April 5, 1966 H. W. PARKIN 3,244,112

PUMPING APPARATUS

Filed Jan. 23, 1964 2 Sheets-Sheet 1

Fig. 1.

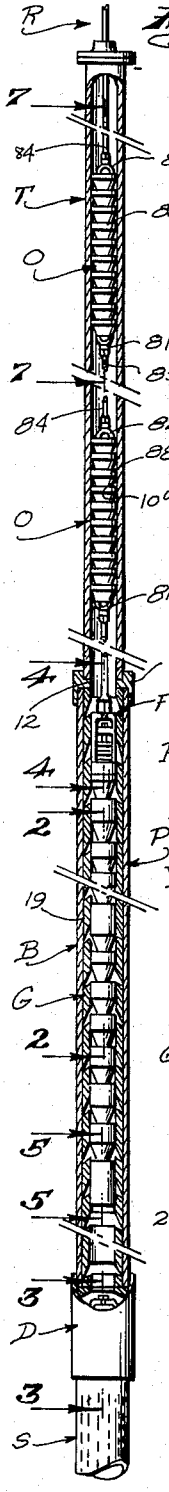


Fig. 2.

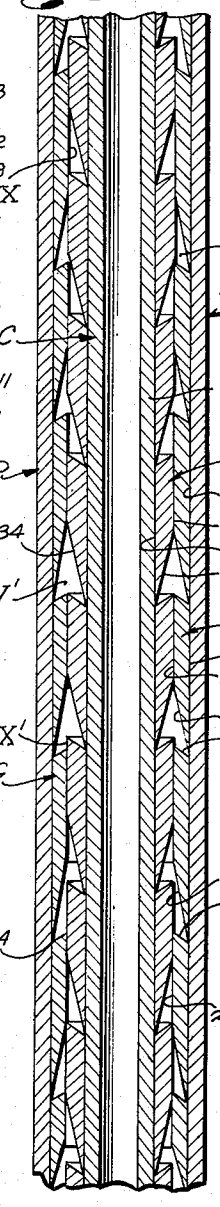


Fig. 3.

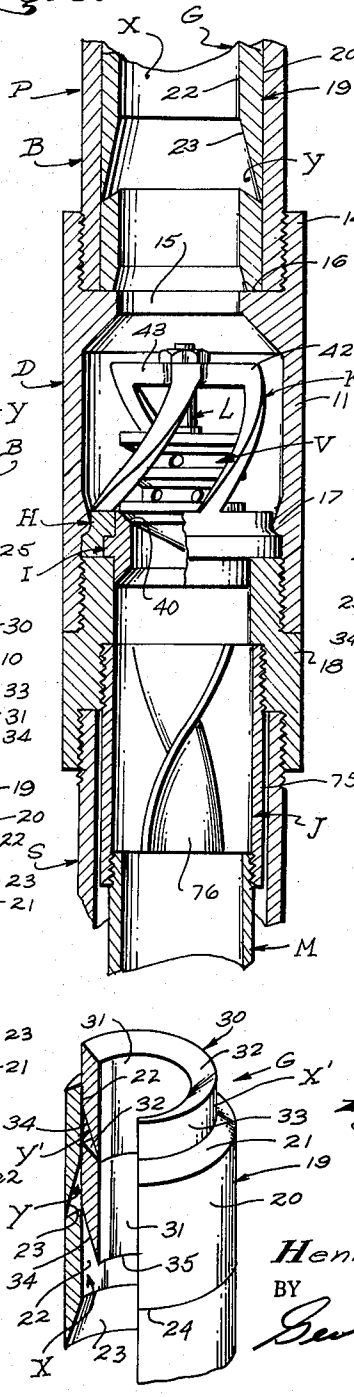


Fig. 4.

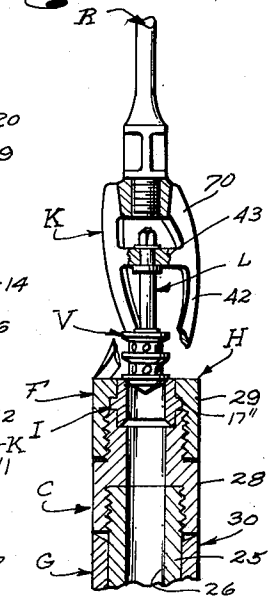


Fig. 5.

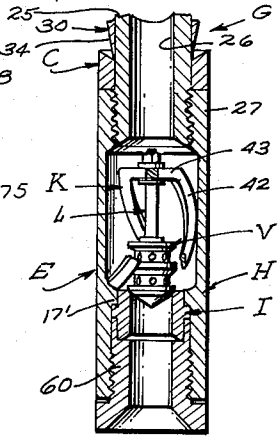


Fig. 6.

INVENTOR.
Henry W. Parkin
BY
George A. Strauch Jr.

April 5, 1966 H. W. PARKIN 3,244,112

PUMPING APPARATUS

Filed Jan. 23, 1964 2 Sheets-Sheet 2

Fig. 7.

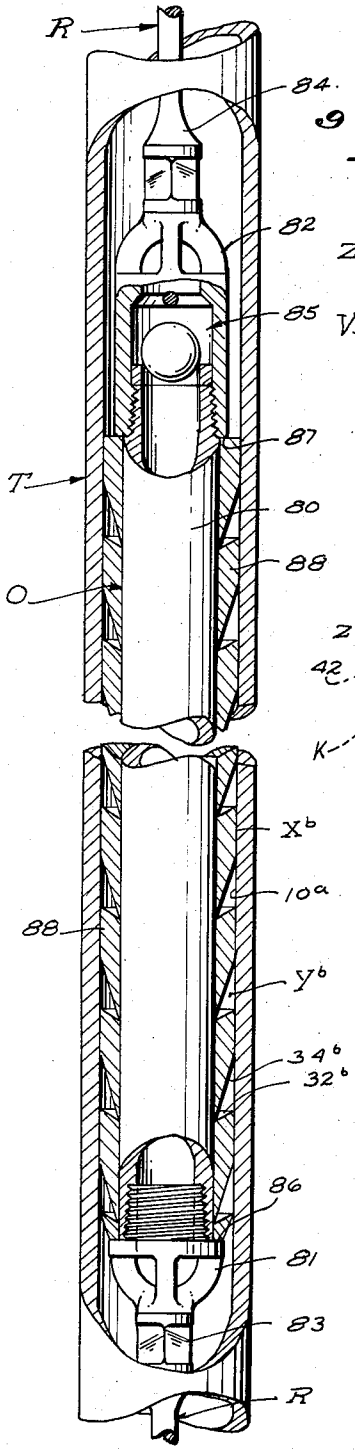


Fig. 8.

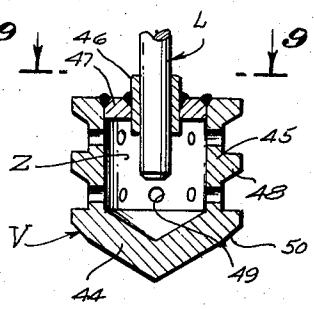


Fig. 9.

