Dec. 27, 1960 F. E. BOYDSTON 2,966,119

TANDEM TUBING PUMP

Filed Dec. 16, 1957 2 Sheets-Sheet 1

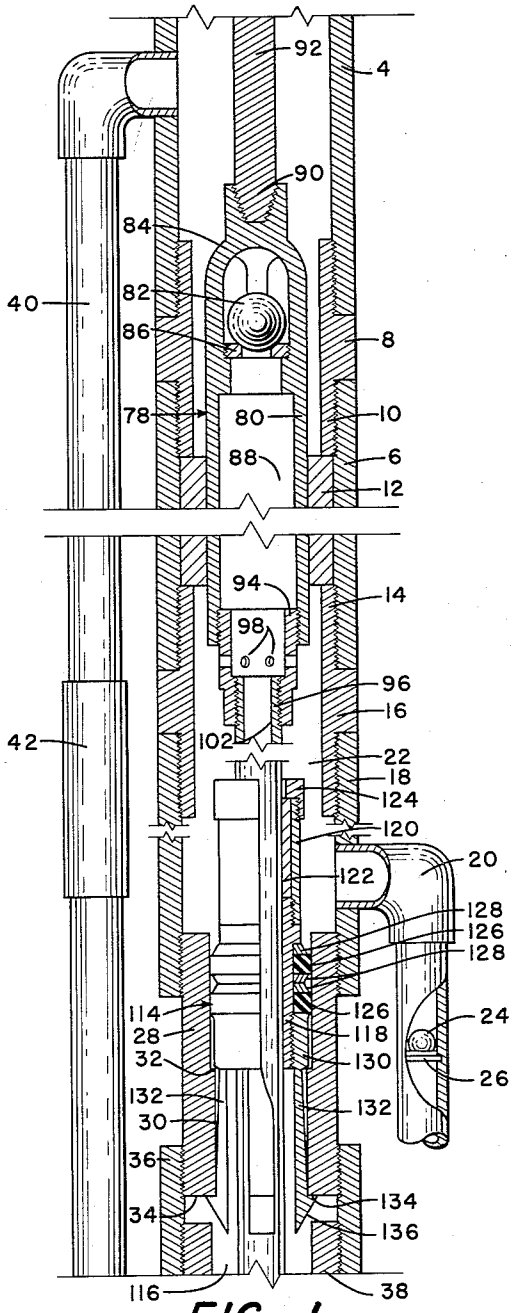


FIG. 1

INVENTOR.
FRED E. BOYDSTON

BY
Arthur W. Fuzak
ATTORNEY

Dec. 27, 1960 F. E. BOYDSTON 2,966,119

TANDEM TUBING PUMP

Filed Dec. 16, 1957 2 Sheets-Sheet 2

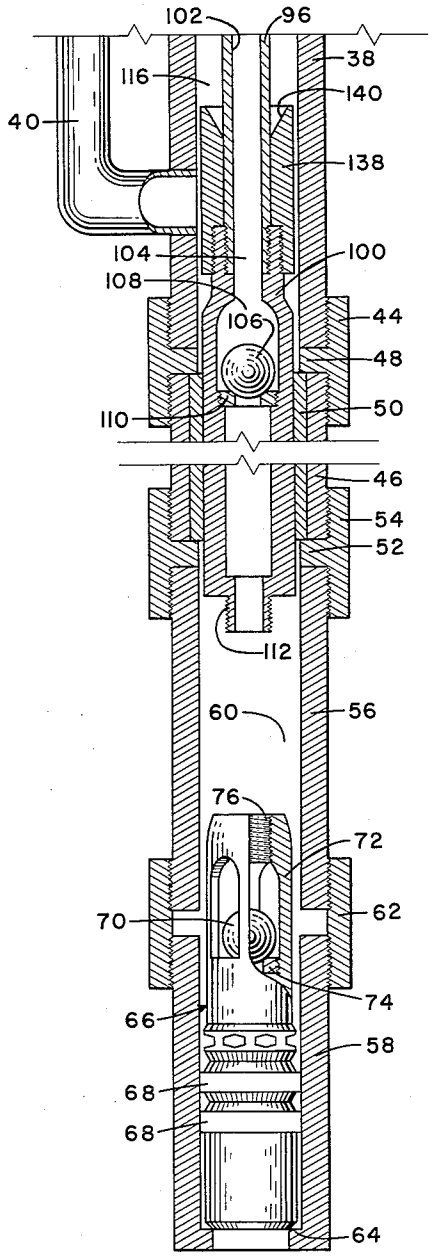


FIG. 2

INVENTOR.
FRED E. BOYDSTON
BY
Arthur W. Fuzak
ATTORNEY

United States Patent Office 2,966,119 Patented Dec. 27, 1960

2,966,119

TANDEM TUBING PUMP

Fred E. Boydston, Nocona, Tex., assignor to Continental Oil Company, Ponca City, Okla., a corporation of Delaware

Filed Dec. 16, 1957, Ser. No. 703,218

7 Claims. (Cl. 103—4)

This invention relates to improvements in subsurface well pumps, and more particularly, to an improved subsurface well pump of the type having two pump plungers and pumping chambers in tandem.

As it is well known in the art, various attempts have been made to provide a sucker rod type pump having two vertically spaced pumping chambers, with two plungers or pistons operated simultaneously by the sucker rod string. Heretofore, however, the lower pump plunger has been constructed and arranged in such a manner that a substantial force must be transmitted through the sucker rod string to move the plunger assembly on a down stroke; thereby materially increasing fatigue of the sucker rod string and resulting in early failure of the pump system. Also, the sealing means used around the connecting rod between the plungers to separate the two pumping chambers has been anchored in the tubing in such a manner as to require excessive manipulation of the sucker rod string and plungers to release the sealing means from the tubing and permit withdrawal of the main working parts of the pump assembly.

