed to relieve excessive pressure within the chamber 30 as a result of leakage of the lifting medium, such as compressed air or gas, into the chamber 30. The building up of an excessive pressure in the chamber 30 would defeat the purpose of the invention as it would prevent the movement of the valve section 18 to air or gas inlet position under the load of a predetermined volume of fluid in the tubing.

Attention is invited to Figure 1 which illustrates that the piston section 12 is provided with a suitable number of longitudinal ports 34 by which the weight of the column of fluid accumulated within the tubing may act on the upper end of the piston section 18 to urge the piston section 18 downwardly against the influence of the air compressed within the chamber 30.

During the accumulation of oil in the tubing the piston valve is held in an oil inlet position and in air or gas excluding position by an elongated dog 40 having a stem or shank 41 positioned within a tubular carrier 42 and encircled by a spring 43. The spring 43 is confined between the inwardly flanged upper end of the tubular carrier 42 and a nut 44 adjustable on the lower portion of the stem. It is important to note that when the piston valve is in the elevated position illustrated in Figure 2 the rear or lower end of the dog rests upon the annular attaching portion of a sleeve 48, and the downward movement of the valve to air inlet and oil excluding position under the weight of the tubing fluid is resisted and delayed. The shoulder or lower end of the dog 40 is urged laterally into seating engagement with the sleeve 48 by a bowed spring 53 confined between the dog 40 and the fluid conduit 20.

The ports 34 provide a means whereby the pressure of the fluid accumulated in the tubing is borne by the section 18 and when the pressure exceeds a predetermined value the section 18 will move downwardly and carry with it the section 12. When the section 12 is thus moved downwardly a lug or cam 50 carried by the same will be engaged with the beveled upper portion of the dog 40 whereby the dog is moved laterally out of seating engagement with the sleeve 48.

In summarizing the foregoing arrangement it is pointed out that the dog 40 will transmit the entire weight of the column of accumulating fluid in the tubing until the weight of this fluid overcomes the resistance of the spring 43 at which period in the operation of the invention the section 12 is moved downwardly to release the dog 40 from seating engagement with the sleeve 48.

When the dog 40 is thus released the descent of the piston valve is resisted only by the air compressed within the chamber 30, but this will be very much less than sufficient to hold the piston in an elevated position so that the piston is moved downwardly to a point where the ports 22 and 24 are in register to admit of the entrance of compressed air or gas through the conduit 20.

When the piston is moved downwardly by the weight of the column of fluid above, the shoulder of a dog 55 will be engaged with

a spring catch 56 by which the return of the piston to oil inlet position is delayed until the pressure within the tubing is substantially below the pressure within the chamber 30. The dog 55 which is carried by the piston will remain in locking engagement with the spring fastener 56 until the tubing pressure has dropped substantially by reason of the movement of the oil.

It is important to observe that as a portion of the column of fluid is discharged from the tubing the compressed air or gas is employed expansively to accelerate the flow of the fluid. When the compressed air or gas thus expands a substantial drop in tubing pressure will occur so that the piston valve is moved to oil inlet position prior to the complete discharge of the column of fluid above. Therefore, additional oil or gas may enter from the producing stratum by way of the ports 10 to assist the expanding lifting medium in completing the discharge of the column of fluid above the swab. In explaining this it is pointed out that during the admission of compressed air or gas for head flowing the well the natural pressure of the producing stratum will be increased to a point where the oil will be supplied to the tubing by way of the ports in sufficient volume and with sufficient force to accelerate the movement of the column of oil above. This also quickens each cycle so that the natural pressure of the well actively cooperates with the artificially compressed air or gas in flowing the well.

Of course during the admission of the lifting medium by way of the ports 22 and 24 the supply of oil to the tubing is positively prevented. Therefore, the possibility of cutting the oil by mixing air or gas with it is minimized. As will be described later the mixing of the lifting medium with the oil accumulated in the tubing is further minimized by the employment of the swab 14.

The piston valve section 18 is provided with sets of rings or cups 58, 59 and 60 arranged in spaced relation and adapted to be positioned at opposite sides of the inlet ports 24 to avoid leakage of both oil and compressed air or gas. More specifically the sets of rings or cups 58 and 59 are positioned at opposite sides of the inlet ports 24 when the valve section 18 is in air inlet position. When the valve is in oil inlet position the rings 59 and 60 are positioned at opposite sides of the ports 24.

The section 18 may be provided with a longitudinally extending reservoir 65 having lateral branches 66 by which a suitable lubricant may be supplied to the rings. Of course, the inner wall of the cylinder 9 will be supplied with the lubricant from the reservoir 65 and the rings 58 and 59 will thus be lubricated.

