May 8, 1934. J. PENROD 1,958,170

LINER PUMP

Filed March 16, 1928 2 Sheets-Sheet 1

Fig. 1

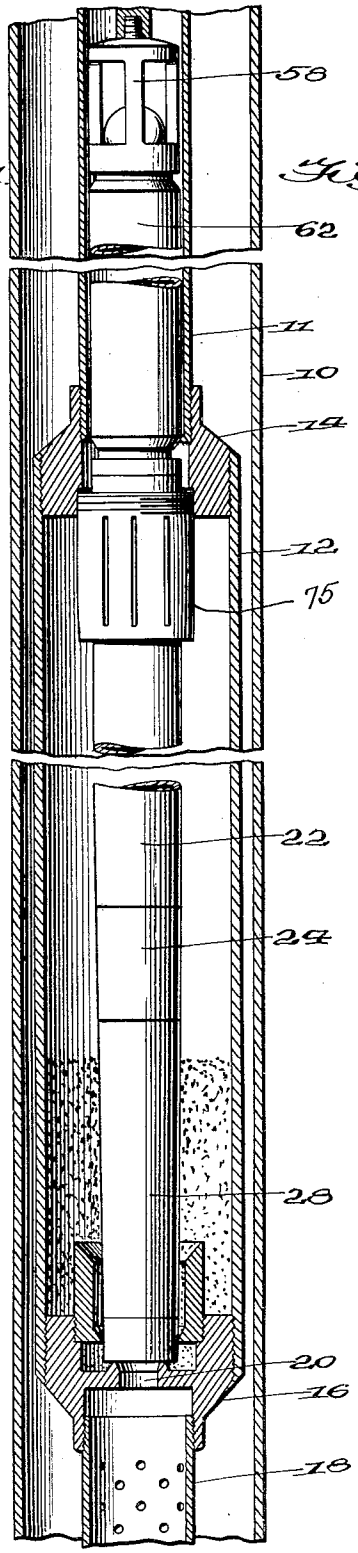
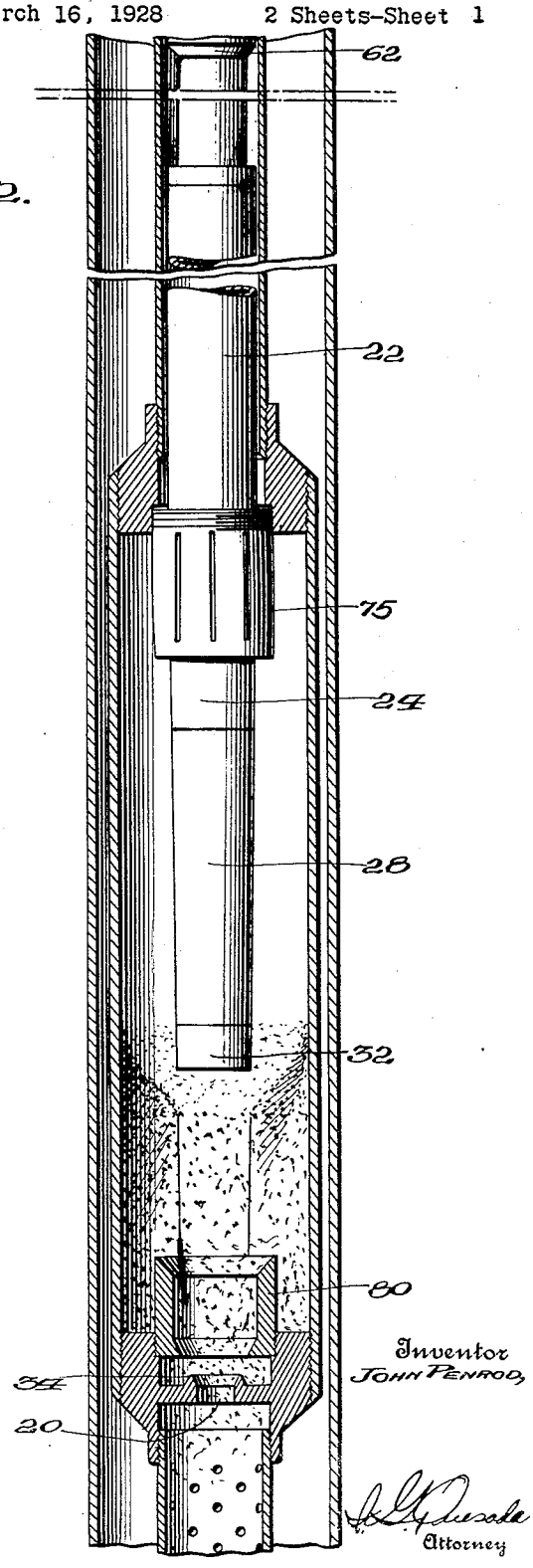


Fig. 2.



