

Aug. 9, 1960

M. L. HART

2,948,231

WIRE LINE OPERATED WELL PUMP

Filed Oct. 25, 1957

2 Sheets-Sheet 1

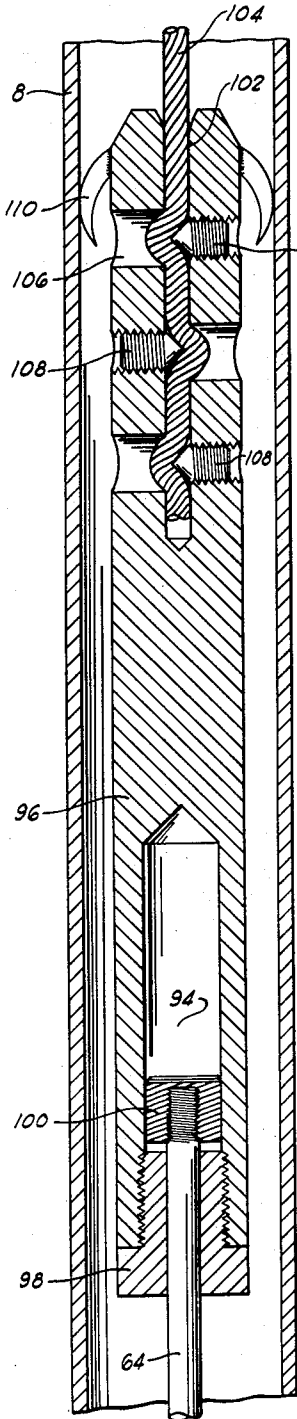


Fig. 1

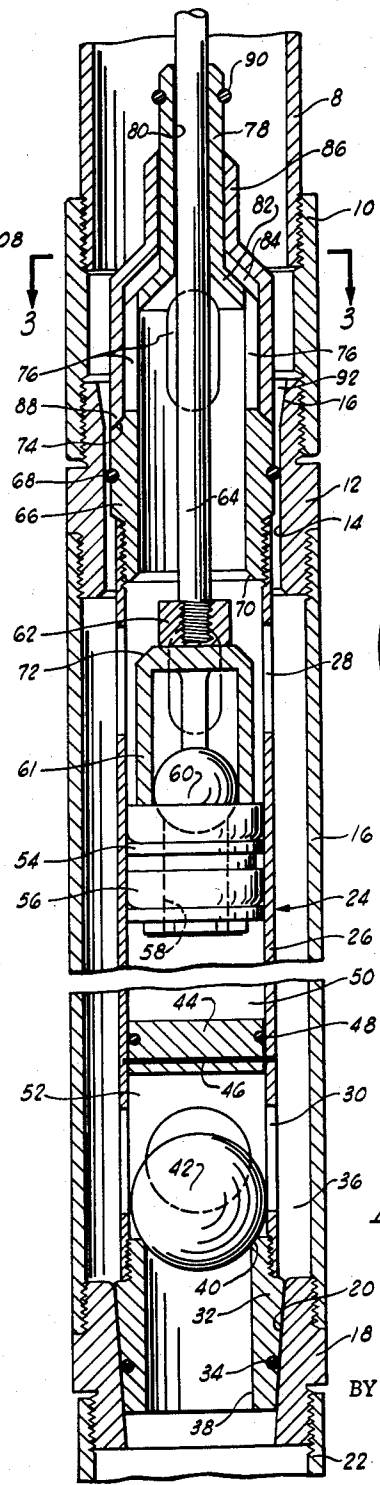


Fig. 2

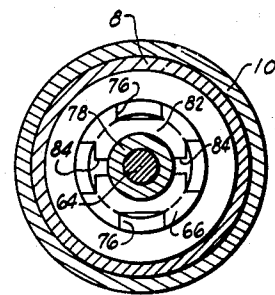


Fig. 3

INVENTOR.
M. L. HART
BY *Gerry J. Dunlop*
ATTORNEY

Aug. 9, 1960

M. L. HART

2,948,231

WIRE LINE OPERATED WELL PUMP

Filed Oct. 25, 1957

2 Sheets-Sheet 2

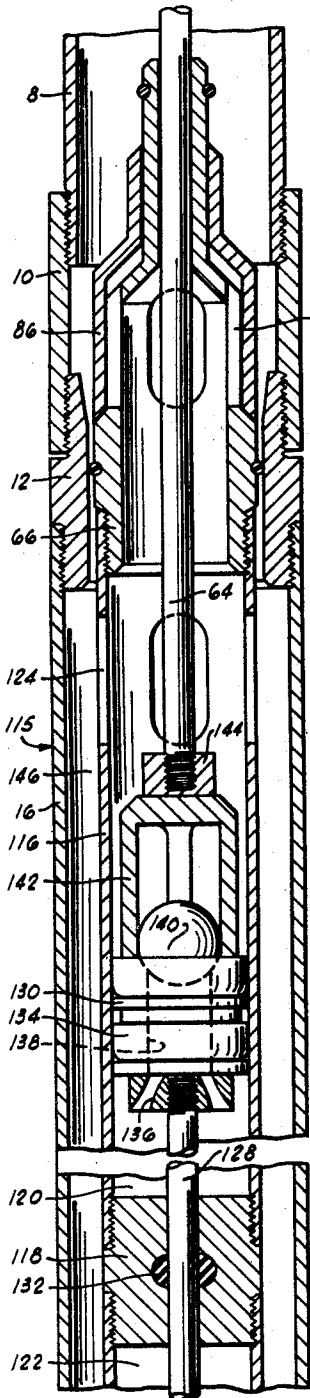


Fig. 5

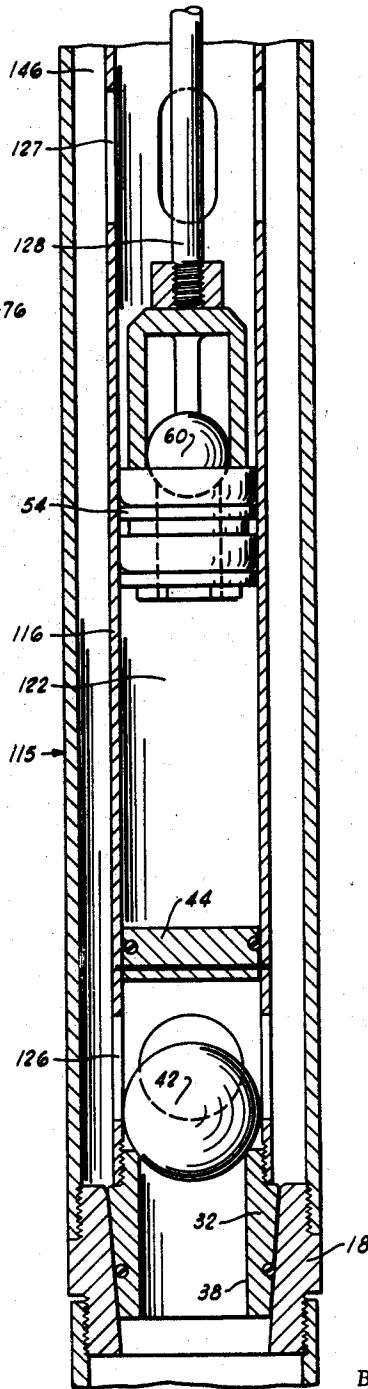


Fig. 6

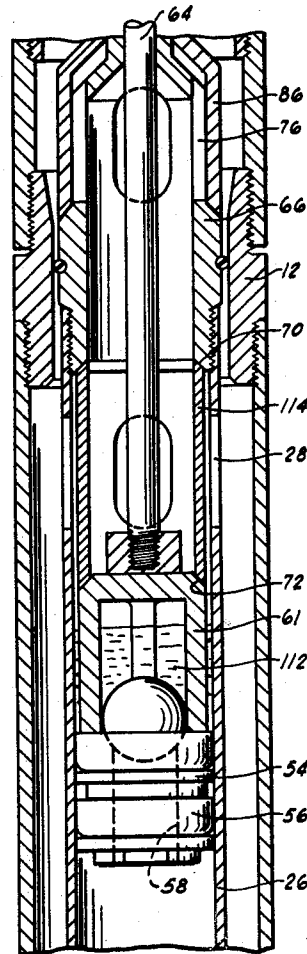


Fig. 4

INVENTOR.
M. L. HART
BY *Jerry J. Dunlop*
ATTORNEY

1

2,948,231

WIRE LINE OPERATED WELL PUMP

Merida L. Hart, Oklahoma City, Okla., assignor to Hart Industries, Inc., Oklahoma City, Okla., a corporation of Oklahoma

Filed Oct. 25, 1957, Ser. No. 692,300

5 Claims. (Cl. 103—181)

This invention relates to improvements in reciprocating pumps of the type used below the surface for pumping oil and water wells, and more particularly, to an improved pump assembly of this type which is operated by a wire line extending downwardly in the well from the surface to the pump assembly.

As it is well known in the art, many types of reciprocating subsurface well pumps have been developed and extensively used. The great majority of these pumps, particularly in the oil industry, are operated by a string of sucker rods extending through the well from the surface to the pumping unit, which may be several thousand feet under the ground. These sucker rod type pumps require heavy and expensive equipment on the surface of the ground for reciprocating the rod string and operating the pump. Also, the rods are alternately subjected to tension and compression to provide the up and down strokes of the pump, thereby causing the rods to fatigue in a relatively short period of service and resulting in frequent parting of the rod string, with an attendant loss of time and money in recovering the pump unit and placing the unit back in operation. In addition, the operation of installing and removing the pump requires an excessive amount of time in jointing and unjointing the various sections of the sucker rod string.

