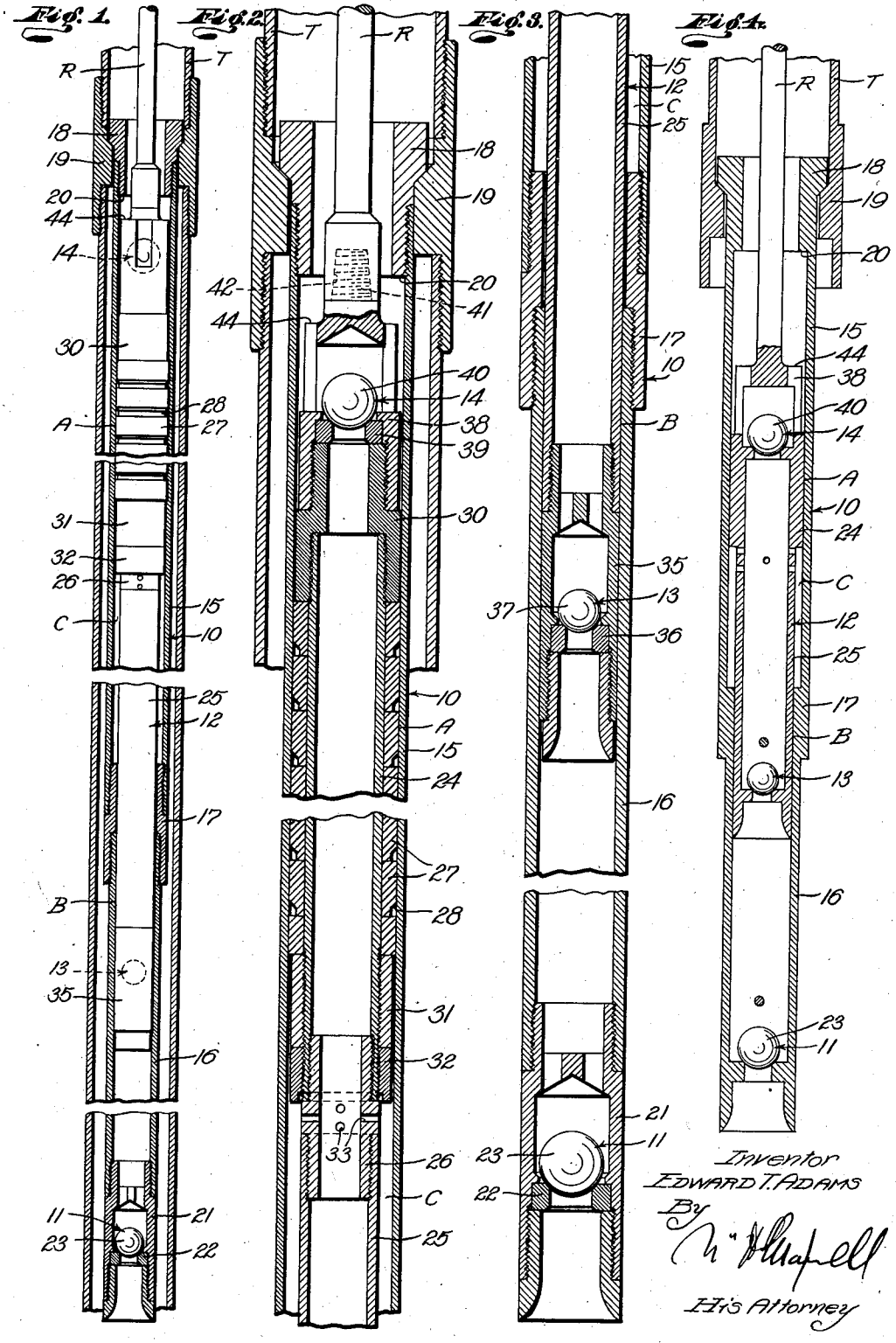
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WELL PUMP

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WELL PUMP

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This invention relates to a well pump and relates more particularly to a pump for use in a deep well such as an oil well. A general object of this invention is to provide an improved well pump that is simple and inexpensive to manufacture, that is efficient in operation, and that is economical to operate and keep in repair.

