April 13, 1954 L. D. HILTON 2,674,956

FLUID LIFT PUMP ROD AND PISTON

Filed Oct. 18, 1948 2 Sheets-Sheet 1

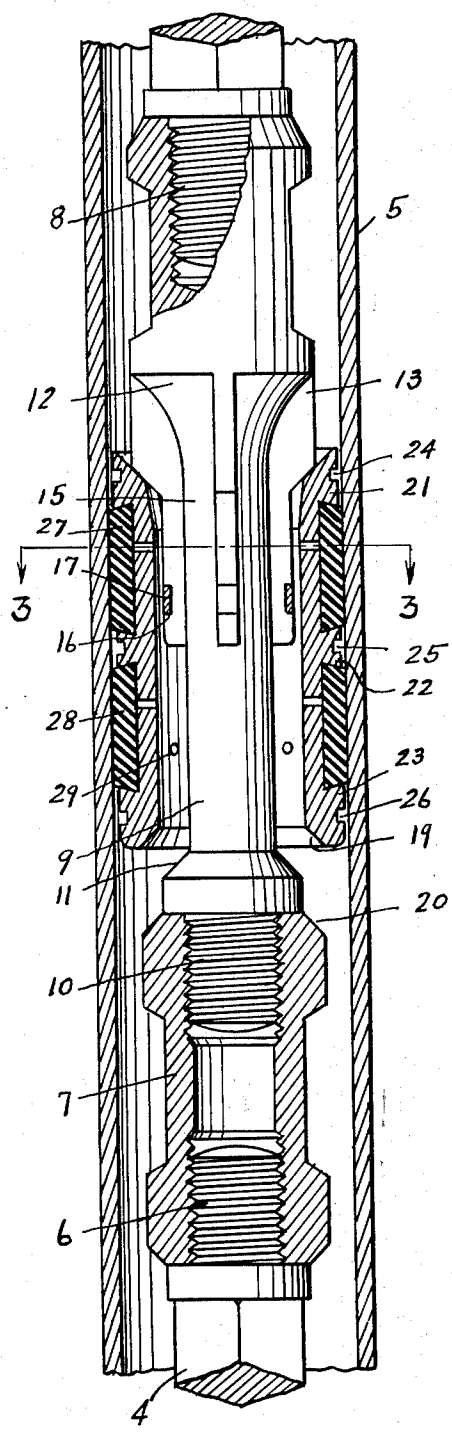


Fig. 1.

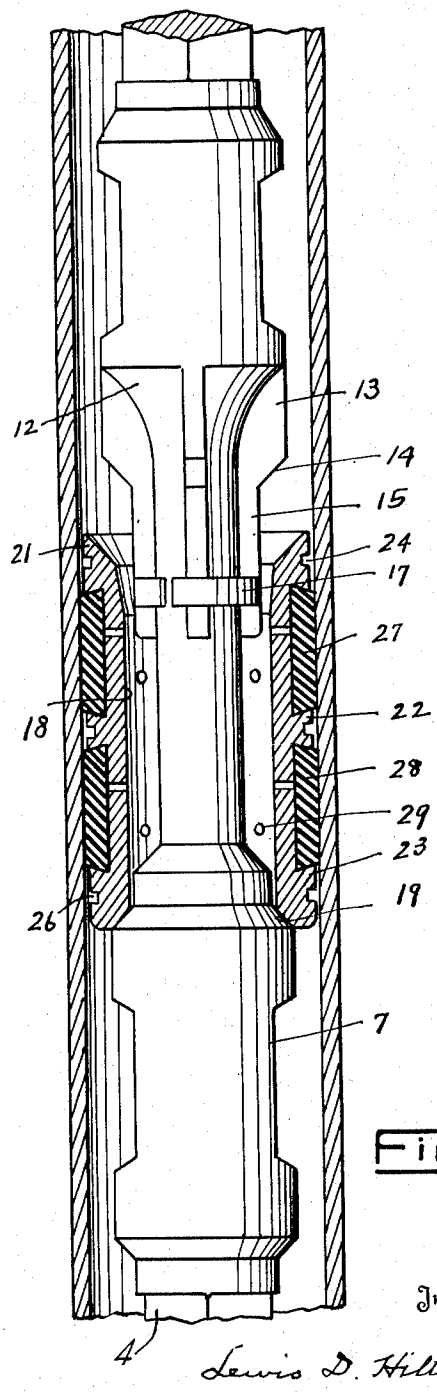


Fig. 2.