Several attempts have also been made to produce a subsurface well pump which may be operated by a cable or wire line. Up to the present time however, a completely satisfactory pumping unit of this type has not been provided. One of the major problems in wire line type pumps of the insert type is the provision of suitable means for seating the pump in the well tubing or casing in such a manner that the pump may be easily seated, yet will remain in a seated position during operation of the pump. Heretofore, pumps of this type have been provided with seating cups at the lower end of the pump which are inserted in a suitable shoe or nipple in the lower portion of the well tubing or casing. To be effective, these seating cups must have substantial friction against the seating shoe, thereby complicating the installation of the pump, since the wire line or cable cannot be used to force the pump into a seated position, as in sucker rod type installations. Another problem encountered in wire line pumps is the provision of a standing valve at the upper end of the pump which will not become sanded-up, particularly during idle periods of the pump, and which will not be affected by misalignment of the pump operating rod which normally extends from the pump plunger upwardly through the pump for connection with the wire line or cable. Still another problem encountered in the art is the accomplishment of a complete down stroke of the pump plunger. In previous wire line type pumps, the plunger is moved on its down stroke by the combination of the force of gravity and the force exerted by the hydrostatic head of fluid standing in the well. When the pump plunger fits in its working barrel sufficiently tight to provide a practical working up stroke,

2

a down stroke provided by these two forces is extremely slow, usually resulting in an incomplete down stroke of the unit when a practical operating speed is attempted.

