May 9, 1933. A. G. GAGE 1,907,947

OIL WELL PUMP

Original Filed May 14, 1926 2 Sheets-Sheet 1

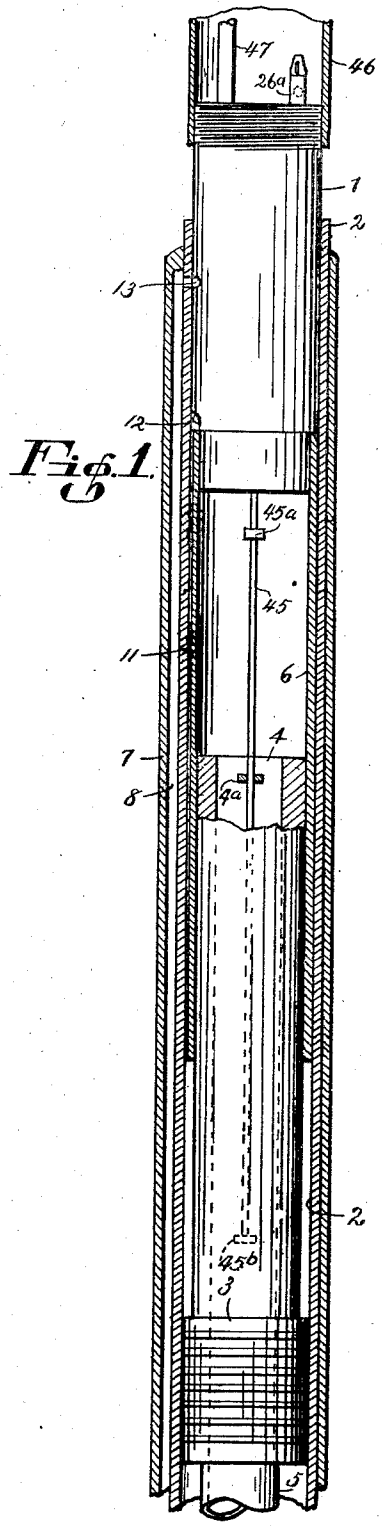

Fig. 1.

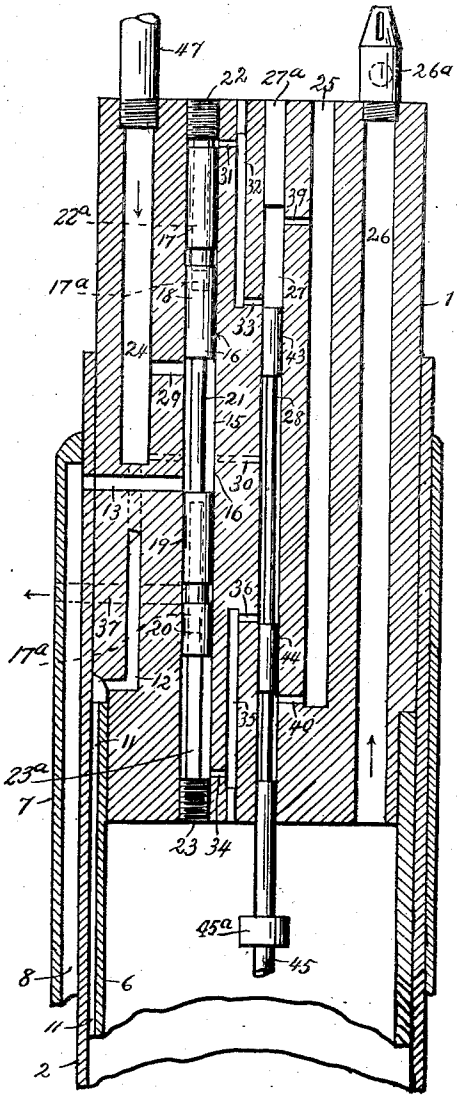

Fig. 2.

INVENTOR.

