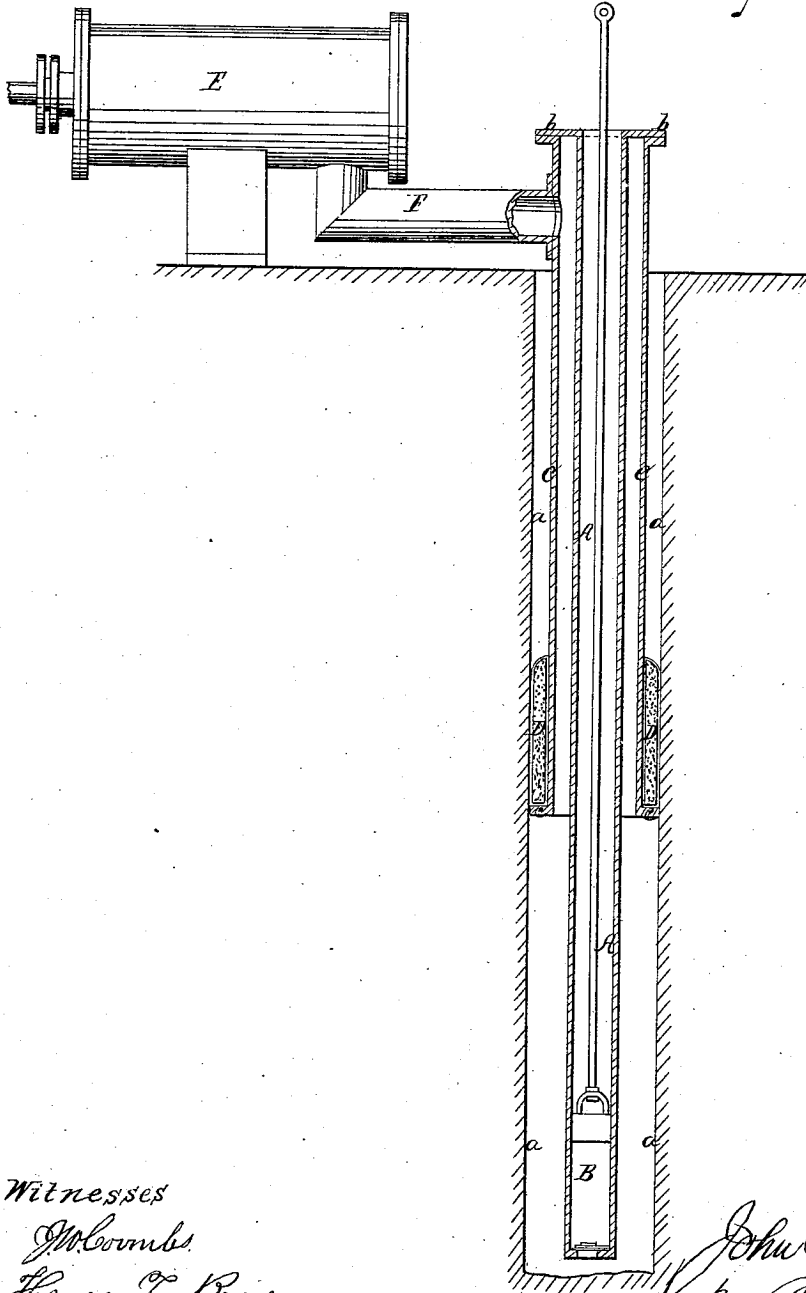


*J. B. Root,*

*Water Elevator,*

*No 47,133,*

*Patented Apr. 4, 1865.*



*Witnesses*

*W. Coombs*  
*Henry J. Brown*

*Inventor*

*John B. Root*  
*per Brown, C.*

# UNITED STATES PATENT OFFICE.

JOHN B. ROOT, OF NEW YORK, N. Y.

## IMPROVEMENT IN OIL-WELL PUMPS.

Specification forming part of Letters Patent No. 47,133, dated April 4, 1865.

*To all whom it may concern :*

Be it known that I, JOHN B. ROOT, of the city, county, and State of New York, have invented a new and useful Improvement in Tubing and Pumps for Oil-Wells; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, said drawings representing a vertical section of a well tubed and having pumps applied according to my invention.

The gases which are formed in petroleum-wells interfere very seriously with the pumping up of the oil when the wells are tubed in the usual manner with a single tube. This is owing to there being no other outlet for the gases but through the oil-pump, which constantly works on their expansion with its valves continually open, and so fails entirely to bring up oil, or bring up very little, though there is a copious supply in the well. The object of this invention is to obviate this interference of the gases with the working of the oil-pump; and to this end it consists in providing in an oil-well, besides the ordinary oil-tube connected with the oil-pump, an additional tube connected with an exhausting-pump at the top of the well for drawing off or permitting the escape of gases. It also consists in a certain mode, hereinafter described, of applying such additional tube and the "seed-bag" in combination with each other and with the oil-tube, whereby great facility is afforded for applying the said additional tube and for the removal of the oil-tube and oil-pump from the well without disturbing the seed-bag or permitting water to enter the lower part of the well.

A is the oil-tube, made much smaller than the well, and having the oil-pump B at its lower end, as is usual in the ordinary system of tubing oil-wells.

C is the additional tube, represented as made of iron, with an internal diameter larger than the external diameter of the oil-tube A. This tube C surrounds the oil-tube, and is attached to the upper end thereof by an air-tight flanged joint, *b*. The length of the said tube C is such that it extends from the upper end of the oil-tube to such depth down the bore *a a* of the well as it is desirable to place the seed-bag D, which is employed to exclude the water from

the lower part of the bore whence the oil is obtained. The seed-bag is supported upon an external flange, *c*, formed upon the open lower end of the said tube C. At or near the mouth of the well, above the ground, there is an exhausting-pump, E, which may be like an ordinary air-pump, the gas-exhaust pipe F of which is connected with the upper part of the tube C.

The exhausting-pump E may be kept at work continually, if necessary, or so long as gas is being collected or accumulating in the well, which may be ascertained by a pressure-gage attached to the gas-exhaust pipe, or by such other means as experience may suggest, the gas coming up the tube C to the exhaust-pipe F, and by its keeping the well free of gas it leaves nothing for the oil-pump to do but to bring up the oil. So long as it is kept in operation it will, if of sufficient capacity and worked at a proper speed, keep a partial vacuum in the lower part of the well and so encourage the flow of oil to the well through the crevices in the sides thereof. Without the pump the tube C might in some cases be used to allow the gas to escape in a natural way.

It is not absolutely necessary to arrange the gas-tube C around the oil-tube, as it might be arranged on one side thereof if the seed-bag be properly applied in connection with the two tubes to exclude water from the lower part of the well; but I consider it best to arrange it around the oil-tube as represented, as so applied it enables the oil tube and pump to be taken up whenever necessary by disconnecting the flange *b* without disturbing the seed-bag. Even in cases where it is not necessary to exhaust or provide for the escape of gas, such a tube, C, might be used in the form and manner represented as a means of enabling the oil tube and pump to be removed without disturbing the seed-bag. By constructing the tube C of soft wood and inserting it tightly into the bore it might be made to dispense with the seed-bag, as it would be swollen by any incoming water and so made to exclude the water from the lower part of the well.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The employment, in an oil-well, of an additional tube, so arranged and applied, in combination with the oil-tube and an exhausting-pump, that while it permits the exclusion of

water from the lower part of the well by means of the seed-bag, it provides for the escape of the gases from the well, substantially as herein described.

2. The arrangement of the tube C, surrounding and connected with the upper part of the oil-tube A, and applied within the well,

substantially as herein described, whereby the oil-tube and oil-pump may be removed without disturbing the seed bag.

JOHN B. ROOT.

Witnesses:

HENRY T. BROWN,  
J. W. COOMBS.

No. 615,760.

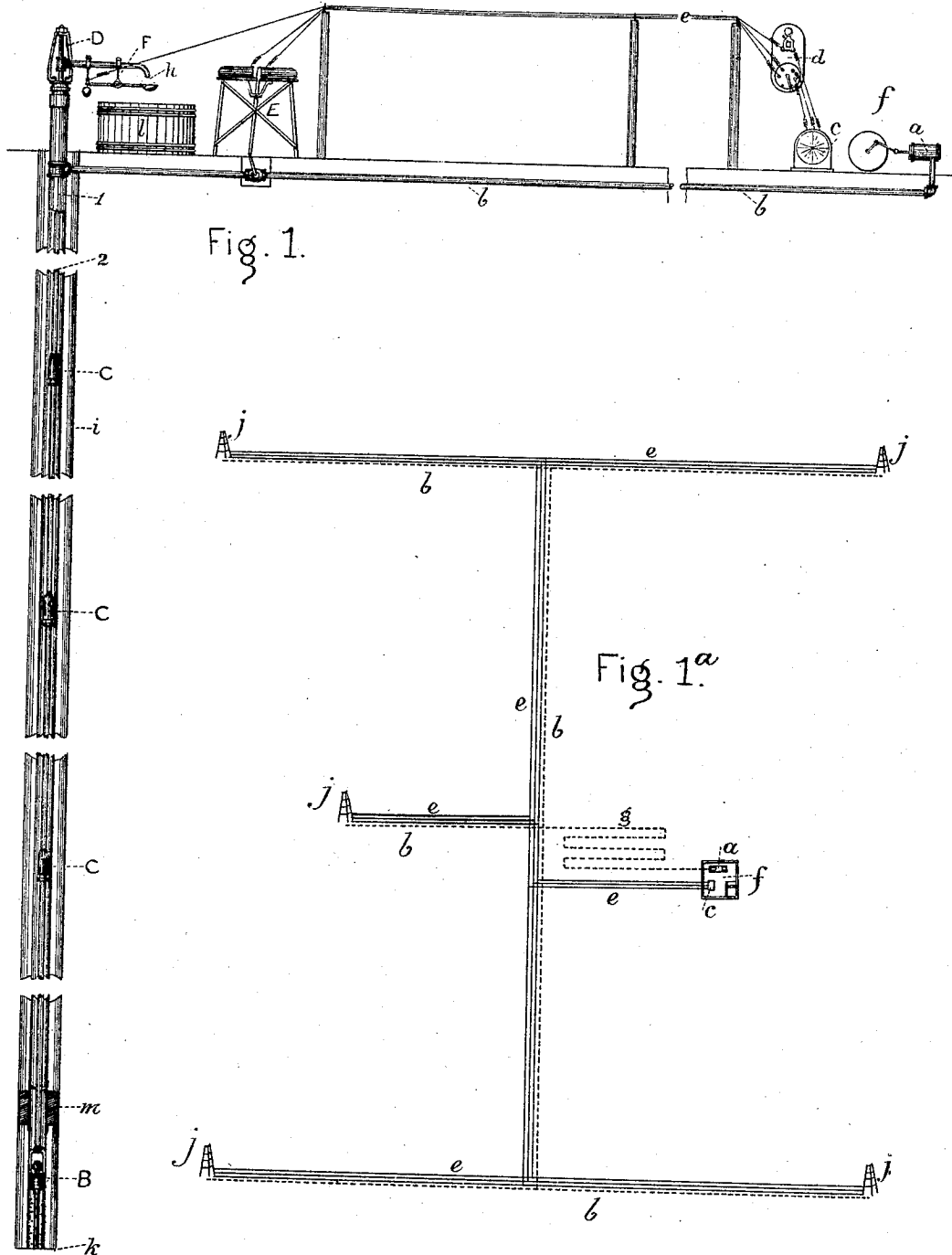
Patented Dec. 13, 1898.

J. S. SMITH.  
PNEUMATIC PUMPING MACHINE.

(Application filed July 9, 1898.)

(No Model.)

6 Sheets—Sheet 1.



Witnesses:  
*Clasf. Spaak*  
*J. Leonard*

Inventor:  
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Patented Dec. 13, 1898.

J. S. SMITH.  
PNEUMATIC PUMPING MACHINE.

(Application filed July 9, 1896.)

(No Model.)

6 Sheets—Sheet 2.

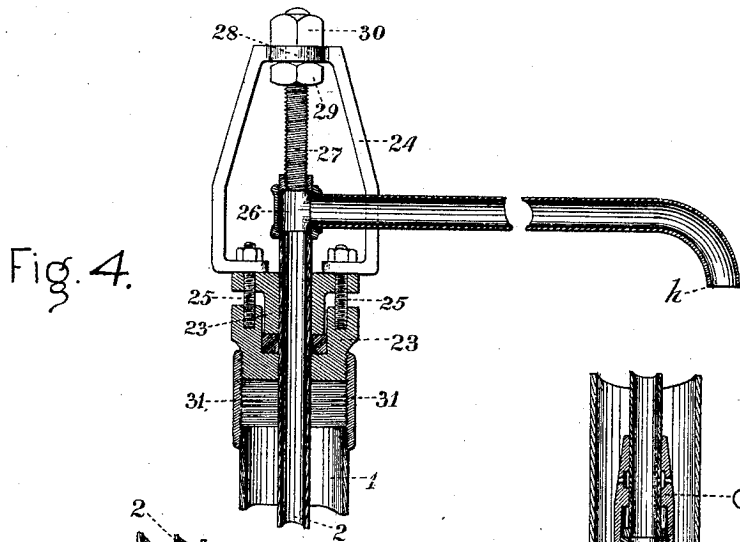


Fig. 4.

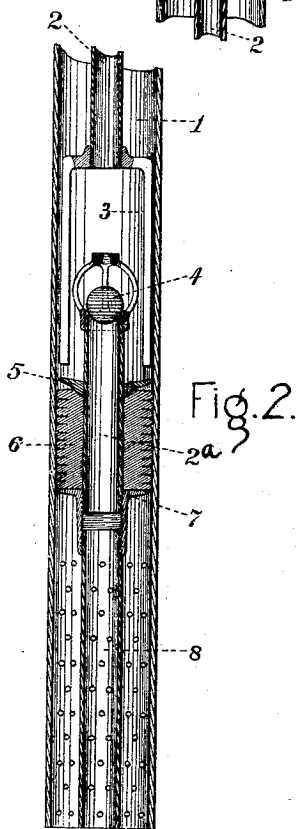


Fig. 2.

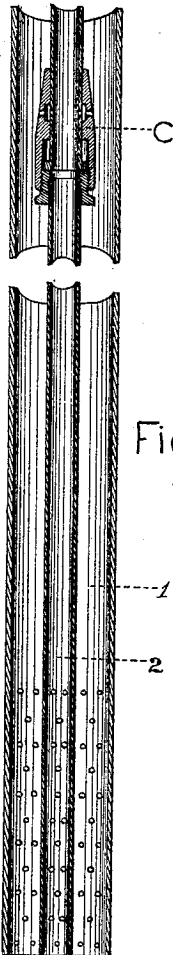


Fig. 2a

Witnesses:

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Patented Dec. 13, 1898.

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PNEUMATIC PUMPING MACHINE.

(Application filed July 9, 1896.)

(No Model.)

6 Sheets—Sheet 3.

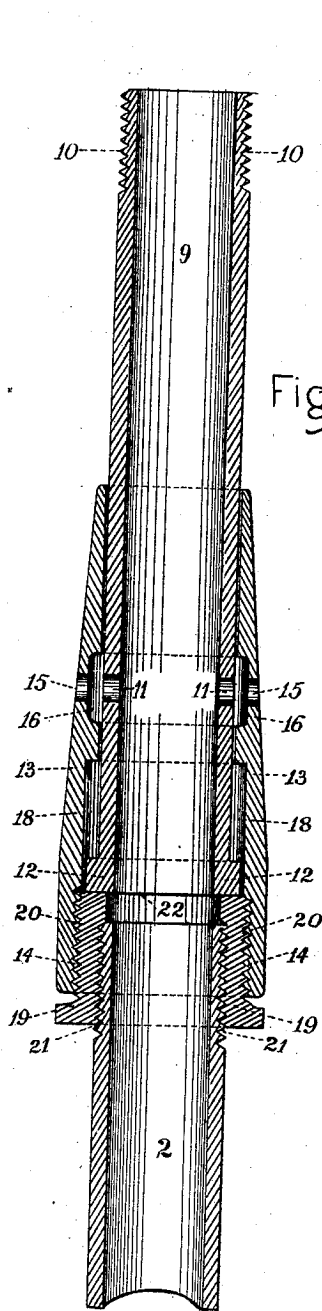


Fig. 3.

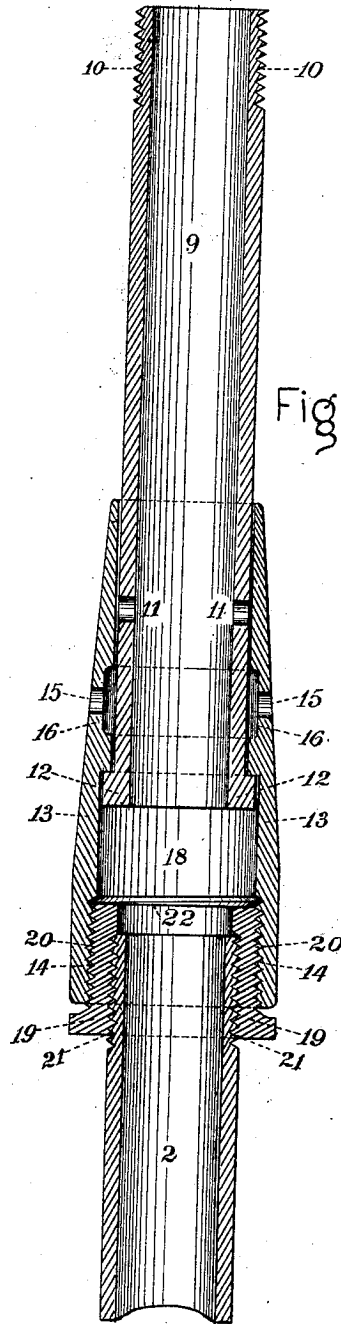


Fig. 3a

Witnesses:

*Charles Spack*  
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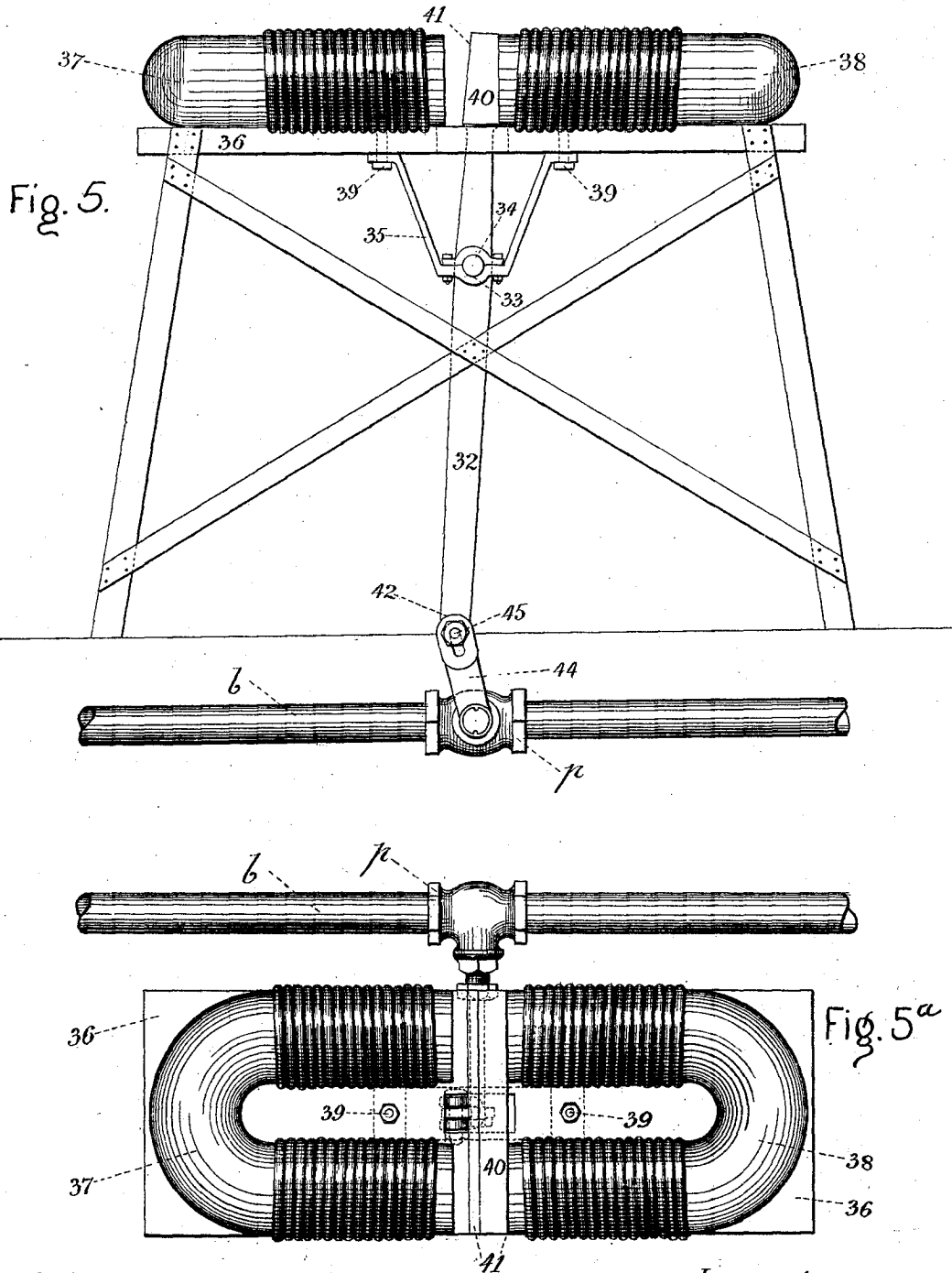
Patented Dec. 13, 1898.

J. S. SMITH.  
PNEUMATIC PUMPING MACHINE.

(Application filed July 9, 1896.)

(No Model.)

6 Sheets—Sheet 4.



Witnesses:

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J. S. SMITH.  
PNEUMATIC PUMPING MACHINE.

(Application filed July 9, 1896.)

(No Model.)

6 Sheets—Sheet 5.

Fig. 6.

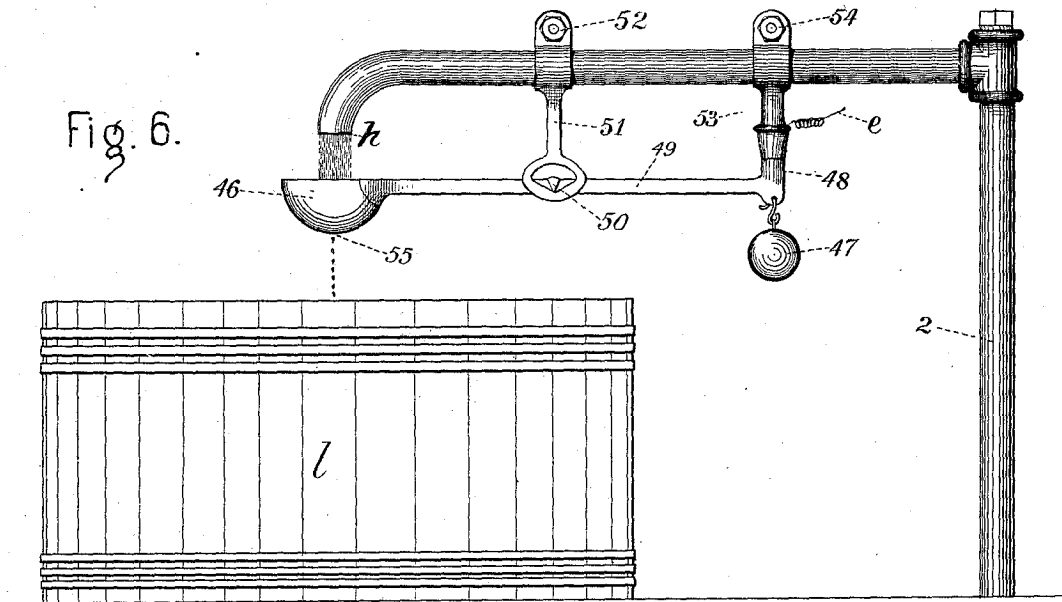
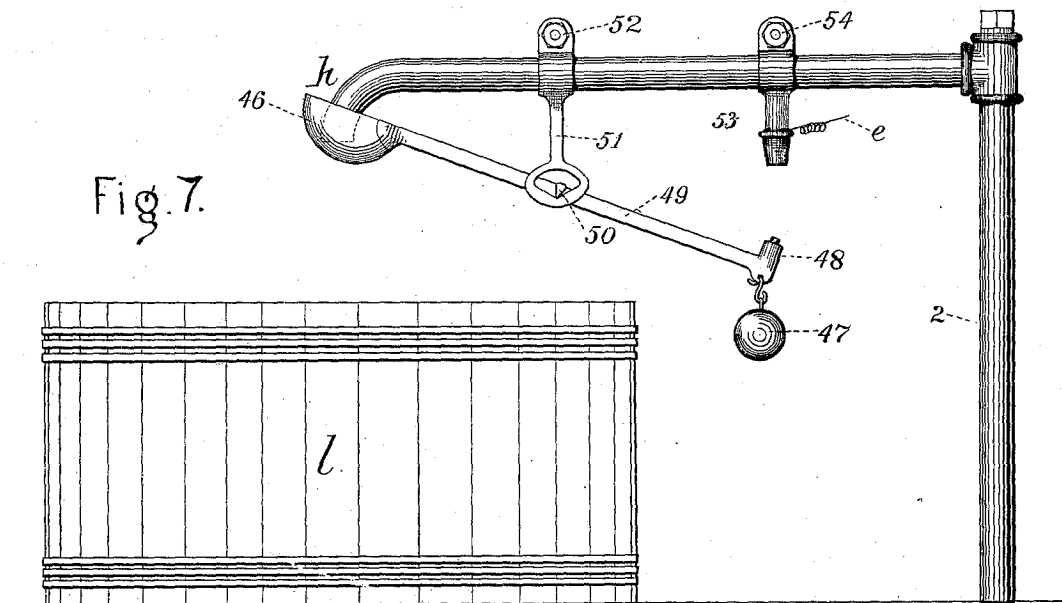


Fig. 7.



Witnesses:

*Charles Spaak*  
*J. H. Leonard*

Inventor:

*James S. Smith*  
*Berger & Orin*  
Attorneys



No. 615,760.

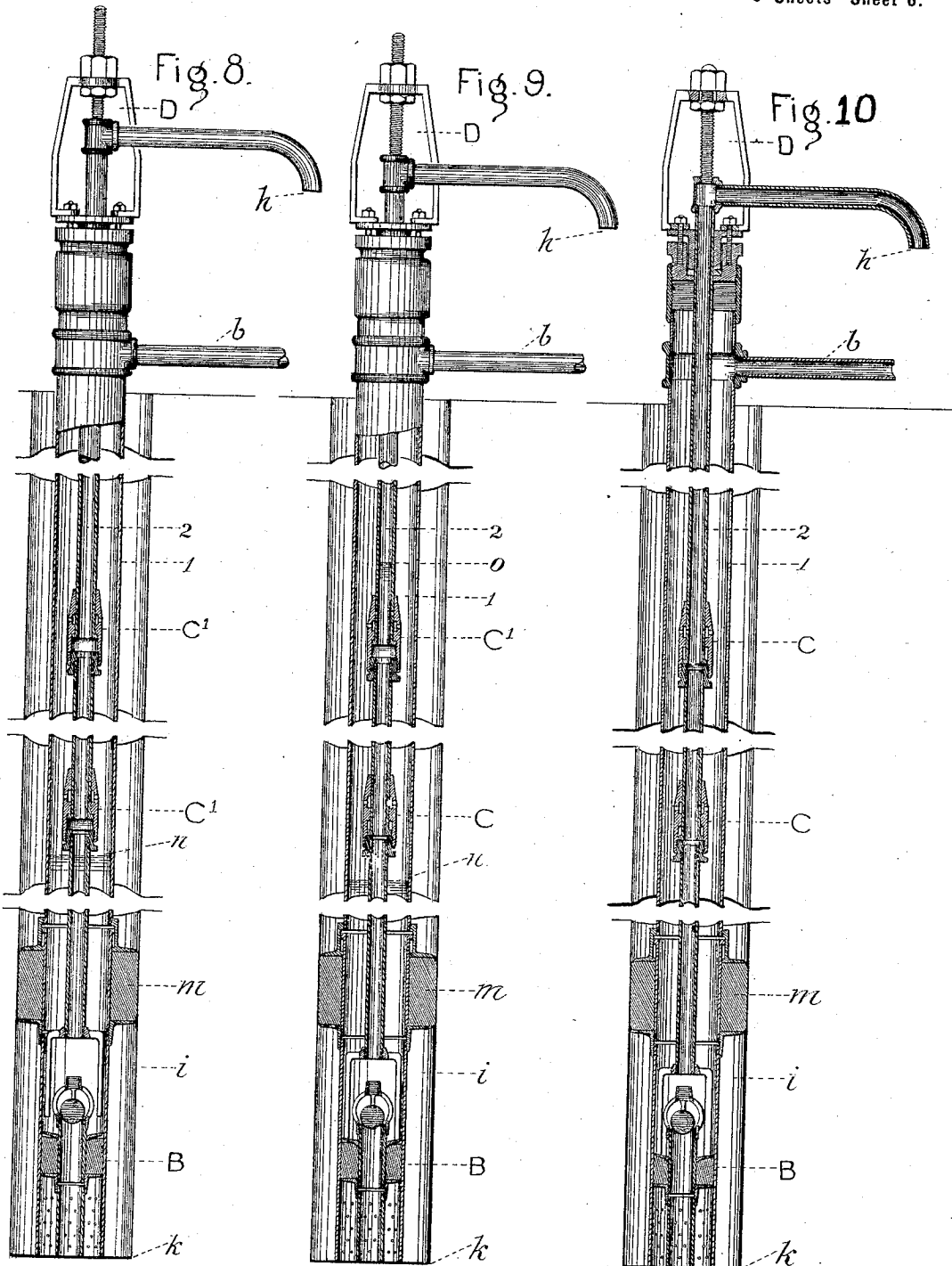
Patented Dec. 13, 1898.

J. S. SMITH.  
PNEUMATIC PUMPING MACHINE.

(Application filed July 9, 1896.)

(No Model.)

6 Sheets—Sheet 6.



Witnesses:  
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*J. Hemard*

Inventor:  
*Jacob S. Smith*  
*per J. S. O'Connell*  
*Attorney*

# UNITED STATES PATENT OFFICE.

JACOB S. SMITH, OF CHICAGO, ILLINOIS.

## PNEUMATIC PUMPING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 615,760, dated December 13, 1898.

Application filed July 9, 1896. Serial No. 598,606. (No model.)

*To all whom it may concern:*

Be it known that I, JACOB S. SMITH, a citizen of the United States, residing at the city of Chicago, in the county of Cook and State of Illinois, have invented a new and useful Pneumatic Pumping Apparatus, of which the following is a specification.

My invention consists of an apparatus for accumulating at a central station, conveying thence by pipe-line to distant points, and there utilizing compressed air or gas by admitting the same into that part of the apparatus contained in the well and consisting of two strings of tubing, one string within the other, as hereinafter shown, and is operated, controlled, and regulated from such central station by means of electrical appliances, the object of my invention being to simultaneously control from such central station any number of Artesian wells located at different points for the purpose of pumping the same by admitting such compressed air or gas into the outer string of tubing, thus ejecting the contents of the well through the inner string, or vice versa. I attain that object by the use of the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a view of my invention in elevation, and Fig. 1<sup>a</sup> is a view of a system of wells to which my invention is applied. Fig. 2 is an upright sectional view of the stop. Fig. 2<sup>a</sup> is a view of a modification. Fig. 3 is a sectional view of the piston-valve, showing its transverse passage open; and Fig. 3<sup>a</sup> is a similar view of the same, showing its transverse passage closed. Fig. 4 is an upright sectional view of the hanger. Fig. 5 is an electromagnetic motor in elevation, and Fig. 5<sup>a</sup> is a plan of the same. Fig. 6 is the indicator in elevation in operation, and Fig. 7 is a similar view of the same at rest. Figs. 8, 9, and 10 show that part of my invention contained in the well with the pressure and contents of the well in three relatively different positions.

Similar numbers and letters refer to similar parts throughout the several views.

*The apparatus.*—Figs. 1 and 1<sup>a</sup> show the compressing-engine *a* connected with the pipe-line *b* and the dynamo or battery *c* and the alarm and switchboard *d* connected with the electric wires *e*, located at the central sta-

tion *f*, said pipe-line *b* having a dehydrator *g*, attached near the central station *f*, extending thence and connected to the outer string of tubing 1, and said wires *e* also extending thence and connected to the electromagnetic motor and valve shown in Fig. 5 and attached to the pipe-line *b* and to the indicator shown in Fig. 6 and attached to the discharge *h* of the inner string of tubing 2, which are located near the well *i* at the distant point *j* and communicate thence with that part of my invention located in the well *i* and consisting of the hanger shown in Fig. 4, the piston-valve shown in Fig. 3, and the stop shown in Fig. 2 and attached to the outer string of tubing 1 and the inner string of tubing 2.

In Fig. 2 is illustrated the mechanism attached to the lower portion of the inner string of tubing, the duty of this part of my invention being to prevent the contents of the tubing from retreating into the recesses of the well upon the admission of pressure from above. This mechanism, which I call the "stop," consists of a section of the inner string of tubing 2, to which is attached a yoke 3, which, with the inner string of tubing 2, is suspended, raised, and lowered from the hanger shown in Fig. 4. The yoke 3 fits loosely between the wall of the outer tubing 1 and the cage of the ball-valve 4, and when lowered rests upon the wedge-rimmed plate 5, which is thus forced downward along the lower section or central pipe 2<sup>a</sup> of the inner tubing, and by the weight thus applied expands the rubber packer 6, which is secured to the inner tubing 2<sup>a</sup> by the rest 7, which position, together with air or gas pressure admitted from above to close the ball-valve 4, effects the stop, preventing the upward or downward flow of liquid or gas through the perforations 8. The packer 6 normally permits the liquid to flow between the central pipe 2<sup>a</sup> and the walls of the outer tubing 1, the object of such normal passage being to facilitate the flow of liquid into the tubing above by the natural tendency of the fluid in the well to rise until the force of the pressure in the well is equalled by the weight of the liquid and to obviate the difficulties usually incident to the accumulation of paraffin or other substances in the ball-valve 4. In the practical operation of this part of my inven-

tion as soon as the accumulation of liquid in the tubing prevents the flow of gas from the well it becomes necessary to eject the same. This is done by the application of pressure from above, which expands the packer 6 to close the annular space or the normal passage between the tubing 2<sup>a</sup> and the outer tubing 1. This may be done either by the weight of the tubing 2 and the yoke 3 resting upon the wedge-rimmed plate 5 or by charging the other tubing with equivalent air or gas pressure, and when such pressure is removed the packer 6 will resume its former position, leaving the normal passage. The packer is so constructed that this operation may be repeated whenever the accumulation in the tubing above necessitates the pumping of the well. The reason for inserting the inner tubing 2<sup>a</sup> is to form a support for the packer 6 independently of the outer tubing; and at the same time by using the ball-valve in the inner tubing 2<sup>a</sup> in connection with the expandable character of the packer 6 allows the greatest passage consistent with practical mechanics and the successful operation of my apparatus.

A thread is cut in the top of the cage of the ball-valve 4 to enable the operator to extract the portion 2<sup>a</sup> of the inner tubing by means of sucker-rods or other appliances.

Figs. 3 and 3<sup>a</sup> illustrate the form of valve, one or more of which are connected with the inner string of tubing 2, intersecting the same at desired intervals, the valve being capable of being opened and closed by the longitudinal movement of the tubing with which it is connected by means of the mechanism shown in Fig. 4, the duty of this part of my invention being to procure the application of pressure to the column of contents of the tubing by way of a transverse passage between the inner and outer strings of tubing through the valve at the point where the same is connected and at the same time maintain a longitudinal passage through the same without the use of ball, plug, lid, stem, or wheel, or other similar contrivances. This valve consists of a piece of tubing 9, provided with threads 10 upon the outer surface of the upper end to permit connection with the inner string of tubing, perforations 11 being provided at the sides upon a line encircling the same and having an outwardly-projecting shoulder 12 encircling the same and being a part thereof at the lower end; a tube-like sleeve 13, provided with threads 14 upon the inner surface of the lower end, perforations 15 being provided at the sides upon a line encircling the same, an encircling groove 16 upon the inner surface upon the same line and communicating with the perforations 11, and a recess 18, extending from a point slightly below the lower edge of the groove 16 to its lower end and of sufficient depth to receive the shoulder 12, and a bushing 19, provided with a thread 20 upon the outer surface of the upper end and to receive the thread 14 and provided

with threads 21 upon the inner surface of the lower end to receive the thread of the inner string of tubing 2, and the upper end of the same forming a rest 22 for the shoulder 12. The tube 9 forms a piston without packing of any kind within the sleeve 13, its shoulder 12 reciprocating in the recess 18 between the upper end of the same and the rest 22 and is the immediate means employed to operate the valve, thus: Fig. 3 illustrates the valve open by lowering the tube 9 to contact by the shoulder 12 upon the rest 22, thus connecting the ports 11 and 15 by way of the groove 16 and forming a transverse passage between the inner and outer strings of tubing through the valve, the longitudinal passage remaining intact. Fig. 3<sup>a</sup> illustrates the valve closed by raising the tube 9 and carrying the ports 11 upward in the sleeve 13, the longitudinal passage remaining intact.

*The hanger.*—Fig. 4 illustrates a mechanism attached to and upon the upper end of the outer string of tubing above the mouth of the well, forming the upper part of my invention contained in the well, from which is suspended the inner string of tubing 2, the duty of this part of my invention being to manipulate the valve shown in Fig. 3 and the stop shown in Fig. 2. This hanger consists of the stuffing-box 23 and the bracket 24, fastened together by means of the screws 25. A section of the inner string of tubing 2 is attached by means of the coupling 26 to the screw 27, thus passing through the stuffing-box 23. The screw 27 extends through a suitable opening in the crown 28 of the bracket 24, at which point it is suspended, raised, lowered, and locked by means of the nuts 29 and 30, and is attached to the upper end of the outer string of tubing 1 by means of the coupling 31.

*The electromagnetic motor.*—Figs. 5 and 5<sup>a</sup> illustrate a mechanism in which a lever oscillating upon a fulcrum located between the points of resistance and power is operated by means of two electromagnets, the duty of this part of my invention being to procure reversible power by a to-and-fro motion at distant points by the transmission from a central station of electrical currents to the said electromagnets operating said lever. The lever 32 rests and oscillates upon the fulcrum formed by the bearing 33 and is held securely in position by the box 34, which is supported by the legs or hanger 35, fastened to the bed-plate 36 at a point within the U of the magnets 37 and 38 by means of the nuts and bolts 39. The lever 32 at the point of power 40 is of sufficient breadth and height to cover the entire surface of the poles of the magnets, as shown by the lines 41, so that alternately energizing the electromagnets 37 and 38 controls the point of power 40 of the lever 32, thus operating at the point of resistance 42 the valve  $p$  in the pipe-line  $b$ , said valve  $p$  being loosely connected with the said lever by means of the crank 44 and the bolt and nut 45.

*The indicator.*—Figs. 6 and 7 illustrate a

mechanism constructed and operated after the manner of a simple straight-arm balance, the weighted extremity of which, by the deposit of the contents of the well in the pan extremity, contacts with an electric wire communicating with an alarm at the central station, the duty of this part of my invention being to indicate the commencement, duration, and cessation of the flow of the liquid in the wells.

5 The pan 46, the weight 47, and the contact 48 are attached to or form a part of the bar 49, which rests and oscillates by the pivots 50 upon each side upon the hanger 51, forming the fulcrum, and strapped to the discharge 15 *h* of the inner string of tubing 2, so that the pan 46 is under the nozzle of the discharge *h* by means of the bolt and nut 52. Upon the deposit of the contents of the well into the pan 46 the contact 48 engages with the wire 20 *e*, inserted in the socket 53, which is also strapped to the discharge *h* by means of the bolt and nut 54. The pan 46 is slightly perforated in the bottom 55, through which upon the cessation of the flow of the well it is emptied into the tank *l*, whereupon this mechanism assumes the position illustrated in Fig. 7.

Fig. 8 illustrates that part of my invention located in the well at rest, with the stop shown in Fig. 2 resting upon the bottom of the well, 30 contacted with the wall of the well by the rubber packer *m*, the hanger shown in Fig. 4, with the pipe-line *b* and the discharge *h*, resting upon and attached to the outer tubing 1 at the mouth of the well, and the inner string of tubing 2, with two piston-valves shown in Fig. 3 attached, suspended from the hangers shown in Fig. 4, showing fluid of equal height in both strings of tubing 1 and 2 at a point *n* below the lower piston-valve shown 40 in Fig. 3.

Fig. 9 illustrates the same part of my invention in the same position last above described, except that pressure is admitted from the pipe-line *b* into the outer tubing 1, which 45 pressure, operating independently of or in conjunction with the weight of the inner string of tubing 2 upon the ball-valve 4, the plate 5, and the packer 6, closes the same, thus effecting the stop shown in Fig. 2, and raises 50 the contents of the well through the inner tubing 2 at its opening in the yoke 3 to a point above the first piston-valve shown in Fig. 3, which is now opened by lowering the inner string of tubing 2 by means of the screw and nuts in the hanger shown in Fig. 4 until it rests with the yoke 3 upon the plate 5, thus admitting pressure through the transverse passage in the valve shown in Fig. 3 from the outer to the inner string of tubing, and thus 60 raising the contents of the well through the latter to the point above the second piston-valve shown in Fig. 3, which remains closed, as shown.

Fig. 10 illustrates the same part of my invention in the same position as last described, except that both the piston-valves shown in

Fig. 3 are open, thus admitting more pressure from the outer string of tubing 1 into the inner string of tubing 2 and ejecting the contents of the well through the discharge *h*. 70

The size and power of the different parts of my invention and the number of the piston-valves attached to the inner tubing depend upon the number of wells operated, the quantity of water or other contents in the wells to 75 be ejected, and the available degree of pressure and the depth of the wells relatively considered, all the parts of this apparatus to be made of iron or other metal, except where herein otherwise specified. 80

In Fig. 2<sup>a</sup> I have illustrated a modification in which the stop shown in Fig. 2 and auxiliaries are omitted, the inner pipe 2, provided with perforations, extending to the bottom of the well. This form is applicable to wells 85 where the pressure from beneath is sufficient to counteract the pressure from above, and the cavities in the well are of such character that the contents of the tubing will not readily retreat from the tubings upon application 90 of compressed air. The valves, Figs. 3 and 3<sup>a</sup>, may be employed as in the construction before described and operated in the same manner.

Having described my invention, what I claim as new, and desire to secure by Letters 95 Patent, is—

1. In a well, the combination with outer and inner tubing communicating by a passage near the lower end, of a central pipe below said passage, a valve in said central pipe opening to pressure from beneath and closing to pressure from above, a packer surrounding said central pipe and normally permitting fluid to flow between said central pipe and the walls of said outer tubing, and means for 100 pressing the exterior of said packer against the walls of said outer tubing by pressure applied from above, substantially as described.

2. In a well, the combination with an outer tubing and an inner tubing provided near the 110 lower end with an opening leading into the outer tubing, a valve for sealing the inner tubing below said opening, opening to pressure from below and closing to pressure from above, a packer surrounding the inner tubing 115 below said opening and normally permitting fluid to flow between said inner tubing and the walls of said outer tubing and expanding against the walls of said outer tubing by pressure from above, means for supplying compressed air to the upper end of one of said tubings and an exit-duct for the fluid provided at the upper end of the other tubing, substantially as described. 120

3. The combination with the outer tubing 1, 125 of the inner tubing 2 and 2<sup>a</sup>, the packer 6 between the said inner tubing 2<sup>a</sup> and the outer tubing, the valve for sealing the inner tubing 2<sup>a</sup>, the yoke 3 secured to the inner tubing 2, means for moving said inner tubing 2 longitudinally, and a valve or valves in the inner 130 tubing 2, opened and closed by the movement

of the upper sections of the inner tubing 2, substantially as described.

4. The combination with the outer tubing 1, of the inner tubing 2 and the inner tubing 2<sup>a</sup>, the packer 6 between the said inner tubing 2<sup>a</sup> and the outer tubing, the valve for sealing the upper end of the inner tubing 2<sup>a</sup>, the yoke secured to the inner tubing 2, and means for moving said inner tubing 2 longitudinally to bring said yoke into engagement with said packer, substantially as described.

5. In a well, the combination with the outer and inner tubings communicating by a passage near the lower end, of a central pipe below said passage, a valve therein, a packer surrounding said central pipe, said inner tubing being formed in longitudinally-movable sections, a yoke supported upon the end of the lower section, ports or openings in said inner tubings at intervals, means for lowering and raising said inner tubing to bring said yoke into engagement with said packer and to move the sections of the inner tubing longitudinally to successively open and close the ports or passages therein, means for sup-

plying compressed air to the upper end of one of said tubings, and an exit-duct for the fluid provided at the upper end of the other tubing, substantially as described.

6. In a plurality of wells, the combination with an outer and inner tubing in each well, of means for supplying compressed air or gas to the upper end of one of said tubings in each well, and an exit-duct provided at the upper end of the other of said tubings in each well, a valve in said first-mentioned tubing at each well to control the pressure-supply thereto, means for operating all of said valves from a common point, and signaling apparatus at said common point communicating with said exit-duct at each well, and operated by the flow of liquid from each well, whereby the several wells may be controlled from a common point, substantially as described.

JACOB S. SMITH.

Witnesses:

CHAS. E. SPAAK,  
S. P. LEONARD.

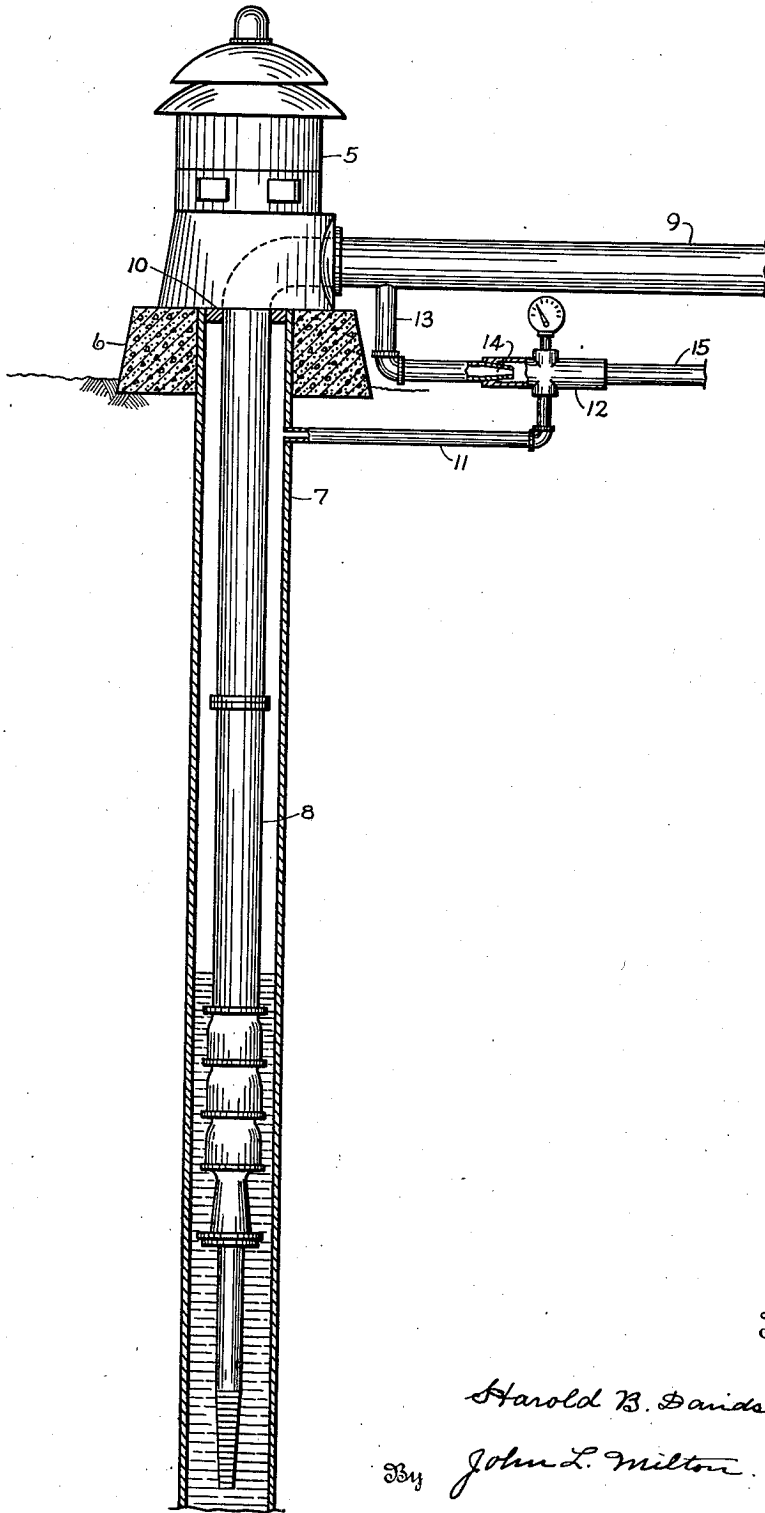
Feb. 14, 1939.