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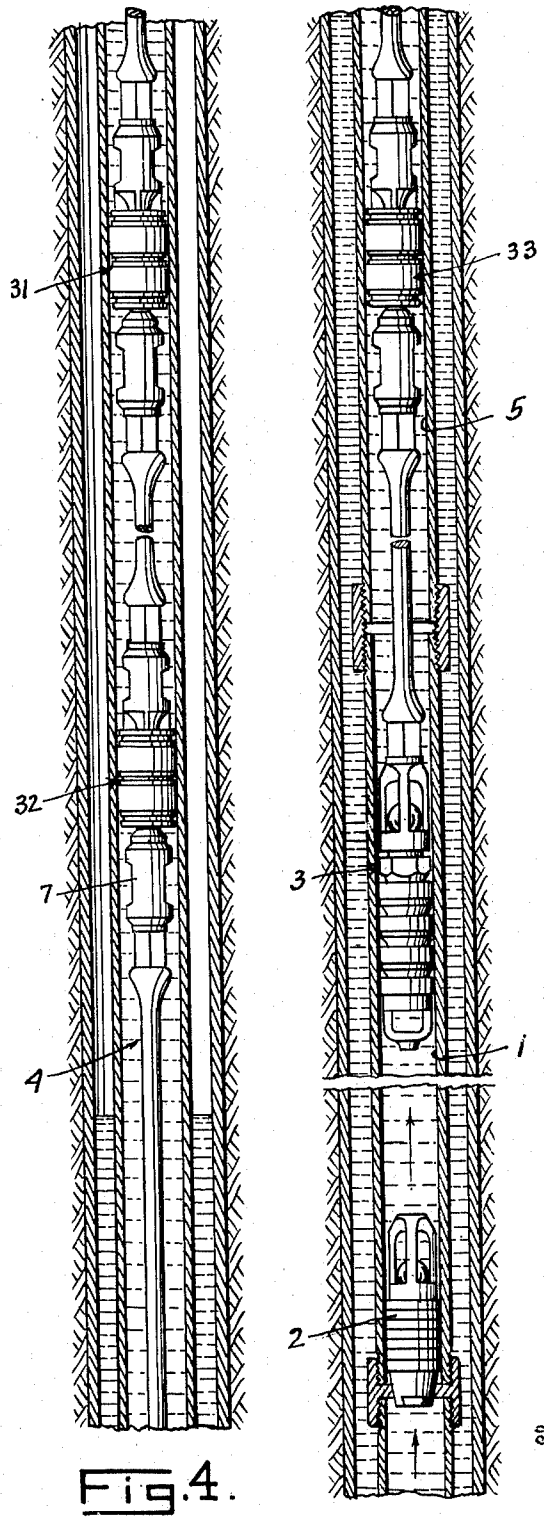


Fig. 4.

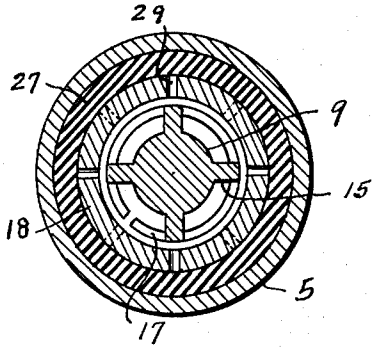


Fig. 3.

