Nov. 15, 1932. B. H. SCOTT 1,887,736

DEEP WELL PUMP

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Fig. 1

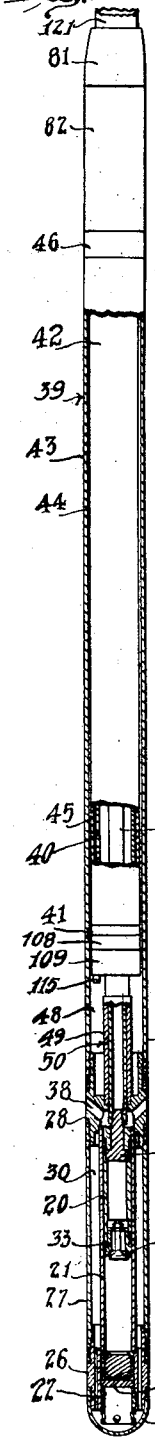


Fig. 2

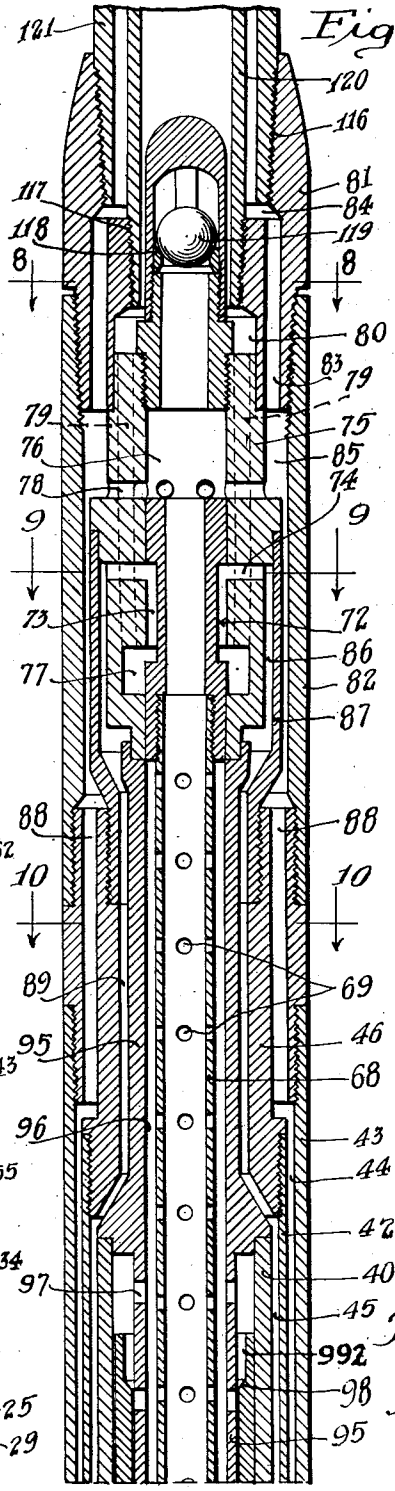
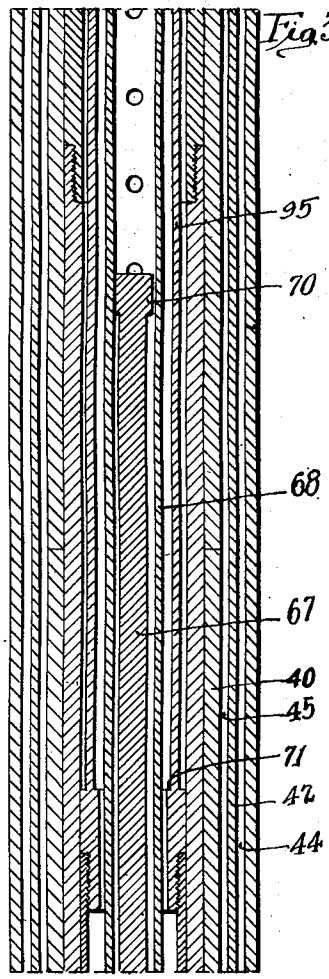


