Dec. 12, 1961 D. G. KNOX 3,012,832

FREE PISTON WELL PUMP DEVICE

Filed May 12, 1958

3 Sheets-Sheet 1

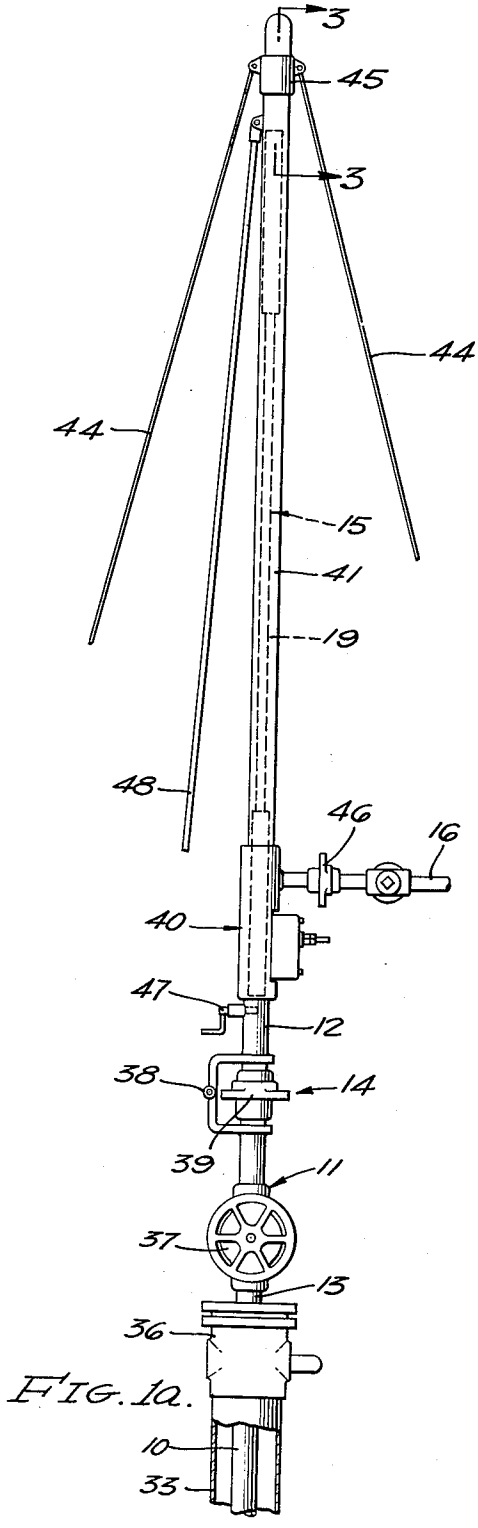


FIG. 1a.

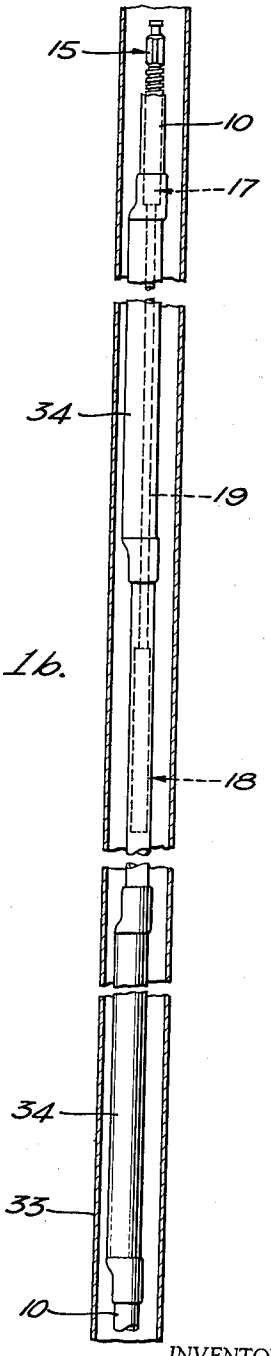


FIG. 1b.