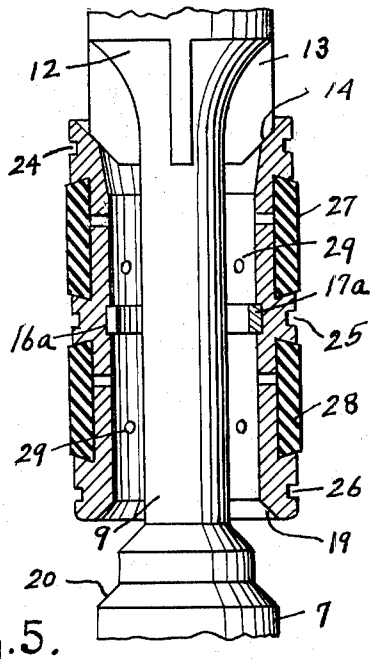


Fig. 5.

Fig. 6.

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FLUID LIFT PUMP ROD AND PISTON

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2 Claims. (Cl. 103—225)

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This invention relates to a pump stager and has more particular relation to a stager adapted to be mounted on the pump sucker rod.

This device relates to a conventional fluid lift pump having a working barrel with a standing valve and traveling valve associated therewith and a sucker rod for reciprocating the traveling valve, the invention relating more particularly to the sucker rod equipped with a single stager or a plurality of stagers spaced a selected distance apart along the sucker rod.

As at present constructed and operated the pump sucker rod is connected at its lower end to the pump traveling valve which reciprocates within the working barrel. This combination of sucker rod, traveling valve, working barrel and standing valve supports and lifts the entire load of fluid in the tubing from the bottom of the well to the ground surface.

The sucker rod and traveling valve are reciprocated by a power unit at the ground surface which unit usually embodies a walking beam to which the upper end of the sucker rod is connected by means of a polish rod and grip attachment.

The sucker rod is usually several thousand feet long. Its movement, in pumping, is determined by the operator. The average stroke of the walking beam and sucker rod is approximately forty inches in length and usually there is about twenty strokes per minute. This, therefore, means a sucker rod travel of about one hundred and thirty feet per minute with forty reversals per minute. The rod on the upstroke is required to maintain a lift, in addition to its own weight, the weight of the fluid in transit. This fluid weight is determined by the diameter of the tubing, height of the fluid column being lifted, the character or type of fluid being lifted and by friction.

The lifting of the imposed weight causes the pump rod to stretch upon upstroke and, therefore, the range of travel of the walking beam or other operating mechanism at the ground surface is usually greater than the corresponding range of travel of the traveling valve at the lower end of the rod.

At the end of the upstroke the rod will be relieved of its fluid load and stretch, and will move rapidly and easily on downstroke, to be instantly checked upon reversal of the movement of the walking beam at the surface and a severe stretching of the rod occurs due to the sudden reversal of its movement from its downward drop

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to upstroke with its suddenly acquired additional load of fluid, plus its own weight, thus transmitting an intense strain to the sucker rod thus requiring frequent replacements of the rod due to breakage caused by metal fatigue.

The lifting process also imposes a pounds pressure per square inch load on the mechanism of the pump assembly which assembly comprises the working barrel and standing valve at the lower end of the tubing and the traveling valve at the lower end of the sucker rod. This pressure is determined by the type of fluid being pumped and the height of the fluid column being lifted; for example, if the pump is lifting a three thousand foot column of water it must be in mechanical condition to operate against a static head of approximately one thousand three hundred pounds pressure per square inch while if the fluid being lifted is oil the static head would be approximately one thousand pounds pressure per square inch.

When the conventional pump mechanism becomes worn to the point of failure to lift the fluid to the required elevation then it must be removed from the well and repaired. The expense of removal and repair is one of the main expense factors in the operation of raising oil to the ground surface by the reciprocating pump method.