Fig. 3



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DEEP WELL PUMP

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Fig. 4

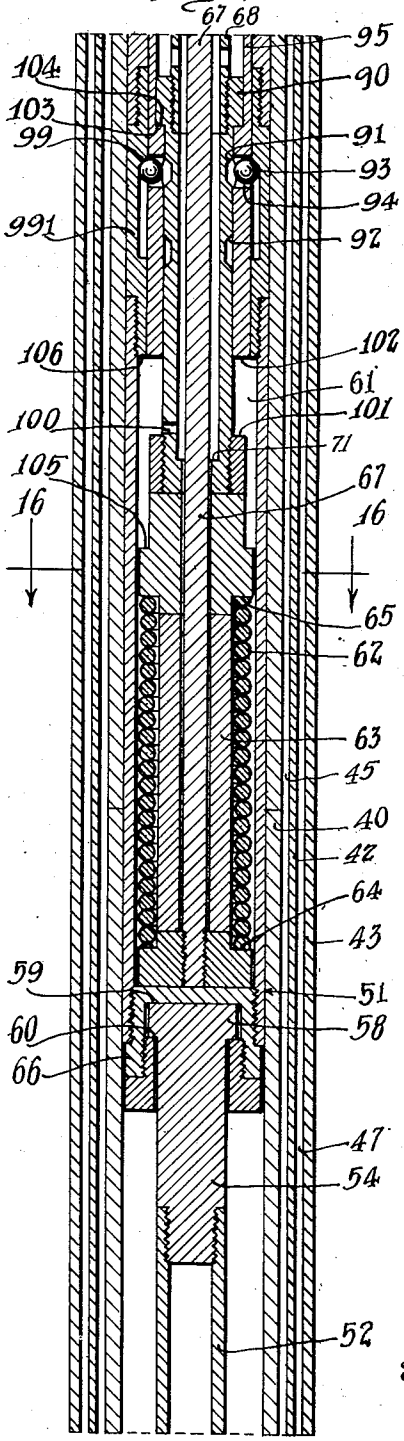
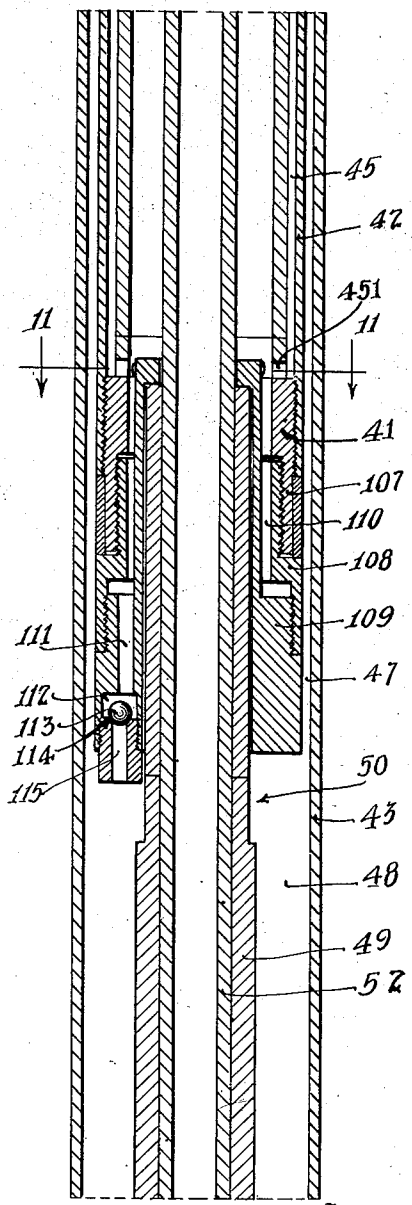


Fig. 5



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DEEP WELL PUMP

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Fig. 6

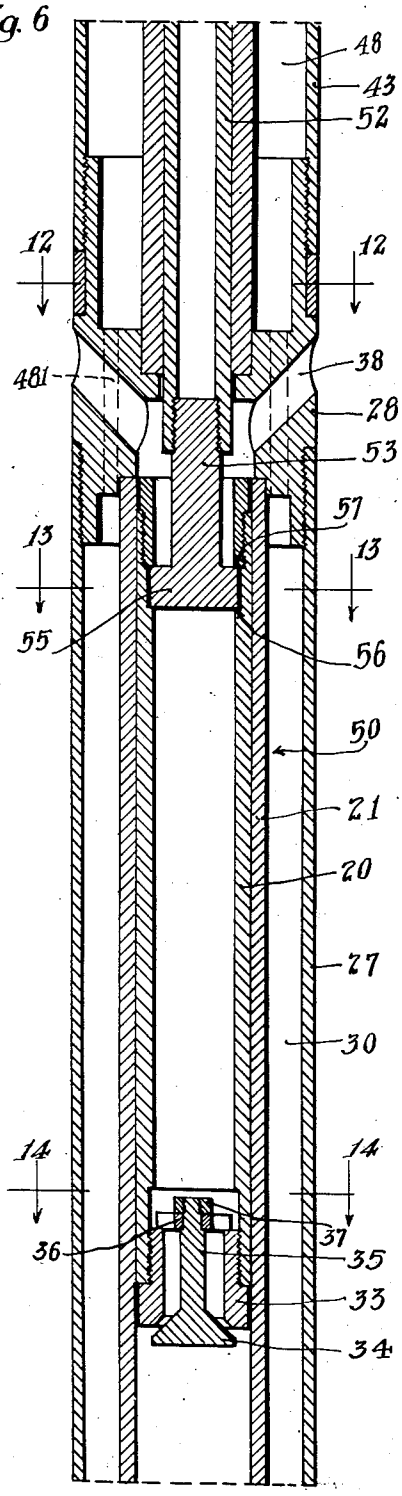
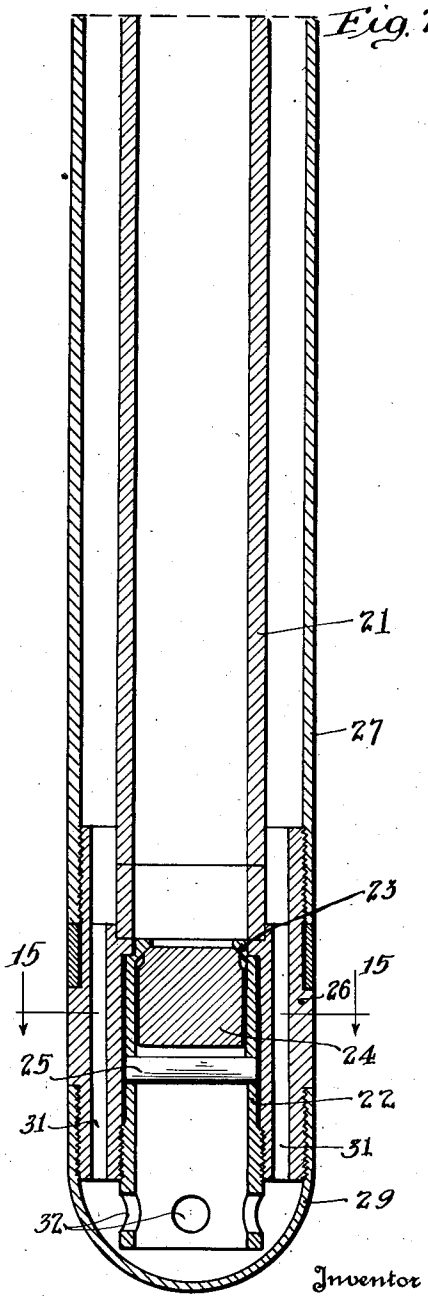