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OIL WELL PUMP

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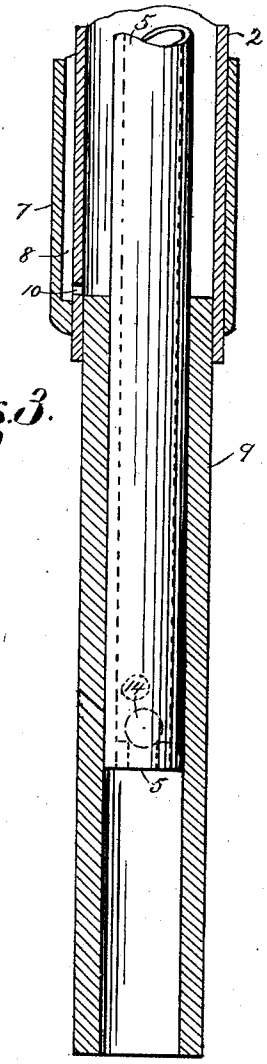

Fig. 3.

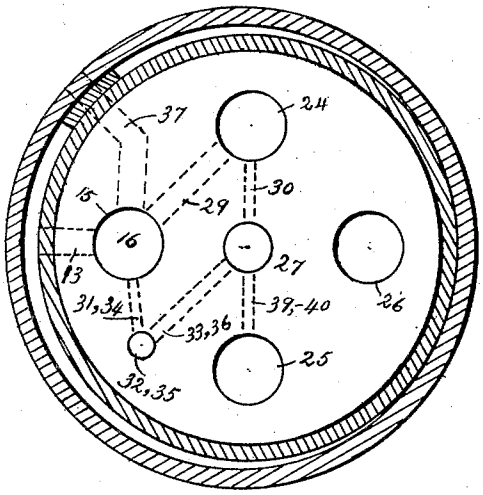

Fig. 4.

INVENTOR.

Arthur G. Gage

Patented May 9, 1933 1,907,947

UNITED STATES PATENT OFFICE

ARTHUR G. GAGE, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO ALTA VISTA HYDRAULIC CO., LTD., OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA

OIL WELL PUMP

Application filed May 14, 1926, Serial No. 109,098. Renewed October 7, 1932.

My present invention relates to hydraulically operated pumps to be used for raising water or oil from deep bored wells, the objects being to provide a deep well pump that is operated by fluid pressure from the surface of the ground; also to provide a simple single acting pump having few moving parts, and to provide a pump for oil wells having a single acting pumping cylinder actuated by a double acting operating cylinder.

With reference to the drawings:

Fig. 1 is a sectional elevation of the upper portion of the pump;

Fig. 2 is a view of the valves and parts of a valve head for the pump.

Fig. 3 is a sectional elevation of the lower portion of the pump, and is intended to be a nether continuation of the portion shown in Fig. 1.

Fig. 4 is a transverse view of the valve head showing the position of longitudinal bores and transverse connecting parts.

The pump proper includes a valve head 1, hereinafter more fully described in detail, to which is attached a depending cylinder 2. Within the cylinder 2 is a tubular plunger assembly comprising a piston head 3, a reduced diameter section 4 extending above the piston, and a second section 5, of smaller diameter than section 4, extending below the piston head. By virtue of the differential diameters of plunger sections 4 and 5, there is formed an annular pressure area on the upper end of piston 3 of comparatively smaller area than the downwardly facing pressure area on the lower end of the piston. The advantages of providing such differential pressure areas at the ends of the piston section of the plunger will be made apparent in the description to follow. Plunger section 4 has a smooth sliding fit within a sleeve 6 attached to the lower end of the valve head and depending therefrom within the piston cylinder 2, the interior of sleeve 6 forming a displacement chamber for the well liquid being pumped. An outside sleeve 7 is placed eccentrically about the cylinder 2, the eccentric positioning of the sleeve providing a longitudinal fluid passage 8 leading from the valve head to the bottom of cylinder 2.

A second cylinder 9 is seated in the lower part of the cylinder 2 and is adapted to carry slidably the plunger 5. The upper end of this cylinder forms the lower head for the driving cylinder 2. A port 10 connects the port 8 with the lower end of the cylinder 2 and a port 11 is formed by grooving the cylinder 6 and connects an orifice 12 of the valve head with the top of the cylinder 2. The sleeve 7 is welded top and bottom to the cylinder 2, and at the top the port 8 connects with the valve head by an orifice 13. In the bottom of the plunger 5 is a ball check valve 14.

