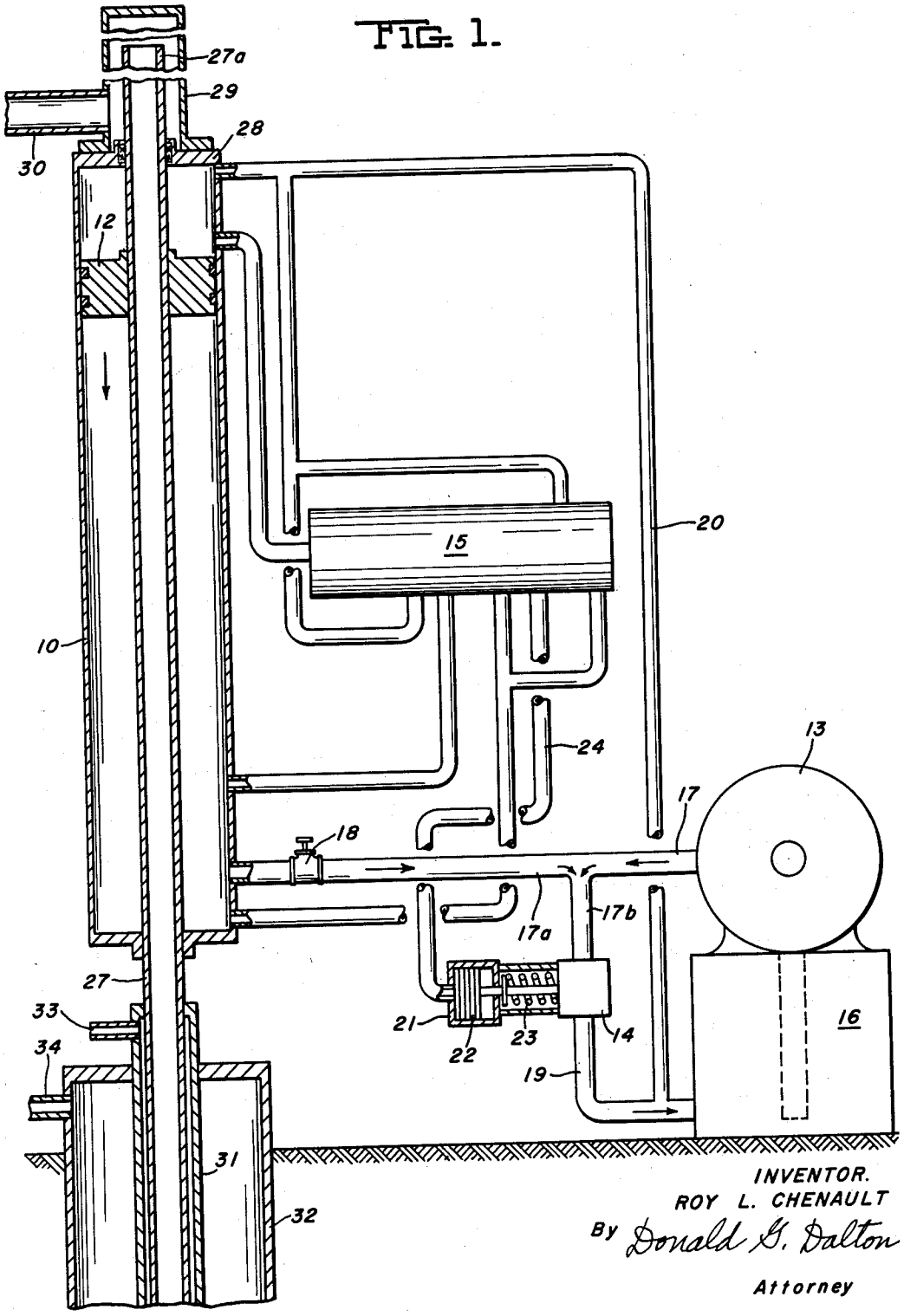
Dec. 1, 1964 R. L. CHENAULT 3,159,105

HYDRAULIC PUMPING UNIT

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FIG. 1.



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FIG. 2.