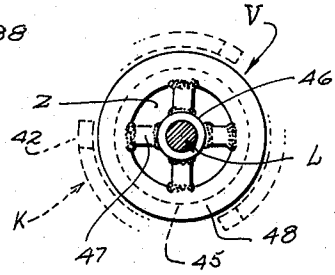


Fig. 10.

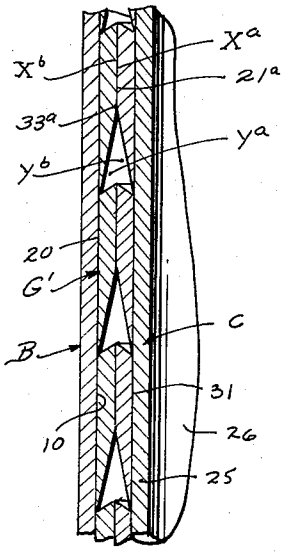
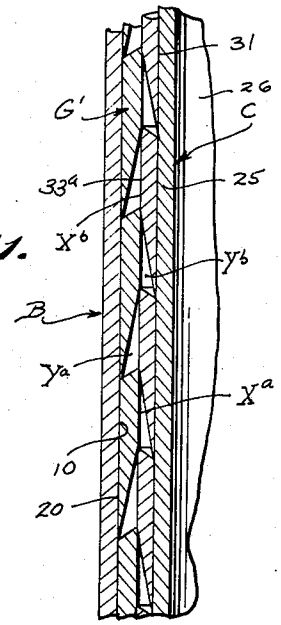


Fig. 11.



INVENTOR.

Henry W. Parkin

BY

George A. Inskeep

United States Patent Office 3,244,112 Patented Apr. 5, 1966

3,244,112

PUMPING APPARATUS

Henry W. Parkin, Los Angeles, Calif., assignor of one-half to Rudolph W. Wedderien, Monterey Park, Calif., and one-half jointly to Alexander J. Harris and Henry W. Parkin

Filed Jan. 23, 1964, Ser. No. 339,757
12 Claims. (Cl. 103—179)

This invention relates to a deep well, multiple stage, pumping apparatus for pumping deep oil wells and the like, where the fluids are highly contaminated or ladened with sand and other abrasive materials generally found in oil well fluids.

The present invention has to do with certain improvements in the pump construction disclosed in my Patent No. 1,896,719, issued February 7, 1933, and entitled Pump Barrel and Plunger.

There exists many oil wells which cannot be advantageously put into or maintained in production due to the presence of sand and the like in the production zone. In these wells, sand and foreign matter settles and packs in the pumps, rendering them inoperative, or abrades and so rapidly wears the relatively moving parts of the pumps that it is economically impractical to keep and maintain the wells producing.

Effords have been made to establish well pumps that will move oil ladened with sand or the like, which will mat sand or pack up, that is, become packed and rendered inoperative by the sand or foreign material and without wearing out rapidly as a result of the abrasive nature of the sand or said foreign material being handled.

One of the problems to be overcome in such constructions is to provide a seal between the pump barrel and plunger of a reciprocating well pump which is such that the sand and foreign material being handled will not act upon the mating or sealing surfaces of the barrel and plunger in such a manner as to abrade and wear away such mating or sealing surfaces; and a seal which is such that it will not readily become packed with sand and the like and rendered useless.

A most satisfactory and serviceable seal for the above purpose, is a fluid seal wherein the fluid being pumped is utilized as a sealing medium. Such a seal is disclosed in the above identified patent and includes a plurality of vertically spaced radially inwardly opening annular grooves in the pump barrel, each having a horizontally disposed bottom wall and an upwardly and radially inclined side wall; a plurality of vertically spaced radially outwardly opening annular grooves in the plunger, opposing the grooves in the barrel and having horizontally disposed bottom and radially upwardly and outwardly inclined side walls. The grooves in the barrel and the plunger are equal in vertical extent and the bottom walls converge with the said side walls of adjacent grooves. Sufficient clearance is provided between the major diameter of the plunger and the minor diameter of the barrel to freely accommodate or pass the sand carried by the oil being handled or pumped.

The several grooves in the above-noted structure were shaped and arranged so as to impede the downward flow of fluid or oil between the barrel and the plunger and to induce an upward flow of oil therebetween, upon normal relative movement or reciprocation of the plunger in the barrel.

While the above-noted structure did not "sand up" and did not wear, the seal established thereby was not sufficiently effective so as to render the construction practical. It has been determined that the failure of the above-noted structure to operate efficiently resided in the fact that as the grooves in the barrel moved by the grooves about the plunger, an open, somewhat zig-zag

flow passage was established, through which passage the fluid or oil being handled was free to flow. This defeated the intended sealing and flow inducing effect and rendered the construction ineffective.

Further, since the several grooves in the above-noted construction were only effective to establish a seal intermittently during the operation of the construction, a pulsating or hammering effect was established during the operation of the construction, which created manifold adverse effects.

Another short coming in the above-noted patented structure resided in the fact that the grooves tended to catch and load up or pack with sand and the like, rendering the entire construction ineffective and useless.

An object of my invention is to provide an improved fluid-type seal between the plunger and barrel of a deep well pump which seal is effective under high operating pressures to induce flow of production fluid upwardly between the barrel and the plunger, when the construction is in operation. More particularly, it is an object of my invention to provide a means on the working surface of the plunger and the working surface of the barrel of a reciprocating deep well pump which is such that when the plunger is reciprocated in the barrel, the working surfaces of the plunger and barrel will produce fluid, or sand in fluid, by conveying anything that enters or gets between the plunger and the barrel to the top of the barrel. This provides a fluid seal, when in operation, by broaching the fluid into a series of fluid rings about the plunger and the barrel working surfaces when the plunger is going up on the production stroke, this being accomplished by the provision of angular cup-shaped sleeves on the plunger; and, when the plunger is going down, by the provision of angular cup-shaped sleeves or liners in the barrel which broach the fluid into a series of fluid rings between the barrel and the plunger.

This broach construction of the plunger and barrel makes a fluid seal tight enough to pump against any amount of pressure that may be required in oil wells, with annulus of 1/8" to 1/16" between the plunger and the barrel.

Another object of this invention is to provide means whereby the plunger can be arranged within the working barrel with a great amount of tolerance, so the plunger will be free to drop in oil affiliated with large amounts of sand; also, a means on the plunger and barrel to form a tight fluid seal that will pump water or oil against any high pressure encountered in oil wells of any depth or condition of fluid that may be contaminated with a high percentage of sand, and to keep itself clean and in an effective operating and productive condition.

It is a feature of my invention to provide a plunger and barrel construction of the general character referred to involving a plurality of axially spaced longitudinally staggered, opposing grooves in the barrel and plunger of a pump, which grooves are such that at no time during relative travel between the barrel and the plunger is open communication established between adjacent grooves in the barrel or adjacent grooves in the plunger.

