Feb. 20, 1940. R. L. CHENAULT 2,191,369

RECIPROCATING FLUID MOTOR DRIVEN PUMP

Filed Dec. 20, 1938 2 Sheets-Sheet 1

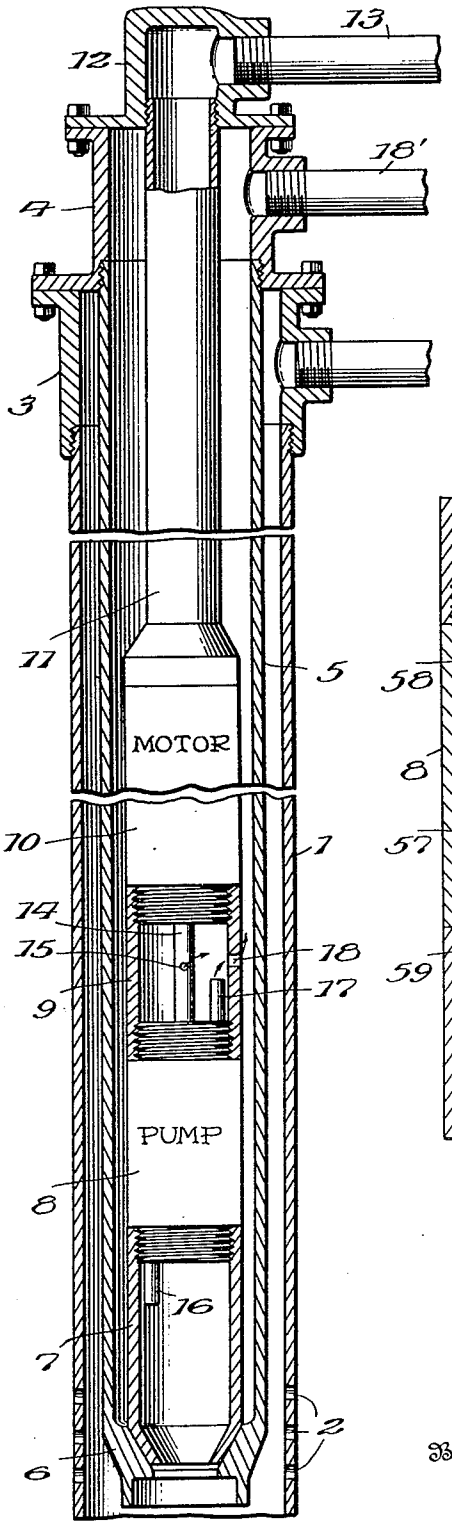


Fig. 1.

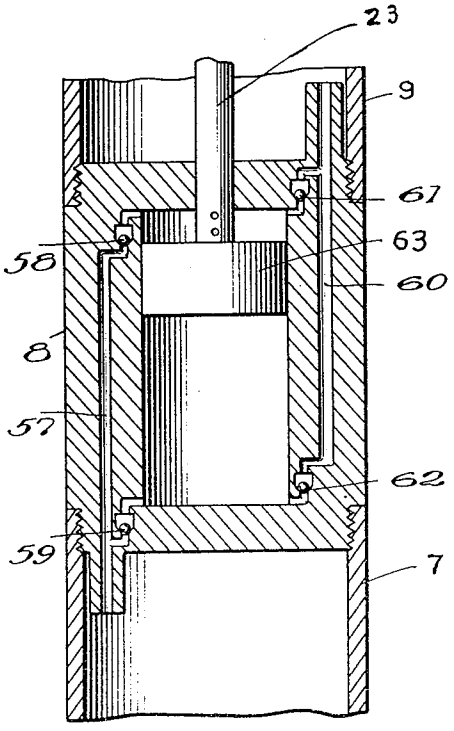


Fig. 4.

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Fig. 2.