The present invention contemplates an improved wire line pump assembly using a tapered seating nipple in the tubing or casing and a similarly tapered seating member on the lower end of the pump unit, with a simple sealing member on the seating member to provide a seating of the pump unit with a minimum of force. The pump unit is held in the seating nipple during operation by a hydraulic hold-down. The upper standing valve of the pump unit is tubular in shape and guided in its movement by a head rigidly secured on the working barrel of the pump unit, out of contact with either the pump rod or the tubing, to provide constant alignment of the valve and prevent sanding-up of the valve. I also contemplate using a sinker bar between the pump rod and the wire line to facilitate the down stroke of the pump, as well as the seating of the pump in the tubing or casing.

An important object of this invention is to provide a wire line pump having an upper standing valve which will not be rendered inoperative by sand settling from fluid standing in the tubing or casing above the pump, even when the pump is out of operation for extended periods of time.

Another object of this invention is to provide a wire line type pump wherein the upper standing valve is not affected by misalignment or bending of the pump operating rod.

A further object of this invention is to provide an insert type wire line pump which may be easily inserted in a well tubing or casing, yet will remain in a seated position during normal operation of the pump.

A still further object of this invention is to provide a wire line pump which will accomplish a complete pumping cycle at relatively high speeds of operation.

Another object of this invention is to provide a wire line pump having means for completing the down stroke of the pump in a minimum of time.

Another object of this invention is to provide a wire line pump having a plurality of pump plungers, but a single lower standing valve and a single upper standing valve.

A further object of this invention is to provide an insert type wire line pump which is simple in construction and may be economically manufactured.

Other objects and advantages of the invention will be evident from the following detailed description, when read in conjunction with the accompanying drawings which illustrate my invention.

In the drawings:

Figure 1 is a vertical sectional view through the upper portion of a pump assembly constructed in accordance with this invention.

Figure 2 is a vertical sectional view of a lower portion of the pump assembly, and is a continuation from the lower end of Fig. 1.

Figure 3 is a transverse sectional view, with the upper standing valve removed, as taken along lines 3—3 of Fig. 2.

Figure 4 is a vertical sectional view of a pump assembly similar to the upper portion of Fig. 2, but illustrating a modified pump structure.

Figure 5 is a vertical sectional view of the central portion of another modified pump assembly.

Figure 6 is a vertical sectional view of the lower portion of the pump assembly shown in Fig. 5, and is a continuation from the lower end of Fig. 5.

Referring to the drawings in detail, and particularly Figs. 1 and 2, reference character 8 designates a well tubing or casing which extends downwardly from the surface through a well bore (not shown) to a depth below

the normal level of fluid standing in the well. As shown in the upper portion of Fig. 2, a suitable collar 10 is threadedly secured on the lower end of the tubing 8 to support a bushing 12 in alignment with the tubing 8. The bushing 12 is preferably threaded into the lower end of the collar 10, and the inner bore 14 of the bushing is slightly smaller than the inner diameter of the tubing 8. Also, the upper end portion 16 of the inner bore 14 of the bushing is preferably tapered upwardly and outwardly to a diameter substantially corresponding to the inner diameter of the tubing 8 for purposes which will hereinafter be set forth. A tubular pump housing 16 is threadedly secured on the lower end of the bushing 12 and has a seating nipple 18 threadedly secured in the lower end thereof. Although the pump housing 16 is preferably slightly larger in diameter than the tubing 8, the housing may be formed out of a section of the tubing 8 and may be considered as a continuation of the tubing. The inner bore 20 of the seating nipple 18 is tapered downwardly and inwardly and the diameter thereof is less than the inner diameter of the bushing 12. If desired, a tail pipe or suction collar 22 may be secured on the lower end of the seating nipple 18. The structure thus far described is a part of the permanent well installation and once installed will normally not be removed from a well unless the tubing 8 develops a leak or some other portion of the structure becomes damaged through use. In other words, the structure thus far described is normally left in the well and merely utilized as a receptacle for my novel pump, which is generally designated by reference character 24.

As shown in Fig. 2, the pump 24 comprises a tubular working barrel 26 having a diameter less than the diameter of either the tubing 8 or the housing 16, and having a series of transverse ports 28 in the upper end portion thereof and a series of ports 30 in the lower end portion thereof. The working barrel 26 is substantially the same length as the pump housing 16 and has a seating member 32 threadedly secured in the lower end thereof. The outer diameter of the seating member 32 is tapered in conformity with the inner bore of the seating nipple 18 to provide a support of the pump 24 in the nipple 18. Also, a suitable O-type sealing ring 34 is disposed in a complementary groove in the outer periphery of the seating member 32 to contact the inner periphery of the seating nipple 18 and provide a seal of the member 32 in the nipple 18 to prevent the leakage of fluid downwardly from the annular chamber 36 between the working barrel 26 and the pump housing 16. It is to be particularly observed, however, that the O-ring 34 will provide a minimum of friction upon insertion and withdrawal of the seating member 32 in the seating nipple 18. Furthermore, the mating tapered surfaces of the seating member 32 and the nipple 18 facilitate easy insertion and withdrawal of the member 32 from the nipple 18. Therefore, a minimum of force need be used for lowering the pump 24 into its seated position as illustrated in Fig. 2.

