June 3, 1958 G. E. MOHNKERN 2,837,029

HYDRAULIC SUBSURFACE PUMP AND MOTOR

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FIG. 2.

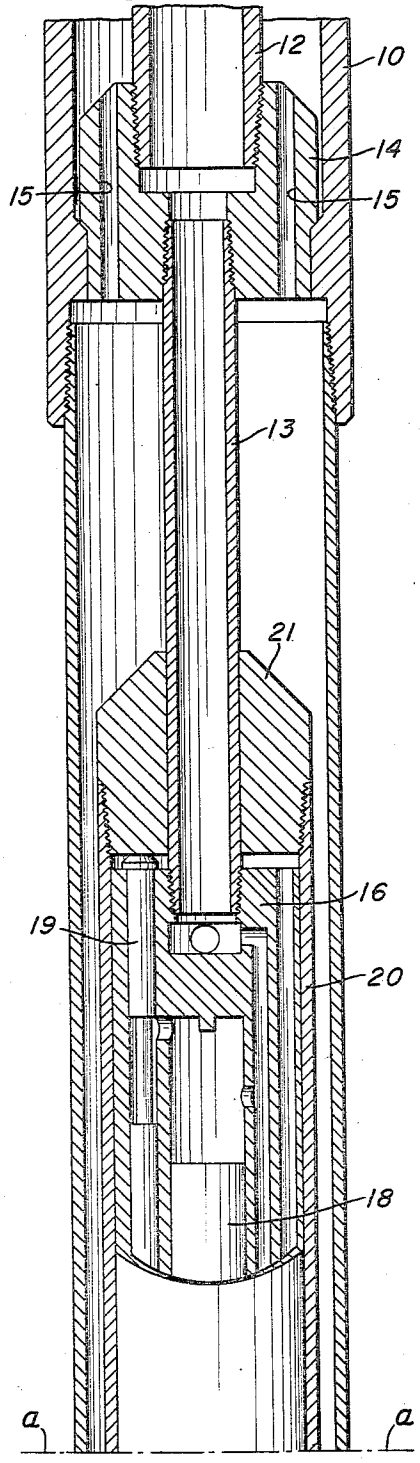
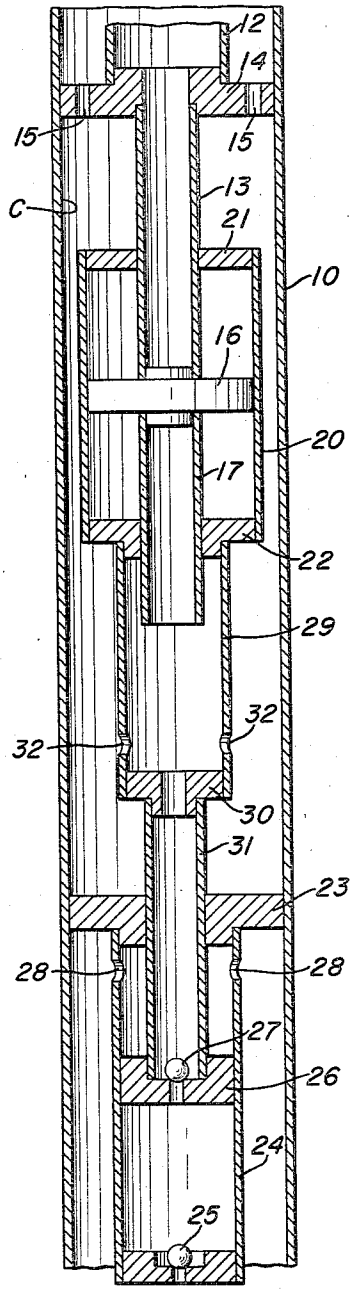


FIG. 1.



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FIG. 2a.