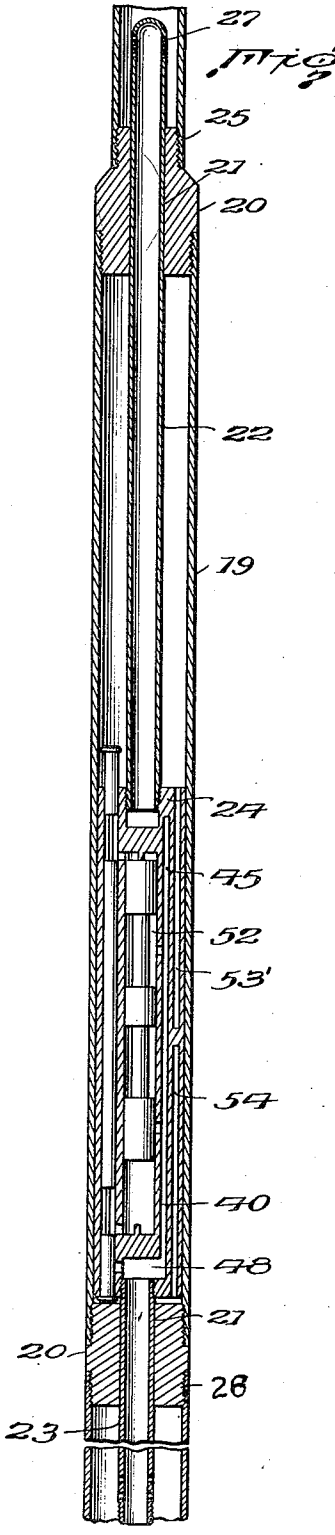
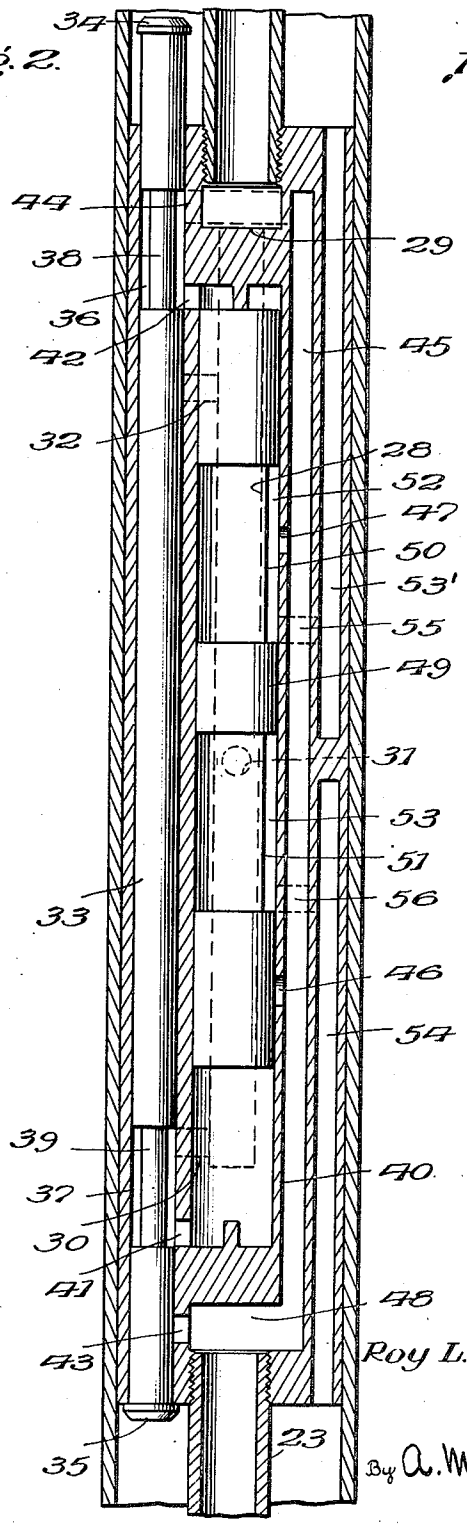


Fig. 3.



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UNITED STATES PATENT OFFICE

2,191,369

RECIPROCATING FLUID MOTOR DRIVEN PUMP

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Application December 20, 1938, Serial No. 246,894

12 Claims. (Cl. 103—5)

This invention relates to reciprocating fluid motor driven pumps; and more particularly to improvements in that class of pumps used to deliver oil from the bottom of deep wells wherein the motor and the pump are arranged tandem fashion, maintained in the well at the end of a string of tubing concentrically arranged within an outer string of tubing, the inner string of tubing serving as means for delivering fluid pressure to the motor, and the space between the inner and outer strings of the tubing serving as a means for delivering liquid pumped to the top of the well, and the invention comprises, in such a motor-pump arrangement, a valved piston in the motor cylinder, the piston being provided with ports and passages adapted to cooperate with the valve for the distribution of fluid pressure to and from the ends of the cylinder to drive the piston, means connecting said piston with a source of fluid pressure through the upper end of the cylinder and a hollow piston rod connecting the motor piston with the pump for operating the pump, said piston rod being adapted to receive and discharge exhaust pressure fluid from the motor; all as more fully hereinafter set forth and as claimed.