The inner bore 38 of the seating member 32 forms the inlet for well fluid into the pump 24. A suitable seat 40 is formed at the upper end of the bore 38 to receive a ball type standing valve 42. It will be apparent that the standing valve 42 is used to alternately open and close the fluid inlet 38 and is of a diameter slightly less than the working barrel 26 to provide easy vertical movement of the valve in response to fluid pressure differentials across the valve. A plug member 44 is secured in the working barrel 26 by means of a cross pin 46 a short distance above the lower transverse ports 30. Also, the plug 44 is sealed in the working barrel 26 by means of a suitable sealing ring 48 to divide the working barrel 26 into an upper chamber 50 and a lower chamber 52. As indicated, the plug 44 is secured a short distance above the ports 30, and one function of the plug is to limit the upward movement of the standing valve 42 so that the

standing valve cannot be moved into a position above the ports 30 and render the pump 24 inoperative. The ports 30 will, of course, be smaller in diameter than the standing valve 42.

A tubular pump plunger 54, having suitable upwardly extending cups 56, is slidingly disposed in the upper chamber 50 of the working barrel above the plug 44. The inner bore 58 of the plunger 54 is alternately opened and closed by a ball type traveling valve 60, and the valve 60 is retained in operating position by a suitable guide structure 61 in the normal manner. An internally threaded member 62 is rigidly secured on the upper end of the guide structure 61 to receive the lower end of a pump rod 64. The rod 64 extends upwardly from the working barrel 26 a substantial distance for connection with the wire line, as will be hereinafter set forth.

A tubular head 66 is threadedly secured in the upper end of the working barrel 26 around the pump rod 64. The outer diameter of the head 66 immediately above the upper end of the working barrel is slightly less than the inner diameter of the bushing 12 and is provided with an O-ring 68 of a size to sealingly engage the inner bore 14 of the bushing 12. The sealing ring 68 prevents a drainage of well fluid from the tubing 8 downwardly between the head 66 and the bushing 12. The inner diameter of the head 66 is such that the lower end 70 of the head extends inwardly above the outer edge portion 72 of the guide structure 61 on the plunger 54 in order that the guide 61 will contact the head 66 when the pump rod 64 is pulled upwardly beyond the normal up stroke of the pump, in removing the pump from the well, as will be more fully hereinafter set forth.

An annular seat 74 is cut in the outer periphery of the head 66 a short distance above the sealing ring 68. As will be apparent to those skilled in the art, the seat 74 may be either a machined surface of the head 66 or a separate element (not shown) to provide an extended service life. A plurality of transverse ports 76 are provided in the head 66 immediately above the seat 74 for the discharge of pumped fluid from the pump 24 upwardly into the tubing 8. The upper end portion 78 of the head 66 is swedged inwardly (reduced in size) to such an extent that the inner bore 80 of the portion 78 provides a sliding fit of the portion 78 around the pump rod 64. Thus, the upper portion 78 of the head 66 provides a guide for the pump rod 64 to maintain the pump rod and the pump plunger 54 in alignment with the head 66 and working barrel 26. The tapered portion 82 of the head 66 between the ports 76 and the reduced upper end portion 78 is provided with a plurality (preferably two) slots 84 in the outer surface thereof for purposes which will be hereinafter set forth. As shown most clearly in Fig. 3, the slots or grooves 84 extend throughout the length of the tapered portion 82 and are arranged on opposite sides of the portion 82 in alignment with the longitudinal axis of the head 66.

A tubular valve 86 (Fig. 2) is slidingly disposed on the head 66 to alternately open and close the ports 76. The inner diameter of the valve 86 is varied in accordance with the outer diameter of the head 66 from the seat 74 upwardly, and the lower end 88 of the valve is shaped to mate with the seat 74 to provide a metal-to-metal seal over the ports 76 when the valve 86 is in its lower position, as shown. The upward movement of the valve 86 is limited by a suitable ring 90 secured at the upper end of the head 66. The ring 90 is spaced from the seat 74 such a distance that the valve 86 may be raised until the lower end 88 thereof is above the ports 76. It should also be observed that the outer diameter of the valve 86 is substantially less than the inner diameter of the tubing 8, collar 10 and upper end portion 16 of the bushing 12, to provide free movement of the valve 86, as well as an annular chamber 92 between the outer periphery of the valve and the inner periphery of the upper end of the bushing 12.

As shown in the lower portion of Fig. 1, the pump rod 64 extends into an elongated socket or chamber 94 of a sinker bar 96. The socket 94 may be formed by boring into the lower end of the sinker bar 96 and then closing off the lower end of the bore by means of a tubular threaded cap 98. The inner bore of the cap 98 is such to provide a loose sliding fit of the pump rod 64 therein. A head 100 is threadedly secured on the upper end of the pump rod 64 within the socket 94, and the diameter of the head 100 is preferably substantially less than the diameter of the socket 94 to provide a loose fit of the head in the socket. Thus, the sinker bar 96 may be moved vertically over the head 100 until the head strikes either end of the socket 94 to actuate the pump 24, as will be more fully hereinafter set forth.