Another feature of my invention is to provide a structure of the character referred to wherein the grooves established by the rings in and about the barrel and the plunger are V-shaped and are provided with upwardly inclined bottom walls, which walls establish annular catch basins and which serve to scoop the fluid being handled in such a manner as to establish a turbulence which cleans said basins and prevents settling and packing of sand and foreign material in the construction.

Another problem which is present in establishing deep well pumps that will advantageously handle sand ladened

oil is the provision of valving means which will not become packed with sand and which will not become cut or worn in an uneven manner and rendered ineffective.

An object of the present invention is to provide an improved self-grinding, self-cleaning and positive seating valve construction.

Still another object of my invention is to provide a valve construction of the character referred to having novel flushing means to prevent sand from packing and settling in and about the valve construction.

A feature of my invention is to provide a spiral cage about the valving member of the several valves employed in my new pump construction and/or the provision of a vein at the inlet side of the valve construction, whereby the fluid flowing through the valves and the pump construction is caused to rotate and thereby impart rotary motion to the valve member when said valve member is acted upon by the rotating fluid.

It is an object of my invention to provide a deep well multiple-stage pump or pumping apparatus for pumping fluids and oil from oil wells highly affiliated or ladened with sand and other foreign material generally found in oil wells and the like.

A further object is to provide a means to keep the fluid in constant agitation, velocity or movement, from the time it enters the standing valve of the pump until it reaches the top of the well, at a velocity equal to the speed of the plunger that moves the fluid; this agitation keeps the sand or foreign matter in the fluid suspended and prevents the sand and/or foreign matter from separating or settling out of the fluid and sanding up the valves or plunger and thereby shutting off production.

Another object is the provision of means for keeping the fluid moving at a high velocity so that any sand or foreign matter will not have a chance to accumulate over the top of the working barrel and the plunger. This is accomplished by placing another working barrel and plunger at any desired distance above the main working barrel and plunger, operated by the same string of rods that operates the main plunger in the bottom of main working barrel, this will act as a second stage. In order to keep the sand from settling out of the fluid when pumping fluid with excessive sand, it has been determined by experience that a second stage should be installed about a 100–300 feet above the main working barrel; and, another stage would be installed on an average of 300–500 feet throughout the remaining distance. The distance between the upper stages is related and determined by the amount of sand being produced with the fluid.

It is an object of my invention to provide a pump construction of the character referred to that is easy and economical to manufacture and a construction which is highly effective and dependable in operation.

Another object is the provision of an apparatus of the character referred to that can be advantageously installed in any oil well now equipped with conventional sucker rod and tubing without any extra expense of alteration, using the same sucker rods and tubing.

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 my invention, throughout which description reference is made to the accompanying drawings, in which:

FIGURE 1 is a diagrammatic sectional view of my new pumping apparatus;

FIGURE 2 is an enlarged detailed sectional view taken as indicated by line **2—2** on FIGURE 1;

FIGURE 3 is an enlarged detailed sectional view taken as indicated by line **3—3** on FIGURE 1;

FIGURE 4 is an enlarged detailed sectional view taken as indicated by line **4—4** on FIGURE 1;

FIGURE 5 is an enlarged detailed sectional view taken as indicated by line **5—5** on FIGURE 1;

FIGURE 6 is an isometric view of certain parts of my new construction;

FIGURE 7 is an enlarged detailed sectional view taken as indicated by line 7—7 on FIGURE 1;

FIGURE 8 is an enlarged detailed sectional view of my new valve member;

FIGURE 9 is a view taken as indicated by line **9—9** on FIGURE 8;

FIGURE 10 is a view similar to a portion of the structure shown in FIGURE 2 and showing another form of my invention;

FIGURE 11 is a view similar to FIGURE 10, and showing the parts in a different position.

The present invention has to do with a novel pumping apparatus, which apparatus includes a novel pump construction P engageable on the lower end of a string of production tubing T extending into a well and operated by a string of sucker rod S extending through said tubing; and a plurality of vertically-spaced fluid conveyors O arranged in the string of sucker rod and cooperating with the production tubing T to convey production fluid upwardly through said tubing.

The pump construction P that I provide includes generally, an elongate tubular barrel B engageable on the lower end of the string of production tubing T. A suitable tubular screen S is shown fixed to and depending from the lower end of the pump P. The tubing T with the pump barrel B and screen S is adapted to be arranged in an oil well structure (not shown) to extend from the top of the well to the bottom thereof, or into the oil producing formation.

My pump construction P further includes a standing valve D arranged at the lower end of the barrel B and an elongate vertically disposed tubular plunger C arranged within the barrel above the standing valve D. A bottom or foot valve E is provided at the lower end of the plunger C and a top or traveling valve F is provided at the upper end of the plunger C. The plunger C is fixed to the lower end of the string of sucker rod R, extending through the production tubing T into the pump barrel B and is operatively coupled or connected with a suitable jack mechanism at the top of the well (not shown) to effect reciprocation of the sucker rod and of the plunger.

My new pump construction P further includes a novel combination flow inducing and sealing means G related to the barrel B and the plunger C.

The barrel B is a simple elongate vertically disposed length of tubing having a straight or cylindrical bore **10** and is externally threaded at its upper and lower ends. A coupling member or collar **11** is threadedly engaged on the upper end of the barrel B and establishes threaded engagement with the bore end of the production tubing T. The collar **11** is provided with a central radially inwardly projecting stop flange **12** which flange provides a seat for the adjacent ends of the barrel and the tubing T and projects radially inwardly from the bore **10** of the barrel to establish a downwardly-disposed stop shoulder.

A tubular valve case **14** for the standing valve D is threadedly engaged on the lower end of the barrel B and like the collar **11**, is provided with a radially inwardly projecting flange **15** that defines an upwardly-disposed stop shoulder **16** at the lower end of the barrel.

The lower end portion of the case **14** is provided with a radially inwardly projecting annular shoulder **17** upon which an element of the valve means seats and seals, as will hereinafter be described.

The lower end of the case **14**, below the shoulder **17**, is internally threaded and receives a male-female bushing **18** which bushing serves to hold the valve means engaged on the shoulder **17** as will hereinafter be described, and also serves to receive and connect with the upper end of a screen S and with the upper end of a fluid circulating means J and/or gas anchor K, as clearly illustrated in FIGURE 3 of the drawings.

In addition to the foregoing, the barrel B further includes a plurality of axially aligned rings **19** slidably engaged in the bore **10**, in stacked relationship, between the stop shoulders **13** and **16**. Each ring **19** has a straight cylindrical outer surface or wall **20** to slidably engage the bore **10**, a radially inwardly and upwardly inclined top wall **21** and an inner wall having a straight cylindrical upper portion **22** and a downwardly and radially outwardly inclined lower portion **23**. The upper portions **22** of the several rings **19** are, in the preferred carrying out of the invention, of unequal and varying longitudinal or vertical extent.

The top walls **21** and bottom ends **24** are pitched or inclined at from 15° to 30° and when the rings are stacked, the opposing top walls and bottom ends of adjacent rings establish uniform bearings and seated engagement with each other.