Figure 1 illustrates that the upper portion of the valve section 18 is chambered to receive the depending sleeve 48 to define a trap, the lower portion of which is supplied with compressed air or gas by ports 70 so that any sand which may accumulate in the chambered upper end of the section 18 will be blown out when the well is flowed. Since the sleeve 48 at all times extends into the chambered upper end of the section 18 gas will accumulate between the sleeve and the cylinder 9 so that sand laden oil is prevented from working its way into destructive contact with the opposed surfaces of the section 18 and the cylinder.

It will be seen that the attaching portion of the gas trapping sleeve 40 not only functions as such, but as a stop to limit upward movement of the piston valve under the influence of the air within the chamber 30.

The swab 14 is in the nature of a rubber or metal body having a transverse wall or support 84 ported as shown at 90 for the entrance of oil or other products of the well into the tubing. Normally the closure plate 85 beneath the port 90 is spaced from the port by coil springs 88 whereby oil or the like may freely flow upwardly through the swab. The closure 85 is suspended from stem or hangers 86 against which coil springs 88 are engaged. It is the office of the springs 88 to urge the closure 85 to open position to allow of the free passage of oil through the port 90. However, when the valve section 18 is moved to air or gas inlet position the inrushing air or gas will by reason of the greater volume and pressure thereof promptly move the closure plate 85 to the position illustrated in Figure 1 whereby the port 90 is closed and the swab moved upwardly.

That oil or other product of the well which flows through the swab is discharged from the swab by way of a port 91 with which a flap valve 92 is associated. It will be seen that the flap valve 92 will relieve the closure plate 85 of the weight of the column of fluid above when the swab is being elevated. In other words, the column of fluid being elevated will have the effect of holding the flap valve 92 in closed position while the lifting medium, such as compressed air or gas, discharged under the swab will hold the closure plate 85 in closed position. This double valve arrangement permits the swab to move upwardly without the leakage of air or oil through the swab.

Figure 1 illustrates that the diameter of the swab is slightly less than the diameter of the tubing and that the upper portion of the tubing is provided with an annular scraper 96 adapted to have scraping contact with the walls of the tubing during the flowing of the well. It will be seen that the scraping ring 96 is radially cut to provide a number of separate scraping members which

have effective contact with the wall of the tubing to remove paraffin therefrom. The upper end of the swab defines somewhat of a shoulder by which the scraper 96 is held in operative position during the ascent of the swab. However, on the descent of the ring 96 the inherent flexibility of the scraper will permit the edge portion of the scraper to bend upwardly so that the swab will not be seriously retarded in its descent. In other words, the action of the scraper is strictly one-way.

The descent of the swab is cushioned by the column of air or oil below. In explaining this it is pointed out that the column of air beneath the swab will move the plate 85 to closed position should the swab descend too rapidly and the swab will be slackened in its speed. When the swab drops to the level of the column of oil accumulated in the tubing during the previous head flowing of the well its descent will be further cushioned whereby destructive contact of the swab with the conduit 20 is avoided.

The limited space between the swab and the tubing and the pressure behind the lifting medium will prevent the leakage of oil about the swab during the elevation thereof whereby mingling of the oil and the lifting medium is minimized. By thus maintaining the oil separate from the lifting medium cutting or emulsifying of the oil is greatly reduced. Also by maintaining the lifting medium separate from the column of oil being elevated a reduction in the gravity of the oil is avoided.

It is intended to have superposed outlets at the upper portion of the tubing spaced a greater distance than the length of the swab so that when the swab passes the lower outlet a portion of the lifting medium may be discharged to allow of the free descent of the swab.

In the form of invention illustrated in Figures 4 and 5 the shell 100 encloses a cylinder 101 within which a piston valve 102 operates. In carrying out this form of the invention the piston valve is provided with a transverse port 103 adapted for communication with inlet ports or passages 104. Of course, the passages 104 are adapted to establish communication between the interior of the well casing and the transverse port 103 when the piston valve is in open position. Figure 5 clearly illustrates that the piston 102 is provided with a port 106 communicating with the port 103 and the lower portion of the cylinder 101. Air admitted to the lower portion of the cylinder by way of the port 106 enters the shell 100 by way of ports 108 and flows upwardly into lifting relation to the column of oil above.

The upper portion of the cylinder 101 contains compressed air by which the piston 102 is constantly urged to the closed position illustrated in Figure 5.