H. B. DAVIDSON

2,146,798

PUMPING SYSTEM

Filed Dec. 2, 1936



Inventor

*Harold B. Davidson,*

*By John L. Milton.*

Attorney

# UNITED STATES PATENT OFFICE

2,146,798

## PUMPING SYSTEM

Harold B. Davidson, Louisville, Ky.

Application December 2, 1936, Serial No. 113,913

4 Claims. (Cl. 103-5)

This invention relates to a pumping equipment for drawing water from a well tube supplied by water flowing into the tube from contiguous subterranean areas.

5 Many wells equipped with high capacity centrifugal pumps of the type shown in the drawing become impaired after operation, due to an inadequate supply of water entering the tube, which  
10 after a rest period becomes restored only to again prove inadequate for the planned capacity. Coincident with this development the static water level has a "draw down" to the pumping level due to an inadequate flow of water into the tube. Such a failure frequently necessitates ad-  
15 ditional pumping equipment which incidentally results in embarrassment for the sales engineers, who assured the purchasers of certain results, which in turn were based on tables of proven capacities for the selected pump.

20 In wells of the type under consideration which periodically develop deficiencies there is generally an adequate potential supply of water in the contiguous subterranean areas, however its flow to the tube is insufficient, consequently an  
25 object of this invention is to provide means and a method of automatic operation, which will enable the pumping equipment to deliver the calculated performance by providing means to expedite percolation from subterranean areas, thereby causing more water to flow into the well  
30 tube than without the use of this invention.

The main object of this invention is to provide additional simple low priced apparatus for a modern pumping equipment, especially of the  
35 deep well centrifugal type, in order that an increased quantity of water can be taken from the well without making any alteration in the pumping equipment or materially departing from the normal operation of same.

40 With the above and other objects in view, as will hereinafter appear, my invention comprises the features of construction and operation set forth in the following specification and illustrated in the accompanying drawing. In such  
45 drawing, annexed hereto and forming a part of this specification, I have shown certain specific embodiments of my invention, but it will be understood that the invention, can be otherwise embodied, and that the drawing is not to be  
50 construed as defining or limiting the scope of the invention, the claims appended to this specification being relied upon for that purpose.

The drawing is a vertical elevation of an installed equipment showing my improvements  
55 wherein the foundation tube and a portion of

the other equipment is shown in cross section and the remainder of the figure shown in full lines.

The figure shown in the accompanying drawing is illustrative of a vertically disposed motor  
5 5 mounted on foundation 6 and over well tube or casing 7, in which is disposed a pump or rotor housing 8, sometimes referred to herein as "pump tube". The latter serves as the discharge  
10 pipe and is provided with the conventional shaft and impellers, constituting a centrifugal pump, all arranged and coordinated for elevating and forcibly delivering water from delivery duct 9.

The well tube is a closed chamber since its top end is hermetically sealed by a plug or collar  
15 10, consequently a relatively high vacuum can be drawn and sustained inside of the tube during the pumping periods. To accomplish this, pipe line 11 connects the tube with a hydraulic ex-  
20 hauster 12. The latter is activated by diverting a portion of the water being delivered through duct 9 by means of pipe 13 which delivers the water, under high pressure, through nozzle 14  
25 to a conventional venturi, which in turn produces an effective vacuum within the well tube, as indicated. The water used for this purpose passes  
30 through auxiliary outlet pipe 15. It will thus be perceived that incident to the operation of the pump a partial vacuum will be maintained within the well tube and thereby assist the pump to sustain delivery of water through decreasing the  
"draw down" range of the water level within the well tube.

The well tube is indicated as having an im-  
35 perforate wall with the lower end open to admit water from the immediately contiguous area. A well tube having apertures in selected sections can be substituted or included according to judgment. It will also be obvious that other changes,  
40 such as the employment of a reciprocating type of pump, can be made without departing from the spirit of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. An apparatus for elevating liquids from a  
45 lower level to a higher level, comprising a casing in which is disposed a pump tube; a pumping device communicating with said tube; a delivery duct leading from said pumping device; said casing being sealed at its upper end to form a chamber therein closed against ingress of the atmosphere; and means activated by said device to establish and maintain a partial vacuum in said chamber.

2. An apparatus for elevating liquids from a  
55

lower level to a higher level, comprising a casing in which is disposed a pump tube; a pumping device communicating with said tube; a delivery duct leading from said pumping device; said casing being sealed at its upper end to form a chamber therein closed against ingress of the atmosphere; and means to utilize a portion of the water pumped by said pumping device to establish and maintain a partial vacuum in said chamber.

3. An apparatus for elevating liquids from a lower level to a higher level, comprising a casing in which is disposed a pump tube; a pumping device communicating with said tube; a delivery duct leading from said pumping device; said casing being sealed at its upper end to form a cham-

ber therein closed against ingress of the atmosphere; and means to utilize water pumped by said pumping device to establish and maintain a partial vacuum in said chamber.

4. An apparatus for elevating liquids from a lower level to a higher level, comprising a casing in which is disposed a pump tube; a pumping device communicating with said tube; a delivery duct leading from said pumping device; said casing being sealed at its upper end to form a chamber therein closed against ingress of the atmosphere; and an auxiliary outlet pipe connected to said delivery duct, said outlet pipe having an exhaustor interposed therein, said exhaustor being connected to said chamber by a pipe whereby a partial vacuum is effected in said chamber.

HAROLD B. DAVIDSON.



Oct. 28, 1947.

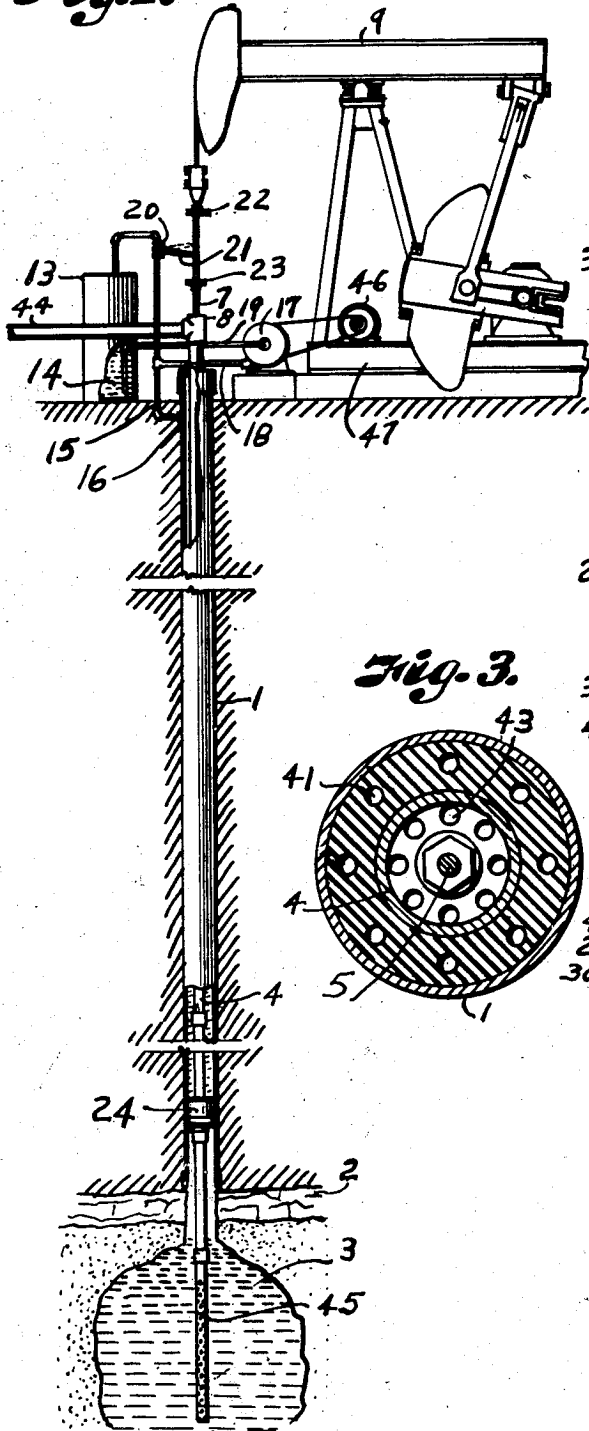
A. G. SMITH

2,429,848

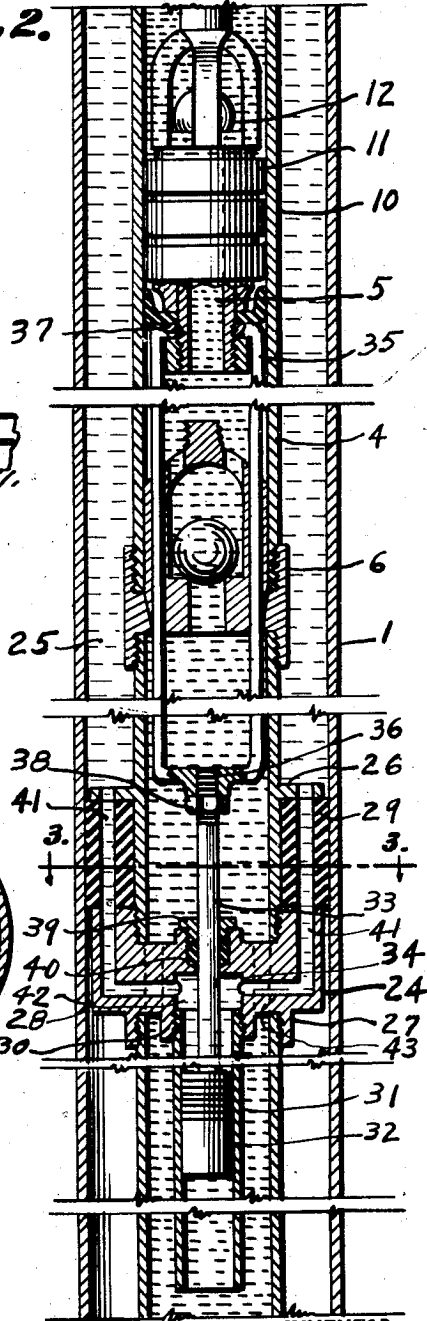
WELL PUMPING EQUIPMENT

Filed March 10, 1945

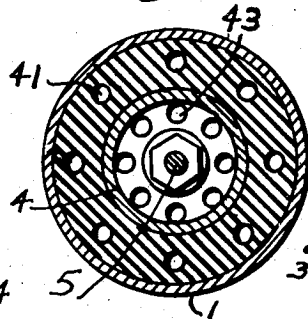
*Fig. 1.*



*Fig. 2.*



*Fig. 3.*



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# UNITED STATES PATENT OFFICE

2,429,848

## WELL PUMPING EQUIPMENT

Archie G. Smith, Tonkawa, Okla.

Application March 10, 1945, Serial No. 582,071

10 Claims. (Cl. 103—179)

1

This invention relates to well pumping equipment, and more particularly to apparatus for aiding in reciprocation of sucker rods.

Heretofore, in reciprocation of a string of rods in a well, there is a certain amount of "stretch" in such rods due to the liquid in the tubing exerting a resisting force on the rods during the down stroke. In other words, at the bottom of the down stroke there will be slack in the rods and there will be a certain amount of "play" in the up stroke before actual raising of the piston in the pump barrel connected to the bottom of the rods, thus shortening the effective stroke of the pump. The slack in the rods will cause a "whip" therein, and cause "fatigue" of the rods and eventual breakage.

The principal objects of the present invention are, therefore, to provide means in the bottom of the well hole for exerting downward force on the sucker rods to keep them extended or stretched to their full capacity and to provide a device for this purpose, simple, relatively economical, and operating in an efficient manner.

In accomplishing these and other objects of the invention, I have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawing, wherein:

Fig. 1 is a vertical sectional view of part of an oil well equipped with apparatus embodying the features of my invention.

Fig. 2 is an enlarged vertical sectional view particularly illustrating the pump and my apparatus connected to the bottom thereof, for holding the rods in extended position.

Fig. 3 is a cross-section taken on the line 3—3, Fig. 2.

Referring more in detail to the drawing:

1 designates a casing which extends through the bore hole of an oil well or the like from the surface of the earth to the cap rock 2 above the producing formation and shot hole 3. 4 designates a tubing which extends through the casing from a point slightly above the top thereof, to near the bottom of said casing.

A string of sucker rods 5 is adapted to reciprocate in the tubing having a pump 6 connected to the bottom of the tubing. The top of the string of rods is connected to the usual polish rod 7 extending through a stuffing box 8 and connected to the usual pumping jack 9. The pump connected to the lower end of the tubing may be of conventional form comprising a barrel 10, standing valve 11, and ball valve 12.

The foregoing is conventional apparatus forming no part of the present invention.

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Located above the surface of the ground I preferably provide a reservoir 13 containing a supply of fluid 14. The reservoir has a pipe 15 leading to the casing 1 and is connected thereto slightly below the surface of the ground as indicated at 16, Fig. 1. Leading from the pipe 15 to the pump 17 is a pipe 18, and leading from the pump 17 back to the reservoir 13 is a pipe 19. The pipe 15 is also provided with a valve 20 having an operating lever or arm 21 adapted to be operated by lugs 22 and 23 on the polish rod 7 as later described.

Located slightly above the cap lock 2 I preferably provide a packer 24 between the casing and tubing for preventing liquid from passing from the space 25 around the tubing inside the casing from entering the casing below the packer. The packer may be of any conventional form but I provide a circumferential flange 26 at the top of the packer integral with the tubing 4 and the bottom thereof being integral with a collar 27 for connecting two sections of the tubing by the screw threads (not numbered). The collar 27 is of a size to extend substantially to the inner wall of the casing, as indicated at 28. I provide a packing or the like 29 which may be of rubber or other suitable material between the enlarged portion of the collar 27 and flange 26 for effectively sealing the packer in the casing. The lower portion of the collar 27 is provided with an internally screw threaded hub 30 adapted to receive a piston chamber 31 connected to the bottom of the packer. Adapted to reciprocate within the chamber 31 is a piston 32 having a rod 33 attached to the upper end thereof, and extending through a central bore opening 34 in the packer 24.

Connected to the sucker rods 5 is a yoke 35 adapted to reciprocate in the pump barrel upon reciprocation of said rods. The lower end of the yoke is connected to the upper end of the piston rod 33 as indicated at 36, Fig. 2. While the upper end of the yoke may be attached to the sucker rods in any suitable manner, I have here shown the yoke as being centrally bored and provided with screw threads adapted to engage with a screw threaded sleeve 37 on the sucker rods. The upper end of the piston rod is provided with screw threads adapted to engage with the lower end of the yoke and be fastened thereto by a lock nut 38. The piston rod may be sealed in the packer in any suitable manner but here shown to be a bushing 39 provided with rubber packing 40 for preventing the flow of oil in the tubing through the piston chamber.

The packer 24 is provided with a plurality of ports 41 leading to the cylinder chamber 31 for

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passage of liquid from around the tubing supplied from the reservoir 13 to the top of the piston chamber 32 as indicated at 42. I also provide a plurality of ports 43 in the collar 27 so that oil may pass from the tubing below the packer to the tubing above the packer and then on up through the tubing and pipe 44 to a source of supply above ground (not shown). A perforated strainer or the like 45 may be attached to the lower end of the tubing if desired, as indicated in Fig. 1.

Operation of the apparatus constructed and assembled as described is as follows:

With the valve 20 closed, the space 25 between the tubing and casing is filled with fluid from the reservoir 13 by the pump 17 through pipe 19, pipe 18, and pipe 15 leading to the casing as illustrated in Fig. 1. The pump 17 is operated by a conventional motor 46 mounted on the base 47 of the pumping jack 9. Pumping of the well is started through reciprocation of the rods by the pumping jack from a suitable source of power (not shown). During down stroke of the rods the valve 20 should be closed. With the valve 20 closed and the pump 17 operating, pressure will be created in the fluid space 25 between the tubing and casing, and continued down stroke of the rods will cause the fluid to flow through ports 41 in the packer 24 to the head of the piston chamber, the fluid pressure exerting a downward force on the piston to keep the rods in stretched position and also causing faster down stroke of the rods. During this down stroke the pump will continue to force fluid from the reservoir to the casing to provide sufficient force to the rods. Just as the rods reach the bottom of the down stroke the lug 22 on the polish rod 7 will contact the lever 21 to open valve 20 to allow fluid pressure on the piston to be relieved and the fluid will flow back to the reservoir 13 on the up stroke of the rods. Just as the rods reach the limit of the up stroke the lug 23 on the polish rod contacts the lever 21 to again close valve 20 for again closing the circuit so that pressure may be exerted again on the down stroke of the rods.

While I have described the pressure means in the reservoir as "fluid," it will be obvious that any liquid may be used, such as water, oil, air or gas.

It will be obvious that this apparatus will provide faster down stroke of the sucker rods so that a faster pumping operation may be effected as well as preventing "whip" of the rods due to slack caused by fluid pressure in the tubing.

What I claim and desire to secure by Letters Patent is:

1. In well pumping equipment of the character described including a string of tubing and sucker rods in said tubing, a packer in said tubing near the bottom thereof, a cylinder connected to said packer, a piston in said cylinder having a rod, means connecting said piston rod to the lower end of the sucker rods and means for supplying pressure to said piston to maintain said rods in stretched position and allow faster down stroke of said rods.

2. In well pumping equipment of the character described including a string of tubing and sucker rods in said tubing, a packer in said tubing near the bottom thereof having ports therein, a cylinder connected to said packer, the top of said cylinder connecting with said ports, a piston in said cylinder having a rod, means connecting said piston rod to the lower end of the sucker

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rods and means for supplying pressure to said piston to maintain said rods in stretched position and allow faster down stroke of said rods.

3. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing having a piston connected to said rods, a packer between said tubing and casing, a cylinder suspended from the lower end of said packer, a piston connected to said pump piston and reciprocable in said cylinder, and means for supplying liquid to said cylinder to exert force on said cylinder to maintain said rods in stretched condition.

4. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing having a piston connected to said rods, a packer between said tubing and casing, a cylinder suspended from the lower end of said packer, a piston connected to said pump piston and reciprocable in said cylinder, means for supplying liquid to said cylinder to exert force on said cylinder to maintain said rods in stretched condition, and means for releasing said pressure on up stroke of said rods.

5. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing having a piston connected with said rods, a packer between said tubing and casing at the lower end of said pump, a cylinder suspended from the lower end of said packer, a piston connected to said pump piston and reciprocable in said cylinder, and means for supplying liquid to said cylinder to exert force on said cylinder to maintain said rods in stretched condition, means for releasing said pressure on up stroke of the pump, and means in said packer for passage of oil therethrough to said pump.

6. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing having a piston connected to said rods, a packer between said tubing and casing, a cylinder suspended from the lower end of said packer, a piston connected to said pump piston and reciprocable in said cylinder, a reservoir containing a supply of liquid, and means for supplying liquid to said cylinder to exert force on said piston to maintain said rods in stretched condition.

7. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing having a piston connected to said rods, a packer between said tubing and casing, a cylinder suspended from the lower end of said packer, a piston connected to said pump piston and reciprocable in said cylinder, a reservoir containing a supply of liquid, means for supplying liquid to said cylinder to exert force on said piston to maintain said rods in stretched condition, and means releasing said pressure on upstroke of said pump.

8. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing, a packer between said tubing and casing having ports therein, a cylinder suspended from the lower end of said packer and connecting with said ports, a piston connected to said rods and reciprocable in said cylinder, a reservoir containing a supply of liquid, and means for supplying liquid to said cylinder to exert force

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on said piston on the down stroke of said pump.

9. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing, a picker between said tubing and casing, a cylinder suspended from the lower end of said packer, said packer having ports connecting with said cylinder, a piston connected to said rods reciprocable in said cylinder, a yoke connecting said piston to said rods, a reservoir containing a supply of liquid, and means for supplying liquid to said cylinder to exert force on said piston to maintain said rods in stretched condition.

10. In well pumping apparatus including a casing, tubing in said casing, a string of sucker rods reciprocable in said tubing, a pump on the lower end of said tubing, a packer between said tubing and casing, a cylinder suspended from the lower

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end of said packer, said packer having ports connecting with said cylinder, a piston connected to said rods and reciprocable in said cylinder, a liquid reservoir, including a line leading to said casing, means for supplying liquid to said cylinder to exert force on said cylinder to maintain said rods in stretched condition, and a valve in said line for releasing pressure on said piston on upstroke of said pump.

ARCHIE G. SMITH.

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| 26,580 | Great Britain | ----- 1902 |

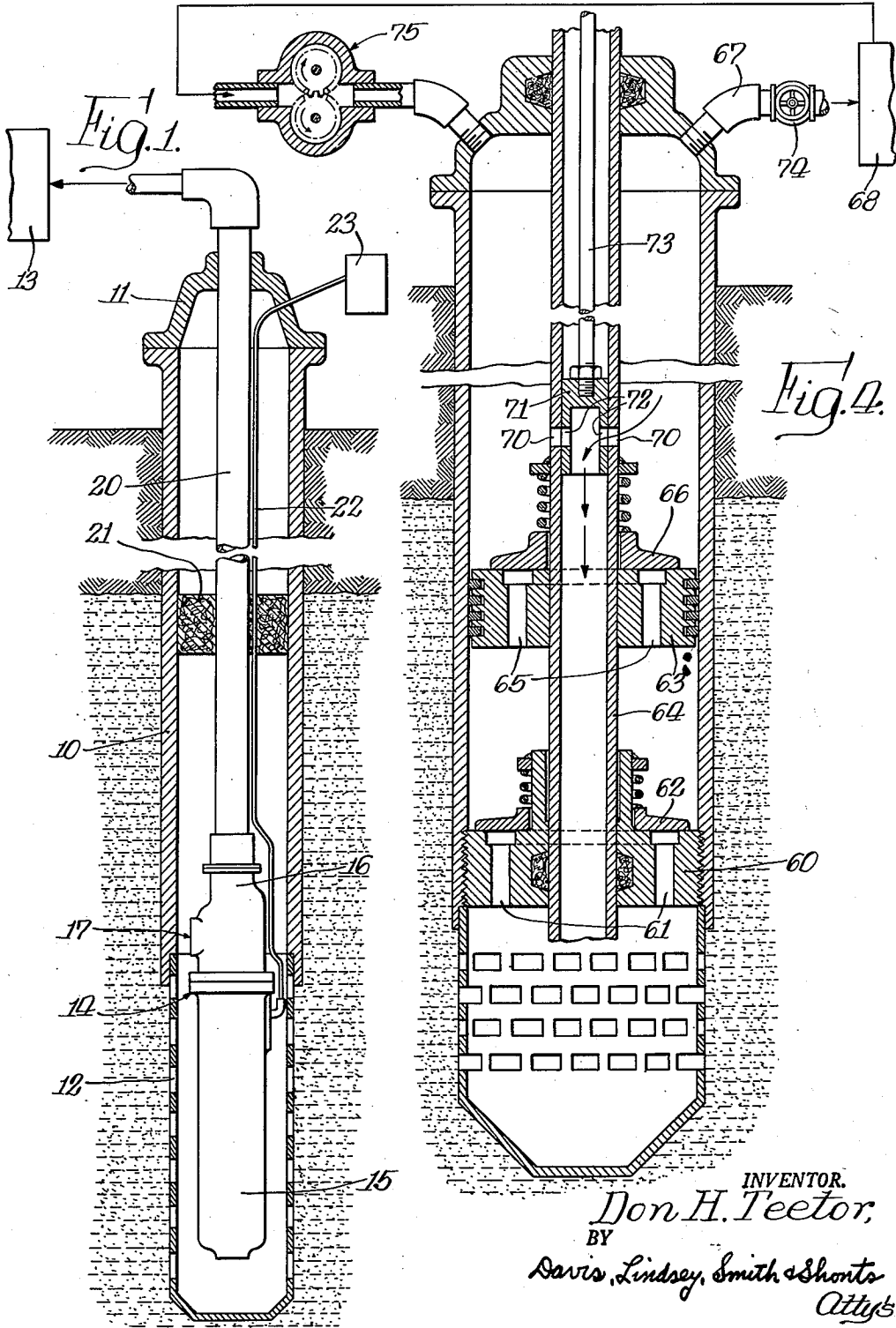
Dec. 25, 1951

D. H. TEETOR  
PUMPING APPARATUS

2,580,331

Filed Nov. 22, 1946

2 SHEETS—SHEET 1



INVENTOR.  
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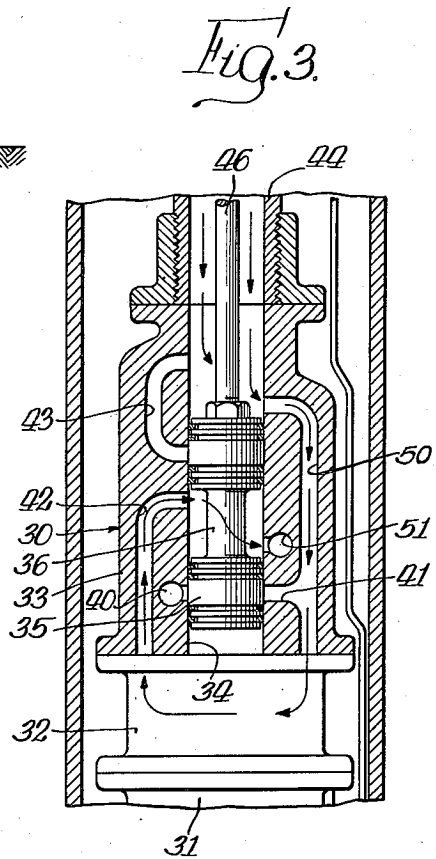
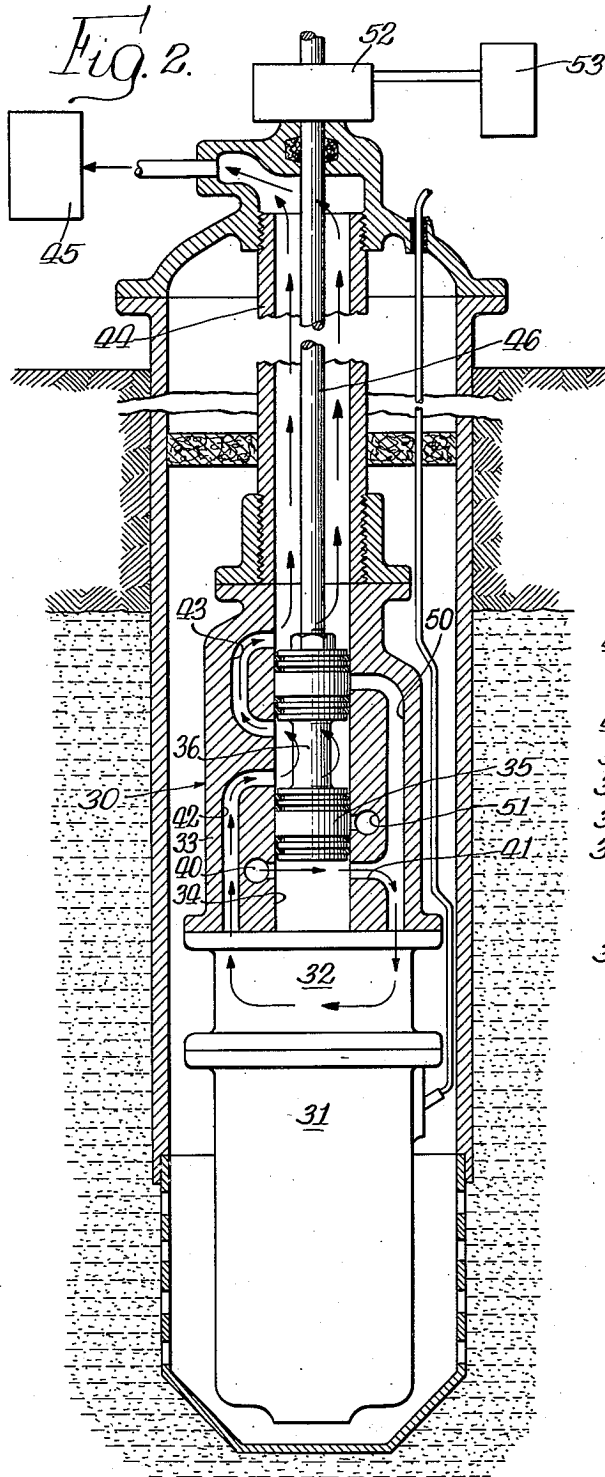
Dec. 25, 1951

D. H. TEETOR  
PUMPING APPARATUS

2,580,331

Filed Nov. 22, 1946

2 SHEETS—SHEET 2



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# UNITED STATES PATENT OFFICE

2,580,331

## PUMPING APPARATUS

Don H. Teeter, Hagerstown, Ind.

Application November 22, 1946, Serial No. 711,582

8 Claims. (Cl. 103—3)

1

The invention relates generally to pumping apparatus for use in wells and more particularly to such apparatus used in connection with oil wells.

In small oil wells where the oil has to be removed by pumping, a type of pumping apparatus frequently employed comprises a casing extending to the bottom of the well and having an intake at its lower end which may comprise a slotted or perforated pipe or a screen to prevent solid material from being drawn into the apparatus or which may open in case the adjacent earth formation is sufficiently tight. Located in the lower end of the casing is a reciprocating pump operated by a sucker rod extending upwardly through the casing and mechanically actuated above ground. Such mode of operation is obviously inefficient.

With wells of this character, the sand or other earth formations at the bottom of the well may become clogged, through age, to such an extent that the yield is too low to warrant further continued operation. The well must therefore either be abandoned or cleaned. Cleaning may be effected by forcing water, acids, or other fluid into the sand formation to remove the obstructing material in the vicinity of the lower end of the casing and thus permit the oil to flow freely.

Heretofore, in so cleaning a well, the pump with its sucker rod is removed since no provision is made for carrying fluid reversely through the reciprocating pump, and a temporary pipe is inserted in the casing to carry the cleaning fluid under pressure to the lower end thereof. After the cleaning has been completed, the temporary pipe is removed and the pump with its sucker rod is reinserted. Obviously such a mode of cleaning involves considerable expense, and in many cases it is questionable whether, when the production of the well at best is small, the expense is warranted.

The general object of the invention is therefore to provide novel pumping apparatus for a well, with which the well may be readily maintained in a clean, free-flowing condition at relatively small expense.

Another object is to provide novel pumping apparatus for a well, through which fluid may be reversely conducted to effect cleaning of the intake of the apparatus as well as the sand formations in the vicinity of the intake.

A further object is to provide novel pumping apparatus for a well, which includes a timer for automatically reversing the flow in the apparatus at predetermined intervals to remove

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obstructions to flow to and through the intake of the apparatus.

Still another object is to provide novel pumping apparatus for an oil well, which may be reversely operated to produce a flow from or to the well, the apparatus normally being operated to pump oil from the well but being operable at predetermined intervals to pump oil to the well under pressure to effect cleaning of the intake and the sand formations in the vicinity thereof.

A still further object is to provide a novel method of maintaining an oil well in a clean free-flowing condition.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a vertical sectional view, partially diagrammatic, of a pumping apparatus embodying the features of the invention;

Fig. 2 is a view similar to Fig. 1 but showing a modified form of apparatus, with the parts of the apparatus in position for producing a normal flow of oil;

Fig. 3 is a fragmentary view showing the modified form of Fig. 2 but with the parts in position for producing a reverse flow of oil; and

Fig. 4 is a view similar to Figs. 1 and 2 but showing another modified form of apparatus.

In the usual form of apparatus utilized for pumping oil, an elongated tubular casing is provided, extending from the ground level to the bottom of the well, such a casing being shown at 10 in Fig. 1. The upper end of the casing may be closed by a cover 11 while the lower end constitutes an intake 12 embedded in the sand or other earth formation from which the oil is obtained and which may be open if the adjacent earth formation is sufficiently tight, or which may comprise a slotted or perforated pipe or screen. In the drawings, the intake 12 is shown in the form of a screen. The oil is drawn inwardly through the intake 12 and forced upwardly to the ground level by a pumping unit located in the casing 10, where it may be collected as in a tank 13.

In the mode of operation heretofore commonly employed, such pumping continues indefinitely, and as a result obstructions to flow will occur in the sand formation adjacent the intake and, if the intake is in the form of a pipe or screen, material will collect on the exterior thereof to such an extent that production of the well will be lowered below the point where its operation

is warranted. At such time, if the well is thought to be capable of continued production, the well is cleaned as described above and operation is thereafter continued. The cost of such cleaning is relatively large, however, and if the maximum production of the well is small, such cleaning is not undertaken and the well is abandoned.

The present invention provides apparatus which maintains the intake and the surrounding sand formation in a clean free-flowing condition. This result is attained by periodic interruption of the normal flow which causes the collection of obstructions, and effecting a reverse flow, preferably of the oil itself, through the apparatus so that obstructions to flow inwardly through the intake as well as in the sand formation are cleared away and normal flow can thereafter be resumed. While other liquids than oil could, of course, be employed for the reverse flow, oil from the well itself is preferred since no problem of separation is thereby involved. The periodic reversal occurs at sufficiently short intervals to prevent a large accumulation or solidifying of obstructing material and the reverse flow may therefore be maintained for a relatively short period of time, leaving the major portion of time available for productive pumping.

In the form of apparatus shown in Fig. 1 of the drawings, I provide a pumping unit indicated generally at 14 and comprising a motor 15 and a pump 16. Both of these are of a reversible type. Thus, the motor may be of a well known type adapted to be reversely operated by reversal of the connections therefor, and the pump may be of the gear type which is operable in opposite directions to produce opposite directions of flow. The motor and pump in the present instance are constructed with proper dimension to permit their insertion into the casing 10, the unit being located adjacent the lower end thereof with space between the unit and the casing and intake to provide an intake reservoir. The pump is provided with an opening indicated at 17, which normally serves as an intake through which oil is drawn from the reservoir. The oil delivered by the pump during normal flow is carried upwardly through a delivery pipe 20 which may extend through the cover 11 and to the tank 13. A packer 21 may be placed in the lower part of the casing 10 a short distance above the pump unit, segregating the intake reservoir from the upper portion of the casing so that a decreased pressure may be induced in the reservoir by the pump to draw oil from the surrounding earth formation inwardly through the intake 12. The wiring connections for the motor 15, indicated at 22, may extend upwardly to the ground level in the space between the delivery pipe 20 and the wall of the casing for connection with a source of current (not shown).

Obviously, continued operation of the pumping unit in a direction to draw oil inwardly through the intake 12 will result in clogging of the earth formation in the vicinity thereof and of the openings in the screen, if that form of intake is employed, by material from the surrounding area. However, reversal of flow, particularly if the reverse flow is under pressure, will clear away such obstructions and reestablish conditions suitable for free inward flow. Thus, by operating the motor 15 and pump 16 in the reverse direction from that required to produce the normal flow, oil from the tank 13 may be drawn downwardly through the pipe 20 and forced under pressure into the reservoir space below the packer 21.

Such packer being adjacent the lower end of the casing permits a rapid building up of pressure in the reservoir, depending upon the extent of clogging, and the oil will be forced outwardly through the intake to remove the obstructions therefrom. The reversal of the motor and pump may be easily effected by suitable switching means in the wiring connections 22 at the ground level.

The maintenance of a free-flowing condition for the well is better attained if the reversal of flow is effected periodically and at relatively short intervals of time. While the apparatus may of course be controlled manually to attain this result, it is preferably controlled by an automatic timing device indicated diagrammatically at 23. The timing device 23 includes switch means for effecting a current reversal at predetermined intervals, the reversal being maintained for the desired period of time. The time of reverse operation may be considerably less than the time during which normal operation occurs so that the major portion of time is spent in productive operation, the flow during such period being maintained at a high rate because of the riddance of any substantial clogging.

In the modified form of apparatus shown in Figs. 2 and 3, the pumping unit is generally the same as that shown in Fig. 1, but in this instance the motor and pump are operated constantly in the same direction and a valve means, indicated generally at 30, is provided for reversing the flow. Thus, I provide a motor 31 and pump 32, both of which may be adapted only for one direction of operation. The valve means 30 is preferably mounted above the pump 32 and comprises a valve body 33 having a central vertically extending valve chamber 34 in which a valve member 35 is slidably mounted. The valve member 35 in this instance is of the spool type and has an intermediate section 36 of reduced diameter.

The valve body 33 is provided with an intake port 40 communicating with the reservoir space in the lower end of the casing and with the valve chamber 34. During normal flow, oil enters through the intake port 40, passes through the lower end of chamber 34 and then through a passage 41 to the pump, as indicated by the arrows in Fig. 2.

From the pump, oil is delivered into a passage 42 carrying it to the portion of the chamber 34 where the reduced portion 36 is then located. From this portion of the chamber 34, the oil is carried through a passage 43 around the upper end of the member 35 and discharged into a delivery pipe 44 preferably aligned with valve chamber 34 and communicating at its upper end with a tank 45. To actuate the valve member 35, a rod 46 is connected to the upper end thereof and extends upwardly through the pipe 44 to the ground level.

For reverse flow, the valve member 35 is adapted to be shifted downwardly to the position shown in Fig. 3. In this position, with the pump operating in the same direction, oil is drawn downwardly from the pipe 44 through a passage 50 in the valve body 33 and is delivered by the pump into the passage 42. Because of the location of the reduced portion 36 of the valve member 35, oil will pass from the passage 42 transversely through the chamber 34 and to an outlet port 51 for discharge under pressure into the reservoir space in the lower end of the casing.

To shift the valve member 35 between its two



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positions described above, the valve rod 46 may be provided with shifting means indicated diagrammatically at 52. The shifting means 52 may be arranged for manual control or for automatic control by a timing device indicated at 53 or for both. The apparatus shown in these two figures thus may be operated to produce a normal flow drawing oil inwardly through the intake at the lower end of the casing and forcing it upwardly to the tank 45, and may be reversed by shifting the valve member 35 to cause a flow from the tank with the oil forced under pressure by the pump into the reservoir space in the lower end of the casing and outwardly through the intake to remove obstructions therefrom.

The embodiment shown in Fig. 4 utilizes a reciprocable pump unit somewhat similar to that heretofore employed but modified to provide for the reverse flow. The pump unit in this instance comprises a cap 60 secured in the lower end of the casing or cylinder. The cap 60 is provided with a plurality of ports 61 adapted to be closed by a spring actuated disc valve 62. Located above the cap 60 is a piston 63 adapted to be reciprocated in the cylinder or casing by a piston rod 64 extending upwardly through the casing to the ground level for connection with a source of power (not shown). The piston 63 is provided with a plurality of ports 65 adapted to be closed by a spring actuated disc valve 66.

In the normal action of this unit to produce a flow of oil from the well to the tank, assuming that the piston 63 is at the lower end of its stroke, upward movement of the piston produces a suction lifting the spring valve 62 and drawing oil inwardly through the intake at the lower end of the casing and upwardly through the ports 61 into the space between the cap 60 and piston 63. On the down stroke of the piston, valve 62 closes and the oil in the space between the cap and piston is forced upwardly through the ports 65 in the piston to lift the valve 66 and thence in to the space above the piston. On the next up stroke, the oil above the piston is lifted in the cylinder, since the valve 66 is then closed, and more oil is drawn into the space below the piston. After a number of strokes, the cylinder thus becomes filled and the oil is forced outwardly from the top thereof through a pipe 67 to a tank 68.

The foregoing structure is arranged to provide for reverse flow whereby oil from the tank 68 may be forced outwardly through the intake at the lower end of the cylinder. To this end, the piston rod 64 is made tubular and is provided with transverse apertures 70 at a point adjacent but above the piston 63, thus providing communication between the interior of the piston rod and the interior of the casing or cylinder. The piston rod extends downwardly through the cap 60 so that it is guided thereby and its lower end opens into the space within the screen. Mounted within the piston rod is a flushing valve 71 for controlling the flow through the apertures 70. In the present instance, the valve 71 is cup-shaped and is provided with lateral apertures 72 adapted to be moved into and out of registration with the apertures 70, as by rotation. To rotate the valve 71, a rod 73 is connected thereto, which extends upwardly through the piston rod to the ground level.

In operation, if the obstructions clogging the intake can be removed by an oil pressure equal to the head due to the column of oil in the cylinder and the tank 68, then the valve 71 is rotated to align the apertures 70 and 72, and the oil will

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flow from the interior of the cylinder through the apertures 70 and 72 downwardly through the piston rod into the interior of the intake and thence outwardly therethrough to remove obstructions therefrom. The pressure of the oil may be sufficient to lift the disc valve 62, but disc valve 63 will remain seated, since substantially the same pressure will be applied to the top as to the bottom thereof.

In the present form, means may also be provided for creating a reverse flow of even greater pressure than the head provided by the casing and the tank. To this end, the pipe 67 leading to the tank 68 is provided with a shut-off valve 74. Connected to the tank is a pressure pump 75 adapted to discharge oil under pressure into the upper end of the casing when the shut-off valve 74 is closed. Thus a greater pressure can be built up within the casing than that provided by the column of oil in the casing and tank, so that thorough flushing of the intake can be accomplished. The apparatus illustrated in this figure may of course be provided with means for automatically effecting the reversal of flow. Thus a timing device may be provided for automatically stopping the reciprocation of the piston and then opening the flushing valve 71, closing the shut-off valve 74 and starting the pump 75. As in the case of the other forms, such reversal may be continued for a short period of time and then the normal flow resumed.

I claim:

1. Pumping apparatus for an oil-well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, and a pump unit mounted in said casing adjacent the lower end thereof and being normally operable to create a flow of oil drawn through said intake into the lower end of said casing and delivered upwardly through said casing to the ground level, said unit having a pipe extending upwardly through said casing, and valve means shiftably mounted adjacent the lower end of said casing to provide for reverse flow through said unit, said valve means having an operating member extending upwardly through said pipe to the ground level.

2. Pumping apparatus for an oil well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, a pump unit mounted in the lower end of said casing comprising a motor, a pump, a valve member controlling the inlet and delivery of said pump, and a delivery pipe extending from said valve member to the ground level, said unit being normally adapted to draw oil inwardly through said intake and deliver it upwardly through said pipe, and means for shifting said valve means to cause said pump unit to draw oil downwardly through said pipe and force it outwardly through said intake to remove obstructions therefrom.

3. Pumping apparatus for an oil well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, and a pump unit mounted in the lower end of said casing comprising a motor, a rotary pump driven by said motor, a delivery pipe extending to the ground level, shiftable valve means connected to said delivery pipe and to said pump and adapted when in one position to cause said pump to draw oil through said intake and force it upwardly through said pipe and in another position to cause said pump to draw oil downwardly through said pipe and force

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it outwardly through said intake to remove obstructions therefrom, and a valve operating rod extending upwardly through said pipe to the ground level.

4. Pumping apparatus for an oil well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, and a pump unit mounted in the lower end of said casing and having a delivery pipe extending upwardly through said casing to the ground level, said pump comprising a motor, a rotary pump driven by said motor, and valve means comprising a valve casing having a valve chamber aligned with said pipe and intake and outlet passages, a valve member slidably mounted in said chamber and adapted when in one position to cause said pump to draw oil inwardly through said intake and force it upwardly from said pipe and in another position to draw oil downwardly through said pipe and force it outwardly through said intake to remove obstructions therefrom, and a rod extending upwardly from said valve member through said pipe for shifting said member from one position to the other.

5. Pumping apparatus for an oil well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, a pump unit mounted in the lower end of said casing and including a piston reciprocable in said casing, a piston rod extending upwardly to the ground level, said unit being normally operable to draw oil inwardly through said intake and force it upwardly through said casing to the ground level, said piston rod being tubular and having an aperture located above said piston providing communication to the rod from the interior of said casing, and a shiftable valve for closing said aperture during normal operation of said unit, and means for forcing oil from the ground level through said casing and said piston rod, when said valve is shifted, into the lower end of said casing and thence outwardly through said intake to remove obstructions therefrom.

6. Pumping apparatus for an oil well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, a tank at the ground level, a piston pump mounted in the lower end of said casing and normally operable to draw oil inwardly through said intake and force it upwardly through said casing to said tank, said pump including a tubular piston rod communicating at its lower end with the lower end of said casing below said unit and having an opening to the upper part of the casing above said unit, and a flushing valve controlling said opening, a shut-off valve for controlling communication between said casing and said tank, and a pump for delivering oil under pressure from said tank through said casing and said piston, when said shut-off valve is closed and said flushing valve is open, to the lower end of said casing to force it outwardly

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through said intake to remove obstructions therefrom.

7. Pumping apparatus for an oil well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, a tank connected to the upper end and provided with a shut-off valve, a pump unit comprising a ported cap fixed in the lower end of said casing and having a spring-operated valve for closing the ports thereof, a ported piston mounted in the lower end of said casing and having a spring-operated valve for closing the ports thereof, a tubular piston rod connected to said piston and extending from the upper end of said casing downwardly through said cap with its lower end open, said piston rod having lateral apertures above said piston, a flushing valve mounted in said piston rod for opening and closing said apertures and closing said piston rod above said apertures, and an operating rod for said flushing valve extending upwardly through said piston rod, and a pressure pump connected to the upper end of said casing for delivering oil from said tank to said casing, when said shut-off valve is closed and said flushing valve is open, whereby said oil passes through the lower end of said piston rod into the lower end of said casing below said cap and is forced outwardly through said intake to remove obstructions therefrom.

8. Pumping apparatus for an oil well comprising a casing adapted to extend from the ground level to the bottom of the well and having an intake at its lower end, and a pump unit mounted in the lower end of said casing, and having a delivery pipe extending upwardly through said casing to the ground level, said pump unit comprising a motor, a rotary pump driven by said motor and having an inlet and an outlet, and valve means comprising a casing having a chamber communicating with the casing intake and with the delivery pipe and also with the inlet and outlet of said means, and a shiftable valve member in said chamber adapted in one position to connect the pump inlet with casing intake and to connect the pump outlet with the delivery pipe, and in another position to connect the pump inlet with the delivery pipe and the pump outlet to the casing intake to pump oil under pressure into the casing intake to clear obstructions therefrom.

DON H. TEETOR.

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[54] SEALING MEANS FOR DEEP-WELL 3,721,296 3/1973 Tubbs ..... 166/106

[76] Inventor: Carlos Mayer Ortiz, Blas Pascal  
135-1002, Mexico City, Mexico

Primary Examiner—James A. Leppink  
Attorney, Agent, or Firm—Anthony A. O'Brien

[22] Filed: Feb. 4, 1974

[21] Appl. No.: 439,040

[57] ABSTRACT

[52] U.S. Cl. .... 166/68.5; 166/106

[51] Int. Cl. .... E21b 43/00

[58] Field of Search ..... 166/68.5, 68, 127, 191,  
166/106; 285/302

A sealing means to be employed to seal a wall section of a deep-well is disclosed. Said sealing means is formed by a seal carrier, solidary of the upper end of the pump; an outer sealing element carried by said carrier and covering this latter; O-ring means at said carrier; an elastic seal coupled to said outer sealing element; all of these constituting a lower end seal; and an upper end seal of resilient nature, and formed by the same elements as the lower one. Said sealing means are suitable to seal and isolate said wall section in order this to be used as the discharge conductor for said well.