A class of well pumps that has gone into extensive use, particularly where considerable amounts of sand are encountered in the liquid, is the loose fitted pump. Pumps of the loose fitted type are usually formed of thin walled tubing which is seldom truly round and which is usually crooked and these defects make it necessary to have a loose fit between the barrel and the plunger and the loose fit necessitates the employment of a plunger of great length. While the loose fitted type of well pump will pass a substantial amount of sand without sticking, it is very inefficient due to the excessive tolerances made necessary by the character of the thin walled tubing employed in its construction.

Another object of this invention is to provide a well pump of the loose-fitted type in which the tolerances or clearances are much less than in the typical loose fitted pump whereby a much higher efficiency is obtained.

It is often the practice to employ a well pump of as large diameter as possible, leaving a very small annular space between the pump barrel and the well tubing. This space becomes choked with sand and silt. When a loose fitted pump is employed in such a situation the slip or leakage past the plunger is drawn from the silt and sand charged annular space and the solid matter thus drawn into the clearance space causes excessive wear. Further, when the annular space becomes filled with sand and silt and a traveling barrel type loose fitted pump is employed the barrel movement is retarded or stopped reducing the output. Another object of this invention is to provide a well pump of the loose fitted type that overcomes these defects of the prior loose fitted pumps. The pump of the present invention embodies a standing barrel and a top lock for the barrel so that the annular space between the traveling barrel and the well tubing is eliminated.

Another object of this invention is to provide a well pump of the character mentioned in which there are two vertically spaced pairs or sets of cooperating sealing surfaces on the barrel and plunger, the lower set of sealing surfaces being smaller in diameter than the upper set of surfaces and the two spaced sets of sealing surfaces, together with the barrel and plunger defining an annular space that is vented to the interior of the plunger. The advantages of this relationship of parts in the pump of the present invention may be enumerated as follows:

First: The pump has double pumping action, operating to discharge fluid on the down stroke of the plunger as well as on the up stroke, providing a substantially constant upflow of fluid at the upper end of the barrel to prevent the accumulation of sand and silt that might otherwise be drawn between the barrel and plunger.

Second: The leakage between the upper set of sealing surfaces of the barrel and plunger is received in the said annular space whose contents are completely displaced at each down stroke of the plunger, thus producing a washing effect and preventing the undesirable solid matter in such leakage fluid from reaching the second set of sealing surfaces.

Third: The employment of the two spaced sets of sealing surfaces permits the construction of both the barrel and plunger of relatively short sections which are straighter and more truly round than long sections of tubing and the means coupling the said short sections lend rigidity or stiffness to the pump elements. These two advantages permit a marked reduction in the tolerances and permit the replacement of any one of the sections of either the barrel or the plunger when it becomes worn without disturbing the other parts of the pump.

Fourth: The improved pump construction of the invention permits increased plunger thickness at the top seal increasing the rigidity of the plunger assembly whereby it will remain truly round and permitting the employment of a hard abrasion resisting material at this point.

Fifth: The pump of the present invention may be efficiently operated in a crooked hole or well bore due to its reduced length and reduced diameter.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and application of the invention, throughout which description reference is made to the accompanying drawing, in which:

Fig. 1 is a central longitudinal detailed sectional view of the improved pump provided by this invention arranged in operating position in a well tubing and illustrating the plunger in elevation. Fig. 2 is an enlarged longitudinal de-

tailed sectional view of the upper portion of the pump. Fig. 3 is an enlarged longitudinal detailed sectional view of the lower portion of the pump and Fig. 4 is a diagrammatic longitudinal sectional view of the pump.