The present invention contemplates a novel tandem type sucker rod pump utilizing two pump plungers and two pumping chambers in vertically spaced relation, wherein fluid pumped by the lower plunger is directed upwardly through the plunger assembly and a by-pass is provided from the production column to the top of the lower pumping plunger to facilitate the down stroke of the unit, thereby minimizing fatigue of the sucker rod string. I contemplate the use of separate well fluid inlets for the two pumping chambers to provide a minimum resistance to the inflow of well fluid into the pump and a consequent increase in capacity for the pump. I further contemplate the use of a sealing arrangement between the two pumping chambers having a novel anchoring means for preventing dislodgement of the seal during normal operation of the pump unit, yet which may be released by simply moving the plunger assembly upward beyond the normal stroke of the pumping unit, whereby the plunger assembly may be easily removed from the well.

An important object of this invention is to provide a sucker rod type pump of increased capacity which will operate smoothly, particularly on the down stroke, to minimize fatigue of the sucker rod string.

Another object of this invention is to facilitate the removal of the plunger assembly in a tandem type sucker rod pump assembly.

A further object of this invention is to provide a locking or hold down means for the seal between the pumping chambers of a tandem type pump which may be released by a simple upward movement of the pump plunger assembly.

Another object of this invention is to impose the hydrostatic pressure of the production column on the upper end of the lower plunger and provide a downward movement of a portion of the production column in a tandem type pump to facilitate the down stroke of the pump.

A still further object of this invention is to provide a tandem type sucker rod pump assembly 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 partially schematic vertical sectional view through the upper portion of a pump assembly constructed in accordance with this invention.

Figure 2 is a partially schematic vertical sectional view through the lower portion of the pump assembly shown in Fig. 1 and is a continuation from the lower end of Fig. 1.