Efficient pumping of liquids such as oil, from deep wells, is difficult to obtain because of the limitations imposed on the construction and operation of apparatus useful for this purpose. Sucker rod operated pumps which work efficiently in shallow wells are prohibitive for pumping deep wells, mainly for the reason that the rods break under the severe strains to which they are subjected. As a substitute for the sucker rod type of pump, so-called "rodless" pumps have been developed in which a relatively thin stream of fluid, usually oil, under high pressure, is continuously pumped down the well to a reciprocating motor located in the well adjacent the pump.

Such pumps are subject to the disadvantage of having to conform in diameter to the diameter of the well casing at the bottom of the well. This is frequently so small that the maximum diameter of the production tubing used, may be no greater than two and one-half inches, because, with the present methods of drilling wells, the diameter or bore of the well casing generally decreases as the well deepens. Also, since the use of small diameter tubing results in decreased costs, its use in many installations is desirable. As a result, the motors for driving the pumps have had to be operated under very high fluid pressures both because of the excessive load imposed on the pump and because the design of such motors required the pressure fluid to be conducted past the motor cylinder, on the outside, or through suitable passages in the walls of the cylinder, to act below the piston for the up stroke. This construction seriously limits the effective motor piston area, which due to the size of the bore hole of the well, is already small.

Among the objects achieved by the present invention, are the provision of a reciprocating fluid motor-pump particularly adapted for use in deep wells because of the relatively high effective piston area of its motor; the provision of such a pump in which pressure fluid for operating the motor is conducted to and from the motor cylinder through hollow piston rods and a suitably valved motor piston and in which pressure fluid is not by-passed around the motor cylinder to act below the piston for the up stroke; the provision of a deep well pump that may be operated with relatively low working fluid pressures and which will be highly efficient and reliable in operation, composed of a comparatively few number of parts, inexpensive of manufacture and capable of ready assemblage.

Still other achieved objects and advantages of the invention will be apparent from the following detailed description and accompanying drawings in which,

Fig. 1 is a diagrammatic view partly in section of a motor-pump in a well.

Fig. 2 is a detail, longitudinal, sectional view of the fluid motor.

Fig. 3 is a detail, longitudinal, sectional view of the motor piston, and

Fig. 4 is a detail, sectional view of the pump.

Referring to the drawings in which like numerals designate corresponding parts throughout the several views, the numeral 1 designates an oil well casing provided at its lower end with perforations 2 for admitting oil from the surrounding formation, and at its upper end with a coupling member 3 forming the base of the usual "Christmas tree" or well casing head. From a fitting 4 forming an intermediate part of the casing head, an oil discharge tube or string of tubing 5 extends downwardly into the oil collected in the bottom of the well casing. This tubing, open at the bottom, is provided with an inwardly extending conical seat 6 adapted to receive the tapered open end of a tube 7 attached to the lower end of a pump 8. Attached to the upper end of the pump is a coupling member 9 securing the lower end of motor 10 and spacing the motor a suitable distance from the pump. Both the motor and pump are lowered into the well by means of pressure fluid delivery tube or pipe 11, the upper

end of which connects to cap member 12 of the casing head. As thus far described, the general operation of the pump is as follows: Oil or other fluid, under high pressure, is delivered to the motor 10 through a pipe 13 connected with pipe 11 through the cap member 12. Motor 10, which consists of a reciprocating piston in a cylinder, drives pump 8 by means of a hollow piston rod 14 provided with an opening 15, for discharge of spent pressure fluid from the motor. Pump 8 receives oil from the well through inlet tube 16 attached to the lower end of the pump and discharges the oil through pipe 17 into the space between the pump and the motor defined by coupling member 9. Here, the oil pumped and the spent pressure fluid from the motor mix and are discharged into oil discharge tube 5 through openings 18 in the walls of the coupling member. The lower end of pipe 5 being sealed as at 6, the oil is forced to the top of the well where it is discharged into pipe 18' for delivery to storage or to some distant point for treatment.

