June 11, 1957 R. H. DEITRICKSON 2,795,192

SURFACE OPERATED PUMP CONTROL MEANS

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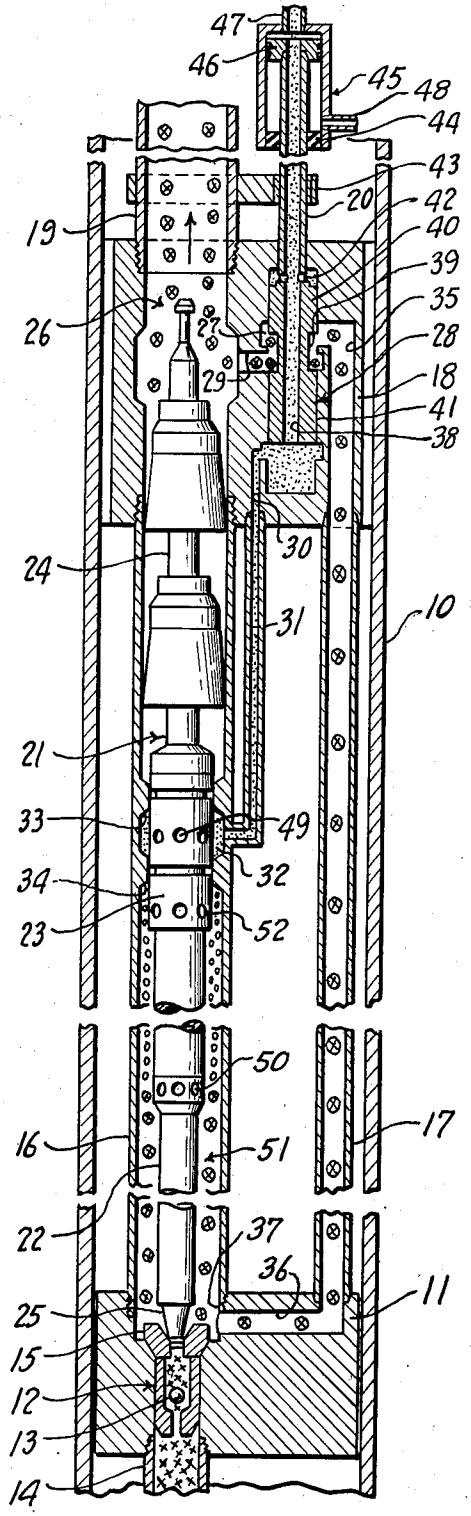


FIG. 1.

LEGEND

POWER FLUID

ENGINE EXH. FLUID

PRODUCTION FLUID

PRODUCTION & EXH. FLUID

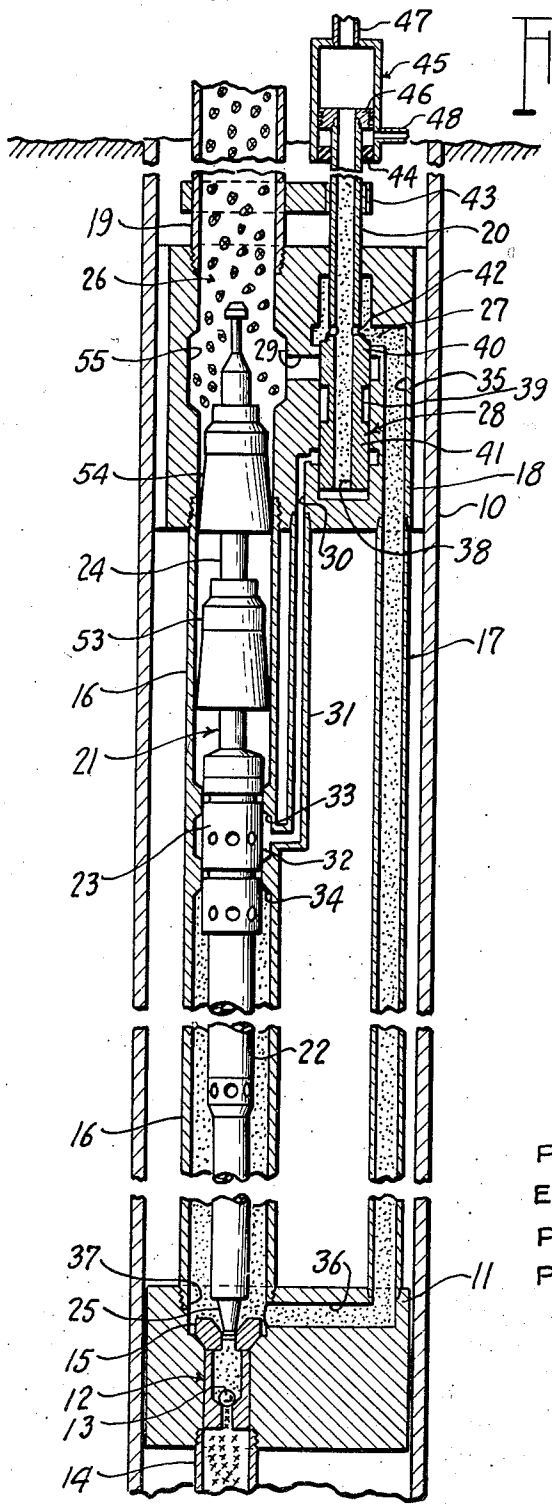
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FIG. 2.