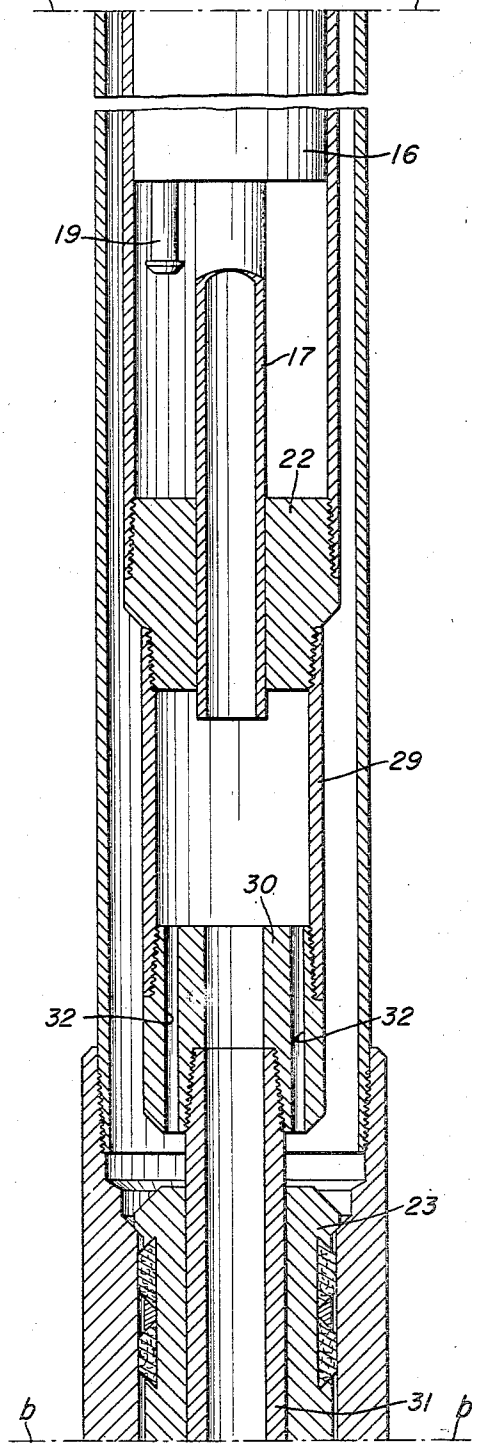
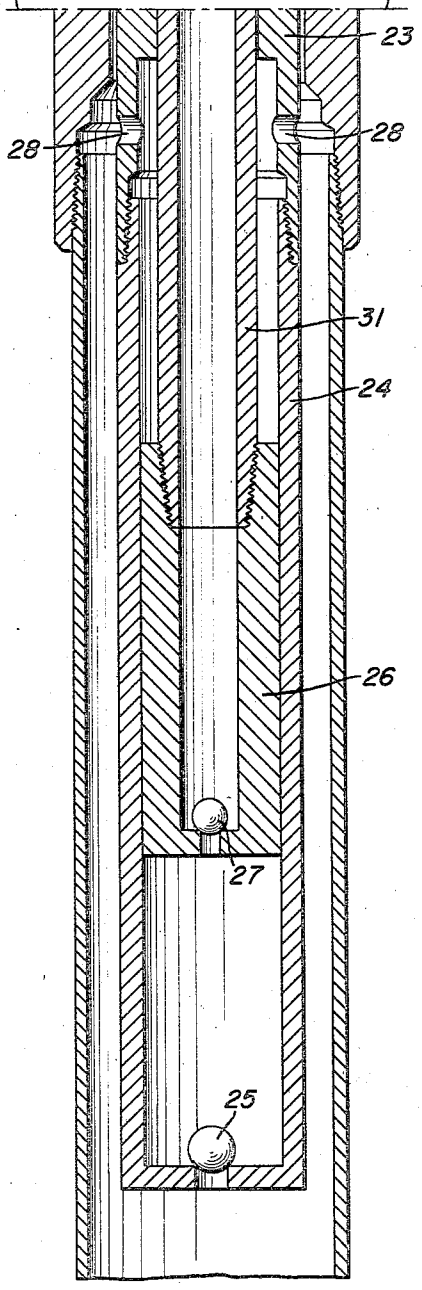


FIG. 2b.



