April 2, 1957 E. J. SARGENT 2,787,223

HYDRAULIC PUMP

Original Filed Aug. 23, 1947 2 Sheets-Sheet 1

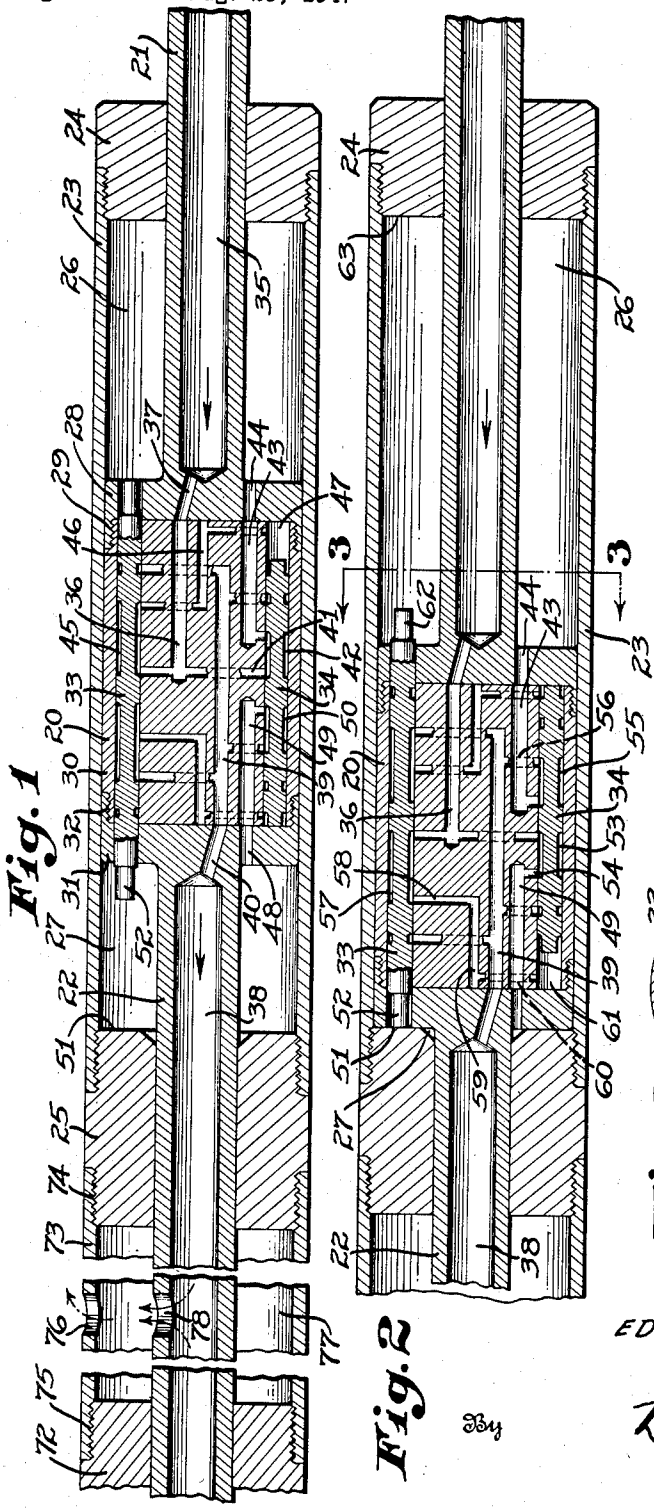


Fig. 1

Fig. 2

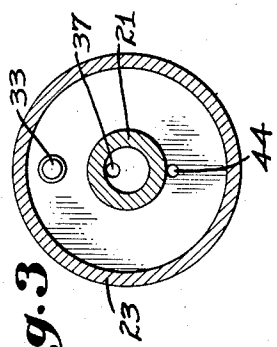


Fig. 3

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HYDRAULIC PUMP

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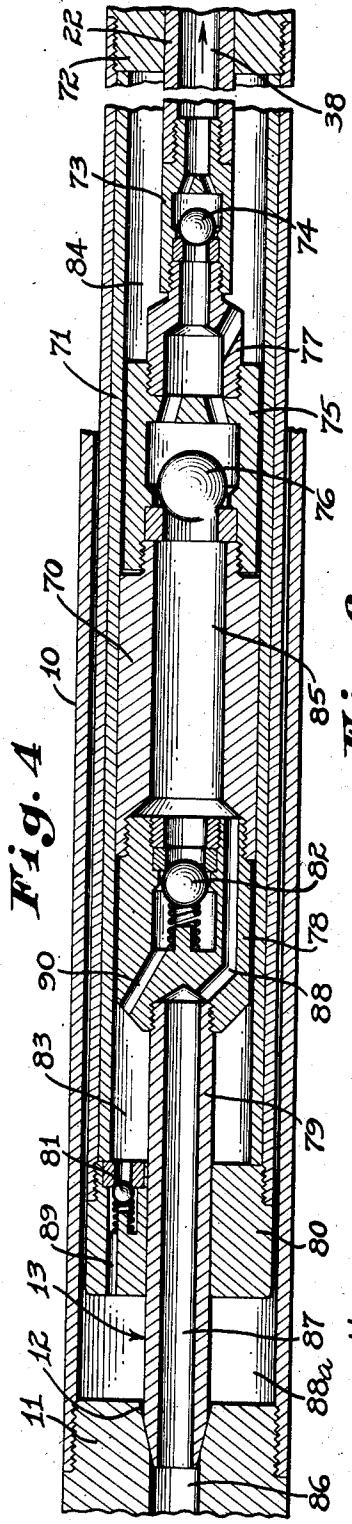


Fig. 4