The improved well pump of the present invention may be said to include generally, a barrel 10 of two effective diameters carrying a foot or standing valve 11, and a tubular plunger 12 of two diameters carrying two working valves 13 and 14 and operating in the barrel 10, the barrel 10 and plunger 12 being formed and related to provide two vertically spaced sealing zones A and B and an annular fluid space or chamber C between the two sealing zones A and B.

The pump barrel 10 is an elongate tubular structure or assembly and is the stationary element of the pump. The barrel 10 is intended to be secured or anchored to a well tubing T. It is preferred to anchor or lock the upper end of the barrel 10 to the tubing T with what is known as a top lock. However, the barrel may be secured at its lower end to the tubing T by a suitable anchor. The barrel 10 includes an elongate tubular upper section 15 and an elongate tubular lower section 16. The sections 15 and 16 may be of substantially the same length and may both be formed of suitable tubing. In accordance with the invention the lower barrel section 16 is of less diameter than the upper section 15. The adjacent ends of the barrel sections 15 and 16 are detachably connected in concentric relation by a suitable coupling or adapter 17. The sections 15 and 16 are threaded to the adapter 17 and the internal diameter of the adapter 17 may be the same as, or slightly greater than, the internal diameter of the lower section 16. In the preferred arrangement illustrated in the drawing the internal member or mandrel 18 of a suitable top lock is threaded into the upper end of the upper barrel section 15. The mandrel 18 is seated in or removably locked in a shoe 19 interposed in the tubing T to removably suspend the barrel 10 in the tubing. It will be observed that the lower end of the mandrel 18 forms a downwardly facing shoulder 20 at the upper end of the barrel 10.

The foot valve or standing valve 11 is provided at the lower end of the barrel 10 to control the fluid flow through the barrel. The valve 11 may be of any suitable type and construction. In the case illustrated the valve 11 is a typical ball type valve including a tubular cage 21 threaded in the lower end of the barrel section 16. The cage 21 carries a removable upwardly facing valve seat 22. A ball 23 is retained in the cage 21 and is adapted to seal downwardly against the seat 22 to close the lower end of the barrel 10.

It is to be noted that the barrel 10 is a simple, inexpensive structure comprising, primarily, two connected lengths or sections 15 and 16 of tubing. The sections 15 and 16 each being approximately one half the length of the barrel 10 are not excessively long and, therefore, may be formed of tubing stock that is straighter and more truly round than long tubing stock. The adapter 17 connecting the two barrel sections 15 and 16 midway between the ends of the barrel lends rigidity or stiffness to the barrel construction.

The plunger 12 is the moving or reciprocating element of the pump and operates in the stationary barrel 10. The plunger 12 is an elongate tubular assembly and is adapted to be operated by a reciprocable sucker rod R. It may be assumed that the rod R extends to the ground surface and that it is operated by a walking beam, crank or other form of pump jack. In the preferred construction the plunger 12 is formed of two tubular sections, namely, an upper section 24 and a lower section 25. The adjacent ends of the plunger sections 24 and 25 are connected by a suitable coupling or adapter 26. In the form of the invention illustrated in the drawing the adapter 26 is threaded into the opposing ends of the sections 24 and 25. In accordance with the invention the upper plunger section 24 is in sealing relation to the interior of the upper section 15 of the barrel 10 to form or provide the above mentioned sealing zone A and the lower plunger section 25 is in sealing relation to the interior of the lower barrel section 16 to provide the above mentioned sealing zone B. Because of this relationship of parts the upper section 24 or the upper portion of the barrel 12 is of larger outside effective diameter than the lower section or portion of the plunger.