When the piston 102 is in closed position the bill on the lower end of the elongated dog 110 is engaged with a shoulder 111 on a member 112. The elongated dog 110 is extended through a barrel 114 having an internal cam 116 adapted to engage a cam or beveled surface on the adjacent portion of the elongated dog 110 so that when the tubing pressure acting on the under side of the piston 102 exceeds a predetermined point the locking dog 110 will be moved laterally out of engagement with the shoulder 111. When the locking dog 110 is thus released from engagement with the shoulder 111 the tubing pressure is allowed to move the piston valve 102 to open position with speed whereby compressed air or gas may flow in through the ports 104, 103, 106 and 108 in sufficient volume and with sufficient velocity to effectively lift the oil.

Figure 5 illustrates that a spring 115 is mounted on the upper portion of the dog 110 and is held thereon by an adjustable nut 117 by which the pressure under which the spring is compressed may be varied. In use the nut is adjusted on the elongated dog 110 to cause the spring 115 to yield under a given tubing pressure. The initial movement of the piston 102 results in the engagement of the co-acting cams or shoulders on the barrel 114 and the dog 110 so that the bill of the dog is removed from engagement with the shoulder 111. It will be seen that the dog 110 is urged laterally in the direction of the member 112 by a bowed spring 118. Of course when the shoulder 116 is engaged with the opposed shoulder on the dog 110 the pressure of the bowed spring 118 will be overcome with the obvious result that the bill of the dog will be released from engagement with the shoulder 111.

When the piston 102 is thus moved to open position a second dog 120 carried by the upper end thereof is engaged with the laterally projecting terminal portion of a spring catch 124. The spring catch 124 is carried by the upper end of the cylinder 101 and when engaged with the shoulder of the dog 120 will delay the return of the piston 102 to closed position under the influence of the air in the air chamber.

Oil is admitted to the lower portion of the cylinder 110 through a one-way valve 130, the ball of which is firmly held in seated position by the lifting medium during its flow through the lower portion of the cylinder.

Preparatory to the installation of the improved fluid lift into a well the tension of the spring 43 is adjusted by the nut 44 to permit of the release of the piston valve under a given tubing pressure. By this means the volume of oil to be elevated at each flowing operation may be regulated. The chamber 30 is supplied with air which exerts a pres-

sure somewhat less than the pressure of the spring 41 so that when the dog 40 is released the piston valve may promptly move to air inlet position.

When the improved pump is installed in the well oil is allowed to accumulate in the tubing until the weight of this oil overcomes the spring 43 and causes the lug 50 to trip the dog 40 whereupon the piston valve is moved to open position. Air or gas under pressure now enters and is discharged in the lower portion of the tubing and against the closure plate 85 so that the closure plate is caused to move upwardly to cut off the port 90. The swab and the column of oil above now ascend, during which time the scraping ring 96 removes the paraffin or a substantial portion of it from the tubing.

As a portion of the column of fluid leaves the tubing the air is expanded to accelerate the movement of the remaining oil in the tubing. When the air is thus expanded the tubing pressure will drop so that the piston valve is moved to air excluding and oil inlet position whereupon the built up natural pressure of the well will cause the oil to enter the tubing and aid in the completion of the flowing operation. The completion of one flowing operation is marked by the descent of the swab to the position illustrated in Figure 1 and when the oil reaches a predetermined height in the tubing the pressure of the same will again move the piston valve to oil excluding and air inlet position whereupon the well is flowed again.

Having thus described the invention, what is claimed is:

1. In a fluid lift for oil wells, a casing having separate passages for oil and an oil lifting medium, a piston having means separately controlling said passages to close the oil passage when the passage for the oil lifting medium is open, and means to hold said valve in position to admit oil and to exclude the oil lifting medium until the weight of the column of oil exceeds a predetermined value.

2. In a fluid lift for oil wells, a casing having passages for oil and an oil lifting medium, a piston having means separately controlling said passages to close the oil passage when the passage for the oil lifting medium is open, a member to hold said valve in position to admit oil and to exclude the oil lifting medium until the weight of the column of oil exceeds a predetermined value, and a releasing device for said member.

3. In a fluid lift for wells, a tubing, a cylinder having means whereby the same may be connected to the tubing and having separate inlets for oil and an oil lifting medium, a piston in said cylinder and adapted to separately close said inlets to exclude the oil lifting medium during the admission of oil, a dog holding the valve in a predetermined position, and a tripping member adapted to engage said dog to release the same.

4. In a fluid lift, a tubing for the passage of oil, a cylinder having means whereby the same may be incorporated in the tubing and being provided with separate inlets for the admission of oil and an oil lifting medium, a piston having spaced sections controlling said inlets and positioned to exclude an oil lifting medium during the flow of oil through the oil inlet, there being yieldable means associated with said piston to support a column of fluid of a predetermined height in the tubing, and means urging said piston to oil inlet position.