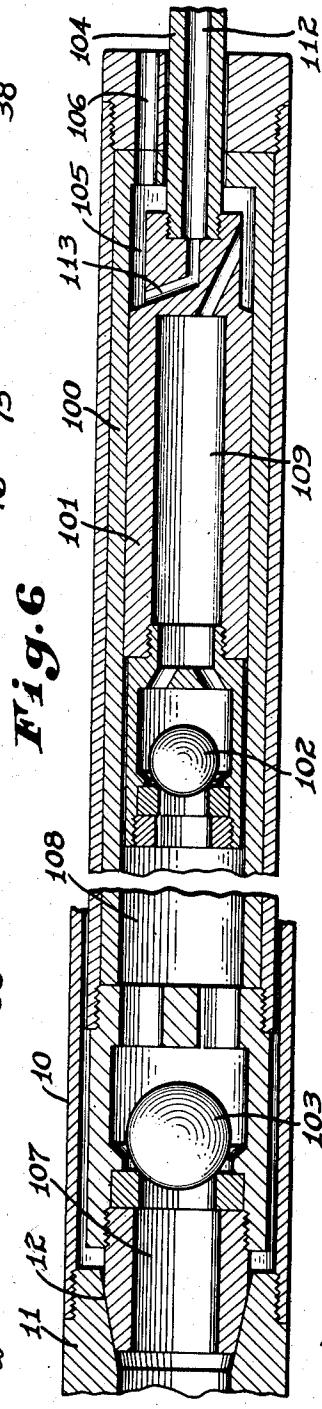


Fig. 6

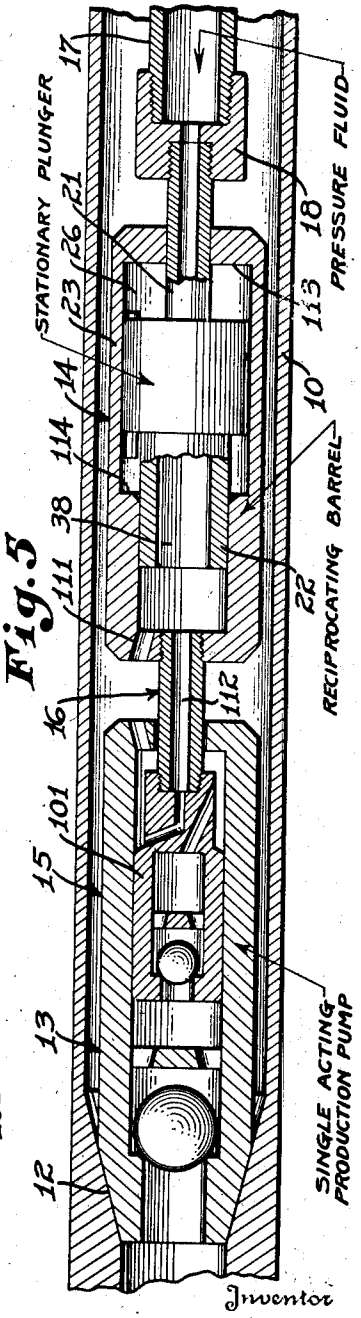


Fig. 5

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2,787,223

HYDRAULIC PUMP

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Original application August 23, 1947, Serial No. 770,280, now Patent No. 2,748,712, dated June 5, 1956. Divided and this application March 30, 1953, Serial No. 345,420