The several rings **19** cooperate to establish a vertically spaced, straight, cylindrical sealing surfaces X and intermediate, radially inwardly opening, substantially V-shaped annular grooves Y.

The surfaces X and grooves Y in the barrel establish a part of the sealing and flow inducing means G, as will hereinafter be described.

The plunger P is an elongate, vertically disposed structure having a tubular core **25** defining a central longitudinal flow passage **26**. The lower end of the core **25** is threadedly engaged in the upper end of an annular or tubular body **27** of the valve E, as will hereinafter be described. The upper end of the core **25** is threadedly engaged in an annular coupling **28**, which coupling is threadedly engaged in the body **29** of the working valve F, which valve is connected with the lower end of the sucker rod string R, as will hereinafter be described. The plunger P further includes a plurality of axially aligned rings **30** slidably engaged about the core **25** in stacked relationship between the valve body **27** and coupling **28**. Each ring **30** has a straight cylindrical inner surface or wall **31** to slidably engage about the core **25**, a radially outwardly and upwardly-inclined top wall **32** and an outer wall having a straight cylindrical upper portion **33** and a downwardly and radially inwardly-inclined lower portion **34**. The lower portions **34** of the inner walls of the several rings are of equal longitudinal extent while the upper portions **33** of the said inner walls are of varying longitudinal extent.

The top walls **32** are pitched or inclined at from 15–30° and when the rings are stacked, the opposing top walls **32** and bottom ends **35** of adjacent rings establish uniform bearing and seated engagement with each other.

The several rings **30** cooperate to establish a plurality of vertically spaced, straight, cylindrical sealing surfaces X′ and intermediate, radially outwardly opening V-shaped annular grooves Y′.

From the foregoing, it will be apparent that the plunger C is shifted axially within the barrel B and that when thus shifted, the several sealing surfaces X′ and the several grooves Y′, shift into and out of register with opposing sealing surfaces X and grooves Y in the barrel B.

Sufficient working clearance is provided between the opposing surfaces X and X′ to accommodate a body of sealing (well) fluid and to freely receive or accommodate sand and the like carried by a fluid.

In practice, the particle size of the sand and/or foreign matter carried by the production fluid can be readily determined. Accordingly, the tolerance between the sealing surfaces X and X′ can be varied as circumstances require and so as to maintain the said tolerance at a minimum.

In operation, the annulus between the plunger and barrel and defined by the opposing sealing surfaces X and X′ and the opposing recesses Y and Y′, are filled with well fluid. The fluid tends to flow downwardly in the annulus and into the recesses. However, the rate of such flow is restricted by the friction loss and/or beaning down effect established by the closely related opposing surfaces X and X′. Such tendency for the fluid to flow down is further impeded by the vertically spaced top walls or surfaces **21** and **32** of the rings **19** and **30**, which surfaces, being pitched or inclined upwardly and inwardly toward the annulus between the barrel and the plunger, tend to catch or scoop downwardly flowing fluid, directing said fluid radially outwardly and inwardly into the recesses Y and Y′, whereupon it is directed by and flows upwardly along the related side walls **23** and **34** of the rings, defining the recesses Y and Y′. Such upward flow, commingling with the downward flow creates a turbulence in the recesses Y and Y′ that interferes with and effectively impedes the downward flow of fluid.

It is to be noted that the inclined top surfaces of the rings which establish the bottoms of the recesses Y and Y′ create annular catch basins in the barrel and about the plunger, which basins tend to catch and hold a volume of fluid. Further, the scooping effect afforded by the top walls or inclined surfaces **21** and **32** serve to maintain such circulation in the annular basins as to effectively prevent the settling out and/or packing of sand therein.

When the plunger C is moved upwardly relative to the barrel B, the fluid in the recesses Y′ and between the surfaces X and X′ is forced upwardly, the recesses Y of the barrel B with their upwardly inclined surfaces **21** affording little or no resistance to such upward movement of fluid. Thus, a conveying or pumping action is established which induces an upward flow of fluid between the barrel and the plunger.

Upon downward movement of the plunger C, the inclined or pitched nature of the top walls **32** and the lower portions **34** of the outer walls of the rings **30**, defining the recesses Y′, afford little or no scooping effect and tend to leave the fluid in the recesses Y′ up, in the annulus, between the plunger and barrel, while the top walls **21** of the rings **17** in the barrel B, tend to catch and stop downwardly flowing fluid and hold it up in the annulus and in the recesses Y. The wiping and/or flow inducing effect created by the surfaces X and X′ upon the upward stroke of the plunger C, while present upon the downward stroke of the plunger C prevented or checked by the standing valve D, which is closed and is further impeded by the top walls **21** of the rings **19** and, by the above-noted flow impeding turbulence established in the chambers Y and Y′. As a result, downward flow is prevented and an upward flow is induced by the displacement effect afforded by the plunger as it is lowered into the fluid in the barrel above the valve D.

As pointed out above, the surfaces **22** and **33** of adjacent rings **19** and **30** are of different and varying longitudinal or axial extent. As a result of this relationship of parts, at no time are all of the recesses Y and Y′ in or out of register with each other, or in or out of communication with each other; but rather, a limited number of recesses Y and Y′ are in register with each other, a limited number of said recesses are out of register with each other and the remainder of said recesses are moving into or out of register with each other, and are in communication with each other to varying degrees at all times during operation of the construction.

Since a maximum seal is established when the recesses Y and Y′ are not in register and a minimum seal is established when said recesses are in register, varying the longitudinal extent of the surfaces **22** and **33** so as to obtain the above-noted staggered relationship of the recesses, a most effective seal is established and maintained at all times, during the operation of the construction.

In FIGURES 10 and 11 of the drawings, I have illustrated a modified form of the invention wherein the

longitudinal extent of the recesses Ya and Yb and the surfaces 21a and 33a or surfaces Xa and Xb, are all equal. In this form of the invention, the several recesses shift into and out of register with each other simultaneously as the pump is operated. Wtih this construction a pulsation or tendency for the construction to hammer may be encountered. However, since at no time is communication established between adjacent recesses Ya and Yb, an effective seal and pumping action is established.

It will be apparent that in addition to inducing an upward flow of fluid between the plunger and barrel, the rings 19 and 30, in establishing the spaced opposing surfaces X and X' and the annulus therebetween, establish and maintain a fluid bearing between the plunger and barrel, which bearing provides for a freely working construction, subject to a minimum amount of wear and a free dropping of the plunger C in the barrel B, upon the downward stroke of the pump.

Still further, the recesses Y and Y', related to the surfaces X and X', cooperate to the prevent downward flow of fluid between the barrel and the plunger and thereby establish what is, in effect, a fluid seal between said plunger and barrel, which seal takes the place of the mechanical seal or seals associated with conventional deep well pump constructions.

The several valve means provided by the present invention, that is, the standing valve D, lower or foot valve E and top or traveling valve F, are all similar in nature, there being certain minor structural variations between each to adapt it to incorporation in the pump construction.