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7 Claims, 2 Drawing Figures

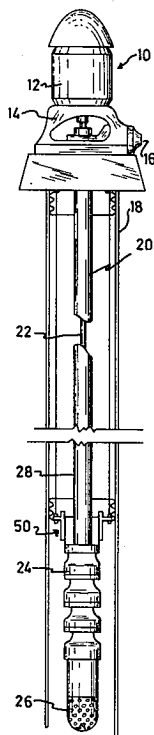


FIG. 2

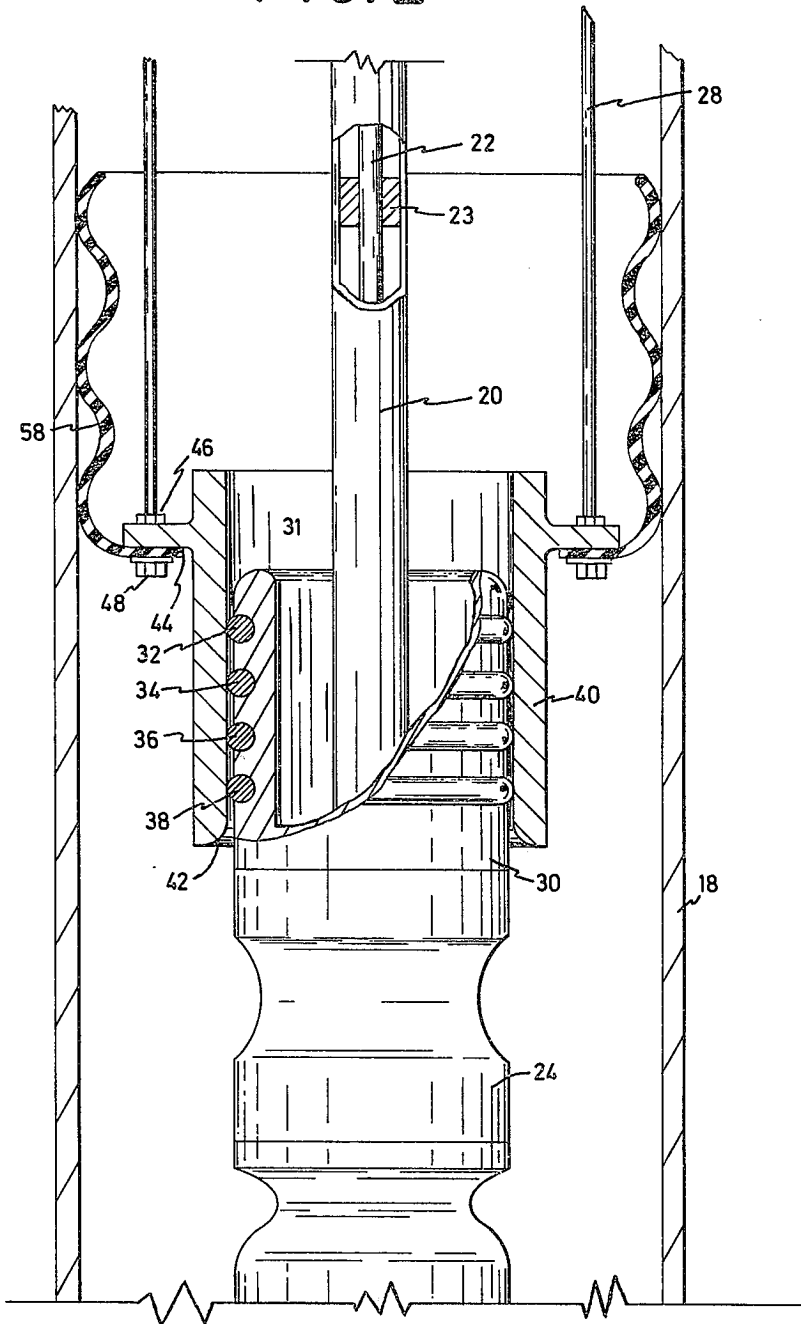
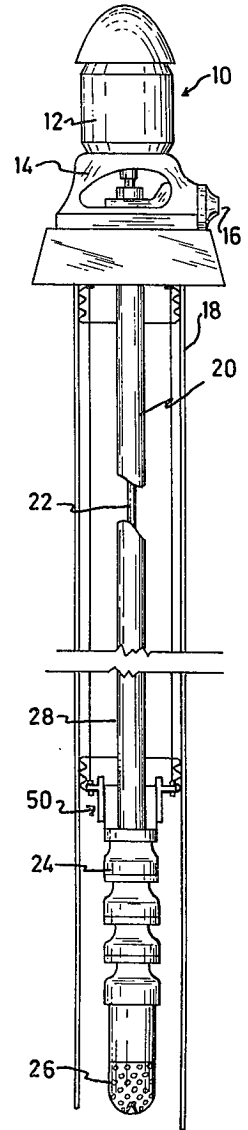


FIG. 1



## SEALING MEANS FOR DEEP-WELL

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

This invention relates to deep-wells. More particularly it refers to a means for sealing a wall section of said well in order to avoid the need of a highly-costly discharge casing string.

## 2. The Prior Art

Recently a system has been developed by means of which the discharge casing string of a deep-well pump can be dispensed with, by providing for the sealing of a portion of the wall, so as this can be used as the discharge conduct for the well. The seals capable of being used in said application, must be provided with certain requirements, e.g. they must effectively isolate the wall portion of the well to be employed as the discharge casing, whereby they must be capable of establishing a firm and tight contact with said wall, irrespective of the unevenness or nonuniformities of said wall. Likewise, when using together with the upper portion of the pump, they must be perfectly tight, so as constitute really a seal against any leakage of fluid and, furthermore, must be capable of supporting the weight of the water column formed on said seal, and withstand the stress thus imparted without breaking or otherwise destroying the shape and condition of said seal.

## CROSS-REFERENCE TO RELATED APPLICATION

This invention is partially related to the invention of the U.S. Pat. copending application Ser. No. 439,041 filed concurrently herewith in the name of the same inventor, and entitled "A System of Suppressing the Discharge Casing String in Deep-Well Vertical Pumps," the disclosure of which is incorporated herein by reference.

## SUMMARY OF THE INVENTION

The instant invention deals with sealing means to be employed with the system of the above referred to U.S. application, as the top seal and the lower seal of the well, so as to isolate a wall section. Therefore, the invention provides sealing means and a supporting means therefor in order to reinforce said sealing means to provide for the maintaining of a good seal, even when the maximum weight of fluid is gravitating on said seal.

## BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a sectional view of a deep-well pump, carrying the seal of this invention; and

FIG. 2 is a partially sectional view, magnified, showing the seal of this invention as employed in the pump depicted in FIG. 1.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

In general, this invention provides, at the same time, a highly effective sealing means for the lower part of the string of a deep-well pump, and the sealing means for the top thereof, suitable to connect the fluid extracting conduct to the wall of the well, in a tight-way; a coupling system of said seal to said pump, and a coupling system of said seal to the wellhead, so as said seals can maintain the sealing capacity thereof irrespective of the stresses imposed thereon by the weight of the fluid column.

Thus, in FIG. 1 a pump 10 is shown consisting of a motor 12, supported on the wellhead 14, wherein there is also a discharge mouth 16, in fluid-communication with the inside of the well. From said motor 12, a tubing string projects consisting of a supporting sheath 20, inside which there is a shaft 22 transmitting the power from motor 12 to a pump 24, by means of which the fluid of the well will be suctioned at the suction end 26. On the other side, the wellhead 14 is arranged to cover the wellhole, formed by a circular wall 18, impermeable in a grade enough to be employed in lieu of the current discharge casing string.

According to the teachings of the above identified application, a top sealing means (not shown) is provided, so as to reduce the opening of the wellhole, at the top end thereof, to just an opening corresponding to the size of the passing conduct located at the wellhead (not shown) and in direct communication with the discharge mouth 16, in order said pumped fluid from the well goes through that only exit through said conduct and mouth. Likewise, a lower end is provided, identified generally by numeral 50, and arranged to limit by the lower end, the wall of the well in a point corresponding to the uppermost edge of said pump 24, all in a manner most clearly shown in FIG. 2.

Referring to FIG. 2, a pump 24 is supported from a string formed by said sheath 20 carrying internally a shaft 22 supported thereinto by bearing 23. The upper end of said pump 24 is provided with a seal-carrier 30, solidary and firmly connected to said pump 24, and arranged to carry a plurality of seals of the O-ring type 32, 34, 36 and 38, carried in suitable slots in the exterior of said seal carrier 30. The upper end 31 of said carrier is rounded in order to make easy the introduction of said carrier within the outer seal or outer sealing device 40.

Said outer seal 40, shown in the preferred embodiment as a cylindrical seal, can be contacted with the exterior of said carrier 30, by means of said plurality of O-rings 32-38 and is provided with the lower end thereof 42 internally rounded, in order to make easy also the coupling with said portion. At a certain distance from the upper end, said cylindrical seal 40 has an outer peripheral land 44, extending diametrically outwardly.

Said land 44 is provided with suitable holes so as to allow the pass therethrough of a threaded lower end of a corresponding plurality of supports, e.g., cables, rods or beams, identified by numeral 28, affixed in place by means of nuts and counternuts 46, 48, and thereby the cylindrical seal 40 is supported on said supporting means. Said supports 28, as shown in FIG. 1, run until the wellhead 14, wherein they are fastened by suitable means, in order that said seal 40 remains pending from said wellhead.

Said land 44 also serves as a coupling means between a peripheral resilient seal 58, disposed to be coupled sealingly to said land 44, and fastened by means of a counternut 48 to the respective support, in order to further straighten the coupling thereof. The material from which said seal 58 is made, the shape of which has been shown as a preferred embodiment is outwardly flared, with a sinus shape, must be resilient enough to bear firmly against the wall 18 but, at the same time, must have enough strength to support the weight of the fluid column formed during the pumping of the fluid from the bottom of the well, above the cylindrical seal 40, to

the discharge mouth 16 (FIG. 1). As will be easily understood, the degree of said bearing of the seal 58 against the wall 18 will increase as a response to the weight of the fluid supported as a column above said seal; and this fact will increase the sealing action.

Therefore, on the one side, said O-ring seals 32-38 make a tight joint between said cylindrical seal 40 and said carrier 30; and on the other side, said elastic seal 58 makes a tight joint between said platform 44 and said wall 18. Furthermore, said supports 28 prevent said seal assembly from coming out of place when supported by said cylindrical seal and, therefore, with the resilient seal connected to said land, by said supports from the wellhead, as above discussed.

Although the invention has been described with reference to a pump of the so-called water-or oil-lubricated deep-well pumps, it can be understood that this invention also can be applied to other types of pumps, such as those of the underwater electric motor type, wherein, due to its different construction, makes necessary slight modifications in order to apply this invention to said systems; but the modifications and changes are well within the spirit and scope of the invention.

It will be obvious that changes and modifications can be made relating the above discussed; therefore, any of the herein pointed out must be considered not as limitative but as illustrative only, since the only limits are those imposed by the true spirit of the annexed claims.

What is claimed is:

1. In a sealing means for a wall of a deep-well, a well head, a pump device having an upper end, the sealing means being suitable to connect the wall in a tight manner to the upper end of the pump device, a supporting string supporting the pump device;

a seal carrier means solidarily coupled to the upper end of said pump device and in fluid-flow relationship with the interior thereof;

an outer sealing device arranged to cover said carrier

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means;  
a plurality of O-ring seals carried by said carrier means;

said O-rings being disposed to make a tight joint between said carrier means and said outer sealing device;

an elastic sealing device coupled to said outer sealing device, being disposed to extend from the latter toward the wall of the well, and uniting in a tight manner said outer sealing device and said wall; and elastic sealing means located at the uppermost point of the well; whereby a section of the wall interposed between said elastic sealing means and the wellhead is isolated from the bottom of the well and disposed to be employed as a discharge casing.

2. Sealing means according to claim 1, wherein said outer sealing device is a cylindrical rigid seal.

3. Sealing means according to claim 1, wherein said outer sealing device is formed with an outer peripheral land, extending normal to said sealing device; and with said elastic sealing device being connected thereto.

4. Sealing means according to claim 1, wherein said elastic sealing device comprises a plurality of flared resilient seals.

5. Sealing means according to claim 1, wherein support means are provided supporting said outer sealing device independently from said pump device and said seal carrier means.

6. Sealing means according to claim 5, wherein said outer sealing device is a cylindrical seal; said support means are constituted by a plurality of rods connected to said cylindrical seal.

7. Sealing means according to claim 6, wherein said cylindrical seal includes a land; the coupling of said support means is effected through holes provided at the land of said cylindrical seal, and by the use of suitable fastening elements.

\* \* \* \* \*

[54] FLUID-OPERATED OIL OR WATER WELL PUMP

[76] Inventor: John B. Awerkamp, 720 N. 2nd St., Quincy, Ill. 62301

[21] Appl. No.: 448,719

[22] Filed: Dec. 10, 1982

[51] Int. Cl.<sup>3</sup> ..... F04B 47/08

[52] U.S. Cl. .... 417/404

[58] Field of Search ..... 417/397, 403, 404

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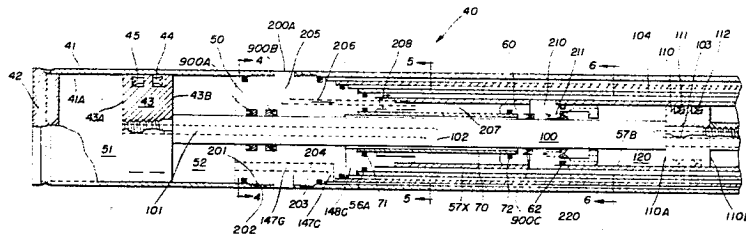
Primary Examiner—Leonard E. Smith  
Attorney, Agent, or Firm—Birch, Stewart, Kolasch & Birch

[57] ABSTRACT

A fluid operated pump for use in a vertical orientation includes an outer casing with a closure member disposed at one end thereof. A piston is operatively mounted for reciprocation within the outer casing and defines a first fluid chamber between the closure member, the outer housing and a first face of the piston. A first casing is provided at a point spaced from the closure of the housing. A second fluid chamber is formed between the outer housing, the first casing and a second

face of the piston. A rod member is operatively disposed for reciprocation within the outer housing. The first piston member is affixed to one end of the rod member. A second casing is provided which is spaced at a predetermined distance from the first casing. A chamber is defined between the outer housing and the first and second casings. A plurality of tubes having inner and outer surfaces are disposed within the chamber and define a plurality of fluid passages between the inner and outer surfaces and the first and second casings. A third and fourth casing are operatively positioned at a predetermined distance with respect to each other within an inner tube disposed within said chamber. A working pump chamber is defined between the third and fourth casings and the inner tube. A second piston member is affixed to the rod and is operatively disposed within the working pump chamber. An inlet conduit is in communication with one of said plurality of fluid passages for supplying fluid to said working pump chamber. An outlet conduit is in communication with one of said fluid passages for discharging fluid from the working pump chamber. Pressurized fluid is in communication with at least one of said plurality of fluid passages for selectively supplying fluid to said first and second fluid chambers to impart movement to said first piston member. Imparting movement to said first piston member imparts movement to the rod to reciprocate the second piston member. Reciprocating the second piston member within the working pump chamber supplies fluid to a first working chamber while discharging fluid from a second working chamber.

21 Claims, 18 Drawing Figures



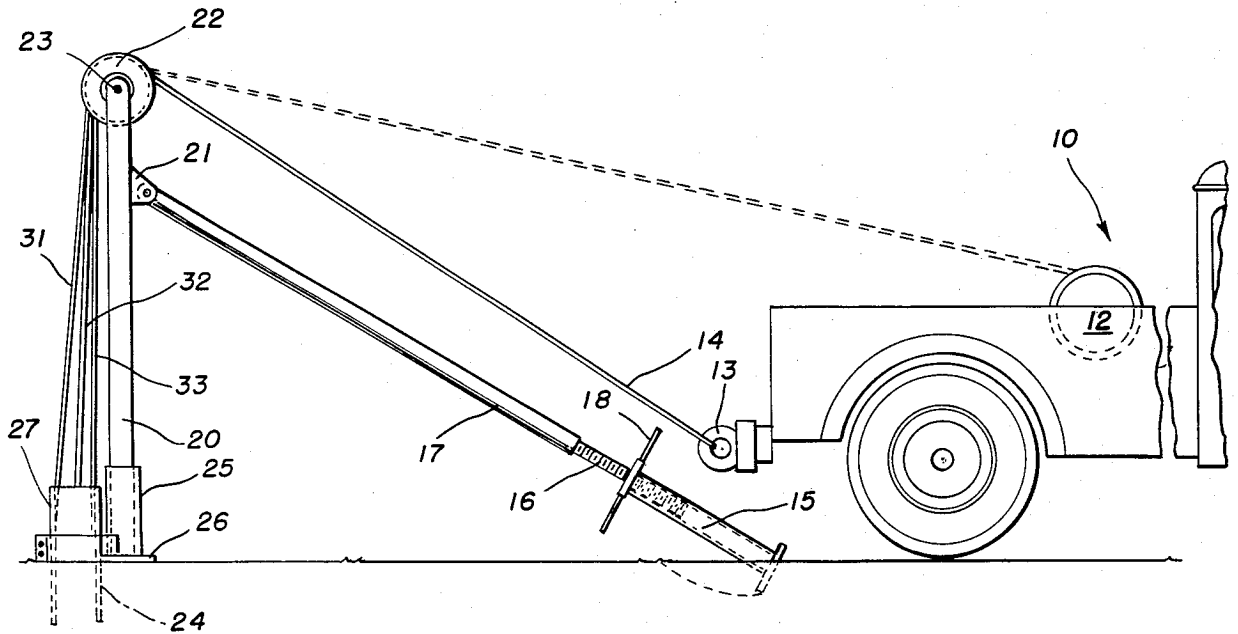


FIG. 1A

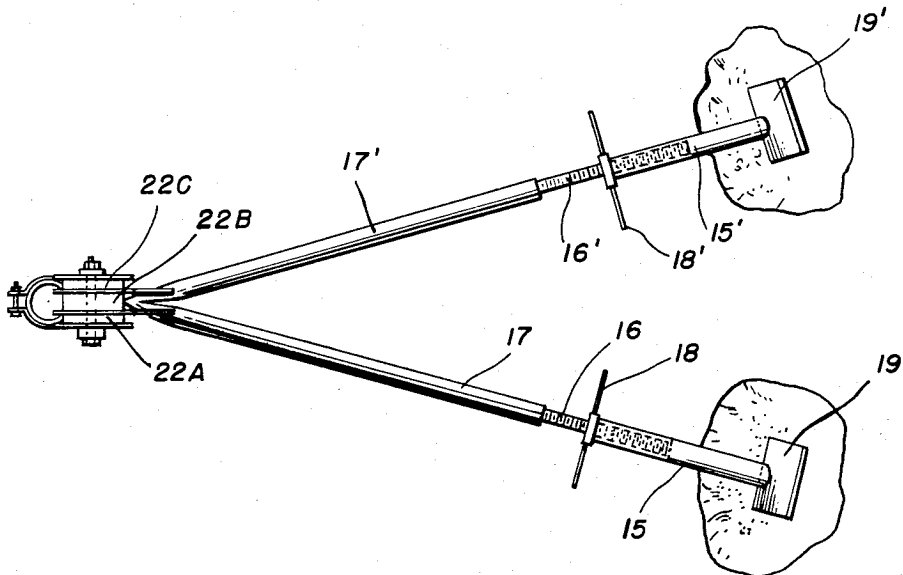


FIG. 1B



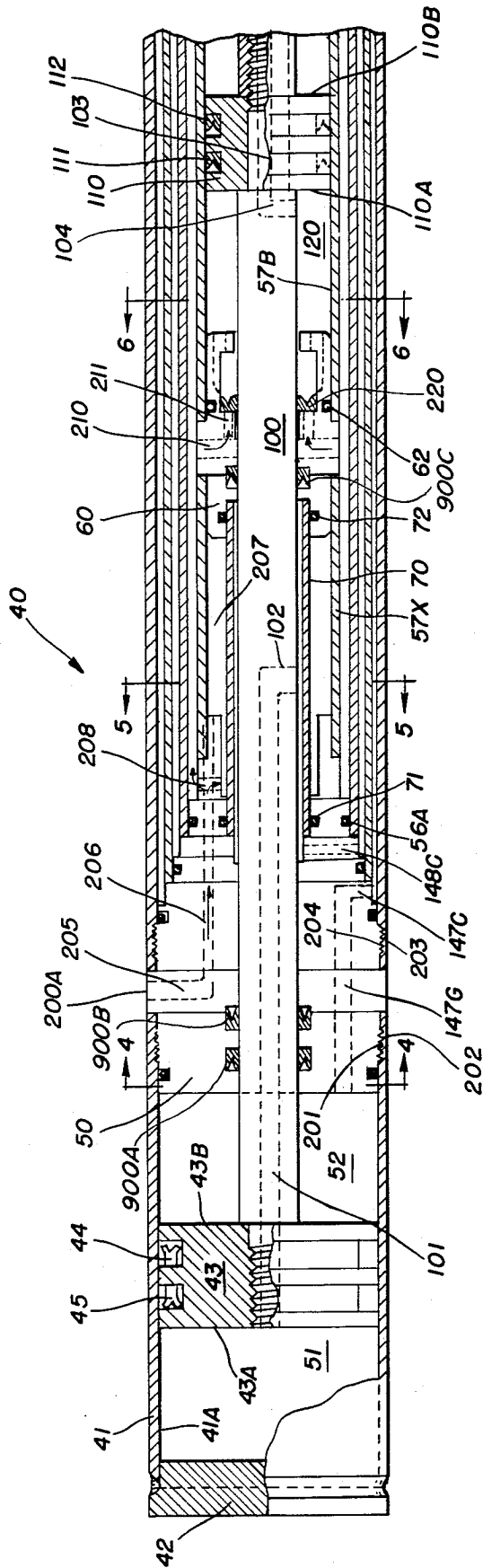


FIG. 2A

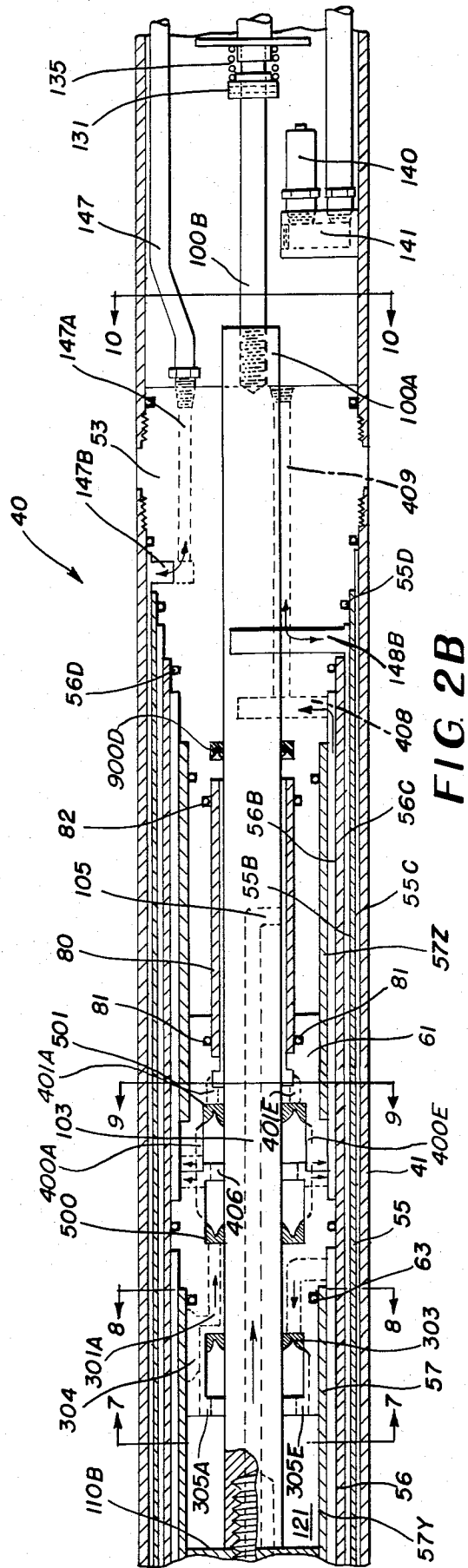


FIG. 2B

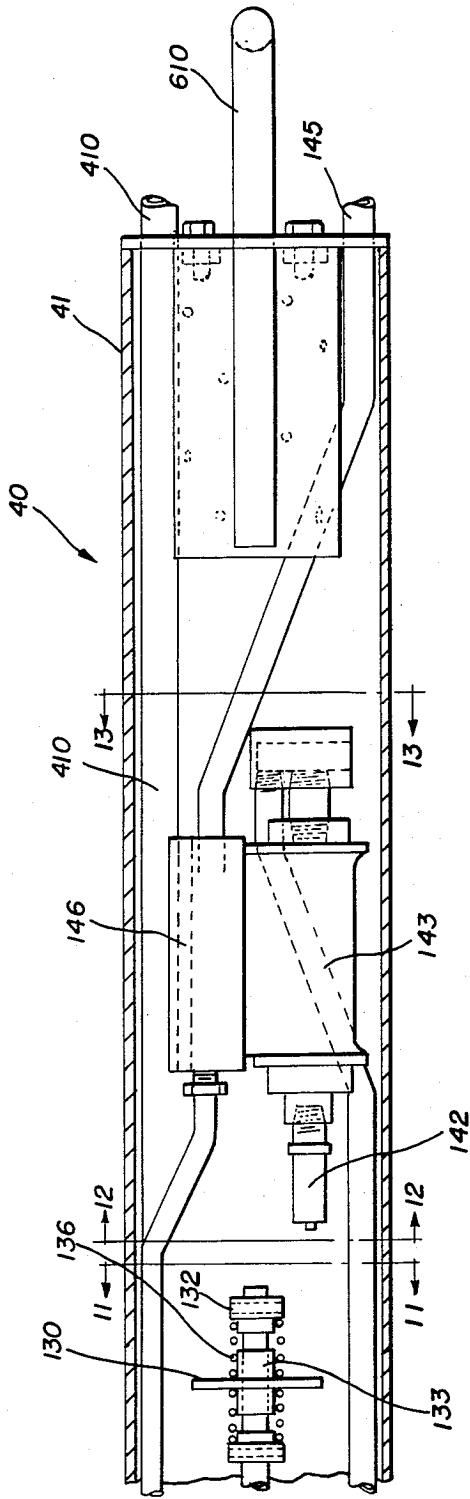


FIG. 2C

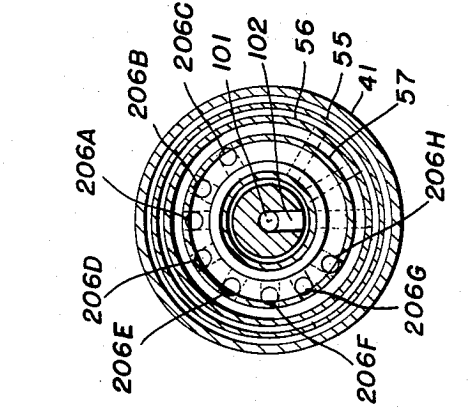


FIG. 5

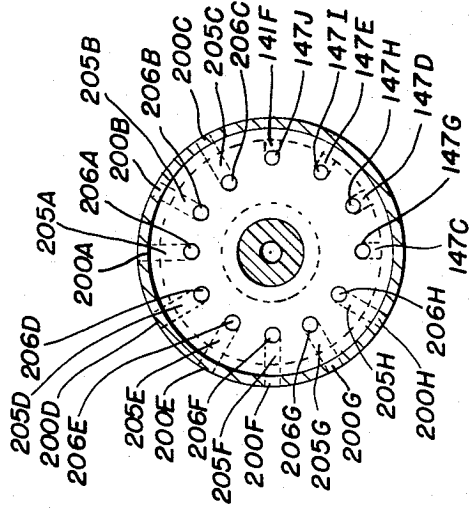


FIG. 4

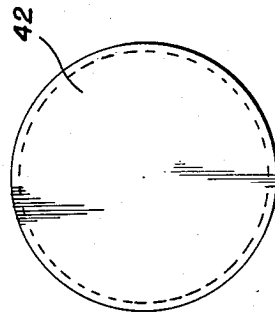


FIG. 3

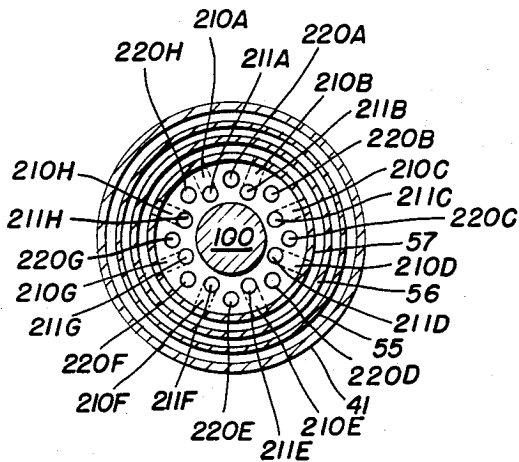


FIG. 6

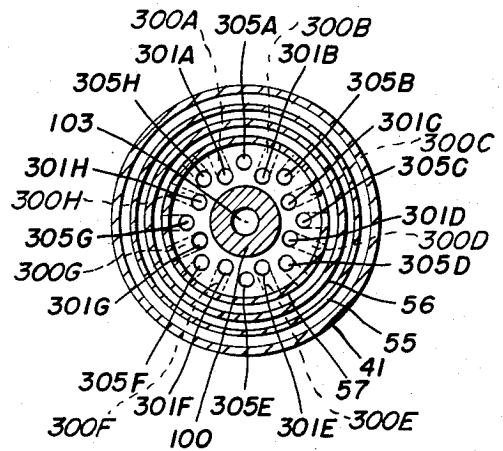


FIG. 7

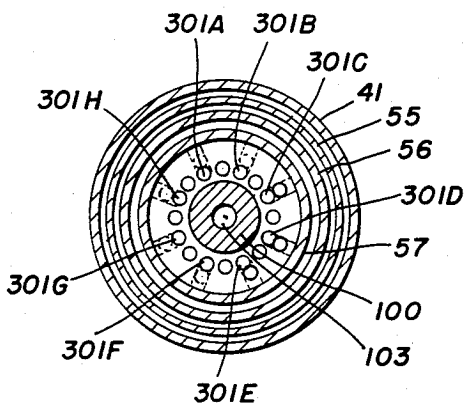


FIG. 8

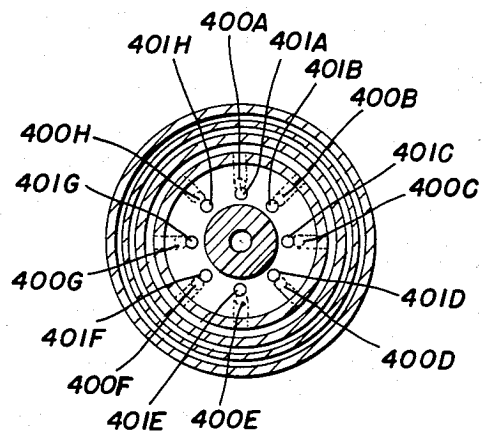


FIG. 9

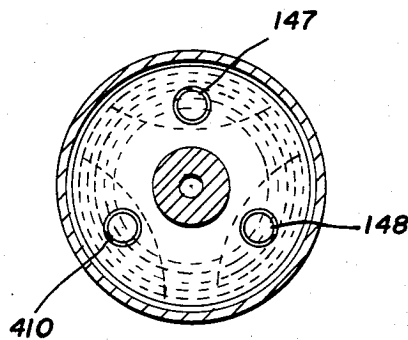


FIG. 10

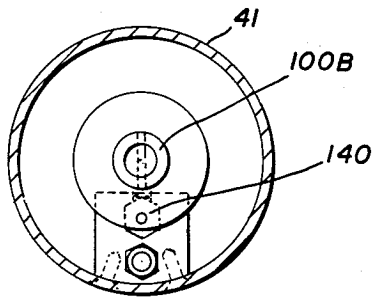


FIG. 11

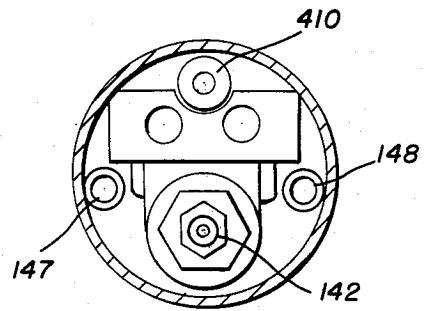


FIG. 12

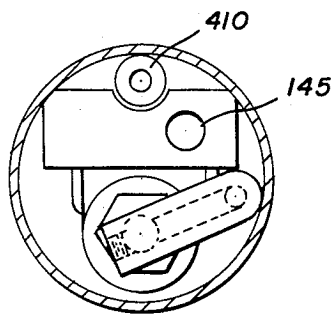


FIG. 13

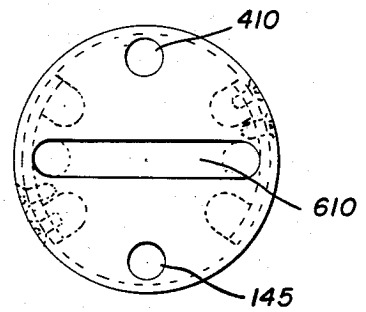


FIG. 14

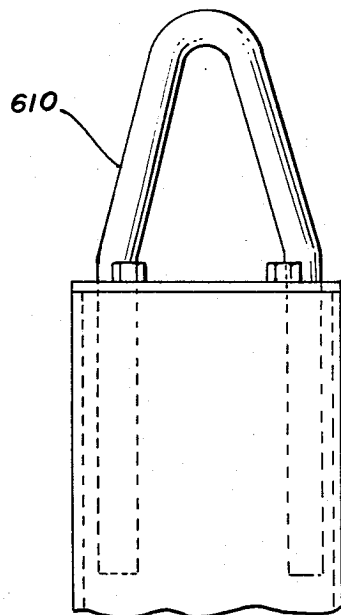


FIG. 15

**FLUID-OPERATED OIL OR WATER WELL PUMP****BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention relates to a fluid operated pump which is adaptable for use in a vertical orientation.

**2. BRIEF DESCRIPTION OF THE PRIOR ART**

Hitherto, it has been difficult to pump fluid from a vertical well. Prior art pumps have not been successfully developed for pumping either oil or water from a well casing when the pump is positioned in a vertical orientation.

**SUMMARY AND OBJECTS OF THE PRESENT INVENTION**

It is an object of the present invention to provide a fluid operated pump which is adapted to pump a fluid from a well casing when the pump is disposed in a vertical orientation.

A further object of the present invention is to provide a fluid-operated pump which is capable of readily pumping oil or water from a well casing.

Another object of the present invention is to provide a fluid-operated pump which is easy to install and remove from the well casing.

A further object of the present invention is to provide a fluid-operated pump which may be readily positioned within a well casing by hoisting equipment which would include a top mounted roller divided into three sections to accommodate and separate a steel cable, oil discharge hose and air pressure input hose.

A further object of the present invention is to provide a fluid-operated pump which includes a lifting eye for connection to a cable which may be easily connected to a power winch or pulled by a vehicle to raise or lower the fluid-operated pump into a well casing.

These and other objects of the present invention are accomplished by a fluid-operated pump having an outer housing and being closed at a first end thereof. A first piston member is operatively positioned within the outer housing and defines a first fluid chamber between the closure, the outer housing and a first face of the first piston member. A rod member is operatively mounted for reciprocation within the outer housing and is affixed to the first piston member at one end thereof. A first casing is positioned within the outer housing adjacent to the first piston member and defines a second fluid chamber therebetween. A second casing is positioned at a predetermined distance from said first casing and defines a chamber between the outer housing and the first and second casings. A plurality of tubes having inner and outer surfaces are disposed within the chamber and define a plurality of fluid passages between the inner and outer surface and the first and second casings. A third and fourth casing are positioned at a predetermined distance with respect to each other within an inner tube disposed in the chamber and defining a working pump chamber therebetween. A second piston member is affixed to the rod and is operatively disposed within the working pump chamber. An inlet conduit is provided being in communication with one of said plurality of fluid passages for supplying fluid to said working pump chamber. An outlet conduit is provided in communication with one of said plurality of fluid passages for discharging fluid from said working pump chamber. Pressurized fluid is in communication with at

least one of said plurality of fluid passages for selectively supplying fluid to said first and second fluid chambers to impart movement to said first piston member. Imparting movement to the first piston member reciprocates the rod and the second piston member for supplying fluid to the working pump chamber and simultaneously discharging fluid therefrom.

Other objects of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

FIG. 1A is a side view illustrating a pump hoisting mechanism for use in combination with the present invention;

FIG. 1B is a top plan view of the pump hoisting mechanism illustrated in FIG. 1A;

FIG. 2A is a partial cross-sectional view illustrating a lower portion of fluid pump according to the present invention;

FIG. 2B is a cross-sectional view illustrating an intermediate portion of the fluid pump according to the present invention;

FIG. 2C is a partial cross-sectional view illustrating an upper portion of a fluid pump according to the present invention;

FIG. 3 is an end view of the lower portion of the fluid operated pump;

FIG. 4 is a cross-sectional view taken along lines 4—4 as illustrated in FIG. 2A;

FIG. 5 is a cross-sectional view taken along lines 5—5 as illustrated in FIG. 2A;

FIG. 6 is a cross-sectional view taken along lines 6—6 as illustrated in FIG. 2A;

FIG. 7 is a cross-sectional view taken along lines 7—7 as illustrated in FIG. 2B;

FIG. 8 is a cross-sectional view taken along lines 8—8 as illustrated in FIG. 2B;

FIG. 9 is a cross-sectional view taken along lines 9—9 as illustrated in FIG. 2B;

FIG. 10 is a cross-sectional view taken along lines 10—10 as illustrated in FIG. 2B;

FIG. 11 is a cross-sectional view taken along lines 11—11 as illustrated in FIG. 2C;

FIG. 12 is a cross-sectional view taken along lines 12—12 as illustrated in FIG. 2C;

FIG. 13 is a cross-sectional view taken along lines 13—13 as illustrated in FIG. 2C;

FIG. 14 is an end view of the top portion of the fluid-operated pump as illustrated 2C; and

FIG. 15 is a side view of the end portion of the fluid-operated pump as illustrated in FIGS. 2C and 14.

### DETAILED DESCRIPTION OF THE INVENTION

As illustrated in FIGS. 1A and 1B, the present invention is directed to a fluid operated pump which is designed to be lowered into a well casing. The pump hoisting mechanism may include a truck 10 with a winch mechanism 12 mounted thereon. Of course, a winch mechanism may be independently disposed apart from a truck body for raising and lowering the fluid operated pump within the well casing.

Support arms 17, 17' include a threaded section 16, 16' which is threadedly received within a support rod 15, 15'. The support rods 15, 15' are anchored to the ground surface by means of the anchor supports 19, 19'. A vertical support rod 20 is positioned within a housing 25 mounted on the ground surface by means of a base member 26. The support rod 20 includes a flange 21 to which the support arms 17, 17' are operatively mounted. A roller 22 is mounted to the support rod 20 by means of the axle 23. The roller 22 is divided into three sections 22A, 22B and 22C. The three sections support the oil or water hose 31, the steel cable 32 and the air hose 33 so that they are separated with respect to each other as the fluid-operated pump is raised or lowered with respect to the well casing 24, 27.

The truck 10 may include a support eye 13. The cable 32 may be affixed between the support eye 13 and the pump to raise and lower the pump within the well casing 24, 27. In a second mode of operation, the cable 32 may be independently connected to a winch, not shown in the drawings, to raise and lower the pump within the well casing 24, 27. The support arms 17, 17' may be adjusted relative to the anchor members 19, 19' by rotating the adjustment members 18, 18'.

FIGS. 2A, 2B and 2C together define the fluid-operated pump of the present invention. The fluid-operated pump has been broken into three sections to more clearly illustrate the various components of the pump. The fluid operated pump 40 includes an outer housing 41 with a closure member 42 disposed at one end thereof. The closure member 42 may be actually welded to the outer housing 41 to provide an airtight closure for a first end of the outer housing 41.

A first piston 43 is operatively mounted within the outer housing 41. The first piston 43 includes a first face 43A and a second face 43B. Circular U-cup seals 44, 45 are provided around the peripheral surface of the first piston 43. The U-cup seals 44, 45 ensure a fluid tight engagement between the first piston 43 and an inner surface 41A of the outer housing 41.

A first casing 50 is mounted within the outer housing 41 and is spaced at a predetermined distance from the closure 42. The first piston 43 is mounted for reciprocation between the closure 42 and the first casing 50. A first fluid chamber 51 is disposed between a first face 43A of the first piston 43, the inner surface 41A of the outer housing 41 and the closure 42. A second fluid chamber 52 is provided between a second face 43B of the first piston 43, and inner surface 41A of the outer housing 41 and the first casing 50.

A second casing 53 is mounted within the outer casing 41 and spaced a predetermined distance from the first casing 50. A chamber is formed between the first casing 50, the inner surface 41A of the outer housing 41 and the second casing 53. A plurality of tubes are disposed within the chamber and define a plurality of fluid passages between inner and outer surfaces of the tubes

and the first casing 50 and the second casing 53. A first tube 55 is the largest diameter of the plurality of tubes disposed between the first casing 50 and the second casing 53. The first tube 55 is mounted on the first casing 50 and includes an O-ring 55A to seal the inner surface 55B and the outer surface 55C with respect to the first casing 50. The first tube 55 is sealed to the second casing 53 and includes an O-ring 55D to ensure a fluid tight seal therebetween.

A second tube 56 is disposed between the first casing 50 and the second casing 53. The second tube 56 includes an O-ring seal 56A to ensure the fluid tight seal between the first casing 50 and the second tube 56. The second tube 56 includes an inner wall 56B and an outer wall 56C. An O-ring seal 56D is provided between the inner tube 56 and the second casing 53 to ensure a fluid tight seal therebetween.

The third tube 57 is broken into three sections, 57X, 57Y and 57Z. The first section 57X is mounted to the first casing 50. The third section 57Z is mounted to the second casing 53. Operatively positioned between the first casing 50 and the second casing 53 are a third casing 60 and a fourth casing 61. The first section 57X is secured to the third casing 60 at a second end thereof. The second section 57Y is secured at one end to the third casing 60 and at a second end to the fourth casing 61. The third section 57Z is secured at one end to the fourth casing 61. O-ring seals 62, 63 are provided to ensure a fluid tight seal between the second section 57Y relative to the third casing 60 and the fourth casing 61, respectively.

A fourth tube 70 is operatively mounted between the first casing 50 and the third casing 60. O-ring seals 71, 72 are provided to ensure a fluid tight seal between the first casing 50, the fourth tube 70 and the third casing 60, respectively. In addition, a fifth tube 80 is operatively mounted between the fourth casing 61 and the second casing 53. O-ring seals 81, 82 are provided between the fourth casing 61, the fifth tube 80 and the second casing 53, respectively.

A rod 100 is operatively mounted for reciprocation within the outer housing 41 and includes seals 900A, 900B, 900C and 900D for sealing the outer surfaces of the rod 100 as the rod is reciprocated within the first casing 50, the second casing 53, the third casing 60 and the fourth casing 61. The rod 100 is affixed at one end to the first piston 43. A fluid channel 101 is operatively positioned within the thickness of the rod member 100 and includes a radially disposed portion 102. Fluid may be supplied to the first fluid chamber 51 through the fluid channel 101 and the radial portion 102.

The rod 100 is affixed to a second piston 110 which is operatively mounted within a working chamber disposed between the inner surface of the second section 57Y of the third tube 57 and the third and fourth casings 60, 61. The second piston 110 includes U-cup seals 111, 112 which ensure a fluid tight relationship between the second piston 110 and an inner surface 57B of the third tube 57. A second fluid channel 103 is provided within the thickness of the rod 100 and includes radial portions 104 and 105. A first working pump chamber 120 is provided between the third casing 60, the inner surface 57B of the third tube 57 and a first face 110A of the second piston 110. A second working pump chamber 121 is provided between the fourth casing 61, the inner surface 57B of the third tube 57 and a second face 110B of the second piston 110.

The rod 100 includes an end portion 100A which is affixed to a second portion of the rod 100B. The second portion of the rod 100B includes an activating member 130 mounted at one end thereof. The activating member 130 is affixed to a rod portion 133 mounted for reciprocation on the rod 100B. A spring 135 is mounted between the activating member 130 and an end stop 131. A spring 136 is mounted between the activating member 130 and an end member 132. A pilot bleed valve 140 is operatively mounted to a conduit to 141 and is adapted to be selectively opened when engaged by the activating member 130. A second pilot bleed valve 142 is operatively mounted to a four-way inner valve 143 and is adapted to selectively open a conduit when engaged by the activating member 130. A supply of pressurized fluid is provided through the conduit 145 to the valve manifold 146. The pressurized fluid is thereafter supplied to the conduit 147 for communication to the fluid operated pump 40. A second fluid pressure conduit 148 as illustrated in FIG. 10 is provided for selectively supplying pressurized fluid to the fluid operated pump 40. The four-way air valve 143 selectively communicates fluid to either the conduit 147 or the conduit 148. The pilot bleed valves 140, 142 selectively exhaust the pressurized fluid from either the conduit 147 or the conduit 148 as the rod 100 reciprocates within the outer housing 41.

As illustrated in FIGS. 2A, 2B, 2C and 10-13, pressurized fluid is supplied through the conduit 145, through the valve manifold 146 to the conduit 147. A fluid passage 147A is provided in the second casing 53 and includes a radially disposed portion 147B. The fluid is thereafter supplied to the space between an inner surface 41A of the outer housing 41 and an outer surface 55C of the first tube 55. The fluid is communicated along the outer housing 41 to radially disposed passages 147C-147F positioned in the first casing 50. The radially disposed fluid passages 147G-147J are in communication with fluid conduits 147G-147J which supply pressurized fluid to the second fluid chamber 52.

Selectively, the pilot bleed valves 140, 142 may exhaust fluid from the second fluid chamber 52 by venting the pressurized fluid supplied to the space between the inner surface 41A of the outer housing 41 and the outer surface 55C of the first tube 55 to the atmosphere. As the second fluid chamber 52 is vented to the atmosphere, pressurized fluid is supplied through the conduit 148 and through a passageway extending longitudinally through the second casing 53. A radially extending passage 148B is provided to communicate fluid to a space between an inner surface 55B of the first tube 55 and an outer surface 56C of the second tube 56. The pressurized fluid is supplied along the outer housing 41 to a radially extending passageway 148C. The fluid thereafter is supplied to the space between the fourth tube 70 and the rod 100. The fluid thereafter communicates with the radially extending portion 102 and the fluid channel 101 to supply pressurized fluid to the first fluid chamber 51. Thereafter, as the first piston 43 is reciprocated towards the first casing 50, the activating member 130 engages the pilot bleed valve 142 to discharge the pressurized fluid from the first fluid chamber 51 and reconnect the pressurized fluid to the second fluid chamber 52.

By selectively supplying fluid to the first fluid chamber 51 while discharging fluid from the second fluid chamber 52 and thereafter supplying pressurized fluid to the second fluid chamber 52 while discharging fluid

from the first fluid chamber 51 imparts reciprocation to the first piston 43 which imparts reciprocation to the rod 100 and the piston 110.

The second piston 110 is reciprocated within the working chamber which is divided into a first working pump chamber 120 and a second working pump chamber 121.

