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RETRIEVABLE WELL PUMPS

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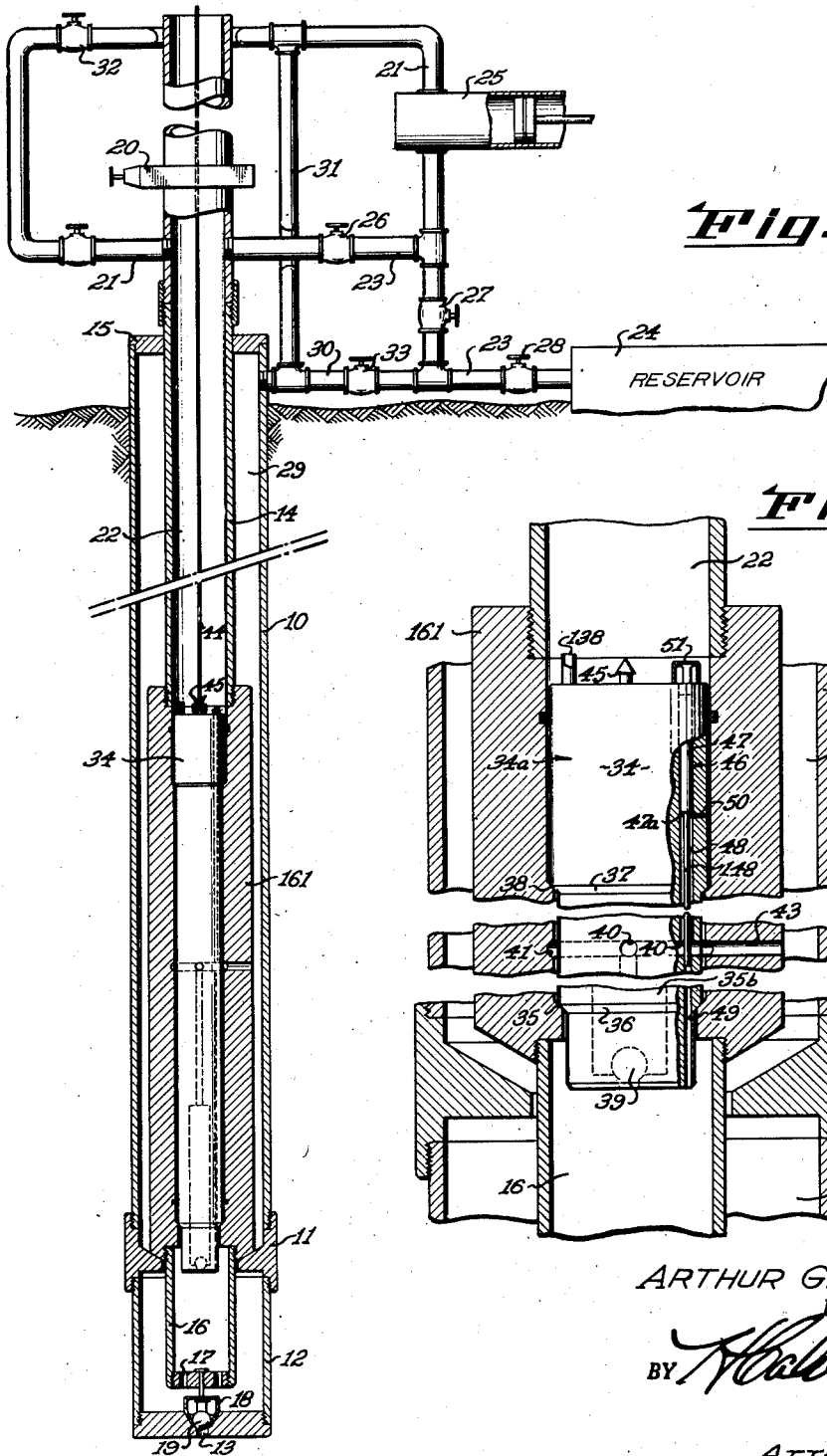


Fig. 1.