In accordance with the broader aspects of the invention the upper plunger section 24 may be proportioned to have a loose sealing fit in the upper barrel section 15 or may be provided with any suitable form of sealing or packing means for cooperating with the interior of the barrel section 15. In the construction illustrated in the drawing a plurality of sealing rings 27 of hard metal or the like is provided on the upper section 24 to effect a sliding seal with the interior of the barrel section 15. The rings 27 are provided with annular external liquid trapping grooves 28. The rings 27 preferably have only slight clearance or tolerance with the internal surface of the barrel section 15. When the upper section 24 of the plunger 12 is provided with the rings 27, as just described, it may be formed of tubing of substantially the same diameter as the tubing of the lower section 25. A pin section or connecting member 30 is threaded on the upper end of the plunger section 24 to connect the valve 14 with the plunger 12 as will be subsequently described. The upper end of the uppermost ring 27 may engage against the lower end of the member 30. A retaining nut 31 is threaded on the lower portion of the section 24 and engages upwardly against the lower end of the lowermost ring 27 to clamp the superimposed rings 27 together in place on the plunger. A lock nut 32 may be threaded on the section 24 to engage against and lock the nut 31 in place.

It is to be observed that the sealing rings 27 materially increase the wall thickness of the upper portion of the plunger 12 and materially add to the stiffness or rigidity of the plunger. Owing to the fact that the rings 27 may have only very slight clearance with the internal surface of the barrel section 15 the sealing zone A and, therefore, the upper section 24 may be much shorter than if a loose fitted plunger tube section is depended upon to effect the necessary seal at the zone A. Thus the employment of the sealing rings 27 or their equivalent permits the employment of a shorter barrel and plunger. The hard sealing rings 27 relatively closely fitted in the barrel section 15 materially lessen the slip or leakage of fluid through the sealing zone A to increase the efficiency of the pump and the sealing rings 27 may operate as grinders to reduce the size of any sand particles or metal particles that may settle from the liquid in the tubing T and enter between the barrel 10 and the plunger 12.

The lower section 25 of the plunger 12 is pref-

erably a simple length of tubing shiftably fitting in the lower section 16 of the barrel 10 whereby the sliding cooperation between the barrel section 16 and the plunger section 25 provide the lower sealing zone B. The plunger section 25 may be of substantial length to have a long or extensive sealing cooperation with the interior of the lower barrel section 16. However, the section 25 is not of excessive length and the opposing surfaces of the barrel section 16 and the plunger section 25 may have only slight suitable tolerance or clearance to be effective in providing a dependable seal. It is to be observed that the external diameter of the lower plunger section 25 is considerably smaller than the external diameter of the sealing rings 27 on the upper section 24. Thus the plunger 12 has two effective outside diameters.

The two diameter construction of both the barrel 10 and the plunger 12, whereby there are two vertically spaced sealing zones A and B, provides the annular fluid space or chamber C between the two sealing zones. The chamber C is defined by the upper section 15 of the barrel 10, the lower section 16 of the plunger 12 and the two vertically spaced sealing zones A and B. Considered in another light the chamber C is defined by the spaced telescoped sections 15 and 25, the upper end of the lower barrel section 16 and the lower end of the lock nut 32 or the lower end of the lowermost packing ring 27. The width or transverse dimension of the chamber C is substantially equal to the difference in the effective diameters of the sealing rings 27 and the plunger section 25. The length of the chamber C constantly changes during the operation of the pump.

In accordance with the invention the chamber C is maintained in communication with the interior of the tubular reciprocating plunger 12. The plunger 12 is ported to maintain the chamber C in communication with its interior throughout the entire stroke or movement of the plunger. In the particular construction illustrated in the drawing the adapter 26 has a plurality of ports 33 connecting the chamber C with the interior of the plunger. There may be a plurality of circumferentially spaced ports 33 and the ports 33 are staggered or vertically spaced with certain of the ports immediately below the lower end of the lock nut 32 so that the chamber C remains in communication with the interior of the plunger 12 when the plunger reaches the lower end of its down stroke. The purpose of this arrangement and the function of the chamber C will be subsequently described.

