

Dec. 12, 1944.

W. L. CHURCH

2,364,600

WELL PUMP

Filed Oct. 2, 1943

4 Sheets-Sheet 1

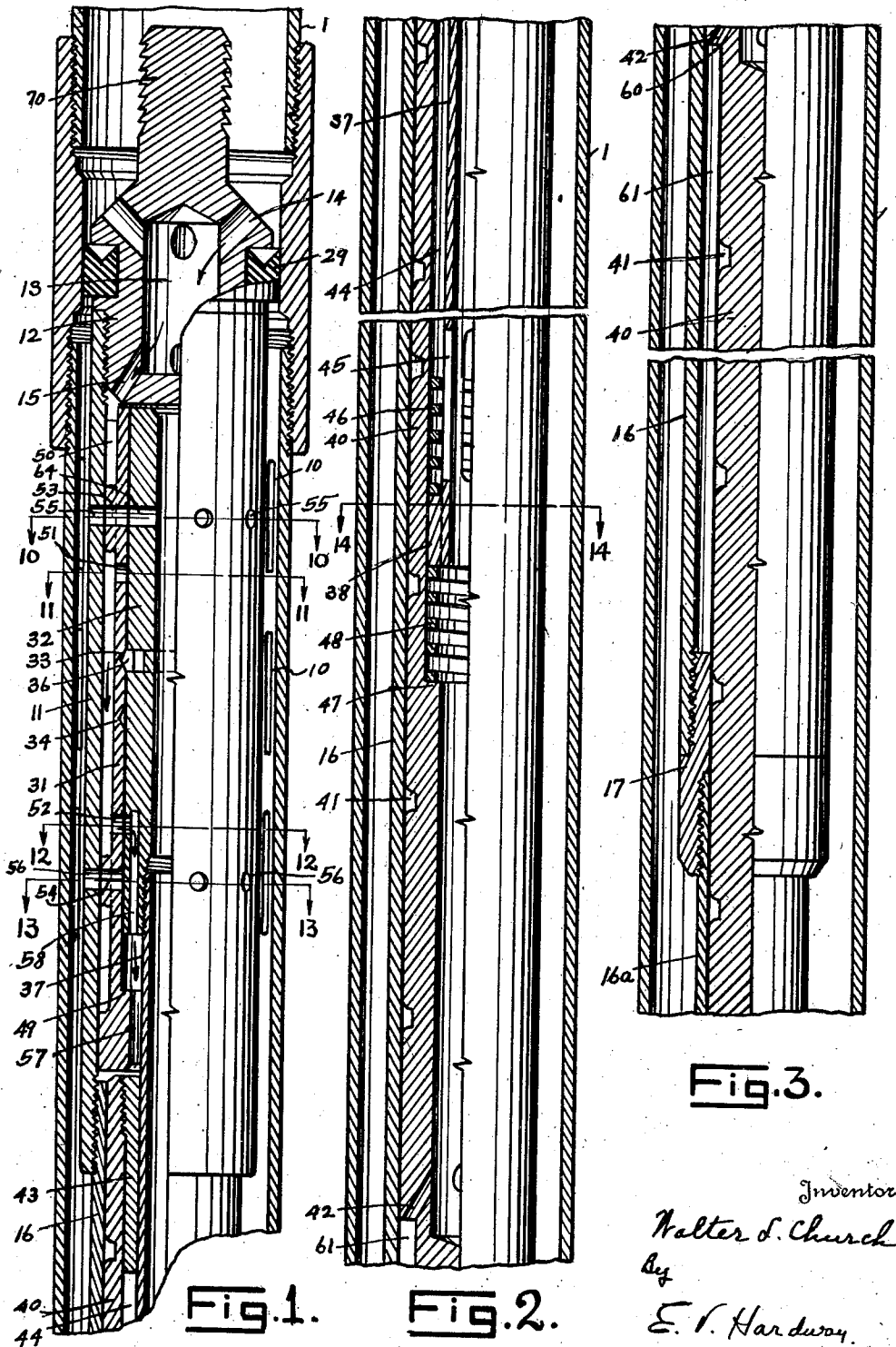


Fig. 3.