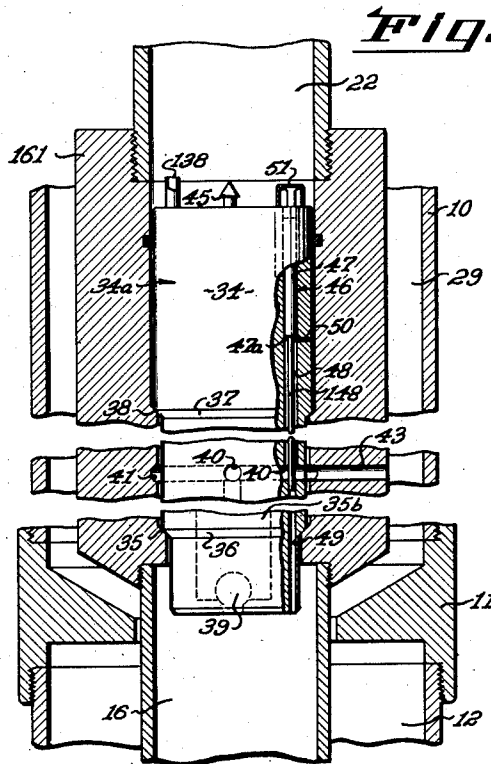


Fig. 2.

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RETRIEVABLE WELL PUMPS

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10 Claims. (Cl. 103—46)

This invention has to do generally with improvements in submersible oil well pumps and pumping systems characterisable as comprising a fluid pressure operated pump proper, adapted to be run down to a seating and operative position within the inner of two annularly spaced pipe strings, the outer of which contains about the inner string a fluid column and the inner string containing a second fluid column. The pump is actuated by pressurized fluid delivered to it through one of these columns, and the production fluid displaced by the pump is discharged into the other column for delivery to the ground surface.

While not necessarily limited thereto in its broader aspects, the invention affords utility to particular advantage in pumps and associated pipe strings wherein the pump is returnable to the ground surface by itself being pumped up through the inner string, as for inspection, repair and replacement of parts.

In the present type of pump installation, the pump is subjected to the hydrostatic head of a fluid column ordinarily extending from the location of the pump upwardly within the inner string to the ground surface. Accordingly, removal of the pump from its seat to permit return of the pump to the ground surface necessitates either lifting the pump against the great pressures imposed by the hydraulic fluid head, or so compensating or balancing the pressures applied to the top and bottom of the pump as to relieve lifting of the pump from the pressure or load resistance of the hydraulic column. In Patent No. 2,663,261 issued December 22, 1953 to me on "Retrievable Well Pump," I disclose means utilizing specifically, novel arrangements of passages and valves within the pipe strings or parts other than the pump itself, carried thereby.

The present invention is directed to a new and improved pressure compensating valve arrangement which is carried by or within the pump itself, and which is pressure responsive to variations of the fluid column pressure differential at the location of the pump, to open or close communication between one of the fluid columns and the underside of the pump below its seat. As will appear, in accordance with my preferred embodiment of the invention, the pump, which is fluid pressure operated and may be of any of various well-known specific constructions insofar as its parts are concerned, operates in working position while rested on a seat, the pump being actuated by pressurized fluid in the inner pipe string, and discharging the production fluid from a location above the seat, into the outer fluid column. When the pump is to be removed, the outer fluid column is pressurized and fluid therefrom is discharged to a location below the pump and its seat, thus to apply to the bottom of the pump pressure that may not only compensate or equal the hydrostatic head of the inner column to permit easy unseating of the pump, but which may serve to displace the pump out of the well. This object may be accomplished simply by providing within the wall of the pump, a valve which during normal pumping operations, is

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maintained by the hydrostatic head of the inner column in a position closing off the communication of fluid from the outer column to the underside of the pump. Upon reversal of the column pressure differential at the pump, the valve is displaced to open communication between the outer column and underside of the pump at a rate which may not only serve for pressure compensation or equalization as to the pump, but also enable the pump to be displaced upwardly through the inner pipe string.