The upper end of the sinker bar 96 is provided with a longitudinal bore 102 of a size to receive the lower end of the usual wire line 104. The wire line 104 extends downwardly from the surface through the tubing 8 and is connected to any suitable device (not shown) at the surface of the well which may be used to reciprocate the wire line. A plurality of transverse bores 106 are provided through the upper end portion of the sinker bar 96 in intersecting relation with the vertical bore 102. One end of each transverse bore 106 is reduced in diameter and threaded to receive a clamping screw 108 which is used to clamp the wire line 104 in the sinker bar. As shown, the vertically adjacent screws 108 are preferably opposed to more effectively wedge the wire line 104 in the sinker bar. Also, suitable guide fingers 110 are secured to the upper end of the sinker bar 96 to slidably engage the inner periphery of the tubing 8 and maintain the sinker bar 96 substantially in the center of the tubing. Thus, the sinker bar 96 will be retained substantially in alignment with the working barrel 26 of the pump 24 to minimize bending of the pump rod 64 during operation of the unit.

Operation

To install the pump unit 24, it is secured to the lower end of the wire line 104 in the manner shown in Figs. 1 and 2. The entire unit is then lowered through the well tubing 8 until the pump 24 approaches the lower end of the tubing. It will be apparent that since the seating member 32 of the pump is smaller in diameter than the bore 14 of the bushing 12, the seating member 32 and the working barrel 26 will be lowered freely through the bushing 12 and the pump housing 16. Also, since the outer diameter of the lower end of the seating member 32 is less than the diameter of the upper end of the bore 20 of the seating nipple 18, the member 32 will be easily inserted in the nipple 18. Normally, the weight of the pump unit 24 will be sufficient to move the lower sealing ring 34 into a sealing position in the bore 20 of the seating nipple 18 and the sealing ring 68 into the bore 14 of the bushing 12. It will also be observed that as the pump unit 24 is lowered into the fluid standing in the tubing 8 and housing 16, the lower standing valve 42 will be opened and fluid will flow relatively upward through the inlet 38, ports 30, chamber 36, ports 28 and head 66 into contact with the upper standing valve 86. The downward movement of the pump unit 24 will be sufficient to also open the upper standing valve 86 such that fluid will pass completely through the pump unit 24, including the upper ports 76.

In the event the pump unit 24 is not completely seated by its own weight, the wire line 104 is dropped a short distance until the upper end of the socket 94 of the sinker bar 96 contacts the upper end of the pump rod head 100. The weight of the sinker bar 96 will then be imposed on the plunger 54 to lower the plunger into contact with the plug 44. At this time, the weight of the sinker bar will be imposed on the working barrel 26 to completely seat the sealing rings 34 and 68. Furthermore, if necessary, the sinker bar 96 may be raised a short

distance and dropped after the pump plunger 54 is in contact with the plug 44 to effectively drive the pump unit 24 into the seated position shown in Fig. 2.

When the pump unit 24 is fully seated in the nipple 18, the standing valves 42 and 86 will close by the force of gravity. The wire line 104 is then reciprocated to operate the pump unit 24. During the initial upward movement of the wire line 104, the socket 94 will be moved over the head 100 and the pump unit 24 will not be operated. However, as soon as the lower end of the socket 94 contacts the head 100, the pump plunger 54 will be moved in an up stroke. During this up stroke, fluid standing in the working barrel 26 above the plunger will be forced upwardly through the head 66 to increase the pressure on the lower end of the upper standing valve 86. It will also be apparent that the traveling valve 60 will be retained in a seated position to close the bore 58 of the plunger 54 for the working stroke, as well as create a partial vacuum in the lower portion of the chamber 50. When the pressure of the fluid in the head 66 is increased, the fluid pressure will be exerted upwardly through the ports 76 and the slots 84 in the head 66 to act on the inner surface of the valve 86 opposite the tapered portion 82 of the head. This force will be sufficient to raise the valve 86 on the head 66 and open the ports 76; whereupon the fluid will be forced upwardly in the tubing 8 toward the surface of the well. Simultaneously, the increased pressure of the fluid in the upper portion of the working barrel 26 will be exerted through the ports 28 and downwardly through the chamber 36 and ports 30 to retain the lower standing valve 42 in a closed position over the inlet 38.

At the end of the up stroke, it will be apparent that the fluid in the tubing 8 will be at a higher level than the well fluid standing in the well around the tubing 8. Therefore, when the wire line 104 is moved downwardly by the surface equipment, the pressure above the upper standing valve 86 will be greater than the pressure in the working barrel 26 and the head 66 to lower the standing valve 86 into its seated position as shown in Fig. 2. Although the downward movement of the upper standing valve 86 is preferably fast, it is preferred that the speed of the final seating movement of the valve be reduced to minimize wear of the seat 74 and mating portion 88 of the valve. It will be observed that in the present structure, fluid will be present between the tapered portion 82 of the head 66 and the correspondingly tapered portion of the valve 86. During the final closing movement of the valve, this fluid is removed from between the valve and the tapered portion 82 only through the slots 84. Thus, this fluid will act as a hydraulic shock absorber to retard the downward movement of the valve 86, yet the slots 84 facilitate a complete removal of the fluid between the valve and tapered portion 82 to facilitate a complete closing of the valve. Upon closing of the upper standing valve 86, the fluid standing in the well provides a pressure differential across the lower standing valve 42 to again open the inlet 38.