Referring more specifically to Figs. 2 and 3 of the drawings, the motor for driving the pump is provided with a cylinder 19 which consists simply of a length of tubing threaded internally at each end for engagement with capping members 20 forming the end walls of the cylinder. These capping members are each provided with centrally arranged tubular opening 21 serving as stuffing boxes for upper and lower piston rods 22 and 23 respectively, attached to piston 24 in the cylinder. Each capping member also serves as a coupling member for connecting the motor cylinder at the top with fluid pressure delivery pipe 11 and at the bottom with the pump through coupling 9. For this purpose, the capping members are provided with projecting and externally threaded end portions 25 and 26 respectively.

Motor piston 24 in the cylinder is provided with ports and passages and with a main valve and a pilot valve for control of power fluid in and out of the cylinder. Power fluid is admitted to the piston for distribution in the cylinder by means of upper piston rod 22 provided with perforations 27 at its top end. This piston rod is made longer than the stroke of the piston in the cylinder so that its perforated end is at all times in communication with power fluid in pipe 11. Power fluid is conducted from the piston rod into the power fluid passage 28 (shown in dotted lines) in the piston, by means of port 29. The power fluid passage extends substantially the length of the piston and is provided with outlet ports 30, 31 and 32 also shown in dotted lines. Ports 30 and 32 are opened and closed by means of a piston type pilot valve designated generally by the numeral 33 which extends longitudinally through the piston and is slightly longer than the piston. This valve is slidable in the piston by contact with the end walls 20 of the cylinder and for this purpose it is provided at each end with enlarged heads 34 and 35 respectively. Two annular chambers 36 and 37 are provided in the valve by reduced portions 38 and 39 respectively, formed on the valve piston.

Pilot valve chamber 36 is adapted to establish communication between power fluid passage 28 and the upper end of main valve cylinder 40 by means of ports 32 and 42, while chamber 37 is adapted to establish communication between the power fluid passage and the lower end of the main valve cylinder through ports 30 and 41. Exhaust of power fluid from the lower end of the main valve cylinder is by way of port 41, pilot valve chamber 37 and port 43, and from the upper end of the main valve cylinder by way of port 42, pilot valve chamber 36 and port 44. Ports 43 and 44 open into an exhaust passage in the body of the motor piston designated by the numeral 45. This passage extends substantially the length of the piston and is provided in addition to ports 43 and 44 opening into the pilot valve chamber, with ports 46 and 47 communicating with the main valve cylinder 40. As shown, the upper end of exhaust passage 45 is closed while the lower end is adapted, through port 48, to connect with the lower, hollow motor piston rod 23. As is readily seen from the above description, the purpose of the pilot valve in the motor piston is simply to admit and discharge power fluid alternately to the ends of the main valve cylinder to actuate the main valve.

The main valve consists of a piston 49 reciprocable in valve cylinder 40 and provided with reduced portions 50 and 51 forming with the cylinder walls, main valve chambers 52 and 53, respectively. In order for the main valve to alternately admit and discharge power fluid to the ends of the motor cylinder to drive the motor piston, passages 53' and 54 respectively are provided in the motor piston. Passage 53' is in open communication with the upper end of the motor cylinder while passage 54 is in open communication with the lower end of the motor cylinder. The passages are each connected by means of ports 55 and 56 respectively to the main valve cylinder.

Thus main piston valve 49 is adapted to establish communication between power fluid passage 28 in the piston and the upper end of the motor cylinder through ports 31, main valve chamber 52, port 55 and passage 53' and is adapted to establish communication between the power fluid passage and the lower end of the cylinder by way of ports 31, main valve chamber 53, port 56 and passage 54.

In operation of the motor, power fluid (fluid pressure) is supplied to the motor through pipe 11 and upper perforated piston rod 22 to power fluid passage 28 in the body of the motor piston 24. Assuming piston 24 to be at the bottom of its stroke in cylinder 19, the lower end 35 of pilot valve 33 has contacted the end wall 20 of the cylinder and raised the pilot valve to its "up" position. In this position, power fluid is admitted to the main valve cylinder 40 beneath main valve piston 49, by means of port 30, pilot valve chamber 37 and main valve cylinder port 41, and spent power fluid above the main valve piston is connected to the exhaust passage in hollow piston rod 23 by way of port 42, pilot valve chamber 36, port 44, exhaust passage 45 and port 48. Thus the main piston valve is moved to its "up" position as shown, by the action of the power fluid on the lower end of the valve piston. In this position the main valve admits power fluid to the lower end of the motor cylinder 19 below the motor piston 24 by means of ports 31, main valve chamber 53, port 56 and passage 54, and discharges spent power fluid from the upper end of the motor cylinder above the motor piston to the hollow piston rod by means of passage 53', port 55, main valve chamber 52, port 47, exhaust passage 45 and port 48. Power fluid thus acting on the lower end of the motor piston forces the piston up or to the other end of the cylinder. During the up-stroke, the pilot valve