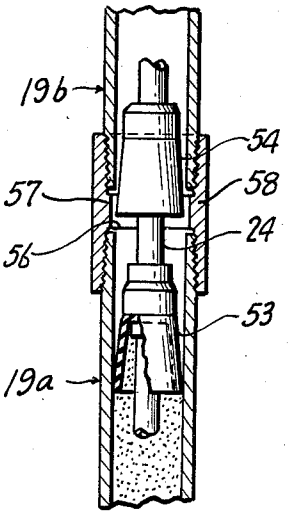


FIG. 3.

LEGEND

POWER FLUID

ENGINE EXH. FLUID

PRODUCTION FLUID

PRODUCTION & EXH. FLUID

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SURFACE OPERATED PUMP CONTROL MEANS

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Application January 11, 1954, Serial No. 403,281

4 Claims. (Cl. 103—46)

This invention relates to hydraulic pumps for deep wells such as oil wells and to the type of hydraulic pump known as a "free pump," and in particular to a surface operated pump control means comprising hydraulic mechanism for the purpose of so affecting the flow of operating fluid to the pump and its associated mechanisms so that the pump can be raised to the surface of the well when desired.

It has heretofore been proposed to set a hydraulically actuated downwell pump in an appropriately prepared space in a well tubing in such a manner that the pump could be removed by reversing the circulation of power oil and production fluid. In most such "free pump" installations power oil flows normally down the tubing and the intermingled exhaust power oil and production fluid has been taken to the surface through a narrower side string or "macaroni." A four way valve at the surface has been interposed in the lines to both the tubing and macaroni so that this normal circulation could be changed to send the power oil down the macaroni to a point in the tubing below the pump where the pressure of the power oil could be exerted upwardly thereagainst to force the pump upwardly through the tubing to the surface. Such an arrangement exposes the tubing that is intended to carry the cleaned and treated power oil to the contaminated and unfiltered production fluid during the operation of raising the pump to the surface. It has been proposed to overcome this and other disadvantages of such systems by using a third small tube for the return of power oil which then flows entirely in a closed system which is thus not subject to the contaminating influence of the production fluid at any time. Such an expedient is needlessly complex, and the present invention provides an arrangement in which the production fluid travels always through the same path and never contacts the conductors in which power oil flows during pumping. Further, by the arrangement of the present invention, the collection of dislodged scale and dirt incident to lowering the pump into place in the tubing is prevented from interfering with proper operation of the pump when seated.

The above mentioned system also subjects the well tubing to the high pressure of the power oil during normal operation and the side string or small tubing to the high pressure of power oil during the removal of the pump. Inasmuch as old tubing is frequently used because of a desire to save expense it frequently happens that the tubing will rupture under the pressure of the power oil and the pump must thereafter be removed by "fishing." It is also readily apparent that the quantity of power oil flowing through the large tubing is less than the combined quantity of exhaust power oil and production fluid that is conducted in the smaller side tubing. The production of the pump is thus limited by the capacity of the smaller tubing. In the present invention the production fluid and exhaust power oil flow in the larger tubing so that the capacity of the pump is not so limited, larger passages being available for circulation of the several fluids than is the case with presently known devices.

It has also been proposed, however, to conduct exhaust power oil and production fluid to the surface through the larger tubing but such known systems are characterized by a valving arrangement which must be operated by a separate unit that is pumped down the well whenever it is desired to remove the free pump from its seat and bring it to the surface. During the operation of pumping the valve shifting member down the tubing it is apparent that the corrosive fluid standing in the tubing must be brought to the surface through the small side string thus subjecting the interior of this normally clean tubing to the corrosive and erosive effects of the contaminated oil containing the production fluid. Further, if the known devices have been badly sanded up during a prolonged operation, difficulty may be encountered in properly seating the valve shifting unit that is pumped down the well for the purpose of changing the oil circuits to permit the pump to be raised by the subsequent introduction of power oil beneath it.