During the main portion of the down stroke of the unit 24, the plunger 54 is moved by a combination of the weight of the plunger, the force exerted by the well fluid standing in the well acting through the inlet 38, ports 30, chamber 36 and ports 28, as well as a partial vacuum created in the chamber 50 below the plunger during the up stroke. These forces will quickly lower the plunger 54 into proximity with the plug 44 and retain the pump rod head 100 in contact with the lower end of the socket 94. However, when the plunger 54 contacts fluid in the lower portion of the chamber 50 which leaked around the cups 56 during the up-stroke, the speed of movement of the plunger is substantially retarded. If given sufficient time, the plunger 54 would, in effect, settle through this fluid standing above the plug 54 and this fluid would be moved upwardly through the bore 58 in the plunger to raise the traveling valve 60. However, if when the

plunger 54 contacts fluid standing above the plug 44 the plunger is moved downwardly only by its own weight, at a normal operating speed of the pump, the plunger 54 would be moved on another up stroke before the down stroke were actually completed.

In the present structure, when the plunger 54 contacts fluid standing in the working barrel above the plug 44, the sinker bar 96 moves downwardly relative to the pump rod 64 until the upper end of the socket 94 contacts the pump rod head 100. When this occurs the weight of the sinker bar 96 is imposed on the plunger 54 to greatly accelerate movement of the plunger through the fluid in the lower portion of the working barrel chamber 50 and greatly increases the speed of the complete down stroke. Therefore, the speed of operation of the pumping unit is increased. It may also be noted that not only will the cups 56 of the plunger 54 inherently provide some leakage of fluid to the lower end of the chamber 50 during the up stroke, but such leakage is intentionally obtained to facilitate the down stroke of the plunger 54. If the cups 56 fit too tightly in the working barrel 26, the down stroke of the plunger 54 will be unduly retarded, and the speed of operation of the pump materially decreased.

From the foregoing it will be apparent that not only is the wire line 104 retained under tension during the up stroke, but also during the major portion of the down stroke. Thus, fatigue of the wire line 104 will be reduced to a minimum. It may also be noted that the normal movement of the wire line 104 is greater than the normal stroke of the pump unit 24 by a distance equal to the length of the socket 94 in order that the sinker bar 96 may be used to force the plunger 54 through the final portion of the down stroke. When it is desired to remove the pump unit 24, the wire line 104 is simply pulled upwardly. When the upper end 72 of the plunger guide structure 61 contacts the lower end 70 of the head 66, the entire pump unit 24 will be unseated from the seating nipple 18 and bushing 12 and the entire unit is removed from the well through the tubing 8.

As it is well known in the art, most well fluids contain an appreciable amount of sand which normally interferes with the operation and excessively wears out the pump, particularly the upper standing valve of the pump. In the present invention, sand settling out of well fluid above the pumping unit 24 will fall down past the valve 86 into the annular space 92 between the outer periphery of the valve and the head 66 and the inner periphery of the bushing 12 onto the sealing ring 68 and will have a minimum effect on the operation of the valve 86. The contour of the valve 86 enhances the downward movement of sand contacting the valve, whereby the sand will have a minimum tendency to accumulate on any working surface of the valve. It may also be noted that any sand settling from well fluid standing in the chamber 36 between the working barrel 26 and pump housing 16 will tend to settle into the lower end of the chamber 36, and not on the lower standing valve 42 or its seat 40. In the event sand accumulates either in the chamber 92 or the chamber 36 to such an extent as to interfere with operation of the pump, it is simply necessary to raise the pump 24 a slight distance above the seating nipple 18, whereby fluid will drain from the tubing 8 through the bushing 12 and the seating nipple to wash away the accumulated sand.

In excessively sandy wells, I prefer to maintain a small quantity of mercury 112 on the pump plunger 54 as illustrated in Fig. 4. The mercury 112, being substantially heavier than sand, will catch and trap any sand attempting to settle in the working barrel 26 before the sand contacts the cups 56, thereby minimizing wear of the cups. It is recognized that the mercury 112 will tend to leak downwardly around the cups 56 in the same manner as oil. Such leakage does take place, but the mercury leaking by the plunger 54 is forced upwardly through the bore 58 of the plunger in the same manner as the

well fluid in the lower end of the chamber 50 at the end of the down stroke as previously described. When using mercury 112, the stroke of the plunger 54 is slightly shortened in order that the mercury will not be raised to a level corresponding with the ports 28 in the upper end of the working barrel at the end of the up stroke. If this were to occur, the mercury would, of course, pour out through the ports 28 into the lower end of the annular chamber 36. Also, I provide a spacer pipe or tube 114 on the upper end 72 of the plunger guide structure 61. The spacer 114 is of a size to contact the lower end 70 of the head 66 during removal of the pump unit 24 to prevent the plunger 54 being raised to such an extent that the mercury would spill through the ports 28. During the normal stroking movement of the plunger 54, the spacer pipe 114 is retained by gravity on the upper end 72 of the plunger guide structure 61 to move with the plunger 54, and the plunger 54 is not raised to such an extent that the upper end of the spacer pipe contacts the head 66.