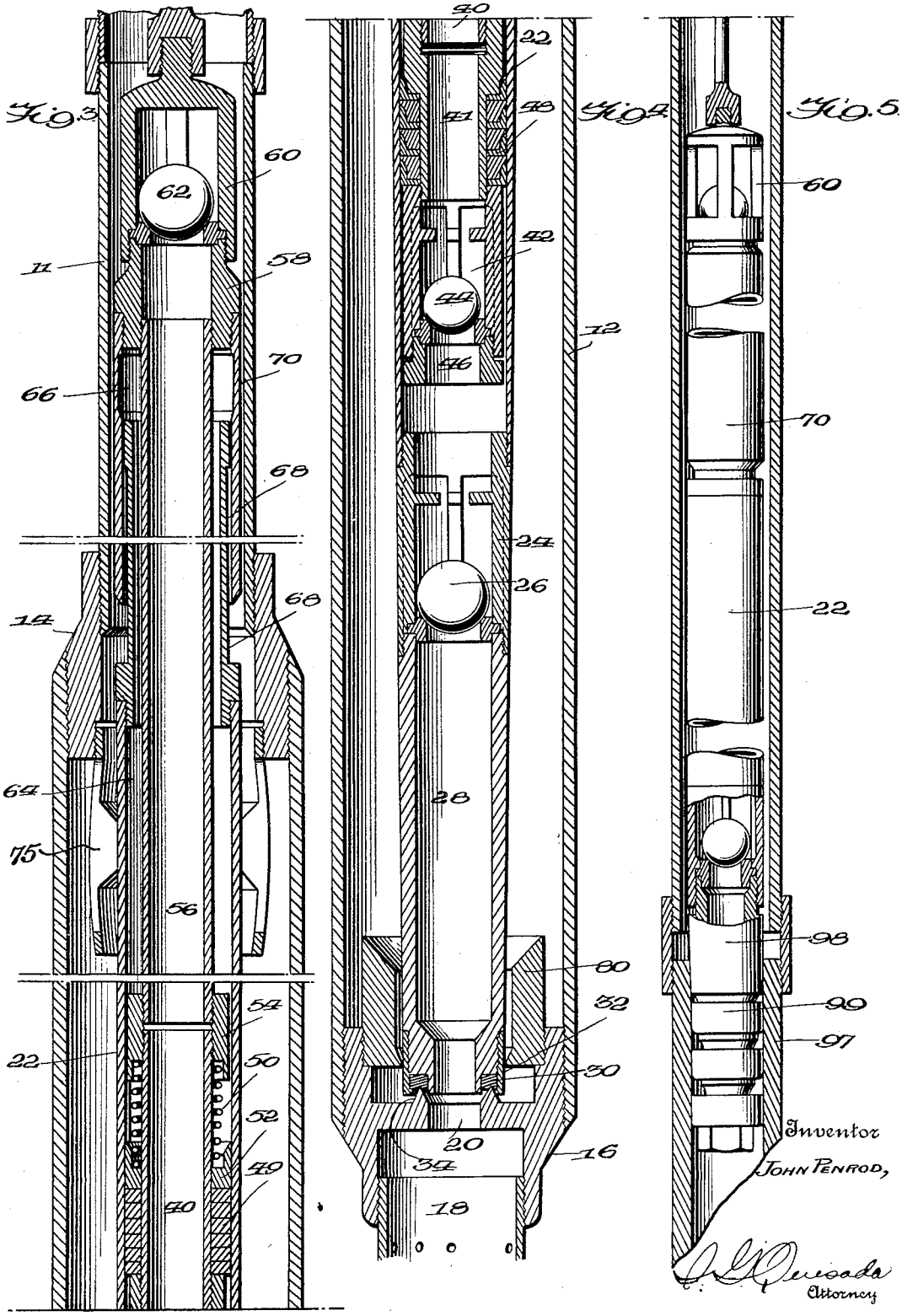
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LINER PUMP

Filed March 16, 1928 2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

1,958,170

LINER PUMP

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5 Claims. (Cl. 103—220)

This invention relates to pumps for use in wells and embodies special means by which particles of sand suspended in the products of a well are prevented from coming into destructive contact with the close working surfaces of the pump.