The valve 13 is a traveling valve on the lower end of the plunger 12 while the valve 14 is a traveling valve at the upper end of the plunger. The valve 13 may be a typical ball valve including a tubular cage 35 threadedly connected with the lower end of the plunger section 25. An upwardly facing replaceable valve seat 36 is provided in the cage 35 and a ball 37 in the cage is adapted to seal downwardly on the seat 36 to control or prevent a down flow through the plunger. The valve 14 may comprise a suitable cage 38 threaded on the upper end of the member 30. The interior of the valve cage 38 is adapted to communicate with the interior of the plunger 12 and is ported to communicate with the interior of the barrel 10 and the tubing T. The cage 38 clamps a replaceable valve seat 39 against the upper end of the member 30 and a ball 40 is provided in the cage 38 to seal downwardly against the seat 39. The valve cage 38 may serve to connect the plunger 12 with the pump rod R. In the construction illustrated a pin 41 is provided on the upper end of the cage 38 and is threaded into a socket 42 in the lower end of the rod R to connect the cage and the plunger 12 with the rod. The valve cage 38 preferably has a shoulder 44 adapted to engage upwardly against the shoulder 20 to transmit upward movement to the barrel 10 when the rod R is raised to remove the pump from the well. It is to be noted that the valves 13 and 14 in addition to performing the usual functions of inlet and lifting valves, respectively, operate as inlet and discharge valves, respectively, for the chamber C.

In operation when the plunger 12 is moving upwardly the valve 14 is closed whereby the plunger lifts the column of fluid in the tubing T. The standing valve 11 opens during upward movement of the plunger 12 to admit fluid from the well to the interior of the barrel 10 between the valve 11 and the valve 13 which portion of the barrel increases in volume with the upward movement of the plunger. In actual practice the motion of the plunger 12 at the start of its upward stroke is quite slow and the increase in volume within the pump barrel 10 and within the annular chamber C is small. There is a certain amount of leakage of fluid past the sealing zones A and B and during the initial portion of the upward movement of the plunger 12 this leakage will be at a rate greater than the increase in volume of the annular chamber C. The excess liquid thus admitted to the chamber C cannot escape upwardly past the valve 14 and cannot escape to the interior of the plunger 12 which is already full of fluid and, therefore, tends to increase the pressure at the ports 33 and within the plunger between the valves 13 and 14. This increase in pressure within the plunger 12 serves to close the lower traveling valve 13 and the excess fluid admitted to the chamber C due to leakage past the sealing zone A leaks through the sealing zone B to the main pump chamber of the barrel 10 below the valve 13. At this time both the sealing zones A and B are in operation and the leakage fluid entering past the zone A supplies sufficient fluid to keep the annular chamber C filled during the slow motion period of the plunger. As the plunger 12 approaches its mid-stroke position the annular chamber C increases in volume at a greater rate of leakage of fluid past the sealing zone A resulting in a marked reduction of the pressure in the chamber C and the interior of the plunger 12 between the valves 12 and 14. This reduction in pressure causes the lower traveling valve 13 to open and admit fluid from the well to keep the interior of the plunger 12 and the chamber C filled. This gives an increased economy. As the plunger 12 moves upwardly from its mid-stroke position toward the upper end of its stroke the rate of increase of the volume of the chamber C decreases until the leakage of fluid past the upper sealing zone A is again sufficient to keep the chamber filled and the lower sealing zone B again comes into operation and remains in operation until the upward stroke is ended.

During the downward stroke of the plunger 12 the valve 11 is closed and the pump plunger settles downwardly through the liquid trapped below it. During the downward movement of the plunger the chamber C decreases in volume. This decrease in volume of the chamber C re-

sults in the displacement of fluid from the chamber C through the ports 33 into the interior of the plunger 12. The fluid thus discharged into the chamber within the plunger 12 causes opening of the valve 14 and an upward flow of fluid through the valve. Accordingly, the pump is double acting serving to lift the column of fluid in the tubing T during the up stroke of the plunger 12 and causing an upward displacement of fluid from the chamber C into the tubing T during the down stroke of the plunger. The substantially continuous discharge thus provided prevents the undesirable accumulation of sand and silt at the upper end of the barrel 10 and around the top lock. The displacement of fluid from the chamber C continues throughout the down stroke of the plunger assuring a complete discharge or evacuation of all fluid from the chamber. The uppermost ports 33 remain in communication with the chamber C to the end of the down stroke of the plunger 12 to assure the complete displacement of fluid from the chamber. Accordingly, any sand or silt that may have entered the chamber C past the sealing zone A is discharged into the plunger 12 to be removed with the main body of fluid. This displacement of the sand and silt from the chamber C prevents the sand and silt from reaching the sealing zone B so that the said sealing zone is long wearing.