As illustrated in FIGS. 2A and 4, the first casing 50 includes a plurality of inlet openings 200A-200H. The first casing 50 includes a threaded portion 201 which mates with a threaded portion 202 of the outer housing 41. In addition, the first casing 50 includes a second threaded portion 203 which mates with a second threaded portion 204 of the outer housing 41. The inlet openings 200A-200H are disposed around the peripheral surface of the first casing 50 in a space between the first threaded portion 202 and the second threaded portion 203.

Fluid to be pumped from a well casing is supplied through the inlet openings 200A-200H to a radially disposed conduits 205A-205H, respectively. The radially disposed conduits 205A-205H are in communication with a longitudinally extending conduit 206A-206H, respectively. The longitudinally extending conduits extend through an end portion of the first casing 50 and terminate in conduit openings 206A-206H as illustrated in FIG. 5. The conduit openings 206A-206H communicate fluid into the chamber 207 disposed between the fourth tube 70 and the first section 57X of the third tube 57. In addition, radially disposed conduit 208 communicates fluid from the inlets 200A-200H to a passageway defined between an outer surface of the first section 57X and the second 57Y of the third tube 57 and an inner surface 56B of the second tube 56. The fluid is communicated along this fluid passageway to the third casing 60. Radially extending passages 210 communicate fluid from the longitudinally extending passage to the third casing 60. The third casing 60 includes a plurality of radially extending passages 210A-210H. The radially extending passages communicate with a plurality of longitudinally extending passages 211A-211H. The longitudinally extending passages 211A-211H communicate pressurized fluid to the U-cup valve seal 220. The pressurized fluid lifts the U-cup valve seal 220 from the seal seat to a new position to open inlet and outlet passages for the flow of fluid. This permits fluid to enter the longitudinally extending passages 220A-220H in the third casing 60. As illustrated in FIGS. 2A and 6, the passageways 210A-210H, 211A-211H and 220A-220H are in fluid communication with the passageway defined between the outer surface of the first section 57X of the third tube 57 and the inner surface 56B of the second tube 56.

Fluid from the inlet openings 200A-200H is also in communication with radially disposed conduits in the fourth casing 61. As illustrated in FIGS. 2B and 7, the radially disposed conduits 300A-300H are in communication with the longitudinally extending passages 301A-301H. The fluid in the longitudinally extending passages 301A-301H is supplied against one side of the U-cup valve seal 303. The pressurized fluid lifts the U-cup valve seal 303 from the seal seat to a new position to open inlet and outlet passages for the flow of fluid. In addition, a longitudinally extending passage 304 is provided adjacent an upper surface of the fourth casing 61 for directly communicating fluid from selective longitudinally extending passages 301A-301H to the passages 305A-305H. Further, the fourth casing 61 as illustrated

in FIGS. 2B and 9, includes passageways 400A-400H which are in communication with a chamber 406. In addition, passageways 401A-401H communicate fluid to a space defined between the rod 100 and an inner surface of the tube 80. Further, fluid is communicated between the chamber 406 and an inner surface 56B of the second tube 56 and an outer surface of the third section 57Z of the third tube 57. The fluid in the passageway between the inner surface 56B of the second tube 56 and the third section 57Z of the third tube 57 is communicated to a radially extending passage 408 which communicates with a longitudinally extending passage 409 connected to a discharge conduit 410 for discharging fluid from the working chambers 120, 121.

As illustrated in FIG. 2B, the fourth casing 61 includes U-cup valve seals 500, 501 which are disposed on opposite sides of the chamber 400. As pressurized fluid is supplied one side of the U-cup valve seal 500, it lifts the U-cup valve seal from the seal seat to a new position to open inlet and outlet passages for the flow of fluid. This permits fluid to flow into the chamber 406. Similarly, as pressurized fluid is supplied to one side of the U-cup valve seal 501, it lifts the U-cup valve seal from the seal seat to a new position to open inlet and outlet passages for the flow of fluid. This permits fluid to flow into the chamber 406. The U-cup valve seals 500, 501 function independently to either permit or prevent fluid to enter the chamber 406.

FIGS. 10-13 disclose the conduits 147, 148 and 410 which either supply pressurized fluid or discharge fluid from the fluid operated pump. FIGS. 14 and 15 illustrate an end view of the fluid-operated pump outer housing. The outer housing includes an eye 610 for connection to a cable. The eye 610 is substantially V-shaped.

### OPERATION

In operation, pressurized fluid is supplied through the conduit 145 to the valve manifold 146. Thereafter, fluid is supplied to either the conduit 147 or the conduit 148. As fluid is supplied to the conduit 147, it communicates through the passage 147A and the radially extending passage 147B to the space defined between the inner surface 41A of the outer housing 41 and an outer surface 55C of the first tube 55. The fluid is communicated along the outer housing 41 to the radially extending passages 147C-147F and the longitudinally extending passages 147G-147J in the first casing 50 to the second fluid chamber 52. At the same time, pressurized fluid is exhausted from the first fluid chamber 51. In this first mode of operation, the pressurized fluid in the second fluid chamber 52 forces the first piston 43 towards the left as illustrated in FIG. 2A, to reciprocate the rod 100 and the second piston 110. As the second piston 110 is reciprocated towards the left, fluid within the first working pump chamber 120 is sealed therein by means of the U-cup valve seal 220. The fluid in the first working chamber 120 can only be discharged through the radially extending passage 104, the longitudinally extending passage 103 and the radially extending passage 105. The fluid is thereafter disposed between the rod 100 and an inner surface of the tube 80. The fluid communicates through the passageways 401A-401H to the chamber 406 where it is communicated to the space between the outer surface of the third section 57Z of the third tube 57 and the inner surface 56B of the second tube 56. Thereafter, the fluid is communicated to the radially extending passage 408 and the longitudinally

passage 409 in the second casing 53. The fluid in the longitudinally passage 409 is communicated to the discharge conduit 410 to supply the fluid through the well casing to the surface.

As the fluid is discharged from the first working pump chamber 120, additional fluid is supplied from the inlet passageways 200A-200H through the radially extending passageways 205A-205H to the longitudinally extending passages 206A-206H to the chamber 207. The fluid in the chamber 207 extends through the radially extending passages 210A-210H to the space between the outer surface of the first section 57X of the third tube 57 and the inner surface 56B of the second tube 56. The fluid in this passage is communicated through the radially extending passages 300A-300H to the longitudinally extending passages 305A-305H and is sucked past the U-cup valve seal 303 into the second working pump chamber 121.

As the first piston 43 reaches the closure 42 of the outer housing 41, the activating mechanism 130 engages the pilot bleed valve 140 to discharge pressurized fluid from the second fluid chamber 52 through the same passageway that the pressurized fluid was supplied thereto. At this point in time, pressurized fluid is then connected to the conduit 148 and is supplied to the radially extending passageway to the space between the inner surface 55b of the first tube 55 and the outer surface 56c of the second tube 56. The pressurized fluid is communicated along the fluid pump to the radially extending passage 148c to the space between the tube 70 and the rod 100. Fluid is then communicated through the radially extending passage 102 and the longitudinally extending passage 101 to the first fluid chamber 51. Pressurized fluid in the first fluid chamber 51 imparts movement to the first piston 43 to reciprocate the rod 100 and the second piston 110 towards the right as illustrated in FIGS. 2A and 2B. Reciprocating the second piston 110 towards the right discharges fluid from the second working chamber 121 through the passages 304A-304H to the passages 301A-301H passed the U-cup seal 500 to the chamber 406. Fluid in the chamber 406 is communicated to the space between the inner surface 56b of the second tube 56 and the outer surface of the third section 57Z of the third tube 57. The fluid in this passageway is communicated through the radially extending passage 408 to the longitudinally extending passage 409 in the second casing 53. Fluid in the longitudinally extending passage 409 is communicated to the discharge conduit 410 to discharge fluid from the second working pump chamber.

As fluid is discharged from the second working pump chamber 121, fluid is sucked into the first working pump chamber 120. Fluid is communicated through the inlet passageways 200A-200H to the radially extending passageways 205A-205H to the longitudinally extending passageways 206A-206H to the chamber 207. Thereafter, fluid is supplied to the space between the inner surface 56B of the second tube 56 and the outer surface of the first section 57X of the third tube 57. The fluid is communicated through the passageways 210A-210H and the passageways 211A-211H to the one side of the U-cup valve seal 220 and through the passageways 220A-220H to the first working pump chamber 120.

The U-cup valve seals disposed along the rod 100 are normally arranged in pairs to seal the rod 100 relative to the respective casings. The U-cup valve seals 220, 303, 500, and 501 have a snug fit on the rod 100 and a free fit on the interior portion of the respective casings. As



pressure is selectively applied to one side of the U-cup valve seals 500 and 501, the seals are biased away from the fourth casing to permit fluid to flow therebetween. As suction is applied to one side of the U-cup valve seals 220 and 303, the seals are biased away from the third casing and the fourth casing, respectively, to permit fluid to flow therebetween. Holes may be provided between the U-cup valve seals 220, 303, 500 and 501 and their respective casings to permit material to pass on the outer surface of the U-cup valve seals.

The fluid operated pump of the present invention may be operated by utilizing either hydraulic fluid or pressurized air. If hydraulic fluid is used to impart movement to the piston 43, it will be necessary to employ an exhaust conduct (not illustrated). Exhausted hydraulic fluid from either the fluid chamber 51 or 52 will pass through the pump housing and into the exhaust conduit to be conveyed upwardly to ground level. If pressurized air is utilized to impart movement to the piston 43, an exhaust conduct is not necessary.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

I claim:

1. A fluid operated pump adaptable for use in a vertical orientation comprising:  
 an outer housing including a closure mounted adjacent a first end thereof;  
 a rod operatively mounted for reciprocation within said outer housing and including first and second ends;  
 a first piston member affixed to a first end of said rod and being operatively disposed within said outer housing adjacent said closure and defining a first fluid chamber therebetween;  
 a first casing being positioned within said outer housing adjacent to said piston member and defining a second fluid chamber therebetween;  
 a second casing being positioned at a predetermined distance from said first casing and defining a chamber between said outer housing and said first and second casings;  
 a plurality of tubes having inner and outer surfaces being disposed within said chamber and defining a plurality of fluid passages between said inner and outer surfaces and said first and second casings;  
 a third and fourth casing being positioned at a predetermined distance within an inner tube of said plurality of tubes being disposed in said chamber and defining a working pump chamber therebetween;  
 a second piston member being affixed to said rod and being operatively disposed within said working pump chamber;  
 an inlet conduit being in communication with one of said plurality of fluid passages for supplying fluid to said working pump chamber;  
 an outlet conduit being in communication with one of said plurality of fluid passages for discharging fluid from said working pump chamber;  
 pressurized fluid being in communication with at least one of said plurality of fluid passages for selectively supplying fluid to said first and second fluid chambers to impart movement to said first piston member;

whereby selectively supplying pressurized fluid to said first and second fluid chambers imparts reciprocation to said first piston member which imparts reciprocation to said rod and said second piston member for supplying fluid to said working pump chamber and simultaneously discharging fluid therefrom.

2. A fluid operated pump according to claim 1, wherein said rod is reciprocatably mounted within said first, second, third and fourth casings and U-cup seals are provided within said casings to provide a tight seal against an outer surface of said rod.

3. A fluid operated pump according to claim 1, wherein said pressurized fluid is air.

4. A fluid operated pump according to claim 1, wherein a pair of oppositely facing U-cup seals are operatively positioned within said first casing and being in engagement with said rod to provide a fluid tight seal when said rod is reciprocated.

5. A fluid operated pump according to claim 1, wherein a first and second oppositely facing U-cup valve seals are operatively positioned within said third casing and are in engagement with said rod, said first U-cup valve seal providing a seal when said rod is reciprocated in a first direction while said second U-cup valve seal permits fluid flow through a passage in said third casing and said second U-cup valve seal providing a fluid tight seal when said rod is reciprocated in a second direction.

6. A fluid operated pump according to claim 1, wherein a third, fourth and fifth U-cup valve seals are operatively positioned within said fourth casing and are in engagement with said rod, said third and fifth U-cup valve seals providing a seal when said rod is reciprocated in a first direction while said fourth U-cup valve seal permits fluid flow through a passage in said fourth casing and said fourth U-cup valve seal providing a fluid tight seal when said rod is reciprocated in a second direction while said fifth U-cup valve seal permits fluid flow through a passage in said fourth casing.

7. A fluid operated pump according to claim 1, wherein a U-cup seal is operatively positioned in said second casing and being in engagement with said rod to provide a fluid tight seal therebetween.

8. A fluid operated pump according to claim 1, wherein U-cup seals are provided on outer peripheral surfaces of said first and second pistons to provide a fluid tight seal with said outer housing.

9. A fluid operated pump according to claim 1, and further including a four way fluid valve for directing pressurized fluid to said first and second fluid chambers.

10. A fluid operated pump according to claim 1, and further including an activating member affixed to said rod for selectively engaging a first exhaust valve for exhausting pressurized fluid from said second fluid chamber when said rod is reciprocated in a first direction and for selectively engaging a second exhaust valve for exhausting pressurized fluid from said first fluid chamber when said rod is reciprocated in a second direction.

11. A fluid operated pump according to claim 1, wherein said pressurized fluid is hydraulic fluid.

12. A fluid operated pump according to claim 1, wherein a first pressurized fluid passageway is provided through a longitudinal and at least one radial passageway in said second casing, through a space formed between an inner surface of said outer housing and a first tube, through at least one radial and a correspond-

ing number of longitudinal passageways in said first casing to supply pressurized fluid to said second fluid chamber.

13. A fluid operated pump according to claim 12, wherein said first tube is the largest diameter tube with respect to said plurality of tubes.

14. A fluid operated pump according to claim 1, wherein a second pressurized fluid passageway is provided through a second longitudinal and at least one second radial passage in said second casing, through a space formed between an inner surface of a first tube and an outer surface of a second tube, through at least one radial passageway in said first casing, through a space formed between an outer surface of said rod and an inner surface of a fourth tube, through a radial and a longitudinal passageway in said rod, through an opening in said first piston to supply pressurized fluid to said first fluid chamber.

15. A fluid operated pump according to claim 14, wherein said second tube is of a smaller diameter with respect to said first tube and is larger in diameter with respect to the remaining plurality of tubes.

16. A fluid operated pump according to claim 14, wherein said fourth tube is the smallest diameter tube with respect to said plurality of tubes and is disposed in close spaced relationship to said rod.

17. A fluid operated pump according to claim 1, wherein said working pump chamber includes a first working pump chamber and a second working pump chamber.

18. A fluid operated pump according to claim 17, wherein fluid positioned within said second working pump chamber is discharged through at least one longitudinal passageway in said fourth casing, through a U-cup valve seal being in sealing engagement with said

rod and being disposed in said fourth casing, to a chamber disposed in said fourth casing, through at least one radial passage in said fourth casing, to a space formed between an inner surface of a second tube and an outer surface of a third tube, through a radial and a longitudinal passageway in said second casing to a discharge conduit to discharge fluid from said second working pump chamber when pressurized fluid is supplied to said first fluid chamber.

19. A fluid operated pump according to claim 17, wherein fluid positioned within said first working pump chamber is discharged through a radial and a longitudinal passageway in said rod and in said second piston, through a radial passage in said rod to a space formed between an outer surface of said rod and an inner surface of a fifth tube, through a U-cup valve seal being in sealing engagement with said rod and being disposed in said fourth casing, to a chamber disposed in said fourth casing, through at least one radial passage in said fourth casing, to a space formed between an inner surface of a second tube and an outer surface of a third tube, through a radial and a longitudinal passageway in said second casing to a discharge conduit to discharge fluid from said first working pump chamber when pressurized fluid is supplied to said second fluid chamber.

20. A fluid operated pump according to claim 19, wherein said fifth tube is the smallest diameter tube with respect to said plurality of tubes and is disposed in close spaced relationship to said rod.

21. A fluid operated pump according to claim 19, wherein said third tube is larger in diameter with respect to said fifth tube and smaller in diameter with respect to the remaining plurality of tubes.

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[54] WELL PUMP

[56]

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[76] Inventor: Donald I. G. MacLeod, 46 Waitara Crescent, Greenwood 6024, Australia

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§ 371 Date: Aug. 10, 1987

§ 102(e) Date: Aug. 10, 1987

[87] PCT Pub. No.: WO87/03649

PCT Pub. Date: Jun. 18, 1987

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Attorney, Agent, or Firm—Pearne, Gordon, McCoy & Granger

[57] ABSTRACT

A submersible well pump of the barrel and piston type characterized by a valve chamber formed coextensively with the barrel and containing an inlet valve and an outlet valves arranged to admit fluid to one end of the barrel on a first stroke of an unported piston and to discharge the fluid from the same end of the barrel on a second opposite stroke of the piston. A double acting version of the pump is also disclosed.

[30] Foreign Application Priority Data

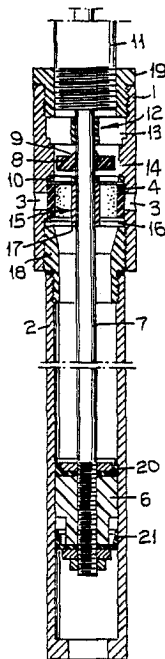
Dec. 11, 1985 [AU] Australia ..... PH03826

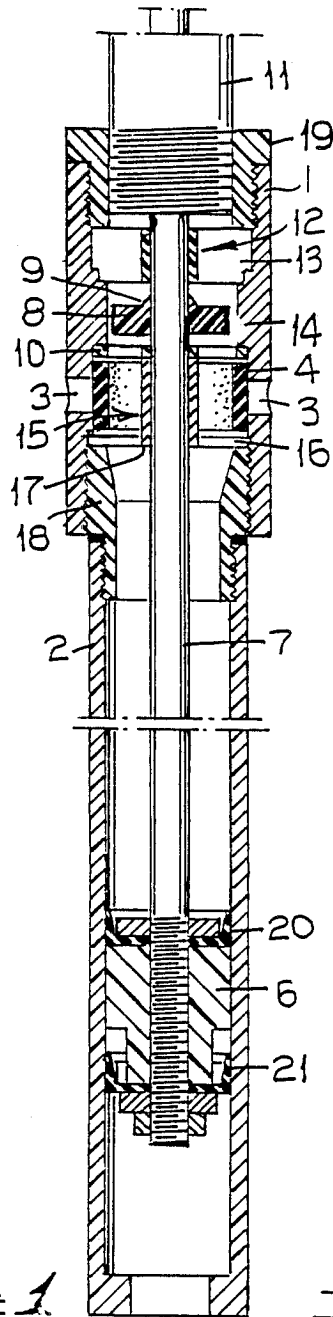
[51] Int. Cl.<sup>4</sup> ..... F04B 39/10; F04B 21/00

[52] U.S. Cl. .... 417/566; 137/533.27

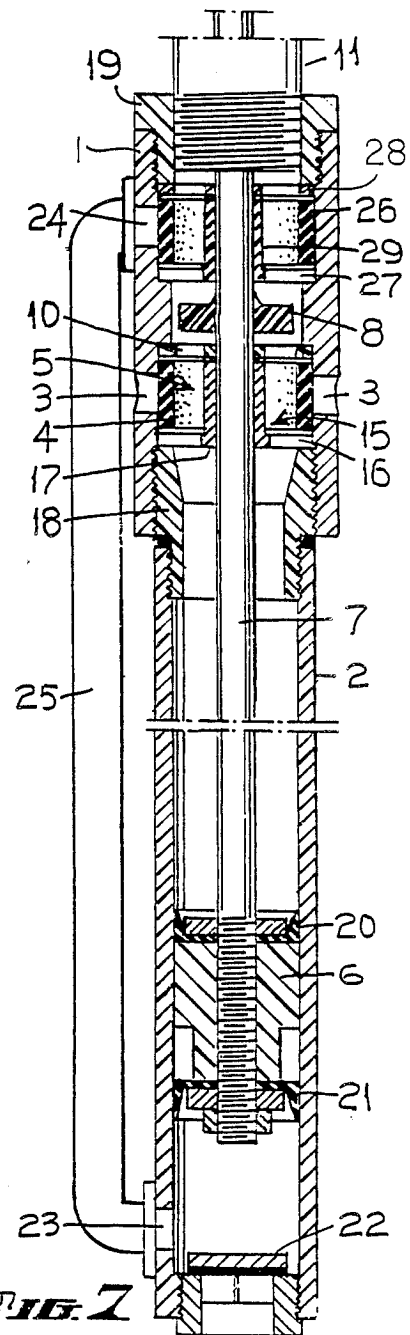
[58] Field of Search ..... 417/566; 137/533.27

5 Claims, 2 Drawing Sheets





**FIG. 1**



**FIG. 2**

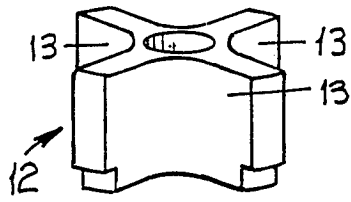


FIG. 3

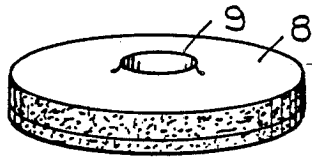


FIG. 4

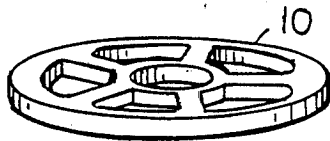


FIG. 5

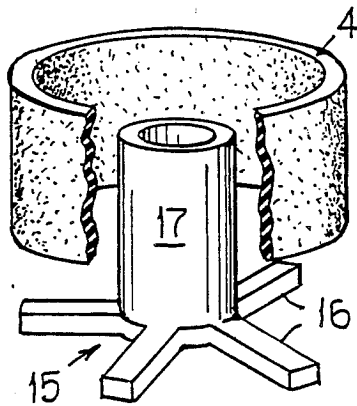


FIG. 6

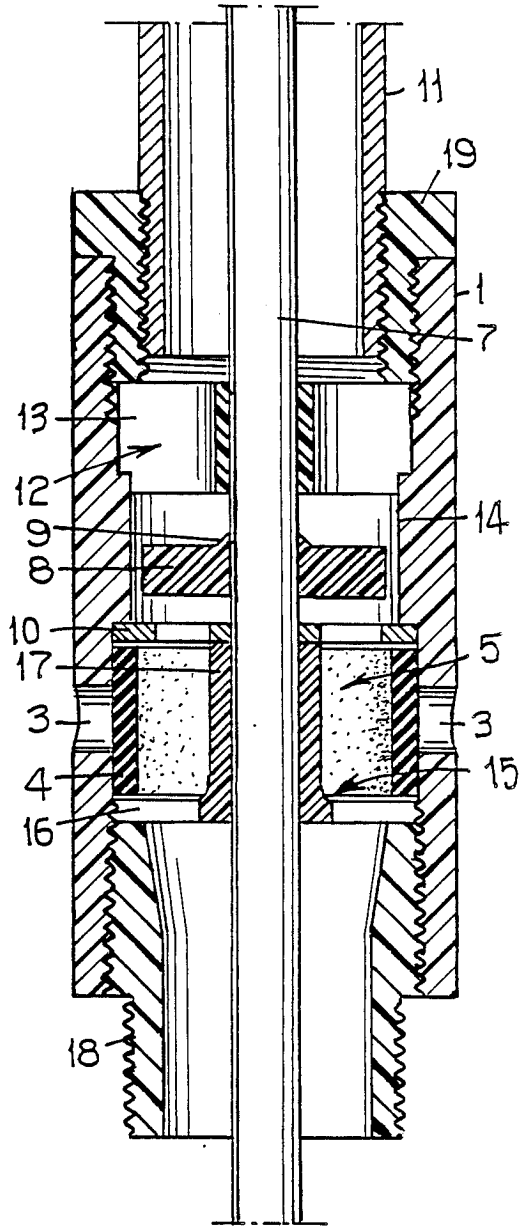


FIG. 2

## WELL PUMP

This invention relates to a well pump and in particular it relates to a pump of the type which is positioned in a well at the end of a string of delivery pipes which convey liquid pumped from the well to an elevated position, in which the pump is actuated by a plunger rod passing up the string of pipes.

It is customary in pumps of this kind to have a barrel which has in it a piston reciprocated by the plunger rod actuated from a windmill or other driving means and to have in the base of the barrel a foot valve which allows liquid to enter the barrel at the appropriate time, and to have within the piston a valve which allows liquid to move upwardly through the piston but not down, so that as the piston is reciprocated, liquid is lifted by the piston on the upstroke with the piston valve closed and the foot valve open, but on the downstroke the piston moves freely through the liquid with the piston valve open and the foot valve closed so that the space above the piston is then filled with liquid for the next lift.

According to an earlier invention of mine, the pumping was achieved by a balance system using fluids to actuate the piston in the pump cylinder, but the present invention is directed to a mechanically actuated pump of the general type described earlier herein.

The object of the present invention is to provide certain improvements to pumps of this type, the object being achieved according to this invention by utilizing a barrel in which a piston is reciprocated by means of a plunger rod, but the piston itself is not provided with valve means but has buckets arranged to prevent the passage of liquid or fluids past the piston, the valve mechanism being situated in an extension at the top of the barrel in which the piston moves, the valves being situated in this extension.

The invention thus comprises a submersible well pump of the barrel and piston type characterised by a valve chamber formed coextensively with the barrel and containing at least an inlet valve and an outlet valve arranged to admit fluid to one end of the barrel on a first stroke of the piston and to discharge the fluid from the same end of the barrel on a second opposite stroke of the piston.

In its preferred form the invention comprises a pump having a barrel adapted to be supported by a delivery type and adapted to be submerged in the fluid to be pumped and comprising a barrel having a piston within it adapted to be coupled by a plunger rod to a reciprocating mechanism and including inlet and outlet flow control valves, characterised in that the flow control valves are positioned in an extension of the barrel coextensive with the barrel and arranged on a first stroke in one direction to cause a flow of fluid into the barrel through the inlet valve to the retreating side of the piston and, at a second stroke in the opposite direction to discharge the fluid from the barrel through the outlet valve to the delivery pipe.

The invention also has reference to a double-acting pump.

To enable the invention to be fully understood embodiments thereof will now be described with reference to the accompanying drawings in which:

FIG. 1 is a longitudinal sectional view of first embodiment of the invention,

FIG. 2 is an enlarged longitudinal sectional view of the valve extension,

FIGS. 3, 4, 5 and 6 are components of the valve mechanism, and

FIG. 7 is a longitudinal sectional view of a second embodiment showing a double-acting arrangement.

Describing first the form illustrated in FIGS. 1 to 6 inclusive, the extension 1 screws to the top of a barrel 2 to be coextensive therewith and this extension 1 has in it intake ports 3 which terminate in which I term a garter-type reed valve 4, that is a valve which is expanded in a chamber 5 in the extension to engage the inner face of the extension over the intake ports 3. This prevents outflow of fluid but allows fluid flow into the chamber 5 when the reed valve 4 contracts into the chamber 5 due to fluid being drawn into the hollow by the piston 6. The fluid flows through the intake port 3 and around the reed valve 4 into the chamber 5 and thence into the barrel 2 of the pump. This reed valve 4 is the fluid inlet valve to the barrel 2.

By this arrangement the pump barrel 2 is filled from the top end when the piston 6 is on the down-stroke, the piston aiding inflow of the liquid to the barrel 2 as it is downwardly displaced.

Within the extension 1, situated in the chamber 5 surrounding the plunger rod 7 is a non-return disc valve 8 having rod seal 9, which valve is adapted to seat downwardly onto a webbed valve seat 10 also surrounding the plunger rod 7. This is the outlet valve from the barrel 2.

The arrangement of this non-return valve 8 is such that on the upstroke of the piston 6, when the reed valve 4 is forced outwardly to close off the intake ports 3, liquid flows upward through the ported valve seat 10 and past the non-return valve 8 which it lifts to allow free flow past it and up the delivery pipe 11 which in turn is secured to the top of the extension 1.

This non-return valve 8 frictionally engages the plunger rod 7 through the rod seal 9 so that when the plunger rod 7 moves downwardly it moves with it until the ported valve seat 10 is engaged to seal downward flow, and at that stage the delivery pipe 11 holds the liquid within it as it cannot return to the barrel 2.

The non-return valve rod seal 9 is pressed against the plunger rod so that when this non-return valve 8 is seated on the ported valve seat 10, no fluid can flow past the non-return valve 8. Situated above the non-return valve 8 is a ported rod guide 12 through the ports 13 of which the liquid flows into the delivery pipe, but this rod guide 12 correctly guides the plunger rod to retain its axial position in relation to the chamber 5 in the extension 1.

Assembly of the valves in the extension 1 is by inserting the ported valve seat 10 upwards into the chamber 5 from the barrel end and holding it against a step 14 in the chamber 5 in the extension 1 by means of a flow-through holding member 15 which comprises a spider 16 with a hollow stem 17 which encircles the plunger rod 7, and retaining this by a threaded ferrule 18 which is part of or engages the barrel 2.

In this way a cage is formed, consisting of a spider 16 and the ported valve seat 10, in which the reed valve 4 is axially confined. The reed valve 4 is however able to flex to allow fluid to be drawn inward to the chamber 5 by action of the piston 6 or by fluid pressure.

The non-return valve 8 is confined in a flow-through cage formed by the webbed valve seat 10 and the ported rod guide 12, and the ported rod guide is inserted from above and is held against the stop 14 by a socket 19 which engages the delivery pipe 11.

The piston 6 is provided with a pair of buckets 20 and 21 which are positioned to prevent flow past the piston 6 during its lifting stroke. The lower bucket 21 can however be reversed if greater suction is required on the downstroke of the piston 6 to draw fluid through the ports 3 and past the reed valve 4.

The above described embodiment results in a single acting pump which delivers liquid on the upstroke but draws liquid into the barrel on the downstroke.

According to a modification of the invention as shown in FIG. 7, in which similar reference numerals for components similar to those referred to with reference to the first described embodiments are used.

This is generally similar in construction to the form first described but has a foot valve 22 positioned in the barrel 2 so that on the upstroke of the piston 6, fluid can be drawn into the lower part of the barrel 2. A port 23 in the lower part of the barrel 2 is connected to a port 24 in the upper part of the extension 1 above the ported rod guide 12 by a transfer pipe 25, which allows fluid on the downstroke of the piston 6, when the foot valve 22 and the non-return valve 8 are closed, to flow upwardly through the transfer pipe 25 into the delivery pipe 11 so that, on the downstroke, the fluid below the piston 6 is displaced into the transfer pipe 25 and hence into the delivery pipe 11 which takes the fluid to the surface.

The port 24, which communicates with the transfer pipe 25, is in turn provided with a second non-return valve 26, which is in the form of another garter-type reed valve at the upper part of the extension 1, although a flap valve could be used. This garter-type reed valve 26 is positioned in the upper part of the chamber 5 above a ported disc 27 to normally close the port 24 when the reed valve 26 is pressed against the wall of the chamber in which it is housed to prevent back flow down the transfer pipe 25 from the delivery pipe 11 which leads to the surface.

The second reed valve 26 can be inserted from above and held in a cage formed between a spider 27 and a ported disc 28 which is engaged by the socket 19, the spider having a hollow stem 29 projecting upwards to space the ported disc 28 at the correct distance from the spider 27.

From the foregoing it will be realised that a simple and effective pump is provided which can be readily assembled and which comprises a barrel as a lower integer of the pump with an extension at the top which carries all the valve means excepting the foot valve in the case where the pump is to be double acting.

It will also be appreciated that a pump is formed having an extension 1 on one side of the barrel 2 which is coextensive with the barrel 2 and houses at least an inlet valve 4 and an outlet valve 8 in flow-through cages in the chamber 5 formed in the extension 1, and that the pump can readily be converted to be double acting by simply adding a foot valve 22 and a second inlet valve 26.

The valves 4 and 8 and 26 can be located by means other than the flow-through cages, but the form illustrated allows the valves to be located by positioning at least one from each end of the chamber and locking the structure together by end members such as the barrel 2 and the socket 19.

To enable the string of delivery pipes and pump to be withdrawn readily for servicing or the like a small valve may be included at the top of the pump which is normally closed, but can be opened by pull on a line leading to the surface to allow the water from the delivery pipe to flow out of the pipe to thereby lighten the load when withdrawing the pipe, but such a release is not illus-

trated but can be readily applied by persons versed in the art.

I claim:

1. A well pump comprising a barrel adapted to be supported by a delivery pipe and arranged to be submerged in a fluid to be pumped, a piston within the barrel adapted to be coupled by a plunger rod to a reciprocating mechanism and including inlet and outlet flow control valves positioned to surround the said plunger rod in an extension at the delivery end of the barrel and coextensive therewith, said pump being arranged in a first stroke of the piston in one direction to cause a flow of fluid through the inlet valve into the barrel on the retreating side of the piston and in a second stroke in the opposite direction to discharge the fluid from the advancing side of said piston in the barrel through the outlet valve to the delivery pipe, said inlet valve being a reed valve positioned in a chamber in the extension over fluid inlet ports through the wall of the extension, said extension having a step inwardly extending into said chamber, and a webbed seat for the outlet valve urged against one side of the step by a flow-through holding member to form a flow-through cage for the reed valve.

2. A well pump according to claim 1, wherein a ported plunger rod guide in the chamber of the extension is confined against the other side of the step to form a flow-through cage for the outlet valve between the ported valve seat and the ported plunger rod guide.

3. A well pump according to claim 1, wherein the extension is removable and communicates at an upper end with the delivery pipe and at a lower end with the barrel, the plunger rod passes axially through the chamber, the flow control valves are positioned in the chamber, and said outlet valve is a disc valve seated on said webbed seat and extending across the chamber and around the plunger rod.

4. A well pump according to claim 1, including a foot valve at the end of the barrel opposite the extension, and a fluid transfer pipe between a first foot port at the foot valve end of the barrel and a second foot port opening through the wall of the extension into the chamber, said second foot port opening into said chamber through a second outlet valve also in the said chamber above the first said outlet valve, the second outlet valve being a reed valve positioned over the second foot port and confined in a second flow-through cage in said extension.

5. A well pump comprising a barrel adapted to be supported by a delivery pipe and arranged to be submerged in a fluid to be pumped, an extension for connecting the barrel to the delivery pipe, a plunger rod extending through the extension for coupling a piston within the barrel to a reciprocating mechanism, inlet and outlet flow control valves positioned in said extension to surround said plunger rod, said pump being arranged in a first stroke of the piston in one direction to cause a flow of fluid through the inlet valve into the barrel on the retreating side of the piston and in a second stroke in the opposite direction to discharge the fluid from the advancing side of said piston in the barrel through the outlet valve to the delivery pipe, said extension including a wall providing a chamber and fluid inlet ports extending through the wall to the chamber, said inlet valve being a reed valve positioned in the chamber over the fluid inlet ports, said extension wall also including a step extending inwardly into said chamber for engaging a webbed seat for said outlet valve, and a flow-through holding member arranged to urge said webbed seat against said step and to cooperate therewith to provide a flow-through cage for the reed valve.

\* \* \* \* \*

[54] DEEP WELL SOLAR PUMP

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[52] U.S. Cl. .... 417/379; 60/478

[58] Field of Search ..... 417/379, 478; 60/641.8

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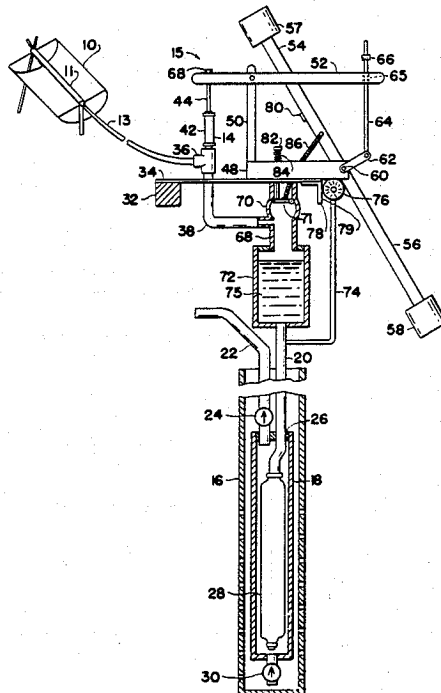
Primary Examiner—Leonard E. Smith  
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 Attorney, Agent, or Firm—Peter L. Tailer

[57] ABSTRACT

A solar deep well steam pump has a solar collector, a steam boiler in the collector's focus, a deep well bladder pump having an actuating tube and a water delivery tube, and a mechanism periodically injecting steam

under pressure from the boiler into the actuating tube of the bladder pump, the mechanism having an expansion chamber connected to the actuating tube of the bladder pump, a long period pendulum swinging by gravity to a first position, a steam injection valve between the boiler and the expansion chamber, the steam injection valve being opened by the pendulum in the first position, an impulse bladder connected to the expansion chamber so that steam pressure in the expansion chamber inflates the impulse bladder against the pendulum in the first position to urge the pendulum against the force of gravity toward a second position, an exhaust valve leading from the expansion chamber to the atmosphere, the exhaust valve being opened by the pendulum in the second position, the injection of steam into the expansion chamber by the injection valve forcing water down the actuating tube of the bladder pump and forcing pumped water from the delivery tube, the release of pressure in the expansion chamber by the exhaust valve allowing water to be forced back up the actuating tube into the expansion chamber for a subsequent pump cycle. A multi-layer pump bladder is adjustable according to well depth. The pump can also be operated by any source of compressed air or gas.

9 Claims, 2 Drawing Sheets







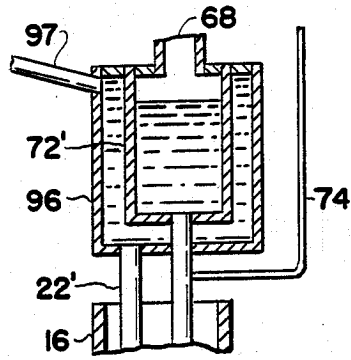


FIG. 4

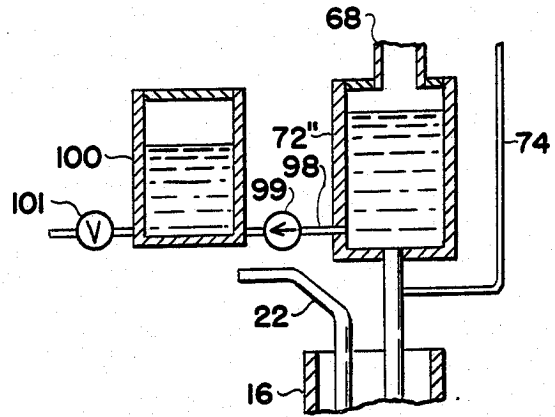


FIG. 5

## DEEP WELL SOLAR PUMP

### FIELD OF THE INVENTION

This invention provides a pump that can use solar generated steam or any gas under pressure to raise water from a deep well.

### DESCRIPTION OF THE PRIOR ART

Bladder pumps are known. A deep well pump, known as the Vergnet pump, has a single layer elastic bladder in a pump cylinder. The pump cylinder has an inlet check valve, an outlet check valve, an actuating tube extending down the well to the pump bladder, and a water delivery tube extending up the well from the outlet check valve. In the Vergnet pump water is forced down the actuating tube by a plunger operated by stepping on a foot pedal. This expands the bladder forcing water up the delivery tube. On releasing the pedal, the bladder contracts drawing water into the pump cylinder through the inlet check valve and forcing water back up the actuating tube for a subsequent pump cycle.

### SUMMARY OF THE INVENTION

It is an object of this invention to provide a deep well pump operated by solar generated steam for use in non-industrialized countries that lack fuels.

Another object of this invention is to provide a solar deep well pump that may be very easily manufactured for a low capital cost using readily available materials.

A further object of this invention is to provide a pump of maximum efficiency operated by solar generated steam or any other source of gas under pressure.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the deep well solar pump of this invention with portions shown in section and with a connected steam generating solar collector shown in perspective;

FIG. 2 is a vertical section through a steam injection valve;

FIG. 3 is a longitudinal section through a bladder pump cylinder having a bladder modified according to this invention;

FIG. 4 is a vertical section through a broken away fragment of the pump showing a modified expansion chamber; and,

FIG. 5 is a vertical section through a broken away fragment of the pump showing a modification providing pressurized water.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in detail, FIG. 1 shows the deep well pump of this invention. A single axis tracking collector 10 has a tubular steam boiler 11 in its focus. An insulated steam line 13 leads to steam injection valve 14 of the mechanism generally designated by the reference numeral 15.

A well casing 16 contains a pump cylinder 18 which is also shown in FIG. 3. An actuating tube 20 and a water delivery tube 22 extend down the well casing 16. Water delivery tube 22 is connected to an outlet check valve 24 mounted on and allowing flow upward past a top closure 26. Actuating tube 20 extends through top closure 26 to enter an elastic bladder 28. An inlet check

valve 30 at the bottom of cylinder 18 allows well water flow into cylinder 18.

Mounted on a suitable frame member 32 is a base plate 34 through which steam injection valve 14 is mounted. As shown in FIG. 2, steam injection valve 14 receives steam through line 13 in the leg of "T" 36. Steam delivery line 38 is fixed to base plate 34 and mounts "T" 36. A small tubular extension 40 extends upward from "T" 36 to have a soft rubber sleeve 42 clamped about it by clamp 43. A valve shaft 44 extends slidably through extension 40 and through sleeve 42. Sleeve 42 has its lower end clamped about extension 40 by clamp 43. The upper end of the rubber sleeve 42 is clamped gas tight around valve shaft 44 by clamp 45.

A tapered plug 46 at the lower end of shaft 44 seals the upper end of tube 38. The plug 46 can be the readily available center cone bearing of a bicycle wheel.

As shown in FIG. 1, a mounting bracket 48 is fixed on base plate 34. An upstanding support 50 has a control lever 52 pivotally mounted at its upper end. A long period pendulum 54 has a shaft 56 centrally fixed to and rotatably mounted by axle 60. Shaft 56 has weight 57 and 58 at its ends. Weight 58 is either heavier or further from axle 60 than weight 57. This tends to turn pendulum 54 clockwise as shown so weight 58 is in a lowermost first position. A pendulum arm 62 is fixed to axle 60 at right angles to shaft 56. A wire link 64 extends upward from arm 62 through a clearance aperture 65 in lever 52. An adjustable nut 66 is disposed on link 64 so that, when pendulum 54 is substantially vertical in the first position, nut 66 will pull down the end of control lever 52. Link 64 may be a bicycle wheel spoke.

Valve shaft 44 also has an adjustable nut 66 at its upper end. When the pendulum 54 swings clockwise to a second position to rotate control lever 52 clockwise by means of link 64, valve shaft 44 is pulled upward stretching rubber sleeve 42 and opening steam injection valve 14. Steam then flows through line 38 into a tube or pipe nipple 68 which has an exhaust valve 70 at its upper end with a swinging closure 71. Exhaust valve 70 may be a conventional swing check valve. Below tube 68 is an expansion chamber 72 connected to the upper end of actuating tube 20. An impulse tube 74 leads from below expansion tank 72 to an impulse bladder 76. Bladder 76 may be a short length of bicycle inner tube sealed about the end of tube 74 and closed at the other end of the short length.

A length of angle iron 78 is fixed to base 34. Angle iron 78 has a surface 79 adjacent to impulse bladder 76 so that bladder 76 is between shaft 56 and surface 79 at the first position of the swing of pendulum 54. In this position of pendulum 54, steam injection valve 14 is opened so that the steam pressure acting through water in expansion chamber 72 inflates impulse bladder 76 to push against and give an impulse to pendulum 54 to maintain its oscillating motion.

Expansion chamber 72 is filled with water 75 as is actuating tube 20 and pump bladder 28. Steam under pressure introduced in expansion chamber 72 forces water down tube 20 to inflate bladder 28 and force water to the top of the well casing 16 through delivery tube 22. Nut 66 is adjusted so that steam injection valve 14 closes after a short interval to allow steam in chamber 72 to continue to expand while pendulum 54 rotates counter-clockwise as it is shown in FIG. 1.

When pendulum 54 is substantially horizontal in a second position, a striker 80 on arm 56 forces plunger 82 down against the slight upward force of compression

spring 84. Plunger 82 opens the swinging closure 71 of exhaust valve 70 against gas pressure to open expansion chamber 72 to the atmosphere. The opening of exhaust valve 70 allows pump bladder 28 to contract and force water back up tube 20 into chamber 72. As the elastic pump bladder 28 contracts, more water to be pumped is drawn into cylinder 18 through check valve 30. As pendulum 54 swings clockwise from the horizontal position, an elastic strand 86 fixed between arm 56 and the swinging closure 71 closes exhaust valve 70 so that later injected steam will be contained within expansion chamber 72. The elastic strand 86 only need close the swinging closure 71 and exerts so small a force that it does not restrict motion of the pendulum 54. Strand 86 is of a length to allow exhaust valve 70 to remain open for a needed period of time so that contraction of pump bladder 28 can accelerate water up actuating tube 20 into chamber 72.

To increase the efficiency of the steam injection pump, the pump bladder 28 is made from several layers 90, 91, and 92 of tubular elastic material such as the elastomer butyl. According to the vertical distance the expansion chamber 72 is above bladder 28, additional layers 90 may be added so that the head of water pressure is about balanced by the contraction of the bladder 28. This allows a minimum steam pressure only slightly greater than the head of water above bladder 28 to expand bladder 28 and force water up delivery tube 22. If water is being pumped up 68 feet, a minimum steam pressure of 30 psig is required. If steam is injected at a higher pressure, the steam may be made efficiently used as it can be allowed to expand to 30 psig after closure of the injection valve 14 and before the pendulum 54 opens exhaust valve 70.

As in all bladder pumps, there may be some slight loss of water through leakage from the actuating tube 20 or the bladder 28. In the pump of this invention, any loss is made up by the condensation of steam in the expansion chamber 72. When pumping at moderate depths, condensation will take place in expansion chamber 72 as it is cooled by air. If too much condensate water 75 starts to overflow chamber 72, its level is automatically regulated as too high a water 75 level will allow some water 75 to be blown out exhaust valve 70 on its opening.

When pumping at depths that require higher pressure and temperature steam, expansion chamber 72 may become heated so steam will not condense in it. As shown in FIG. 4, expansion chamber 72' is surrounded by a water jacket 96 which is entered by delivery tube 22'. Water jacket 96 has an outflow spout 97. Water jacket 96 allows pumped water to cool expansion chamber 72' and ensure condensation in it.

As shown in FIG. 5, a pressurized water tube 98 leads from expansion chamber 72' through a check valve 99 into a pressure tank 100. Tank 100 provides a limited source of water under pressure when valve 101 is opened to operate a solar tracking device (not shown) for solar collector 10 or for other purposes. The amount of pressurized water is limited as it is derived from condensation.

The most available and least costly material for the tubes 20 and 22 is polyethylene tubing. So that this tubing won't be softened by heat from steam, the first upper few feet of tube 20 may be of copper tubing or steel pipe. While this pump has been described as a deep well pump, it can also pump from shallow wells, lakes, or rivers. The tolerances required for its manufacture are very wide so that it can be built in non-industrialized

countries using hand tools. If a source of gas under pressure is available, it can be used in place of steam to operate the pump. The injection mechanism with its pendulum can be set to provide as long or as short a period as required. Moving the weights 57 and 58 inward toward axle 60 speeds up the period of oscillation. The injection mechanism can also be used to directly inject steam or any gas under pressure into a direct injection pumping device.

What is claimed is:

1. In a pump having a source of gas under pressure, and a gas operated pump, a mechanism periodically injecting gas from said source of gas into said gas operated pump, said mechanism comprising, in combination, a long period pendulum turning towards a first position by gravity, an injection valve connected between said source of gas under pressure and said gas operated pump, a linkage between said pendulum and said injection valve, said linkage opening said injection valve when said pendulum is in said first position, an impulse tube connected between said injection valve and said gas operated pump, a member having a surface adjacent to the first position of said pendulum, and an elastic impulse bladder connected to said impulse tube adjacent to said surface so that inflation of said impulse bladder on the opening of said injection valve forces said impulse bladder against said pendulum urging said pendulum against the force of gravity toward a second position.