Regarding the valve head 1, and with reference to Figs. 2 and 4; the valve head carries a plurality of longitudinal bores, some of which carry piston valves, and transverse connecting ports. If all the ports and bores were spread out on an elevated plane they would appear as shown in Fig. 2, and the relative position of the longitudinal bores and connecting ports are all shown in Fig. 4, the connecting ports being shown by dotted lines.

The bore 15 carries a main valve 16 having pistons 17 and 18 at its upper end and 19 and 20 at the lower end, the said pistons 18 and 19 being connected by a waist 21. The bore 15 is closed at its upper and lower ends by plugs 22 and 23, respectively, having fingers 22*a* and 23*a* which extend into end bores 17*a* and 20*a*, respectively, of the main valve, thus forming checks to keep the valve from pounding. A bore 24 forms an inlet for the fluid which operates the pump. A bore 25 is the discharge means for the fluid which is used to operate the master valve. A bore 26 is used as a discharge conduit through the valve head for the oil being discharged by the pump, and carries a discharge valve 26*a* at the top end.

The central bore 27 carries a pilot valve 28 adapted to be operated by each stroke of the piston and plungers, the upper end of bore 27 being closed by plug 27*a*. The inlet bore 24 is connected with the main valve bore 15 by a port 29 and with the pilot valve

bore 28 by a port 30. The master valve bore 15 is connected with the pilot valve bore 27 by a port 31 bore 32 and port 33 at the top, and by a port 34 bore 35 and port 36 at the bottom. The main valve bore also carries a port 37 which discharges into the well, and a port 13 connecting into the port 8.

The pilot valve bore is connected with the bore 25 by a port 39 at its upper end and by a port 40 at the lower end. The inlet bore 24 is also connected with the port 11 by a port 12. The pilot valve carries an upper piston 43, a lower piston 44 and a long stem 45 extending down into the plungers and piston below which are tubular, there being a lug 45*b* at the bottom and a second lug 45*a* near the top of the pilot valve stem adapted to be engaged by a bar 4*a* positioned within the top of the plunger 4. The pilot valve is caused to be moved a short distance at the end of each stroke of the plungers and piston by the engagement of bar 4*a* with lugs 45*a* and 45*b*.

It is intended that the pump shall be screwed into the lower end of a string of tubing 46, and that there shall be a smaller string of tubing 47 within the tubing 46 adapted to conduct to the pump a high pressure operating fluid which preferably, though not necessarily, may be a clean fairly light oil. The fluid that is pumped by the device is conducted to the surface of the ground by the larger tubing 46. The operating fluid should be of a higher pressure than the pumped liquid.

The operation of the device is as follows: During the up stroke of the plunger 4, piston 3 and plunger 5, any oil filling the cylinder above the plunger 4 will be discharged through the valve 26*a* and conduit 46. During the downward movement of the plunger, oil from the well is drawn in through the bottom valve 14, and through the tubular plunger into the space above to be discharged as before into the tubing 46. The upward movement of the plunger is obtained by admitting high pressure oil from the valve head through the port 8 and port 10 into the bottom of the cylinder 2 below the piston 3; the downward movement of the plunger is obtained or accelerated by the constant pressure of oil, for example the high pressure operating fluid upon the small exposed area of the top of the piston, the oil under the piston being released by the valve head out into the well. This small volume of fluid acting upon the smaller upper area of the piston, surges back and forth from the inlet bore 24, of the valve head through ports 11 and 12.

This present pump is designed to operate on a small volume of high pressure oil entering under the piston 3 which is subsequently discharged into the well, and to draw in at each stroke from the well a larger volume of oil into the larger space above the plunger 4 which shall be sufficient to show a substantial net volume over the oil discharged from under the piston. Therefore, the upper plunger is the pumping plunger and the upper end of the cylinder is the pumping end, while the lower end of the cylinder is the operating end and the lower piston is fixed to the plunger merely to set up a proper differential in area between the oil pumped and the oil consumed in the operation of the pump. The area on the upper side of the piston 3 which is exposed to the high pressure operating oil should be only large enough to force the oil out from under the piston and through the valve head, and to afford a quick down movement of the plunger on the return stroke.