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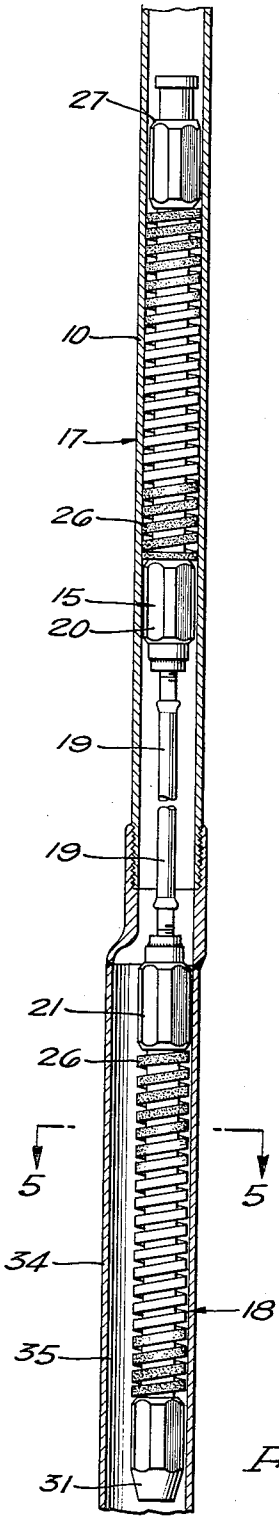


FIG. 2.

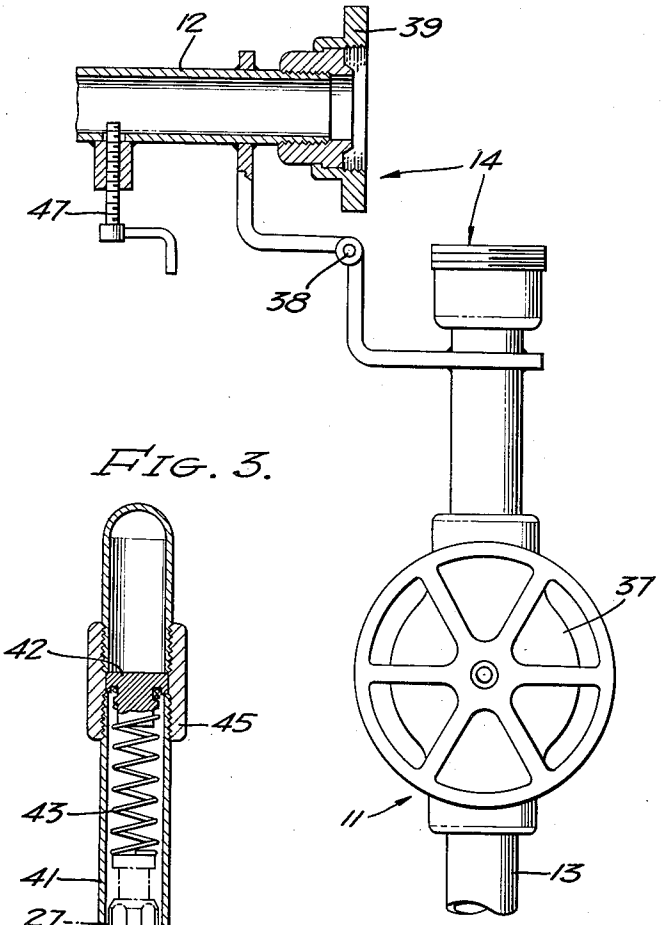


FIG. 3.

FIG. 4.

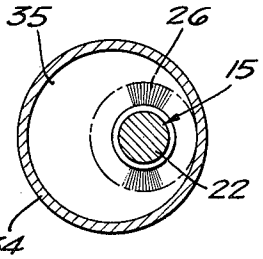


FIG. 5.