Referring to the drawings in detail, and particularly Fig. 1, reference character 4 designates a string of well tubing which extends downwardly in a well bore (not shown) to below the level of fluid standing in the well. A tubular jacket 6 is threadedly connected to the lower end of the tubing 4 by means of a collar 8 to align the jacket 6 with the tubing string. The collar 8 has a flange 10 extending downwardly from the lower end of the collar inside of the jacket 6 to contact the upper end of a tubular pump liner 12 disposed within the jacket 6. The liner 12 forms the upper working barrel of the pump assembly, as will be more fully hereinafter set forth, and is retained in the jacket 6 by the flange 10 and a flange 14 extending upwardly into the lower end of the jacket from a lower collar 16. The flange 14 is externally threaded for connection with internal threads at the lower end of the jacket 6, and the collar 16 is utilized to suspend another tubing section 18 below the jacket 6 and the main tubing string 4.

An inlet conduit 20 is connected to one side of the tubing section 18, preferably at the lower end of the tubing section, and is directed downwardly from the tubing 18. The conduit 20 may be of any desired length and serves as an inlet for well fluid into the tubing section 18 which forms an upper pumping chamber 22. A suitable standing valve 24 and cooperating seat 26 are provided in the inlet 20 to control the flow of fluid into the pumping chamber 22, as will be more fully hereinafter set forth.

A tubular seating member 28 is threadedly secured in the lower end of the tubing section 18. The bore 30 through the seating member 28 is reduced in diameter at substantially the central portion of the member to provide an upwardly facing circumferential shoulder 32 for purposes which will be hereinafter set forth. The lower end 34 of the seating member 28 extends into a threaded coupling 36 which connects the seating member 28 to another tubing section 38 (see also Fig. 2). It will be observed that the lower end 34 of the seating member 28 is exposed inside of the coupling 36 to present a downwardly facing circumferential shoulder.

The tubing section 38 is connected by a by-pass conduit 40 to the tubing string 4 above the liner 12 to impose the pressure of fluid in the tubing 4 into the tubing section 38 and facilitate the down stroke of the pump assembly, as will be more fully hereinafter set forth. A suitable coupling 42 is interposed in the conduit 40 to facilitate connection of the conduit to the tubing 4 and the tubing section 38.

The lower end of the tubing section 38 is connected by a collar 44 to a lower tubular jacket 46. A flange 48 is provided on the inner periphery of the collar 44 to extend inwardly beyond the upper end of the jacket 46 and contact the upper end of a lower pump liner 50 telescoped in the jacket 46. The liner 50 forms a lower working barrel for the assembly, as will be hereinafter set forth, and is held at its lower end by an inwardly extending flange 52

of another collar 54 threaded onto the lower end of the jacket 46.

A final tubing section 56 is threaded into the lower end of the collar 54 to support another seating member 58 and form a lower pumping chamber 60. The lower seating member 58 is connected to the tubing 56 by a suitable coupling 62 and is provided with an internal circumferential shoulder 64 forming a seat for a lower standing valve assembly 66.

The standing valve assembly 66 is tubular in form and provided with the usual seating cups or sealing rings 68 to prevent a downward flow of fluid around the standing valve assembly. A ball type standing valve 70 is provided in an open cage 72 at the upper end of the standing valve assembly and cooperates with a seat 74 to control the flow of fluid through the standing valve assembly. The upper end 76 of the cage 72 is preferably bored and threaded for purposes which will be hereinafter set forth.

From the foregoing it will be observed that the tubing sections 18, 38 and 56, along with the tubular jackets 6 and 46 actually form a continuation of the tubing string 4, and may be considered a part of the tubing string, with the seating member 28 interposed therein.

A tubular pump plunger assembly, generally designated by reference character 78, extends from the upper pump liner 12 downwardly through the lower pump liner 50 to produce a pumping action in both of the pump chambers 22 and 60 and provide a production of well fluids upwardly through the tubing string 4. The plunger assembly 78 comprises an upper tubular plunger 80 of a size to provide a sliding fit thereof in the upper pump liner 12. A ball type traveling valve 82 is retained in the upper end of the plunger 80 by an open type cage 84 and cooperates with a valve seat 86 to control the flow of fluid through the bore 88 of the plunger. As it is well known in the art, the valve cage 84 may be formed integrally with the plunger 80, or separately, and then suitably secured to the upper end of the plunger, and the valve seat 86 is preferably threaded into the upper end of the plunger for convenient replacement of the valve seat.