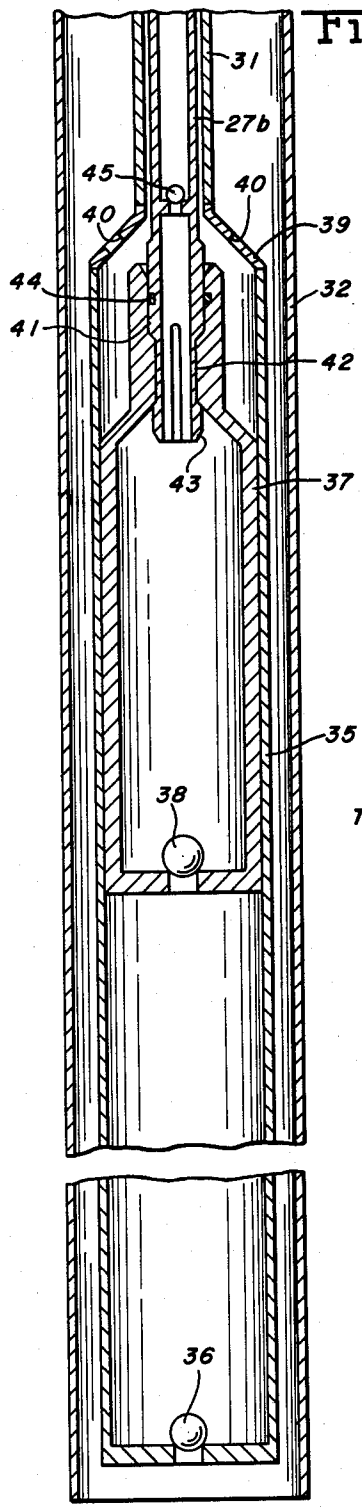
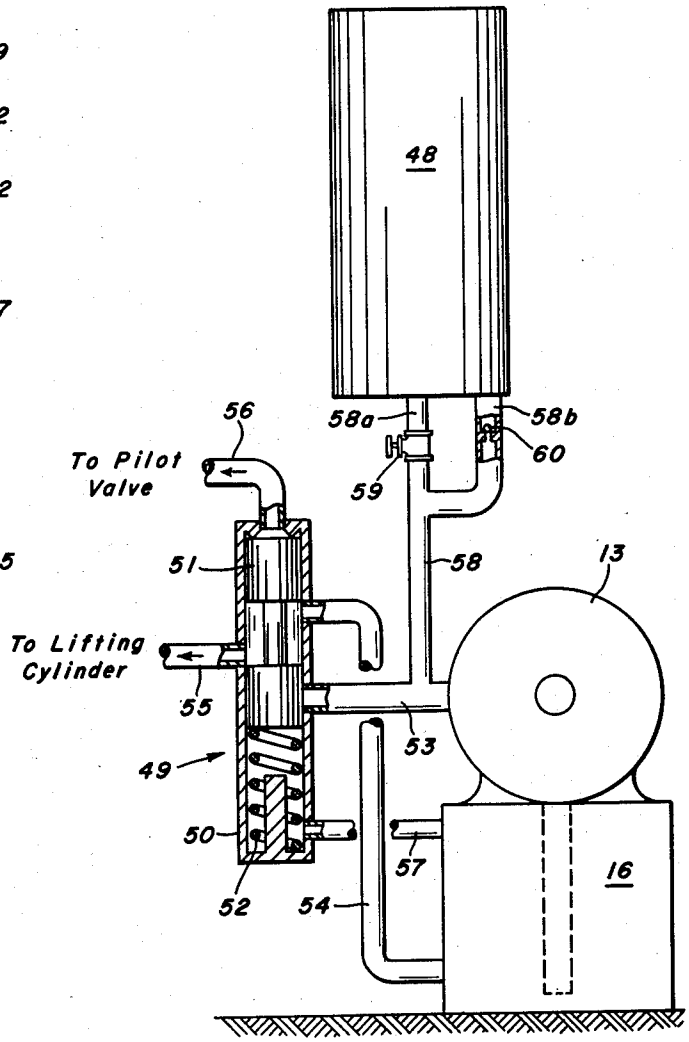


FIG. 3.



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HYDRAULIC PUMPING UNIT

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5 Claims. (Cl. 103—45)

This invention relates to an improved combination of hydraulically-operated surface pumping unit and subsurface pump.

A conventional hydraulic pumping unit includes a long vertical lifting cylinder, a reciprocable power piston or ram within the cylinder, a motivating pump for supplying power fluid to the cylinder, and a system of valves for alternately directing power fluid from the pump to the lower end of the cylinder and relieving the lower end. The power piston is attached to a polished rod, which in turn is attached to a sucker rod string extending to a subsurface pump at the bottom of a well. Such units offer an advantage of providing a much longer stroke than a mechanical unit, but they usually require an elaborate counterbalance mechanism to equalize the load on the motivating pump during upstrokes and downstrokes. As the parts descend during a downstroke, the motivating pump delivers fluid to a counterbalance tank, where it builds up pressure. The energy thus stored assists the pump in lifting the parts during the next upstroke. Reference can be made to my earlier Patent No. 2,665,551 for a showing of several embodiments of pumping units of this type.

An object of the present invention is to provide an improved combination of hydraulic pumping unit and subsurface pump which operates with acceptable efficiency without dependence on a counterbalance mechanism, thereby simplifying the structure.

A further object is to provide a combination of the foregoing type in which the subsurface pump delivers well fluid to the surface only during its downstroke and takes in well fluid during its upstroke, thereby diminishing the difference in load during the two strokes.