Fig. 7



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DEEP WELL PUMP

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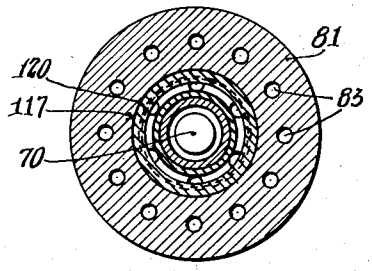


Fig. 8

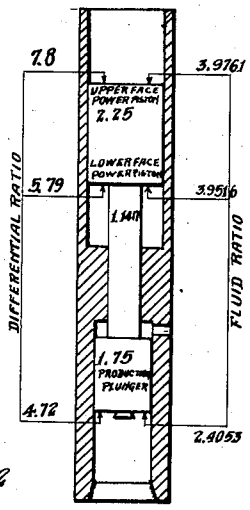


Fig. 17

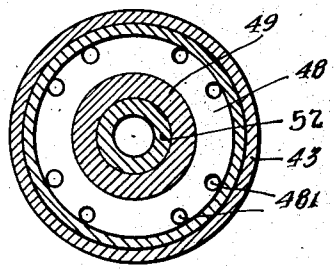


Fig. 12

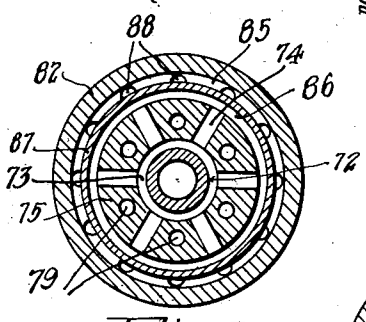


Fig. 9

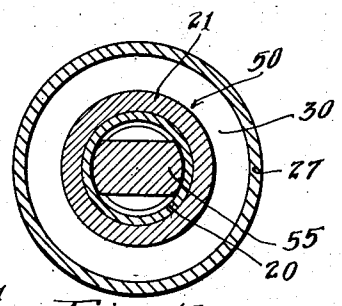


Fig. 13

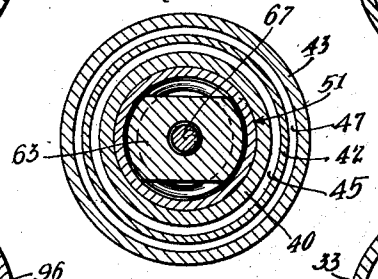


Fig. 16

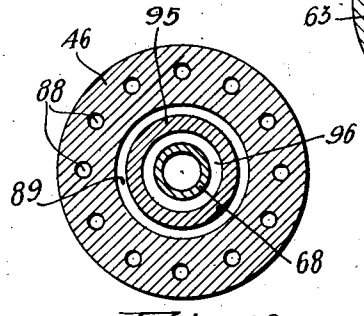


Fig. 10

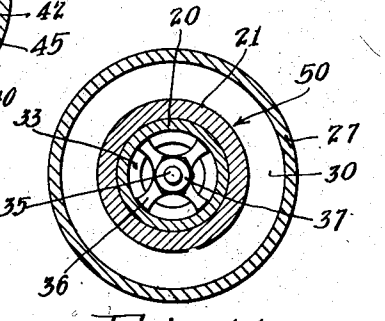


Fig. 14

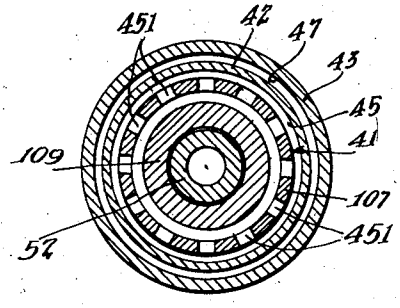
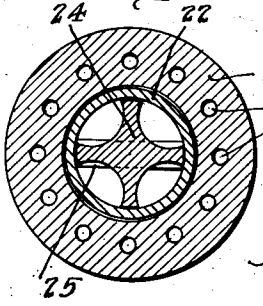


Fig. 11

Fig. 15



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Patented Nov. 15, 1932 1,887,736

UNITED STATES PATENT OFFICE

BERNARD H. SCOTT, OF GLENDALE, CALIFORNIA, ASSIGNOR TO RODLESS PUMP COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF NEVADA

DEEP WELL PUMP

Application filed February 4, 1930. Serial No. 425,799.

This invention relates to deep well pumps and an object, in general, is to improve the construction and operation of this class of pumps.

More particularly, the invention relates to that type of pump that is operated by a motor means which, in this instance, is of the fluid pressure operated type.

Another important object is to effect a continuous flow of liquid from the well so as to minimize any tendency to sanding-up of the pump and so as to minimize power requirements in operating the pump, since there is no inertia of a stationary column of liquid to overcome during the pumping cycle.

Another object is the evenness of power requirements in operating the pump throughout the pumping cycle.

Another object is ease with which the pump may be freed from clogging sand in event of the pump not being operated for a period of time and thus permitting sand to settle in the pump so as to cause what is commonly termed "sanding-up".

Another important object is to provide a construction that will utilize tubular members of standard dimensions so that many parts of the pump can be manufactured from cold rolled members produced by manufacturers thereof and carried in stock for many uses.

Other objects and advantages will appear in the subjoined detailed description.

The accompanying drawings illustrate the invention:

Figure 1 is an elevation, partly in section, of a rodless pump constructed in accordance with the provisions of this invention. The pump is shown as being shorter in proportion to its diameter than would be customarily employed in practice, in order to contract the view.