More specifically, the invention forming the subject of this application aims to provide a well pump having reliable protecting means by which the upper surface of the working piston is prevented from coming into contact with the fluid being pumped either during the movement of this fluid through the pump or at any time thereafter, the aforesaid protecting means being in the nature of a chamber located immediately above the working piston and adapted to be substantially filled during the installation of the pump with a portion of the naturally accumulated well fluid and thereby prevent the subsequent incursion of the products of the well into the chamber.

It will be further found that the arrangement of the protecting chamber with respect to the pumping chamber makes it possible to provide maximum displacement or diameter of the pumping chamber, the achievement of this having long been sought in a liner pump provided with effective sand combating means.

A further and equally important aim is to provide a well pump having reliable means by which a special foot valve employed for seating the working barrel and associated parts and for controlling the discharge of sand from a special sand receiving pocket may be held in a firmly seated or closed position against the contrary influence present during the up stroke of the plunger, the arrangement of this part of the invention being such, however, that it is a simple matter to intentionally raise the foot valve when it is desired to flush the aforesaid sand receiving pocket or when it is desired for any reason to remove the equipment to the surface.

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

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

Figure 1 is a fragmentary side elevation of the improved pump installed in a well and ready for operation, parts being in section,

Figure 2 is a similar view, the barrel and the foot valve being partly withdrawn,

Figure 3 is a fragmentary vertical sectional view through the upper portion of the improved pump,

Figure 4 is a vertical sectional view through the lower portion of the improved pump,

Figure 5 is a fragmentary side elevation of the pump seated in the upper portion of a previously used working barrel, parts being shown in section.

In the drawings the numeral 10 designates a casing receiving the usual tubing to the lower portion of which a special tubing or pump nipple 11 is connected. Figure 1 illustrates that a housing 12 is connected to the nipple through the medium of a bushing 14 and is provided at the lower portion thereof with a second bushing 16. Fluid is allowed to enter the pump through a perforated inlet nipple 18 and an opening 20 through the bushing 16. The nipple 18 is shown to be suspended from the bushing 16.

Figures 3 and 4 illustrate that a working barrel 22 is adapted to be introduced into the housing 12 and is provided at the lower portion thereof with a closed valve cage 24 within which a standing valve 26 is located. An upstanding tubular foot member 28 is suspended from the closed valve cage 24 and has the lower portion thereof externally stepped or shouldered to provide for the attachment of a valve ring 30 and a combined protecting and fastening sleeve 32. The member 32 is shown to be extended about the periphery of the valve ring 30 to protect the ring during the descent of the pump to an operative position in the well. The lower terminal of the sleeve 32 is flanged inwardly to underlie the valve element and thereby hold the same in place.

In passing, it might be noted that the valve ring 30 is adapted to be seated upon an upwardly presented annular seat 34 carried by the lower bushing 16 and surrounding the opening 20 therein. Obviously, the valve ring 30 and the annular seat 34 cooperate in the formation of a seat or rest for the pump when introduced into the well and at the same time constitute an easily controlled closure for the bottom of the housing 12.

The working barrel receives a piston 40, the lower portion of which is provided with a nipple 41 to which a closed valve cage 42 is connected. A ball valve 44 located within the valve cage 42 is seated during the up stroke of the piston and is unseated during the down stroke thereof in a manner well understood to those acquainted with the art to which this invention relates. The lower end of the closed valve cage 42 carries a ring nut 46 adapted to be lowered into bumping engagement with the closed valve cage 24 to bring about the firm seating of the valve

element 30 as will be described more fully hereinafter.

The nipple 41 forming a part of the piston is provided with a plurality of cups 48 or other suitable sealing devices. Immediately above the nipple 41, the piston 40 is provided with a packing 49 preferably in the nature of a number of similar packing rings, all of which are pressed into fluid tight contact with the wall of the working barrel by a spring 50. The spring 50 is engaged at the lower end thereof with a thimble 52 resting on the packing 49, while the upper portion of the spring is engaged with a combined abutment and striking element 54.