All the features and objects of the invention, as well as the details of an illustrative embodiment, will be understood fully from the following description of the accompanying drawing, in which:

Fig. 1 is a general view showing a dual pipe string and contained pump run down into the well, together with associated ground surface equipment; and

Fig. 2 is a fragmentary enlargement showing in vertical section the pipe strings at the location of the pump, and the pressure equalizer valve carried by the pump.

The pipe string assembly is shown to comprise an outer string 10 carrying toward its lower end a fitting 11 serving as a seat and coupling for connecting a bottom chamber 12 which carries the usual bottom inlet 13 through which production fluid enters the chamber from the well. The inner pipe string 14, annularly spaced within the pipe 10, extends downwardly through an appropriate head or packer 15 to connect with a sub 161 which engages downwardly upon the seat 11 and carries a depending tube 16, the bottom of which contains fluid entry ports 17 and the usual connection 18 operable to lift ball check 19 which normally serves to prevent return displacement of well fluid taken into chamber 12 through inlet 13. The top of the pipe string 14 may carry the usual gate or valve 20 and a connection 21 through which pressurized fluid may be pumped into the column contained at 22 within the string 14. The latter may also connect as by pipes 23 with a reservoir 24 from which fluid may be taken by pump 25 for discharge through line 21, or into which fluid may be discharged through lines 23, depending upon the setting of valves 26, 27 and 28. The reservoir is also communicable with the fluid column in the annular space 29 by way of line 30. The pump 25 may be operated to discharge fluid into the outer column by way of line 31, with proper setting of valves 32 and 33.

Referring now particularly to Fig. 2, the pump 34 is shown to rest in operative position on a downwardly inclined annular seat 35, with respect to which the seating surface 36 on the pump is similarly shaped. The pump may also, if desired, have a second upper seating shoulder 37 engaged upon seat 38. As previously indicated, the pump may be of any of various specific types or designs of fluid pressure actuated pumps, all of which have an upper motor end section generally indicated at 34a receiving pressurized fluid through inlet 138, and a lower pumping piston section 34b from which well fluid flows into chambers 12 and 16 is taken past check valve 39 in the bottom of the pump, to be discharged through one or more ports 40 and channel 41 into passage 43 in the sub 161 into the fluid column at 29. The pump may be lowered or pumped down to seating position independently of any suspension, or it may be lowered on a wire line 44 releasably connectible with the pump at 45.

While the pump-carried valve means for communicating fluid pressure from column 29 into chamber 16 below the seat 35 may be of any of various specific types or designs, I have shown as illustrative, a reciprocating piston-type valve generally indicated at 46 having an enlarged diameter section 47 working within a bore 48 of corresponding diameter in the wall of the pump, the valve having a smaller diameter portion 148 intersecting passage 42 and extending into a correspondingly re-

duced bore 49 in the pump wall below the passage. The extent 148 of the valve is sufficiently small and has such clearance from the wall of passage 42 to permit free discharge fluid to be displaced by the pump out through passages 42 and 43 and to the column 29.