A pump unit constructed in accordance with this invention may be easily modified to increase the capacity of the pump by using a plurality of pump plungers and increasing the length of the unit as shown in the pump assembly generally indicated at 115 in Figs. 5 and 6. The pump housing 16 is increased in length and provided with the usual bushing 12 at its upper end and seating nipple 18 at its lower end. The working barrel 116 is modified by being longer than the previously described working barrel 26 and having a threaded plug 118 interposed in the central portion of the working barrel as illustrated in the lower portion of Fig. 5. The plug 118 divides the working barrel 116 into an upper pumping chamber 120 and lower pumping chamber 122. Also, transverse ports 124 are provided in the upper end portion of the working barrel, ports 126 are provided in the lower portion of the working barrel, and an additional set of transverse ports 127 are provided in an intermediate portion of the working barrel immediately below the center plug 118. The upper end of the working barrel 116 is secured to a head 66 of the type previously described, and the lower end of the working barrel is secured to a seating member 32 of the type previously described. The standing valves 42 and 86 are provided in the seating member 32 and on the head 66 in the same manner as previously described. Finally, a plug member 44 of the type previously described is provided in the lower portion of the working barrel 116 immediately above the lower ports 126 and lower standing valve 42.

The lower pumping chamber 122 of the modified pump structure 115 contains a pump plunger 54 constructed in the same manner as previously described to provide a pumping action in the lower portion of the working barrel. The upper end of the pump plunger 54 is connected to a pump rod 128 which extends upwardly through a complementary bore in the center plug 118 into connection with an upper pump plunger 130 slidingly disposed in the upper pumping chamber 120. A suitable seal 132 is provided in the center plug 118 around the pump rod 128 to prevent any substantial leakage of well fluids between the pumping chambers 120 and 122 through the plug 118. The upper pump plunger 130 is tubular in form and provided with a pair of upwardly facing cups 134 to force fluid upwardly in the chamber 120 on upward movement of the plunger 130. Since the lower end of the pump plunger 130 must be threaded to receive the upper end of the pump rod 128, a plurality of biased ports 136 extend through the lower portion of the plunger into communication with the central bore 138 of the plunger and provide communication through the plunger. A suitable traveling valve 140 is provided in the upper portion of the plunger 130 to alternately open and close the upper end of the bore 138, and the traveling valve 140 is retained in

the proper position by a guide structure 142 in the same manner as previously described in connection with the pump plunger 54. An internally threaded member 144 is secured on the upper end of the guide structure 142 to receive the lower end of the usual pump rod 64. The rod 64 extends upwardly through the head 66 into connection with a sinker bar 96 and a wire line in the same manner as shown in Fig. 1.

In operation of the pumping unit 115, the upper pump rod 64 is reciprocated in the same manner as previously described to simultaneously raise and lower the pumping plungers 130 and 54. On the up stroke, the upper pump plunger 130 forces fluid standing in the upper pump chamber 120 above the plunger upwardly through the head 66 and outlet ports 76 to raise the valve 86 and force the well fluid on upwardly through the tubing 8. Simultaneously, the lower pump plunger 54 forces well fluid from the upper portion of the lower pump chamber 122 outwardly through the middle ports 127 into the annular space 146 between the pump housing 16 and working barrel 116. This fluid then flows upwardly through the annulus 146 and into the upper pump chamber 120 through the upper ports 124 to join with the fluid being pumped by the upper pump plunger 130. Also simultaneously, the pressure of the fluid being pumped from the lower pumping chamber 122 is exerted downwardly through fluid standing in the annulus 146 and in through the lower ports 126 to hold the lower standing valve 42 on its respective seat. The traveling valve 140 of the upper pump plunger 130 and the traveling valve 60 of the lower pump plunger 54 will both be closed to provide a partial vacuum in the lower portions of both pumping chambers 120 and 122.

On the down stroke, each of the pump plungers 130 and 54 will be initially moved downwardly by the suction created in the lower portion of the respective pumping chamber and the weight of the pump plunger assembly, in combination with the hydrostatic pressure of well fluid standing in the well being exerted through the fluid inlet 38 upwardly through the ports 126 and annulus 146 and then downwardly through both sets of ports 127 and 124. When either pump plunger contacts fluid in the lower portion of its respective pumping chamber, the sinker bar 96 is lowered over the pump rod head 100 in the same manner as previously described to force the plungers on down to the lower ends of their respective pumping chambers. As the upper pump plunger 130 is forced downwardly through fluid standing in the lower end of the upper pumping chamber 120, the traveling valve 140 will open to allow the trapped fluid to flow upwardly through the ports 136 and the bore 138 into the upper portion of the pumping chamber 120 above the plunger. The lower plunger operates in the same manner as previously described. Simultaneously, well fluid flows into the pumping unit through the inlet 38 and the ports 126 into the annulus 146, and then into each of the pumping chambers above the respective pump plunger to fill the pumping chambers with a new supply of well fluid.

In analyzing the modified pump structure 115, it will be observed that the working barrel of the pump may be extended as desired and any number of pump plungers may be used while using only one lower standing valve and one upper standing valve. It is simply necessary that the uppermost ports 124 in the working barrel 116 be made of sufficient size to accommodate the fluid being pumped by the pump plungers in the lower pumping chambers. When comparing the structure shown in Figs. 5 and 6 with the structure shown in Figs. 1 and 2, it will be observed that with the same diameter of working barrel and the same stroke length, the capacity of the pump unit shown in Figs. 5 and 6 will be twice the capacity of the pump unit shown in Figs. 1 and 2. Regardless of its length, a pump constructed in accordance with the present invention may be inserted in a well

tubing or casing and removed therefrom in the same manner as previously described in connection with Figs. 1 and 2.