Incidentally, the member 54 not only performs the functions suggested in the previous sentence but it constitutes a coupling by which a tubular extension or conduit 56 may be connected rigidly to the piston 40. Figure 3 illustrates that the upper portion of the fluid conduit 56 is connected rigidly to the head 58 to which the crown 60 of an upper traveling valve 62 is also connected. Clearly, the flow of the fluid being pumped is up through the conduit 56, the head 58 and up into the tubing by way of the crown 60 and the special nipple 11.

Special attention is directed to the fact that the conduit 56 is spaced inwardly from the wall of the working barrel 22 and cooperates therewith in the formation of a lower fluid receiving chamber 64 communicating with a superposed fluid receiving chamber 66 defined by inner and outer liners 68 and 70 respectively. The inner liner 68 is rigidly connected to and is held in a relatively stationary position on the upper portion of the working barrel 22, while the outer liner is rigidly attached to and is movable with the head 58. It will be seen that during the reciprocation of the piston 40, the fluid in the chambers 64—66 shuttles between these chambers. On the up stroke of the pump, a decrease in the volume of the lower chamber 64 will be accompanied by a corresponding increase in the volume of the chamber 66 and vice versa on the down stroke. This is true since the distance between the packing 48—49 and the head 58 remains constant and since the portion of the outer liner alternately covered and uncovered by the inner liner is of the same diameter as that of the working barrel.

Otherwise expressed, a mutually compensating arrangement is provided between the chambers 64—66 so that the reciprocation of the pump will not result in the creation of a vacuum or a pressure variation within the chambers 64—66. Preparatory to the introduction of the improved pump into the well, the same may be adjusted to bring about the filling of the reservoirs 64—66 either during the descent of the pump through the naturally accumulated tubing fluid or after the pump has been seated. In explaining this, it is pointed out that the upper portion of the inner liner 68 is externally enlarged and is adapted to be positioned within the internally enlarged upper portion of the outer liner 70 to cooperate therewith in forming a passage by which fluid may be freely admitted to the chambers 64—66. Should it be desired to fill the reservoirs 64—66 with the high gravity fluid forming the upper portion of the column of tubing fluid, the enlarged terminal portion of the inner liner 68 is positioned within the internally enlarged upper portion of the outer liner preparatory, of course, to the introduction of the pump into a well.

The frictional engagement of the packing 48—49 with the wall of the working barrel may be relied on to hold the parts in this position during the descent of the pump through the tubing fluid. With the upper portion of the liner 68 thus located within the internally enlarged upper portion of the liner 70, the pump may be lowered into the well and the high gravity fluid forming the upper portion of the column of tubing fluid will be received within the reservoirs 64—66 and will be trapped therein by the depending outer liner 70. Thus, when the pump is seated in an operative position, the chambers or reservoirs 64—66 will contain a high gravity fluid which is trapped by the depending liner 70 and which is protected against the incursion of the low gravity fluid known to be located in the lower portion of the tubing. By this arrangement the gravity differential obtaining between the separate bodies of fluid in the reservoirs 64—66 and the tubing may be relied on to maintain these bodies of fluid separate even after wear destroys the fluid tight contact between the liners.

On the other hand, should it be desired to supply the reservoirs 64—66 with a low gravity fluid, such as is found in the lower portion of the tubing, the parts may, preparatory to the introduction of the pump in a well, be positioned as suggested in Figures 3 and 4 with the internally enlarged upper portion of the liner 68 in close working contact with the outer liner 70. The parts will remain in this position until the pump is seated on the member 34 and the ring nut 46 brought down into bumping engagement with the cage 24. With the piston thus lowered, the enlarged upper portion of the liner 68 is positioned within the internally enlarged upper portion of the liner 70 to allow of the entrance of the low gravity fluid surrounding the pump.

When the pump is finally seated as shown in Figure 1, the standing and traveling valves are spaced as is customary in pumping wells whereby the externally enlarged upper portion of the liner 68 will be positioned within the major or working portion of the outer liner. During the reciprocation of the main pumping piston 40, the concurrent movement of the outer liner will be such that the same will remain in close working and substantially fluid tight contact with the externally enlarged terminal portion of the inner liner. In other words, during normal pumping, a generous overlap of the inner and outer liners with the working surfaces thereof in close contact will be provided.