Considering the improved pump of the present invention just described, particularly with relation to the functioning of its parts, it will be observed that the pump comprises three elements, namely, the primary seal zone A through which the slippage or leakage must originate, the annular space or chamber C in which the silt from the primary seal or zone A is received and which is ported to be cleaned or washed during each stroke of the plunger 11 and the secondary seal or sealing zone B below the chamber C. As described above the sealing zone B acts during the dwell and slow motion periods at the ends of the plunger stroke, the extent or time of such action depending on the volume of the annular chamber C, because if the rate of increase in the volume of the chamber C during the stroke is always less than the natural slippage or leakage past both the sealing zones A and B then the secondary or lower sealing zone B will never be out of action. However, this reduction in the volume of the chamber C also reduces the volume of the cleansing flow through the chamber during the up stroke of the plunger 11 and it becomes desirable to increase this flow either by a natural washing action past the ports of the chamber C as the plunger drops through the fluid on its downward stroke, or by the employment of a Venturi type passage in the plunger at the inner ends of the chamber ports, producing a more positive washing action during the down stroke of the plunger.

In actual practice the volume of the chamber C will probably be determined by the tube sizes which the manufacturer has in stock, and in the case of the usual pump speeds the chamber C formed as described above will have a substantial volume by reason of the difference in the diameters of the barrel and plunger and will give very satisfactory results. However, where low pump speeds are desirable it is preferred to make the chamber C of smaller volume. To accomplish this the cylinder diameter may be reduced, as desired, until finally the effective diameters of both the sealing zones of the pump are equal, in which case the silt trapping chamber will be wholly within the confines of the plunger and will have its outer side or periphery closed by the surrounding barrel. In such a structure where the silt receiving chamber is wholly within the confines of the plunger the pump embodies the same principal elements, as the pump described above, namely, the barrel and plunger providing the vertically spaced primary and secondary sealing zones, the annular chamber between the zones for receiving the silt from the primary sealing zone, the vents for the annular chamber, and the valves on the plunger above and below the vents.

My co-pending application, Serial No. 231,878, filed as a continuation in part of the present application, describes and claims a well pump of the character referred to in the foregoing paragraph, that is, a well pump in which the barrel and plunger are both of uniform diameter and a chamber is provided in the periphery of the plunger to temporarily receive the solid matter for removal by the fluid flow.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A well pump comprising, a barrel having its upper portion of greater diameter than its lower portion, a standing valve at the lower end of the barrel, a tubular plunger reciprocable in the barrel and having its upper portion of greater diameter than its lower portion, the respective upper and lower portions of the barrel and plunger having sealing cooperation whereby the barrel and plunger enclose an annular chamber between the zones of said sealing cooperation, the plunger having a port connecting said chamber with the interior of the plunger, and traveling valves carried by the plunger above and below said port.

2. A well pump comprising a barrel having an upper portion and a lower portion of less internal diameter than the upper portion, a tubular plunger in the barrel having an upper portion in sealing relation to the upper portion of the barrel and having a lower portion of less external diameter in sealing relation to the said lower portion of the barrel, the barrel and plunger defining an annular fluid chamber between their zones of sealing cooperation, the plunger having a port placing said chamber in communication with the interior of the plunger, a standing valve for the lower end of the barrel, and downwardly closing traveling valves carried by the plunger at opposite sides of said port.