It will be recognized that although the differential of total applied force to raise the plunger has been obtained in the present embodiment by a differential of oppositely facing areas exposed to the same fluid under the same pressure, that the essence of the system resides not necessarily in a differential of areas, but in a differential of oppositely applied total effective forces, whether or not these forces are caused by the same actuating fluid, or by actuating fluids at the same pressure.

In the operation of the valve head 1, high pressure operating oil is admitted into the bore 24 from which it flows to the pilot valve bore 27 by port 30. With the pilot valve in the position shown in Fig. 2, which position has been obtained by being pulled down due to the engagement of bar 4*a* with lug 45*b* toward the end of downward movement of the plungers, the operating oil flows from the pilot valve bore through ports 34, 35 and 36 into the bottom of the main valve, bore 16, forcing the main valve up to the top of its bore. With the main valve in this elevated position the operating oil then flows from the inlet bore 24 through ports 29, 13, 8 and 10 into the bottom of the cylinder 2, forcing the plunger up. When the plunger reaches the top of its stroke it moves the pilot valve upwardly, thus shutting off the flow of oil to the bottom of the main valve bore, and opening it, through ports 34, 35 and 36 and 40, to the discharge bore 25, and at the same time allowing the operating oil to flow into the upper end of the main valve bore through ports 31, 32 and 33, thus moving the main valve down to the bottom of its bore. With the main valve in this position, the high pressure operating oil is cut off from the cylinder 2, and the oil which entered under the piston then flows back out through ports 10, 8, 13 and 37 and into the well. When the plunger reaches the bottom of its stroke the pilot valve is pulled down and the main valve is again reversed.

The oil discharged from the main valve bore is discharged across the pilot valve bore and into the bore 25, and this bore 25 is connected into the tubing 46 in order that the static pressure of the oil in that tubing shall in part balance the pressure of the high pressure operating oil on the valves, there being sufficient difference between the two pressures to operate the master valve.

It will be noticed that the upper end of the plunger is exposed to dirty well oil, and is subjected alternately to well pressure and column pressure, and that the lower end of the plunger is subjected always to dirty well oil under well pressure. The clean high pressure oil applied to the upper end of the piston head is then at a pressure higher than column pressure so that any leakage taking place is leakage of clean oil traveling from the high pressure oil zone to the dirty oil end of the plunger at all times, thus continually washing the plunger and maintaining it clean of sand particles. A part of the plunger above the lower end is subjected to clean oil under the alternating pressures of high pressure and well pressure, so that, whenever leakage takes place at that zone, clean oil is traveling down toward the dirty well oil zone at the lower end of the plunger, and thus also cleaning the plunger at its lower end.

It is to be understood that I do not limit myself to the exact arrangement of the valves and ports in the valve head and that many changes might be made in the invention as shown without departing from the spirit thereof, as claimed.

Having thus described my invention, I claim:

1. In an oil well pump in combination, a cylinder, a tubular piston for the cylinder, a tubular plunger part extending from one end of the piston and adapted to decrease the area of the piston to provide an area of small extent against which a high pressure fluid may operate to move the piston and plunger through a filling stroke of the pump, a cylinder for the plunger, a discharge valve for the plunger cylinder, a port adapted to conduct a high pressure fluid constantly against the small exposed area of the piston, a second hollowed plunger part extending from the other end of the piston and adapted to decrease the area thereof to a determined extent less than the area of the first mentioned plunger, a cylinder for the second plunger, an inlet valve for controlling flow of operating fluid to the piston and plungers, a valve head for the pump, a port connecting with the valve head and adapted to conduct the high pressure operating fluid to and from the larger exposed area of the piston, and valves mounted in the valve head for alternately admitting into and discharging the operating fluid from said second named port whereby the piston and plungers may be operated through a discharging stroke.