Each of the above-noted valves includes an annular body H, an annular seat insert I, having an annular upwardly and radially outwardly inclined seating surface 40 carried by the body, an open cage K having circumferentially spaced helically extending or pitched legs 42 projecting upwardly from the body and an upper spider 43 connected with and extending between the upper ends of the legs 42 and overlying the body in spaced relationship thereabove, a vertical stem L fixed to and depending from the spider into the confines of the cage and in axial alignment with the insert I, and a cylindrical valve member V slidably engaged on the stem L, within the cage K and engageable with the insert I.

The valve member V (see FIGURES 8 and 9) involves an elongate vertically disposed upwardly-opening, cup-like body having a downwardly convergent, conical bottom wall 44, an annular axially extending side wall 45, and cooperating with the bottom wall to define a chamber Z. A stem receiving bushing 46 is arranged and supported in the upper end of the body by means of suitable supports 47. The side wall 45 is provided with a plurality of vertically spaced radially outwardly projecting annular veins 48, and a plurality of circumferentially spaced, laterally outwardly opening ports 49, between the veins 48.

The bottom wall 44 of the valve member V is provided with an annular radially outwardly and upwardly inclined sealing surface 50 about its outer perimeter to cooperatively engage and seat on the surface 40 of the insert I.

In operation, each time the valve member V is urged upwardly, the upwardly flowing fluid, which is caused to flow in a circular manner by the pitched or helically extending legs 42 of the cage K, acts upon the veins 48, causing the member to raise and to rotate about the stem L, and relative to the insert I. This rotary action or turning of the valve member assures uniform wear between the seating surfaces of the valve and the insert and imparts a self-grinding effect therebetween.

Upon upward movement of the valve member and further, upon seating of the valve member, by virtue of the valve member moving upwardly in the production fluid and/or by virtue of the head of production fluid above the valve urging the valve member down, fluid in the chamber C is urged radially outwardly through the ports 48. The fluid thus urged outwardly through the ports in the valve member flushes the cage K and the surrounding structure and prevents the settling out and/or packing of sand and foreign material carried by the production fluid in and about the valve structure.

Since the particular details of the several valve constructions vary to a noticeable extent in the instant case and in practice can be varied in other details, I will not burden this specification with further detailed descriptions of each of the valve structures disclosed in the drawings, but will limit the following to setting forth, in general terms, the structural environment in which the basic elements of the several valves, as set forth above, are found.

In the case of the standing valve D, the annular body H is engaged and sealed on the shoulder 17 in the case 14 and is retained therein by the bushing 18. The cage K is formed integrally with the body and projects freely upwardly therefrom into the case 14.

The annular body H of the valve E is, as set forth above, threadedly engaged on the lower end of the plunger core 25. The cage K is in the nature of an insert, arranged in the body and can be suitably fixed therein as by welding. The seat insert I is slidably engaged in the body and stops against the lower end of a stop shoulder 17' and is retained therein by means of a suitable keeper 60, threadedly engaged in the lower end of the body.

The annular body H of the valve F, as set forth in the preceding, and as indicated by the numeral 29, is threadedly engaged on the coupler 28, which coupler is engaged on the upper end of the plunger core 25. The cage K is fixed to the top of the body to project upwardly therefrom and is provided with an extension 70 which extension connects with the lower end of the sucker rod string R. The body is provided with a downwardly disposed stop shoulder 17" against which the insert I seats. The insert I is slidably engaged in the body from its lower end to engage and seat against the shoulder 17" and is retained therein by the coupler 28.

The fluid circulating means J related to the bushing 18 at the lower end of the pump P and adjacent the lower inlet side of the valve D involves a short flow tube 75 threadedly engaged into the bushing to depend therefrom and into the screen S. The tube 75 is provided with a vane or vanes 76, extending longitudinally therethrough, which vane or vanes 76 serves to impart a vortex or circular flow into the fluid flowing upwardly into and through the valve D, thereby supplementing the action of the legs 42 of the valve cage K and assuring rotation of the valve member V in the manner set forth above.

In practice, a similar circulating means J, such as is related to the valve D, can be related to either or both of the valves E and F, if desired, or if circumstances require.

The fluid conveyors O, engaged in the sucker rod string R and disclosed in FIGURES 1 and 7 of the drawings, involve an elongate flow tube 80, an open cage-type coupler 81 threadedly engaged in the lower end of the flow tube 80 and connected with the upper end of the next lower stand of sucker rod 83 of the sucker rod string and an open cage-type coupler 82 threadedly engaged in the upper end of the flow tube 80, connected with the lower end of the next upper stand of sucker rod 84 of the sucker rod string, and carrying a suitable check valve 85, which check valve is operable to allow for upward flow of production fluid through the flow tube, only.

The couplers 81 and 82 are greater in diametric extent than the flow tube 80 and define opposing stop shoulders 86 and 87 at the opposite ends of the flow tube.

Arranged about the flow tube and between the shoulders 86 and 87 of the couplers, is a plurality of stacked annular rings 88, similar to the rings 30 engaged about the core 25 of the pump plunger C.

The rings 30 cooperate to define a plurality of straight, axially-spaced sealing surfaces Xb, to oppose the bore 10a of the tubing T, and a plurality of alternate or intermedi-

ate, radially outwardly opening, annular, V-shaped recesses *Yb*, having radially outwardly and upwardly-inclined bottom walls **32***b*, and radially outwardly and upwardly-inclined side walls **34***b*. The walls **32***b* and **34***b* cooperate to define upwardly disposed annular catch basins at the lower end of the several recesses *Yb*.

The sealing surfaces *Xb* of the conveyors O are spaced from the wall or bore **10***b* of the tubing T a sufficient distance to accommodate the particles of sand and the like carried by the production fluid and to prevent excessive wear of the structure and/or packing up of the plunger-like conveyors in the tubing.

Since the details of construction of the conveyor O can be varied considerably without departing from the spirit of this invention, I will not burden this specification with further detailed description of the particular structure illustrated in the drawings.

In operation, as the sucker rod string is reciprocated in the tubing T, the conveyors serve to keep the fluid agitated and moving upwardly through the tubing and prevent the sand and/or foreign matter from separating and settling, and, as a result, sanding up the apparatus.

Further, each conveyor, having its own check or traveling valve, and producing its own fluid seal against the tubing T, seals off the load of its own fluid head and enables each conveyor to lift and transfer fluid to the next conveyor, thus dividing the weight of fluid column in the tubing and thereby reducing or minimizing the back pressure against the traveling valve in the pump P and promoting increased production.

The plurality of conveyors makes bottom hole and deep well pumping practical by counteracting the impeding effects of adverse conditions such as: rod stretching, gas locks, heaving, back pressure and fluid compression. They also enable the pump to be set in the production zone and to move the sand and fluid as it enters the production zone, rather than stripping the production above the production zone and allowing the sand to settle and eventually sand up the production zone, thereby restricting or shutting off production and requiring the equipment to be pulled so that the sand can be removed from the production zone with a baler.