Figures 2, 3, 4, 5, 6 and 7 are enlarged longitudinal sections of different portions of the pump shown in Fig. 1, the views taken in succession representing different successive portions from the upper end of the pump to the lower end.

Figures 8, 9 and 10 are horizontal sections on the lines indicated by 8—8, 9—9 and 10—10, respectively, Fig. 2.

Figure 11 is a horizontal section on the line indicated by 11—11, Fig. 5.

Figures 12, 13 and 14 are horizontal sections on the lines indicated by 12—12, 13—13, 14—14, respectively, Fig. 6.

Figure 15 is a horizontal section on the line indicated by 15—15, Fig. 7.

Figure 16 is a horizontal section on the line indicated by 16—16, Fig. 4.

Figure 17 is a diagrammatic view illustrating the differential pressure areas of the pump.

Referring to the drawings, the valved hollow or tubular plunger of the pump is indicated at 20, and the valved working barrel, in which said plunger operates, at 21. It is to be understood that any suitable type of valved working barrel and valved plunger may be employed, but the type disclosed in the drawings and now to be described in detail, has particular advantages which will be mentioned hereinafter.

Into the lower end of the working barrel 21 is threaded a tubular valve body 22 which is provided near its upper end with an internal annular beveled seat 23 against which seats a valve closure 24 which, in this instance, is in the form of a plug. It will be noted that the valve 24 closes upwardly on the seat 23 and opens downwardly. Opening movement of the closure 24 is restricted by a stop 25 which, in this instance, is in the form of a bar or pin that extends across the bore of the body 22 and has its opposite ends anchored in said body. In this instance the working barrel is constructed in sections which are held assembled by reason of a lower section 26 being screw-threaded into the lower end of a tubular jacket section 27 and the upper section 28 being screw-threaded into the upper end of said jacket section 27. The pump is closed at its lower end by a hemispherical cap 29 which is screwed onto the lower end of the section 26.

The working barrel 21 is spaced from the jacket 27 to form an annular passage 30 into which liquid may flow from the cap 29, through one or more vertical passages 31 in

the section 26. The body 22 projects below the lower end of the section 26 into the cap 29 and is provided with one or more horizontally opening ports 32 so that the liquid can freely flow into the interior of the cap 29 from the valve body 22.

The valve body 22 and closure 24 together constitute the foot or standing valve, and it will be noted that the construction of said valve permits the lower end of the plunger to approach within a relative minute distance of the seat 23 so that when the plunger descends practically all of the liquid in the working barrel below said plunger will be forced from said working barrel.

The plunger is provided at its lower end with a valve seat 33 against which closes a valve closure member 34 which, in this instance, is in the form of a cone-shaped plug adapted to fit the seat. The closure 34 is provided with a stem 35 which works in a guide 36. It will be noted that the valve closure 34 closes upwardly onto its seat and opens downwardly. Opening movement of the closure 34 is restricted by a shoulder 37 on the stem 35 coming into engagement with the upper face of the guide 36. Liquid enters the pump through one or more ports 38 in the barrel section 28, said ports 38 preferably extending aslant downwardly and inwardly so that any gas tending to escape between the working barrel and the plunger, on the down stroke of said plunger, will readily flow through the ports 38 into the body of oil that is outside of the pump, so that said gas will not interfere with the operation of the pump.

A suitable operating means is provided for the plunger 20 and said means, in this instance, is in the form of a motor, indicated in general by the character 39, and the motor, in this instance, is operated by fluid pressure as, for example, by liquid that is forced from the surface of the earth into the pump by another pump, not shown, at the surface.

Oil is a very suitable medium for operating the motor which is constructed as follows: There is a cylinder 40 which, in this instance, is of sectional construction and the sections are held assembled by reason of the lower section 41 being screwed into an intermediate tubular member 42 and the upper section 46 being screwed into the upper end of said member 42. A tubular jacket 43 surrounds the tubular member 42 and is spaced therefrom to form an annular passage 44. The tubular member 42 is spaced from the cylinder 40 to form an annular passage 45 for liquid. The lower end of the passage 45 communicates with the bore of the pump barrel through a port or ports 451.

The lower end of the jacket section 43 is screwed onto the upper end of the barrel section 28 and the upper end of said jacket section 43 is screwed onto a coupling 46 that connects the jacket section 43 to a jacket section 82.

The outside diameter of the barrel section 41 is less than the inside diameter of the jacket 43 so as to form an annular space 47 which communicates the passage 44 with an annular passage 48 that exists between the jacket 43 and a tubular guide 49 for the stem 50 that connects the plunger with a motor piston 51. In this instance the stem guide 49 is of sectional construction and the sections are held tightly against one another by reason of the upper guide section engaging the lower cylinder section 41 and the lower guide section engaging the upper barrel section 28. The lower end of the passage 48 communicates with the upper end of the passage 30 through a vertical port or ports 481 in the barrel section 28. The ports 481 are staggered with respect to the ports 38 so as to avoid cutting into said ports 38. The stem 50 comprises a relatively long or tubular section 52, a member 53 screwed into the lower end of the member 52, and a member 54 screwed into the upper end of said member 52. The lower end of the stem member 53 terminates in a head 55 that is confined between internal shoulders 56, 57 in the plunger. The diameter of the head 55 is slightly less than the inside diameter of the plunger at that point so that self-alining of the plunger within the working barrel can readily take place irrespective of whether or not the stem is alined with the plunger. In other words, the head 55 and shoulders 56, 57 constitute a loose connection between the plunger and the stem so that the self-alining can take place. The head 55 is flattened on its sides so as to permit liquid to flow past said head within the plunger.

The stem member 54 connects with the piston 51 by reason of said member 54 terminating at its upper end in a head 58 which is confined between shoulders 59 and 60 provided in the piston. The piston is provided with a chamber 61 in which is a coil spring 62 that surrounds a tubular spring guide 63 between a lower spring seat 64 and an upper spring seat 65.