is held in its "up" position by the fluid pressure acting on its lower end and no auxiliary locking device is required to hold this valve in either working position.

Exhaust fluid entering hollow piston rod 23 is discharged through opening 15 in the rod into the annular space between the motor and the pump and passes through openings 18 in the coupling member into the oil discharge pipe 5 leading to the top of the well, as already described.

As the motor piston approaches the top of the cylinder, the upper end 34 of the pilot valve will strike the upper end wall 20 of the cylinder and continued upward motion of the motor piston will cause shifting of the pilot valve relative thereto, to its lower-most position. This will result in the pilot valve piston closing ports 30 and 44 and connecting ports 41 and 42 respectively with ports 43 and 32. Power fluid will then be admitted to the upper end of the main valve cylinder through port 32, pilot valve chamber 36 and port 42, and power fluid in the lower end of the main valve cylinder will be exhausted through port 41, pilot valve chamber 37, ports 43 and 48 into hollow piston rod 23. This shifts the main valve piston 49 to its lower position where it admits power fluid to the upper end of the motor cylinder above the motor piston through ports 31, main valve chamber 52, port 55 and passage 53', and exhausts spent power fluid from the lower end of the motor cylinder below the piston through passage 54, port 56, main valve chamber 53, port 46, passage 45 and port 48 to the hollow motor piston rod 23. The motor piston then will move downward until the lower end of the pilot valve again contacts the lower cylinder head. This will bring both the pilot and main valve back into the positions shown in the drawings and the cycle of operation above described will be repeated.

The axes of motor piston passages 45, 53' and 54 are shown in the drawings in the same plane as the axes of the pilot and main valves for the purpose of clearness. Actually the passages would be spaced around the axis of the motor piston in such a manner as to give maximum flow area and they may be much larger than the drawing indicates.

The motor piston may be lubricated, if desired, by providing a groove (not shown) around the center of the piston and a small port leading from the power fluid passage 26, to the groove.

tached to piston rod 23 of the motor for reciprocating, double action piston type of pump adapted for use with the motor just described. This consists of a cylinder 8 provided with liquid inlet passage 57 communicating with the upper and lower ends of the cylinder through downwardly closing ball check valves 58 and 59 respectively. Liquid discharge from the cylinder is by means of passage 60 communicating with the opposite ends of the cylinder through check valves, as at 61 and 62. Pump piston 63 is adapted to be attached to piston rod 23 of the motor for reciprocation. The lower and upper ends of the pump cylinder, as shown, are screw threaded externally for connection with the sealing coupling 7 and spacing coupling 9 respectively. Discharge fluid from the pump mixes with the exhaust pressure fluid from the motor in coupling 9 and passes through openings 18 in the wall of the coupling into pipe 5 to the top of the well. A simple single-acting pump may be used, if desired, or any type pump which has been found most suitable for a particular well may be attached to the motor.

While the reciprocating fluid motor pump arrangement described is particularly adapted for use in pumping deep oil or water wells, the fluid motor of the pump may also be useful in other relations, as for instance, in surface pumping wells with sucker rods, in oil pipe installations and for steam pumping heads or hydraulic or pneumatic pump heads. As will be readily appreciated, the source of power for driving the motor is not necessarily limited to a liquid fluid. A gaseous fluid under pressure may be used with equally good results.

What I claim is:

1. A reciprocating fluid motor driven pump adapted to be positioned in a well comprising a motive fluid delivery tube extending into the well, a fluid motor positioned on the end of said tube, a piston in said fluid motor, a hollow piston rod extending from said piston, through the motor into the motive fluid delivery tube for delivering motive fluid to the motor for operation of the motor, a pump positioned in the well beneath said motor, a second hollow piston rod extending from the motor piston to said pump for operation of the pump, a pump fluid discharge tube extending into the well and arranged to receive fluid from the pump, said tube enclosing the motive fluid delivery tube and the motor but spaced therefrom, and means for discharging spent motive fluid from the motor through the second named hollow piston rod into the pump fluid discharge tube.