The lower end 90 of a string of sucker rods 92 is threadedly secured in the upper end of the valve cage 84 to provide a reciprocation of the plunger assembly 78 upon reciprocation of the sucker rod string. The sucker rod string 92 extends from the plunger assembly 78 upwardly through the tubing 4 to the top of the well for connection with suitable surface equipment (not shown) in the usual manner.

An adapter 94 is threadedly secured in the lower end of the plunger 80 to connect the plunger 80 with a downwardly extending, hollow connecting rod 96. As shown, the adapter 94 is tubular in form to provide communication between the upper end of the connecting rod 96 and the bore 88 of the plunger 80, and is provided with a plurality of transverse ports 98 therethrough between the lower end of the plunger 80 and the upper end of the connecting rod 96. As will be observed, the ports 98 provide communication between the pumping chamber 22 and the bore 88 of the plunger 80.

The connecting rod 96 is of substantial length and extends downwardly through the seating member 28 for connection with the upper end of a lower tubular pump plunger 100. The connecting rod 96 is threadedly secured in the upper end of the lower plunger 100 in such a manner that the bore 102 through the connecting rod 96 is in communication with the bore 104 extending through the lower plunger 100. A suitable ball type traveling valve 106 is disposed in an enlarged portion 108 of the lower plunger bore 104 and cooperates with a seat 110 to control the flow of fluid through the lower plunger 100. It will be understood that the lower plunger 100 may be formed in sections to facilitate the assembly and disassembly of the standing valve 106 and valve seat 110. However, it is to be observed that the complete plunger 100 is solid walled to provide communication from the bore 104 only with the bore 102 of the connecting rod 96 and the pumping chamber 60 below the plunger. A threaded pin 112 is preferably provided on the lower end of the plunger 100 for connection with the upper threaded end 76 of the lower standing valve assembly 66, when the plunger 100 is lowered beyond its normal pumping stroke, to facilitate removal of the lower standing valve assembly 66.

It will be observed that the upper pumping plunger 80 is larger in diameter than the lower pumping plunger 100, and the outer diameter of the lower pump plunger 100 is slightly smaller than the inner bore 30 of the seating member 28. Thus, the plunger 100 may be moved through the seating member 28 to permit removal of the plunger assembly 78 from the tubing 4 and the members connected therebelow. It will also be observed that the diameter of the connecting rod 96 is not only substantially less than the diameters of the plungers 80 and 100, but is also substantially less than the diameter of the bore 30 of the seating member 28.

A sealing assembly, generally designated by reference character 114, is disposed in the seating member 28 to divide the pumping chamber 22 from the chamber 116 formed by the tubing section 38 above the lower pump plunger 100. The sealing assembly 114 comprises a tubular mandrel 118 loosely disposed around the connecting rod 96 and threadedly connected at its upper end to another liner jacket 120. The liner jacket 120 is tubular in form to receive a reduced diameter liner 122 which is of a size to slidingly receive the connecting rod 96 and provide a metal-to-metal seal with the connecting rod 96. The liner 122 is secured in the jacket 120 by a tubular cap 124 threaded onto the upper end of the jacket, and by contacting the upper end of the mandrel 118.

A pair of sealing rings or cups 126 are telescoped onto the mandrel 118 and are retained in spaced relation on the mandrel by spacer rings 128. The rings or cups 126 are of a size to sealingly engage the enlarged portion of the bore 30 of the seating member 28 and prevent a flow of fluid around the sealing assembly 114. A sealing ring 130 is threaded on the lower end of the mandrel 118 to retain the cups 126 in assembly on the mandrel and to support a plurality of downwardly extending locking bars 132. It should also be observed that the outer diameter of the sealing ring 130 is such to provide engagement of the lower end of the seating ring with the upwardly facing shoulder 32 in the seating member 28 and limit the downward movement of the sealing assembly 114 in the seating member 28.