It is a prime object of the present invention to equip the pump rod with one or more stagers. This stager or valve assembly is mounted on the sucker rod and closely fitting the inner bore of the tubing. Each stager closes on upstroke of the sucker rod and opens on downstroke and when installed on the sucker rod at the required point or points distributes the imposed static head along the rod and relieves the traveling valve of that part of the static head load being handled by the stager or stagers above it. For example with the traveling valve on the lower end of the sucker rod in its operating position in the working barrel and lifting a column of water a distance of three thousand feet the static head against the traveling valve is approximately one thousand three hundred pounds pressure per square inch. With the stager on the sucker rod at an elevation of one thousand feet above the traveling valve the static head on the traveling valve will be reduced to four hundred thirty-four pounds pressure per square inch and the stager itself will be operating under a static head of eight hundred sixty-eight pounds per square inch. With an additional stager on the sucker

rod at an elevation of one thousand feet above the first stager the static head of the first stager will be reduced to four hundred thirty-four pounds per square inch and the second stager will then also be operating under a static head of four hundred thirty-four pounds per square inch. If the traveling valve is worn to a point of lifting capability of five hundred pounds per square inch only and with the first stager installed on the rod above the traveling valve a distance of one thousand feet, thus reducing the static head load on the traveling valve to approximately four hundred pounds per square inch, it is readily obvious that the traveling valve need not be removed from the well for repairs until it reaches a point of wear below the capability of raising the fluid load to a height of one thousand feet at which point the stager above the traveling valve picks up the load and stages it up to the next stager above it, or to the surface if only one stager is on the rod. It is thus obvious that the pulling expense on oil well pumps will be greatly reduced.

Another object of the invention is to provide means for retarding the downward drop of the sucker rod and traveling valve after the discharge of the fluid load at the end of the upstroke. The weight of the rod moving downwardly exerts a force that is utilized by mechanical means within the stager, to retard the rapid downward plunge of rod. This means is in the form of a choke of dimensions determined by the operator and which retards the flow of fluid through the stager on downward stroke and thereby supports the rod. This hydraulic action slows down the rapidly plunging rod and equalizes the travel of the rod with that of the walking beam movement which eliminates the extremely violent stretching action of the rod at the reversal period at the end of the downstroke. Thus the rod and traveling valve will move more nearly in harmony with the walking beam.

A further object of the invention is to equip the sucker rod with stagers which will conduce to the harmonious movement of the operating equipment at the ground surface and the pumping equipment beneath, thus reducing rod replacements and repairs of surface equipment which in turn will reduce the pulling expense and maintenance expense as well as power expense and will increase the quantity of fluid raised to the surface within a given time.

A still further object of the invention is to provide equipment of the character described which, on account of its peculiar construction, will conduce to the free flow of gas from the well thus eliminating gas pockets.

Furthermore the invention is of such construction that it will shield the traveling valve from the gritty substances tending to settle out of the fluid being pumped.

Other objects and advantages will be apparent from the following specification which is illustrated by the accompanying drawings, wherein:

Figure 1 is a fragmentary, side elevation, partly in section, of a stager or lift valve shown in its relation to the pump rod upon downstroke of the rod.

Figure 2 is a similar view upon upstroke of the pump rod.

Figure 3 is a cross-sectional view taken on the line 3—3 of Figure 1.

Figure 4 is a fragmentary, longitudinal sectional view, on a reduced scale of a portion of the pump tubing showing the pump rod therein equipped with spaced stagers or lift valves.

Figure 5 is an extension of Figure 4 showing the pump working barrel connected to the lower end of the tubing with the standing valve and traveling valve therein, the latter being connected to the lower end of the pump rod, and

Figure 6 is a fragmentary, vertical, sectional view of another embodiment of the stager.

Referring more particularly to the drawings, the numeral 1 designates the pump barrel, mounted in the lower end of which there is the upwardly opening and downwardly closing standing valve 2.

Reciprocable in the barrel above the standing valve there is a conventional upwardly opening and downwardly closing traveling valve 3 which is connected to the lower end of the pump rod designated generally by the numeral 4 and also known as the sucker rod.