The spring seat 64 rests upon a hollow member 66 which forms the shoulder 59. The spring seat 65 is tubular and surrounds a stem section 67 which is threaded into or otherwise secured at its lower end to the spring seat 64. Thus relative motion may take place between the spring seats 64, 65 for compression and expansion of the spring. The spring seat 65 is flattened on its sides to permit of the power fluid passing it.

The stem section 67, in this case a rod, is in telescopic relation with another stem section 68 which, in this instance, is of tubular construction and is provided at intervals substantially throughout its length with ports 69. Near its upper end the stem section 67 is provided with an annular shoulder 70 adapt-

ed to engage an annular shoulder 71 within the lower end of the stem section 68 when the piston moves to the lower end of the stroke so as to pull downwardly the stem section 68, to thus operate the power fluid control valve 72 which is screwed on or otherwise secured to the upper end of said stem section 68.

The valve 72 is of the slide type and is provided in its periphery with an annular passage 73 adapted, when in its lower position, to communicate at its upper end with a port or ports 74 in a valve body 75 provided with a bore 76 in which the valve 72 slides. When in this position, the lower end of the passage 73 communicates with an enlarged bore portion 77 in the valve body 75. When said valve is in its uppermost position, the upper end of the passage 73 registers with a port or ports 78 extending horizontally in the valve body 75 and, in this upper position of the valve 72, said valve cuts off communication between the passage 73 and the chamber 77, and the lower end of the passage 73 registers with the ports 74. The valve body 75 is provided with a vertical port or ports 79 which communicate at their lower ends with the chamber 77 and at their upper ends with a bore 80 of a coupling member 81 that is screwed into the upper end of a jacket section 82, the lower end of which is screwed onto the upper end of the cylinder section 46. The ports 79 are in staggered relation to the ports 74, 78 so as to miss the latter mentioned ports. The coupling member 81 is provided with a vertical port or ports 83 which communicate at their upper ends with an enlarged bore portion 84 of the coupling member 81 and which communicate at their lower ends with an annular passage 85, that exists between the valve body 75 and the jacket section 82 and that communicates with the passage 88.

This extension 95 is spaced from the stem section 68 to form an annular passage 96 with which the ports 69 communicate and the upper portion of the extension 95 is provided with ports 97 to permit of liquid flowing in and out of the cylinder above the piston on the down and up strokes, respectively, of said piston.

The piston is provided at its inner face with spaced, beveled, annular shoulders 98, 99, the upper shoulder 98 adapted, when the piston ascends, to force the detents 93 inwardly so as to engage the shoulder 91, thus locking the valve stem against upward movement. On the down stroke of the piston the shoulder 99 is adapted to thrust the detents 93 inwardly so as to engage the shoulder 92 to prevent downward movement of the valve 72. The shoulder 98 is near the upper end of the piston and shoulder 99 is below the middle of said piston and is formed by the upper end wall of an annular, internal recess 991 in the piston. It will be noted that, when the piston is driven downwardly so that the shoulder 99 forces the detents 93 into locking position, said detents will be maintained in the locking positions by the inner face of the piston until the shoulder 98 passes below the level of the detents. The shoulder 98 is formed by the end wall of an internal, annular recess 992 in the upper end of the piston, which recess permits the detents to move outwardly to unlocking position.

The ports 78 communicate the passage 85 with the bore 76 of the valve body 75.

The outer ends of the ports 74 communicate with an annular passage 86 that exists between the valve body 75 and an upward extension 87 of the jacket coupling 46, into which said extension is screwed. The lower end of the annular passage 85 communicates through a vertical port or ports 88 in the coupling 46 with the annular passage 44. The lower end of the annular passage 86 communicates with the annular passage 45 through an annular passage 89 that exists between the coupling 46 and the valve body 75.

The valve stem section 68, in this instance, comprises members of different outside diameters, and a means is provided for locking the lower one of said members 90 in two different positions to the extension 95, said locking means being releasable by movement of the piston.

This locking means, in this instance, is constructed as follows: The member 90 is provided with upper and lower external annular beveled shoulders 91, 92. Adapted to selectively engage the shoulders 91, 92 is a ball detent or detents 93 which are carried in openings 94 in the tubular downward extension 95 of the valve body 75 that constitutes the upper head for the cylinder.

Likewise, as the piston is driven upwardly the inner face of the piston maintains the detents 93 in locking position until the recess 991 registers with the detents 93, whereupon said detents are free to move outwardly into unlocking position. The spacing of the shoulders 98, 99 is sufficient to permit of full stroke of the piston.

The member 90 is provided with one or more ports 100 to permit of influx and efflux of liquid beneath the piston when the piston moves up and down, respectively. The stem section 90 is provided near its lower end with a shoulder 101 adapted to engage an abutment 102 formed, in this instance, by the lower end of the extension 95 so as to limit upward movement of the valve 72. Said shoulder 101 is in engagement with the abutment 102 when the shoulder 92 is in register with the detents 93. Downward movement of the valves 72 is limited by an external, annular shoulder 103 on the stem section 90 engaging an internal, annular abutment 104 on the extension 95. The shoulder 103 engages

the abutment 104 when the shoulder 91 is in register with the detents 93.

The spring seat 65 is provided with an external annular shoulder 105 adapted to be engaged by an internal, annular shoulder 106 of the piston, when the piston descends, to effect compression of the spring 62 after the shoulders 70, 71 engage.