The locking bars 132 are preferably formed by slotting the lower end portion of the seating ring 130 to provide a plurality of circumferentially spaced locking bars formed integrally with the main body portion of the seating ring 130. Each locking bar 132 diverges outwardly toward its lower end away from the connecting rod 96. A circumferential shoulder 134 is formed on the outer face of each locking bar 132 near the lower end of the locking bar at a distance from the main body portion of the seating ring 130 to provide an engagement of the shoulder 134 with the lower end 34 of the seating member 28 when the ring 130 is seated on the shoulder 32. The locking bars 132 may be biased outwardly by suitable springs (not shown) but are preferably made of a resilient material and machined in such a manner that they will normally diverge outwardly and yet may be compressed toward the connecting rod 96. The outer face of each locking bar 132, below the respective shoulder 134, is tapered downwardly and inwardly as shown at 136.

A tubular releasing member 138 is telescoped over the connecting rod 96 and threadedly secured to the upper end of the lower plunger 100 in such a position that the releasing member 138 will be below the locking bars 132 during normal operation of the plunger assembly 78. A tapered counter bore 140 is formed in the upper

end of the releasing member 138 and is of a size and shape to mate with the tapered portions 136 of the locking bars 132, upon upward movement of the member 138, as will be more fully hereinafter set forth.

Operation

In installing the present pump assembly, the liner jackets 6 and 46, the tubing sections 18, 38 and 56, and seating members 28 and 58 are suspended from the tubing string 4, with the liners 12 and 50 installed as shown in Figs. 1 and 2. Also, the inlet 20 is secured to the tubing section 18 and the by-pass conduit 40 is installed as illustrated in Figs. 1 and 2. The tubing string 4 is then run (lowered) in the well in the normal manner. As previously indicated, the tubing string 4 is run into the well to a depth such that the inlet 20 and the lower seating member 58 are below the level of fluid standing in the well. Also, the tubing string 4 is preferably anchored in the well bore in a manner well known in the art.

The plunger assembly 78 is then assembled as shown in Figs. 1 and 2, with the sealing assembly 114 telescoped over and floating upon the connecting rod 96, and the lower ends 136 of the locking bars 132 seated on the tapered bore 140 of the releasing member 138. The plunger assembly 78 is then run in the tubing string 4 on a string of sucker rods 92 below the normal down stroke until the end of the adapter 94 strikes the cap 124. The adapter urges the sealing assembly 114 through seating member 28 until the locking bars 132 spring outwardly and the shoulders 134 engage the lower end 34 of the seating member 28. The sealing assembly 114 will then be anchored in the seating member 28 and will not move up and down during operation of the pumping unit.

If desired, the lower standing valve assembly 66 may be threaded onto the pin 112 at the lower end of the pump plunger 100 and run in the tubing string 4 along with the plunger assembly 78. In seating the sealing assembly 114, the plunger assembly 78 necessarily moves downwardly by a sufficient distance to seat the lower standing valve assembly 66 on the shoulder 64 in the seating member 58. The sucker rod string 92 is then turned in an appropriate direction to unthread the pin 112 from the upper end 76 of the standing valve assembly 66 and release the plunger assembly 78 from this standing valve assembly. To assure that no part of the sucker rod string 92 will be unthreaded by this operation, the threads on the pin 112 and the mating threads in the upper end 76 of the seating assembly may be made left-handed to unthread the pin 112 from the standing valve assembly 66 upon a right-hand turning movement of the sucker rod string 92.

The sucker rod string 92 is then reciprocated in the usual fashion to reciprocate the plunger 80 in the upper liner 12 and the lower plunger 100 in the lower liner 50. On the up stroke of the plunger assembly 78, well fluid will be drawn through the lower standing valve assembly 66 to open the lower standing valve 70 and provide a charge of well fluid in the lower pumping chamber 60 below the lower plunger 100. It will be understood that the traveling valve 106 in the plunger 100 will be closed during the up stroke. Also on the up stroke, well fluid will be drawn through the inlet 20 into the upper pumping chamber 22 below the upper plunger 80. The traveling valve 82 in the plunger 80 will also be closed during the up stroke. Simultaneously, fluid will be forced upwardly by the upper plunger 80 in the tubing string 4 (assuming that the pumping unit has been in operation and fluid has been previously pumped into the tubing string 4) and fluid will be displaced from the chamber 116 above the lower plunger 100 through the by-pass 40 into the tubing string 4.