2. In combination, in an oil well pump, a cylinder, a tubular piston for the cylinder, a tubular plunger part extending from one end of the piston and adapted to decrease the area of the piston to provide an area of relatively small extent against which a high pressure fluid may operate to move the piston and plunger through a filling stroke of the pump, a cylinder for the plunger, a discharge valve for the plunger cylinder, means for admitting a high pressure fluid constantly against the small exposed area of the piston, a second tubular plunger part extending from the other end of the piston and adapted to decrease the area thereof to a determined extent less than the area of the first mentioned plunger, a cylinder for the second plunger part, an inlet valve for the pump mounted in said tubular piston and plungers, and a valve head for the pump adapted to conduct a high pressure operating fluid against and away from the larger exposed area of the piston whereby the piston and plungers may be operated through a discharging stroke.

3. In combination, in an oil well pump, a cylinder, a tubular piston for the cylinder, a tubular plunger part extending from one end of the piston and adapted to decrease the area of the piston to provide an area of relatively small extent against which a high pressure fluid may operate to move the piston and plunger part through a filling stroke of the pump, a cylinder for the plunger, a discharge valve for the plunger cylinder, means for admitting a high pressure fluid constantly against the small exposed area of the piston, a second tubular plunger part extending from the other end of the piston and adapted to decrease the area thereof to a determined extent less than the the area of the first mentioned plunger, a cylinder for the second plunger, an inlet valve for the pump mounted in said tubular piston and plungers, and means for conducting a high pressure operating fluid to and from the larger exposed area of the piston whereby the piston and plungers may be operated through a discharging stroke of the pump.

4. In a pump of the kind described, the combination of a pump barrel having a bore of relatively small diameter above and a relatively large bore below, a valve-head at the upper end of the barrel, a plunger having a tubular body with its upper portion mounted to reciprocate in the said small bore of the barrel below the valve-head, said plunger having a medial piston-head mounted to reciprocate in the bore of larger diameter, the tubular body of said plunger above the piston-head being of larger diameter than

the body of the plunger below the piston-head whereby an effective annular area is formed on the under side of the piston-head of greater area than the annular area on the upper side of the piston-head, a check-valve in the tubular body of the plunger, means for admitting fluid under high pressure to the barrel below the said piston-head to raise the plunger, means for admitting fluid under pressure to the interior of the barrel above the piston-head and below the bore of reduced diameter, and a valve in the valve-head operating to pass the pumped fluid upwardly through the valve-head on each up-stroke of the plunger, a pipe confining a well liquid discharge column above said valve head, and a second pipe confining a high pressure fluid column above the valve head, one of said pipes being within the other.

5. In a pump of the kind described, the combination of a pump barrel having a bore of relatively small diameter above and a relatively large bore below, a valve-head at the upper end of the barrel, a plunger having a tubular body with its upper portion mounted to reciprocate in the said small bore of the barrel below the valve-head, said plunger having a medial piston head mounted to reciprocate in the bore of larger diameter, the tubular body of said plunger above the piston-head being of larger diameter than the body of the plunger below the piston-head whereby an effective annular area is formed on the under side of the piston-head of greater area than the annular area on the upper side of the piston head, a check-valve in the tubular body of the plunger, means for periodically admitting fluid under higher pressure than the pressure in the pumped column of liquid to the barrel below the said piston-head to raise the plunger, means for constantly admitting fluid under pressure to the interior of the barrel above the piston head and below the bore of reduced diameter, to actuate the plunger in its down-stroke, and a valve in the valve-head operating to pass the pumped liquid upwardly through the valve-head on each up-stroke of the plunger.