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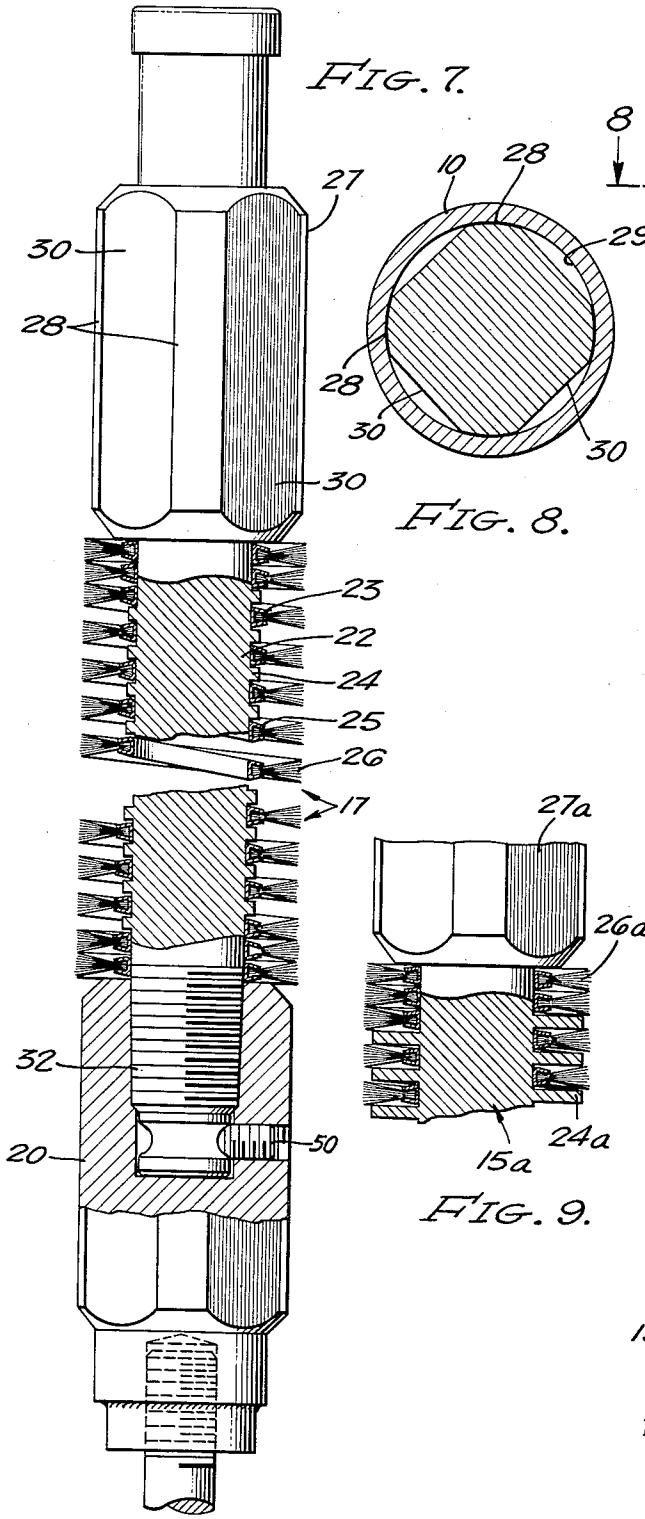


FIG. 7.

FIG. 8.

FIG. 9.

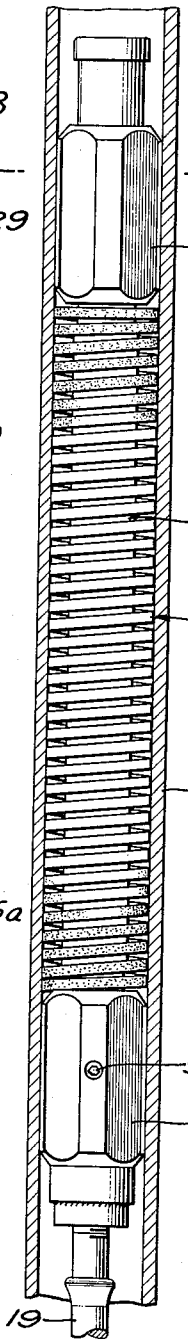


FIG. 6.

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3,012,832

FREE PISTON WELL PUMP DEVICE

Donald G. Knox, Rolling Hills, Calif., assignor, by mesne assignments, to Camco, Inc., Houston, Tex., a corporation of Texas

Filed May 12, 1958, Ser. No. 734,554
4 Claims. (Cl. 309—23)

This invention relates to free piston well pumping apparatus of the general type shown in my prior patents, Nos. 2,642,002 and 2,661,024, and is particularly directed to improved forms of plungers for such devices.

I have found that it is possible to produce a plunger having superior operating characteristics for some types of wells, which plunger employs one or more brush elements for sealing contact with the inner surface of the eduction tube. The brush may be formed of metallic or non-metallic bristles and these produce a sliding seal in the eduction tube. Variations in diameter and roundness of the eduction tube can therefore be tolerated to a greater extent than with conventional forms of plungers. Brush type plungers having non-metallic bristles have been found to give particularly good results in removing unwanted accumulations of water in gas wells which produce considerable quantities of sand. The brush type plunger has been found to give surprisingly good results and it is believed that the sealing effect is based upon turbulence which develops around the bristles.

In another aspect of the invention, a long plunger with spaced sealing elements is provided in order to span sections in the eduction tube which are laterally enlarged to provide space for retrievable kick-off valve assemblies. Kick-off valves are very old in the gas lift art but one of the disadvantages in their use has been the requirement that the eduction tube be pulled from the well each time it became necessary to repair or replace such valve assemblies. In more recent times, retrievable kick-off valves have been developed and are commercially available. These may be inserted and retrieved through the interior of the eduction tube on a wire line and without requiring that the eduction tube be removed from the well. Such retrievable kick-off valves are mounted in specially formed sections of the eduction tube and the increased size of the interior of the sections is such as to prevent full sealing contact of the sealing elements of the plunger.