In the drawing:

FIGURE 1 is a diagrammatic vertical section of my improved hydraulic pumping unit;

FIGURE 2 is a diagrammatic vertical section of a subsurface pump I use in combination with my pumping unit; and

FIGURE 3 is a diagrammatic vertical section of a modified pumping unit constructed in accordance with my invention, omitting some parts which are the same as in FIGURE 1.

FIGURE 1 shows a pumping unit which comprises a lifting cylinder **10**, a power piston **12** reciprocable up and down in said cylinder, a motivating pump **13**, a main valve **14** and a pilot valve **15**. Pump **13** draws hydraulic fluid from a reservoir **16** and discharges it through a pipe **17** which has branches **17***a* and **17***b* leading to the lower end of the lifting cylinder **10** and to the main valve **14** respectively. Branch **17***a* contains a flow control valve **18**. A pipe **19** connects the main valve with the reservoir **16**, and a scavenger pipe **20** connects the upper end of the lifting cylinder **10** with the reservoir. The main valve has an operating mechanism which includes a hydraulic cylinder **21** and a reciprocable piston **22** mounted in said cylinder. A spring **23** urges the piston to a position in which the main valve is open, that is, in which the valve allows fluid from pump **13** and branch **17***b* to flow into pipe **19**. A pipe **24** connects cylinder **21** with the pilot valve **15**. When the pilot valve moves to a position in which it admits hydraulic fluid to pipe **24**, the resulting pressure on piston **22** closes the main valve against the action of spring **23**. The pilot valve **15** is constructed

and operates the same as the pilot valve shown in FIGURES 1 and 2 of my aforementioned earlier patent and its connections with the lifting cylinder and main valve are the same; in the interest of simplicity I have not repeated the detailed showing nor the description.

I replace the usual sucker rods with a tubular rod string **27** through which fluid pumped from the well is delivered to the surface. The uppermost rod section **27***a* is fixed to the power piston **12** and extends therethrough and through a stuffing box **28** at the top of the lifting cylinder **10**. I mount a standpipe **29** on the top of the lifting cylinder above this stuffing box. Fluid pumped from the well discharges from the rod string into this standpipe, which has an outlet pipe **30**. The rod string extends down the well through a conventional tubing string **31** and casing **32**. The upper ends of the tubing and casing have gas vents **33** and **34**.

FIGURE 2 shows a subsurface pump which comprises a stationary barrel **35**, a standing valve **36** at the bottom of the barrel, a reciprocable hollow plunger **37** fitted in said barrel, and a traveling valve **38** in said plunger. An adapted **39** connects the barrel to the bottom of the tubing string **31**. The adapter has vent ports **40** to permit application of casing pressure to the plunger at all times. The lowermost rod section **27***b* has an enlargement **41** spaced from its bottom end, a series of prongs **42** extending downwardly from said enlargement, and additional enlargements **43** at the bottoms of said prongs. The upper end of plunger **37** is shaped to receive these prongs, which snap into place when the rod string is lowered into the tubing **31** or pull free when the rod string is raised after the plunger reaches the top of the barrel. The enlargement **41** has an external groove which contains an O ring **44** to afford a seal between the rod string and plunger. Preferably the lowermost rod section contains a check valve **45** to prevent the weight of the fluid inside the rod string from being supported on the plunger proper.

In operation, the motivating pump **13** delivers hydraulic fluid continuously from the reservoir **16** through pipe **17**. When the main valve **14** is closed, fluid passes from the pump through branch **17***a* into the lower portion of the lifting cylinder **10**. The power piston **12**, rod string **27**, and the subsurface pump plunger **37** make their upstroke, during which the standing valve **36** opens and the traveling and check valves **38** and **45** close. The plunger draws well fluid into the pump barrel **35**, but no fluid is delivered to the surface. Thus the load during an upstroke is restricted substantially to the weight of the rod string. When piston **12** reaches the top of the lifting cylinder, the pilot valve **15** shifts to relieve the valve operating cylinder **21**, whereupon the main valve opens (the position FIGURE 1 shows). Fluid from both the motivating pump **13** and the lower portion of the lifting cylinder flow through the main valve into pipe **19** and return to the reservoir **16**. Piston **12**, rod string **27** and the subsurface pump plunger **37** make their downstroke gravitationally, during which the traveling and check valves **38** and **45** open and the standing valve **36** closes. Descent of the plunger forces well fluid from the pump barrel **35** up the tubular rod string **27** to the surface. The purpose of the flow control valve **18** is to limit the rate of fall of the power piston and rod string. The rate can become excessive if the well pumps off to the extent that no oil is displaced on all or part of a downstroke. I adjust valve **18** to limit the descent to a safe rate regardless of load conditions.