6. In a pump of the kind described, the combination of a pump barrel having a bore of relatively small diameter above and a relatively large bore below, a valve-head at the upper end of the barrel, a plunger having a tubular body with its upper portion mounted to reciprocate in the said small bore of the barrel below the valve-head, said plunger having a medial piston-head to reciprocate in the bore of larger diameter, the tubular body of said plunger above the piston-head being of larger diameter than the body of the plunger below the piston-head whereby an effective annular area is formed on the under side of the piston-head of greater area than the annular area on the upper side of the piston-head, there being a fluid passage extending through said valve head and barrel to the upper side of the piston, a check-valve in the tubular body of the plunger, a fluid-actuated valve for admitting fluid under high pressure to the interior of the barrel below the piston-head to raise the plunger, and for opening communication from the interior of the barrel below the piston-head to the exterior, to permit exhaust of the fluid under pressure on the down-stroke of the plunger, said fluid actuated valve also operating to control the application of high pressure fluid to the upper face of the piston, and an automatic valve for controlling the flow of the operating fluid to the fluid-operated valve.

7. In a well pump of the character described, the combinations comprising a well pipe, a pump barrel suspended within the well on said pipe, a fluid pressure actuated plunger within said barrel, means for maintaining a relatively small effective fluid pressure force constantly on the plunger to press it in one direction of its movement, and means for intermittently applying a relatively larger opposing fluid pressure force on the plunger to move it in the other direction.

8. In a well pump of the character described, the combination comprising a well pipe, a pump barrel suspended within the well on said pipe, a fluid pressure actuated plunger within said barrel, a pressure area on said plunger facing in one direction, means for constantly maintaining a fluid under pressure on said pressure area to press the plunger in one direction of its movement, a second pressure area on said plunger facing in the opposite direction to the first said area, and means for intermittently applying fluid under pressure to the said last mentioned pressure area, the total effective pressure applied to said last mentioned area being greater than the total effective pressure on said oppositely facing first mentioned area.

9. In a well pump of the character described, the combination comprising a well pipe, a pump barrel suspended within the well on said pipe, a fluid pressure actuated plunger within said barrel, a pressure area on said plunger facing in one direction, means for constantly maintaining a fluid under pressure on said pressure area, a relatively larger pressure area on said plunger facing in the opposite direction, and means for intermittently applying a fluid under pressure to the last mentioned pressure area, whereby the plunger is alternately raised and lowered.

10. In a pump of the character described, the combination of a pump barrel, a plunger mounted to be reciprocated therein, a pres-

sure area on said plunger facing in one direction, means for constantly maintaining a fluid under pressure on said pressure area, a relatively larger pressure area on said plunger facing in the opposite direction, and means for intermittently applying the same fluid under pressure to the last mentioned pressure area, whereby the plunger is alternately raised and lowered.

11. In a pump of the character described, the combination of a pump barrel, a plunger mounted to be reciprocated therein, means for constantly maintaining an effective fluid pressure downwardly on the plunger for downward movement thereof, and means for intermittently applying an effective fluid pressure upwardly on the plunger sufficient to overbalance the weight of the plunger plus the effective downwardly acting fluid pressure, whereby the plunger is alternately raised and lowered.

12. In a pump of the character described, the combination of a pump barrel, a plunger mounted to be reciprocated therein, an upwardly facing effective area on said plunger, means for constantly maintaining an effective fluid pressure on said upwardly facing area whereby said plunger is constantly pressed downward, a downwardly facing effective area on said plunger, and means for intermittently applying an effective fluid pressure on said downwardly facing area whereby said plunger is intermittently pressed upward, the total effective pressure on said downwardly facing area being greater than the total effective pressure on said upwardly facing area.

13. In a pump of the character described, the combination of a pump barrel, a plunger mounted to be reciprocated therein, an upwardly facing effective area on said plunger, means for constantly maintaining a fluid under pressure on said upwardly facing area whereby said plunger is constantly pressed downward, a downwardly facing effective area on said plunger, said downwardly facing effective area being relatively larger than said upwardly facing effective area, and means for intermittently applying the same fluid under pressure on said downwardly facing area, whereby the said plunger is alternately raised and lowered.