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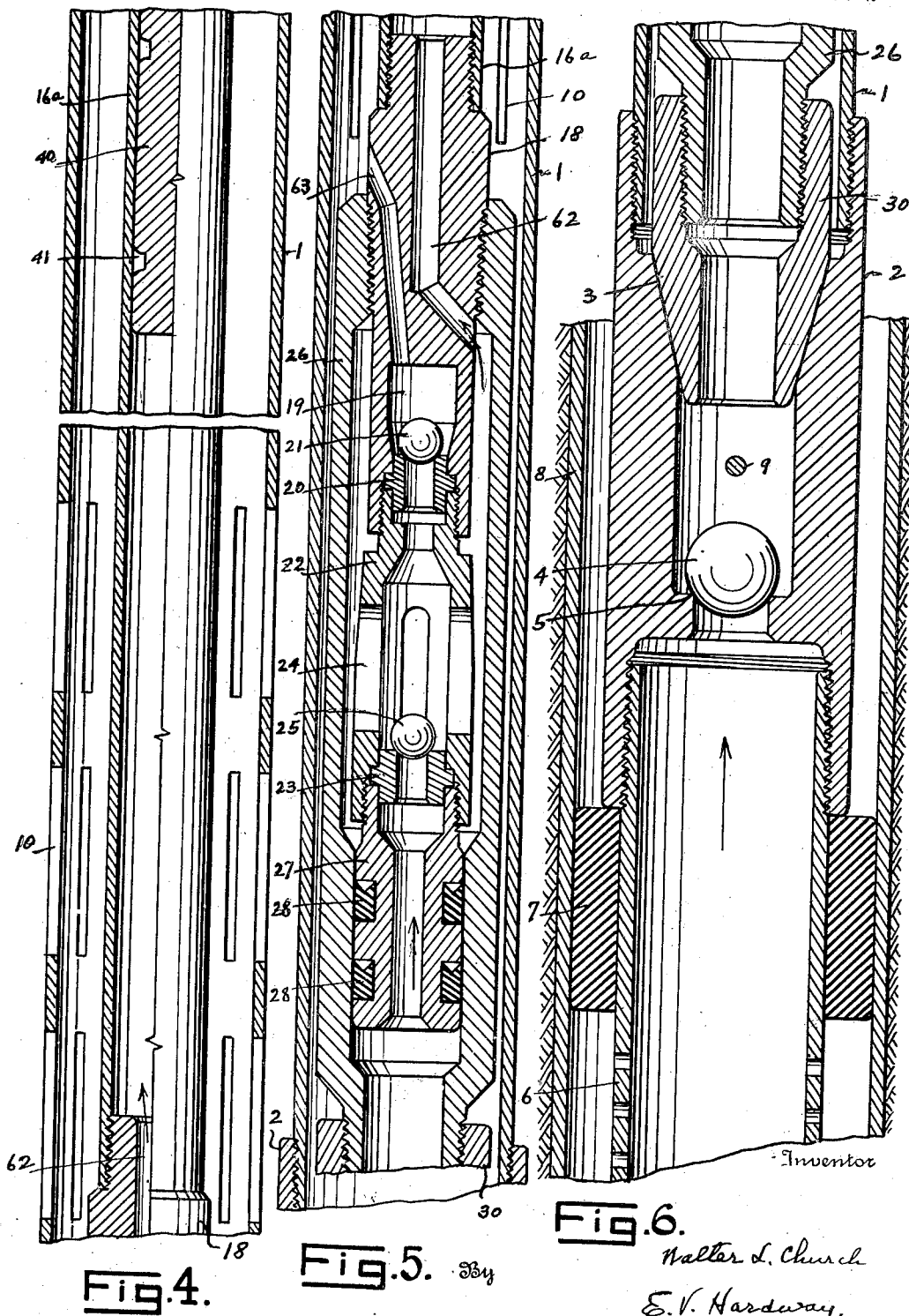


Fig. 6.