6 Claims. (Cl. 103—46)

This invention relates to a hydraulic pump and is particularly directed to an improved form of hydraulically operated pump assembly adapted to be lowered into a well bore and to be powered from the surface. This invention finds particular usefulness in connection with improvements in hydraulic motors for reciprocating a plunger pump in the bore of an oil well.

This application is a division of my copending application Serial Number 770,280, filed August 23, 1947, now Patent No. 2,748,712, and entitled Hydraulic Pump.

Hydraulically operated well pumps are known and have achieved a measure of commercial success. The usefulness of commercial types so far developed has been limited by complicated and expensive design resulting in high installation cost and excessive maintenance charges. The hydraulic motors for such pumps commonly employ a reciprocating plunger within a stationary barrel, and therefore a slender rod is used to connect the hydraulic motor to the production pump situated below it. Since the slenderness ratio of the rod is unfavorable for action in compression the effective length of the stroke must be held to a low value and the speed of operation maintained at a high value in order that a sufficient quantity of well fluid may be pumped. For these reasons hydraulically operated plunger pumps for oil wells particularly have been found to be economically feasible only for very deep wells or wells having crooked or slanting bore holes in which the conventional sucker rods give poor service.

It is the principal object of this invention to provide a novel form of hydraulically operated pump assembly which overcomes or minimizes the above named disadvantages.

A more particular object is to provide improvements in a hydraulic motor for reciprocating a plunger pump in an oil well bore.

Another object is to provide a hydraulically operated pump assembly having a motor provided with a stationary valve body acting as a plunger and having an enclosing barrel adapted to reciprocate relative to the plunger.

Another object is to provide a device of this type which may operate with a long stroke to actuate a production pump in the well and which employs a tubular connection between the barrel and the pump to afford maximum resistance against lateral deflection when the tubular member operates under compression.

A further object is to provide a hydraulic holder adapted to a position within a well bore to drive any conventional form of plunger pump, either single acting or double acting.

Other objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a longitudinal sectional view through the upper portion of a hydraulic pump assembly embodying my invention.

Figure 2 is a view similar to Figure 1 illustrating parts of the valve assembly moved to another position.

Figure 3 is a transverse sectional view taken substantially on the line 3—3 as shown in Figure 2.

Figure 4 is a longitudinal sectional view of the lower portion of the hydraulic pump assembly embodying my invention.

Figure 5 is a longitudinal section in diagrammatical form showing a modified form of my invention incorporating a single acting production pump.

Figure 6 is a sectional view of the production pump illustrated diagrammatically in Figure 5.

Referring to the drawings, the well tubing 10 extends down into the well bore from the surface and carries a shoe 11 at its lower end. A conical seating surface 12 is provided on the shoe 11 to receive the lower end of an insertable assembly generally designated 13. This assembly 13 includes an hydraulic motor 14, a production pump 15 and a connection element 16 for operating the pump 15 from the motor 14. This assembly 13 is lowered into the well bore inside the tubing 10 and is carried on the lower end of a small diameter pipe string 17 hereinafter referred to as the macaroni. When the lower end of the assembly 13 has been landed on the conical seating surface 12, hydraulic fluid may be pumped under high pressure down through the macaroni string 17 to operate the hydraulic motor 14. The hydraulic motor drives the pump 15 and well fluid is produced up through the tubing 10 in the annulus between the tubing 10 and macaroni 17.

The hydraulic motor generally designated 14 includes a stationary plunger 20 carried on the lower end of the macaroni string 17. A connection fitting 18 may be provided to connect the macaroni string 17 to the upper piston rod 21 which is secured to the plunger 20. A lower piston rod 22 depends from the lower end of the plunger 20 and is connected to the stationary elements of the plunger pump which is positioned within the well bore below the hydraulic motor 14.