At the beginning of the down stroke, the standing valves 24 and 70 will be closed, and the traveling valves 82 and 106 will be opened, by an increased pressure in the pumping chambers 22 and 60. During the down stroke, fluid standing in the pumping chamber 60 will be forced through the bore 104 of the lower plunger 100, the bore 102 of the connecting rod 96 and through the bore 88 of the upper plunger 80 into the tubing string 4. Simultaneously, fluid standing in the upper pumping chamber 22 will be forced through the ports 98 into the bore 88 of the upper plunger 80 to join with the fluid being pumped from the lower pumping chamber 60 into the tubing 4. Also simultaneously, a portion of the fluid standing in the tubing 4 (the production column) flows downwardly through the by-pass 40 into the chamber 116 above the lower pump plunger 100 to react on the upper end of the plunger 100 and assist in moving the plunger assembly 78 on a down stroke. Communication through the by-pass 40 provides not only a transmission of the hydrostatic pressure of the production column, but also a downward movement of fluid, the momentum of which assists in moving the plunger assembly 78 down. Thus, a minimum of force must be transmitted through the sucker rod string 92 to produce the down stroke of the pump unit and minimize fatigue of the sucker rod string.

During the reciprocation of the plunger assembly 78, the connecting rod 96 will slide up and down through the reduced diameter liner 122 and will tend to move the sealing assembly 114 with the plunger assembly 78. However, the engagement of the seating ring 130 with the shoulder 32 of the seating member 28, and the engagement of the shoulders 134 of the locking bars 132 with the lower end 34 of the seating member 28 will retain the sealing assembly 114 in its position in the seating member 28. Thus, the upper pumping chamber 22 is effectively separated from the lower chamber 116 to permit a pumping action in the pumping chamber 22.

When it is desired to remove the plunger assembly 78, as when the traveling valve seats 86 and 110 become worn, it is simply necessary to pull upwardly on the sucker rod string 92. As the counter bore 140 of the releasing member 138 moves over the tapered portions 136 of the locking bars 132, the locking bars are wedged inwardly into contact with the connecting rod 96 to disengage the shoulders 134 from the lower end 34 of the seating member 28. The sealing assembly 114 will then be free to move upwardly through the bore 30 of the seating member 28, and the entire plunger assembly 78 may be pulled upwardly through the tubing string 4.

From the foregoing it will be apparent that the present invention provides a tandem type sucker rod pump assembly wherein the minimum force must be transmitted through the sucker rod string to move the pump plungers on a down stroke. The pressure of fluid in the production column is transmitted to the upper ends of both plungers, and a portion of the fluid from the production column is moved down to facilitate the down stroke. A novel sealing assembly is secured in the tubing string between the pumping chambers to permit a pumping action by both of the plungers, yet the sealing assembly may be easily removed from the well simply by pulling the plungers upwardly beyond the normal up stroke. No manipulation of the sucker rod string is required, except upward movement, to remove the plungers from the well. It will also be observed that each of the pumping chambers is provided with a separate inlet to provide a maximum capacity for the pumping unit. Furthermore, a pump assembly in accordance with this invention is simple in construction and may be economically manufactured.

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

I claim:

1. A subsurface well pump assembly, comprising a string of tubing extending downwardly in the well, a pair of pump liners secured in the tubing in vertically spaced relation, a tubular seating member secured in the tubing between said liners, an inlet conduit connected to the tubing between the seating member and the upper liner, standing valves in the inlet conduit and the tubing below the lower liner, an elongated tubular plunger assembly in the tubing having an enlarged portion slidingly disposed in each of said liners and a reduced diameter portion extending through said seating member, said plunger assembly having a plurality of transverse ports extending therethrough at the lower end of the upper enlarged portion, a by-pass conduit connected to said tubing at its upper end above the upper liner and at its lower end between the seating member and the lower enlarged portion of said elongated tubular plunger assembly, traveling valves in the plunger assembly above and below said ports, and sealing means secured in said seating member for providing a fluid tight seal between the reduced diameter portion of the plunger assembly and said seating member.