At all positions of the pump, the outer liner depends a substantial distance below the enlarged upper terminal portion of the inner liner 68 and thereby cooperates with the inner liner in forming a supplemental reservoir adapted for the reception of a portion of the tubing fluid. The fluid which enters the annular supplemental reservoir will be trapped therein to form a barrier by which sand is prevented from working its way up between the close working surfaces of the inner and outer liners. Attention is directed to the fact that the packing 48—49 is relieved of the increased tubing pressure during the up stroke of the pump, first by the restricted space between the liner 70 and the special pump nipple 11, second by the smaller space between the liners 68—70, third by the close working fit between the enlarged upper portion of the inner liner and the working face of the outer liner and finally by the greater volume of the fluid trapped within the special protecting reservoir or chambers

64—66. Thus, on the up stroke of the piston the packing 48—49 will act only against the previously trapped fluid.

When the improved pump is seated in an operative position as suggested in Figures 3 and 4, the piston may be reciprocated without producing a mixture of the reservoir fluid with the surrounding fluid. In further alluding to this, attention is directed to the fact that the fluid originally admitted to the reservoirs 64—66 will protect the reservoir against the subsequent incursion of the fluid to be found at the bottom of the well tubing.

In other words, and as previously set forth herein the distance between the packing 48—49 and the movable head 50 is constant and since the portion of the outer liner 70 alternately covered and uncovered by the inner liner 68 is of the same diameter as that of the working barrel, a decrease in the volume of the upper chamber 66 will be accomplished by a corresponding increase in the volume of the lower chamber 64 making the aggregate volume of the lower chambers 64 and 66 constant. By providing for a constant volume of the mutually compensating chambers 64—66, the fluid received therein is prevented from mixing with the well fluid immediately surrounding the pump. That is to say, the fluid in the mutually compensating chambers 64—66 remains isolated so that these chambers are protected against the incursion of the sand-laden fluid surrounding the pump. Clearly, by maintaining a constant aggregate volume in the mutually compensating chambers 64—66 there is no circulation of fluid between these chambers on one hand and the surrounding well fluid on the other.

The small amount of sand which may be present in the fluid admitted to the reservoirs 64—66 is allowed to settle in the thimble 52 and thereby prevented from coming into destructive contact with the packing 48 and 49. The upper edge of the thimble is shown to be beveled inwardly to direct sand into the hollowed portion of the thimble. Since there is no travel or flow of outside fluid through the reservoir, the thimble 52 will be of ample capacity to provide for the collection of sand in the reservoir.

Figures 2 and 3 illustrate that a gripping sleeve 75 is rigidly connected at the upper end thereof to the bushing 14 and is adapted for the passage of the tapered foot member 28 and for gripping engagement with the working barrel to hold the same in a firmly seated position against the drag incident to the up stroke of the plunger. The gripping sleeve 75 is provided with a series of spaced parallel longitudinal slots terminating short of the ends of the sleeve and defining an annular series of leaf springs adapted for firm gripping engagement with the barrel. Of course, the internal diameter of the gripping portion of the sleeve 75 is normally less than the external diameter of the working barrel and the leaf springs formed by the aforesaid longitudinal incisions are possessed of sufficient strength to firmly grip the working barrel and anchor the same in place. During the descent of the tapered foot member 28 through the sleeve 75 the same expands the gripping portion of the sleeve for subsequent engagement with the working barrel.

The incisions in the gripping sleeve 75 not only define gripping leaves, but also provide a sand discharge means by which settling sand is allowed to descend into the lower portion of the housing 12. Furthermore, the lower end of the gripping sleeve is entirely open to prevent sand from lodging in the sleeve and possibly impairing operation of the same.

The gripping sleeve 75 is sufficiently strong to hold the working barrel in place without the need of interfitting or mating holding devices, such as circumferential ribs. This makes possible random engagement of the gripping sleeve 75 with the working barrel. The numerous screw threaded connections necessary in a pump of this kind would make it a very difficult matter to assure the proper engagement of coacting locking devices on the gripping sleeve and the working barrel. Also, by this random engagement of the gripping sleeve with the barrel the valve element is held firmly in place regardless of the extent to which the same is forced down over the wedge-shaped seat 34 either on the original or subsequent seating of the pump.

Reference might now be made to the specific seating arrangement for the pump and the closure at the bottom of the sand pocket. In this connection attention is invited to Figure 4. The upstanding annular seat 34 is of a material much harder than that from which the valve ring 30 is made so that the major wear is on the element 30. For example, the upstanding annular seat 34 may be of tool steel, while the valve element 30 may be of bronze, babbitt or rubber and since it is a simple matter to withdraw the working barrel together with the member 28 and the valve element 30 to the surface, a renewal of the valve ring may be accomplished without a substantial loss of time and production. Also, this arrangement avoids the necessity of mating the valve element 30 with the seat 34 or grinding these two parts together preparatory to the installation of the same in a well.