It is the principal object of this invention to provide a simple valve mechanism for diverting the high pressure operating fluid from the circuit leading into the pump engine to a space in the well tubing beneath the pump so that the "free pump" located at the bottom of the tubing can be pumped out of the well when desired, the circuit being such that the small tubing in which power oil is conducted to the pump is never used to conduct a contaminated fluid.

Another object of the invention is the provision of valve means for directing the flow of power oil to a down well pump set as a "free pump" so disposed and arranged that the tubing through which power oil is conducted remains free of dirt and contaminants.

Another object of the invention is to provide a simple and effective valve means for a "free pump" located near the pump itself and operated effectively and with certainty from the surface.

A more complete understanding of the problems involved and of the solution thereof embodying the invention will be apparent from the specification which follows and from the drawings, in which:

Fig. 1 is a fragmentary vertical sectional view, somewhat diagrammatic in nature, illustrating a typical well casing in which a "free pump" is located and showing a valve mechanism embodying the invention; the mechanism being connected in its operating or oil pumping position.

Fig. 2 is a view similar to Fig. 1 but showing the mechanism in its pump raising position.

Fig. 3 is a fragmentray vertical sectional view illustrating the specific purpose for and operation of certain elements of a pump designed for control by a mechanism embodying the invention.

In the following specification reference will be made to four different types of fluid encountered in a well casing which are illustrated in the accompanying drawings by different indications. They consist of: power fluid (shown by dots in the drawings) which is pumped down from the surface under high pressure for the purpose of operating the pump engine during the normal operation of the well and for raising the pump and its engine and associated equipment to the surface when desired; engine exhaust fluid (indicated by small circles) which is exhausted power fluid as discharged from the pump engine; production fluid (indicated by x's) which is the actual fluid drawn from the well, i. e., the crude oil or other fluid located at the bottom of the well and constituting the production from the well; and combined or intermingled production and exhaust fluid (indicated by encircled x's, thus ⊗) this being the combination of the exhausted operating or power fluid and the production fluid drawn into the well and actually constituting

the fluid which is pumped to the surface by operation of the pump.

Structure

A deep well such as an oil well has an outer casing generally indicated by the legend in Fig. 1 and the number **10**. The casing **10** extends from the surface of the ground to the production zone of the well itself and constitutes a housing in which is contained all of the mechanism necessary for operating the well. Near the bottom of the casing **10** there is located a shoe block **11**. The shoe block **11** serves as a housing for a standing valve **12** which usually comprises a valve ball **13**. A screen, or gas anchor, generally indicated at **14**, may be threaded or otherwise engaged in the shoe block **11**, in position to screen the crude oil or other production fluid drawn into the standing valve **12** during intake strokes of the pump.

The shoe block **11** also carries a pump seat **15** and is connected by pump tubing **16** and connector tubing **17** to a distribution block **18**. The distribution block **18** is in turn connected to the surface by a continuous length of well tubing **19** and "macaroni" tubing **20**. The weight of the mechanism at the bottom of the well, comprising the shoe block **11**, pump tubing **16**, connector tubing **17** and distribution block **18**, is all borne by the length of well tubing **19** extending upwardly to the surface of the well.

A hydraulically actuated deep well pump generally indicated at **21** is located in the pump casing **16**. The pump **21** consists of several sections not shown in detail but operatively connected to each other. These parts are a production pump **22**, an engine **23**, a stem **24** and the necessary valve housings, connecting rods, etc. which are not shown in the drawings. The pump **21** is generally supported by and seated in the seat **15** which engages with a conical stem **25** located at the lower end of the production pump **22**.

The distribution block **18** has a generally cylindrical chamber **26** coaxially aligned with the well tubing **19** and the pump tubing **16** and serving functionally as a continuation thereof. The distribution block **18** also has a spaced parallel valve chamber **27** in which there is located a generally spool-shaped valve body **28**. The chamber **27** is connected to the chamber **26** by a short horizontal passageway **29**. Near its lower end the chamber **27** is connected by a passageway **30** in the distribution block **18** and a conductor tubing **31** to a chamber **32** formed within the pump casing **16** by a pair of spaced annular seats **33** and **34** which are engaged by the periphery of the pump when seated in operating position. The chamber **27** is also connected through a parallel passageway **35** and the main connector tubing **17** to a passageway **36** in the shoe block **11** and then to a bore **37** in the shoe block **11** serving functionally as the lower end of the pump tubing **16**. The passageway **36** is connected into the bore **37** at a level above the standing valve **12** and beneath the seat **34**.