During normal operation of the pump in its Fig. 2 position, the hydrostatic pressure of the column in 22 applied to the valve 46 through the top open end of the bore 48, maintains the valve in its lower position shown, at which the valve is arrested by engagement of its larger diameter portion 47 against stop pin 50. The lower end of the depending section 148 closes bore 49 and communication between the column in 29 and chamber 16. When it is desired to remove the pump, pressurization of the columns in 22 and 29 is reversed by pumping into column 29 to a pressure which at the location of the pump, is sufficiently greater than the pressure in column 22, to raise the valve 46 by communication of the pressurized fluid from column 29 through passages 43 and 44 into bore 48, the pressure acting against the underside 47a of the valve section 47, to raise the valve a distance which may be limited by its engagement with an open stop cage 51. Being thus withdrawn from bore 49, the lower extent of the valve permits passage of fluid from column 29 through bore 49 into chamber 16. Thus the pressure applied upwardly against the pump may be made to at least equal the total pressure exerted by the fluid column in 22 which resists unseating of the pump, and as previously stated, the fluid flow from column 29 into chamber 16 may be employed not only to unseat but to displace the pump upwardly through the string 14 to the ground surface.

I claim:

1. The combination comprising inner and outer spaced pipe strings lowered in a well one inside the other and containing inner and outer fluid columns, a fluid pressure actuated pump adapted to be lowered within said inner string to operating position, said pump including a well liquid inlet containing a check valve, an annular seat engaged by the pump in said operating position, said pump being operable by pressure fluid delivered to the pump by way of one of said columns to discharge well fluid into the other column for delivery to the ground surface, upward displacement of the pump from said seat being resisted by the pressure of said one of the columns, and valve controlled means contained in the pump in addition to said check valve and exposed to the pressure of said other column and operable thereby at a pressure higher than the normal operating hydrostatic pressure at the column to transmit through a passage in the pump to the underside of the pump below said seat fluid pressure effective to unseat the pump and permit it to be pumped to the ground surface.

2. The combination defined by claim 1, in which said valve controlled means comprises a passage in the pump and through which fluid in said other column is deliverable to the underside of the pump, and a valve normally closing said passage and operable by variation of the differential of the column pressures at the location of the valve.

3. The combination as defined by claim 1, in which said valve controlled means comprises a valve exposed to and operable by variation of the differential of the column pressures at the location of the valve.

4. The combination as defined by claim 1, in which said valve controlled means comprise a reciprocable piston valve normally closing said passage under the influence of the pressure of the operating fluid being delivered to the pump, said valve having oppositely facing surfaces exposed respectively to the pressures of said columns.

5. The combination comprising inner and outer spaced pipe strings lowered in a well one inside the other and containing inner and outer fluid columns, a fluid pressure actuated pump adapted to be lowered within said inner string to operating position, said pump including a well liquid inlet containing a check valve, an annular seat engaged by the pump in said operating position, said pump being operable by pressure fluid delivered to the pump by way of said inner column to discharge well fluid into the outer column for delivery to the ground surface, upward displacement of the pump from said seat being resisted by the pressure of said inner column, a passage in said pump for communicating the fluid and abnormally increased pressure of said outer column to the underside of the pump below said seat to unseat the pump, and valve means in the pump in addition to and functioning independently of said check valve for normally closing said passage, said valve means being exposed to and operable by variations of the differential of the column pressures to open said passage.

6. The combination defined by claim 5, in which said valve means is a reciprocable piston valve having a cylindrical portion sliding within a bore in the pump.

7. The combination defined by claim 5, in which said valve means has a pressure area exposed to the inner column pressure and an oppositely facing pressure area exposed to the outer column pressure, and is operable to open said passage by increase of the outer column pressure over the inner column pressure.

8. The combination defined by claim 5, in which said valve means comprises a piston valve having an upwardly facing area exposed to the inner column pressure, and a relatively smaller downwardly facing area exposed to the outer column pressure.

9. The combination as defined by claim 1, in which, after its unseating, the pump is displaceable upwardly through the inner pipe string by fluid pumped down through said outer column.

10. The combination as defined by claim 5, in which, after its unseating the pump is displaceable upwardly through the inner pipe string by fluid pumped down through said outer column.

References Cited in the file of this patent

UNITED STATES PATENTS

2,338,903	Coberly	Jan. 11, 1944
2,568,320	Coberly	Sept. 18, 1951
2,663,261	Gage	Dec. 22, 1953