In light of the foregoing, it will be apparent that the structure provided by the present invention is easy and economical to manufacture, is highly effective and dependable in operation and, as such, that it can advantageously move and pump oils ladened with sand and the like without becoming packed and rendered ineffective, and without becoming rapidly and excessively worn as a result of the presence of foreign matter in the production fluid.

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

Having described my invention, I claim:

1. A pump of the character referred to including an elongate tubular barrel having a standing valve at its lower end and a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate tubular plunger having a working valve at its upper end and a foot valve at its lower end arranged within the barrel for longitudinal shifting therein and having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said sealing surfaces and recesses in the barrel and about the plunger opposing each other and establishing a fluid bearing and seal between the plunger and barrel, said recesses and sealing surfaces being arranged whereby communication between the several recesses in the barrel and plunger is not established, said recesses in the barrel being V-shaped and having radially inwardly and upwardly inclined side walls and radially inwardly and upwardly inclined bottom walls, said recesses about the plunger being V-shaped and having radially outwardly and upwardly inclined side walls and radially upwardly and outwardly inclined bottom walls, said side and bottom walls in the recesses defining upwardly opening catch basins in and about the barrel and plunger, said inclined bottom walls serving to catch and direct fluid moving downwardly relative to the plunger and the barrel radially into the recesses, said side walls of the recesses directing said fluid flowing into the recesses at the bottom thereof upwardly and outwardly in the recesses.

2. A pump of the character referred to including an elongate tubular barrel having a standing valve at its lower end and a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate tubular plunger having a working valve at its upper end and a foot valve at its lower end arranged within the barrel for longitudinal shifting therein and having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said sealing surfaces and radially outwardly opening recesses, said sealing surfaces and recesses in the barrel and about the plunger opposing each other and establishing a fluid bearing and seal between the plunger and barrel, said valves including annular bodies at the lower end of the barrel and at the upper and lower ends of the plunger, annular valve seats carried by the bodies, open cages projecting upwardly from the bodies and carrying depending stems concentric with the seats and valve members arranged within the cages and slidably engaged on the stems and engageable with the seats, said valve members having upwardly opening chambers and pluralities of ports opening radially outwardly above the seats and communicating with the chambers, said ports serving to direct fluid within the chambers radially outwardly when the valve members are elevated whereby structure adjacent the valve members is flushed with fluid.

3. A pump of the character referred to including an elongate tubular barrel having a standing valve at its lower end and a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate tubular plunger having a working valve at its upper end and a foot valve at its lower end arranged within the barrel for longitudinal shifting therein and having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said sealing surfaces and recesses in the barrel and about the plunger opposing each other and establishing a fluid bearing and seal between the plunger and barrel, said recesses and sealing surfaces being arranged whereby communication between adjacent recesses in the barrel and/or the plunger is never established, said recesses in the barrel being V-shaped and having radially inwardly and upwardly inclined side walls and radially inwardly and upwardly inclined bottom walls, said recesses about the plunger being V-shaped and having radially outwardly and upwardly inclined side walls and radially upwardly and outwardly inclined bottom walls, said side and bottom walls in the recesses defining upwardly opening catch basins in and about the barrel and plunger, said inclined bottom walls serving to catch and direct fluid moving downwardly relative to the plunger and the barrel radially into the recesses, said side walls of the recesses directing said fluid flowing into the recesses at the bottom thereof upwardly and outwardly in the recesses, said valves including annular bodies at the lower end of the barrel and at the upper and lower ends of the plunger, annular valve seats carried by the bodies, open cages projecting upwardly from the bodies and carrying depending stems concentric with the seats, and valve members arranged within the cages and slidably engaged on the stems and engageable with the seats, said

valve members having upwardly opening chambers and pluralities of ports opening radially outwardly above the seats and communicating with the chambers, said ports serving to direct fluid within the chambers radially outwardly when the valve members are elevated, whereby structure adjacent the valve members is flushed with fluid, said cages having helically extending legs adapted to impart circulatory flow in the fluid flowing thereby, which flow acts upon and rotates the valve members.

4. A pump of the character referred to including an elongate tubular barrel having a standing valve at its lower end and a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinl extent, an elongate tubular plunger having a working valve at its upper end and a foot valve at its lower end arranged within the barrel for longitudinal shifting therein and having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said sealing surfaces and recesses in the barrel and about the plunger opposing each other and establishing a fluid bearing and seal between the plunger and barrel, said recesses and sealing surfaces being arranged whereby communication between the adjacent recesses in the barrel or the plunger is closed at all times, said recesses in the barrel being V-shaped and having radially inwardly and upwardly inclined side walls and radially inwardly and upwardly inclined bottom walls, said recesses about the plunger being V-shaped and having radially outwardly and upwardly inclined side walls and radially upwardly and outwardly inclined bottom walls, said side and bottom walls in the recesses defining upwardly opening catch basins in and about the barrel and plunger, said inclined bottom walls serving to catch and direct fluid moving downwardly relative to the plunger and the barrel radially into the recesses, said side walls of the recesses directing said fluid flowing into the recesses at the bottom thereof upwardly and outwardly in the recesses, said valves including annular bodies at the lower end of the barrel and at the upper and lower ends of the plunger, annular valve seats carried by the bodies, open cages projecting upwardly from the bodies and carrying depending stems concentric with the seats, valve members slidably engaged on the stems and engageable with the seats, said valve members having upwardly opening chambers and pluralities of ports communicating with said chambers and opening radially outwardly above the seats, said ports serving to direct fluid within the chambers radially outwardly when the members are elevated whereby structure adjacent the valve members is flushed with fluid, and an elongate flow tube with inclined veins extending longitudinally therethrough arranged below the standing valve and adapted to impart a circular flow pattern in fluid moving upwardly through the structure whereby the valve members are rotated relative to the seats when engaged by the upwardly and circularly flowing fluid.

5. A pump of the character referred to including an elongate tubular barrel having a standing valve at its lower end and a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate tubular plunger having a working valve at its upper end and a foot valve at its lower end arranged within the barrel for longitudinal shifting therein and having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said sealing surfaces and recesses in the barrel and about the plunger opposing each other and establishing a fluid bearing and seal between the plunger and barrel, said valves including annular bodies at the lower end of the barrel and at the upper and lower ends of the plunger, annular valve seats carried by the bodies, open cages projecting upwardly from the bodies, having helically disposed legs to impart circulatory flow in fluid flowing therethrough and carrying depending stems concentric with the seats, and valve members arranged within the cages and slidably engaged on the stems and engageable with the seats, said valve members having upwardly opening chambers and pluralities of ports opening radially outwardly above the seats and communicating with the chambers, said ports serving to direct fluid within the chambers radially outwardly when the valve members are elevated whereby structure adjacent the valve members is flushed with fluid, and an elongate flow tube with inclined veins arranged below the standing valve and adapted to impart a circular flow pattern in the fluid moving upwardly through the structure to supplement the action of the legs of the cages, whereby said valve members are rotated relative to the seats when engaged by said circulating fluid, said valve members having annular veins about their exteriors, above the seats and adapted to be engaged by the upwardly and circularly flowing fluid.