The valve body **28** has an axial bore **38** and a peripheral groove **39** is cut between its upper and lower enlargements **40** and **41**. The upper end of the valve body **28** is fixedly connected to the lower end of the "macaroni" tubing **20**. Radial passageways **42** connect the interior of the "macaroni" **20** and the axial bore **38** to the chamber **27** at the upper edge of the enlargement **40**.

The "macaroni" string **20** is vertically slidable in a plurality of guide brackets **43** which are clamped on the well tubing **19** at spaced intervals throughout the length of the tubing **19**. At its upper end, adjacent the well head, the "macaroni" **20**, or a rod-like functional extension thereof, extends through a packing **44** at the bottom of a hydraulic cylinder **45** and is operatively connected to a piston **46** vertically reciprocable in the cylinder **45**. A power fluid inlet pipe **47** is connected to the upper end of the cylinder **45** and a valve shifting fluid inlet pipe **48** is connected to the cylinder **45** below the piston **46**.

Pumping operation

When it is desired to operate the well for the purpose of pumping the production fluid up the well tubing **19**, the piston **46** is moved upwardly to the position shown in Fig. 1, and may be locked in this position by any suitable means (not shown). Thereafter, power or operating fluid is pumped downwardly through the pipe **47** and through the piston **46** into the upper end of the "macaroni" tubing **20**. The power fluid is led downwardly through the "macaroni" tubing **20** and the bore **38** in the valve body **28** to the bottom of the chamber **27** in the distribution block **18**. It then flows through the passageway **30** and the connector tubing **31** to the annular chamber **32** in the pump casing **16** and then through a plurality of ports **49** serving as the inlets to the pump engine **23**.

The power fluid fed into the engine **23** actuates its piston and, through appropriate mechanical or other connections, actuates the piston of the production pump **22** to draw production fluid through the screen or gas anchor **14** and past the standing valve **12**. The production fluid raises the standing valve ball **13** as it flows inwardly. Operation of the pump discharges the production fluid drawn into the pump **22** from a series of exhaust ports **50** and into the pump tubing **16** in an annular space **51** surrounding the pump **22** and located beneath the relatively tight annular seat **34**. At the same time exhausted power fluid is discharged out of a plurality of radial ports **52** into the upper portion of the space **51**. The action of the engine in discharging the exhaust fluid and the pump in discharging the production fluid blends these two fluids and forces them out through the passageway **36** and up the conductor tubing **17** through the passageway **35** in the distribution block **18**, through the chamber **27** around the groove **39**, through the passageway **29** and into the chamber **26**, and thence up the well tubing **19** to surface manifolding and storage equipment.

This operation continues for as long as the valve body **28** is held in its upper position by a quantity of control fluid located in the cylinder **45** and holding the piston **46** in its upper position, although as above noted, any suitable locking means may be used to perform the holding function of the body of control fluid.

Pump elevation

When it is desired to raise the pump **21** to the surface of the well to repair or clean any of its elements or for any other purpose, the hydraulic cylinder **45** is vented or the pressure on the actuating fluid therein released so that the weight of the "macaroni" tubing **20** supported by the piston **46** pulls the piston **46** downwardly and thrusts the valve body **28** into the position illustrated in Fig. 2. In this position of the valve body **28** the lower enlargement **41** blocks the passageway **30** and the upper enlargement **40** blocks the passageway **29**. The power fluid conducted through the "macaroni" tubing **20** is thus connected through the radial passageway **42** to the passageway **35** and the connector tubing **17**, through the passageway **36** in the shoe block **11** and into the lower end of the pump tubing **16**.

Since the connector tubing **31** and passageway **30** are now closed off from the power fluid, the engine **23** does not operate. The pressure of power fluid in the bottom of the pump casing **16** beneath the seat **34** is effective upwardly against the housing of the engine **23** and operating pump **22**, thrusting the entire unit upwardly. This breaks the seal between the stem **25** and seat **15** and power fluid enters the standing valve housing **12** seating the ball **13** and closing the lower end of the casing to the production area.

As power fluid continues to be pumped into the lower end of the well tubing **16** it continues to move the pump

21 as a whole upwardly and when the mating surfaces of the pump are free of seats 33 and 34, the power fluid enters the pump tubing 16 beneath one or more flexible swab cups 53 carried on the pump stem 24.