14. In a pump of the character described, the combination of a pump barrel having a medial bore, an upper bore of reduced diameter above said medial bore, and a lower bore of still further reduced diameter below said medial bore, a hollow plunger mounted to reciprocate in the pump barrel, said hollow plunger comprising a piston head adapted to work in the said medial bore of the barrel, an upper plunger part of reduced diameter extending upwardly from said piston-head and adapted to work in the said reduced upper bore, whereby an upwardly facing annular area is provided on the upper end of the said piston-head, a lower plunger part of reduced diameter extending downwardly from said piston-head and adapted to work in the said reduced lower bore, whereby a downwardly facing annular area is provided on the lower end of the piston-head of greater extent than the upwardly facing annular area on the upper end of the piston-head, means for constantly admitting fluid under pressure to the medial bore of the barrel above the piston-head, and valvular means for intermittently admitting fluid under pressure to the medial bore of the barrel below the piston-head.

15. In a pump of the character described, the combination of a pump barrel having a medial bore, an upper bore of reduced diameter above said medial bore, and a lower bore of still further reduced diameter below said medial bore, a valve head at the upper end of the barrel, a hollow plunger mounted to reciprocate in the pump barrel, said hollow plunger comprising a piston head adapted to work in the said medial bore of the barrel, an upper plunger part of reduced diameter extending upwardly from said piston-head and adapted to work in the said reduced upper bore, whereby an upwardly facing annular area is provided on the upper end of the said piston-head, a lower plunger part of reduced diameter extending downwardly from said piston-head and adapted to work in the said reduced lower bore, whereby a downwardly facing annular area is provided on the lower end of the piston-head of greater extent than the upwardly facing annular area on the upper end of the piston-head, a shell surrounding the pump barrel with clearance, and being connected to the valve head at its upper end and connected to the barrel below the medial bore thereof at its lower end, there being a conduit in the valve head for admission to the pump of high-pressure operating fluid, said conduit being communicable with the medial bore of the barrel above the piston-head, and valvular mechanism in the piston head for intermittently admitting high pressure fluid from the said conduit to the clearance space between the pump barrel and surrounding shell, there being a port in the wall of the barrel at the lower end of its medial bore providing communication between the said clearance space and the medial bore below the piston-head for the passage of high pressure fluid.

16. In a pump of the character described, the combination of a pump barrel having a medial bore, an upper bore of reduced diameter above said medial bore, and a lower bore of still further reduced diameter below said medial bore, a hollow plunger mounted to reciprocate in the pump barrel, said hollow plunger comprising a piston

head adapted to work in the said medial bore of the barrel, an upper plunger part of reduced diameter extending upwardly from said piston-head and adapted to work in the said reduced upper bore, whereby an upwardly facing annular area is provided on the upper end of the said piston-head, a lower plunger part of reduced diameter extending downwardly from said piston-head and adapted to work in the said reduced lower bore, whereby a downwardly facing annular area is provided on the lower end of the piston-head of greater extent than the upwardly facing annular area on the upper end of the piston-head, means for admitting clean high-pressure oil to the barrel and to a medial portion of the plunger above the upwardly facing annular area thereof, the said clean high-pressure oil acting to press the plunger downward and to maintain the plunger clean by virtue of leakage, means for intermittently admitting clean high-pressure oil to the barrel and to a medial portion of the plunger below the downwardly facing annular area thereof, the said clean high-pressure oil acting intermittently to press the plunger upward and to maintain the plunger clean by virtue of leakage.

17. In a pump of the character described, the combination of a pump barrel, a plunger mounted to be reciprocated therein, an upwardly facing effective area on said plunger and intermediate the ends thereof, a downwardly facing effective area on said plunger and intermediate the ends thereof, means for constantly admitting clean high-pressure oil to the barrel and to a medial portion of the plunger above the said upwardly facing area, said clean high-pressure oil acting to exert pressure downward on the plunger and to maintain the plunger clean by virtue of leakage, means for intermittently admitting clean high-pressure oil to the barrel and to a medial portion of the plunger below the said downwardly facing area, the total pressure of the high-pressure oil against the said downwardly facing area being sufficiently large to overbalance the total downward pressure due to the weight of the plunger plus the said first mentioned effective oil pressure, whereby the said last mentioned clean-high-pressure oil acts intermittently to raise the plunger and to maintain the plunger clean by virtue of leakage.