5. In a fluid lift for wells, a cylinder having separate inlets for the admission of oil and an oil lifting medium, a piston valve having separate sections controlling said inlets, one of said sections being pressure actuated, a spring pressed dog associated with one of said sections, means carried by said cylinder to hold said dog in a set position, and a releasing device for said dog.

6. In a fluid lift for wells, a tubing, a cylinder having means whereby the same may be connected to the tubing and being provided with passages for oil and an oil lifting medium, a valve controlling said passages and being exposed to hydrostatic pressure, a spring pressed dog holding said valve in oil inlet position against a predetermined hydrostatic pressure, and separate means urging said valve to oil inlet position.

7. In a fluid lift for wells, a cylinder having passages for oil and an oil lifting medium, a valve within said cylinder and having a chambered portion, a sleeve connected to said cylinder and extending into the chambered portion of said valve to cooperate therewith in the formation of a gas trap in protecting relation to one end of the valve, said valve having means controlling said passages.

8. In a fluid lift for wells, a cylinder having passages for oil and an oil lifting medium, a passage controlling valve within said cylinder and having a chambered portion, a sleeve connected to said cylinder and extending into the chambered portion of said valve to cooperate therewith in the formation of a gas trap in protecting relation to one end of the valve, and a spring pressed dog associated with said valve and having means to engage said sleeve to hold the valve in a fixed position against a predetermined hydrostatic pressure.

9. In a swab for use in fluid lifts of the type described a freely movable body having a passage, a valve associated with said passage and having a spring urging the same to open position, and a second valve associated with said passage and movable to closed position under the weight of the column of fluid above.

10. In a fluid lift for wells, an inlet mem-

ber having separate passages for the products of a well and a lifting medium, a valve having means separately controlling said passages, a spring pressed dog carried by said valve, a seating device for said dog and adapted to hold the dog in a set position under a predetermined hydrostatic pressure on said valve, and a releasing device for said dog.

11. In a fluid lift for wells, a cylinder having separate passages for the products of a well and a fluid lifting medium, a piston valve in said cylinder and having sections separately controlling said passages, said piston valve being provided with means connecting said sections, a sleeve between said sections and cooperating with one of the sections in the formation of a trap, and means to hold said piston valve in position to admit the products of the well to said cylinder.

12. In a fluid lift for wells, a cylinder having separate passages for a lifting medium and the products of a well, a valve associated with said cylinder and having a pair of spaced sections separately controlling said passages, a fluid conduit rigidly connecting said sections, a sleeve carried by said cylinder at a point between said sections and cooperating with one of the sections in the formation of a trap, and a dog carried by one of said sections and adapted to engage said sleeve to hold the valve in a set position under a predetermined hydrostatic pressure.

13. A swab for use in wells comprising a freely movable body having a passage extending entirely therethrough, a one-way valve controlling said passage, and a second one-way valve controlling the passage, said valves being movable in opposite direction to open position.

14. A swab for use in wells comprising a freely movable body having separate ports, a one-way valve controlling one of said ports, a second one-way valve controlling the other port, and a paraffin scraping device carried by said body, said valves being movable in opposite directions to open positions.

15. A swab for use in a well tubing comprising a freely movable body, and a ring extending beyond the body and having an edge portion adapted to remove paraffin from the wall of the well tubing, and being movable with respect to the body.

16. In an apparatus for recovering liquid from wells, a fluid conductor in the well and having a passage for a pressure fluid, a passage controlling valve substantially below the level to which the native well liquid rises naturally and urged to open position by the pressure of such liquid above the same, and a casing having a substantially isolated body of expansible gas urging the valve to closed position and being yieldable to a superior pressure of the native well liquid above the valve.

17. In an apparatus for recovering liquid from wells, a fluid conductor in the well and having a passage for a pressure fluid, a passage controlling valve substantially below the level to which the native well liquid rises naturally and urged to open position by the pressure of such liquid above the same, a casing having a substantially isolated expansible body of gas urging the valve to closed position and being yieldable to a superior pressure of the native well liquid above the valve, and a restraining means holding the valve in open and closed positions and yieldable to a predetermined pressure.

18. In an apparatus for recovering liquid from wells, a fluid conductor in the well and having a passage for a pressure fluid, a passage controlling valve substantially below the level to which the native well liquid rises naturally and urged to open position by the pressure of such liquid above the same, a casing having a substantially isolated body of initially compressed gas urging the valve to closed position and being yieldable to a superior pressure of the native well liquid above the same, and means cooperating with said body of gas to hold the valve in closed position against a predetermined pressure of the native well liquid above the same.