3. A well pump for use on a well tubing comprising a barrel having an upper portion and a lower portion of less internal diameter than the upper portion, a reciprocable tubular plunger in the barrel having an upper portion and a lower portion of less external diameter than its upper portion, the barrel and plunger defining an annular chamber with their upper and lower portions in sealing cooperation at the upper and lower ends of the said chamber, the plunger having a port maintaining the chamber in communication with the interior of the plunger, a standing valve for the lower end of the barrel, traveling valves on the plunger above and below said port, and means suspending the upper end of the barrel from the tubing.

4. A well pump for use on a well tubing comprising a barrel, the upper portion of the barrel being of greater diameter than the lower portion

of the barrel, means removably suspending the upper end portion of the barrel from the tubing, a tubular plunger reciprocable in the barrel and having its upper portion of greater diameter than its lower portion, the barrel and plunger enclosing an annular fluid displacement chamber, the barrel and plunger having effective metallic sealing cooperation throughout vertically elongated zones above and below said chamber, the plunger having a port maintaining the upper end of the chamber in communication with the interior of the plunger, a standing valve at the lower end of the barrel, and traveling valves on the plunger above and below said port.

5. A well pump for use on a well tubing comprising a barrel, means removably suspending the upper end of the barrel from the tubing, a tubular plunger reciprocable in the barrel, the upper portions of the barrel and plunger being of greater diameter than the lower portions of the barrel and plunger whereby the barrel and plunger enclose an annular fluid chamber, the barrel and plunger having sliding sealing cooperation below said chamber metal to metal, sealing means providing long effective sealing cooperation between the plunger and barrel above said chamber with slight tolerance, the plunger having a port below and adjacent to said sealing means placing the upper end of said chamber in communication with the interior of the plunger, a standing valve at the lower end of the barrel, and traveling valves on the plunger above and below said port.

6. A well pump comprising a standing barrel including an upper tube and a lower tube of less internal diameter than the upper tube detachably connected with the upper tube, a standing valve on the lower end of the barrel, a tubular plunger reciprocable in the barrel including an upper section in sliding sealing relation to the upper tube of the barrel, and a tube of less external diameter than the said upper section and detachably secured to said upper section, the tube of the plunger having a sealing sliding fit in the lower tube of the barrel, the barrel and plunger defining an annular chamber spacing the zone of sealing cooperation of the upper plunger section and upper tube of the barrel from the zone of sealing cooperation of the said lower tube of the barrel and the tube of the plunger, the plunger having a port maintaining the chamber in communication with the interior of the plunger, and traveling valves on the plunger above and below said port.

7. A well pump comprising a standing barrel including, an upper tube and a lower tube of less internal diameter than the upper tube detachably connected with the upper tube, a standing valve on the lower end of the barrel, a tubular plunger reciprocable in the barrel including an upper section, sealing means on said upper section in sliding sealing relation to the upper tube of the barrel, and a tube of less external diameter than the said upper section and detachably secured to said upper section, the tube of the plunger having a sealing sliding fit in the lower tube of the barrel, the barrel and plunger defining an annular chamber spacing the zone of sealing cooperation of the said sealing means and upper tube of the barrel from the zone of sealing cooperation of the said lower tube of the barrel and the tube of the plunger, the plunger having a port maintaining the chamber in communication with the interior of the plunger, and traveling valves on the plunger above and below said port.

8. A well pump comprising a standing barrel including an upper tube and a lower tube of less internal diameter than the upper tube detachably connected with the upper tube, a standing valve on the lower end of the barrel, a tubular plunger reciprocable in the barrel including an upper tube section, sealing rings on the upper tube section in sliding sealing relation to the upper tube of the barrel, and a tube of less external diameter than the said upper section and detachably secured to said upper section, the tube of the plunger having a sliding sealing fit in the lower tube of the barrel, the barrel and plunger defining an annular chamber spacing the zone of sealing cooperation of the said sealing rings and upper tube of the barrel from the zone of sealing cooperation of the said lower tube of the barrel and the tube of the plunger, the plunger having a port maintaining the chamber in communication with the interior of the plunger, and traveling valves on the plunger above and below said port.

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