6. A pump of the character referred to including an elongate tubular barrel having a standing valve at its lower end and a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate tubular plunger having a working valve at its upper end and a foot valve at its lower end arranged within the barrel for longitudinal shifting therein and having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said sealing surfaces and recesses in the barrel and about the plunger opposing each other and establishing a fluid bearing and seal between the plunger and barrel, said recesses and sealing surfaces being arranged whereby communication between adjacent recesses in the barrel and the plunger is closed at all times, said recesses in the barrel being V-shaped and having radially inwardly and upwardly inclined side walls and radially inwardly and upwardly inclined bottom walls, said recesses about the plunger being V-shaped and having radially outwardly and upwardly inclined side walls and radially upwardly and outwardly inclined bottom walls, said side and bottom walls in the recesses defining upwardly opening catch basins in and about the barrel and plunger, said inclined bottom walls serving to catch and direct fluid moving downwardly relative to the plunger and the barrel radially into the recesses, said side walls of the recesses directing said fluid flowing into the recesses at the bottom thereof upwardly and outwardly in the recesses, said valve including annular bodies at the lower end of the barrel and at the upper and lower ends of the plunger, annular valve seats carried by the bodies, open cages projecting upwardly from the bodies and carrying depending stems concentric with the seats, valve members slidably engaged on the stems and engageable with the seats, said valve members having upwardly opening chambers and pluralities of ports communicating with said chambers and opening radially outwardly above the seats, said ports serving to direct displaced fluid within the chambers radially outwardly when the members are elevated whereby structure adjacent the valve members it flushed with fluid, and an elongate flow tube with inclined veins extending longitudinally therethrough arranged below the standing valve and adapted to impart a circular flow pattern in fluid moving upwardly through the structures whereby the valve members are rotated relative to the seats when engaged by the upwardly and circularly flowing fluid, said cages having helically pitched legs extending longitudinally of the structure adapted to induce and maintain said circular flow of fluid, said valve members having veins projecting from their exteriors to be engaged by the upwardly and circularly flowing fluid.

7. A deep well reciprocating pump construction of the character referred to including, an elongate tubular barrel fixed to and depending from the lower end of a string of production tubing extending into a well structure, a

standing valve at the lower end of the barrel, said barrel having a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate tubular plunger having a working valve at its upper end and connected with the lower end of a string of reciprocating sucker rods extending longitudinally through said production tubing, a foot valve at the lower end of the plunger, said plunger having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said recesses and sealing surfaces being arranged whereby communication between the adjacent recesses in the barrel and the adjacent recesses in the plunger remains closed at all times, said recesses in the barrel being V-shaped and having radially inwardly and upwardly inclined side walls and radially inwardly and upwardly inclined bottom walls, said recesses about the plunger being V-shaped and having radially outwardly and upwardly inclined side walls and radially outwardly and upwardly inclined bottom walls, said side and bottom walls in the recesses defining upwardly opening catch basins in and about the barrel and plunger, said inclined bottom walls serving to catch and direct fluid moving downwardly relative to the plunger and the barrel radially into the recesses, said side walls directing said fluid flowing into the recesses at the bottoms thereof, upwardly and outwardly from the recesses, said valve at the bottom of the barrel and said valves at the upper and lower ends of the plunger including annular bodies fixed to said barrel and plunger, annular valve seats carried by the bodies, open cages projecting upwardly from the bodies and carrying depending stems concentric with the seats, and valve members slidably engaged on the stems and engageable with the seats, said valve members having upwardly opening chambers and pluralities of ports communicating with the chambers and opening radially outwardly above the seats, said ports serving to direct displaced fluid within the chambers radially outwardly when the valve members are urged upwardly whereby structure adjacent the valve members is flushed with fluid, and an elongate flow tube with inclined veins extending longitudinally therethrough arranged below the standing valve and adapted to impart a circular flow pattern in the fluid moving upwardly through the structure and into engagement with the valve members, whereby said valve members are rotated relative to the seats, said valve members having veins projecting therefrom to be engaged by said upwardly and circularly flowing fluid.

8. A deep well reciprocating pump construction of the character referred to including, an elongate barrel fixed to and depending from the lower end of a string of production tubing extending into a well structure, a standing valve at the lower end of the barrel, said barrel having a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate plunger having a working valve at its upper end and connected with the lower end of a string of reciprocating sucker rods extending longitudinally through said production tubing, a foot valve at the lower end of the plunger, said plunger having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said recesses and sealing surfaces being arranged whereby communication between adjacent recesses in the barrel and adjacent recesses in the plunger remains closed at all times, said recesses in the barrel being V-shaped and having radially inwardly and upwardly inclined side walls and radially inwardly and upwardly inclined bottom walls, said recesses about the plunger being V-shaped and having radially outwardly and upwardly inclined side walls and radially outwardly and upwardly inclined bottom walls, said side and bottom walls in the recesses defining upwardly opening catch basins in and about the plunger and at the lower end of said recesses, said inclined bottom walls serving to catch and direct fluid moving downwardly relative to the plunger and the barrel radially into the recesses, said side walls directing said fluid flowing into the recesses at the bottoms thereof, upwardly and outwardly from the recesses, said valve at the bottom of the barrel and said valves at the upper and lower ends of the plunger including annular bodies fixed to said barrel and plunger, annular valve seats carried by said bodies, open cages projecting upwardly from the bodies and carrying depending stems concentric with the seats, and valve members slidably engaged on the stems and engageable with the seats, said valve members having upwardly opening chambers and pluralities of ports communicating with the chambers and opening radially outwardly above the seats, said ports serving to displace fluid within the chambers radially outwardly when the valve members are urged upwardly whereby structure adjacent the valve members is flushed with a fluid, an elongate flow tube with inclined veins extending longitudinally therethrough arranged below the standing valve and adapted to impart a circular flow pattern in the fluid moving upwardly through the structure and into engagement with the valve members, whereby said valve members are rotated relative to the seats, said valve members having veins projecting therefrom to be engaged by said upwardly and circularly flowing fluid, and a plurality of conveyors engaged in the sucker rod string in vertical spaced relationship and between adjacent stands of sucker rods, each conveyor including an elongate body with a central flow passage, means at the end of the body to connect with adjacent sucker rods, a check valve carried by the body to allow for upward flow of fluid therethrough and a plurality of axially spaced, radially outwardly disposed sealing surfaces about the body and opposing the adjacent wall of the tubing and intermediate radially outwardly opening recesses opposing the adjacent wall of tubing and defining annular fluid sealing chambers.