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United States Patent Office 2,837,029 Patented June 3, 1958

2,837,029

HYDRAULIC SUBSURFACE PUMP AND MOTOR

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Application September 14, 1954, Serial No. 455,930

2 Claims. (Cl. 103—46)

This invention relates to an improved hydraulically operated subsurface motor and pump combination.

In the subsurface pumping art, such combinations are known as "rodless pumps," and they can be used for pumping oil wells in lieu of the more common sucker rod pumps. A rodless pump is installed near the bottom of a well and its motor is actuated by a stream of oil or other liquid pumped down the well. The motor conventionally includes a barrel, a piston reciprocable therein and joined to the reciprocable element of the pump, a main valve for alternately applying power fluid to opposite ends of the piston for producing upstrokes and downstrokes, and usually a pilot valve for shifting the main valve at the ends of the strokes. Chenault Patent No. 2,191,369, dated February 20, 1940, shows a rodless pump in which both the main valve and the pilot valve are housed within the motor piston, thereby dispensing with longitudinal passages in the walls of the motor barrel. Such passages not only are difficult and costly to form, but they necessitate thicker walls. Pumps of this type must be installed in tubing of limited cross-sectional dimensions, commonly a two inch inside diameter. Consequently all space occupied by the barrel walls is at the expense of piston area.

The Chenault patent shows a double-acting pump, that is, a pump with inlet and discharge valves at both ends of its barrel. Such a pump must have longitudinal passages in its barrel walls, but was used to balance the load on the motor on its up and down strokes. Single-acting pumps are simpler and have become standard for sucker rod installations. They do not require longitudinal passages in the barrel walls, but ordinarily they deliver fluid only during the stroke in one direction and their power requirements on the two strokes are unbalanced. Nevertheless the greater piston area possible because of the absence of longitudinal wall passages assures that the capacity of a single-acting pump of given outside diameter is at least as great as that of a double-acting pump.

A later Chenault Patent No. 2,679,806, dated June 1, 1954, shows an arrangement for using a motor of the type shown in the first Chenault patent with a single-acting pump. Although the power requirements on the two strokes are balanced in this later patent, the volumes of fluid delivered to the surface are unequal. The total volume delivered to the surface of course equals the volume of exhaust power fluid displaced by the motor plus the volume which the pump lifts or forces from the well. The motor displaces exhaust power fluid on both strokes, but the pump forces more fluid from the well on its downstroke than on its upstroke. A further disadvantage is that any change in the size of either the motor or pump necessitates a change in the other to maintain balanced power requirements.

An object of the present invention is to provide an improved hydraulic motor and pump combination which altogether avoids longitudinal passages in the barrel walls and has both balanced power requirements and equal fluid deliveries on the two strokes.

A further object is to utilize a hydraulic motor resembling that shown in the first mentioned Chenault patent with a conventional single-acting pump and yet provide balanced power requirements and equal deliveries on both strokes.

A further object is to provide a hydraulic motor and pump combination in which the motor and pump are individually balanced, whereby changes can be made in either without affecting the balance of the other nor of the combination.

A more specific object is to provide a combination of the foregoing type in which the motor has a stationary piston otherwise constructed as shown in the first mentioned Chenault patent and a traveling barrel, said barrel being coupled to the reciprocable element of a conventional single-acting pump.

In accomplishing these and other objects of the invention, I have provided improved details of structure, a preferred form of which is shown in the accompanying drawings, in which:

Figure 1 is a diagrammatic vertical sectional view, not to scale, of a motor and pump combination constructed in accordance with my invention;

Figure 2 is a vertical sectional view of the upper portion of the combination more nearly as it actually may be constructed although somewhat simplified;

Figure 2*a* is a vertical sectional view of the mid-portion, being a continuation of Figure 2; and

Figure 2*b* is a vertical sectional view of the lower portion, being a continuation of Figure 2*a*.