The pump barrel 1 is connected to the lower end of the well tubing 5 which is of slightly greater inside diameter than the inside diameter of the barrel and which extends to the ground surface.

The traveling valve 3 is reciprocable and is operated by the pump rod. This rod extends to the ground surface and is operated by a walking beam, of conventional construction, or other selected operating equipment.

On upstroke of the traveling valve said traveling valve is closed and elevates the fluid above it and at the same time draws in a charge of well fluid through the standing valve 2.

Upon upstroke of the traveling valve the standing valve will open and the fluid below it will pass up through the standing valve to be elevated upon the next succeeding upstroke of said traveling valve.

During the operation of the pump the pump tubing is filled from the pump to the ground surface and upon each stroke of the traveling valve, when operated by a pump rod of conventional construction, the entire column of fluid must be lifted thus imposing on the pump rod not only its own weight but the weight of the column of the fluid being pumped as well; and upon downstroke the pump rod moves downwardly very rapidly, that is it substantially drops and is suddenly checked by the reversal of movement of the walking beam from downstroke to upstroke, thus imposing great stress not only on the pump rod itself but also on the operating equipment. This causes a stretching of the pump rod and also prevents the walking beam or other operating equipment from moving in unison with the traveling valve.

In order to overcome these objections the pump rod has been equipped with lift valve assemblies, or stagers, spaced apart therealong and whereby the load in the pump tubing will be distributed along the rod upon upstroke of the pump rod, said lift valve assemblies, or stagers, being of such construction that they will operate as buffers, or chokes, to retard the downward movement of the pump rod and traveling valve on downstroke.

The upper end of each section of the pump rod is formed with an externally threaded pin 6 to receive the lower end of a tubular coupling 7 and the lower end of each section of the pump rod is formed with an externally threaded pin 8 which is screwed into the internally threaded upper end of a stager mandrel 9, the lower end of said mandrel being formed with an externally threaded

pin 10 which is screwed into the upper end of the coupling 7.

The lower portion of the mandrel 9 is of reduced diameter which is outwardly flared, at its lower end, above the pin 10, forming a downwardly flared guide 11.

The upper portion of each mandrel 9 is enlarged in diameter thus forming a flared portion 12, and this portion of the mandrel is provided with radial wings, as 13, whose lower ends are reduced in diameter forming downwardly converging faces 14, said wings having reduced downward extensions 15 which are provided with external notches 16. Seated in these notches there is a split ring 17, acting as a baffle, which may vary in cross sectional area and which is provided for a purpose to be hereinafter stated.

Around each mandrel there is a sleeve-like valve cage 18 whose lower end is flared forming a valve 19 which co-operates with the upwardly tapering valve seat 20 on the upper end of the coupling 7 to open and close said valve cage 18. In a preferred form of the invention the valve cage has upper, intermediate and lower external annular ribs 21, 22 and 23 which are provided with annular grooves 24, 25 and 26 forming pockets.

Around the cage and between the respective ribs there are the upper and lower resilient seal rings 27 and 28 preferably formed of rubber or some similar resilient material.

It will be noted that the valve cage 18 has a series of radial openings, as 29, which are enclosed by said seal rings so that the pressure of the fluid within the cage may be exerted outwardly against the seal rings to hold them in close contact with the well tubing 5. In this connection it should be observed that upon upward movement of the sucker rod the valve 19 will seat on the valve seat 20 and trap the liquid so that the pressure of the liquid will be exerted against said seal rings to expand them but upon downward movement of the sucker rod the valve will be spaced above its seat and the pressure will be relieved from the seal rings.

However, during the upward and downward movements the seal rings will be in sealing contact with the tubing 5.

The mandrel 9, with its appendants, the valve cage with its seal rings and the coupling 7 with its valve seat 20 form what may be termed a stager. In the present illustration three of these stagers are shown and are designated generally by the numerals 31, 32 and 33, all of which are similar in construction. However, in practical use these stagers will be distributed along the sucker rod substantially throughout the length thereof at any selected distance apart.