It will be seen that the upstanding annular seat 34 is wedge-shaped in cross section and the side walls converge toward the upper edges thereof so that when the valve ring 30 is lowered onto the seat an effective multi-point contact will be provided. In other words, the sealing surfaces of the members 30 and 34 are located in intersecting planes. Thus, the fluid must take a tortuous path to escape.

When the pump is introduced into the well, the same is guided into place by the gripping sleeve 75 and by a guide member 80, the latter being threaded into the lower bushing 16. Figure 4 illustrates that the upper portion of the ring 80 is internally enlarged to form a gradually restricted entrance opening for the valve element 30 and that the lower portion of the ring 80 is internally restricted to further guide the valve element into proper engagement with the seat 34. With the valve element 30 thus resting on the seat 34 the main working piston and more specifically the ring nut 46 thereof is lowered into striking engagement with the upper end of the valve cage 24 so that the soft material forming the valve element 30 is brought down into pressure engagement with the upwardly converging side walls of the seat. When the sharpened upper edge of the valve seat 34 is thus embedded in the softer material forming the valve element 30, an effective seal or closure is provided and is maintained by the pressure engagement of the gripping sleeve with the working barrel. In other words, when the weight of the rods is placed on the valve element 30 to force the valve element 30 into firm pressure engagement with the seat, the gripping sleeve 75 will effectively hold the valve element in the lowermost position to which the same has been forced.

The working barrel is centered and positively held against tilting or lateral vibration by the gripping sleeve 75. Thus, disturbance of the seal established by the members 30 and 34 is avoided and the liner 70 and the head 58 accurately centered in the nipple 11.

Since the valve element 30 is not wedged into place as are the foot valves of ordinary liner pumps, but is merely brought down into pressure engagement with an upwardly presented seat, the subsequent unseating or elevation of the working barrel and associated parts is greatly simplified.

In case the valve element is made from rubber or other soft material, the sleeve 32 may be extended a sufficient distance below the valve element to bottom on a portion of the bushing 16 and thereby limit compression of the valve. Also, by engaging the valve element 30 with the upwardly presented seat as illustrated in Figure 4, the passage 20 for the admission of fluid to the pump may be of a generous diameter. In other words, the location of the closure 30—34 above the opening 20 avoids a restriction of this opening. This also makes it possible to employ a greater external taper on the working barrel and the anchor 28. The working barrel may, if desired, be of the same diameter throughout or it may be externally tapered downwardly from a point immediately below the gripping sleeve 75.

In operation, the reciprocation of the piston will result in the alternate filling and emptying of the pumping chamber located between the valves 26 and 44. As shown in Figure 4 the closed valve cage 42 is spaced inwardly from the wall of the working barrel to cooperate therewith in the formation of an annular chamber for the reception of gas introduced into the pump. The gas trapped in the space between the valve cage 42 and the wall of the working barrel will constitute an effective barrier by which sand suspended in the fluid being pumped is prevented from ascending into destructive contact with the packing 48 and 49.

On the down stroke of the piston the fluid previously admitted to the pump chamber is directed up through the piston and the conduit 56 and is discharged into the nipple 11 by way of the crown 60. Upon leaving the pump, the fluid will begin its ascent and any sand which settles from this fluid is received within the housing 12. As the sand descends it will be effectively excluded from the reservoirs 64—66 by the depending liner 70. Since the sand is heavier than the tubing fluid, the descent of the sand will continue until the same is deposited in the sand receiving housing 12.

From time to time depending, of course, on the percentage of sand in the fluid, the sand pocket may be emptied. To accomplish this, it is merely necessary to move the sucker rods upward until the combined abutment and striking element 54 on the upper portion of the piston is engaged with the lower end of the liner 68 to lift the working barrel and the members 28 and 30 to the position suggested in Figure 2. With the working barrel and the members 28 and 30 thus elevated, the tubing fluid will surge through the housing and disintegrate the body of tightly packed sand therein. The sand thus attacked by the tubing fluid is returned to the well by way of the opening 20. The working barrel and the anchor member 28 are tapered toward the lower portion thereof as illustrated in Figure 4 to simplify the removal of these parts from the sand accumulated in the housing. When the sand receiving pocket has been cleansed the pump may be returned to the seated position illustrated in Figure 1 and normal pumping resumed.