Referring mainly to Figure 1, which is much simplified over the actual construction shown in Figures 2, 2*a* and 2*b*, my motor and pump combination is situated at the bottom of a well which contains outer and inner concentric strings of tubing **10** and **12**. A stationary upper piston tube **13** is connected to the lower end of the inner tubing **12** through a coupling **14**, which contains ports **15** communicating with the outer tubing **10**. A stationary motor piston **16** is fixed to the lower end of the upper piston tube **13** and carries a depending lower piston tube **17**, which likewise is stationary. The piston houses a main valve **18** and a pilot valve **19** (Figure 2). The valves and the internal passages in the piston are not disclosed in detail since they are identical with the showing in Chenault Patent No. 2,191,369. A traveling motor cylinder **20** receives the piston **16** and carries upper and lower cylinder heads **21** and **22** within which the respective piston tubes **13** and **17** are closely fitted. The outer tubing **10** supports a stuffing box **23** located below the motor piston and cylinder. The space within the outer tubing bounded by the coupling **14** and stuffing box **23** forms a chamber C.

A stationary barrel **24** of a standard single-acting pump is joined at its upper end to the stuffing box **23**. The lower end of this barrel carries a conventional standing valve **25**. A pump plunger **26** is mounted for reciprocable movement in the barrel **24** and carries a conventional traveling valve **27**. The upper portion of the pump barrel contains relief ports **28** to permit escape of any fluid which leaks past the plunger **26**. An extension tube **29** is joined to the bottom of the lower cylinder head **22** of the motor and carries a coupling **30** at its lower end. A pump tube **31** is joined at its respective ends to the coupling **30** and to the pump plunger **26**. The extension tube **29** contains a plurality of ports **32**.

To operate the pump, a stream of power oil is pumped from the surface down the inner tubing **12** and upper piston tube **13** into the motor piston **16**. The valves within this piston alternately direct this oil to the space within the motor cylinder **20** above the piston and that below the piston. The valves also relieve the other of these spaces to the lower piston tube **17**, from which

the exhaust power oil flows into the chamber C through the extension tube 29 and its ports 32. Consequently the motor cylinder is driven up and down, and it raises and lowers the pump plunger 26.

For the motor to be balanced it is only necessary for the upper and lower piston tubes 13 and 17 to be of the same cross-section. Both the effective power piston area and motor displacement area on both the upstroke and downstroke are then the same. Numerically each of these four quantities equals the cross-sectional area of the bore of the motor cylinder 20 less the cross-sectional area of one of the piston tubes 13 or 17. Therefore on each stroke exhaust power oil displaced from the motor forces oil from the chamber C through the ports 15 and up the outer tubing 10, and the volume of this oil equals that pumped down the well to drive the motor.

For the pump to be in balance it is only necessary for the outside cross-sectional area of the pump tube 31 to be one-half the cross-sectional area of the bore of the pump barrel 24. On the downstroke a volume of oil proportional to the cross-sectional area of the bore of the barrel is forced through the traveling valve 27 into the pump tube 31. This tube and also the chamber C already are filled with oil; consequently a volume of oil equivalent to that forced into the pump tube 31 is forced from this tube through the extension tube 29 and its ports 32 into the chamber C, blending with the exhaust power oil from the motor. As the pump tube 31 travels downwardly out of the chamber C, the effective volume of this chamber continually increases. With the parts proportioned as described, half the oil forced from the pump tube 31 into the chamber C replaces the volume gained because the pump tube is traveling out of the chamber, and the other half forces oil from this chamber through the ports 15 and up the outer tubing 10 to the surface. On the upstroke the pump tube 31 re-enters the chamber C and the effective volume of this chamber continuously diminishes. A corresponding volume of oil again is forced from the chamber through the ports 15 and up the tubing 10. Because of the proportioning, this volume equals that forced from the chamber on the downstroke.