2. The combination according to claim 1 wherein said gas pressure operated pump is a bladder pump having a pump cylinder, an inlet check valve in said pump cylinder, an actuating tube extending into said pump cylinder, an elastic bladder in said pump cylinder connected to said actuating tube, an outlet check valve leading from said pump cylinder, and a water delivery tube extending from said outlet check valve, said mechanism injecting gas under pressure injecting gas into said actuating tube, and with the addition of an expansion chamber between said injection valve and said actuating tube, an exhaust valve to the atmosphere connected to said expansion chamber, and means activated by said pendulum in said second position opening said exhaust valve.

3. The combination according to claim 2 wherein said source of gas under pressure is a solar collector having a focus, and a steam boiler in the focus of said collector, said exhaust valve having a swinging closure, and with the addition of a striker on said pendulum, a plunger above said exhaust valve, said striker contacting said plunger when said pendulum is in said second position forcing said plunger down against said swinging closure of said exhaust valve opening said exhaust valve, and means closing said swinging closure on subsequent movement of said pendulum towards said first position.

4. The combination according to claim 3 wherein said means closing said swinging closure is an elastic strand connected between said swinging closure and said pendulum.

5. The combination according to claim 4 with the addition of a rotatable axle mounting said pendulum, a pendulum arm on said rotatable axle, a pivotally mounted control arm having a first end above said pendulum arm and a second end above said injection valve, said control arm end above said pendulum arm containing an aperture, a link from said pendulum arm extending slidably through said aperture in said control arm, and an adjustable nut on said link so that said nut pivots said control arm when said pendulum is in said first

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position, and means at said second end of said control arm opening said injection valve.

6. The combination according to claim 5 wherein said injection valve has a "T" with upper and lower ends and a leg, said steam boiler being connected to said leg, said expansion chamber being connected to said lower end of said "T", a valve shaft extending down through the upper end of said "T", a plug at the lower end of said valve shaft closing said lower end of said "T", and a soft rubber tube disposed about said valve shaft fixed at the upper end of said "T" and to said valve shaft, said valve shaft being connected to said second end of said control arm so that pivoting of said control arm lifts said valve shaft stretching said rubber tube and raising said plug to open said injection valve.

7. The combination according to claim 6 wherein said elastic pump bladder has multiple layers, the number of said layers substantially balancing the head of water above the pump bladder.

8. The combination according to claim 7 with the addition of a water jacket disposed about said expansion chamber, said water delivery tube conducting pumped water into said water jacket, and an outflow spout conducting pumped water from said water jacket.

9. The combination according to claim 7 with the addition of a pressure vessel, a pressurized water tube connecting said expansion chamber and said pressurized vessel, and a check valve in said pressurized water tube allowing flow from said expansion chamber into said pressurized vessel.

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US005222553A

# United States Patent [19]

[11] Patent Number: **5,222,553**

Temple

[45] Date of Patent: **Jun. 29, 1993**

## [54] WATER WELL PUMP

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[21] Appl. No.: **875,418**

[22] Filed: **Apr. 29, 1992**

[51] Int. Cl.<sup>5</sup> ..... **E03B 3/08; E21B 43/00**

[52] U.S. Cl. .... **166/75.1; 166/105; 417/544**

[58] Field of Search ..... **166/75.1, 81, 84, 105, 166/106; 417/544**

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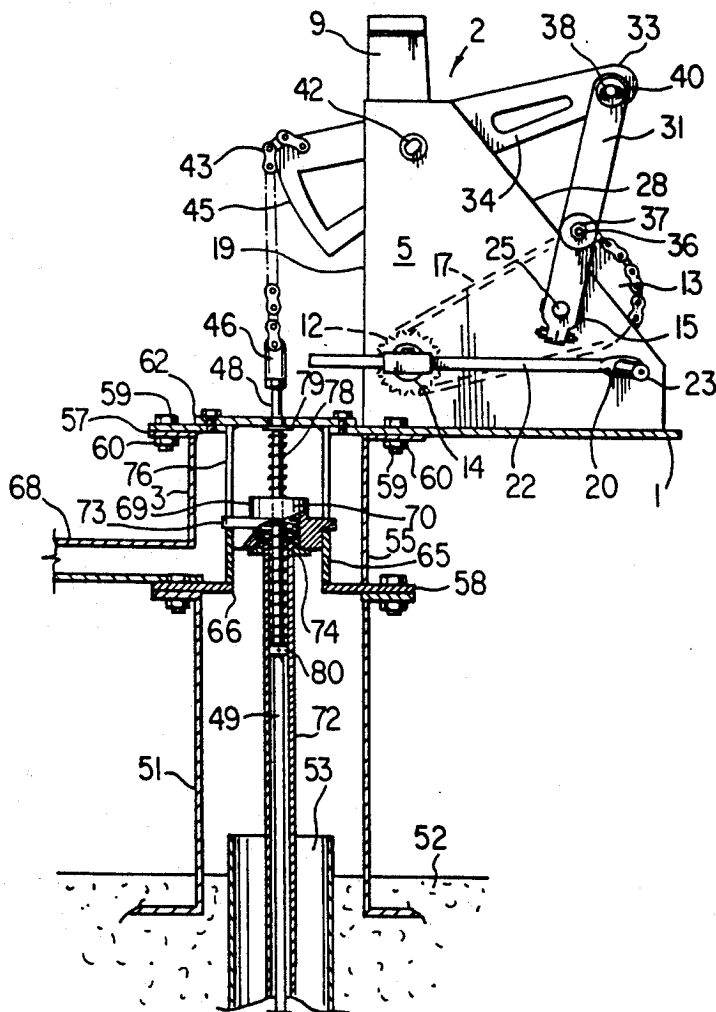
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*Primary Examiner*—Terry Lee Melius  
*Attorney, Agent, or Firm*—George H. Dunsmuir

### [57] ABSTRACT

A manually operable water well pump includes a baseplate with a casing thereon, a rocker arm pivotally mounted in the casing for reciprocating movement therein, a chain on one end of the rocker arm outside the casing for reciprocating vertical movement with the rocker arm, a connector on the free end of the chain for connecting the latter to a pump rod, whereby the rod can be reciprocated in a well casing, the transmission in the casing including a pair of gears interconnected by an endless chain, a crank for rotating the smaller of the gears and a linkage between the larger of the gears and the other end of the rocker arm for reciprocating the latter, and a tank suspended from the baseplate concentric with the pump rod for mounting on a well casing to receive and discharge water from the well.

**9 Claims, 4 Drawing Sheets**



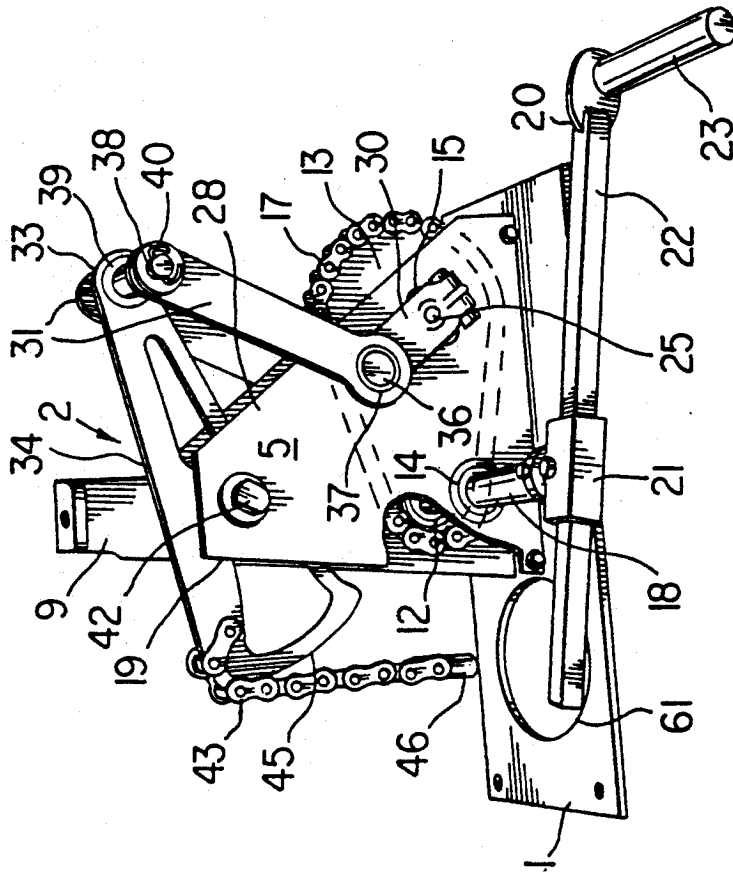


FIG. 2

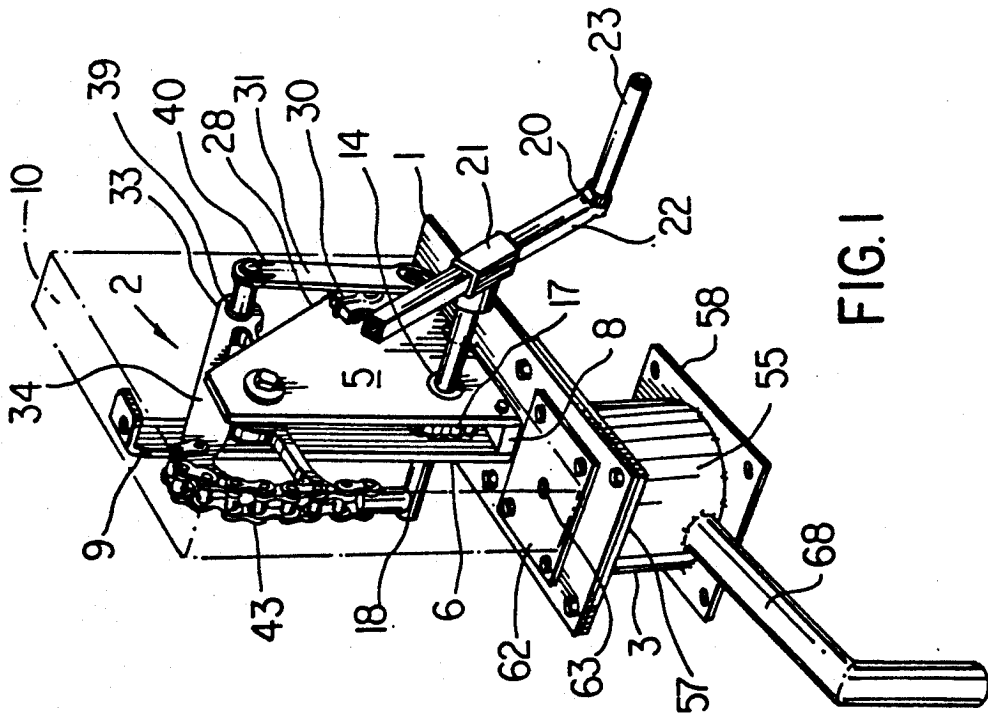


FIG. 1





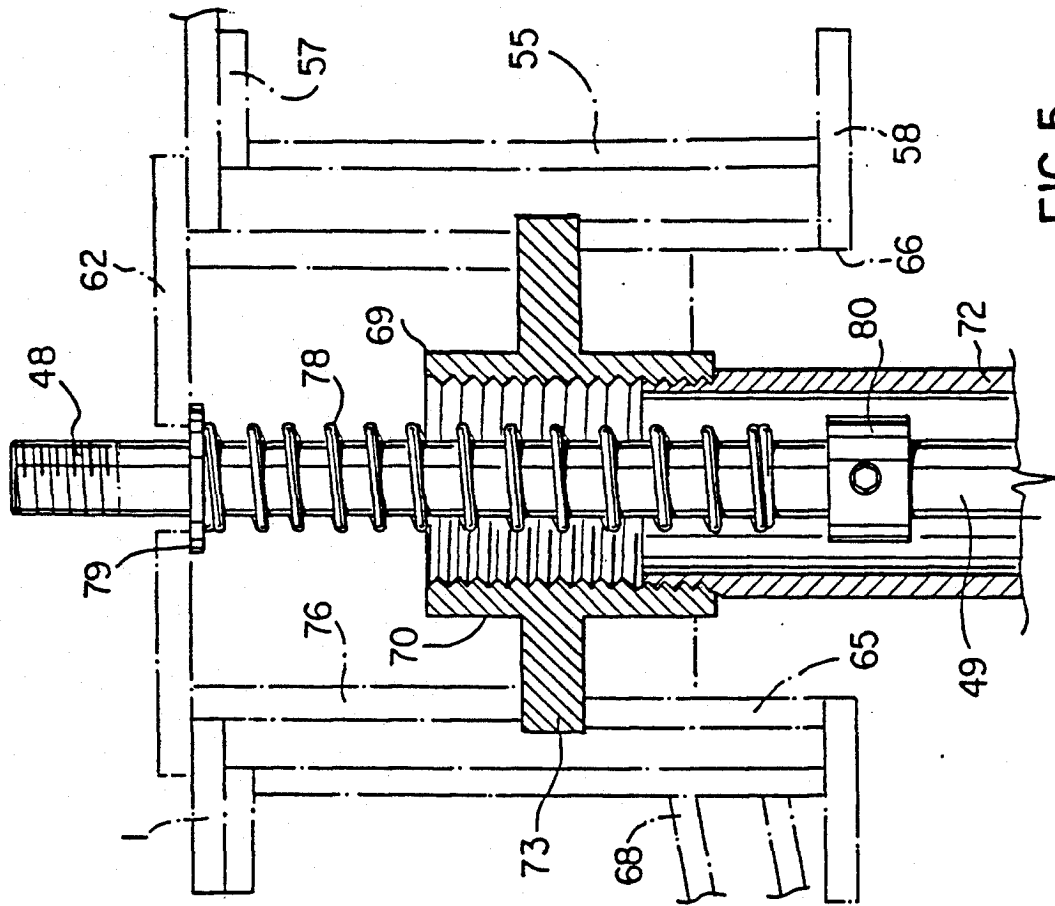


FIG. 5

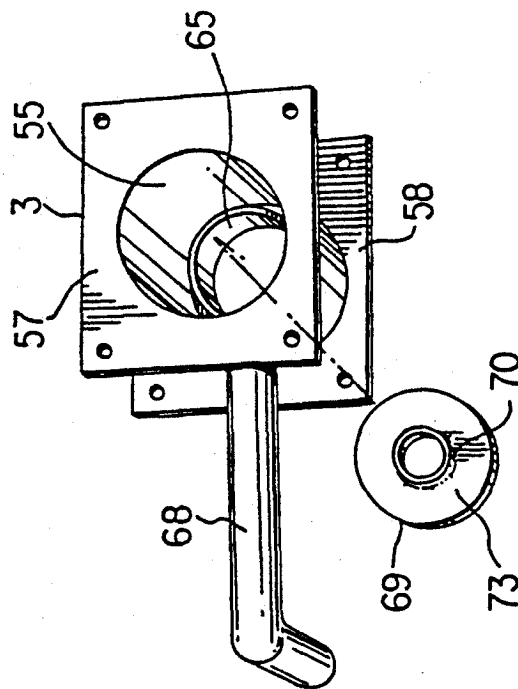


FIG. 4

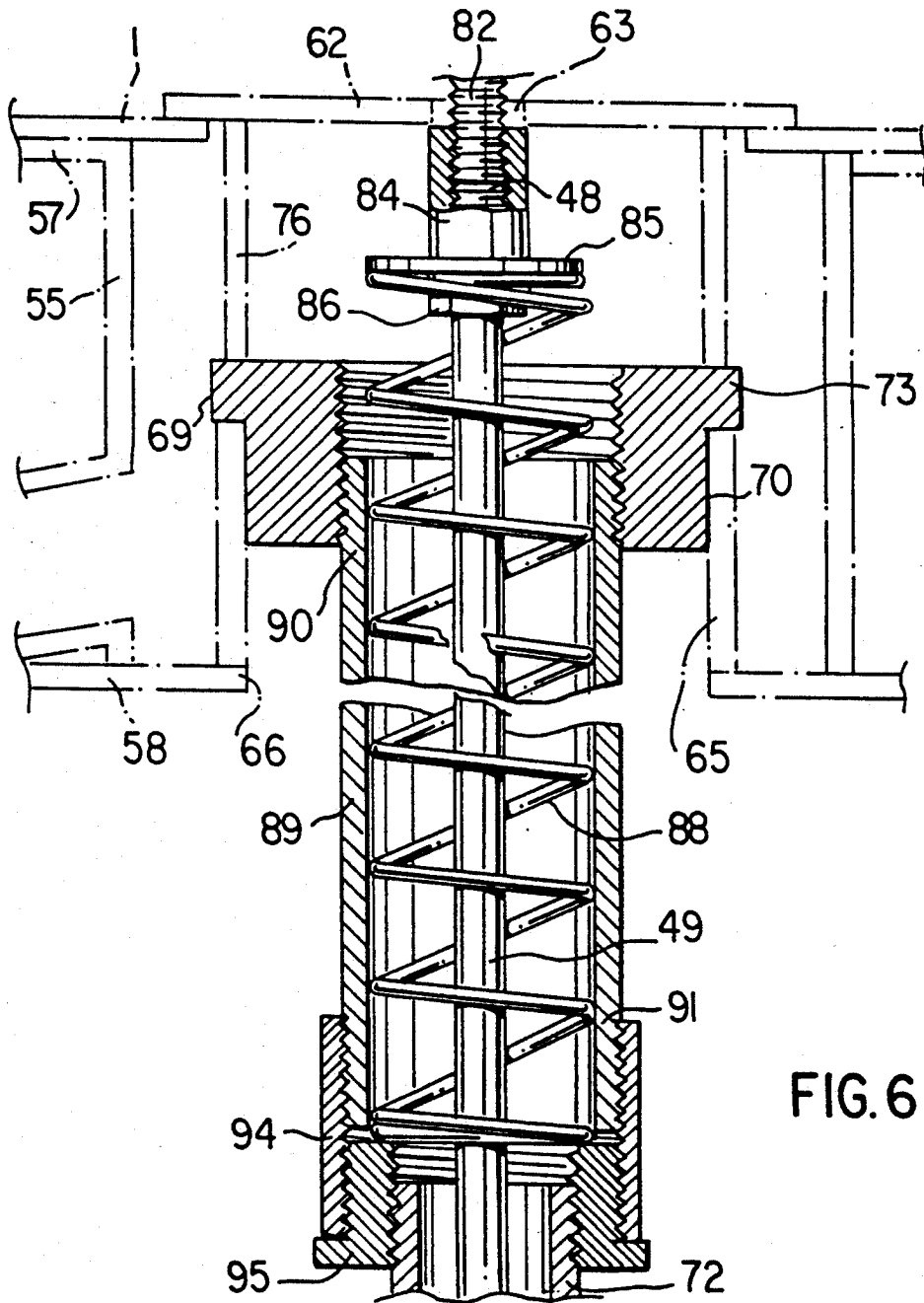


FIG.6

## WATER WELL PUMP

### BACKGROUND OF THE INVENTION

This invention relates to a pump, and in particular to a manually operable pump for a water well. The conventional pump for a water well is a simple device, which is operated by a long handle or lever. Over the years there has been precious little change in the structure of such pumps, which can be somewhat mechanically inefficient. The present inventor has found that this problem can be solved by using some of the same principles used in pump jacks for oil wells.

The object of the present invention is to provide a relatively simple pump for a water well, which is mechanically efficient and easy to operate.

### BRIEF SUMMARY OF THE INVENTION

Accordingly, the present invention relates to a pump comprising baseplate means; casing means on said baseplate means; rocker arm means mounted in said casing means for reciprocating rotary movement therein; drive means in said casing means for rotating said rocker arm means; chain means on an outer end of said rocker arm means for reciprocating vertical movement with said rocker arm means; coupler means on said chain means for connecting the latter to a pump rod, whereby the rod can be reciprocated in a well casing; and tank means suspended from said baseplate concentric with said pump rod for mounting on a well casing to receive water from the well.

### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail with reference to the accompanying drawings, which illustrate a preferred embodiment of the invention, and wherein:

FIG. 1 is a schematic, isometric view from above and one end of a pump in accordance with the present invention;

FIG. 2 is a partly sectioned, isometric view of the pump of FIG. 1 from one side and slightly above with parts omitted;

FIG. 3 is a partly sectioned side view of the pump of FIGS. 1 and 2 in the use position;

FIG. 4 is an exploded, isometric view of a tank and pipe retainer used in the pump of FIGS. 1 to 3;

FIG. 5 is a longitudinal sectional view of a pump rod and spring assembly used in the apparatus of FIGS. 1 to 3; and

FIG. 6 is a longitudinal sectional view of an alternate form of pump rod and spring assembly for use in the apparatus of the present invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Wherever possible the same reference numerals have been used in the various figures of the drawings to identify the same or similar elements.

With reference to FIGS. 1 to 3; the pump of the present invention includes a baseplate 1, which carries a casing generally indicated at 2 and a cylindrical tank 3. The casing 2 is defined by a pair of generally triangular sides 5 and 6 interconnected at their bottom ends by a strip 8. An inverted L-shaped post 9 integral with one of the sides 6 extends upwardly for supporting a cover 10 (FIG. 1). The cover 10 is intended to protect the user.

A pair of toothed sprockets 12 and 13 are mounted in bearings 14 and 15, respectively in each of the sides 5 and 6 of the frame 2. A chain 17 extends around the sprockets 12 and 13. A shaft 18 carrying the smaller sprocket 12 extends through the bearings 14 beyond the frame sides 5 and 6 at one end 19 of the frame 2. The shaft 18 is rotated by an elongated L-shaped crank 20, which is connected to the shaft 18 by a T-shaped, tubular coupler 21. The outer end of the coupler 21 and the longer arm 22 of the crank 20 have a square cross section, and the short arm 23 of the crank is cylindrical for use as a handle by the pump operator. Rotation of the shaft 18 is accompanied by rotation of the transmission defined by the sprockets 12 and 13, and the chain 17. A short shaft 25 carrying the larger sprocket 13 extends through the bearings 15 in the sides 5 and 6 at the other end 28 of the frame 2.

Articulated crank arms 30 and 31 connect each outer end of the shaft 25 to one end 33 of a rocker arm 34. The arms 30 and 31 are pivotally interconnected by a pin 36 and a roller bearing 37. The upper end of each top arm 31 is pivotally connected to one end of a shaft 38, which extends through a bearing 39 in the end 33 of the rocker arm 34. The arms 31 are retained on the shaft 38 by a cotter pin 40.

The generally triangular rocker arm 34 is pivotally mounted on a shaft 42 extending between the sides 5 and 6 of the frame 2 near the end 19. One end of a chain 43 is connected to the top of the arcuate outer free end 45 of the rocker arm 34. The chain 43 straddles the end 45 of the rocker arm 34, so that the rocker arm engages the chain during reciprocating rotation of the arm around the axis of the shaft 42. An internally threaded coupler 46 is provided on the bottom end of the chain 43 for connecting the latter to the threaded upper end 48 (FIGS. 3 and 5) of a pump rod 49. The pump rod 49 extends downwardly through the tank 3 and a standpipe 51, which is embedded in a concrete pad 52 at the top of a well casing 53.

As best shown in FIG. 4, the tank 3 includes a cylindrical side wall 55, and rectangular top and bottom plates 57 and 58, respectively. The top plate 57 is connected to the baseplate 1 by bolts 59 and nuts 60 (FIGS. 1 and 3) beneath an opening 61 (FIG. 2) in the baseplate 1. The opening is closed by a square cover 62 with a hole 63 in the center thereof for slidably receiving the rod 49. An inlet pipe 65 extends upwardly from the bottom plate 58 around a central opening 66 therein. An L-shaped outlet spout 68 extends outwardly from the side wall 55 near the bottom end thereof.

The top of the pipe 65 is closed by a riser pipe retainer 69, which includes a central, internally threaded sleeve 70 for mounting on the top end of a well riser pipe 72. An annular flange 73 extends outwardly from the sleeve 70 for seating on the pipe 65. In the form shown in FIG. 3, an externally threaded coupler 74 is mounted on the top end of the pipe 72, and connected to the retainer 69. In the embodiment of the invention shown in FIG. 5, the sleeve 70 is connected directly to the top end of the pipe 72. In each case, a slotted, cylindrical sleeve 76 extends downwardly from the plate 72 and seats on the retainer 69.

A helical spring 78 is mounted on the rod 49 between a washer 79, which bears against the plate 62 and a collar 80 on the rod 49. The spring 78 biases the rod 49 downwardly, ensuring a smooth return stroke when the rod is released from the chain 43. The structure illustrated in FIGS. 3 and 5 is designed for shallow wells.

An assembly intended for deep well use is shown in FIG. 6. In the assembly of FIG. 6, a threaded rod 82 extends downwardly from the sleeve 46 on the bottom end of the chain 43 through the hole 63 in the plate 62. The rod 82 is connected to the upper end 48 of the rod 49 by an internally threaded coupler 84. A washer 85 is sandwiched between the coupler 84 and a nut 86. The washer 85 acts as a top stop for a heavy duty helical spring 88, which is coaxial with the rod 49. The spring 88 is housed in a tube 89 with externally threaded top and bottom ends 90 and 91, respectively for connecting the tube to the retainer 69 at the top end, and to a sleeve 94 and tubular coupler 95 at the bottom end thereof. The coupler 95 is mounted on the top end of the riser pipe 72, and acts as a seat for the bottom end of the spring 88.

In the operation, when the handle 23 is grasped to turn the crank 22, the gears 12 and 13, and the chain 17 are caused to rotate. Such motion is transmitted through the arms 30 and 31 to the rocker arm 34, which is caused to reciprocate around the axis of the shaft 42. Consequently, the chain 43 and the rod 49 are caused to reciprocate in the riser pipe 72. Water drawn up through the tube 72 enters the tank 3 and is discharged via the slotted sleeve 76 and the spout 68.

As will also be appreciated, while the two embodiments of the invention described above, are adapted for manual actuation, in each case the pump could be power driven by, for example an electric, gasoline, or hydraulic motor.

What is claimed is:

1. A pump comprising baseplate means; casing means on said baseplate means; rocker arm means mounted in said casing means for reciprocating rotary movement therein; drive means in said casing means for rotating said rocker arm means; chain means on an outer end of said rocker arm means for reciprocating vertical movement with said rocker arm means; coupler means on said chain means for connecting the latter to a pump rod, whereby the rod can be reciprocated in a well casing; and tank means suspended from said baseplate concentric with said pump rod for mounting on a well casing to receive water from the well.

2. A pump according to claim 1, wherein said drive means includes transmission means in said casing means

connected to said rocker arm means; and crank means on said casing means for manually operating said transmission means.

3. A pump according to claim 2, wherein said transmission means includes first, small gear means for rotation by said crank means; second, larger gear means for reciprocating rotation of one end of said rocker arm means; and endless chain means extending around said first and second gear means.

4. A pump according to claim 3, wherein said crank means includes shaft means extending through said casing means and said first gear means; and handle means on one outer end of said shaft means for rotating the latter.

5. A pump according to claim 1, including tubular retainer means in said tank means for mounting on the top end of a well riser pipe; and helical spring means for mounting on the pump rod for biasing the latter downwardly into a well.

6. A pump according to claim 5, wherein said tank means includes a cylindrical side wall, an annular bottom wall, inlet tube means extending upwardly from the inner periphery of said bottom wall for supporting said retainer means; and outlet means in said side wall for discharging water from the tank means.

7. A pump according to claim 6, wherein said tank means includes cover means on said baseplate means for slidably receiving the pump rod; and slotted first sleeve means extending downwardly from said cover means into engagement with said retainer means, whereby water entering the tank means through said inlet tube means is discharged through said first sleeve means and said outlet means.

8. A pump according to claim 7, wherein said retainer means includes second, internally threaded sleeve means for connection to a well riser pipe around said pump rod; and annular flange means for seating on said inlet tube means and for supporting said first sleeve means.

9. A pump according to claim 8, including third sleeve means for mounting on the pump rod beneath said tank means, said third sleeve means retaining said spring means on the upper end of the pump rod.

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# United States Patent [19] Smith

[11] Patent Number: **5,618,169**  
[45] Date of Patent: **Apr. 8, 1997**

- [54] **WATER WELL PUMP CYLINDER COMPONENTS**
- [76] Inventor: **Loren E. Smith**, Box 277, Higgins, Tex. 79046
- [21] Appl. No.: **615,550**
- [22] Filed: **Mar. 11, 1996**
- [51] Int. Cl.<sup>6</sup> ..... **F04B 47/12; F04B 53/14**
- [52] U.S. Cl. .... **417/554; 417/555.1; 417/555.2; 92/242**
- [58] Field of Search ..... **417/545, 554, 417/555.1, 555.2; 92/242**

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*Primary Examiner*—Timothy Thorpe  
*Assistant Examiner*—William Wicker  
*Attorney, Agent, or Firm*—Robert K. Rhea

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[57] **ABSTRACT**

Water well pump plunger efficiency is improved by providing a pair of upwardly open outwardly flared wall cups surrounding a pump plunger and supported in superposed relation by a sleeve in the lowermost cup. A fluid passageway through the base of the uppermost cup insures filling the lowermost cup on the plunger upstroke.

**8 Claims, 2 Drawing Sheets**

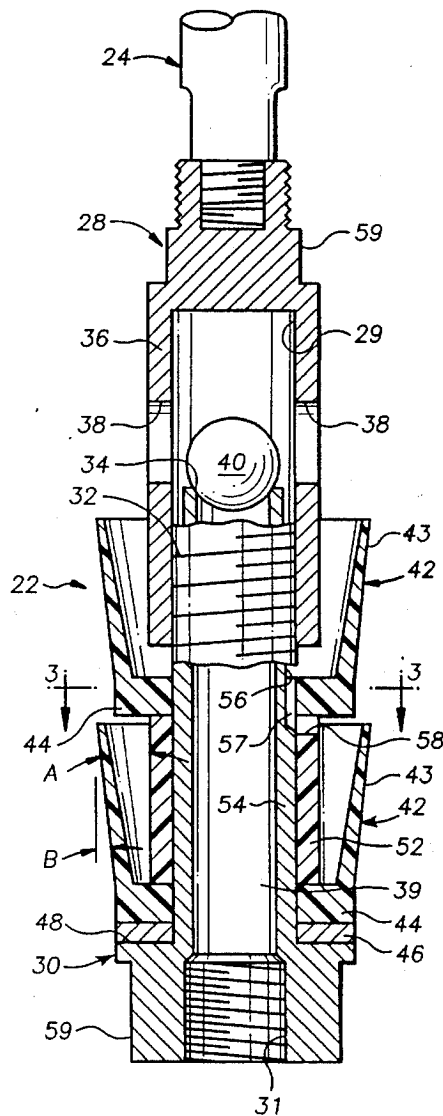


FIG. 1

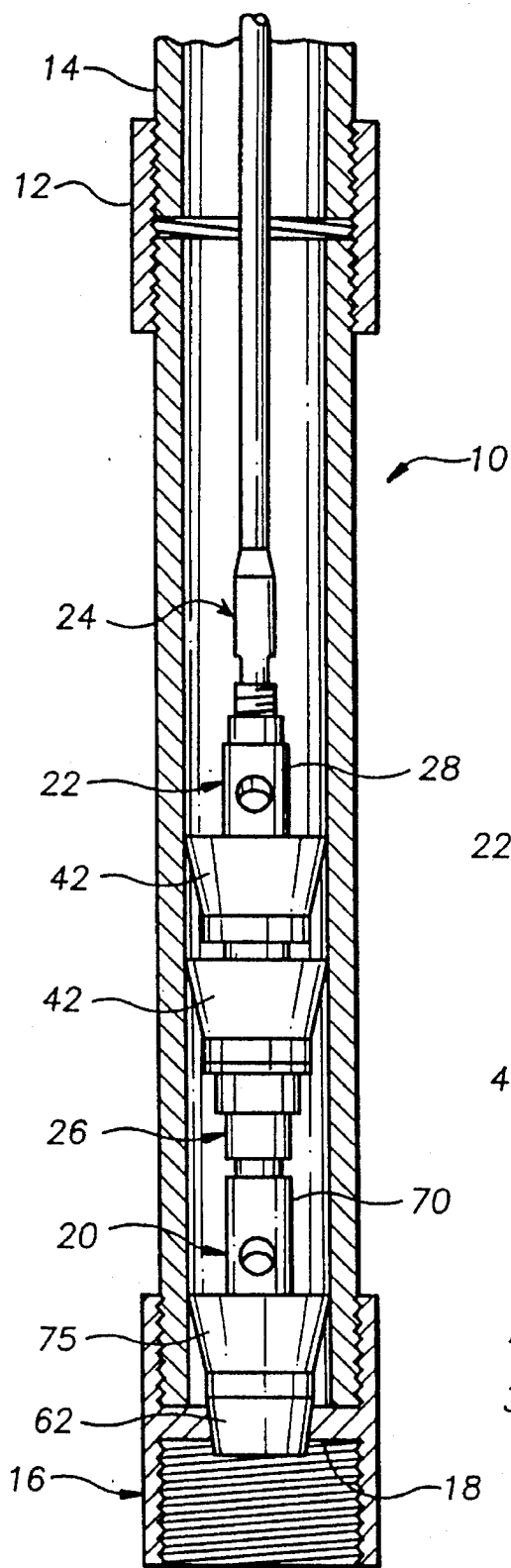


FIG. 2

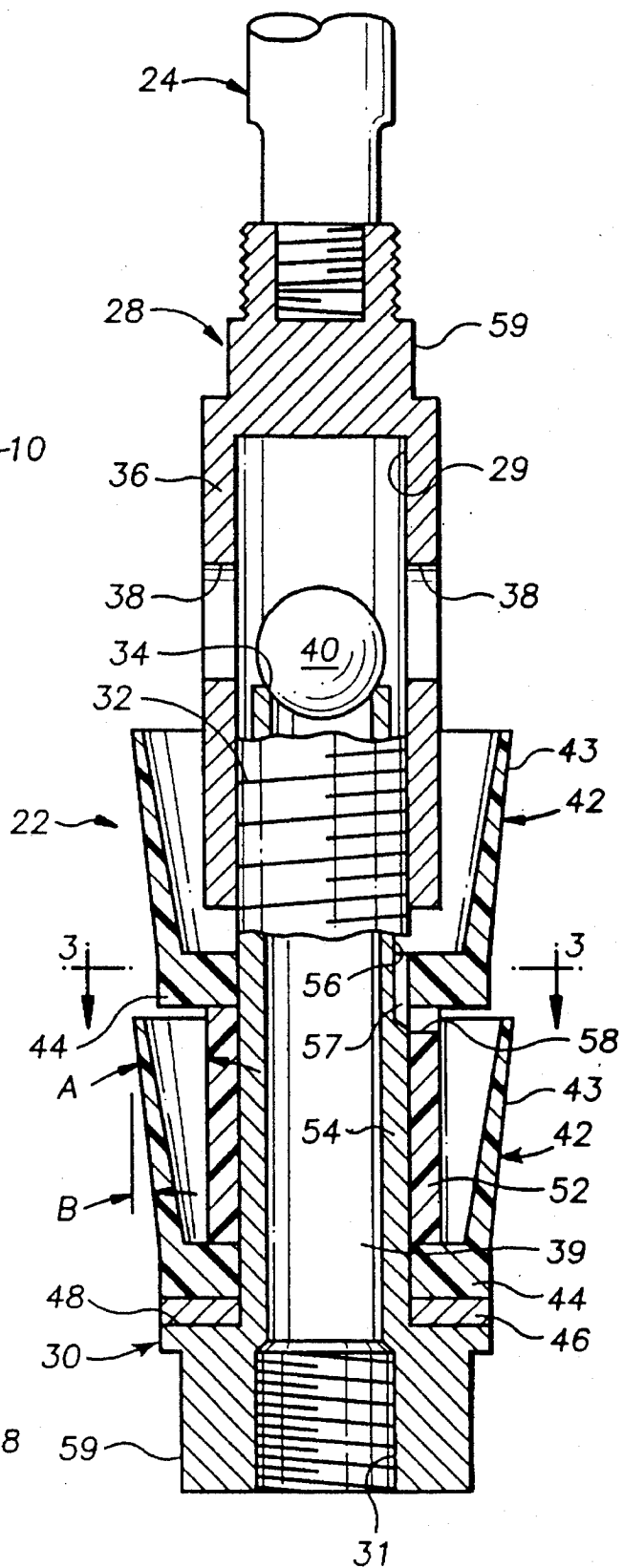


FIG. 3

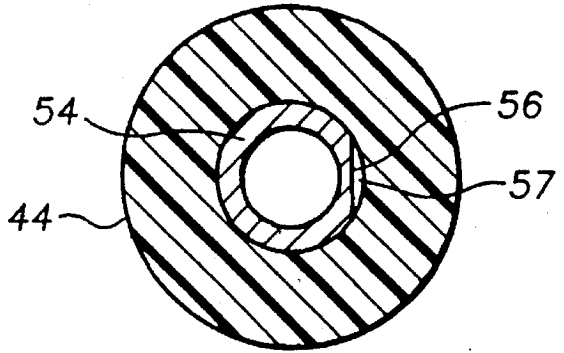


FIG. 4

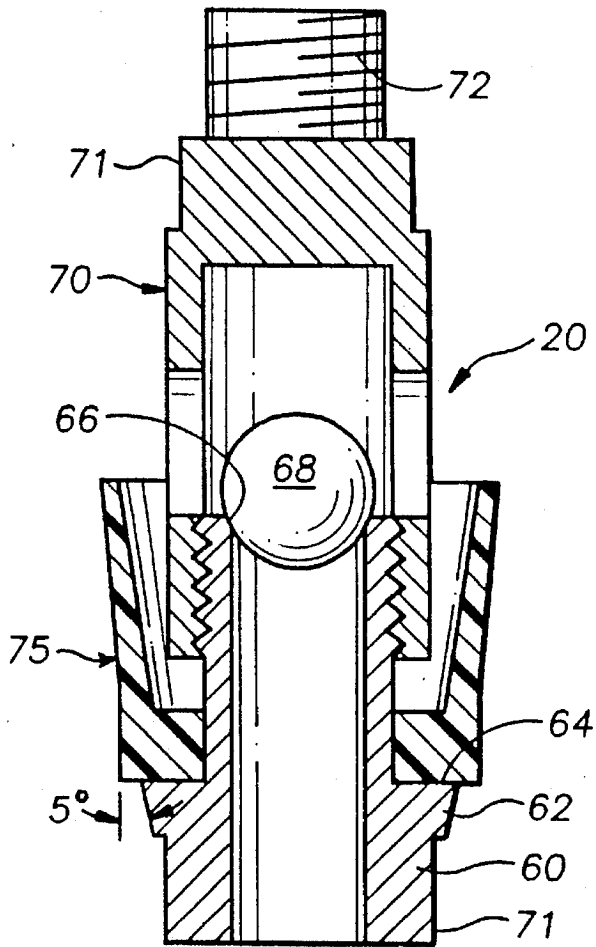
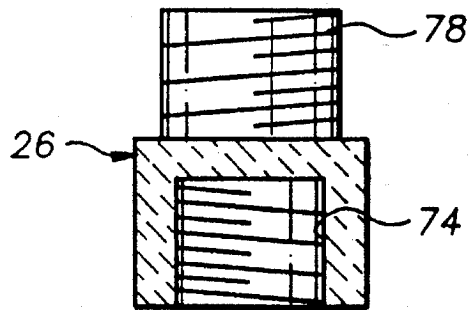


FIG. 5



## WATER WELL PUMP CYLINDER COMPONENTS

### BACKGROUND OF THE INVENTION

The present invention relates to water wells and more particularly to improvements in pump components.

#### 1. Field of the Invention

Water well pumping apparatus usually comprises a pump cylinder lowered into a well bore on the depending end of a tubing string. The cylinder having means at its lowermost end for supporting a check valve generally referred to as a standing valve. A gas anchor, such as a length of perforated screened pipe, may depend axially from the cylinder, if desired. A string of sucker rods are installed in the tubing, and supports at its lowermost end, a hollow plunger having a top end traveling valve, within the cylinder. The plunger has an annular seal or seals which contacts the inner periphery of the cylinder for progressively lifting fluid to exit the surface of the earth at the upper limit of the tubing string by the vertical reciprocating action of the sucker rods by a suitable mechanism at the surface of the earth. Up stroke of the sucker rods reduces the pressure in the cylinder below the plunger to open the standing valve and draw water into the depending end portion of the cylinder. Downward movement of the sucker rods and plunger closes the standing valve and opens the traveling valve for moving water through the plunger into the cylinder above the position of the annular seal or seals. Subsequent upward movement of the sucker rods closes the plunger top valve by gravity and the static head and lifts the water above the plunger seals toward the surface of the earth while simultaneously repeating the opening of the standing valve and filling the depending end of the cylinder.

The above described water well pumping apparatus is improved by this invention by providing an improved type plunger cup which by its manner of construction improves its seal with the inner periphery of the cylinder by the static head and has a long useful life and further provides an improved standing valve seating and retrieval device.

#### 2. Description of the Prior Art

U.S. Pat. No. 430,919 issued Jun. 24, 1890 to Campbell, et al for oil pump, and U.S. Pat. No. 1,039,496 issued Sep. 24, 1912 to Daniels, et al for expanding sleeve for standing valve are considered good examples of the state-of-the-art. The Campbell et al patent discloses a series of cup shaped seals around the centrally bored plunger sealing with the wall of a working barrel, and a standing valve which is tethered to the plunger for removal therewith as a unit.

The Daniels, et al patent discloses a plunger seal of the cylindrical type and a standing valve also tethered to the plunger.

This invention is believed distinctive over these and other similar patents by providing a plurality of cup-like seals on a pump plunger in which the outwardly flared upwardly tapering wall of the cup seal is biased outward into engagement with the inner periphery of the surrounding cylinder by the static head of fluid and upward movement of the plunger. Further, this invention provides a frangible coupler between the depending end of the plunger and the standing valve which is shattered at the time of installation of the standing valve in the depending end of the working cylinder.

#### SUMMARY OF THE INVENTION

An elongated hollow sucker rod reciprocated plunger, dimensioned to be cooperatively received by the bore of a

conventional working barrel or cylinder, is provided with a top traveling valve and cage and at least two superposed peripheral cup seals. A longitudinal planar surface subtends an arc of the plunger periphery and extends across the top cup base to fill the bottom cup with fluid before and during upward movement of the plunger relative to the cylinder to insure a fluid tight seal of both upper and lower cup walls with the inner periphery of the cylinder.

A standing valve, adapted for seating on an annular inner shoulder at the depending end of the cylinder, is removably connected with the depending end of the plunger by a biodegradable frangible coupler. The coupler is shattered by striking the uppermost end of the sucker rod string when the standing valve is initially contacting the annular shoulder which releases the plunger from the standing valve while simultaneously seating it on the annular shoulder.

The principal objects of this invention are to provide a plurality of superposed cups surrounding the plunger in a water well pump cylinder to insure both cups being filled with water on the upstroke of the plunger for biasing the cup walls outwardly in intimate contact with the cylinder inner wall surface for moving all water above the position of the cups upwardly on each upstroke of the plunger; to provide a standing valve with an upwardly open cup which maintains a seal with the cylinder wall by the static head; and, to provide a biodegradable coupler separably joining the plunger to the standing valve for seating the latter on a standing valve seat.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary vertical cross sectional view of a pump cylinder containing the improved plunger, cups and standing valve, the plunger being connected with the depending end of a sucker rod string;

FIG. 2 is a vertical cross sectional view of the plunger assembly;

FIG. 3 is a horizontal sectional view taken substantially along the line 3—3 of FIG. 2;

FIG. 4 is a vertical cross sectional view of the standing valve; and,

FIG. 5 is a vertical cross section of the frangible coupler.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Like characters of reference designate like parts in those figures of the drawings in which they occur.

In the drawings:

The reference numeral 10 indicates a conventional water well cylinder connected by a coupling 12 to the depending end portion of a tubing string 14 within a casing equipped well bore, not shown. The cylinder has a standing valve coupling 16 at its depending end including an internal annular shoulder 18 for supporting and sealing with a standing valve assembly 20 as hereinafter described.

A plunger assembly 22, connected with the depending end portion of a sucker rod string 24, is initially connected to the standing valve assembly 20 by a frangible element 26 comprising a frangible pin and box coupler, preferably formed from biodegradable material, for seating the standing valve and separating the plunger therefrom, as presently described.

The plunger assembly 22 comprises an elongated cage and traveling valve assembly upper portion 28 having a downwardly open socket 29 and a lower or base end portion



30 centrally through bored and threaded at its depending end portion, as at 31, threadedly connected with the top portion 28 by threads 32. The inner periphery of the top end of the lower member 30 forms an annular valve seat 34. Above the seat 34 the wall 36 of the top portion 28 is provided with oppositely disposed ports 38, only two being shown (FIG. 2), which forms the upper end of a longitudinal fluid passageway 39 through the plunger. Prior to assembly of the top portion with the bottom portion, a ball valve 40 is placed within the top portion of the socket 29.

A pair of outwardly diverging wall synthetic material plunger cups 42 surround the lower plunger portion in superposed relation below the depending limit of the top portion wall 36. Each of the cups 42 have a wall 43 and a thickened centrally apertured base portion 44 which snugly contacts an intermediate peripheral portion of the plunger perimeter with the lowermost cup supported on a washer 46 overlying an upwardly facing shoulder 48. Each cup wall 43 is flared outwardly and upwardly and the thickness of each wall converges upwardly. Each cup inner peripheral wall surface is preferably disposed at an angle A (FIG. 2) for example 8°, with respect to the vertical. Similarly, the outer surface of the wall 43 is disposed on an angle B, for example 4° with respect to the vertical. The purpose of the upwardly converging wall feature of the respective cup 42 is to insure that fluid static head will bias the upper limit of the respective cup wall against the inner periphery of the cylinder 10.

A cylindrical spacer or sleeve 52 is interposed between the two cups to support the top cup above the lower cup. Water filling both cups insures a positive seal with the inner periphery of the cylinder 10 when the plunger is moved in an upward direction by the sucker rod string 24. To insure that the lower cup fills with water, a planar surface 56 (FIG. 3) subtends an arc of the periphery of the plunger wall 54 and extends vertically across the thickened base 44 of the upper cup 42 to form a fluid passageway 57 for water passage from the upper cup to the interior of the lower cup. Filling the lower cup is assured by forming a notch or recess 58 in the upper edge of the sleeve wall. Obviously, V-shaped slots, not shown, vertically formed in the plunger wall 54 across the thickened base 44 of the upper cup, would accomplish the same purpose. Wrench flats 59 are preferably formed on respective end portions of the plunger assembly 22.

The standing valve assembly 20 comprises a tubular body 60 and a valve and cage 70. The outer periphery of the body 60 depending end portion 62 converges downwardly from a shoulder 64, as for example on an angle of 5° with respect to the vertical, for entering and seating on the annular shoulder 18 of the coupling 16 (FIG. 1). The inner periphery of the upper end of the tubular body 60 forms an annular valve seat 66 for seating and sealing with the cage 70 ball valve 68. The valve cage assembly 70 is substantially identical with the plunger valve cage assembly 28, and is similarly threadedly connected with the periphery of the upper end portion of the standing valve body 60. Similarly, wrench flats 71 are formed on respective end portions of the standing valve assembly 20. A cup 75, substantially identical with the plunger cups 42, surrounds the body 60 and is supported by the body shoulder 64.

The upstanding threaded pin 72 of the valve cage means 70 threadedly receives the box 74 of the biodegradable frangible coupler member 26 having an upstanding threaded pin 78 threadedly received by the plunger 31 threads for connecting the plunger assembly 22 with the standing valve assembly 20 when lowering the two, as a unit, into the cylinder 10.