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4 Sheets-Sheet 3

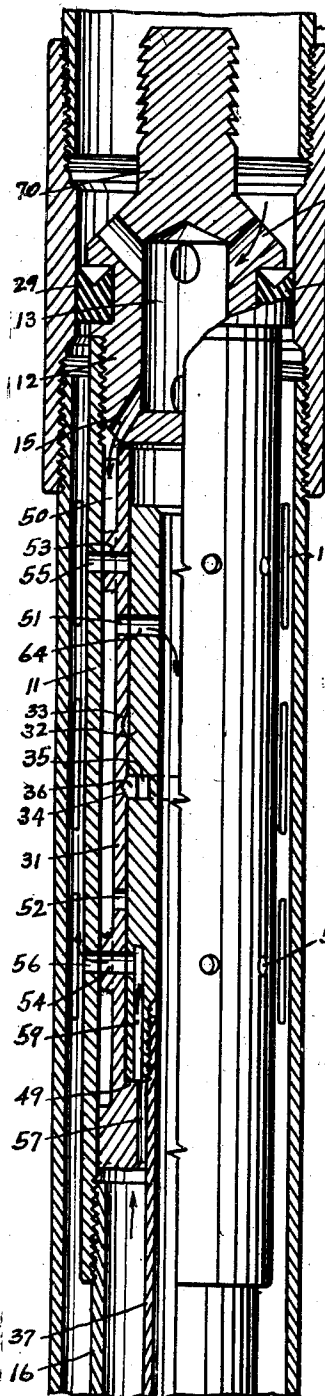


Fig. 7.

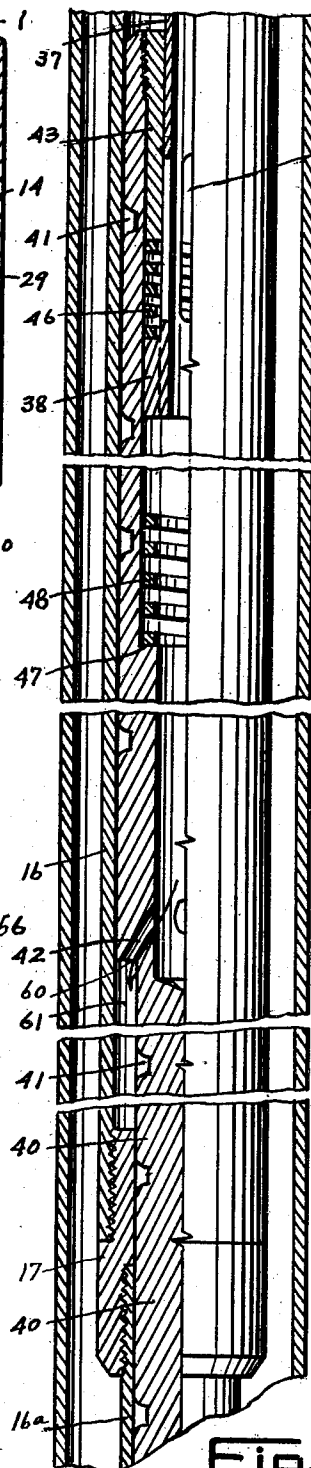


Fig. 8.