FIGURE 3 shows a modified embodiment of pumping unit in which I utilize an extremely simple counterbalance mechanism to equalize the load during the two strokes. The modified unit comprises a motivating pump **13**, a reservoir **16**, a lifting cylinder, and a pilot valve, all constructed similarly to corresponding parts of the embodi-

ment shown in FIGURE 1. In the interest of simplicity, I have not repeated the showing of the lifting cylinder nor the pilot valve. The modified unit comprises a counterbalance tank 48 and a somewhat more elaborate main valve 49. The main valve includes a housing 50, a slide member 51 within said housing, and a spring 52 which urges the slide member upwardly. The housing has ports to which are connected a pipe 53 leading from the discharge side of the motivating pump 13, a pipe 54 leading to the reservoir 16, and a pipe 55 leading to the lower end of the lifting cylinder. The ends of the housing have control ports to which are connected a pipe 56 which leads to the pilot valve and a pipe 57 which leads to the reservoir 16. A pipe 58 is connected to pipe 53 and has branches 58*a* and 58*b* which lead to the counterbalance tank 48. Branch 58*a* contains a flow control valve 59, and branch 58*b* a check valve 60 which allows flow through the branch into the tank but prevents reverse flow.

In operation, the motivating pump 13 delivers hydraulic fluid continuously from the reservoir, as in the embodiment already described. When the slide member 51 of the main valve 49 is in the position illustrated, there is communication between pipes 54 and 55 to relieve the lower end of the lifting cylinder and the parts make a downstroke gravitationally. The output of the motivating pump 13 passes through pipe 58 and branch 58*b* to the counterbalance tank 48 where it builds up pressure. When the power piston reaches the bottom of the lifting cylinder, the pilot valve shifts to apply pressure to the main valve housing 50 through pipe 56. The slide member 51 shifts to establish communication between pipes 53 and 55. Both the motivating pump 13 and the counterbalance tank 48 deliver fluid to the lower end of the lifting cylinder to produce an upstroke. Since fluid is raised to the surface under gravitational descent of the rod string, this embodiment equalizes the load during the two strokes with a simple counterbalance and a smaller motivating pump than used in the first embodiment.

From the foregoing description it is seen that my invention affords a relatively simple pump combination which diminishes the difference in load during the two strokes without a counterbalance, or equalizes the load with an extremely simple counterbalance. The combination also offers several other advantages. I can use a subsurface pump as large as I can run into a well casing and still utilize a gas separator below the pump and permit gas to vent through the casing. Any paraffin deposits are confined to the tubular rod string where I can remove them with wire line scrapers without the necessity for pulling sucker rods.

While I have shown and described certain preferred embodiments of my invention, it is apparent that other modifications may arise. Therefore, I do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

I claim:

1. In a pumping installation which includes in combination a hydraulically operated surface pumping unit,

a subsurface pump below said unit, and means operatively connecting said pumping unit and said subsurface pump, said pumping unit comprising a lifting cylinder, a power piston reciprocable up and down in said cylinder, a motivating pump, and valve means for alternately directing fluid from said motivating pump to the lower end of said cylinder to lift said piston during an upstroke and relieving the lower end of said cylinder to allow said piston to descend gravitationally during a downstroke, said pump comprising a barrel, a standing valve at the lower end of said barrel, a reciprocable plunger mounted in said barrel, and a traveling valve carried by said plunger, said standing valve opening and said traveling valve closing as said plunger makes an upstroke to enable the plunger to draw fluid into the barrel, said standing valve closing and said traveling valve opening as said plunger makes a downstroke to enable the plunger to displace fluid from the barrel, said connecting means comprising a tubular rod string attached to said piston and to said plunger for moving the plunger with the piston and delivering to the surface during a downstroke fluid displaced from said barrel, the weight of said rod string furnishing the force which lifts the fluid to the surface, whereby the load during an upstroke is restricted substantially to the weight of the rod string.

2. A pumping installation as defined in claim 1 in which said pumping unit lacks a counterbalance mechanism and relies on the use of gravitational force delivering fluid to the surface as a means for diminishing the difference in load during upstrokes and downstrokes.

3. A pumping installation as defined in claim 1 in which said pumping unit comprises a counterbalance tank into which said motivating pump delivers fluid during a downstroke, and from which fluid is delivered to said lifting cylinder during an upstroke, said counterbalance tank equalizing the load during the two strokes.

4. A pumping installation as defined in claim 1 in which said pumping unit comprises a standpipe mounted on the top of said lifting cylinder, and said rod string extends through said piston and delivers fluid into said standpipe.

5. A pumping installation as defined in claim 1 in which the lower end portion of said rod string includes a series of prongs and said plunger is shaped to receive said prongs to fix the plunger to the rod string, said prongs snapping into engagement with said plunger as said rod string is lowered and pulling free as said rod string is raised when the plunger reaches the top of the barrel.

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