2. A pump assembly as defined in claim 1 characterized further in that said sealing means comprises a tubular mandrel slidingly receiving the reduced diameter portion of the plunger assembly, sealing rings carried by said tubular mandrel and engaging the inner periphery of the seating member, and means for releasably anchoring said reduced diameter liner to the seating member.

3. A pump assembly as defined in claim 2 characterized further in that the seating member has a downwardly facing circumferential shoulder thereon, and said sealing means includes at least one locking bar carried below said tubular mandrel and biased outwardly at its lower end, the lower end of said locking bar having an upwardly facing shoulder thereon for engaging the downwardly facing shoulder of the seating member, the outer face of said locking bar being downwardly and inwardly tapered below said shoulder, means for limiting the downward movement of the tubular mandrel and a releasing member on the plunger assembly below the seating member having a tapered portion mating the tapered lower end of said locking bar for moving the lower end of said bar inwardly upon upward movement of the plunger assembly.

4. A pump assembly as defined in claim 1 characterized further in that the seating member has an inner diameter larger than the inner diameter of the lower liner and smaller than the inner diameter of the upper liner for removal of the plunger assembly and sealing means upwardly through the tubing.

5. In a subsurface well pump assembly, a string of tubing extending downwardly in the well, a pair of vertically spaced pump liners secured in the tubing, a tubular seating member interposed in the tubing between the liners and having its inner diameter reduced in the central portion thereof to form an upwardly facing circumferential shoulder therein, a plunger slidingly disposed in each of the liners, a reduced diameter rod interconnecting the plungers, a tubular mandrel loosely surrounding the rod, a seating ring on the mandrel of a size to seat on said upwardly facing circumferential shoulder, resilient locking bars carried by the mandrel and biased outwardly toward their lower ends, the lower end portion of each of said bars having an upwardly facing shoulder in the outer face thereof for engaging the lower end of the seating member and having a downwardly and inwardly tapered outer face below said shoulder, a tubular releasing member carried by said rod below the seating member having a tapered counter bore in its upper end of a size to engage the tapered lower ends of the locking bars and force the bars inwardly upon upward movement of said rod, sealing rings around the mandrel of a size to engage the inner periphery of the seating member, and a liner secured to the upper end of the mandrel slidingly receiving said rod.

6. A pump assembly as defined in claim 5 characterized further in that said seating ring is reduced in outer diameter to mate with the upwardly facing shoulder in the seating member, and the lower end portion of said seating ring is vertically slotted to form said locking bars, said locking bars being shaped to diverge outwardly at their lower ends away from the connecting rod and being formed out of a resilient material.

7. A pump assembly as defined in claim 5 characterized further in that said plungers and said connecting rod are tubular in form and the interior of the lower plunger communicates only with the interior of said rod at the upper end of the plunger and the tubing below the plunger, the upper plunger having a plurality of transverse ports through the lower end portion thereof, traveling valves in the lower plunger and in the upper plunger above said ports, an inlet conduit communicating with the tubing between the upper liner and said seating member, standing valves in the inlet conduit and the tubing below the lower liner, and a by-pass conduit having its lower end connected to the tubing between the lower liner and said seating member and its upper end connected to the tubing above the upper liner.

References Cited in the file of this patent

UNITED STATES PATENTS

750,715	Sleeman	Jan. 26, 1904
905,046	Baines	Nov. 24, 1908
1,435,837	Geddes	Nov. 14, 1922
1,736,486	Carnahan	Nov. 19, 1929
1,741,913	Blankenship	Dec. 31, 1929
2,193,020	Collins	Mar. 12, 1940
2,227,122	Brittain	Dec. 31, 1940
2,513,869	Hoffer	July 4, 1950