To extend the economic possibility of the "kick-off" method of gas lift requires a plunger to realize the maximum efficiency in gas utilization and at the same time minimize the emulsion difficulties that are found in some wells operated by gas lift. With the side pockets in the eduction tube for reception of the retrievable type of kick-off valve, a long plunger serves to bridge the full length of the side opening. There can be one or more of such side pockets or openings depending on the number of kick-off valves required. In accordance with my invention, I provide a plunger having a total over-all length substantially greater than the length of any laterally expanded section of the tubing and this plunger takes the form of two sealing elements separated by a central spacer. The brush type sealing element has been found to be particularly well suited for this long form of plunger.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

FIGURE 1*a* is a side elevation showing a well head installation employed in connection with a preferred embodiment of my invention.

FIGURE 1*b* forms a continuation of the lower end of FIGURE 1*a*.

FIGURE 2 is a side elevation partly in section showing the parts on an enlarged scale.

FIGURE 3 is a sectional detail taken substantially on the lines 3—3 as shown in FIGURE 1*a*.

FIGURE 4 is a side elevation partly in section showing the releasable connection between the upper and lower parts of the well head assembly.

FIGURE 5 is a sectional plan view taken substantially on the lines 5—5 as shown in FIGURE 2.

FIGURE 6 is a side elevation partly in section showing details of the plunger.

FIGURE 7 is a sectional view partly broken away of the device shown in FIGURE 6.

FIGURE 8 is a sectional plan view taken substantially on the lines 8—8 as shown in FIGURE 6.

FIGURE 9 is a sectional detail showing a modification.

Referring to the drawings, the free piston well pump device includes an eduction tube **10** having its upper end fixed to a well head assembly generally designated **11** and comprising an upper part **12** and a lower part **13**, joined by a separable connector **14**. A plunger **15** travels vertically within the eduction tube **10** and is adapted to be received within the upper part **12** of the well head assembly **11**. Well fluid brought up through the eduction tube to the surface by means of the plunger **15** passes from the well head assembly through the discharge pipe **16**.

In accordance with my invention, the plunger **15** may comprise a pair of sealing members **17** and **18** separated by a central spacer **19**. This spacer may take the form of a length of conventional sucker rod joined to the sealing members by means of the coupling guides **20** and **21**. Each of the sealing members **17** and **18** comprises a longitudinal mandrel **22** having a continuous helical groove **23** provided on its outer surface. A helical fin **24** thus forms the side of the groove. The retainer **25** is received within the helical groove **23** and the retainer supports the brush bristles in a generally radial direction. The brush **26** comprising the retainer and bristles is assembled on the mandrel in the manner of a nut on a bolt, and is fixed in place to prevent relative movement. Instead of mounting a helical brush retainer in a helical groove, a plurality of circular brush rings can be used, if desired.

The free outside diameter of the brush **26** when unconfined is very slightly smaller than the internal diameter of the eduction tube **10**, that is to say, the tips of brush bristles define a cylinder having a diameter smaller than the internal diameter of the eduction tube. The bristles of the brush **26** are believed to develop localized turbulence when the plunger moves upward in the eduction tube, carrying a load of well fluid, and driven by gas pressure from below. The mandrel **22** carrying the brush **26** is relatively long and substantially longer than the diameter of the brush thereby providing a substantial number of convolutions of the brush for each sealing member **17** and **18**.

As shown in FIGURE 8, the upper guide **27** is noncircular in cross section and has rounded portions **28** with running clearance within the inner surface **29** of the eduction tube **10**. The flat surfaces **30** have substantial clearance with the surface **29** and also provide wrench contacting areas.

The guides **20**, **21** and **31** have the same external configurations as the guide **27**. The guide **20** is connected to the lower end of the mandrel **22** by means of threads **32** and locked by means of a set screw **50**. The brush **26** is thus confined between the guides at opposite ends of the mandrel **22**. The guides serve to center the brush **26** within the inner surface **29** of the eduction tube **10** when the bristles are relatively soft and formed of nonmetallic material, such as nylon.

In the modified form of my invention shown in FIGURE 9, the guides **27***a* may be given greater running clearance within the interior of the eduction tube and the helical fin **24***a* may provide the centering function for the helical brush **26***a*. In other respects, the plunger **15***a* is substantially the same as plunger **15**.