Even though the sand comes into wearing contact with the annular seat 34 and possibly roughens the upper edge of the same during the dumping operation, the subsequent descent of the valve element and the seating blow of the rods on the working barrel will produce a seal quite as effective as the original one. Crevices or voids in the sharpened upper portion of the annular seat or in the side walls thereof will be filled by the softer material forming the valve ring 30 to reestablish a fluid tight multi-point contact seal at the bottom of the housing. Should it be necessary to force the material forming the valve ring 30 a substantial distance down about the converging side walls of the annular seat 34 by the percussion action of the piston sucker rods. the gripping sleeve 75 will continue to operate to the fullest advantage since the same has a random engagement with the barrel 22.

Figure 5 illustrates that the improved pump may be introduced through a tubing and the same seated on the upper portion of a previously used working barrel 97. For this installation, the lower portion of the working barrel is provided with a foot valve 98 adapted to be seated in the upper portion of the previously used working barrel 97. The foot member is provided with a suitable number of cups 99 or other sealing devices by which a fluid tight seat is provided between the members 97 and 98.

In summarizing it will be seen that the invention forming the subject of this application is provided with means by which a fluid, preferably one of a high gravity, is trapped within the sealing reservoir and thereby protects the working parts of the pump from excessive wear from the sand laden fluid being elevated. It will also be apparent that the fluid in the sealing chambers 64—66 moves with the piston and the arrangement of parts is such that the packing 48—49 is relieved of the increased pressure incident to the up stroke of the pump.

The employment of the special nipple 11 which is of a diameter somewhat less than the diameter of the tubing limits the fluid space surrounding the liner 70 and thereby reduces the area of the column of tubing fluid available for application against the sealing medium within the sealing reservoir. In manufacture, the nipple 11 is accurately aligned with the housing so that the upper portion of the piston will be spaced uniformly from the sides of the nipple to cooperate therewith in the formation of a restricted passage for the descent of sand into the housing. Of course, the tubing is greater in diameter than the diameter of the nipple to provide for the free insertion and removal of the pumping unit.

Having thus described the invention, what is claimed is:

1. In a pump, a barrel, a piston in the barrel, interfitting liners associated with the piston and the barrel and forming a chamber, one of the liners being provided with a protuberance and the other liner being provided with a recess adapted to temporarily receive said protuberance and thereby form a fluid inlet to said chamber.

2. In a pump, a barrel, a piston in the barrel, interfitting liners associated with the piston and the barrel and forming a chamber, one of the

liners being provided with a protuberance and the other liner being provided with a recess adapted to temporarily receive said protuberance and thereby form a fluid inlet to said chamber, one of said liners being provided beyond said recess with a working face engaged by said protuberance and cooperating therewith in sealing the chamber.

3. In a well pump, a working barrel having an upstanding inner liner, a piston in the working barrel and having a portion spaced from the barrel to cooperate therewith in forming a lower protecting chamber, a liner carried by the piston and depending about the same in spaced relation and overlapping the inner liner to cooperate with the inner liner and the piston in forming an upper chamber, said inner liner being spaced about the piston to cooperate therewith in forming a passage establishing constant communication between the upper and lower chambers that portion of the outer liner that alternately laps and sweeps beyond the inner liner being of the same internal diameter as the internal diameter of the working barrel making the aggregate volume of the said chambers constant, said inner and outer liners being formed in the opposed sides thereof with annular means adapted for temporary registration to form an inlet to said chambers.

4. In a well pump, a working barrel, a piston for the barrel, inner and outer overlapping liners carried by the piston and the barrel and cooperating with these parts in forming mutually compensating communicating fluid receiving chambers, that portion of the outer liner that alternately laps and sweeps beyond the inner liner being of the same internal diameter as the internal diameter of the working barrel, making the aggregate volume of said chambers constant, said liners being provided adjacent the upper portion of the outer liner with means cooperating during the descent of the pump into the well in forming an annular entrance opening to said chambers.

5. In a pump, a barrel, a piston in the barrel, a liner carried by the barrel, and a second liner movable with the piston and depending about the exterior of the first liner to cooperate therewith in the formation of a protecting chamber, said first and second named liners being formed with temporarily loosely interfitting means forming a temporary fluid inlet to said chamber.

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