From the foregoing description it is seen that the motor and pump are individually balanced, and the balance of one is in no way dependent on the balance of the other. Consequently different sizes of either may be substituted without affecting the other. The volume of fluid forced up the well on any stroke equals the sum of that displaced by the motor and that displaced by the pump. As long as proper proportioning is maintained, the volume from each is the same on both strokes. It follows also that the power requirements are the same (neglecting the negligible weight of the moving parts), since the effective areas and the volumes deplaced are the same.

While I have shown and described only a single embodiment of the invention, it is apparent that 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. A hydraulic subsurface motor and pump combination, the motor portion of said combination comprising a piston of substantially uniform outside diameter, upper and lower stationary piston tubes of equal cross-sectional area connected to opposite ends of said piston and being of a smaller outside diameter than the piston, a traveling cylinder of substantially uniform inside diameter closely receiving said piston, upper and lower cylinder heads of equal cross-sectional area fixed to the ends of said cylinder and through which the respective tubes extend in closely received relation, a main valve and a pilot valve housed in said piston for directing power fluid from said upper tube alternately to the upper end of said piston, where it acts on the bottom of said upper cylinder head to produce an upstroke of said cylinder, and to the lower end of said piston, where it acts on the top of said lower cylinder head to produce a downstroke, said valves relieving the opposite end of said piston in each instance to said lower tube, the pump portion of said combination being single-acting and comprising a stationary cylinder below said traveling cylinder, said stationary cylinder having relief ports adjacent its upper end, tubing engaging means fixed to said stationary cylinder above said ports and preventing flow from said ports into the space thereabove, a standing valve adjacent the lower end of said stationary cylinder, a reciprocable element in said stationary cylinder, a traveling valve in said reciprocable element, a tube connecting said reciprocable element with said traveling cylinder, the cross-sectional area of said last named tube being one-half that of the bore of said stationary cylinder, and means at the top of said stationary cylinder closely receiving said last named tube and preventing downward flow therepast, whereby the pump delivers substantially equal volumes of fluid on both its upstroke and downstroke and the load on the motor is balanced on both strokes.

2. A subsurface pump installation including inner and outer strings of tubing and a hydraulic motor and pump combination housed within said outer tubing, the motor portion of said combination comprising a piston of substantially uniform outside diameter, upper and lower stationary piston tubes of equal cross-sectional area connected to opposite ends of said piston and being of a smaller outside diameter than the piston, the upper end of said upper piston tube being connected to the lower end of said inner tubing, a traveling cylinder of substantially uniform inside diameter closely receiving said piston, upper and lower cylinder heads of equal cross-sectional area fixed to the ends of said cylinder and through which the respective tubes extend in closely received relation, and a main valve and a pilot valve housed in said piston for directing power fluid from said inner tubing and said upper tube alternately to the upper end of said piston, where it acts on the bottom of said upper cylinder head to produce an upstroke of said cylinder, and to the lower end of said piston, where it acts on the top of said lower cylinder head to produce a downstroke, said valves relieving the opposite end of said piston in each instance to said lower tube, the pump portion of said combination being single-acting and comprising a stationary cylinder below said traveling cylinder, said stationary cylinder having relief ports adjacent its upper end, means fixed to said stationary cylinder above said ports and engaging said outer tubing to prevent flow from said ports into the portion of said outer tubing above said stationary cylinder, a standing valve adjacent the lower end of said stationary cylinder, a reciprocable element in said stationary cylinder, a traveling valve in said reciprocable element, a tube connecting said reciprocable element with said traveling cylinder, the cross-sectional area of said last named tube being one-half that of the bore of said stationary cylinder, and means at the top of said stationary cylinder closely receiving said last named tube and preventing downward flow therepast, whereby the pump delivers substantially equal volumes of fluid on both its upstroke and downstroke and the load on the motor is balanced on both strokes.

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