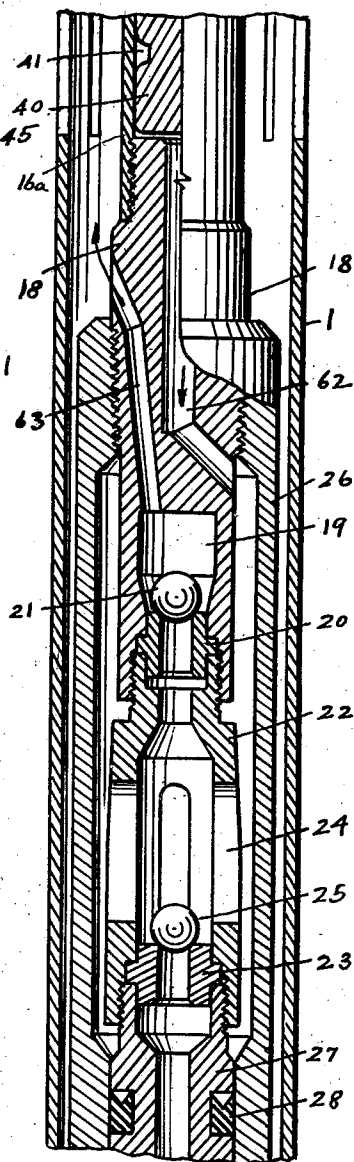


Fig. 9.

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4 Sheets-Sheet 4

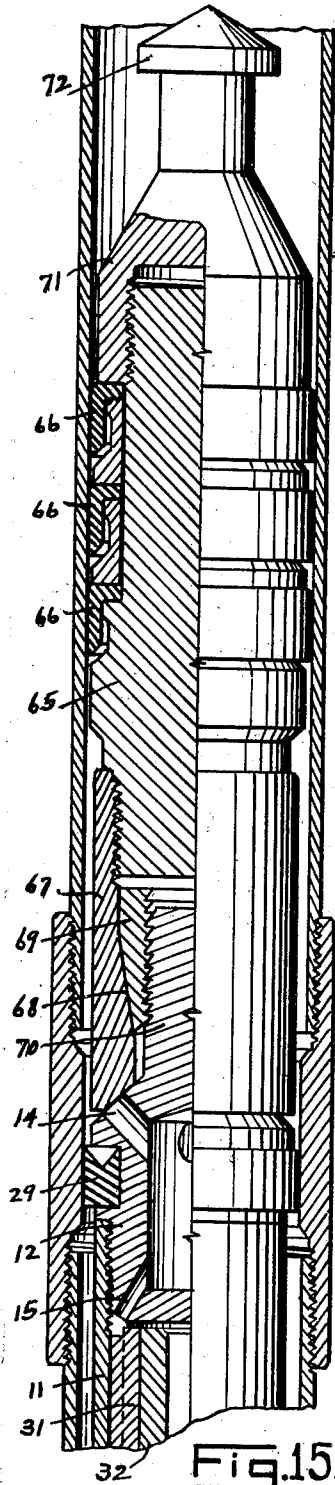


Fig. 15.

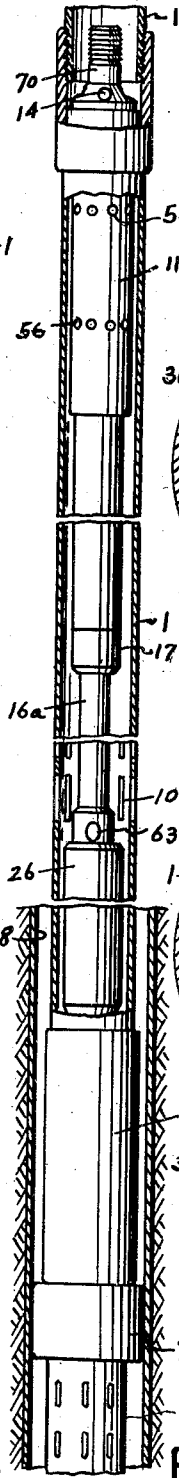


Fig. 16.

Fig. 10.

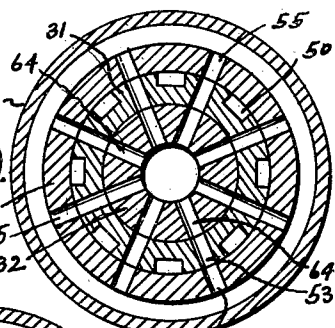


Fig. 11.

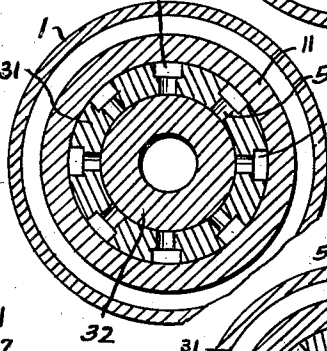


Fig. 12.