## OPERATION

Assuming the plunger assembly 22 connected with the standing valve 20 by the coupler 74 is in the position illustrated by FIG. 1, an operator using a hammer or sledge, not shown, axially sharply strikes the upper end of the sucker rods 24. This forces the plunger assembly downward relative to the standing valve 20 and ruptures the frangible biodegradable material coupler 74, thus separating the plunger assembly 22 from the standing valve and simultaneously seating the standing valve on the annular shoulder 18. This permits vertical reciprocation of the sucker rod and plunger assembly relative to the cylinder 10 by mechanism, not shown, at the surface of the earth. The pumping operation then progresses in the manner briefly described hereinabove.

Briefly stated water, not shown, is forced to the surface of the earth through the tubing by upward movement of the plunger assembly 22 in which static head biases the cup walls 43 outwardly to lift the water within the cylinder while simultaneously filling the cylinder between the standing valve and the plunger by reducing pressure therein which lifts the valve 68 and draws water into the cylinder. Conversely downward movement of the plunger assembly into the filled depending end portion of the cylinder 10, forces the plunger valve 40 off its seat and water flows through the plunger passageway 39 to complete one cycle of operation of the plunger and standing valve.

Over time, the flexible walls 43 of the cups 42 gradually wear away to such an extent that the pumping operation necessitates the replacement of the cups which are pulled with the plunger to the surface of the earth by the sucker rods and replaced. In the event it becomes necessary to replace the standing valve assembly 20, the depending end of the plunger assembly 22 is lowered until the plunger threads 31 contact the threaded pin 72 of the standing valve cage assembly 70. Angularly rotating the sucker rods and plunger assembly 22, to the right in a thread tightening action, engages the plunger assembly threads 31 with the threads of the standing valve pin 70 for unseating the standing valve and moving it with the plunger to the surface of the earth.

Obviously the invention is susceptible to changes or alterations without defeating its practicability. Therefore, I do not wish to be confined to the preferred embodiment shown in the drawings and described herein.

I claim:

1. In a water well having a working cylinder at the depending end of a tubular pump string extending from the earth's surface into a wellbore containing water and having a reciprocable sucker rod string in and substantially coextensive with the tubing string, the improvement comprising:

pump plunger means including a tubular plunger body having a wall connected with a travelling valve cage within the cylinder and depending from said sucker rod string for reciprocation therewith;

a planar surface on the body wall subtending an arc of the periphery of said body intermediate its ends;

a pair of plunger cups, each cup of said pair of cups having an apertured base, surrounding an intermediate portion of said body in superposed relation; and,

sleeve means within the lowermost cup of said pair of cups for supporting the base of the uppermost cup above the upper limit of the lowermost cup and in intersecting relation with respect to said planar surface for forming a vertical fluid passageway across the base of the upper cup of said pair of cups,

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whereby upward movement of said plunger body closes said travelling valve and fills both cups of said pair of cups with water and lifts the water above the cups and plunger means toward the surface of the earth.

2. The combination according to claim 1 in which said sleeve means includes:

a sleeve having a wall recess communicating with the fluid passageway and the interior of the lowermost cup of said pair of cups.

3. The combination according to claim 1 and further including:

standing valve assembly means a tubular standing valve body axially connected with a valve and cage and releasably seated within the depending end portion of the cylinder for admitting and maintaining water in the depending end portion of the cylinder; and,

an upwardly open cup seal surrounding and secured to the standing valve body intermediate its ends for maintaining said standing valve seated by fluid static head.

4. The combination according to claim 2 and further including:

frangible coupler means connecting said plunger means with said standing valve assembly means for separating said plunger means from said standing valve means in response to sudden downward movement of said plunger means relative to said standing valve means.

5. In a water well having a working cylinder at the depending end of a tubular pump string extending from the earth's surface into a wellbore containing water and having a reciprocable sucker rod string in and substantially coextensive with the tubing string, the improvement comprising:

pump plunger means depending from said sucker rod string within the cylinder including a tubular plunger body having a wall connected at its upper limit with a valve and cage closing and opening the tubular body during respective upward and downward reciprocating movement with said sucker rod string;

a planar surface on the body wall subtending an arc of the periphery of said body intermediate its ends;

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a pair of plunger cups, each cup of said pair of cups having an apertured base, surrounding an intermediate portion of said body in superposed relation; and,

sleeve means within the lowermost cup of said pair of cups for supporting the base of the uppermost cup above the lowermost cup and in intersecting relation with respect to said planar surface for forming a vertical fluid passageway through the base of the upper cup for filling the lowermost cup of said pair of cups, whereby upward movement of said plunger body fills both cups of said pair of cups lifts water above the cups toward the surface of the earth.

6. The combination according to claim 5 in which said sleeve means includes:

a sleeve having a wall recess communicating with the fluid passageway and the interior of the lowermost cup of said pair of cups.

7. The combination according to claim 5 and further including:

standing valve assembly means including a tubular body axially connected with a valve and cage and releasably seated within the depending end portion of the cylinder for admitting and maintaining water in the depending end portion of the cylinder; and,

an upwardly open cup seal surrounding and secured to the standing valve body intermediate its ends for maintaining said standing valve seated by fluid static head.

8. The combination according to claim 7 and further including:

frangible coupler means connecting said plunger means with said standing valve assembly means for separating said plunger means from said standing valve means in response to sudden downward movement of said plunger means relative to said standing valve assembly means.

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US005752814A

# United States Patent [19]

[11] Patent Number: 5,752,814

Starks et al.

[45] Date of Patent: May 19, 1998

## [54] PLUNGER AND SEAL FOR WELL PUMP

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Primary Examiner—Richard E. Gluck  
Attorney, Agent, or Firm—John M. Harrison

[21] Appl. No.: 533,916

[22] Filed: Sep. 26, 1995

## [57] ABSTRACT

[51] Int. Cl.<sup>6</sup> ..... F04B 21/04

[52] U.S. Cl. .... 417/554

[58] Field of Search ..... 417/56, 57, 58,  
417/59, 60, 554, 553, 552; 92/87, 248

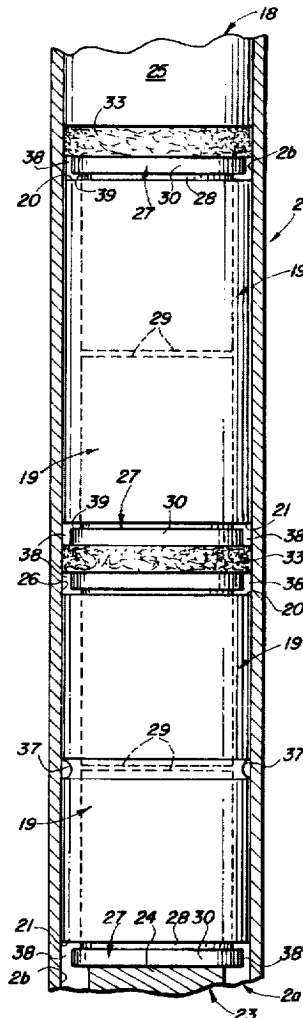
A plunger or traveling valve and seal for a well pump and an oil well pump in particular, which plunger includes a mandrel of selected length, at least one plastic sleeve fitted with at least one metal insert mounted on the mandrel for sealing the mandrel in a pump barrel and a ball and seat valve provided on at least one end of the mandrel. The plunger may include fiber rings and ring holders and is seated inside a conventional pump barrel and the plastic sleeve serves to seal the plunger as the plunger reciprocates in the barrel. The plastic seal is typically constructed of ultra-high molecular weight polyethylene with one or two flanged, typically brass, inserts tightly mounted in the plastic seal bore to control or limit thermal expansion in the plastic seal.

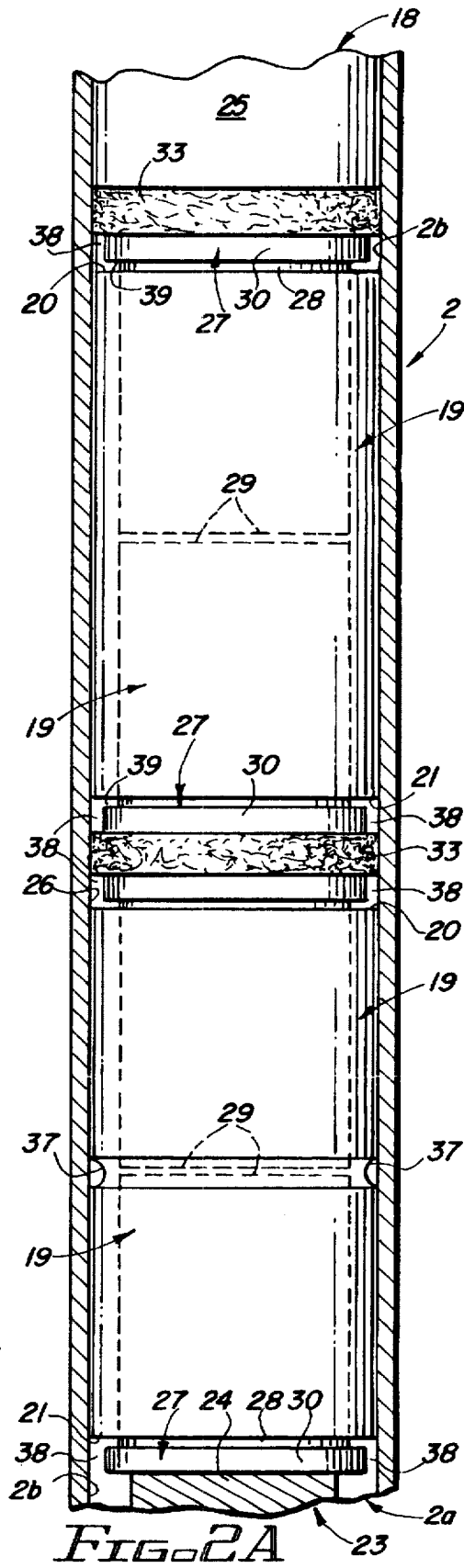
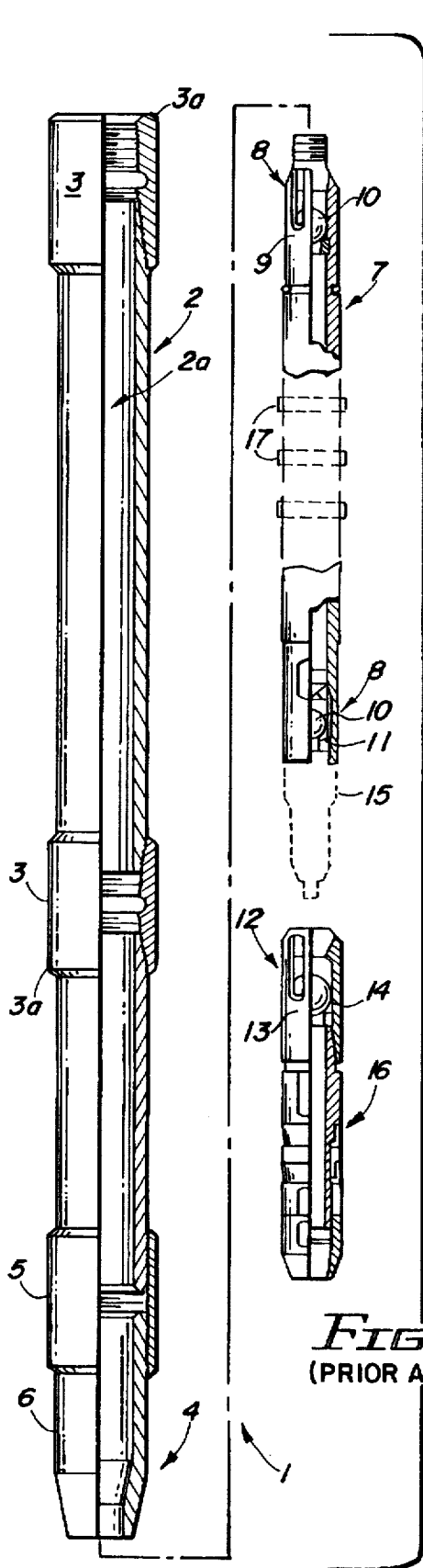
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| 3,915,602 | 10/1975 | Douglas  | 417/554 |
| 4,345,766 | 8/1982  | Turanyi  | 277/30  |
| 4,743,329 | 5/1988  | Hafa     | 156/287 |

21 Claims, 4 Drawing Sheets





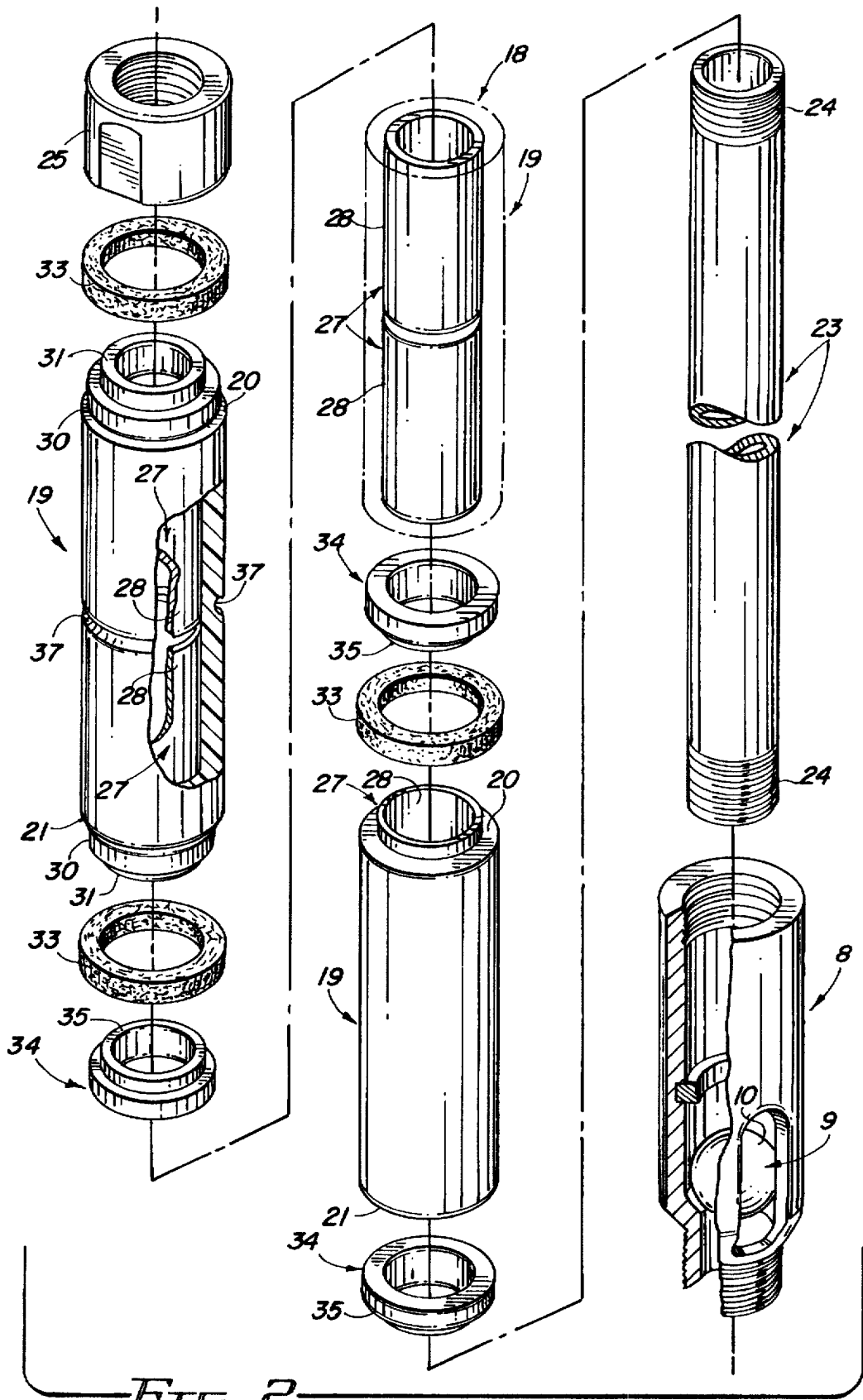


FIG. 2

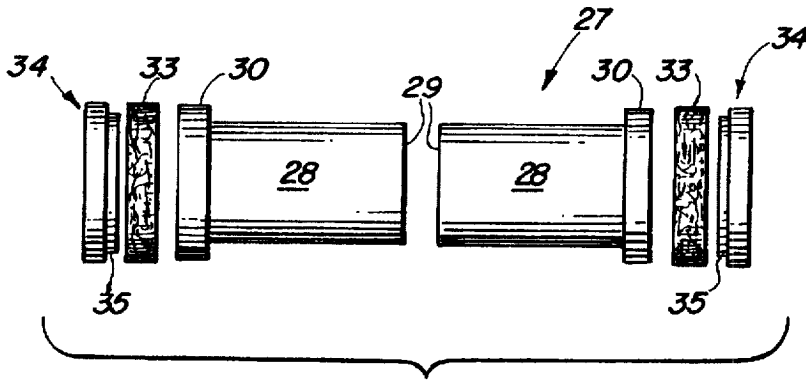


FIG. 3

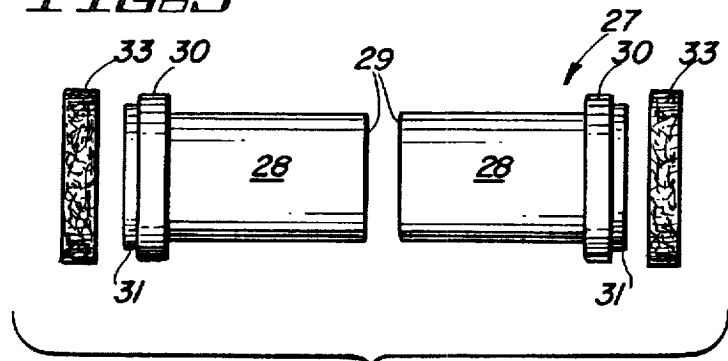


FIG. 4

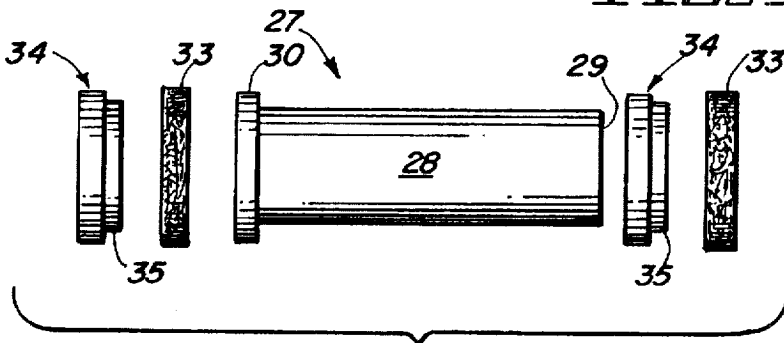


FIG. 5

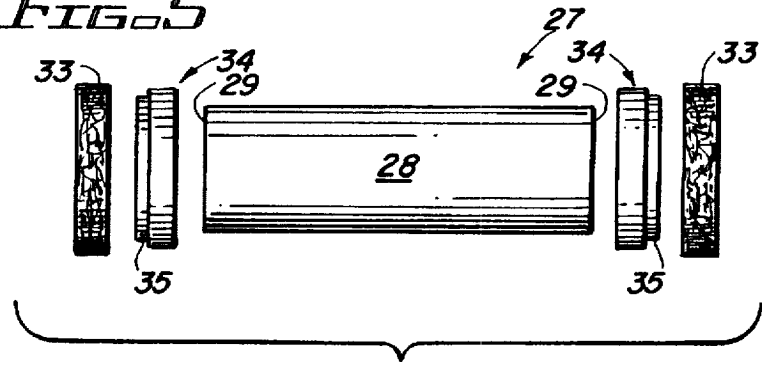
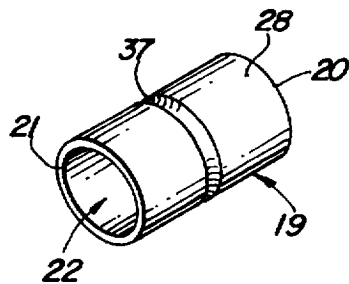
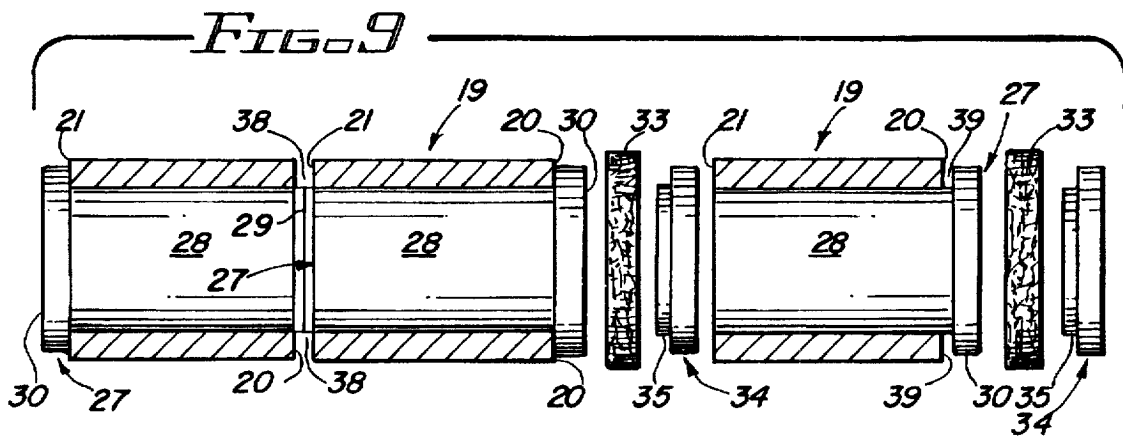
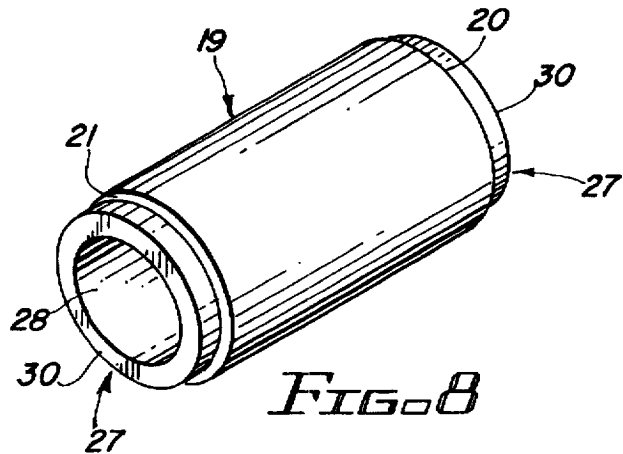
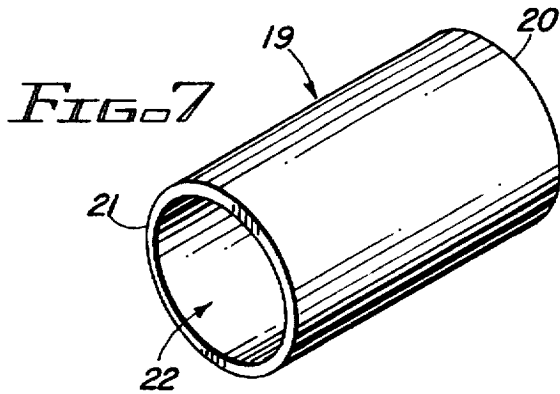


FIG. 6



## PLUNGER AND SEAL FOR WELL PUMP

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates to downhole water and liquid hydrocarbon pumps and more particularly, to a plunger or traveling valve for an oil well pump, which plunger is fitted with a cylindrical plastic seal mounted on a metal insert or inserts that seal the plunger inside the pump barrel. In a preferred embodiment the plunger is characterized by a conventional or specially designed pump mandrel of selected length, material of construction and diameter and at least one plastic sleeve, fitted with at least one metal insert, mounted on the pump mandrel with at least one ball and seat valve attached to one end of the mandrel. The mandrel and assembled plastic sleeve is designed to fit inside a conventional pump barrel mounted in the downhole casing and reciprocates within the barrel to pump water, oil and/or condensate from a down-hole interval or formation to the surface. The plastic sleeve is typically constructed of a rigid, ultra-high molecular weight polyethylene cylinder, with one or two, typically brass, inserts tightly mounted in the plastic seal bore to control thermal expansion in the plastic seal.

It has surprisingly been found that rigid cylindrical plastic sleeves may be fitted with one or more metal inserts for expansion control purposes and mounted on a conventional or specially designed pump mandrel for sealing the resulting pump plunger or traveling valve in the barrel of a downhole water or liquid hydrocarbon pump. In a most preferred embodiment the plastic sleeve is characterized by a cylindrical, ultra-high molecular weight polymer such as polyethylene, sleeve having an internal bore and a wall thickness sufficient to impart rigidity, and the insert is one or more brass, copper, stainless steel or other preferably flanged, metal fitting sized to tightly fit inside the polyethylene sleeve bore and stabilize the polyethylene sleeve against excessive sleeve expansion in the pump barrel as a result of high formation temperatures and friction-induced heat. The mandrel typically includes a ball and seat valve on one end, as well as one or more lock nuts and, optionally, one or more fiber washers and metal rings for holding the fiber washers in place, depending upon the nature and condition of the water or hydrocarbon fluid being pumped from the producing zone or interval.

One of the problems which exists in conventional downhole or well pumps is that of effectively sealing the pump plungers inside the corresponding pump barrels during reciprocation of the plungers inside the barrels, while operating the pump to pump water or hydrocarbons to the surface under a wide variety of fluid contamination. Various types of seals, including o-rings, packing and other seals well known to those skilled in the art have been used in an attempt to increase the efficiency of the pumping operation and prevent "blow back" of production fluid, as well as operate to handle sand and other impurities in the pumped well fluid. Regardless of the type of seals or packing used to prevent, or at least minimize, loss of pumping efficiency due to these undesirable conditions in the well, the pump must be periodically pulled from the well and the seals and/or packing frequently replaced at great expense in labor and material.

A common technique for sealing plungers inside the barrels of downhole pumps is by means of flexible and resilient fiber or plastic cups and rings that are designed to traverse the inside surface of the pump barrel during reciprocation of the pump plunger and insure optimum production of well fluid. However, water and hydrocarbon con-

taminants such as sand and other bits of material from the producing interval and well frequently cut the flexible fiber or plastic cups and drastically reduce pumping efficiency. Furthermore, when the well is "pulled" during maintenance and the pump is thus removed from the well, these flexible and resilient sealing cups tend to further tear or otherwise disintegrate and must be replaced. Moreover, the conventional cups and rings wear significantly during reciprocation of the plunger inside the pump barrel, even under ideal conditions and the pumping efficiency goes steadily down due to this wear, thus necessitating frequent maintenance of the well.

#### 2. Description of the Prior Art

Various types of pump plungers have been devised by those skilled in the art to solve, or at least minimize, the problem of excessive wearing of seals and frequent maintenance of downhole pumps. U.S. Pat. No. 5,120,203, dated Jun. 9, 1992, to Ronald A. Priestly, details a "Universal Plunger For Oil Well Pumps", which plunger includes a symmetrical plunger body having a longitudinal bore, a pair of threaded flange nipples projecting from end flanges located on each end of the plunger body, a pair of spaced o-ring seats provided inwardly of the end flanges, respectively, the O-rings seated in the o-ring seats, a plunger body segment of reduced diameter extending between the inner sets of O-rings and a "Teflon"-hydrocarbon composition disposed between the spaced inside O-rings, the plunger body segment and that portion of the inside surface of the oil well pump barrel which faces the plunger body segment for sealing and lubricating the universal plunger in the pump barrel. U.S. Pat. No. 5,196,108, dated Mar. 23, 1993, to Thomas S. Wilmeth, et al, details a "Sucker Rod Oil Well Pump and Method of Operation". The method details a technique for constructing portions of a sucker rod pump of the type having a steel plunger with an exterior cylindrical wall and a barrel with a cylindrical bore. A chromium case is formed on the cylindrical bore to a selected depth for receiving the plunger in sliding contact. The chromium case is formed by forming a base electrolyte bath, including water, chromic acid, a sulfate compound, an alkyl sulfonic acid and an anion of molybdenum. The bore is exposed to the aqueous electrolyte bath of selected current density and a plating temperature sufficient to form a chromium deposit of desired thickness on the bore. A process for manufacturing composite pipes is detailed in U.S. Pat. No. 4,743,329, dated May 10, 1988, to Hata. Improved composite pipes manufactured by the process of this invention include an outer pipe made of plastic and a thin lead layer on the inner wall of the outer pipe. The lead layer is formed by arranging a lead pipe in the outer pipe and expanding it by pressure into close contact with the inner wall of the outer pipe. The outer pipe may be circular, square or double-path. U.S. Pat. No. 5,255,294, to Bierwirth, dated Oct. 19, 1993, details a "Sealing Device For Cylindrical Hollow Bodies" with an opening at an end face, especially for sealing pump sockets in the interior of reactor containers. The sealing device has a cylindrical sealing insert with two axially displaceable members and an elastic sealing ring disposed between the members. A displacement of the members toward one another results in an enlargement of an outer diameter of the sealing ring and contact pressure between the outer circumference of the sealing ring and the inner wall surface of the hollow body. A remote-controlled placing tool is connectable to the sealing insert for clamping and locking the sealing insert in a sealing position and for releasing the sealing insert therefrom. The tool has a clamping cylinder with a clamping piston and a clamping piston rod in the form



of a hollow cylinder connected to the clamping piston. A clamping anchor is connected to the first co-axial member and a sleeve is connected co-axially and slidably about the anchor. U.S. Pat. No. 5,344,678, dated Sep. 6, 1994, to Kagiwara, et al. details a "Shaft Sleeve Made of Ceramics". The ceramic shaft sleeve is provided in confrontation with a stationary sliding member and a sliding bearing or plain bearing. The shaft sleeve includes a cylindrical body made of ceramics and having a circular outer surface and a circular inner surface, with an elastic member molded on the inner surface of the cylindrical body and formed with an inner opening having a shape corresponding to the cross-section of a shaft. An "Apparatus For Sealing An Oil Well Pump Polished Rod" is detailed in U.S. Pat. No. 4,345,766, to Turanyi. The apparatus has a tubular housing adaptor for securing to a wellhead of an oil well for sealing a reciprocating oil well pump polished rod extending through the tubular housing. The housing is formed in two operating tubular portions that are connected to enable limited angular movement therebetween, but which are resiliently urged to maintain a longitudinal alignment of the two portions. Multiple, longitudinally-spaced packing rings carried in one of the housing portion effects engagement of the wellhead leakage blocking seal with the reciprocating polish rod. Upper and lower rod scrapers protect the spaced seals from contact with undesired foreign matter that may be carried by the polished rod or that will damage the seals. A pair of guide bushings located adjacent the seals maintain the longitudinal alignment of the seal carrying housing portion with the polished rod.

It is an object of this invention to provide a new and improved plunger or traveling valve for a downhole or well pump and particularly, an oil well pump, which plunger is characterized by a mandrel and at least one cylindrical plastic seal having at least one metal insert for mounting on the mandrel and sealing the plunger in the barrel of the pump.

Another object of this invention is to provide a new and improved plunger for a downhole water or oil well pump, which plunger is characterized by an elongated mandrel of selected design, length and diameter, at least one cylindrical plastic sleeve fitted with one or more metal inserts, mounted on the mandrel for sealing the pump plunger inside the barrel of the downhole pump and one or more fiber rings and ring holders for wiping the barrel during operation of the pump.

Still another object of this invention is to provide a new and improved, thermally stabilized sleeve seal polymer for mounting on the mandrel of a downhole pump plunger by means of one or more metal inserts and sealing the pump plunger for reciprocation in the barrel of a downhole well pump.

A still further object of this invention is to provide a new and improved, rigid, cylindrical, ultra-high molecular weight polyethylene sleeve seal fitted with one or more metal inserts for mounting on the mandrel element of a pump plunger, defining creep slots and/or wet seal spaces between the sleeve seals and sealing the plunger in the barrel of a downhole oil well pump.

#### SUMMARY OF THE INVENTION

These and other objects of the invention are provided in a new and improved plunger or traveling valve for a water well pump or an oil well tubing or insert pump, which plunger is characterized by an elongated mandrel of selected design, diameter and length and having a ball and seat valve on at least one end and at least one ultra-high molecular

weight polyethylene plastic sleeve seal fitted with one or more oversized flanged or unflanged metal inserts, mounted on the mandrel for selectively creating creep slots and/or wet seal spaces between the sleeve seals and sealing the plunger in reciprocating fashion inside the barrel of the oil well pump. The plastic sleeve seal receives one or two metal inserts to control or limit thermal expansion in the plastic and, if flanged and oversized with respect to the sleeve seals, create a wet seal space for trapping sand and well fluid debris and/or a creep slot for effecting linear, rather than radial, thermal expansion in the plastic sleeve seal. One or more fiber rings and fiber ring holders, as well as one or more mounting nuts for securing the plastic sleeve seal or seals, fiber ring holders and fiber rings in place, may also be provided on the mandrel, as deemed necessary for specific well conditions.

#### BRIEF DESCRIPTION OF THE DRAWING

The invention will be better understood by reference to the accompanying drawings, wherein:

FIG. 1 is a perspective view, partially in section, of a conventional downhole oil well cup and ring pump;

FIG. 2 is an exploded view of a typical embodiment of the plunger and seal for a well pump of this invention;

FIG. 2A is a sectional view of a preferred embodiment of the plunger and seal mounted in a conventional plunger barrel according to this invention;

FIG. 3 is an exploded view of a first preferred metal insert configuration for fitting inside the plastic sleeve element of this invention;

FIG. 4 is an exploded view of an alternative metal insert configuration;

FIG. 5 is an exploded view of yet another metal insert configuration for the plastic sleeve of this invention;

FIG. 6 is an exploded view of still further preferred configuration for the metal insert;

FIG. 7 is a perspective view of a typical rigid cylindrical plastic sleeve for sealing the plunger of a downhole pump;

FIG. 8 is a perspective view of the plastic sleeve illustrated in FIG. 7 with a pair of metal inserts mounted therein for controlling thermal expansion of the plastic sleeve during service;

FIG. 9 is a partially exploded, sectional view of a typical assembly of a pair of plastic sleeves with accompanying metal inserts and accessory fiber rings and metal rings arranged for assembly on a mandrel to define the plunger and seal elements of a downhole pump according to the invention; and

FIG. 10 is a perspective view of a second preferred embodiment of the plastic sleeve illustrated in FIG. 7.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIG. 1 of the drawings, a typical cup and ring pump, the design of which is well known to those skilled in the art, is generally illustrated by reference numeral 1. The cup and ring pump 1 includes a cylindrical pump barrel 2, having a longitudinal pump barrel bore 2a and fitted with barrel couplings 3 at the top and center thereof. The bottom tubing coupler 5 couples an extension nipple 4 to the pump barrel 2 and the extension nipple 4 further includes a sealing nipple 6. The cup and ring pump 1 also includes a conventional reciprocating soft packed and/or metal plunger 7, fitted with sealing cups 17 and a ball

and seat valve 8 at each end, the top ball and seat valve 8 further including an open-top cage 9, which receives the travelling ball 10. The bottom ball and seat valve 8 is characterized by a plunger cage 11, also having a travelling ball 10 and a standing valve puller 15, detailed in phantom, is connected to the lower end of the soft packed and/or metal plunger 7. A conventional seating cup 16 is designed for insertion in the pump barrel 2 beneath the soft packed and/or metal plunger 7 and includes a standing valve 12, having a standing valve cage 13 and a ball 14, located in the standing valve cage 13.

Referring now to FIGS. 2, 2A, 9 and 10 of the drawings, the plunger of this invention is generally illustrated by reference numeral 18 and is characterized by an elongated cylindrical mandrel 23 of suitable design, length, material of construction and diameter for a selected specific well or downhole pump service. The mandrel 23 is typically constructed of bronze or brass and may be conventional in design with a ball and seat valve 8 threaded on the mandrel threads 24 in conventional fashion. The mandrel threads 24 are provided on both ends of the mandrel 23, not only for mounting the ball and seat valve 8, but also for receiving one or more mounting nuts 25 or other equipment, according to the knowledge of those skilled in the art. A pair of plastic sleeves 19 are each fitted with a pair of sleeve inserts 27, each of which sleeve inserts 27 is further characterized by a cylindrical sleeve insert tube 28, which fits snugly in the internal sleeve bore 22 of the plastic sleeve 19, and an optional tube flange 30 that seats against the top sleeve edge 20 and bottom sleeve edge 21 of each plastic sleeve 19, as illustrated. Each of the tubular sleeve inserts 27 is typically characterized by metal construction such as brass, stainless steel or the like and is designed to tightly fit inside the internal sleeve bore 22 of the plastic sleeves 19 to stabilize plastic sleeves 19 against thermal expansion, as hereinafter further described.

In a most preferred embodiment of the invention the tube edges 29 of the sleeve insert tubes 28 abut each other approximately halfway into the internal sleeve bore 22 of the plastic sleeves 19, respectively. Furthermore, in another preferred embodiment the optional tube flange 30 of each of the sleeve insert tubes 28 is smaller in diameter than the outside diameter of the plastic sleeve 19, thus leaving an annular space between the tube flanges 30 and the internal barrel surface 2b of the pump barrel 2 when the mandrel 23 and accompanying plastic sleeves 19, fitted with the sleeve inserts 27, are assembled on the mandrel 23 in the manner illustrated in FIGS. 2A and 9. This annular space is defined as a wet seal space 38 and is designed to trap sand and other foreign particles and debris which may be present in the well fluid flowing from the interval and pumped by the plunger 18 from the interval through the pump barrel 2 in conventional fashion. A creep slot 39 may also be defined in the sleeve insert 27-plastic sleeve 19 design, under circumstances where the sleeve insert tubes 28 of the respective sleeve inserts 27 are oversized in length, as illustrated in FIGS. 2A and 9. This disparity in length between the sleeve insert tubes 28 and plastic sleeves 19 allows linear, rather than radial, thermal expansion of the plastic sleeves 19. Furthermore, one or more fiber rings 33 may also be provided on the mandrel 23 in combination with or in lieu of fiber ring holders 34, having ring holder extensions 35, as illustrated in FIG. 9. The fiber rings 33 are conventional in design and serve to wipe the internal barrel surface 2b of the pump barrel 2 clear of foreign objects, including sand and other well interval particles, which may be abrasive and tend to damage the plastic sleeve 19. However, it will be appre-

ciated by those skilled in the art that the plastic sleeves 19 are designed to effect embedment of any such abrasive particles such as sand, in the plastic without adversely affecting pumping efficiency, as hereinafter described.

Referring now to FIGS. 2A and 3-7 of the drawings, the sleeve inserts 27 are each characterized by a stiff or rigid cylindrical sleeve insert tube of suitable thickness, terminating at a tube edge 29 at one end and, in one embodiment, a tube flange 30 at the other. In a first preferred embodiment of the invention a pair of sleeve inserts 27 are inserted in the internal sleeve bore 22 of each plastic sleeve 19, with the tube edges 29 abutting approximately in the center of the plastic sleeve 19, as illustrated in phantom in FIG. 2A. One or more fiber rings 33 and fiber ring holders 34 can also be positioned on the mandrel 23 in the manner illustrated in FIGS. 2 and 2A and as further illustrated in FIG. 3. It has surprisingly been found that insertion of the sleeve insert or inserts 27 inside the respective rigid plastic sleeves 19 serves to thermally stabilize the plastic sleeves 19, which would otherwise expand due to pumping friction and elevated formation temperatures to an undesirable extent and "seize" the plunger 18 inside the pump barrel 2. Expansion of the plastic sleeves 19 and insertion of the respective sleeve insert tubes 28 of the sleeve inserts 27 into the plastic sleeves 19 can be effected by liquid baths, convection heating or by other techniques known to those skilled in the art, thereby raising the temperature of the plastic sleeve to a suitable level, expanding the plastic sleeves 19 and slightly enlarging the internal sleeve bore 22. The respective sleeve insert tubes 28 are then inserted in the internal sleeve bores 22 of the respective heated plastic sleeves 19 and when the plastic sleeves 19 cool and contract, the respective sleeve insert tubes 28 are firmly and securely positioned inside the corresponding internal sleeve bores 22 of the plastic sleeves 19, with the tube edges 29 abutting therein.

Referring now to FIGS. 2 and 4 of the drawings, in another preferred embodiment of the invention a tube flange extension 31 is machined or molded in the tube flange 30 of each of the sleeve inserts 27 to receive and stabilize the fiber rings 33, a configuration which eliminates the need for the fiber ring holders 34. Furthermore, as illustrated in FIG. 2, lower center of the drawing, a fiber ring holder 34 may be mounted on the mandrel 23 without a fiber ring 33 to define an additional wet seal space 38 (illustrated in FIG. 2).

Referring to FIGS. 5 and 6 of the drawings, in yet another preferred embodiment of the invention a single sleeve insert 27 is provided with a sleeve insert tube 28 which is substantially equal in length to, or slightly longer than, the internal sleeve bore 22 of the corresponding plastic sleeve 19. Accordingly, a fiber ring holder 34 may be positioned on the mandrel 23 adjacent to the tube edge 29 of the sleeve insert 27 after the sleeve insert tube 28 of the sleeve insert 27 has been inserted in the corresponding internal sleeve bore of the plastic sleeve 19, as heretofore described. The fiber ring holder 34 may also include a ring holder extension 35 for receiving a fiber ring 33. Similarly, the opposite end of the sleeve insert 27, which is fitted with tube flange 30, is positioned adjacent to another fiber ring 33 which is seated on a corresponding ring holder extension 35 of a second fiber ring holder 34, as illustrated.

Referring now to FIGS. 2, 2A, 6 and 7 of the drawings, in yet another preferred embodiment of the invention the sleeve insert 27 is characterized by a sleeve insert tube 28 which has no tube flange 30 and is designed to be inserted inside the internal sleeve bore 22 of a plastic sleeve 19, with a pair of fiber ring holders 34 serving as tube flanges 30. Accordingly, the fiber ring holders 34 are positioned such

that the respective ring holder extensions 35 face outwardly for receiving a corresponding fiber ring 33 and are designed to seat against the extending tube edges 29 of the sleeve insert tube 28 when the sleeve insert tube 28, fiber ring holders 34 and fiber rings 33 are mounted on the mandrel 23 as illustrated in FIGS. 2 and 2A.

As further illustrated in FIG. 9, three plastic sleeves 19, with oversized sleeve inserts 27, may be arranged on the mandrel 23 such that two of the tube edges 29 abut between the respective top sleeve edge 20 and bottom sleeve edge 21 of the two adjacent plastic sleeves 19. This arrangement creates a wet seal space 38 of selected width between the plastic sleeves 19. Accordingly, it will be appreciated by those skilled in the art that many variations of the sleeve insert 27 may be provided to thermally stabilize the plastic sleeve 19 and this thermal stability as a function of temperature is demonstrated in the following table:

| TEMPERATURE | PLASTIC SLEEVE DIAMETER (WITHOUT INSERT) | PLASTIC SLEEVE DIAMETER (WITH INSERT) |
|-------------|--|---------------------------------------|
| 97°         | 2.245 o.d.                               | 2.245 o.d.                            |
| 105°        | 2.248 o.d.                               | 2.246 o.d.                            |
| 135°        | 2.253 o.d.                               | 2.248 o.d.                            |
| 150°        | 2.257 o.d.                               | 2.250 o.d.                            |
| 170°        | 2.260 o.d.                               | 2.251 o.d.                            |

It will be understood that the above table is illustrative of thermal expansion of a typical virgin ultra high molecular weight polyethylene sleeve having a molecular weight in the range of from about 2 million to about six million. Thermal expansion in the plastic sleeve fitted with the insert is considerably less than that without the insert, as shown in the table. It is further understood that other formulations of plastic, including polyethylene, can be used in various pump sealing services, depending upon the thermal characteristics of the service. The molecular weight of these polymers may vary considerably from the above delineated illustrative range.

As described above, it will be appreciated that the sleeve insert 27 component of this invention can be constructed of substantially any metal which is sufficiently chemically resistant to the water or hydrocarbon fluid being pumped, and has sufficient structural integrity to maintain the cylindrical configuration when subjected to shrinkage of the plastic sleeve 19 thereon. For example, brass, stainless steel and like metals, in non-exclusive particular, can be used to construct the sleeve inserts 27 in the various configurations illustrated in the drawings. Not only does the sleeve insert 27 operate to control thermal expansion in the corresponding plastic sleeves 19, but it also operates to effect a precision fit of the plastic sleeves 19 to the mandrel 23 and to keep the plastic sleeves 19 uniform in configuration according to applicable manufacturing standards. For example, the oversized sleeve insert 27 is designed to prevent the plastic sleeve 19 from being warped or otherwise damaged when the plastic sleeve or sleeves 19 are secured on the mandrel 23 by means of the mounting nut 25, since the sleeve insert tubes 28 may be longer than the plastic sleeves 19. The sleeve inserts 27 also serve to facilitate convenient and easy mounting and disassembly of the respective plastic sleeve or sleeves 19 to and from the mandrel 23 and the specific shape of the sleeve insert 27 is designed to facilitate the wet seal spaces 33 and/or creep slots 39 illustrated in FIGS. 2 and 2A, as heretofore described.

The plastic sleeves 19 can be constructed of substantially any plastic material, including thermoplastic and thermoset-

ting resins and polymers, depending upon service temperature requirements. A preferred material of construction is ultra-high molecular weight polyethylene having a molecular weight of from about 2 million to about 6 million, although various other polymers, including polyethylene, polypropylene and polyolefins, and particularly, polyolefins having ultra-high molecular weights, may be used to construct the sleeves of this invention. The various plastics which are suitable for use in the invention may be injection-molded, extruded and compression molded, in non-exclusive particular. Such plastics as low density and high density polyethylene, with a preferred ultra-high molecular weight polyethylene, both virgin (natural) and regrind formulations, are particularly well suited for use in the invention, as well as the doubly-oriented polymers disclosed in U.S. Pat. No. 5,049,347 to Joseph H. Magill, et al. These polymers, including various polyolefins, are well suited for use in the invention since the thermal expansion characteristics of such polymers can be controlled advantageously for use in applicant's plunger. The polyethylene plastic sleeves 19 may also be constructed of both virgin (natural) and regrind (recycle) polyethylene formulations, as well as polyethylene and other polymers, including polyolefins, having special additives to improve desirable properties or suppress undesirable properties to produce the desired minimum thermal expansion service capability. The plastic sleeves 19 are characterized by a low coefficient of friction and can be machined or molded to precisely fit the pump barrel 2 and receive the respective sleeve inserts 27 to control thermal expansion. Because of such a precision fit and low coefficient of friction, the plastic sleeves 19 furnish a desirable substitute for traditional and conventional cups in cup and ring pumps, since foreign particles that typically damage these flexible cups will easily embed in the plastic sleeves 19, thus minimizing damage to the pump barrel 2 during reciprocation of the plunger 18 inside the pump barrel 2. Furthermore, this embedment of sand and other foreign material in the plastic sleeves 19 does not impede sealing of the plunger 18 of the pump barrel 2 by means of the plastic sleeves 19. Moreover, the plastic sleeves 19 serve to eliminate conventional cups, compression rings, rag rings, packing and other conventional equipment used to seal the plungers of downhole pumps in the respective pump barrels. The plastic sleeves 19 can be constructed of any desired length and serve to further eliminate metal plungers under circumstances where temperature is not a factor and the service is at a temperature not exceeding material limits.

It will be appreciated by those skilled in the art that a primary advantage of the plunger 18 and the plastic sleeve 19 and sleeve insert 27 components of the plunger 18 is to provide a downhole pump which may be used in an oil well, gas well or water well to produce oil, condensate or water. It is believed that this is an original application of extruded, machined or compression or injection-molded polymers in this type of downhole pumping application because of the known thermal expansion characteristics of these plastics. Accordingly, the sleeve inserts 27 mounted in the plastic sleeves 19 as described above surprisingly control the thermal expansion of the plastic sleeves 19 to a manageable level and provide a precision fit to the mandrel 23 when installed to define the plunger 18 of this invention. Furthermore, the pumping efficiency of the downhole pump when utilizing the plunger 18 of this invention is greater than conventional pumps and will not significantly deteriorate over a period of time. For example, during tests of a downhole sucker rod pump in which a plunger 18 of this invention was installed, it was found that a pump which

formerly produced 321 barrels per day using the old cup and ring downhole pump elements was increased to 342 barrels per day, an increase of 21 barrels per day, with greatly extended pump life and efficiency.