As hereinbefore indicated the sucker rod is reciprocated by a walking beam or other suitable power so as to reciprocate the traveling valve of the pump.

During the pumping operation the well tubing 5 will be filled with the liquid being pumped to the ground surface and upon upstroke of the sucker rod the valves 19 will seat on the corresponding valve seats 20 so as to trap the liquid above but, it is obvious that each stager will be subjected only to the static head load of liquid between it and the next succeeding stager above to the end that this load elevated by the sucker rod will be distributed along the sucker rod and said entire load will not be concentrated on the traveling valve at the lower end of the sucker rod. The stretch of the sucker rod upon power stroke will therefore be greatly reduced.

On downstroke the valves 19 will be lifted, as shown in Figure 1, so as to permit the liquid beneath to pass upwardly through the corresponding cage 18 but the downwardly movement of the sucker rod will be retarded by the split rings 17 which form buffers or baffles to restrict the flow of liquid through the corresponding valve cages. These rings or buffers 17 may be of any selected cross-sectional area depending on the length and weight of the sucker rod so as to have the desired buoyant effect.

A further modification of the invention is illustrated in Figure 6, wherein the extensions 15 have been removed and the valve cage 18 is provided with an inside annular groove 16a in which the split snap ring 17a is seated. This ring 17a is of sufficient thickness to extend out into and restrict the passageway through the cage 18 and serves as a baffle to retard the downward movement of the sucker rod.

Upon upstroke of the sucker rod the seats 20 will come into contact with the corresponding valves 19, as shown in Figure 2, thus preventing escape of liquid above and the entire column of liquid in the tubing 5 will be lifted but the stagers being spaced apart the static head load of the liquid column in the tubing will be distributed along the sucker rod. The pressure of the liquid through the radial openings 29 will expand the seal rings 27, 28 into sealing engagement with the tubing and also the liquid will be trapped in the pocket 24, to further aid in preventing the flow of liquid between the exteriors of the stagers and the tubing.

The lower stager 33 will also collect, about it, a substantial portion of the sand and gritty substances tending to settle out of the liquid column and thus shield the traveling valve from said sand and gritty substances.

Two embodiments of the invention have been shown and described by way of illustration only and not by way of limitation while the broad principle of the invention will be defined by the appended claims.

What I claim is:

1. In well pumping equipment having well tubing and a reciprocable sucker rod in the tubing; a stager comprising a cylindrical valve cage around the sucker rod adapted to fit in the tubing, said cage having a passageway for the flow of fluid therethrough and the lower end of said cage forming a valve, a seat on the rod beneath the valve which engages the valve to close the valve upon upward movement of the rod to elevate the fluid in the tubing above, radially extending wings on the rod having lower edge portions spaced above the cage during upward movement of the rod and which engage the cage and move the cage and valve downwardly upon downward movement of the rod to allow the well fluid to pass above the stager said wings having downwardly extending portions beneath said edge portions extending into said cylinder and removable baffle means carried by said downwardly extending portions within the cylinder for retarding downward movement of the rod.

2. In well pumping equipment having well tubing and a reciprocable sucker rod in the tubing; a stager comprising, a cylindrical valve cage around the rod adapted to fit into the well tubing and, said cage having a passageway for the flow of fluid therethrough, the lower end of said cage being formed into a valve, resilient means

around the cage to form a seal with the tubing, a valve seat on the rod beneath the valve positioned to engage the valve to close the valve upon upward movement of the rod to thereby elevate the fluid in the tubing above, radially extending wings on the rod having lower edge portions spaced above the cage during upward movement of the rod positioned to engage the cage and move the cage and valve downwardly upon downward movement of the rod to allow the well fluid to pass through the cage above the stager, said wings having longitudinally extending portions within the cage and formed with outwardly opening notches, and a ring surrounding the rod and

removably carried in the notches in the wings and forming a restriction in the fluid passageway through the cage.

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