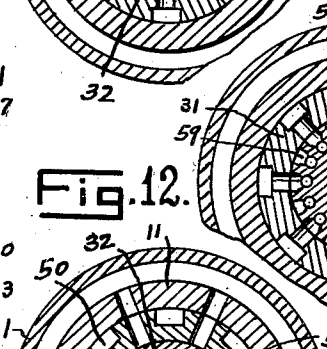


Fig. 13.

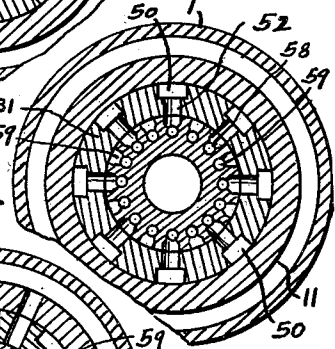
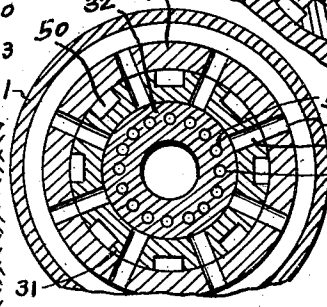
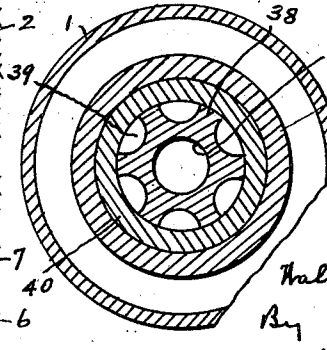


Fig. 14.



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UNITED STATES PATENT OFFICE

2,364,600

WELL PUMP

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Application October 2, 1943, Serial No. 504,793

2 Claims. (Cl. 103-46)

This invention relates to a well pump and has particular relation to a deep well pump which may be operated hydraulically from the ground surface.

An object of the invention is to provide a hydraulically operable well pump which dispenses with the use of sucker rods to reciprocate the pump plunger.

Another object of the invention is to provide a pump of the character described which may be removed from the well either by fluid pressure or by the use of a wire line.

With the above and other objects in view the invention has particular relation to certain novel features of construction, operation and arrangement of parts, an example of which is given in this specification and illustrated in the accompanying drawings where:

Figures 1 to 6 inclusive show upper, intermediate, and lower sections of the pump taken in succession from the upper to the lower ends thereof, shown partly in section, with the parts positioned as at the beginning of a power stroke.

Figures 7, 8 and 9 show upper, intermediate and lower sections of the pump, shown partly in section, with the parts at the end of a power stroke and ready to begin a suction, or intake stroke.

Figure 10 shows a cross sectional view taken on the line 10-10 of Figure 1.

Figure 11 shows a cross sectional view taken on the line 11-11 of Figure 1.

Figure 12 shows a cross sectional view taken on the line 12-12 of Figure 1.

Figure 13 shows a cross sectional view taken on the line 13-13 of Figure 1.

Figure 14 shows a cross sectional view taken on the line 14-14 of Figure 2.

Figure 15 shows a fragmentary side elevation of the upper end of the pump, shown partly in section, showing a combination fishing tool and plunger connected thereto, and

Figure 16 shows a side elevation of the complete structure, partly in section.

Referring now more particularly to the drawings wherein like numerals of reference designate the same parts in each of the figures the numeral 1 designates a well tubing which extends to the ground surface and which, in the present illustration, has a special coupling 2 at its lower end formed with a downwardly converging seat 3 and containing an upwardly opening valve 4 which controls the valve seat 5 formed in said coupling. As shown in the present illustration a well screen 6 is connected to the lower

end of the coupling 2 and there is a packer 7 around the upper end of the screen forming a seal between the well tubing and the outer well casing 8 so as to seal off the producing stratum beneath.