It will be further appreciated by those skilled in the art that the plastic sleeves 19 and sleeve insert 27 combination, in selected lengths and material of construction, can be used on a conventional or specially designed mandrel 23 of suitable size and length to define a plunger 18 which may also incorporate multiple fiber rings 33 and fiber ring holders 34, depending upon the nature and character of the well fluid pumped from the producing sand or interval. For example, under circumstances where there is considerable sand and/or other abrasive particles or debris produced from the producing sand or interval and well, which debris is entrained in the well fluid, a greater number of fiber rings 33 and fiber ring holders 34 may be utilized to minimize the quantity of these particles which may come into contact with the plastic sleeve or sleeves 19 during the pumping operation. However, this problem is also minimized by structuring and spacing the plastic sleeves 19 and internal sleeve inserts 27 and using only the fiber ring holders 34 to create one or more wet seal spaces 38 which entrap these particles and further prevent particle migration into the plastic sleeves 19, as described above. The plastic sleeves 19 may also be fitted with one or more of the wet seal grooves 37 illustrated in FIG. 10 to achieve the same result. Moreover, as described above, it will be appreciated by those skilled in the art that even if some of the sand or other gritty or abrasive particles escape wiping and entrapment by the fiber rings 33 and the wet seal spaces 38, as well as the wet seal grooves 37, since the plastic sleeves 19 are relatively soft, the gritty material tends to embed in the plastic sleeves 19 and minimize damage to the metal pump barrel 2 in which the plunger 18 reciprocates. The result is that use of the plastic sleeves 19 and cooperating sleeve inserts 27 on the mandrel 23 to define the traveling valve or plunger 18 facilitates a pump which does not have to be redressed each time the well is "pulled" or maintained. Furthermore, the plastic sleeves 19 are inert, very resilient, rigid, impact-resistant and therefore have an extended life expectancy and high efficiency over conventional pumps such as the cup and ring type pumps, for example. The plunger and seal of this invention therefore conserves energy over a long period of pumping time and reduces lifting costs due to reduced friction in the pump.

Still another advantage of the plastic sleeve 19 and sleeve insert 27 combination in the plunger 18 of this invention is to serve as a barrel guide to keep the traveling valve or plunger 18 centralized in the pump barrel 2 and facilitate uniform wear on all sides and surfaces of the plastic sleeves 19, as well as the other pump elements contacting the pump barrel 2 as the plunger 18 reciprocates in the pump barrel 2.

While the preferred embodiments of the invention have been described above, it will be recognized and understood that various modifications may be made in the invention and the appended claims are intended to cover all such modifications which may fall within the spirit and scope of the invention.

Having described my invention with the particularity set forth above, what is claimed is:

1. A plunger disposed for reciprocation in a pump barrel and pumping fluid through the pump barrel, said plunger comprising a mandrel; at least one valve means provided on said mandrel for selectively channeling the fluid through said mandrel and the pump barrel; at least one elongated metal insert of substantially uniform diameter throughout its length mounted on said mandrel; and at least one cylindrical

plastic sleeve mounted on said insert for engaging the pump barrel in sealing relationship with respect to the pump barrel for sealing said plunger in the pump barrel.

2. The plunger of claim 1 wherein said at least one valve means comprises a single valve means.

3. The plunger of claim 1 comprising at least one fiber ring holder mounted on said mandrel and at least one fiber ring means seated on said fiber ring holder, whereby said fiber ring means wipes the pump barrel responsive to reciprocation of said plunger in the pump barrel.

4. The plunger of claim 1 comprising flange means provided on said insert and wherein said insert is no longer than said cylindrical plastic sleeve to define a creep slot between said cylindrical plastic sleeve and said flange means on said insert.

5. The plunger of claim 4 comprising at least one fiber ring holder mounted on said mandrel and at least one fiber ring means seated on said fiber ring holder, whereby said fiber ring means wipes the pump barrel responsive to reciprocation of said plunger in the pump barrel and wherein said at least one valve means comprises a single ball and seat valve.

6. The plunger of claim 1 comprising at least one wet seal groove provided in the circumference of said cylindrical plastic sleeve for trapping debris present in the well fluid.

7. The plunger of claim 6 comprising at least one fiber ring holder mounted on said mandrel and at least one fiber ring means seated on said fiber ring holder, whereby said fiber ring means wipes the pump barrel responsive to reciprocation of said plunger in the pump barrel.

8. A plunger disposed for reciprocation in the pump barrel of a downhole pump and pumping well fluid through the pump barrel, said plunger comprising an elongated mandrel; at least one ball and seat valve provided in said mandrel for selectively directing the well fluid through said mandrel and the pump barrel; at least one substantially cylindrical metal insert removably disposed on said mandrel and a substantially cylindrical flange provided on one end of said metal insert; and a substantially cylindrical plastic sleeve tightly mounted on said metal insert, said plastic sleeve having substantially cylindrical sleeve edges at each end thereof, wherein said sleeve edges are larger in diameter than said flange to define a wet seal space between said flange, said sleeve edges and the pump barrel, whereby said plastic sleeve seals said plunger in the pump barrel and said wet seal space traps debris present in the well fluid.

9. The plunger of claim 8 comprising at least one fiber ring holder mounted on said mandrel and at least one fiber ring means seated on said fiber ring holder, whereby said fiber ring means wipes the pump barrel responsive to reciprocation of said plunger in the pump barrel.

10. The plunger of claim 8 wherein said at least one ball and seat valve comprises a single ball and seat valve disposed at one end of said mandrel.

11. The plunger of claim 8 wherein said plastic sleeve is shorter than said metal insert to define a creep slot between said sleeve edges of said adjacent ones of said plastic sleeve and said flange for accommodating thermal expansion in said plastic sleeve.

12. The plunger of claim 8 comprising a ring holder extension provided on said flange and at least one fiber ring means mounted on said ring holder extension, whereby said fiber ring means wipes the pump barrel responsive to reciprocation of said plunger in the pump barrel.

13. The plunger of claim 12 wherein said at least one metal insert comprises two metal inserts and said plastic sleeve is shorter than said metal inserts to define a creep slot

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between said sleeve edges of said adjacent ones of said plastic sleeve and said flange for accommodating thermal expansion in said plastic sleeve.

14. A seal for sealing a plunger having a mandrel in the barrel of a well pump, said seal comprising at least one elongated, tubular metal insert mounted on said mandrel and at least one tubular plastic sleeve means mounted on said insert for slidably engaging the barrel, wherein at least one end of said insert projects from said tubular plastic sleeve means for defining a wet seal space between adjacent ones of said tubular plastic sleeve means, whereby said tubular plastic sleeve means seals the plunger in the barrel at least during reciprocation of the plunger in the barrel.

15. The seal of claim 14 wherein said tubular plastic sleeve means comprises a cylindrical plastic sleeve tightly fitted to said insert.

16. The seal of claim 14 wherein said at least one tubular metal insert comprises a pair of tubular metal inserts fitted in each end of said tubular plastic sleeve means.

17. The seal of claim 16 wherein said tubular plastic sleeve means comprises a cylindrical plastic sleeve tightly fitted to said pair of tubular metal inserts.

18. The seal of claim 14 comprising a flange provided on at least one end of said tubular metal insert for spacing said tubular plastic sleeve means on said plunger.

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19. The seal of claim 18 wherein said at least one of said tubular metal inserts is longer than said tubular plastic sleeve means for shaping a creep slot between said flange and said tubular plastic sleeve means.

20. The seal of claim 18 wherein said flange is smaller in diameter than the diameter of said tubular plastic sleeve means for shaping a wet seal space between adjacent ones of said tubular plastic sleeve means and said flange when said seal is mounted on said plunger.

21. The seal of claim 18 wherein:

(a) said at least one of said tubular metal insert is longer than said tubular plastic sleeve means for shaping a creep slot between said flange and said tubular plastic sleeve means; and

(b) said flange is smaller in diameter than the diameter tubular plastic sleeve means for shaping a wet seal space between adjacent ones of said tubular plastic sleeve means and said flange when said seal is mounted on said plunger.

\* \* \* \* \*



US006352107B1

(12) **United States Patent**  
**Bennett et al.**

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(45) **Date of Patent:** **Mar. 5, 2002**

(54) **WEAR RESISTANT WELL PUMP ROD AND METHOD FOR MAKING SAME**

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(73) Assignee: **Allen & Bennett, Inc.**, Odessa, TX (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(51) **Int. Cl.**<sup>7</sup> ..... **E21B 17/00**; E21B 17/10; E21B 43/00

(52) **U.S. Cl.** ..... **166/105**; 166/241.4; 166/242.6; 417/448

(58) **Field of Search** ..... 166/68, 105, 241.2, 166/241.3, 241.4, 242.1, 242.6, 242.7; 417/448

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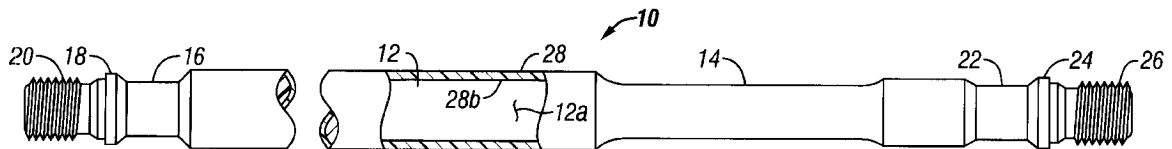
*Primary Examiner*—George Suchfield

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(57) **ABSTRACT**

An elongated pump rod or sinkerbar for use in a pump rod string for a downhole reciprocating well pump is provided with an elongated sleeve of high density or ultra high density polyethylene over a major portion of the length of the sinkerbar to minimize wear on the sinkerbar and a well tubing string as a consequence of deflection of the sinkerbar into engagement with the tubing string and to minimize frictional drag on the pump actuating mechanism as a result of such engagement. The polyethylene sleeve may be assembled over the sinkerbar by apparatus including an elongated hydraulic actuator which may be configured to push a sinkerbar into the sleeve while the sleeve is held stationary within a support tube, or by holding the sinkerbar stationary on a support and pulling the sleeve over the sinkerbar and from a continuous length of tubing from which the sleeve is formed.

**18 Claims, 3 Drawing Sheets**



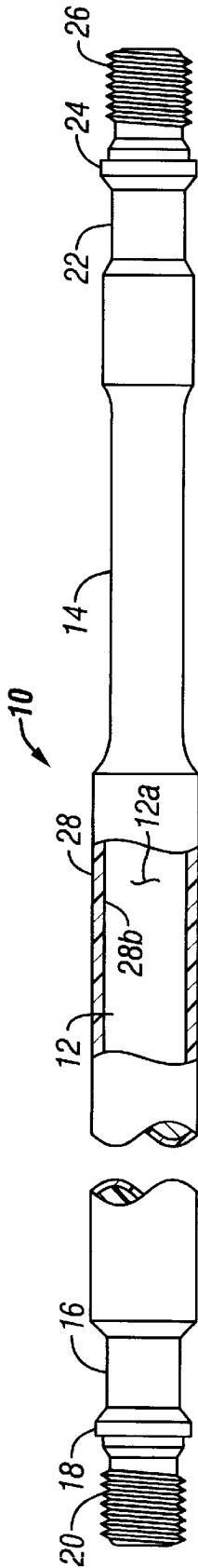


FIG. 1

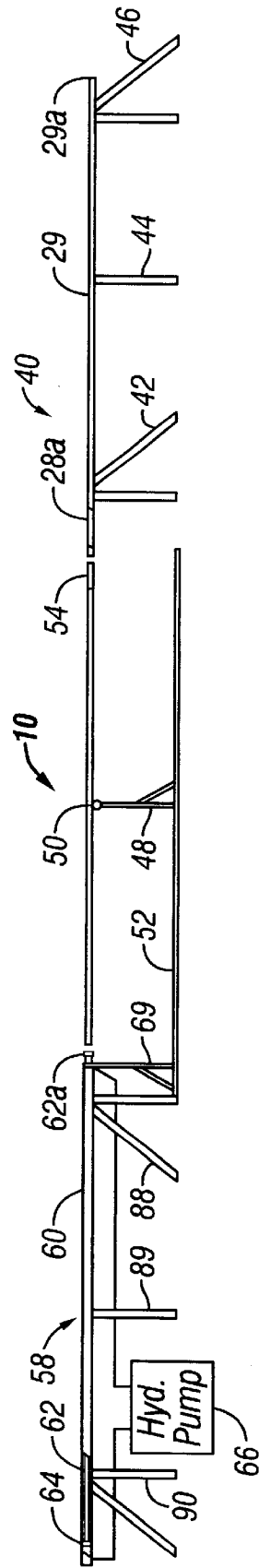
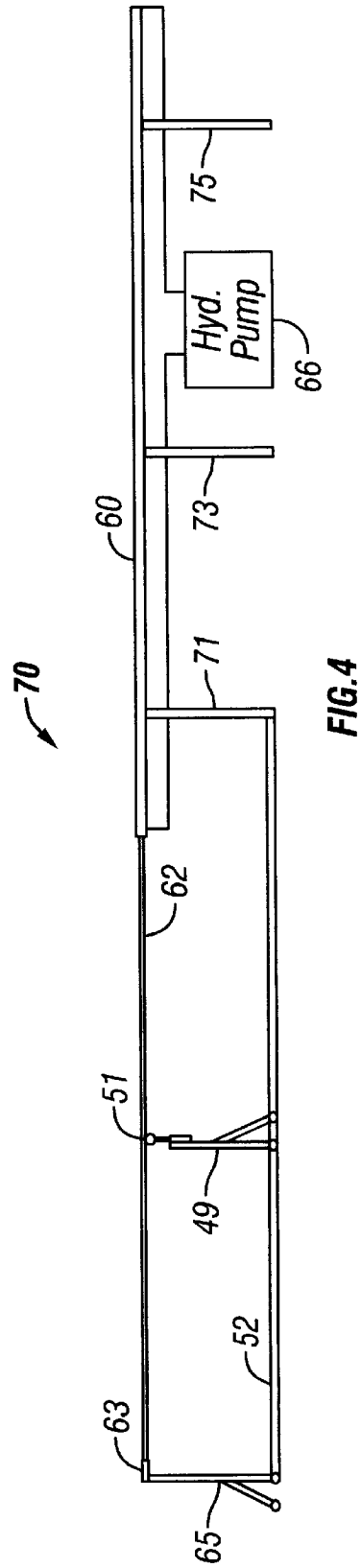
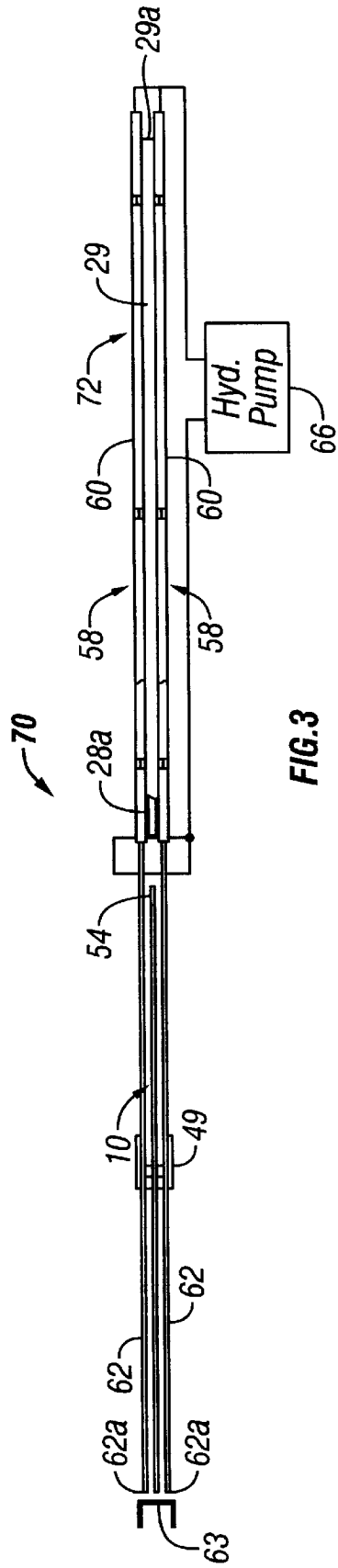
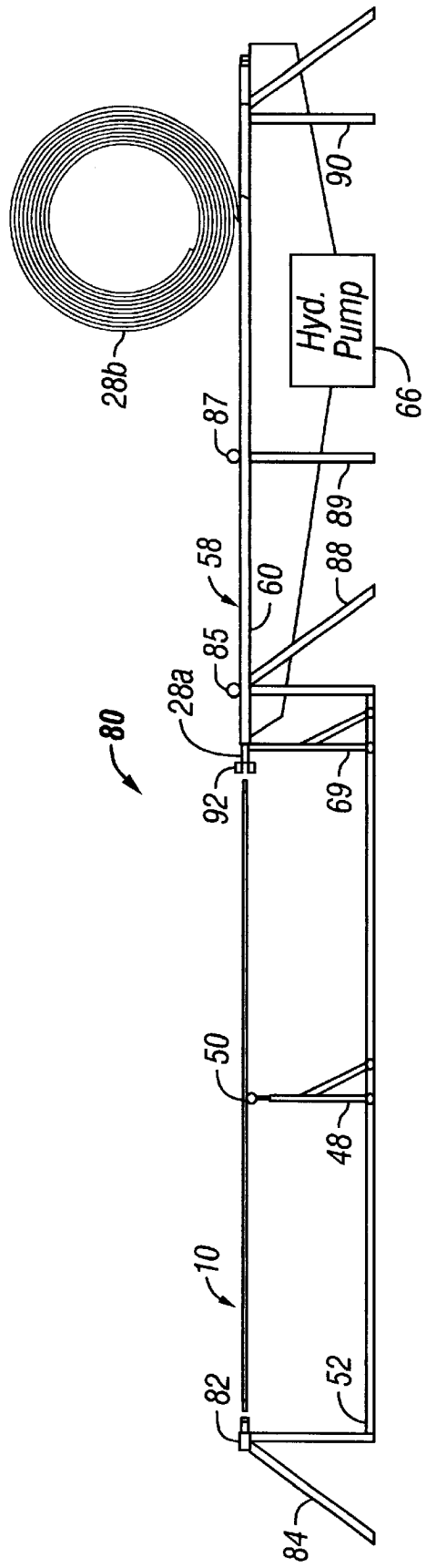
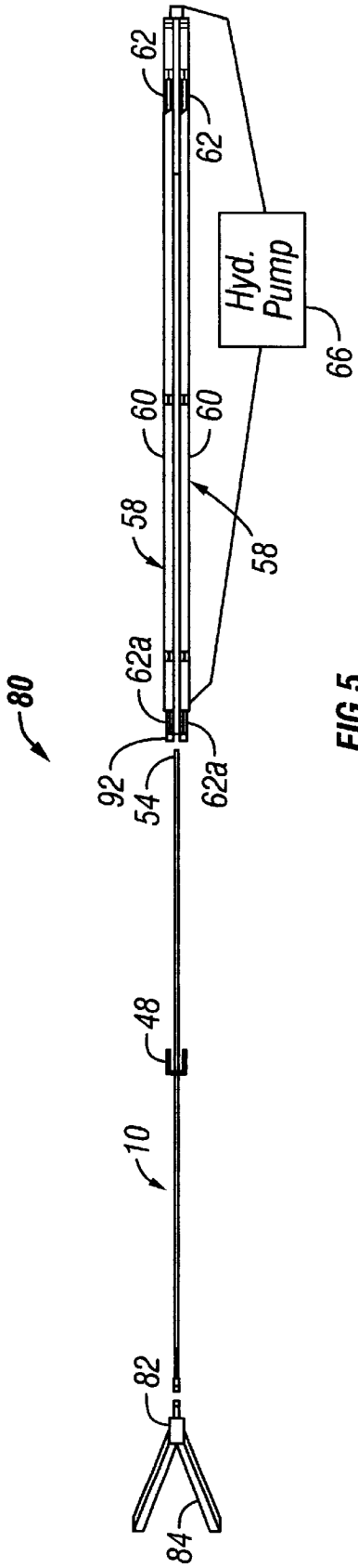


FIG. 2







## WEAR RESISTANT WELL PUMP ROD AND METHOD FOR MAKING SAME

### FIELD OF THE INVENTION

The present invention pertains to well pump rod, including a rod commonly known as a sinkerbar, which is provided with a high density polyethylene sleeve disposed thereover to minimize wear on the rod and well tubing in which it is disposed. The invention also pertains to preferred methods and apparatus for applying a polyethylene sleeve to a pump rod or "sinkerbar".

### BACKGROUND

Downhole well pumps which utilize elongated strings of so-called "sucker rods" as the pump actuating mechanism are widely used for various well pumping applications. Although it was once and long-considered a suitable design to provide a pump rod string, with rod sections having the smallest diameter disposed in the string directly above the pump, with progressively increasing rod diameters in the rod string near the earth's surface, this configuration produces a tendency to significantly buckle and bend the rod string at the rod sections of smallest diameter, that is just above the pump, and cause substantial abrasion of the rod string as well as the tubing string in which the rod and pump are disposed. Consequently, more recent design techniques have utilized rod sections of larger diameter near the bottom of the rod string and directly above the pump, and commonly known as "sinkerbars".

By way of example, a pump rod string including 1.50 inch diameter sinkerbars connected end to end in the bottom 300 feet to 500 feet of the string, directly above the pump, allows the rod string to maintain tension and allows the highest compressive or buckling forces to occur in the relatively larger diameter sinkerbar sections. Accordingly, sinkerbar sections having a larger diameter, compared to the rest of the rod string, are less likely to buckle in compression and when elastic deflection of the sinkerbars occurs and the well tubing is engaged thereby, the contact is disposed over a greater surface area and tends to reduce wear which ultimately requires replacement of the rod and/or the tubing string.

Even with the development of larger diameter rod sections or so-called sinkerbars, there have been efforts to reduce wear on the tubing string by providing, for example, a high or ultra-high density polyethylene liner inside the tubing string, which minimizes wear and friction caused by engagement with a deflected pump rod string. However, certain drawbacks are associated with this approach to reducing wear on tubing as well as rod strings, namely, a reduction in the effective inside diameter of the tubing string due to the thickness of the polyethylene liner and the requirement to install substantial lengths, up to several thousand feet, of lined tubing string in the well in order to accommodate the entire length of pump rod string which is likely to be deflected into engagement with the tubing string as a result, for example, of changing the position of the pump within the tubing string from time to time. U.S. Pat. No. 5,511,619 issued to William E. Jackson on Apr. 30, 1996 describes an example of the aforementioned approach. However, the present invention contemplates an alternative, improved solution to the problems associated with rod actuated well pumps, as discussed hereinabove.

### SUMMARY OF THE INVENTION

The present invention provides an improved elongated pump rod section or sinkerbar for use with downhole rod actuated well pumps and the like.

In accordance with one aspect of the invention, an elongated pump rod or "sinkerbar" is provided which includes a sleeve of polymer material disposed over a major portion of the exterior of the rod or sinkerbar and preferably comprises polyethylene, high density polyethylene or ultra high density polyethylene. This sleeve provides a bearing surface which reduces friction and wear on the well tubing and the pump rod or sinkerbar in the event of engagement between the sinkerbar and the well tubing.

By placing a sleeve of polymer material, such as polyethylene, on the exterior of the pump rod or sinkerbar and in accordance with methods contemplated by the invention, there is no requirement to utilize non-standard tubing string sizes, and/or limit well fluid flow resulting from a reduced internal diameter of the tubing string. At the same time, the ability to maintain tension in the pump rod string and reduce wear on the pump rod string and the tubing string is provided. Moreover, by utilizing only a few hundred feet (200 feet to 500 feet) of pump rod or sinkerbar string incorporating the polyethylene or other polymer sleeve thereover, the cost of providing a wear-reducing arrangement for rod actuated well pumps is reduced.

The present invention also contemplates the provision of methods and apparatus for applying a polymer sleeve over a substantially cylindrical elongated section of a pump rod or sinkerbar. One embodiment of the method and apparatus utilizes a hydraulic cylinder which is operable to engage one end of the rod or sinkerbar and forcibly displace it within a section of stationary polyethylene tubing. Another embodiment contemplates a method and apparatus which holds the rod or sinkerbar stationary and utilizes a hydraulic cylinder actuator to forcibly displace the polyethylene sleeve over the outer diameter of the rod, still further, a third embodiment of a method and apparatus for applying a polyethylene sleeve to a sinkerbar contemplates utilizing a hydraulic cylinder actuator for displacing the sleeve over a stationary rod or sinkerbar and wherein the sleeve is applied from a continuous roll of polyethylene tubing.

Those skilled in the art will further appreciate the above-mentioned advantages and features of the invention together with other important aspects thereof upon reading the detailed description which follows in conjunction with the drawing.

### BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal side elevation, partially sectioned, of a pump rod or sinkerbar including a wear resistant polymer sleeve in accordance with the present invention;

FIG. 2 is a side elevation of a first embodiment of an apparatus for applying a polymer sleeve to a sinkerbar or pump rod in accordance with the invention;

FIG. 3 is a plan view of a second embodiment of an apparatus for applying a polymer sleeve to a sinkerbar;

FIG. 4 is a side elevation of the apparatus shown in FIG. 3;

FIG. 5 is a plan view of a third embodiment of an apparatus for applying a polymer sleeve to a sinkerbar in accordance with the invention; and

FIG. 6 is a side elevation of the apparatus shown in FIG. 5.

### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the description which follows, like parts are marked throughout the specification and drawing with the same

reference numerals, respectively. The drawing figures may not be to scale and certain features may be shown in somewhat schematic or generalized form in the interest of clarity and conciseness.

Referring to FIG. 1, there is illustrated an elongated pump rod or sinkerbar in accordance with the invention and generally designated by the numeral 10. The sinkerbar 10 comprises an elongated cylindrical rod section 12, extending over a major portion of the length of the sinkerbar and extending between a reduced diameter elevator section 14 and a first wrench flat section 16. A cylindrical collar 18 is interposed the wrench flat section 16 and an externally threaded end part 20. A wrench flat section 22 is provided adjacent the opposite end of the sinkerbar and a cylindrical collar 24 is interposed the wrench flat section 22 and a second externally threaded end part 26. The aforescribed configuration of a pump rod section or sinkerbar is somewhat conventional. By way of example, the sinkerbar 10 may be manufactured of alloy steel, such as SAE 1045 or SAE 4623 cold finished bar, in approximately twenty-five foot lengths. Further, by way of example, the rod section 12 may have an outside diameter of about 1.375 inches, the elevator section or neck 14 having a diameter of about 1.0 inches and the wrench flats 16 and 22 also having a cross-sectional dimension of about 1.0 inches. Conventional coupling threads are provided on the externally threaded end parts 20 and 26.

The sinkerbar 10 differs from prior art sinkerbars in that an elongated polymer sleeve 28 extends over a major portion of the length of the bar and substantially covers the entire length of the rod section 12, as shown. The sleeve 28 is preferably formed of a heat and abrasion resistant polymer which also exhibits good lubricity or low friction characteristics in contact with certain other materials, such as steel tubing. High density polyethylene or ultra high density polyethylene, for example, is preferred. A preferred configuration of a sleeve 28 for a sinkerbar having a diameter of 1.375 inches for the rod section 12 is provided by a cylindrical sleeve having an inside diameter of about 1.380 inches and an outside diameter of about 1.562 inches. The inside diameter of the sleeve 28 may be slightly less than the diameter of the rod section 12 so that the sleeve is required to be stretched and then forms a slight interference fit with the rod section after being sleeved over the rod section. Alternatively, the polymer sleeve 28 may be shrink-fitted onto the rod section 12 after application thereto. However, by providing the inner diameter of the sleeve 28 to be approximately a line-to-line fit with respect to the outer diameter of a rod section 12, frictional engagement between the inner surface 28b of the sleeve and surface 12a of the rod section 12 and over a substantial length, i.e., about 25.0 feet, will maintain the sleeve in place and the difference between the coefficients of thermal expansion of the steel rod section 12 and the polyethylene sleeve will also provide for maintaining the sleeve securely on the rod section 12.

Those skilled in the art will appreciate that a pump rod section or sinkerbar according to the invention, enjoys substantial benefits. The sleeve 28 will prevent rapid wear of the sinkerbar section 12 as well as a tubing string which may come into contact with the outer surface of the sleeve. Moreover, the sleeve 28 will protect a substantial portion of the rod or sinkerbar 10 against corrosion in the highly corrosive environment of hydrocarbon wells, for example. Still further, by providing the sleeve 28, which exhibits a low coefficient of friction in contact with many materials, a pump rod string which may be deflected into engagement with the inside wall of a well tubing string will exhibit lower

resistance to reciprocation in normal operation of a pumping system in which the rod is being used.

Referring now to FIG. 2, there is illustrated an apparatus and method for installing a sleeve, such as the sleeve 28, over a cylindrical rod section, such as the rod section 12 of the pump rod or sinkerbar 10. Referring to FIG. 2, a sinkerbar/sleeve assembly apparatus 40 is illustrated comprising spaced apart, vertically extending supports 42, 44 and 46 for suitably supporting a rigid tube 29, closed at one end 29a, and operable to receive a section of polymer tubing 28a therein and which will become the sleeve 28 when assembled in sleeved relationship over a pump rod or sinkerbar 10. The sinkerbar 10 is supported on one or more support members such as the support or steadyrest 48, one shown, having one or more rollers 50 mounted thereon for engagement with the sinkerbar in supportive relationship. The steadyrest 48 may be supported on a track 52 for traversal therealong to support the sinkerbar 10 as it is displaced into the interior of the tubing 28a. A suitable expander member or mandrel 54 may be temporarily secured to one end of the sinkerbar 10 by threaded engagement with one of the external threaded parts 20 or 26 to facilitate insertion of the sinker bar within the tubing 28a.

The sinkerbar 10 is pushed into the length of tubing 28a, which is held stationary within tube 29, by an elongated hydraulic cylinder and piston actuator 58 having a stationary cylinder member 60 and a linearly extensible and retractable piston rod 62 connected to a piston 64 slidably disposed in the cylinder 60. Actuator 58 is mounted on suitable spaced apart supports 88, 89 and 90. A hydraulic pump unit 66 is operably connected to the cylinder actuator 58 in a conventional manner for extending the piston rod 62 to displace the sinkerbar 10 into the tubing 28a and to retract the piston rod to the position shown in FIG. 2 for a subsequent operation. A second steadyrest 69 is mounted on the track 52 and engageable with the distal end 62a of piston rod 62 for movement therewith to steady the piston rod and minimize the risk of deflection of the piston rod as it inserts the sinkerbar 10 into the tubing section 28a. The distal end 62a of piston rod 62 may be provided with a suitable adapter, not shown, for engaging one end of the sinkerbar during the displacement procedure.

Referring now to FIGS. 3 and 4, an alternate embodiment of an apparatus for installing a tubing section 28a in sleeved relationship over a sinkerbar 10 is illustrated and generally designated by the numeral 70. The apparatus 70 includes an actuator unit 72 comprising two side-by-side hydraulic cylinder actuators 58 between which is mounted the rigid tube 29 for holding the polyethylene tubing section 28a therein, as shown in FIG. 3. The hydraulic cylinder actuators 58 and the tube 29 are suitably supported on spaced apart vertically extending support legs 71, 73 and 75, FIG. 4. Hydraulic pump unit 66 is operably connected to both of the actuators 58 in a suitable manner for extending and retracting side-by-side linearly extensible piston rods 62. The piston rods 62 are connected at their distal ends 62a, respectively, to a pusher member 63 and a support 65 therefor. Support 65 is mounted on suitable rollers for linear traversal along track 52. An intermediate support or steadyrest 49, similar to the support 48, includes an extensible rest member 51 comprising a pneumatic cylinder, for example, to align and steady the sinkerbar 10 as it is pushed into the tubing section 28a which is held stationary in the tube 29. An expander mandrel 54 is temporarily secured to one end of the sinkerbar 10 to facilitate insertion of the sinkerbar as it is pushed into the tubing section 28a by retracting the piston rods 62, simultaneously, into their respective cylinders 60.

Referring now to FIGS. 5 and 6, another embodiment of an apparatus for sleeving a section of polyethylene tubing over a sinkerbar 10 is illustrated and generally designated by the numeral 80. The apparatus 80 includes the roller track 52, at least one support or steadyrest 48 for a sinkerbar 10 and an abutment 82 mounted on a suitable support 84. The abutment 82 is engageable with one end of the sinkerbar 10 to hold the sinkerbar stationary when a section 28a of polyethylene tubing is sleeved thereover. The tubing section 28a may be unreeled from a suitable storage spool or reel 28b of a continuous length of tubing and the tubing section is traversed through spaced apart sets of straightening rollers 85 and 87, which are suitably mounted on spaced apart supports 88, 89 and 90.

Side-by-side cylinder actuators 58 are also mounted on the supports 88, 89 and 90 and their respective linearly extensible piston rods 62 are connected at distal ends 62a to a head 92, which is also connected to one end of tubing section 28a for pulling the tubing section 28a from reel 28b and sleeving it over the sinkerbar 10 as the piston rods 62 are extended toward the abutment 82. A steadyrest 69 is also connected to the piston rods 62 adjacent their distal ends 62a and traverses the track 52 to reduce deflection of the rods as they are extended from the respective cylinders 60.

Accordingly, a sleeve 28 may be extended in sleeved relationship onto a sinkerbar 10 over its rod section 12 by one of several methods as described and illustrated.

Although a preferred embodiment of a well pump rod or sinkerbar has been described herein together with preferred embodiments of methods and apparatus for assembling a polymer sleeve over a pump rod section or sinkerbar, those skilled in the art will recognize that various substitutions and modifications may be made to the invention without departing from the scope and spirit of the appended claims.

What is claimed is:

1. An elongated pump rod for use in a pump rod string for a downhole well pump, said pump rod including a generally cylindrical rod section extending over a major portion of the length of said pump rod, said pump rod including means formed thereon for coupling said pump rod to said pump rod string, and an elongated sleeve extending over said cylindrical rod section and secured in engagement therewith, said sleeve being formed of a wear resistant polymer material comprising one of high density polyethylene and ultra high density polyethylene.

2. The pump rod set forth in claim 1 wherein:

the coefficient of friction of said sleeve with respect to a well tubing in which said pump rod is disposed is less than the material of said pump rod.

3. The pump rod set forth in claim 1 wherein:

said sleeve has an inner diameter in a relaxed condition slightly less than the outer diameter of said cylindrical rod section.

4. The pump rod set forth in claim 1 wherein:

said sleeve has an inner diameter in a relaxed condition substantially the same as the outer diameter of said cylindrical rod section.

5. The pump rod set forth in claim 1 wherein:

the coefficient of thermal expansion of said sleeve is substantially the same as the coefficient of thermal expansion of alloy steel.

6. A method for fabricating an elongated pump rod for a downhole well pump wherein said pump rod includes a sleeve of polymer material extending over a major portion of the length of said pump rod, said method comprising the steps of:

providing an apparatus for supporting said pump rod and said sleeve, said apparatus including a linearly extensible and retractable actuator connected to one of said pump rod and said sleeve; and

operating said actuator to move said sleeve relative to said pump rod into sleeved relationship thereover.

7. The method set forth in claim 6 including the steps of: supporting said sleeve stationary relative to said actuator and causing said actuator to push said pump rod into said sleeve.

8. The method set forth in claim 7 including the steps of: supporting said sleeve within an elongated tube during insertion of said pump rod within said sleeve.

9. The method set forth in claim 6 including the steps of: supporting said pump rod stationary with respect to said actuator and causing said actuator to pull said sleeve over said pump rod from one end of said sleeve.

10. The method set forth in claim 9 including the step of: providing said sleeve from a continuous length of polymer tubing and pulling said tubing from one end into engagement with and sleeved over said pump rod.

11. The method set forth in claim 6 including the step of: supporting said pump rod at one end by said actuator and at an intermediate point between said one end and the opposite end of said pump rod.

12. The method set forth in claim 6 including the step of: supporting said pump rod intermediate the ends thereof on a support which is movable relative to said pump rod and actuator in response to sleeving said sleeve over said pump rod, and engaging said pump rod at one end thereof with an abutment to hold said pump rod stationary with respect to said sleeve while said sleeve is being pulled over said pump rod at an opposite end of said pump rod and in sleeved relationship thereto.

13. The method set forth in claim 6 including the step of: providing an expander mandrel connected to one end of said pump rod; and

inserting said expander mandrel into one end of said sleeve while moving said sleeve relative to said pump rod to elastically deform said sleeve for extending said sleeve over a major portion of said length of said pump rod and in sleeved relationship thereto.

14. An elongated sinkerbar for use in a pump rod string for a downhole well pump, said sinkerbar including opposed end parts adapted for coupling said sinkerbar into said pump rod string, an elevator section of said sinkerbar adjacent one of said end parts and an elongated rod section having a diameter greater than said elevator section and said end parts, said elongated rod section having a sleeve of polymer material extending thereover and secured thereto by a forcible fit between the outer surface of said rod section and an inner surface of said sleeve, said sinkerbar being formed by an apparatus for supporting said sinkerbar and said sleeve and including a linearly extensible and retractable actuator connected to one of said sinkerbar and said sleeve and whereby said sinkerbar is formed by operating said actuator to move said sleeve relative to said rod section in to sleeved relationship thereover.

15. The sinkerbar set forth in claim 14 wherein:

said sleeve is formed of one of high density polyethylene and ultra high density polyethylene.

16. The sinkerbar set forth in claim 14 wherein:

said sleeve has an inner diameter in a relaxed condition substantially the same as the outer diameter of said rod section.

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17. The sinkerbar set forth in claim 14 wherein:  
said sinkerbar is provided with an expander mandrel  
connected to one of said end parts for expanding the  
inner diameter of said sleeve while said sleeve is  
moved relative to said sinkerbar into sleeved relation-  
ship over said rod section.

18. An elongated pump rod for use in a pump rod string  
for a downhole well pump, said pump rod including a  
generally cylindrical rod section extending over a major  
portion of the length of said pump rod, said pump rod  
including means formed thereon for coupling said pump rod  
to said pump rod string, and an elongated seamless tubular  
sleeve extending over said cylindrical rod section and hav-

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ing a cylindrical exterior surface for engagement with the  
interior surface of a cylindrical well tubing, said sleeve  
having an inner diameter in a relaxed condition slightly less  
than the outer diameter of said cylindrical rod section and  
secured in forcible engagement therewith, said sleeve being  
formed of a wear resistant polymer material having a  
coefficient of friction with respect to said well tubing which  
is less than the material of said pump rod, and the material  
of said sleeve having a coefficient of thermal expansion  
which is substantially the same as the coefficient of thermal  
expansion of alloy steel.

\* \* \* \* \*



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(12) **United States Patent**  
**Skillman**

(10) **Patent No.:** **US 6,368,084 B1**  
(45) **Date of Patent:** **Apr. 9, 2002**

(54) **DOWNSTROKE SUCKER ROD WELL PUMP**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/495,341**

(22) Filed: **Feb. 1, 2000**

(51) **Int. Cl.**<sup>7</sup> ..... **F04B 53/12**; F04B 19/02; F04B 53/00

(52) **U.S. Cl.** ..... **417/554**; 417/460; 417/555.2; 417/555.1

(58) **Field of Search** ..... 417/555.1, 555.2, 417/554, 460

(57) **ABSTRACT**

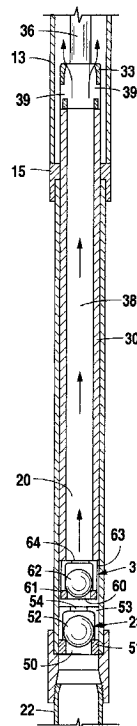
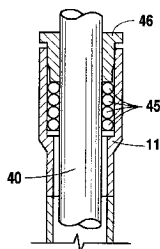
Fluid pumping apparatus for pumping fluids from a well comprising a downhole pump disposed near the lower end of a production string and including a tubular pump barrel and a tubular pump plunger concentrically disposed in the pump barrel in a sliding and sealing fit therewith, one of the pump barrel and the pump plunger being fixed to the production string, the other being attached to the lower end of a string of rods for reciprocal movement. A standing valve is provided in the fixed one of the pump barrel and the pump plunger. A traveling valve is provided in the other. A cylindrical polished rod, the lower end of which is connected to the string of rods, extends upwardly through a sealing assembly for sliding and sealing reciprocation therethrough, the diameter of the polished rod being at least as great as the outside diameter of the pump plunger. A power device is operatively connected to the polished rod for lifting and lowering the polished rod and the string of rods and lift the lower the nonfixed one of the pump barrel and the pump plunger between lower and upper terminal positions, pushing fluids upwardly through the production string on the downstroke of the pump.

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**21 Claims, 2 Drawing Sheets**



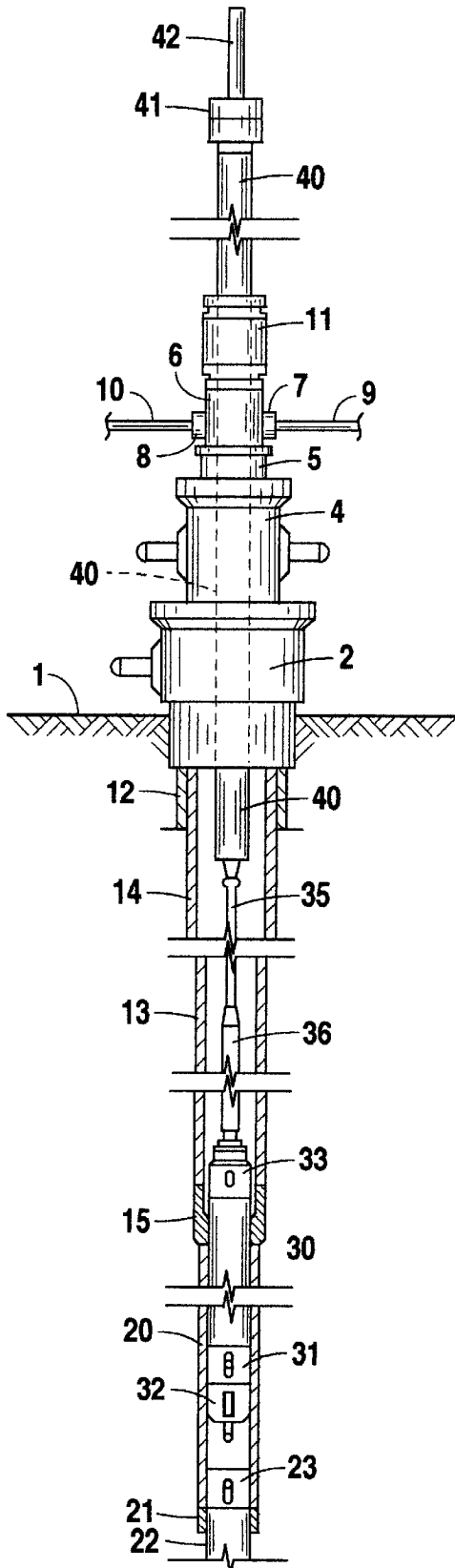


Fig. 1

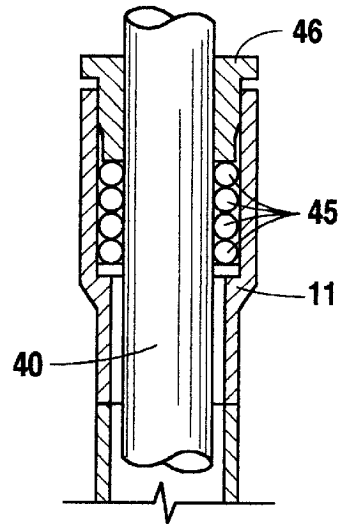


Fig. 2

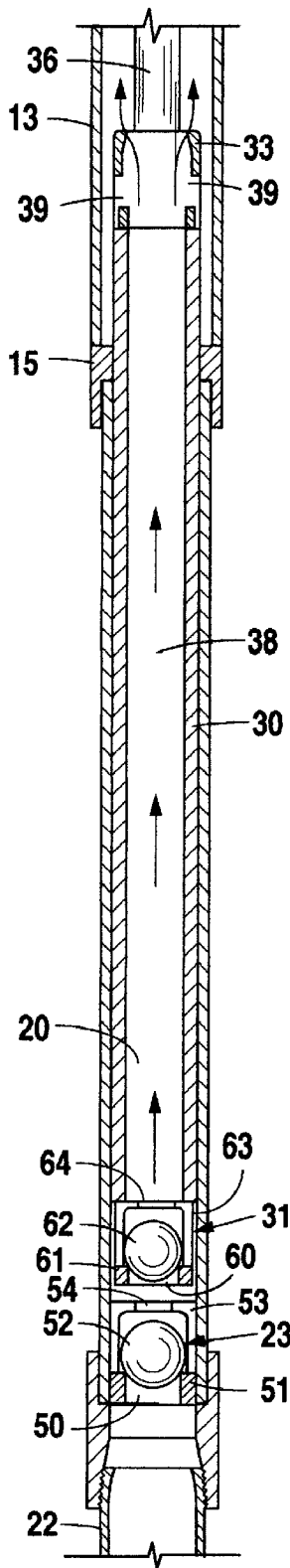


Fig. 3

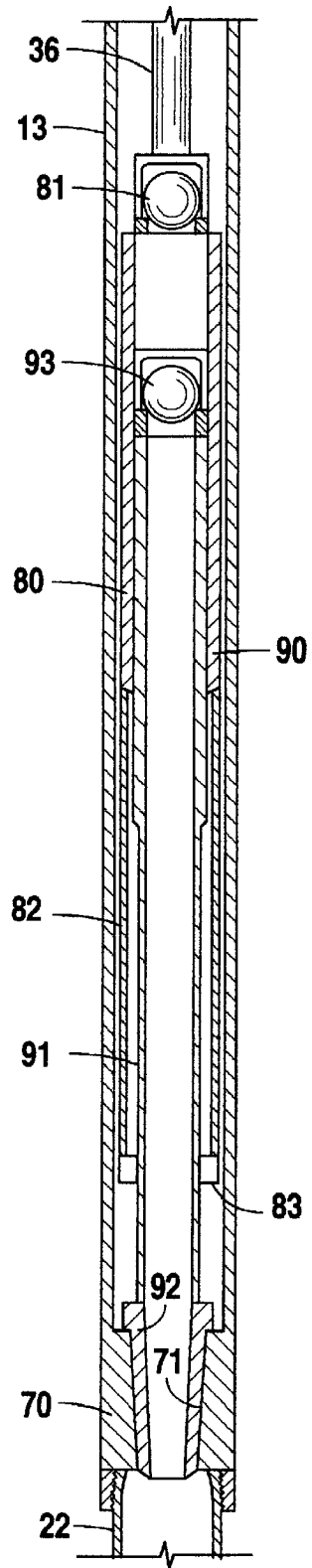


Fig. 4



**DOWNSTROKE SUCKER ROD WELL PUMP****BACKGROUND OF THE INVENTION**

## 1. Field of the Invention

The present invention pertains to pumping apparatus. More specifically, the present invention pretains to reciprocating pumps of the type used for producing fluids from subsurface wells.

## 2. Description of the Prior Art

Subsurface wells, particularly those for producing underground hydrocarbon fluids, typically include a string of tubing or "production string" which extends from near the bottom of the well to the surface for flow of fluids through a flow line connected to the production string at the surface. For wells which do not have enough pressure to produce fluids on their own, some type of pumping system must be employed.

Pumps for lifting subsurface fluids to the surface of an oil well have been in existence for many years. One type of pump, typically referred to as a lift pump, usually includes a tubular barrel (which may be a portion of the production tubing) and a cooperating plunger assembly which reciprocates therein. The plunger assembly may be attached to a rod or string of rods which extends to the surface of the well and by which the plunger assembly may be reciprocated by a source of power such as an internal combustion engine or an electrical motor. Examples of such pumps may be seen in U.S. Pat. Nos. 4,691,735 and 5,178,184.