The casing **33** extends downward into the well from the well head assembly **11** and the eduction tube **10** is positioned within this casing. Sections **34** of the eduction tube **10** may be provided which are laterally enlarged to receive retrievable kick-off valve assemblies (not shown). Laterally positioned pockets **35** are thus provided at one or more locations along the length of the eduction tube **10**. These pockets are longer than the length of either of the sealing elements **17** or **18** but the overall length of the plunger **15** is substantially longer than these pockets **35**. Accordingly, the sealing effect is not lost when the plunger **15** moves upward in the eduction tube **10** even though the pockets **35** are too large to be sealed by the sealing portions **17** and **18**; while one of the sealing elements is passing through a section **34**, the other sealing element on the plunger remains in sealing position within adjacent sections of the eduction tube **10**. The dotted lines in FIGURE 1*a* show the position of the plunger **15** within the upper part **12** of the well head assembly **11**. The plunger **15** is also shown in FIGURE 1*b* to illustrate its length compared to the length of one of the laterally enlarged sections **34**. Only one plunger **15** is used however, and it is shown in two different positions on the drawing for clarity of illustration.

The lower part of the well head assembly **11** includes the casing head **36** and the master gate valve **37**. A hinge **38** having a horizontal axis laterally offset from the axis of the eduction tube connects the upper and lower parts of the well head assembly **11**. A union **39** connects adjacent ends of the tubular parts. Control mechanism **40** which may be of the type disclosed in the copending application of William A. Shaw, Serial No. 640,365, filed February 15, 1957, may be provided to control the cycling operations of the plunger **15**. An extended stack **41** connects the control mechanism **40** to the bumper support **42**. A compression spring **43** is mounted on this support and extends downward into the stack **41** and serves to cushion the deceleration of the plunger **15** at the upper end of its stroke. Guy wires **44** may be attached to the coupling **45** to hold the stack **41** in upright position.

When it is desired to remove the plunger **15** for inspection, replacement or repair, the discharge line **16** is disconnected by means of the union **46**, and the guy wires **44** are released. The union **39** is disconnected and the pole **48** is used to swing the stack **41** and upper portion **12** of the well head assembly about the hinge **38** away from vertical position to a position such as that shown in FIGURE 4. The plunger **15** may then conveniently be withdrawn laterally from the upper portion **12** of the well head assembly. Prior to swinging the stack **41** and upper portion **12** of the well head assembly about the hinge **38**, the screw **47** may be turned and projected into the return path of the plunger **15** to trap it within the stack **41**. The screw **47** is retracted when the plunger **15** is to be withdrawn laterally from the upper portion of the well head assembly.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth but my invention is of the full scope of the appended claims.

I claim:

1. A plunger adapted to travel in the eduction tube of a free piston well pump device, comprising: a mandrel having a brush mounted on the outer surface thereof, the brush being formed of bristles extending outward and the tips of the brush bristles defining a cylinder having a smaller diameter than the internal diameter of said eduction tube, the said brush being substantially longer longitudinally along said mandrel than the said diameter defined by the bristle tips, and guides on the mandrel at opposite ends of the brush having running clearance with said inner surface of the eduction tube.

2. A plunger adapted to travel in the eduction tube of a free piston well pump device, comprising: a solid mandrel having a continuous helical groove on the outer surface thereof, a bristle brush mounted in the groove and the tips of the brush bristles defining a cylinder having a smaller diameter than the internal diameter of said eduction tube, the said brush being substantially longer longitudinally along said mandrel than the said diameter defined by the bristle tips, and non-circular guides on the mandrel at opposite ends of the bristle brush proportioned to have running clearance with said inner surface of the eduction tube.

3. A plunger adapted to travel in the eduction tube of a free piston well pump device, comprising: a mandrel having a continuous helical bristle brush mounted on the outer surface thereof and the tips of the brush bristles defining a cylinder having a smaller diameter than the internal diameter of said eduction tube, the said brush being substantially longer longitudinally along said mandrel than the said diameter defined by the bristle tips, a continuous helical fin on the mandrel adjacent the brush, the outer diameter of the fin being substantially less than the inner diameter of the eduction tube, and metallic guides on the mandrel at opposite ends of the bristle brush proportioned to have running clearance with the inner surface of the eduction tube.

4. A plunger adapted to travel in the eduction tube of a free piston well pump device, comprising: a mandrel having a continuous helical bristle brush mounted on the outer surface thereof and the tips of the brush bristles defining a cylinder having a smaller diameter than the internal diameter of said eduction tube, the said brush being substantially longer longitudinally along said mandrel than the said diameter defined by the bristle tips, and a continuous helical fin on the mandrel adjacent the bristle brush proportioned to have running clearance with the inner surface of the eduction tube.

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