19. In an apparatus for recovering liquid from wells, a fluid conductor in the well and having a passage for a pressure fluid, a passage controlling valve substantially below the level to which the native well liquid rises naturally and urged to open position by the pressure of such liquid above the same, a casing having a substantially isolated body of initially compressed gas at one end of said valve and urging the valve to closed position, said body of gas being yieldable to a superior pressure of the native well liquid above the same, and a restraining device releasably holding the valve in open position against a predetermined pressure of said gas.

20. In an apparatus for recovering liquid from wells, a conductor in the well and having a passage for a pressure fluid, a passage controlling valve in the well at a point substantially below the height to which the native well liquid rises, said valve being subject to and urged to open position by the pressure of the native well liquid, and a member having an initially compressed elastic body of gas urging the valve to closed position against the pressure of the native well liquid above the valve and being yieldable to a superior pressure of such liquid.

21. In an apparatus for recovering liquid from wells, a conductor in the well and having a passage for a pressure fluid, a passage controlling valve at a point in the well substantially below the height to which the well liquid rises naturally, said valve being subject to and urged to open position by the pressure of such liquid, a member having an

elastic body of gas urging the valve to closed position against the pressure of the native well liquid above the valve and being yieldable to a superior pressure of such liquid, and releasable restraining devices securing said valve in open and closed positions.

22. In an apparatus for recovering liquid from wells, a conductor in the well and having a passage for a pressure fluid, a passage controlling valve in the well at a point substantially below the height to which the native well liquid rises naturally, said valve being subject to and urged to open position by the pressure of such liquid, and a member having an initially compressed elastic body urging the valve to closed position against the pressure of the native well liquid above the valve and being yieldable to a superior pressure of such liquid.

23. In an apparatus for recovering liquid from wells, a conductor in the well and having a passage for a pressure fluid, a passage controlling valve in the well at a point substantially below the height to which the native well liquid rises naturally, said valve being subject to and urged to open position by the pressure of such liquid, and a member having an initially compressed substantially isolated elastic body of gas urging the valve to closed position against the pressure of the native well liquid above the valve and being yieldable to a superior pressure of such liquid.

24. In a gas-lift liquid pump for wells, two vertical conduits, a valve for controlling the passage of fluid from one conduit into the other, a member having resilient means exerting force on the valve to close the valve when a predetermined differential of pressure between the interior and the exterior of the member is reached and means excluding the native well liquid from one of the vertical conduits.

25. In a gas-lift liquid pump, two vertical conduits, a valve for controlling the passage of fluid from one conduit into the other, and a member having an isolated body of gas exerting force on the valve tending to close the valve when a predetermined differential of pressure between the interior and the exterior of the member is reached.

26. In a gas-lift pump for wells, an inlet conduit, an outlet conduit, a valve for controlling the passage of fluid from one conduit into the other, a member having means therein exerting force on the valve to close it when a predetermined differential of pressure is reached between the interior and the exterior of the member, and means excluding the native well liquid from the inlet conduit.

27. In a gas-lift pump for wells, an inlet conduit, an outlet conduit, a valve for controlling the passage of fluid from one conduit into the other, a member having an expansible body of gas located in the well at a point substantially below the level to which the native well liquid rises naturally and exerting force on the valve to close it when a predetermined differential of pressure is reached between the interior and the exterior of the member.

28. In a swab for use in well tubings, a freely movable cylindrical body adapted for vertical reciprocation in a well tubing, and a member carried by the body and projecting beyond the periphery thereof for scraping engagement with the wall of the well tubing.

29. In a swab for use in well tubings, a freely movable cylindrical body adapted for vertical reciprocation in a well tubing, and a member carried by the body and projecting beyond the periphery thereof for scraping engagement with the wall of the well tubing and being free to yield during the descent of the body.

30. In a swab for use in well tubings, a freely movable cylindrical body adapted for vertical reciprocation in a well tubing, and a member carried by the body and projecting beyond the periphery thereof for scraping engagement with the wall of the well tubing and being free to yield during the descent of the body, said body being provided with means bracing the member during the ascent of the same.

31. In a swab for use in well tubings, a freely movable cylindrical body adapted for vertical reciprocation in a well tubing and being provided with a fluid passage, a valve controlling said passage, and a scraping member carried by the body and projecting beyond the periphery thereof for scraping engagement with the wall of the tubing, said scraping member being yieldable in one direction.

In testimony whereof I affix my signature.

JOHN PENROD.