The upward movement of the valve 4 is limited by a cross rod 9 in the coupling 2.

Above the seat 3 the lower end of the tubing 1 is provided with suitable outlet openings 10 which, in the present illustration, are shown as vertical, elongated slots.

The numeral 11 designates a cylindrical valve housing, screwed into the upper end of which there is a head 12 having a central chamber 13 and provided with inlet ducts 14 leading into the chamber from the tubing above and having discharge ducts 15 discharging into the upper end of the housing 11.

The pump cylinder is connected to the lower end of said housing and comprises upper and lower cylindrical sections 16, 16a, the latter of which is reduced in diameter and said sections are connected by the reducing coupling 17.

Screwed into the lower end of the reduced section 16a of the cylinder there is a valve casing 18 containing an internal chamber 19. A tubular valve seat 20 is clamped in the lower end of said valve casing 18 and the passageway therethrough is controlled by the upwardly opening ball valve 21 located in the chamber 19.

Screwed into the lower end of the valve casing 18, and clamping the seat 20 in place, there is a valve cage 22 having a tubular valve seat 23 clamped in the lower end thereof and provided with side outlets 24 above said seat with an upwardly opening ball valve 25 controlling the passageway of liquid upwardly through said seat.

There is a valve housing 26 surrounding the valve cage 22. Its upper and lower ends are reduced in diameter internally. The reduced upper end is internally threaded and screwed onto the valve casing 18. A tubular nipple 27 is screwed into the lower end of the cage 22 and clamps the seat 23 in place and is fitted into the reduced lower end of the housing 26 and has countersunk seal rings 28, 28, therein which form seals between it and the valve housing 26.

The upper end of the pump is sealed with the tubing 1 by means of the seal ring 29 which surrounds and is countersunk into the head 12.

Screwed onto the lower end of the valve housing 29 is the tubular guide 30 whose lower end is tapered to conform to the taper of, and to fit within the seat 3.

Fixed within the housing 11 therein is a cylindrical valve cage 31 within which the sleeve valve 32 is mounted. The cage 31 has the inside upper and lower annular grooves 33, 34 whose sides converge outwardly as shown in Figures 1 and 7 and surrounding the valve and seated in the external annular groove 35 thereof there is an expansible ring 36 whose outer side is shaped to conform to the shape of the grooves 33, 34. This ring is provided to hold the valve 32 in upper or lower position but will yield to permit shifting of the valve as hereinafter fully explained.

Secured to and depending from the valve there is a tubular valve stem 37 whose lower end has an enlarged head 38 thereon provided with external vertical flutes 39 as shown in Figure 14.

Within the cylindrical sections 16, 16a there is a plunger 40 whose upper end is tubular and fits closely within the upper section 16 of the cylinder and whose lower end is reduced in diameter and solid and fits closely within the lower reduced section 16a of the cylinder as shown in Figures 3 and 8.

This plunger has the external annular grooves 41 spaced apart therearound to form liquid seals with the cylinder walls. The lower end of the tubular portion of the plunger has the ducts 42 leading outwardly through the wall thereof into the cylinder as shown in Figures 2 and 8. Screwed within the upper end of the plunger, and fitted closely around the valve stem 37 there is a bushing 43, preferably formed of bronze or brass. This bushing at the upper end of the plunger and the head 38 at the lower end of the valve stem form spacers for spacing the valve stem inwardly from the wall of the plunger thus providing the space 44 and the stem is provided with vertical elongated slots 45 above the head 38 to allow the free flow of the operating liquid into and out of said space.