9. A deep well reciprocating pump construction of the character referred to including, an elongate barrel fixed to and depending from the lower end of a string of production tubing extending into a well structure, a standing valve at the lower end of the barrel, said barrel having a plurality of alternate radially inwardly disposed sealing surfaces and radially inwardly opening recesses throughout its longitudinal extent, an elongate plunger having a working valve at its upper end and connected with the lower end of a string of reciprocating sucker rods extending longitudinally through said production tubing, a foot valve at the lower end of the plunger, said plunger having a plurality of alternate radially outwardly disposed sealing surfaces and radially outwardly opening recesses, said recesses and sealing surfaces being arranged whereby communication between adjacent recesses in the barrel and adjacent recesses in the plunger remains closed at all times, said recesses in the barrel being V-shaped and having radially inwardly and upwardly inclined bottom walls, said recesses about the plunger being V-shaped and having radially outwardly and upwardly inclined side walls and radially outwardly and upwardly inclined bottom walls, said side and bottom walls in the recesses defining upwardly opening catch basins in and about the plunger and at the lower end of said recesses, said inclined bottom walls serving to catch and direct fluid moving downwardly relative to the plunger and the barrel radially into the recesses, said side walls directing said fluid flowing into the recesses at the bottoms thereof, upwardly and outwardly from the recesses, said valve at the bottom of the barrel and said valves at the upper and lower ends of the plunger including annular bodies fixed to said barrel and plunger, annular valve seats carried by said bodies, open cages projecting upwardly from the bodies and carrying depending stems concentric with the seats, and valve members slidably engaged on the stems and engageable with the seats, said valve members having upwardly opening chambers and pluralities of ports communicating with the chambers and opening radially out-

wardly above the seats, said ports serving to displace fluid within the chambers radially outwardly when the valve members are flushed with fluid, an elongate flow tube with inclined veins extending longitudinally therethrough arranged below the standing valve and adapted to impart a circular flow pattern in the fluid moving upwardly through the structure and into engagement with the valve members, whereby said valve members are rotated relative to the sets, and valve members having veins projecting therefrom to be engaged by said upwardly and circularly flowing fluid, and a plurality of conveyors engaged in the sucker rod string in vertical spaced relationship and between adjacent stands of sucker rods, each conveyor including an elongate body with a central flow passage, means at the end of the body to connect with adjacent sucker rods, a check valve carried by the body to allow for upward flow of fluid therethrough and a plurality of axially spaced, radially outwardly disposed sealing surfaces about the body and opposing the adjacent wall of the tubing and intermediate radially outwardly opening recesses opposing the adjacent wall of the tubing and defining annular fluid sealing chambers, said recesses having radially upwardly and outwardly inclined outwardly disposed side walls and upwardly and radially outwardly inclined upwardly disposed bottom walls, said side and bottom walls defining annular catch basins at the lower ends of the recesses.

10. A pumping apparatus of the character referred to including, an elongate production tubing extending into a well bore, an elongate pump barrel at the lower end of the tubing having a standing valve at its lower end and a plurality of axially spaced radially inwardly disposed sealing surfaces and radially inwardly disposed annular recesses between said sealing surfaces, an elongate string of sucker rod extending through the tubing, an elongate tubular plunger fixed to the lower end of the sucker rod string to occur within the barrel and having a working valve at its upper end and a foot valve at its lower end, said plunger having a plurality of axially spaced radially outwardly disposed sealing surfaces to oppose and cooperate with the sealing surfaces of the barrel upon axial shifting of the plunger in the barrel and radially outwardly opening annular recesses between the sealing surfaces on the plunger, the recesses in the plunger being spaced axially so that the several recesses in the plunger and barrel are not in register with each other at any one time, said sealing surfaces being greater in axial extent than the recesses whereby said recesses will not bridge opposing sealing surfaces and establish communication between the recesses adjacent said sealing surfaces.

11. A pumping apparatus of the character referred to including, an elongate production tubing extending into a well bore, an elongate pump barrel at the lower end of the tubing having a standing valve at its lower end and a plurality of axially spaced radially inwardly disposed sealing surfaces and radially inwardly disposed annular recesses between said sealing surfaces, an elongate string of sucker rod extending through the tubing, an elongate tubular plunger fixed to the lower end of the sucker rod string to occur within the barrel and having a working valve at its upper end and a foot valve at its lower end, said plunger having a plurality of axially spaced radially outwardly disposed sealing surfaces to oppose and cooperate with the sealing surfaces of the barrel upon axial shifting of the plunger in the barrel and radially outwardly opening annular recesses between the sealing surfaces on the plunger, the recesses in the plunger being spaced axially so that the several recesses in the plunger and barrel are not in register with each other at any one time, said sealing surfaces being greater in axial extent than the recesses whereby said recesses will not bridge opposing sealing surfaces and establish communication between the recesses adjacent said sealing surfaces, and a plurality of conveyors engaged in the string of production tubing in vertical spaced relationship and between adjacent stands of sucker rods, each conveyor including an elongate body with a central flow passage, means at the end of the body to connect with adjacent sucker rod stands, a check valve carried by the body to allow for upward flow of fluid therethrough and a plurality of axially spaced radially outwardly disposed sealing surfaces about the body and opposing the adjacent wall of the tubing and intermediate radially outwardly opening recesses opposing the adjacent wall of the tubing and defining annular sealing chambers.

12. A pumping apparatus of the character referred to including, an elongate production tubing extending into a well bore, an elongate pump barrel at the lower end of the tubing having a standing valve at its lower end and a plurality of axially spaced radially inwardly disposed sealing surfaces and radially inwardly disposed annular recesses between said sealing surfaces, an elongate string of sucker rod extending through the tubing, an elongate tubular plunger fixed to the lower end of the sucker rod string to occur within the barrel and having a working valve at its upper end and a foot valve at its lower end, said plunger having a plurality of axially spaced radially outwardly disposed sealing surfaces to oppose and cooperate with the sealing surfaces of the barrel upon axial shifting of the plunger in the barrel and radially outwardly opening annular recesses between the sealing surfaces on the plunger, the recesses in the plunger being spaced axially so that the several recesses in the plunger and barrel are not in register with each other at any one time, said sealing surfaces being greater in axial extent than the recesses whereby said recesses will not bridge opposing sealing surfaces and establish communication between the recesses adjacent said sealing surfaces, and a plurality of conveyors engaged in the string of production tubing in vertical spaced relationship and between adjacent stands of sucker rods, each conveyor including an elongate body with a central flow passage, means at the end of the body to connect with adjacent sucker rod stands, a check valve carried by the body to allow for upward flow of fluid therethrough and a plurality of axially spaced radially outwardly disposed sealing surfaces about the body and opposing the adjacent wall of the tubings and defining annular sealing chambers, said recesses in the conveyors having radially upwardly and outwardly inclined outwardly disposed side walls and upwardly and radially outwardly inclined upwardly disposed bottom walls, said side and bottom walls defining annular catch basins at the lower ends of the recesses.

References Cited by the Examiner

UNITED STATES PATENTS

Re. 18,791	4/1933	Ruthven	103—179 X
1,896,719	2/1933	Parkin	103—204
2,417,349	3/1947	Colbaugh	103—204 X

MARK NEWMAN, *Primary Examiner.*

WARREN E. COLEMAN, *Examiner.*