A lift pump typically includes a standing valve which is fixed relative to the pump barrel and a traveling valve which is a component of the plunger assembly. The standing valve and traveling valve act as check valves, opening and closing, opposite each other, on upstrokes and downstrokes of the plunger assembly. For example, as the plunger assembly and the attached traveling valve are lowered on a downstroke, the standing valve is closed, blocking reverse fluid flow therethrough, and the traveling valve is opened, allowing fluid within the pump barrel to be displaced through the traveling valve into the production tubing thereabove. On the subsequent upstroke, the traveling valve closes, lifting the column of fluids thereabove towards the surface. Since pressure in the pump barrel below the traveling valve decreases during the upstroke, the standing valve then opens allowing fluid to flow into the pump barrel from the formation for a succeeding downstroke. As this process continues, fluid flows through the standing valve and into the pump barrel during the upstrokes and fluid above the traveling valve is lifted toward the surface of the well on the upstroke.

Since the fluids being produced from a well are typically located at some distance below the surface, in most cases hundreds of thousands of feet, a power unit associated with a lift pump must lift: i) a long string of steel rods, ii) the plunger assembly, and iii) a column of fluid the length of which is approximately equal to the depth of the well. This requires a great deal of energy. With lift pumps of the prior art, no fluid production occurs on the downstroke in which the plunger assembly and the string of rods is lowered before another upstroke. Thus the lifting of great weights on the upstroke requires a great amount of energy while the energy from the weight of the rods and plunger assembly on the downstroke is wasted and not utilized.

The great difference between the load on an upstroke and the lack of load on a downstroke creates a counterbalance problem on the power unit. This great difference in weight cannot be fully counterbalanced. If the power unit is pow-

ered by electricity (an electric motor), the electric motor draws much higher amperage on the upstroke than on a downstroke.

Another problem with lift pumps of the prior art is associated with stretching of the rods by which the plunger and fluids are lifted in the production string. The rods stretch on the upstroke and relax on the downstroke. This results in loss of movement or plunger travel as compared to the length of movement of the power unit stroke. This results in inefficiency.

Attempts have been made in the prior art to reduce the load and the energy required to lift fluids to the surface of a well. Specifically, attempts have been made to utilize the energy normally lost during the downstroke of the plunger assembly by pumping on the downstroke. One such attempt is described in U.S. Pat. No. 5,314,025. Although this pumping apparatus appears to utilize the weight of the rods in response to gravity as a source of pumping energy for pumping on the downstroke, it does not substantially reduce the energy required on the upstroke. This particular apparatus has other characteristics which have apparently prevented it from being accepted in the industry.

**SUMMARY OF THE PRESENT INVENTION**

The present invention comprises pumping apparatus for pumping fluids through the production string of a subsurface well. The apparatus, in a preferred embodiment, comprises a fixed tubular pump barrel attached to the lower end of the production string which has a standing valve in the lower end thereof to permit flow of fluids into the barrel but preventing flow of fluids out of the barrel. It also includes a reciprocating tubular pump plunger concentrically disposed in the pump barrel for sliding and sealing reciprocal movement therein. The reciprocating plunger is provided, on its bottom end, with a traveling valve which permits flow of fluids from the fixed barrel through the reciprocating plunger but prevents flow of fluids through the reciprocating plunger into the fixed pump barrel. The upper end of the reciprocating plunger projects out of the fixed barrel into the production string and is provided with flow passages at the upper end thereof through which fluid may flow from the barrel, through the plunger into the production string. The lower end of a string of rods is attached to the reciprocating pump plunger and extends upwardly through the production string to near the surface. A cylindrical polished rod is connected to the top of the string of rods and extends upwardly through the sealing means in the wellhead for sliding and sealing reciprocation therethrough. A power unit is operatively connected to the polished rod for lifting and lowering the polished rod and the string of rods to lift and lower the reciprocating pump plunger within the fixed pump barrel.

Unique features of the pumping apparatus of the present invention reside in the fact that the upper end of the reciprocating plunger projects out of the barrel and in the fact that the polished rod is of a diameter at least as great as the outside diameter of the pump plunger. For this reason, the volume of the polished rod displaced from the production string on the upstroke is at least as great as the volume of fluids displaced by the reciprocating plunger on the upstroke. Thus, no fluids are displaced or will flow through the production tubing into the flow line on the upstroke and the only energy required during the upstroke is energy required to lift: (a) the reciprocating pump plunger and (b) the string of rods attached thereto. However, as the string of rods and the reciprocating pump plunger are lowered on the

downstroke, the energy derived from the weight of the string of rods and the pump plunger, due to the gravitational pull thereon, is utilized to force fluids in the fixed pump barrel through the reciprocating pump plunger and its traveling valve and through the production string to the surface for flow through the flow line connected to the production string. In summary, production is exactly the opposite of the typical lift pump in which fluids are produced on the downstroke; that is all production of fluids occur on the upstroke.

One of the major advantages of the pumping apparatus of the present invention is the utilization of the normally wasted energy associated with downward movement of the reciprocating pump plunger and the string of rods attached to the reciprocating pump plunger to force fluids to the surface of the well during the downstroke and the fact that the only energy required during the upstroke is energy required for lifting the string of rods and the reciprocating pump plunger. If the power unit is powered by an electrical motor, the motor draws essentially the same amperage on the upstroke as the downstroke, resulting in an approximately 50% reduction in electrical cost per barrel of produced fluid.

There is much less wear and tear, requiring less maintenance, yet the equipment is no more complicated and no more expensive than prior art lift pumps. Many other objects and advantages of the invention will be apparent from reading the description which follows in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical representation, partially in section, of a well and fluid pumping apparatus for pumping fluids from the well, according to a preferred embodiment of the invention;

FIG. 2 is a detailed sectional view of an upper part of the fluid pumping apparatus of FIG. 1, according to a preferred embodiment thereof;

FIG. 3 is a longitudinal sectional view of a lower portion of the fluid pumping apparatus of the present invention, according to a preferred embodiment thereof; and

FIG. 4 is a longitudinal sectional view of a lower portion of the fluid pumping apparatus of the present invention, according to an alternate embodiment thereof.

#### DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is shown a well, for example, an oil well for producing hydrocarbon fluids from a hydrocarbon bearing formation substantially below the surface of the earth. The surface is represented at 1. The well is provided at the surface 1 with a wellhead which includes a casing head 2 attached to the upper end of surface casing 3. Surmounted on the casing head 2 is a tubing head 4, a tubular spool 5 and a flow head 6. The flow head 6 may be provided with outlets 7 and 8. Outlet 7 is shown connected to a flow line 9. Outlet 8 may be connected to a bleeder line 10. Mounted on the top of the flow head 6 is a stuffing or packing box 11 for the polished rod 40 which is shown in more detail in FIG. 2 and will be more fully described hereafter with reference thereto.

As previously stated, the casing head 2 is supported on the upper end of the surface casing 3. The casing head 2 supports a production casing 12 and the tubing head 4 supports a tubing or production string 13 which extends substantially to the bottom of the well and through which

fluids produced by the well may flow or be raised or pushed to the surface thereof. The first or upper joint 14 of the tubing or production string 13 is preferably oversized. Attached near the bottom of the production string 13 by a coupling 15 is a fixed tubular pump barrel 20 of a pump. Attached to the lower end of the fixed tubular pump barrel 20 by a coupling 21 may be a seating nipple, perforated nipple, bull plug or the like generally and collectively represented at 22. The nipple is perforated to allow collection of fluids in the lower end of the production string from the producing formation of the well. Attached to the lower end of the tubular barrel 20 is a standing valve 23 which, since it is fixed with the fixed barrel 20 in the well, is sometimes referred to as a standing valve.

Concentrically disposed in the tubular pump barrel 20 for sliding and sealing reciprocal movement therein is a reciprocating tubular pump plunger 30. Attached, in the exemplary embodiment, to the lower end of pump plunger 30 is a valve 31 which is sometimes referred to as a "traveling valve". Attached at the lower end of the reciprocating plunger 30 and under the standing valve might be a standing valve puller 32 the purpose of which would in some cases be to engage and remove the standing valve 23 when necessary. The upper end of the reciprocating plunger 30 is provided with flow passages through which fluid may flow from the interior of the plunger into the production string 13. These flow passages may be provided in a cage 33 or the like.

The upper end of the reciprocating plunger 30 is attached to a string of rods 35 sometimes referred to as "sucker rods". This connection may be made through a sucker rod coupler 36. The string of rods or sucker rods 35 extend to near the surface 1 where it is connected to a larger polished rod 40. The polished rod 40 extends through components of the wellhead and the stuffing box 11 for connection by a wire hanger 41 to a wire line 42. The wire line 42 is then operatively connected to a reciprocating power unit (not shown) supplied with power through an internal combustion engine or electric motor (not shown) which lifts and lowers the wire line 42, in turn lifting and lowering the polished rod 40, the sucker rods 35 and the pump plunger 30 attached at the lower end thereof. These components and the operation thereof will be more fully described and understood hereafter.

Referring now to FIG. 2, the stuffing box 11 and a portion of the polished rod 40 therein will be more fully described. The stuffing box 11 is provided with a counterbalanced area in which annular seals or packings 45 are mounted. A seal or packing gland 46 is threadedly connected to the upper end of stuffing box 11 to hold the sealing elements 45 in place. The polished rod 40 reciprocates within the stuffing box 11 in sliding and sealing engagement with the sealing elements 45. It is important that the diameter of the polished rod 40 be at least as great as the outside diameter of the pump plunger 30 connected to the string of rods therebelow. The reason for this will be more fully understood hereafter.

Referring now to FIG. 3, the lower portion of the pumping apparatus of the present invention will be described in more detail. In FIG. 3, the standing valve puller 32 shown in FIG. 1 has been removed from under the standing valve since it is not necessary for operation of the pumping apparatus and would only be used for pulling the standing valve 23. FIG. 3 shows the tubular pump barrel 20 connected to the lower end of the production string 13 by the coupling 15. The perforated nipple 22 is connected to the lower end of the tubular pump barrel 20 by a coupling 21 and the standing valve 23 is attached to the lower end of the tubular barrel 20 in any suitable manner. It is preferably attached so that it can

be engaged and removed by a standing valve puller such as the standing valve puller 32 of FIG. 1.

The standing valve 23 has a central flow passage 50 surrounded by a valve seat 51 which is engageable by a ball 52. The ball is enclosed in a cage 53 which allows limited upward movement of the ball 52 away from the seat 51. The cage 53 is provided with one or more flow passages 54 through which fluids may pass. The standing valve 23 acts as a check valve allowing flow of fluids from the perforated nipple 22 through the flow passages 50 and 54 into the interior of the tubular barrel 20. However, it prevents reverse flow therethrough, i.e., flow from the interior of the barrel 20 into the perforated nipple 22.

The outside diameter of the reciprocating tubular pump plunger 30 is slightly less than the inside diameter of the tubular barrel 20. However, the reciprocating pump plunger 30 is designed so that it may reciprocate within the pump barrel 20 in sliding and sealing engagement therewith. This may be in the form of a close fitting metal-to-metal seal, as illustrated in FIG. 3, or some type of sealing mechanism may be provided between the fixed barrel 20 and the reciprocating plunger 30. In any event, the plunger 30 is attached to the lower end of the rod string 35 by the sucker rod coupler 36 and, as already described with reference to FIG. 1, is caused to reciprocate with upstrokes and downstrokes in response to lifting and lowering of the polished rod 40, sucker rods 35 and pump plunger 30 by the power unit at the surface of the well.

As shown in the exemplary embodiment of FIG. 3, the traveling valve 31 is attached to the lower end of the reciprocating pump plunger 30. The traveling valve 31 is very similar to the standing valve 23. However, rather than being fixed as the standing valve 23 is with the pump barrel 20, the traveling valve 31 moves and reciprocates with the pump plunger 30. The traveling valve 31 may also be provided with a central passage 60 around which is provided a valve seat 61. A ball member 62 is carried within the cage 63 and the cage 63 is provided with flow passages such as flow passage 64. The traveling valve 31 also acts as a check valve allowing flow of fluids therethrough from the reciprocating tubular pump barrel 20 into the interior or central flow passage 38 of the pump plunger 30 but preventing reverse flow therethrough. The cage 33, attached to the upper end of the pump plunger 30, is provided with one or more flow passages 39 through which fluid may flow through the plunger interior 38 into the production string 13.

If desired, the traveling valve 31 could be installed near the upper part of the plunger 30. In fact, it could be placed where the cage 33 is shown. In such case, the cage 33 might even be eliminated. The pump barrel 20 and pump plunger 30 illustrated in FIGS. 1 and 3 comprise what is known in the industry as a "tubing pump" in that the barrel 20 is connected to the bottom of the tubing or production string 13. This pump could easily be adapted to an "insert pump" design in which the pump barrel and plunger are actually lowered into a production string and the barrel affixed thereto by a seating nipple of a cup type holddown or some other method.

There are at least two dimensions of the pumping apparatus of the present invention which are unique and critical. The length of the fixed or reciprocating plunger 30 must be the same or greater than the fixed or reciprocating pump barrel 20 so that the upper end of the pump plunger 30 extends out the top of the barrel 20 at all times. In addition, the outer diameter of the polished rod 40, as seen in FIG. 2, where it slidably and sealingly engages the sealing elements

45 of the stuffing box 11, must be at least as great as the outside diameter of the pump plunger 30.

The operation of the pumping apparatus shown in FIGS. 1-3 will now be described. Initially, assuming that the plunger 30 is in the lower terminal position of FIG. 3, the string of rods 35 is lifted by the power unit causing the reciprocating pump plunger 30 to move upwardly (an upstroke) until the traveling valve 31 at the bottom of the plunger 31 is at the upper end of the pump barrel 20, the upper terminal position. As this occurs, the pressure within the space vacated by the reciprocating plunger within the fixed pump barrel is reduced and fluids flow from the production zone of the well through the perforated nipple 22 and the standing valve 23 into the pump barrel 20. On the subsequent downstroke, the string of rods 35 and the reciprocating plunger 30 move downwardly toward the lower terminal position illustrated in FIG. 3. As this occurs, fluid flows from the fixed pump barrel 20 through the traveling valve 31 into the inner passage 38 of the pump plunger 30 since the standing valve 23 will not permit reverse flow therethrough. This action continues until the production string 13 is filled to the surface and the flow outlet 7.

With the production string 13 maintaining a column of fluid therein, the pumping action continues. It is important to note at this point that as the string of rods 35 and the reciprocating plunger is lifted, the polished rod 40 is moving upwardly vacating a volume in the production string 14 at least as great as the volume now being occupied in the production string 13 by the pump plunger 30, remembering that the outside diameter of the polished rod is at least as great as the outside diameter of the reciprocating pump plunger 30. Thus, no fluids are being displaced or forced from the production string 13 on the upstroke. The only energy necessary during the upstroke is the energy expended in lifting the string of rods 35 and the pump plunger 30. However, as this occurs, fluids flow from the producing area of the well through the perforated nipple 22 and the standing valve 23 into the pump barrel 20.

On the subsequent downstroke, the plunger 30 descends into the pump barrel 20 and fluids therein are displaced through the traveling valve 31 and the inner flow passage 38 of the pump plunger 30 and through the cage 33 into the production string 13 and through the outlet 7 of flow head 6 into the flow line 9. The plunger 30 and the fluid within the passage 38 are, in effect, a piston whose diameter is equal to the outside diameter of the plunger 30. The volume of fluid displaced during the downstroke is equal to this cross-sectional area times the length of the downstroke.

It is important to note that the weight of the polished rod 40, the string of sucker rods 35, the plunger pump 30 and other components attached thereto is sufficient to displace the fluids within the pump barrel 20. Thus, the energy due to gravitational forces, normally wasted in the typical lift pump, is utilized to force fluids to the surface of the well. Furthermore, the only energy expended on the upstroke is energy required to lift the polished rod 40, the string of rods 35 and the pump plunger 30, and any fluid contained therein. No energy is expended on the upstroke to produce well fluids at the top of well. This substantially reduces the stretch that occurs in the sucker rods of lift pumps of prior art in which the power unit is required to lift not only the string of rods and the reciprocating plunger but a column of fluid. The stretching of the string of rods and then relaxing of the rods on the downstroke in prior art lift pumps reduces the pumping efficiency. Of course the major advantage of the pumping apparatus of the present invention is the substantial reduction in energy on the upstroke and the much easier

balancing of the pumping apparatus with counterbalances. The pumping apparatus of the present invention can be designed so that the power unit, for example an electric motor, draws essentially the same amperage on the upstroke as it does on the downstroke.

Another feature of the pumping apparatus of the present invention resides in the fact that the upper end of the plunger always extends out of the barrel. With conventional lift pumps, the greatest wear on barrels and plungers is from sand and other solids getting between the barrel and plunger. Solids usually get into the barrel from above and are pulled between the plunger and the barrel as the plunger lifts in the barrel. With the present invention, solids are not allowed to settle out in the pump barrel. This should considerably extend the pump life.

The embodiment of the present invention just described with reference to FIGS. 1-3, in which the pump barrel 20 is stationary in the well and the pump plunger 30 is reciprocated therein, is a preferred embodiment of the invention. However, the principles of the invention can also be utilized in an alternate embodiment in which the plunger is stationary within the well and the barrel is reciprocated through downstrokes and upstrokes. The lower portion of such an embodiment is illustrated in FIG. 4. The sucker rod coupler 36 and all the elements of the pumping apparatus such as the string of rods 35, polished rod 40 and the wellhead components illustrated in FIG. 1 would be essentially the same.

In the alternate embodiment of FIG. 4, the production string 13 is modified to provide at the bottom thereof a coupling 70 which is provided on the interior thereof with threads 71 or any other type of suitable connection means for connecting a portion of the pumping unit as will be described hereafter. The perforated nipple 22 and other formation producing components would be connected below the coupling 70.

The alternate embodiment of FIG. 4 also comprises a tubular barrel 80 and a tubular plunger 90. However, in this embodiment, the barrel 80 is not stationary as in the previous embodiment but is attached to the lower end of the sucker rod coupler 36 for reciprocation therewith. The pump plunger 30 is not attached to the string of sucker rods, instead being attached by a smaller diameter tubular extension 91 and holddown component 92 to the production string coupling 70. As illustrated, the holddown component 92 comprises seating cups which seal in a seating nipple and may be pushed in to seat the pump and pulled out to unseat the pump. Of course, this connection could be made in any other suitable manner.

In the embodiment of FIG. 4, a traveling valve 81 is provided at the upper end of the tubular barrel 80 and is similar to the traveling valve 31 of the embodiment of FIGS. 1-3. The plunger 90 is provided with a standing valve 93 which is similar to the standing valve 23 of the embodiment of FIGS. 1-3.

As in the previously described embodiment, the barrel 80 and the plunger 90 telescopically engage each other in a sliding sealing fit. It will be noted that the barrel 80 is provided with a downwardly depending tubular jacket or extender 82 at the lower end of which is an annular collar or shoulder 83 which surrounds the tube extender 91 of the plunger 90. The jacket 82, collar 83 and the tube 91 serve only to restrict the length of the pump stroke and do not affect the hydraulics thereof.

It is important to note that the length of the plunger 90 is, as in the embodiment of FIG. 1-3, at least as great as the length of the barrel 80 so that the end of the plunger 90, the

lower end in this case, always extends out of the barrel 80. Again, it is also important that the diameter of the polished rod 40 at the surface of the well be at least as great as the diameter of the plunger 90.

Operation of the embodiment of FIG. 4 is similar to the operation of the embodiment of FIG. 3. In explaining the operation of the embodiment of FIG. 4, it will be assumed that the production string 13 has been filled with previous strokes of the pumping apparatus. On the next upstroke, fluid will flow through the standing valve 93 filling the interior of the tubular barrel 80 with fluid. This fluid is prevented from flowing out of the barrel 80 into the production string 13 by the traveling valve 81 during the upstroke. As the tubular barrel 80 is filled with fluid, the same volume is being vacated by the polished rod 40 as it moves upwardly through the stuffing or packing box 11. Thus, no fluids are displaced and no fluids are produced through the flow line. The only energy required is energy required to lift the polished rod 40, the string of rods 36 and the tubular barrel 80, its jacket 82 and other connected components.

On the downstroke, the tubular barrel 80 moves downwardly, the standing valve 93 is closed and fluids are displaced through the traveling valve 81 into the production string 13 and out of the flow head outlet 7 into the flow line (see FIG. 1). The energy required for doing so is simply the energy derived from the gravitational pull on the polished rod 40, the string of rods 35 and the tubular pump barrel 80. The same objects and advantages accrue to the embodiment of FIG. 4 as in the embodiments of FIGS. 1-3, i.e., substantial power savings, substantial increase in pumping efficiency, much easier balancing, less wear and tear, etc.

Thus, the pumping apparatus of the present invention is unique in that fluids are pumped on the downstroke rather than on the upstroke as in lift pumps of the prior art. The major advantage of the pumping apparatus of the present invention is the utilization of the normally wasted energy on the downstroke of the pump and a substantial reduction of energy on the upstroke due to the fact that the only energy required is for lifting the string of rods and either the pump plunger or the pump barrel. There are a number of other advantages many of which have already been discussed. Another results from the fact that less tensile strength is required for the sucker rod. Accordingly, smaller rods of less weight may be used on the upper part of the rod string as long as sufficient weight is maintained to displace fluid at the depth of the well.

Two embodiments of the invention have been described in substantial detail. Other embodiments have been suggested. Still a number of other embodiments will be apparent to those skilled in the art. Accordingly, it is intended that the scope of the invention be limited only by the claims which follow.

What is claimed is:

1. A fluid pumping apparatus for conveying fluids to the earth's surface through a production string having a bottom near the producing formation and a top end connected to a flow line at the earth's surface, said apparatus comprising:
  - a downhole pump disposed near the lower end of said production string including a tubular pump barrel and a tubular pump plunger concentrically disposed in said tubular pump barrel in a sliding and sealing fit therewith, one of said tubular pump barrel and said tubular pump plunger being fixed to said production string, the other of said tubular pump barrel and said tubular pump plunger being attached to the lower end

of a string of rods for reciprocal movement between lower and upper terminal positions;  
 said sliding and sealing fit between said tubular pump barrel and said tubular pump plunger constructed and arranged to provide a stationary seal at the bottom of the production string;  
 a standing valve provided in said fixed one of said tubular pump barrel and said tubular pump plunger which permits flow of fluids into said tubular pump barrel but prevents flow of fluids out of said tubular pump barrel;  
 a traveling valve provided in said other of said tubular pump barrel and said tubular pump plunger which permits flow of fluids from said tubular pump barrel into said production string;  
 a cylindrical polished rod, the lower end of which is connected to said string of rods, said cylindrical polished rod extending upwardly through sealing means located above the flow line for sliding and reciprocation therethrough, the diameter of said cylindrical polished rod being as great as the outside diameter of said tubular pump plunger; and  
 power means operatively connected to said cylindrical polished rod for lifting and lowering said cylindrical polished rod and said string of rods to lift and lower said other of said tubular pump valve and said tubular pump plunger between said lower and upper terminal positions,  
 whereby fluids are pushed through said production string into said flow line as said other of said tubular pump barrel and said tubular pump plunger is lowered from said upper to said lower terminal position and whereby no fluids are pushed through said production string to said flow line as said other of said tubular pump barrel and said tubular pump plunger is lifted from said lower to said upper terminal position.

2. The fluid pumping apparatus as set forth in claim 1 in which said traveling valve is closed when said other of said tubular pump barrel and said tubular pump plunger is lifted from said lower to said upper terminal position, no fluids flowing into the flow line, said standing valve being open to allow fluids to flow into said tubular pump barrel.

3. The fluid pumping apparatus as set forth in claim 1 in which said standing valve is closed when said other of said tubular pump barrel and said tubular pump plunger is lowered from said upper to said lower terminal position, said traveling valve being open to allow fluids to flow from said tubular pump barrel and through the production string for flow through the flow line.

4. The fluid pumping apparatus as set forth in claim 1 in which said traveling valve is attached to one end of said other of said tubular pump barrel and said tubular pump plunger.

5. The fluid pumping apparatus as set forth in claim 1 in which said standing valve is attached to one end of said fixed one of said tubular pump barrel and said tubular pump plunger.

6. The fluid pumping apparatus as set forth in claim 1 in which the length of said tubular pump plunger is as great as the length of said tubular pump barrel, assuring that end of said tubular pump plunger extends out of said tubular pump barrel at all times.

7. A fluid pumping apparatus for conveying fluids to the earth's surface through a production string having a bottom near the producing formation and a top end connected to a flow line at the earth's surface, said apparatus comprising:  
 a tubular pump barrel attached to the lower end of said production string and having a standing valve in said

lower end thereof which permits flow of fluids into said tubular pump barrel but prevents flow of fluids out of said tubular pump barrel;  
 a tubular pump plunger concentrically disposed in said tubular pump barrel for sliding reciprocal movement any sealing fits therewith, said tubular pump plunger having a traveling valve therein which permits flow of fluids from said tubular pump barrel through said tubular pump plunger but prevents flow of fluid through said tubular pump plunger into said tubular pump barrel, the upper end of said tubular pump plunger projecting out of said tubular pump barrel into said production string and having at said upper end thereof flow passages through which fluid may flow from said tubular pump plunger into said production string;  
 said sealing fit between said tubular pump barrel and said tubular pump plunger constructed and arranged to provide a stationary seal at the bottom of the production string;  
 a string of rods, the lower end of which is attached to said tubular pump plunger, said string of rods extending upwardly through said production string to near said surface;  
 a cylindrical polished rod, the lower end of which is connected to said string of rods, said cylindrical polished rod extending upwardly through sealing means located above the flow line for sliding and sealing reciprocation therethrough, the diameter of said polished rod being as great as the outside diameter of said tubular pump plunger, and  
 power means operatively connected to said polished rod for lifting and lowering said polished rod and said string of rods to lift and lower said tubular pump plunger within said tubular pump barrel,  
 whereby fluids are pushed through the production string into the flow line as said tubular pump plunger is lowered into said tubular pump barrel and fluids are not pushed through the production string into the flow line as said tubular pump plunger is lifted out of said tubular pump barrel.

8. The fluid pumping apparatus as set forth in claim 7 in which said traveling valve is closed when said tubular pump plunger is lifted out of said tubular pump barrel, no fluids flowing into the flow line, said standing valve being open to allow fluids to flow into said tubular pump barrel.

9. The fluid pumping apparatus as set forth in claim 7 in which said standing valve is closed when said tubular pump plunger is lowered into said tubular pump barrel, said traveling valve being open to allow fluids to flow from said tubular pump barrel, and through the production string for flow through the flow line.

10. The fluid pumping apparatus as set forth in claim 7 in which said traveling valve is attached to the lower end of said tubular pump plunger.

11. The fluid pumping apparatus as set forth in claim 7 in which said traveling valve is attached to the upper end of said tubular pump plunger.

12. The fluid pumping apparatus as set forth in claim 11 in which said flow passages are provided through said traveling valve.

13. The fluid pumping apparatus as set forth in claim 7 in which the length of said tubular pump plunger is as great as the length of said tubular pump barrel, assuring that the upper end of said tubular pump plunger extends out of said tubular pump barrel at all times.

14. A fluid pumping apparatus for conveying fluids to the earth's surface through a production string having a bottom

near the producing formation and a top end connected to a flow line at the earth's surface, said fluid pumping apparatus comprising:

a tubular pump barrel disposed within the production string for reciprocal movement therein between lower and upper terminal positions;

a tubular pump plunger concentrically disposed within said tubular pump barrel in a sliding and sealing fit therewith, said tubular pump plunger being fixed to said production string;

said sealing fit between said tubular pump barrel and said tubular pump plunger constructed and arranged to provide a stationary seal at the bottom of the production string;

a standing valve provided in said fixed tubular pump plunger which permits flow of fluids through said fixed tubular pump plunger into said tubular pump barrel but prevents flow of fluids out of said tubular pump barrel;

a traveling valve provided in said tubular pump barrel which permits flow of fluids from said tubular pump barrel into said production string but prevents reverse flow of fluids therethrough;

a string of rods, the lower end of which is attached to said tubular pump barrel, said string of rods extending upwardly through the production string to near the surface;

a cylindrical polished rod, the lower end of which is connected to said string of rods, said cylindrical polished rod extending upwardly through sealing means located above the flow line for sliding and sealing reciprocation therethrough, the diameter of said polished rod being as great as the outside diameter of said tubular pump plunger; and

power means operatively connected to said polished rod for lifting and lowering said polished rod and said string of rods to lift and lower said tubular pump barrel between said lower and upper terminal positions, pushing fluids through said traveling valve and the production string as said tubular pump barrel is lowered from said upper to said lower terminal position and not

pushing fluids through said traveling valve in the production string as said tubular pump valve is lifted from said lower to said upper terminal positions.

15. The fluid pumping apparatus as set forth in claim 14 in which said traveling valve is closed when said tubular pump barrel is lifted, no fluids flowing into the flow line, said standing valve being open to allow fluids to flow into said tubular pump barrel.

16. The fluid pumping apparatus as set forth in claim 14 in which said standing valve is closed when said tubular pump barrel is lowered, said traveling valve being open to allow fluids to flow from said tubular pump barrel and through the production string for flow through the flow line.

17. The fluid pumping apparatus as set forth in claim 14 in which said traveling valve is attached to one end of said tubular pump barrel.

18. The fluid pumping apparatus as set forth in claim 14 in which said standing valve is attached to one end of said tubular pump plunger.

19. The fluid pumping apparatus as set forth in claim 14 in which the length of said tubular pump plunger is as great as the length of said tubular pump barrel, assuring that one end of said tubular pump plunger extends out of said tubular pump barrel at all times.

20. The fluid pumping apparatus as set forth in claim 14 in which a plunger extension of smaller diameter is attached to the lower end of said fixed tubular pump plunger, said plunger extension being provided with means for fixing said tubular plunger extension and said tubular pump plunger to the production string.

21. The fluid pumping apparatus as set forth in claim 20 in which a tubular barrel extension of smaller inside diameter than the outside diameter of said fixed tubular pump plunger is attached to said lower end of said tubular pump barrel for reciprocal movement therewith, said lower end of said tubular barrel extension being provided with an inwardly projecting shoulder which limits reciprocal movement of said tubular pump barrel relative to said tubular pump plunger between said lower and upper terminal positions.

\* \* \* \* \*

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 6,368,084 B1  
DATED : April 9, 2002  
INVENTOR(S) : Milton M. Skillman

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 3,

Line 9, delete the term "downstroke" and insert the term -- upstroke -- therein;  
Line 10, delete the term "upstroke" and insert the term -- downstroke -- therein;

Column 10,

Line 6, delete the term "any" and insert the term -- and -- therein;  
and,  
delete the letter "s" from the term "fits".

Signed and Sealed this

Twenty-second Day of October, 2002

Attest:

A handwritten signature in black ink, appearing to read "James E. Rogan", written over a horizontal line.

Attesting Officer

JAMES E. ROGAN  
Director of the United States Patent and Trademark Office



US006857472B2

(12) **United States Patent**  
**Stave**

(10) **Patent No.:** **US 6,857,472 B2**

(45) **Date of Patent:** **Feb. 22, 2005**

(54) **WELL PUMP DEVICE**

(75) **Inventor:** **Roger Stave, Knarrevik (NO)**

(73) **Assignee:** **ADR Subsea AS, Straume (NO)**

(\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(51) **Int. Cl.<sup>7</sup>** ..... **E21B 43/00**

(52) **U.S. Cl.** ..... **166/106; 166/68.5; 166/101;**  
**166/105; 166/107; 166/135**

(58) **Field of Search** ..... 166/68, 68.5, 106,  
166/105, 107, 101, 135

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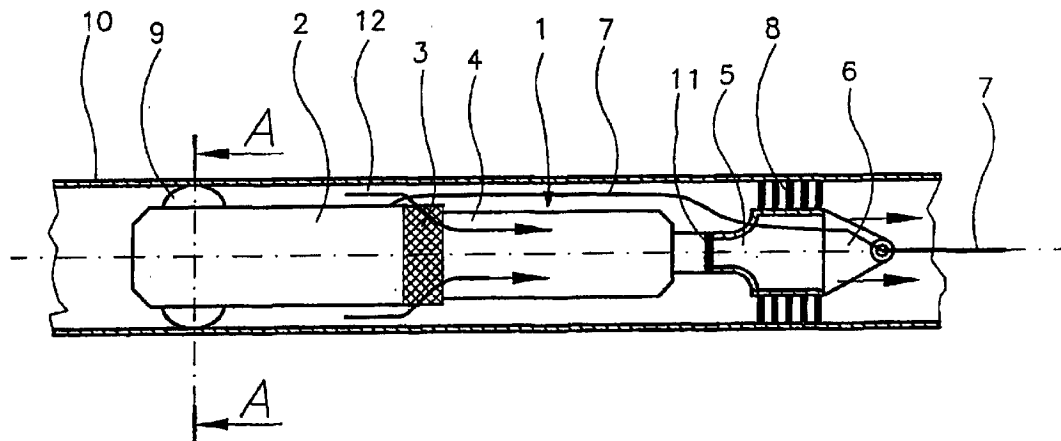
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*Primary Examiner*—David Bagnell  
*Assistant Examiner*—Giovanna Collins  
(74) *Attorney, Agent, or Firm*—Foley & Lardner LLP

(57) **ABSTRACT**

A well pump device, especially for use in connection with the recovery of hydrocarbons, wherein the pump is carried to a predetermined position within a well pipe. The pump is provided with an external seal which is arranged to prevent fluid from flowing from the pressure side of the pump past the pump to the suction side thereof.

**21 Claims, 1 Drawing Sheet**





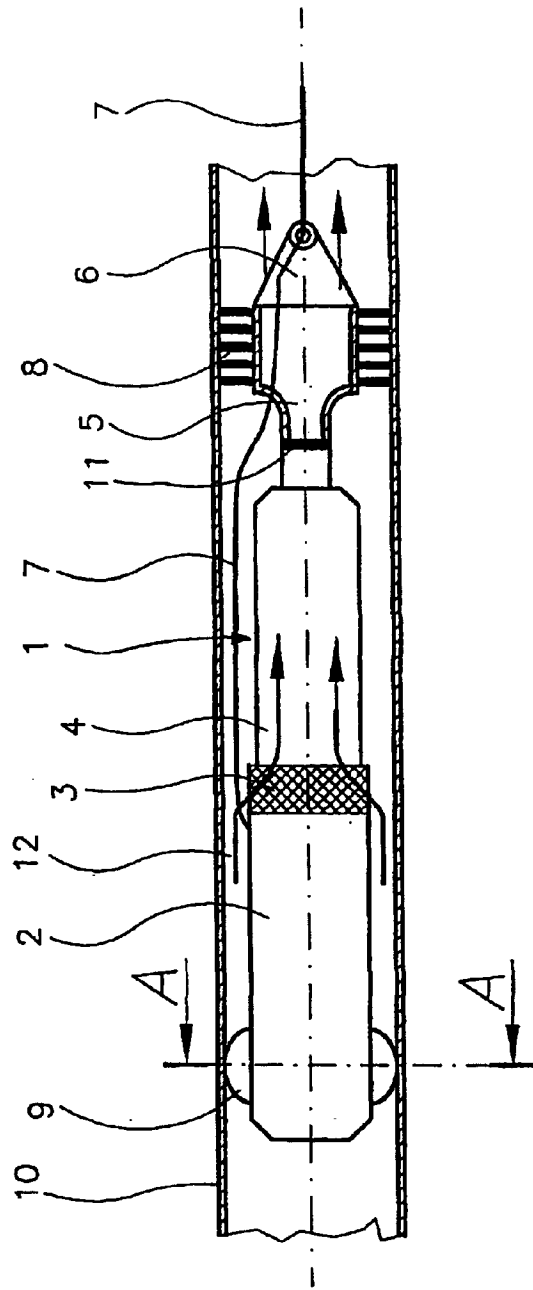


Fig. 1

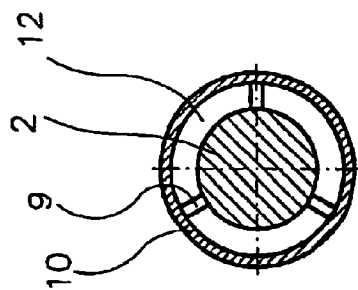


Fig. 2

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**WELL PUMP DEVICE****BACKGROUND OF THE INVENTION**

This invention relates to a well pump in particular for use in a well in connection with the recovery of hydrocarbons.

**SUMMARY OF THE INVENTION**

In recent years the development in the drilling technology for the recovery of petroleum has steadily moved in the direction of more deviation drilling, which means that from a drilling station wells can be drilled to petroleum deposits located at a considerable horizontal distance from the drilling station.

Such drilling involves that the pipe angle in the well strongly deviates from the vertical direction. In some cases the well may be approximately horizontal.

It is often necessary to place a pump in the well in order to increase the pressure or pump fluid up. Conventionally, the pumps have been positioned by being lowered into the well by means of gravity in order then to be pulled back up by means of a line or similar attached to the pump. The pump delivers the fluid through a connected pressure pipe or hose. In wells that have a large angular deviation relative to the vertical axis, the pump must be pushed forward to its predetermined position in the well. This may be accomplished by the use of a so-called drive plug. The drive plug is a device adapted for transporting equipment internally in pipes. It may be provided with seals that seal against the inner wall of the pipe, and is, in that case, pushed back and forth within the pipe by means of the pressure difference in the pipe. Another type of drive plug is provided with driven wheels or belts, which carry the plug in the desired direction through contact with the pipe wall.

Drive plugs based on propulsion by means of differential pressure normally have the greatest pull-thrust-force, and are therefore often used when relatively large loads are to be transported.

The use of such plugs, which must be pulled out of the well after the pump has been installed, represents a great risk of damage to the power and instrument cable of the well pump. To position an often long pressure pipe from the pump up to the surface is expensive and labour-intensive.

The object of the invention is to remedy the drawbacks of known techniques/devices that make use of a drive plug and a separate pressure pipe/hose.

The object is realized according to the invention through the features specified in the description below.

An electrically or hydraulically operated pump of a kind known in itself, comprising a motor, a suction screen/inlet, a pump housing, one or more pump stages, outlet and connected cables or pipes/hoses for the supply of energy and control, is provided with an external seal which seals against the internal wall of the pipe. The pump is provided with centralizing devices, which keep the pump centred in the pipe. The pump may further be provided with a valve/blocking device which may shut off the flow of fluid through the pump.

When the pump is to be used, it is inserted into the well pipe in the same way as a differential pressure drive plug. Because the passage through the pump is closed and the external seal is sealing against the wall of the well pipe, fluid cannot get past the pump.

The position of the pump in the well can be determined by, for example, previously mounted stops or a seat in the

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well pipe, or in that the pump is retained by a line or reinforced cable/hose attached to the pump.

After the passage has been opened and the pump started, the pump delivers fluid from one side of the pump to the other side, thus using the well pipe as a pressure pipe. The external seal against the wall of the well pipe prevents the fluid from returning past the pump.

A development of the pump may be to adapt it for use in tanks and other containers to which access is difficult, but where there are pre-mounted access pipes or similar.

**BRIEF DESCRIPTION OF THE DRAWINGS**

In the following a non-limiting example of a preferred embodiment is described, and it is visualized in the accompanying drawings, in which:

FIG. 1 shows, partly in section, the pump mounted in a well pipe;

FIG. 2 shows a section through the pump and the well pipe at the centralizing devices.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

In FIG. 1 the reference numeral 1 identifies an electrically or hydraulically driven pump comprising a motor 2, a suction screen/inlet 3, a pump housing 4, which may be provided with one or more pump stages not shown, an outlet 5 and an attachment bearing 6 for connected cables or pipes/hoses 7 for the supply of energy and control of the pump. The pump 1 is provided with an external seal 8, which seals against the internal wall surface of a well pipe 10, and a centralizing device 9, which keeps the pump centred within the pipe. The centralizing device may comprise three or more resilient bows secured to the motor housing 2 and arranged to press resiliently against the internal wall of the pipe 10. The pump 1 may further be provided with a valve 11 or a blocking device of a kind known in the art, which may shut off the flow of fluid through the pump 1.

When the pump 1 is to be used, it is inserted into the well pipe 10. The internal valve 11 is closed, thereby sealing against fluid passage through the pump housing 4. The external seal 8 seals against the internal surface of the well pipe 10. The pump 1 thus seals against the well pipe 10 in the same way as a drive plug and may be carried forward to the desired position in the well by means of differential pressure within the pipe.

The position of the pump 1 in the well pipe 10 may be predetermined, for example by a previously installed (not shown) stop in the well pipe 10, or in that the pump 1 is retained by a line or reinforced cable/hose 7 attached to the pump 1 in the attachment bearing 6.

Energy is supplied to the motor 2 through the cable/hose 7. When the valve 11, which may be a butterfly valve, and which may close to fluid flow through the pump, is opened, for example in that the current for the motor 2 is also connected to the valve 11, and the motor 2 is started, fluid will enter through the annular gap 12 which is formed between the well pipe 10 and the motor 2, through the suction screen/inlet 3 and further to not shown pump stages in the pump housing 4. From the pump housing 4 the fluid exits through the outlet 5 into the well pipe 10 on the pressure side of the pump 1 and further through the well pipe 10. The fluid on the pressure side of the pump 1 is prevented from returning between the pipe 10 and the pump 1 by the seal 8.

A device according to the invention remedies the main drawbacks of conventional equipment in that it eliminates

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the need both for a separate drive plug to be used to position the pump, and for a separate pressure pipe to be used for the transport of the fluid out of the well pipe.

What is claimed is:

1. A well pump device for use in connection with the recovery of hydrocarbons comprising:

a pump device including a fluid inlet and a fluid outlet, wherein the pump device is adapted to intake fluid through the fluid inlet and to output fluid through the fluid outlet;

a seal assembly adapted to interface with an interior surface of a well pipe to form a seal between the well pipe and the seal assembly such that the pump device may move through the well pipe while the seal assembly interfaces with the interior surface of the well pipe, wherein the fluid inlet is located on a first side of the seal assembly and the fluid outlet is located on a second side of the seal assembly; and

a valve that alternately:

places the fluid inlet in fluid communication with the fluid outlet; and

removes the fluid inlet from fluid communication with the fluid outlet to enable the formation of a pressure difference between the sides of the seal assembly; wherein

the well pump device is adapted to be moved through the well pipe by the pressure difference when the valve has removed the fluid inlet from fluid communication with the fluid outlet and adapted to pump fluid from the fluid inlet out the fluid outlet when the valve has placed the fluid inlet in fluid communication with the fluid outlet.

2. A well pump device according to claim 1, further comprising centralizing devices adapted to keep the pump device centered in the well.

3. A well pump device according to claim 1, wherein the valve is a butterfly valve.

4. The well pump device of claim 1, wherein the well pump device is further adapted to pump fluid through the outlet to be in direct contact with the well pipe when the valve places the fluid inlet in fluid communication with the fluid outlet.

5. A combination well pump/well drive plug device for use in connection with the recovery of hydrocarbons comprising:

a pump device including a fluid inlet and a fluid outlet, wherein the pump device is adapted to intake fluid through the fluid inlet and to output fluid through the fluid outlet; and

a fluid seal assembly adapted to permit the establishment of a pressure differential when the well pump/well drive plug device is in a well pipe and to permit movement of the well pump/well drive plug device in the pipe due to the pressure differential; wherein

the well pump/well drive plug device is adapted to operate as a well pump when a valve in fluid communication with the fluid inlet and fluid outlet is open to move fluid from the inlet through the outlet and adapted to operate as a well drive plug device when the valve is closed to enable the formation of the pressure differential so that the well pump/well drive plug device may be moved by the pressure differential.

6. The well pump/well drive plug device of claim 5, wherein the pump device is adapted to output fluid to be in direct contact with an interior of the well pipe through which the well pump/well drive plug device moves.

7. The well pump/well drive plug device of claim 5, wherein the fluid inlet is located on a first side of the fluid

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seal assembly and the fluid outlet is located on a second side of the fluid seal assembly.

8. A combination well pump/well drive plug device for use in connection with the recovery of hydrocarbons comprising:

a pump device including a fluid inlet and a fluid outlet, wherein the pump device is adapted to intake fluid through the fluid inlet and to output fluid through the fluid outlet; and

wherein the combination well pump/well drive plug device is adapted to convert from a pumping mode to a well drive plug mode to move through a well pipe as a result of a pressure differential.

9. The combination well pump/well drive plug device of claim 8, further comprising a valve that, when open, permits the fluid inlet to be in fluid communication with the fluid outlet, wherein the combination well pump/well drive plug device is adapted to convert from a pump to a drive plug by the closure of the valve to move through a well pipe as a result of the pressure differential enabled by the closure of the valve.

10. A well, comprising:

a combination well pump/well drive plug device according to claim 9; and

a well pipe; wherein

the well is adapted to move fluid through the combination well pump/well drive plug device and transport the fluid in the direction of pumping so that the fluid comes into direct contact with the well pipe.

11. A well, comprising:

a combination well pump/well drive plug device according to claim 8; and

a well pipe; wherein

the well is adapted to move fluid through the combination well pump/well drive plug device and transport the fluid in the direction of pumping so that the fluid comes into direct contact with the well pipe.

12. A well, comprising:

a combination well pump/well drive plug device according to claim 8, wherein the combination well pump/well drive plug device does not have a separate pressure pipe.

13. A method of pumping fluid comprising the following actions:

(a) placing a combination well pump/well drive plug device according to claim 8 in a well pipe;

(b) converting the combination well pump/well drive plug device to a well drive plug, wherein action (b) may be performed before or after action (a);

forming a pressure difference between a first side and a second side of the combination well pump/well drive plug device and moving the combination well pump/well drive plug device through the well pipe by the pressure difference; and

relieving the pressure difference between the first side and the second side of the combination well pump/well drive plug device; and

pumping fluid from the first side to the second side.

14. A method of placing a pump in a well pipe comprising: placing a combination well pump/well drive plug device into a well pipe, wherein the combination well pump/well drive plug device includes a fluid inlet and a fluid outlet, wherein the combination well pump/well drive plug device is adapted to intake fluid through the fluid

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inlet and to output fluid through the fluid outlet when the fluid inlet is in fluid communication with the fluid outlet;

transporting the combination wellpump/well drive plug device to a location in the well pipe away from the location where the combination well pump/well drive plug device was placed into the well pipe utilizing a pressure difference between one side of a seal on the combination well pump/well drive plug device and another side of the seal on the combination well pump/well drive plug device, the pressure difference being enabled by taking the fluid inlet out of fluid communication with the fluid outlet; and

opening the valve and pumping fluid from the fluid inlet out the fluid outlet.

15 **15.** A method according to claim 14, further comprising using centralizing devices to keep the pump centered in the well.

**16.** A method according to claim 14, wherein the location is determined by a previously installed stop in the pipe or by a line attached to the well pump/well drive plug device.

**17.** The method of claim 14, further comprising pumping the fluid through the outlet so that the fluid comes into direct contact with the well pipe.

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**18.** The method of claim 17, further comprising pumping the fluid towards a surface of the well without the use of a separate pressure pipe.

**19.** A method of pumping fluid comprising:

forming a pressure difference between a first side and a second side of a well pump device, the first side including a fluid inlet and the second side including a fluid outlet; wherein the well pump device is adapted to pump fluid from the fluid inlet through the fluid outlet; transporting the well pump through a well pipe due to the pressure difference;

removing the pressure difference about the well pump device; and

pumping fluid from the fluid inlet through the fluid outlet.

**20.** The method of claim 19, further comprising pumping the fluid through the outlet so that the fluid comes into direct contact with the well pipe.

**21.** The method of claim 19, wherein the pressure difference is formed by taking the fluid inlet out of fluid communication with the fluid outlet.

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