Surrounding the valve stem and supported on the head 38 there is a strong coil spring 46 and beneath said head the plunger is formed with an inside annular upwardly facing shoulder 47 on which there is supported a coil spring 48. Upon down stroke, or power stroke, of the plunger the bushing 43 will contact the spring 46 as it approaches the end of its stroke and as it moves on down said spring will be compressed exerting a pull on the stem 37 and on the valve 32 thus eventually unseating the expansible ring 36 and permitting the valve 32 to move downwardly until said ring 36 registers with the groove 34 into which it will seat thus stopping the further downward movement of the valve, as shown in Figure 7. Upon upward movement of the plunger, as it approaches the end of its upward stroke, the spring 48 will engage the lower end of the stem 37 and upon further upward movement of said plunger the stem and valve will be moved upwardly, the expansion ring 36 being unseated from the groove 34 and seated in the groove 33, as shown in Figure 1. These springs 46 and 48 act as shock absorbers to cushion the shock of the plunger stroke on the valve. The movement of the valve downwardly is limited by the inside annular upwardly facing shoulder 49 formed in the valve housing 31 beneath the valve and its upward movement is limited by the lower end of the head 12; but the expansion ring 36 holds the valve against movement except when it is moved by the plunger.

The valve cage 31 has the external longitudinal inlet channels 50 leading downwardly from the

upper end thereof and terminating above the lower end thereof, as shown in Figures 1, 7 and 10 to 13 and which receives the operating fluid from the tubing 1 above; and also has the corresponding upper and lower inlet ports 51 and 52, as shown in Figures 1 and 7, which lead inwardly from said respective channels as is also shown in Figures 11 and 12.

The valve cage 31 also has the upper and lower exhaust ports 53 and 54, as shown in Figures 1, 7, 10 and 13. These exhaust ports 53 and 54 are staggered, circumferentially, with respect to the channels 50, as shown in Figures 10 and 13 but they are in constant registration with the upper and lower exhaust ports 55, 56 through the valve housing 11, as is also shown in Figures 1, 7, 10 and 13.

The valve stem 37 is spaced inwardly from the lower end of the valve cage 31, as is shown in Figures 1 and 7, to allow a passageway 57 for fluid and the lower end of the valve 32 has a series of inlet bores 58 and a corresponding series of exhaust bores 59 leading upwardly therethrough from the lower end of the valve. The upper ends of these bores are turned outwardly through the valve wall, as shown in Figure 12. These outwardly turned ends are positioned to register, respectively, with the inlet ports 52 and the discharge ports 54 as is illustrated in Figures 1 and 7 and also in Figures 12 and 13.

It will be observed from an inspection of Figures 3 and 8 that the reduction in diameter of the lower end of the plunger 40 forms an external annular shoulder 60 on said plunger thus providing a space 61 for fluid around the plunger between the shoulder 60 and the upper end of the reducing coupling 17 into which the ducts 42 lead and from an inspection of Figures 5 and 9 it will be noted that the valve casing 18 has a bore 62 leading from within the valve housing 26 into the lower end of the pump cylinder and a bore 63 leading from the chamber 19 into the tubing 1.

The valve 32 has the ports 64 adapted to be brought into registration with the inlet and exhaust ports 51 and 53 as the valve is shifted to inlet or exhaust position.

Assuming that the valve is at the end of an exhaust, or up, stroke, as shown in Figures 1 to 4 inclusive, the valve 32 will be in its upper position with the exhaust ports 53, 55 and 64 in registration and with the upper ends of the bores 58 in registration with the ports 52. The ports 51 will be closed as will also the ports 54, 56 and the lower end of the cylinder will be filled with the well liquid drawn in from the preceding up stroke. This well liquid will pass in through the screen 6 and upwardly lifting the valves 4, 25 and passing on up through the bore 62 as indicated by the arrows in Figures 4, 5 and 6. The operating fluid will now pass downwardly through the channels 50, through the ports 52, bores 58 and the passageway 57 as indicated by the arrows in Figure 1 and will move the plunger downwardly expelling the liquid from the pump cylinder beneath the plunger 40 and the valve 25 will be closed and the valve 21 lifted and the pumped liquid will be expelled through the bores 62, 63 as indicated by the arrows in Figure 9 and will pass out into the tubing and on out through the slots 10 thereof into the well casing 8 and on up to the ground surface. As the plunger approaches the end of the downward movement the bushing 41 will contact the spring 46 and compress the same and as it moves on downward it