Continued pumping of power fluid down into the apparatus continues to raise the pump 21 as a whole. The lower swab cup 53 cooperates with a spaced upper swab cup 54 in order to allow the apparatus to pass, first, an enlarged section 55 of the chamber 26 and, secondly, with regular frequency, discontinuities in the walls of the well tubing 19 such as occur at joints in the tubing 19.

The movement of the two swab cups 54 and 53 across a tubing joint without loss of the pressure beneath the pump is illustrated in Fig. 3. In Fig. 3 the upper swab cup 53 is shown as being located just above the discontinuity indicated at 56 between the upper edge of a lower tubing section 19*a* and a flange 57 on a tubing joint 58. The joint 58 is a generally tubular element having a threaded interior so that the upper end of the lower tubing section 19*a* is threaded into the lower end of the joint 58 and the lower end of an upper tubing section 19*a* is threaded into the upper end of the joint 58. The joint 58 serves as a connector between lengths of the tubing 19 and is, of course, conventional.

As power fluid continues to be pumped into the lower end of the pump tubing 16 and the pump 21 continues to move upwardly, beyond the position shown in Fig. 3, the upper swab cup 54 engages with the lower end of the upper tubing section 19*b* preserving the seal so that the lower swab cup 53 can pass the joint 58.

Because of the continuous effective seal against the walls of the tubing 19 provided by the two spaced swab cups 53 and 54, continued feeding of power fluid down through the "macaroni" 20 and connections outlined to the bottom of the well tubing 16 forces the pump 21 and all of its connected equipment up to the surface of the well where it can be physically removed.

When it is desired to reinsert the pump 21 into the well, it is placed in the upper end of the tubing 19 and lowered down the tubing 19 by pumping clean fluid into the tubing and exhausting fluid upwardly through the "macaroni" 20. Prior to insertion the well operator circulates clean fluid in the well for a period sufficient to assure that whatever contaminated fluid might have been standing therein from previous operation has been effectively removed. When the stem 25 has reseated itself in the seat 15, pressure is applied beneath the piston 46 lifting the "macaroni" 20 and valve body 28 to the position shown in Fig. 1, and the apparatus is restored to its normal operating position.

Having described the invention I claim:

1. In a control mechanism for a bottom discharge fluid actuated free pump that is located in and positioned near the bottom of a production fluid well tubing and that has a separate non-concentric power fluid line leading downwardly from the surface of the well, in combination, a valve housing fixed near the bottom of the well, a by-pass tubing leading from said valve housing to said well tubing beneath said pump, a first passageway from said valve housing to said well tubing above said pump,

a pump input passageway from said valve housing to the power fluid input of said pump, shiftable valve means in said housing, said power fluid line being hydraulically connected to said valve housing and surface controlled means operatively connected to said shiftable valve means for shifting said shiftable valve means between a first position connecting said power fluid line to said pump input passageway and said by-pass line to said first passageway and a second position connecting said power fluid line to said by-pass line and closing off both of said passageways.

2. In a control mechanism for a bottom discharge fluid actuated free pump that is located in and positioned near the bottom of a production fluid well tubing and that has a separate non-concentric power fluid line leading downwardly from the surface of the well, in combination, a valve housing fixed near the bottom of the well, a by-pass tubing leading from said valve housing to said well tubing beneath said pump, a first passageway from said valve housing to said well tubing above said pump, a pump input passageway from said valve housing to the power fluid input of said pump, vertically shiftable valve means in said housing, said power fluid line being hydraulically connected to said valve housing and mechanically connected to said vertically shiftable means, and surface controlled means for vertically shifting said power fluid line and said shiftable valve means between a first position connecting said power fluid line to said pump input passageway and said by-pass line to said first passageway and a second position connecting said power fluid line to said by-pass line and closing off both of said passageways.

3. A control mechanism according to claim 2 in which said shiftable valve means is a spool that is secured to the lower end of said power fluid line and that has an axial bore communicating therewith, and said valve housing has a pocket beneath said spool whereby pressure in said power fluid line and in the power fluid in said pocket acting against the lower end of said spool holds said spool and said power fluid line in its first, upper position and the weight of said power fluid line moves said spool down to its second, lower position when pressure of the power fluid is released.

4. A control mechanism for a bottom discharge fluid actuated free pump that is located in and positioned near the bottom of a production fluid well tubing, said mechanism comprising, a valve housing fixed near the bottom of the well, a power fluid line separate from and non-concentric with said production fluid tubing, a vertically shiftable spool valve in said valve housing, said power fluid line being mechanically connected to said spool valve and hydraulically connected to said valve housing and means controllable from the surface for shifting said spool valve.

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