2. A reciprocating fluid motor driven pump adapted for use in a well comprising an outer tube provided with an inwardly extending seat adjacent its lower end, an inner tube, a piston type fluid motor-pump assembly arranged on the end of said inner tube, said inner tube, fluid motor and pump being spaced from said outer tube and said pump being provided with means for engaging with the seat on the outer tube for sealing the lower end of the space between the inner and outer tubes and for supporting the inner tube and motor-pump assembly within the outer tube, a valved piston in said motor, ports and passages in said piston, upper and lower hollow piston rods attached to the piston in communication with the ports and passages, said upper piston rod extending into said inner tube, said lower piston rod being attached to the pump piston for operation of the pump, means including said inner tube and said upper hollow piston rod and valved piston for delivering pressure motive fluid to the motor for operation of the motor, means including said lower hollow piston rod and valved piston for discharging spent motive fluid from the motor into the space between the inner and outer tubes, discharge means for the pump adapted to discharge fluid pumped into the space between the inner and outer tubes for delivery to the top of the well along with the spent motive fluid, and means in said motor for automatically shifting the valves in the piston to cause reciprocation of the motor.

3. In a reciprocating fluid motor driven deep well pump, a motor cylinder, a piston in said cylinder, said piston being provided with a valve and with ports and passages for cooperation with the valve to admit and discharge motive fluid alternately to the ends of the cylinder to drive the piston, a piston rod provided with a passage therethrough adapted for delivery of motive fluid to the motor cylinder through the ports and passages in the piston, a pump, means connecting the pump with the motor for operation of the pump, a pump fluid discharge tube

surrounding but spaced from the motor cylinder and means for discharging spent motive fluid from the motor into the pump fluid discharge tube for passage with the fluid pumped to the top of the well.

4. In a reciprocating fluid motor driven pump, a pump, a pump fluid discharge tube, a motor cylinder in said tube but spaced from the walls thereof, a piston in said cylinder, a tubular piston rod connected to the motor piston and to the pump for operation of the pump, and means including said tubular piston rod for discharging spent motive fluid from the motor cylinder into the pump fluid discharge tube.

5. A reciprocating fluid motor driven pump comprising a pump fluid discharge tube, a motor and a pump positioned in said tube, operating pistons in the motor and the pump, a hollow piston rod extending from the motor piston to a source of supply of motive fluid for operation of the motor, a second piston rod connecting the motor piston with the pump piston for operation of the pump, said second named piston rod being provided with a passage therethrough for delivering spent motive fluid from the motor to the pump fluid discharge tube, and means for discharging fluid from the pump into said pump fluid discharge tube.

6. A reciprocating fluid motor driven pump comprising a pump fluid discharge tube, a motor and a pump positioned in said tube, operating pistons in the motor and the pump, a hollow piston rod extending from the motor piston to a source of motive fluid for operation of the motor, a second piston rod connecting the motor piston with the pump piston for operation of the pump, said second named piston rod being provided with a passage therethrough for delivering spent motive fluid from the motor to the pump fluid discharge tube, means for discharging fluid from the pump into said pump fluid discharge tube and means on said pump for releasably sealing the pump fluid discharge tube adjacent the pump.

7. A reciprocating fluid motor driven pump for oil wells and the like comprising concentrically arranged spaced inner and outer tubes adapted to extend into a well, said inner tube being a motive fluid delivery tube, and said outer tube being a pump fluid discharge tube, a fluid motor and pump in said outer tube adjacent the end of the inner tube, pistons in said motor and pump, a hollow piston rod extending from the motor piston to the motive fluid delivery tube for operation of the motor, a second piston rod connecting the motor piston with the pump piston for operation of the pump, said second named piston rod having a passage therethrough for delivering spent motive fluid from the motor to the pump fluid discharge tube, and means positioned beneath the point of delivery of the spent motive fluid to the pump fluid discharge tube for sealing the space between the inner and outer tubes.