In this instance, the pump barrel section 41 comprises three tubular members, an outer member 107 which is screwed into the lower end of the member 42, a member 108 which is screwed into the member 107, and a member 109 that is screwed into the member 108. The member 107 and, for a distance, the member 108, are spaced from a portion of the member 109 to form an annular passage 110 which communicates the lower end of the cylinder bore with a vertical duct 111 in the member 109. The lower end of the duct 111 communicates with a valve chamber 112 provided with a ball check valve 113 that closes downwardly onto a seat 114 at the upper end of a port 115 that communicates at its lower end with the passage 48.

The bore portion 84 of the coupling member 81 is threaded at 116 so that tubing can be readily connected with said coupling member though it is to be understood that, by suitably packing the space between the pump jacket and the well casing, not shown, the casing itself may be utilized for conducting the pumped fluid out of the well, in which event the tubing will not be employed.

The reduced bore portion 117 of the coupling member 81 is threaded for connection with pump tubing or with "macaroni", which is the term ordinarily employed for designating the small tubing used, in some instances, for conducting the power fluid to the pump from the surface of the earth. The coupling member 81 is provided with a valve seat 118 on which is adapted to close a ball valve 119 to ordinarily prevent the power fluid entering the bore of the valve body 75.

From the foregoing, it will be seen that the cylinder and pump barrel are connected together, with the pump barrel lowermost and that outside thereof and concentric therewith is a jacket and that between the jacket and the cylinder and concentric therewith and spaced therefrom, is the tubular member 42 so as to form an annular passageway, the upper portion of which lies between the member 42 and the jacket, the intermediate portion between the stem guide 49 and the jacket, and the lower portion between the pump barrel and the jacket and, furthermore, it is seen that the stem of the valve 72 comprises sections in shiftable relation to one another, the one connected with the valve 72 and the other adapted to be engaged by the piston on its up stroke to compress the spring, and that said stem sections are provided with the shoulders 70, 71 adapted to engage on the down stroke of the piston to compress the spring.

The invention above described operates as follows: In the ordinary operation of the pump, the fluid under pressure, as for example, clean oil, will be forced down the macaroni, or other tubing, 120 and, assuming that the valve 72 is in its upper position and is locked in said position by reason of the detents 93 engaging the shoulder 92, the power fluid will flow through the ports 79 into the chamber 77 and past the lower end of the valve 72 into the upper end of the passage 96 and through the ports 69 into the bore of the upper stem section 68 and through the ports 97, thus moving said piston on its down stroke. As the piston starts down, the shoulder 99 forces the detents 93 inwardly into locking position against the shoulder 92, thus to prevent the valve 72 from dropping after the piston has descended a sufficient distance to permit of full expansion of the spring 62. The oil or other liquid being pumped, while the piston moves downwardly, will enter the ports 38 from the well and flow into the hollow plunger. At initiation of the down stroke of the plunger, by downward movement of the piston, the valve 34 will be closed by differential pressure, thus forcing the oil beneath the plunger within the lower portion or suction chamber of the pump barrel past the valve closure 24, thence through the ports 32 into the cap 29, thence upwardly through the ports 31 into the passage 30, thence through the ports 481 into the passage 48, thence through the passage 47 into the passage 44, and thence into the passage 85.

During the down stroke of the piston and plunger, the power fluid that is within the cylinder below the lower end of the piston will be forced through the ports 451 into the passage 45 and will pass upwardly through said passage, thence through the passage 89, thence through the passage 86, thence through the ports 74 into the valve passage 73, and thence through the ports 78 into the passage 85, where it mixes with the pumped fluid that has entered said passage from the ports 88. The mixed pumped and power fluids will then flow upwardly through the ports 83 into the larger bore portion of the coupling member 84, thence upwardly through the pump tubing 121, if such tubing is employed for this purpose, or otherwise, upwardly through the well casing to the surface of the earth.

When the lower end of the piston reaches a point about three inches above the lower end of the cylinder, the shoulders 70, 71 will engage, thus holding the lower spring seat stationary. Then the shoulders 105, 106 engage upon further downward motion of the piston, thus compressing the spring 62 be-

tween the spring seats 64, 65. After the spring has been compressed, further downward movement of the piston will bring the shoulder 92 opposite the recess 992, whereupon the shoulder 92 will thrust the detents 93 outwardly and thus permit the spring 62 to move the valve 72 into its lower position, thus shutting off the power fluid from the passage 96, whereupon the piston and plunger come to rest.

The valve 72 now being in the position shown in the drawings, the power fluid passes from the chamber 77 through the passage 73, thence through the ports 74 into the passage 86, thence through the passage 89, and thence through the passage 45, thence through the ports 451 into the lower end of the cylinder so as to produce upward pressure on the lower end of the piston which, accordingly, is driven upwardly, carrying with it the pump plunger. As the plunger ascends it tends to produce a partial vacuum within the pump barrel below the valve 34, thus closing the valve 24 and opening the valve 34, thereby admitting to the pump barrel below the valve 34 the oil that has entered the plunger through the ports 38. As the piston ascends, the power fluid above the piston will be forced through the ports 97 into the passage 96, thence through the ports 69 into the stem of the valve and, also, through the ports 100 into the hollow stem. From the stem the fluid passes through some of the ports 69 into the passage 96 and from said passage 96 back into the stem through other of the ports 69; thence through the valve 72 into the upper bore portion of the valve body 75, thence laterally through the ports 78 into the passage 85, thence through the ports 83 and on out of the well through the pump tubing or casing, as the case may be. As the piston ascends, when it reaches within, for example, three inches of the upper end of its stroke, the spring seat 65 engages the lower end of the stem section 68, thereby compressing the spring 62.

After compression of the spring, further upward movement of the piston will bring the piston recess 991 to register with the shoulder 91 and, accordingly, the expansive force of the spring will move the valve stem upwardly until the shoulder 92 is alined with the detents 93, the valve 72 in this upper position shutting off the power fluid from the ports 74 and this completes one cycle of the pump. The cycle will then be repeated as long as the power fluid is supplied to the pump.