From the foregoing it will be apparent that the present invention provides a novel wire line type pump which will not be easily fouled by pumping sandy well fluid. The upper standing valve has no contact either with the pump rod or the well tubing, whereby the valve will be retained in the desired position to evenly engage its respective seat when the pump is making a down stroke. Furthermore, the upper standing valve will not be easily rendered inoperative by sand settling out of well fluid standing in the tubing or casing above the pump. The pump may be easily inserted and withdrawn from the well and, finally, the pump is simple in construction and may be easily manufactured.

Changes may be made in the combination and arrangement of parts as heretofore set forth in the specification and shown in the drawing, it being understood that changes may be made in the precise embodiments shown without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. A reciprocating wire line operated pump assembly for use in a well tubing or the like, comprising a working barrel having an outer diameter less than the inner diameter of the tubing for insertion of the working barrel in the tubing and having transverse ports in the upper and lower end portions thereof, means for sealing the working barrel in the tubing above the upper ports and below the lower ports, a well fluid inlet in the lower end of the working barrel, a standing valve in the lower portion of the working barrel for opening and closing said inlet, a plug sealed in the lower portion of the working barrel above the lower ports and the standing valve, a tubular plunger slidingly disposed in the working barrel above said plug, a traveling valve in said plunger, a pump rod extending upwardly from said plunger through the upper end of the working barrel for connection with the wire line and reciprocation of the plunger, an elongated tubular head rigidly secured on the upper end of the working barrel and having its side walls extending vertically upward from the working barrel, the upper end portion of said head being reduced in diameter to form a guide and slidingly receive the pump rod, said head having transverse ports through the vertical side walls thereof between the reduced end portion and the point of connection of the head to the working barrel, an upwardly facing annular seat formed in the outer periphery of the head below said ports, and a tubular valve slidingly disposed on the head having its inner diameter shaped to conform with the outer diameter of said head above said seat and having a seating area on its lower end for mating with the seat on the head, whereby said tubular valve is reciprocated by fluid pressure upon reciprocation of said plunger and alternately opens and closes the ports in the head.

2. A pump as defined in claim 1 characterized further in that said head is swedged inwardly toward its upper reduced diameter end portion to form an upwardly and inwardly tapered outer periphery above the ports through the head, said tapered outer periphery having slots therein extending upwardly from the upper ends of the ports through the head providing fluid pressure communication from fluid in the head to the correspondingly tapered portion of the tubular valve, a stop on the upper end of the head limiting the upward movement of the tubular valve, and the outer periphery of the tubular valve being less than the inner diameter of the tubing, whereby the tubular valve has contact only with the head.

3. A pump as defined in claim 1 characterized further in that said head has an inner diameter less than the working barrel to provide a downwardly facing shoulder in the working barrel at the lower end of the head, a supply of mercury on said plunger, and a spacer tube on

11

the upper end of said plunger of a size to contact said downwardly facing shoulder and stop the upward movement of said plunger before said mercury reaches the level of the upper ports in the working barrel.

4. A reciprocating wire line operated pump assembly for use in a well tubing or the like, comprising a downwardly and inwardly tapered seating nipple secured in the tubing, a bushing secured in the tubing above the seating nipple and having an inner diameter greater than the inner diameter of the nipple, a working barrel having an outer diameter less than the inner diameter of the tubing and the bushing and having transverse ports in the upper and lower end portions thereof, a tubular seat on the lower end of the working barrel of a size of engage the seating nipple and having its outer periphery tapered in conformity with the inner periphery of the nipple, an O-ring in said seat for engaging said nipple and providing a seal of the seat in the nipple, a plug sealed in the lower portion of the working barrel above the lower ports, a standing valve in the working barrel between the plug and said seat, a tubular head on the upper end of the working barrel having portions of its side walls extending vertically and having ports through the vertical side walls for the passage of well fluids, an O-ring in the outer periphery of said head below said ports for engaging said bushing, a tubular plunger in the working barrel, a traveling valve in said plunger, a pump rod extending upwardly from said plunger through a complementary bore in said head, a sinker bar connected to the upper end of the pump rod and the lower end of

12

the wire line, a seat on said head below the ports through the head, and a tubular valve slidingly disposed on said head for engaging the last-mentioned seat and alternately opening and closing the ports through the head during reciprocation of the plunger by the wire line.

5. A pump as defined in claim 4 characterized further in that said sinker bar is rigidly secured to the lower end of the wire line and has an elongated socket in the lower portion thereof of a diameter larger than the diameter of the pump rod, said sinker bar also having a bore in the lower end thereof slidingly receiving the upper end portion of the pump rod, and a head rigidly secured on the upper end of the pump rod within said socket, said head being of a size to slide in said socket.

References Cited in the file of this patent

UNITED STATES PATENTS

50,881	Parke	Nov. 7, 1865
446,622	Flanegin	Feb. 17, 1891
739,831	Clark	Sept. 29, 1903
870,410	Bell	Nov. 5, 1907
956,346	Heeter	Apr. 26, 1910
1,151,765	Drader et al.	Aug. 31, 1915
1,337,834	Francis	Apr. 20, 1920
1,408,092	Keller	Feb. 28, 1922
1,487,431	Barger	Mar. 18, 1924
1,605,563	Shutt	Nov. 2, 1926
2,669,190	Mullins	Feb. 16, 1954