18. In a pump of the character described, the combination of a pump barrel, a plunger mounted to be reciprocated therein, means for intermittently applying an effective fluid pressure upward on the said plunger for upward movement thereof, means for constantly maintaining an effective pressure of clean oil downward on said plunger, the last mentioned effective downward pressure being less than the first mentioned effective upward pressure, whereby the plunger is pressed downward between upward applications of fluid pressure, said clean oil being applied to a medial portion of the plunger whereby the said plunger is maintained clean by virtue of leakage.

19. In a pump of the character described, the combination comprising a pump barrel, a fluid pressure actuated plunger within said barrel, means for applying a relatively small effective fluid pressure force on the plunger to press it in one direction of its movement, means for applying a relatively larger fluid pressure force on the plunger to move it in an opposite direction, the first mentioned means comprising means for applying clean oil to a medial portion of the plunger whereby said plunger is maintained clean by virtue of leakage.

20. In a pump of the character described, the combination comprising a pump barrel, a fluid pressure actuated plunger within said barrel, a pressure area on said plunger facing in one direction, a relatively larger pressure area on said plunger facing in the opposite direction, and means for applying fluid pressure to said areas to operate the plunger, said means comprising means for applying clean oil to a medial portion of the plunger whereby said plunger is maintained clean by virtue of fluid leakage.

21. In a well pump of the character described, the combination of a pump barrel having a medial bore, an upper bore of reduced diameter above said medial bore, and a lower bore of still further reduced diameter below said medial bore, a hollow plunger mounted to reciprocate in the pump barrel, said hollow plunger comprising a piston head adapted to work in said medial bore of the barrel, an upper plunger part of reduced diameter extending upwardly from said piston-head and adapted to work in the said reduced upper bore, whereby an upwardly facing annular area is provided on the upper end of the said piston-head, a lower plunger part of reduced diameter extending downwardly from said piston-head and adapted to work in the said reduced lower bore, whereby a downwardly facing annular area is provided on the lower end of the piston-head of greater extent than the upwardly facing annular area on the upper end of the piston-head, means for admitting fluid under pressure to the medial bore of the barrel above the piston-head, valvular means above said pump barrel and operable to intermittently admit fluid under pressure to the medial bore of the barrel below the piston-head.

22. In a pump, a hollow plunger carrying an operating piston and a pumping piston, means confining a hydraulic column in communication with the upper side of the operating piston, means including a tube surrounding the plunger and the said means,

confining a hydraulic column and conveying pressure therefrom to the lower side of the operating piston, means confining a third hydraulic column, means automatically operated by movement of the plunger to intermittently superimpose the third column on the last mentioned column, and a pump barrel containing the pumping piston.

23. In a pump, a well casing and a pump mechanism suspended from the casing and insertable through the casing and withdrawable therefrom, the pump mechanism comprising the following, a head suspended from the casing, a well tubing coaxially connected to and pendent from the head, concentric pump barrels within the tubing, a pump plunger having an operating piston and a pumping piston, the operating piston working in the larger barrel, the pumping piston working in the smaller barrel, means including the tubing and the larger barrel for confining two hydraulic columns, one communicating pressure to the lower side of the operating piston and the other to the upper side thereof, means confining a third hydraulic column, and means for superimposing the third column on the other two columns including means for intermittently applying the third column to at least one of the other two columns.

24. In a well pump, a plunger, a tube to contain a hydraulic column, the said column operating against a portion of the lower side of the plunger, a tube to contain a hydraulic column, the said column operating against a portion of the upper side of the plunger and a conduit to contain the column of fluid to be lifted by the plunger, the latter column being sustained by the remainder of the upper surface of the plunger, the first portion having a larger area than the second portion, and the said plunger operating in one of the tubes.

25. In a well pump, a plunger, a tube to contain a hydraulic column, the said column operating against an annulus on the lower side of the plunger, a tube to contain a hydraulic column, the said column operating against an annulus on the upper side of the plunger, and a conduit to contain the column of fluid to be lifted by the plunger, the latter column being sustained by the remainder of the upper surface of the plunger, the first annulus having a larger area than the second annulus, and the said plunger operating in one of the tubes.

In testimony whereof, I have hereunto signed my name to this specification.

ARTHUR G. GAGE.