Should the pump, for any reason, be permitted to stop its operation and, in such event, should packing of the sand within the pump prevent starting of the pump, by supplying the power fluid in the manner hereinbefore described, the power fluid will be supplied to the pump in a reverse direction, that is to say, through the pump tubing or casing, as the case may be. Assuming that when the pump stopped, the valve 72 was in its lower position, the power fluid will then take the course hereinbefore described for the pumped liquid until said power fluid discharges into the passage 48. From this passage the power fluid will pass through the port 115 past the valve 113 into the valve chamber 112, thence through the port 111, thence through the passage 110 into the bore of the cylinder beneath the piston, thus tending to drive the piston upwardly if it is not at the upper end of its stroke.

While the piston is moving upward the flow of the power fluid thereabove is in a reverse direction to that which it has for causing down stroke of the piston, as in the normal operation of the pump as described above. If the pump mechanism fails to respond quickly, when the power fluid is thus supplied in a reverse direction, the direction of the power fluid will again be reversed by supplying it to the tubing 120 and this alternate method of supplying the operating fluid will be repeated as often as necessary to loosen the packed sand or mud in the pump sufficient to permit normal operation of the pump, as hereinbefore described. Cleansing of the pump in this manner results because even a short reciprocatory movement of the piston will permit of sufficient movement of the fluid to take place to effect washing of the sand or mud out of the pumping mechanism.

The producing assembly, or, in other words, the pump barrel with its foot valve and the plunger with its valve, differs in every respect from the conventional types of well suction pumps operated by sucker rods, as is the prevalent practice in the oil fields. In the conventional pump the plunger is provided with a discharge traveling valve positioned at either the upper or lower end thereof and at the lower end of the pump barrel is a standing valve. As the sucker rods are drawn upward to elevate the plunger, the fluid is displaced above said plunger, causing the pumped fluid to flow out at the mouth of the well.

As the plunger moves upwardly, that portion of the barrel below the plunger becomes a low pressure chamber which receives a charge of fluid from the well through the standing valve. Since all oil produced from oil wells contains a quantity of gas which vaporizes under a decreased pressure, or agitation, the suction chamber of the old type of oil well pump, generally, is not entirely filled with oil but contains gas as well, the pressure of which varies directly with the pressure of the hydrostatic head in the well casing, since the rock pressure is the force that fills the suction chamber. As the plunger moves downward, the standing valve closes and the gas in the suction chamber is compressed by

the weight of the sucker rod string, until pressure of the fluid in the suction chamber is slightly greater than the pressure of the oil in the pump tubing that carries the pumped oil to the surface. When such pressure is reached in the suction chamber, the traveling valve opens and the downwardly moving plunger displaces the gas and oil upwardly. When the plunger again starts up, the traveling valve closes downward and the compressed fluid from the suction chamber is then a part of the fluid column in the pump tubing above the plunger. This compression of the gasified fluid in the suction chamber at each down stroke of the plunger, represents an appreciable loss in the capacity of the pump and in the power that operates said pump.

Another major loss that occurs in such sucker rod operated pumps at present in use, is due to what is generally known as "gas-locking", the suction chamber. Various types of oil and gas separators or gas anchors are employed with the pumps in an effort to combat this objectionable condition. The function of the gas anchor is to separate the free gas from the oil before the oil enters the suction chamber of the pump. The performance of the gas anchor is quite satisfactory insofar as its action on free gas is concerned, but the gas anchor, being attached to the lower end of the pump and, accordingly, subjected to the pressure existing in the well, cannot rid the pump of that gas which separates from the oil after entering the suction chamber under lowered pressure conditions within said chamber, or that gas which is freed from the oil through agitation.

Assuming, for example, that in the old type of pump there is a clearance of .002 of an inch between the plunger and the pump barrel, on the up stroke, the oil seal between the plunger and pump barrel must withstand the hydrostatic pressure of the entire column of fluid being lifted by the plunger through the pump tubing, which pressure, for example, in a well having a depth of 5,000 feet, reaches approximately 2,000 pounds per square inch.

The oil in the clearance space serves as an impervious seal and a lubricant for the upward moving plunger, provided that the agitative movement of the plunger does not release any gas within the oil that forms the seal. However, release of the gas from the seal usually results, and as the gas is released, the pressure above the plunger prevents upward movement of the gas and, accordingly, the gas in the seal flows downwardly as the plunger moves upward, resulting in the suction chamber receiving a volume of high pressure gas which tends to hold the standing valve closed, thus effecting what is commonly known as a "gas-lock". This gas-lock cannot occur when using the hereinbefore described plunger and working barrel for the reason that the traveling valve of the plunger opens downward as the plunger ascends and closes upward as the plunger descends, and the pumped fluid is discharged from the working barrel through the standing valve by the pressure applied downwardly by the plunger and, said standing valve, while the plunger is on its up stroke, is retained in a closed position by the hydrostatic head of the fluid in the well, which hydrostatic head is against the underface of the standing valve. Accordingly, on the up stroke of the plunger, there is a low pressure area existing in the suction chamber below the plunger which causes the fluid from the well to flow downwardly through the ports 38, through the plunger and out through the traveling valve 34 into the suction chamber.