will exert a pull through the valve stem 37 on the valve 32 as herein above explained causing said valve to move downward and causing the port 64 thereof to register with the port 51 and also causing the upper ends of the bores 59 thereof to register with the exhaust ports 54, 56, as shown in Figure 7. Thereupon the pressure of the operating fluid will be relieved from the upper end of the plunger and said operating fluid will pass inwardly through the ports 51, 64 and on down through the plunger and into the space 61 thereby forcing the plunger back upwardly, on intake stroke, thus drawing another charge of well fluid into the pump cylinder and the spent operating fluid above the plunger will be exhausted out through the space 57, the bores 59 and the exhaust ports 54, 56 as indicated by arrows in Figure 7. As the plunger approaches the limit of its upward movement the spring 48 will engage the lower end of the stem 37 and as it moves on upward said spring will be compressed and will move said stem and valve upwardly into the position shown in Figure 1 with the port 64 in registration with the exhaust ports 53, 55 and with the upper ends of the bores in registration with the inlet ports 52 all of which is shown in Figure 1, ready for the next succeeding down stroke, or power stroke, of the plunger. Upon each down stroke of the plunger the pressure of the operating fluid therein and in the spaces 44 and 61 will be relieved through the ports 64, 53 and 55.

Provision has been made for removing the pump from the well tubing 1. In Figure 15 there is shown in combination a fishing tool and plunger wherein the numeral 65 designates a cylindrical plunger body having the downwardly opening cup rings 66 thereupon which fit closely within the tubing 1. Screwed into the lower end of the body 65 there is a slip bowl 67 provided with an inside downwardly converging seat 68 whereon there is mounted a plurality of wedge shaped slips 69 having inside teeth engageable with the outwardly toothed stem 70 upstanding from the head 12.

Screwed onto the upper end of the body 65 and clamping the cup rings in place there is a screw cap 11 having a conical shaped head 72. This combination fishing tool and plunger may be dropped into the tubing 1 at the ground surface and pumped down by fluid pressure until it lands on the upper end of the head 12 and the lower end of the slip bowl will close the ducts 14 and the slips 69 will engage the stem 70.

Thereupon the circulation of the operating

fluid may be reversed, that is it may be forced downwardly through the casing 8 instead of through the tubing and inwardly through the slots 10 beneath the cups 66 and the pressure will ordinarily be sufficient to unseat the pump and carry it to the ground surface. However if it is not, a wire line with a grappling tool may be lowered into the tubing and engaged with the head 72 and the pump pulled out.

What I claim is:

1. A pump for wells shaped to be inserted into a tubing in, and sealed with the wall of, a well and comprising a cylinder, a plunger reciprocable therein, means for admitting an operating liquid from the tubing into the cylinder and applying the pressure thereof in opposite directions, alternately, to the plunger to reciprocate the same, means for relieving the operating liquid in advance of the plunger, as the plunger reciprocates, said liquid admitting and relieving means including a valve to be moved by the plunger into one position to permit application of the operating fluid to the plunger to move the same in one direction, retractable means for temporarily holding the valve in said position, said valve being movable to another position to relieve the operating fluid, releasable means for temporarily holding the valve in said last mentioned position and yieldable means arranged to be placed under compression when the valve is in either of said positions, said pump having a conduit leading from the well beneath the seal and discharging into the tubing above the seal and a valve controlling the advance of well liquid upwardly through the conduit.

2. In a pump, a cylinder, a plunger therein, a valve assembly connected to the plunger, said pump having fluid passageways through which an operating fluid may be applied to the plunger to reciprocate the same, said valve mechanism including a sleeve valve therein movable to one position to direct the operating fluid on one side of the plunger and movable to another position to direct the operating fluid to the other side of the plunger, a valve stem connecting the plunger to the valve for correspondingly moving the valve as the plunger moves, releasable means for temporarily holding the valve in either of said positions and yieldable means arranged to be placed under compression by the stem as said stem approaches the limit of its movement in either direction.

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