8. A reciprocating fluid motor driven pump for pumping oil wells and the like, comprising inner and outer strings of tubing, said inner tubing being adapted to deliver motive fluid to the motor and the space between the tubes being adapted to deliver fluid discharge from the pump and spent motive fluid to the top of the well, a motor and a pump mounted on said inner tube in spaced relation to each other and to the outer tubing, a motor piston and a pump piston, means comprising a hollow piston rod attached to the motor piston and in communication with the motive fluid in the inner tube for delivering motive fluid to the motor through the piston for operation of the same, a second piston rod connecting the motor piston with the pump piston through the space between the motor and the pump, said second named piston rod being provided with a passage therethrough for delivering spent motive fluid into the space between the motor and the pump, pump discharge means for delivering fluid in the space between the motor and the pump, said space being at all times in open fluid communication with the space between the inner and outer tubes, and releasably engaging and sealing means carried by the pump and outer tube beneath the space betwen the motor and the pump for sealing the lower end of the space between the inner and outer tubes.

9. A reciprocating fluid motor driven pump comprising substantially concentrically arranged spaced inner and outer tubes, one of said tubes being a motive fluid delivery tube and the other of said tubes being a pump fluid discharge tube, a motor and a pump carried on said inner tube and adapted to be removably positioned together with said inner tube as a unit in said outer tube, a piston in the motor, motive fluid delivery means including a hollow piston rod extending from the motor piston to the motive fluid delivery tube for operation of the motor, a second piston rod having a passage therethrough for delivering spent motive fluid from the motor to the pump fluid discharge tube, one of said piston rods being connected to the pump for operation of the pump, pump fluid discharge means for delivering fluid pumped into said pump fluid discharge tube and means positioned beneath said discharge means for the pump, said spent motive fluid discharge means and said motive fluid delivery means for sealing the space between the inner and outer tubes.

10. A reciprocating fluid motor driven pump comprising a motive fluid delivery tube, a motor and a pump carried by said tube, a piston in the motor, a hollow piston rod extending from the motor piston to the motive fluid delivery tube for delivering motive fluid to the motor, a second piston rod connecting the motor piston with the pump for operation of the pump, a pump fluid discharge tube spaced from but surrounding said motive fluid delivery tube, motor and pump, means on the pump for discharging pump fluid into said pump fluid discharge tube, a passage in said second named piston rod for delivering spent motive fluid to said pump fluid discharge tube and means beneath the pump fluid discharge means and said spent motive fluid discharge means for sealing the space between the inner and outer tubes.

11. In a reciprocating fluid motor driven deep well pump wherein the motor and the pump are arranged in spaced tandem fashion and maintained in a well adjacent the end of a string of motive fluid delivery tubing, and wherein a second string of tubing concentric with but spaced from said first string of tubing, motor and pump is provided for delivery of fluid pumped to the top of the well, the improvement which comprises a valved piston in the motor, said piston being provided with ports and passages adapted for cooperation with the valves to distribute fluid pressure to and from the motor to move the piston, means extending through the upper end of the motor for connecting the

motor piston with the motive fluid delivery tube, pump fluid discharge means on the pump for delivering fluid pumped into the space between the motor and the pump for passage between the strings of tubing to the top of the well, a piston rod connecting the motor piston with the pump for operation of the pump, said piston rod being provided with a passage therethrough for delivering spent motive fluid from the motor into the space between the motor and the pump for passage in admixture with pumped fluid to the top of the well and means for sealing the space between the tubes at a point below the space formed between the motor and the pump.

12. A reciprocating fluid motor-driven deep well pump comprising a pump fluid discharge tube, a motor and a pump positioned in said tube but spaced from the walls thereof, means for supplying motive fluid to the motor for operation of the same, means for connecting the motor to the pump for operation of the pump, a rod connected to the motor piston and provided with a passage therethrough for delivering spent motive fluid from the motor to the pump fluid discharge tube, means for discharging fluid from the pump into said pump fluid discharge tube and means for sealing the pump fluid discharge tube at a point below said discharge means for the motor and the pump.

ROY L. CHENAULT.

CERTIFICATE OF CORRECTION.

Patent No. 2,191,369. February 20, 1940.

ROY L. CHENAULT.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 52, strike out "tached to piston rod 23 of the motor for" and insert instead In Fig. 4 is illustrated one form of; page 4, second column, line 17, claim 8, for "betwen" read between; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of March, A. D. 1940.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)