If it be assumed that the hereinbefore described valved pump barrel and valved plunger of this invention are installed in a well at a depth of 5,000 feet with a plunger clearance of .002 of an inch, the plunger being down, the power fluid is applied to the under side of the piston, thus driving the plunger on its up stroke. This causes a low pressure area to exist in the suction chamber between the plunger and the closed standing valve. Accordingly, there will be a flow of oil through the ports 38, into the plunger and past the valve 34 into the suction chamber. Any free gas contained in the suction chamber seeks, naturally, the upper end of the chamber immediately under the plunger and, as additional pressure is produced on said gas by the next downward movement of the plunger, any slippage of fluid that might occur between the plunger and the working barrel would result in flow of said fluid from said suction chamber, past the plunger, and upwardly and out through the ports 38 into the well casing. When the plunger reaches the lower end of its down stroke, it will be noted that the lower end of said plunger can approach, approximately, within $\frac{1}{32}$ of an inch of the standing valve so that the suction chamber is practically emptied of the fluid being pumped and there is no dead space for the accumulation of high pressure gas as results in the older forms of pump which employ a standing valve that works within a cage.

There is thus avoided any resistance to inflow of the liquid to the suction chamber on the suction stroke of the pump, due to compressed gas as occurs in the older types of pump. In the older type of pump mentioned above, the valve cage occupies from four to eight inches of space within the suction chamber of the pump, thus permitting gas to be compressed by the plunger within said space. This compressed gas exercises pressure on the standing valve ball until the plunger has ascended to a point that permits

of reduction of the gas pressure sufficient to permit the standing valve to open. Thus, the standing valve is closed during a large part of the upward suction stroke of the plunger and this, of course, lowers the operating efficiency of the pump. This condition is generally known as a partial gas-lock and it cannot exist in the pump hereinbefore described.

With the construction hereinbefore described, it is possible to employ such ratios of pressure faces for the piston and plunger as will produce a substantially balanced condition, whereby the pressure required on the up and down strokes is substantially the same, and this pump, although provided with but one suction chamber, is double acting insofar as there is always a flow of fluid from the pump.

The balancing effect is produced by exhausting the power fluid beneath the piston into the column of fluid forced from the suction chamber on the down stroke of the pump and by exhausting the power fluid into said column of fluid from above the piston on the up stroke of the piston. The lower face of the piston has less area than the upper face, due to the presence of the connecting stem 52, 53, 54.

The ratio of piston and plunger pressure faces, at present employed, is as follows: Referring to Fig. 17, the upper face of the piston has a diameter of 2.25 inches and an area of 3.976 inches; the lower face of the piston is of the same diameter as the upper face, but the connecting stem has a diameter of 1.1417 inches and an area of 1.0246 inches, thus leaving an effective area of 2.9515 inches for the lower face of the piston. The upper face of the plunger is not a factor in the ratio. The lower face of the plunger has a diameter of 1.75 inches and an area of 2.4053 inches.

Thus, on the down stroke the ratio of the surface against which power fluid is acting to the surface against which the pressure of the exhaust fluid is exerted equals:

$$\frac{\text{Area of upper face of power piston}}{\text{Area of lower face of power piston + lower face of production plunger}} = \frac{3.9761}{2.9515 + 2.4053} = .74$$

On the up stroke the ratio of the surface against which power fluid is acting to the surface against which exhaust fluid is acting equals:

$$\frac{\text{Area of lower piston face}}{\text{Area of upper piston face}} = \frac{2.9515}{3.9761} = .74$$

Thus it will be seen that the ratios of the opposed surfaces exposed to power fluid and exhaust fluid during the up and down strokes, respectively, are substantially the same. It follows that since the pressure of the exhaust fluid remains approximately the same at all times, the operating fluid pressure required to move the piston will be the same on both strokes.

Though the invention has hereinbefore been described more particularly as operating in an oil well, it is to be understood that any other fluid than oil may be advantageously pumped. If, for example, water is to be pumped, the power fluid may be water or air under pressure. Whatever the character of the power fluid employed, the pressure thereof is produced by a suitable pump or compressor at the surface of the earth or gas from a gas well may be employed at its natural discharge pressure from said well if such discharge pressure is sufficiently high.

I claim:

1. A rodless well pump including, a working barrel, a standing valve for the working barrel, a hollow plunger in the barrel, a valve for the plunger, a means to carry the pumped liquid upwardly from the working barrel, a cylinder, a piston in the cylinder connected with the plunger, means providing passages for the flow of an operating fluid to the cylinder and the flow of said operating fluid from the cylinder into the liquid column being pumped, a valve to control said passages, a spring means tensioned by movements of the piston as it nears the opposite ends of its stroke to move the valve in opposite directions, and a means releasable by further movement of the piston toward said opposite ends to positively lock the valve in different positions against movement by the spring means while tensioning of the spring means is occurring.

2. A rodless well pump including a cylinder, a piston in the cylinder, a valved working barrel connected with the cylinder, a valved hollow plunger in the working barrel connected with the piston, a means providing a passage for fluid from the working barrel past the cylinder, and a means to alternately apply fluid pressure to the opposed pressure faces of the piston and to alternately exhaust the pressure fluid from opposite ends of the cylinder into said passage, the ratio of the area of one pressure face of said piston to the sum of the areas of the other pressure face of said piston and of the pumping pressure face of the plunger and its valve being approximately the same as the ratio of the area of said other pressure face of the piston to the first mentioned area.

3. A rodless well pump including a cylinder, a piston in the cylinder, a working barrel connected with the cylinder, a downwardly opening standing valve for the working barrel, a plunger in the working barrel connected with the piston, a downwardly opening valve for the plunger, a means providing a passage for fluid from the lower end of the working barrel past the cylinder, and a means to alternately apply

fluid pressure to the opposed pressure faces of the piston and to alternately exhaust the pressure fluid from opposite ends of the cylinder into said passage, the ratio of the area of one of said pressure faces to the sum of the areas of the other of said pressure faces and of the pumping pressure face of the plunger and its valve being approximately the same as the ratio of the area of said other pressure face of the piston to the first mentioned area.

Signed at Los Angeles, California, this 27th day of January, 1930.

BERNARD H. SCOTT.