A barrel 23 slidably mounted to reciprocate with respect to the stationary plunger 20 is provided with end closures 24 and 25 which encircle the piston rods 21 and 22 respectively and form sliding fits therewith which are substantially fluid tight. The stationary plunger 20, piston rods 21 and barrel 23 cooperate to define an upper pressure chamber 26 and a lower pressure chamber 27 on opposite sides of the stationary plunger 20. The connection between the piston rods 21 and 22 and the plunger 20 may be of any suitable or desirable design or type and as shown in the drawings the flange 28 on the piston rod 21 is joined by a threaded connection 29 to the central shell 30 of the plunger 20. Similarly, the flange 31 on the lower piston rod 22 is connected by the threaded joint 32 to the plunger shell 30.

Valve means are provided within the stationary plunger 20 for directing pressure fluid supplied through the macaroni string 17 alternately into the pressure chambers 26 and 27. As shown in the drawings the valve means for accomplishing this result includes a pilot valve 33 and a main valve 34 slidably mounted in parallel relation within suitable bores provided in the stationary plunger 20. A central passage 35 in the upper piston rod 21 communicates with the interior of the macaroni string 17 through the connection fitting 18 and also communicates with the inlet passageway 36 in the stationary plunger 20 by way of the port 37. The central passageway 38 in the lower piston rod 22 communicates with the exhaust passageway 39 by way of port 40. When the pilot valve 33 and main valve 34 are in the positions illustrated in Figure 1, pressure fluid entering the inlet passageway 36 is directed through a lateral passage 41 into the annular space 42 about the main valve 34. From this annular space 42 the pressure fluid passes upwardly through the delivery passage 43 and port 44 into the upper pressure chamber

26. The fluid pressure in the inlet passageway 36 is reflected through the annulus 45 about the pilot valve 33 and through the intermediate passage 46 into the space 47 within the plunger 20 about the main valve 34. The pressure in the space 47 serves to hold the main valve 34 in the position shown in Figure 1.

The admission of pressure fluid into the upper pressure chamber 26 causes the barrel 23 to move upwardly relative to the stationary plunger 20 thereby reducing the volume of the lower pressure chamber 27. Fluid within the lower pressure chamber 27 escapes through the port 48 into the delivery passage 49 and into the annular space 50 about the main valve 34. The annular space 50 communicates with the exhaust passageway 29 and the pressure fluid flows through the port 40 and out through the central passageway 38 in the lower piston rod 22.

Upward motion of the barrel 23 brings the end surface 51 of the closure member 25 into contact with the lower projecting end 52 of the pilot valve 33 and moves it to the position shown in Figure 2. This upward movement of the pilot valve 33 changes the porting within the valve assembly. Pressure fluid in the inlet passage 36 is now in communication with the annulus 57, branch 58, passage 59 and the lateral passage 60 leading to the space 61. Pressure within the space 61 moves the main valve 34 upwardly, so that pressure fluid is now delivered into the lower pressure chamber 27 via the passageways 36, annulus 53, branch 54 and passage 49. Exhaust of fluid from the upper pressure chamber 26 occurs through the passage 43, annulus 55, branch 56 and exhaust passage 39 into the passage 38 within the lower piston rod 22. The barrel 23 moves downwardly with respect to the plunger 20 and eventually the upper end 62 of the pilot valve 33 is contacted by the end surface 63 of the closure member 24. The pilot valve 33 is shifted back to the position shown in Figure 1 and fluid is again delivered into the upper pressure chamber 26 and exhaust from the lower pressure chamber 27. The cycle of operations thus automatically repeats with the barrel 23 reciprocating with respect to the stationary plunger 20.

The vertical reciprocation of the barrel 23 may be utilized to drive a double acting production pump as illustrated in Figure 4 or a single acting production pump as illustrated in Figures 5 and 6. The double acting pump shown in Figure 4 is provided with a central stationary piston 70 and a reciprocating cylinder 71. The lower end of the hollow piston rod 22 depending from the hydraulic motor 14 may extend through an upper closure 72 on the cylinder 71 for connection with the housing 73 for the valve 74. The valve housing 75 for the valve 76 is secured to the piston 70 and may be connected with the valve housing 73 by means of the connection fitting 77. The valve housing 78 secured at the lower end of the stationary piston 70 is secured to the well fluid inlet tube 79 which seats on the conical surface 12 on the tubing shoe 11. A lower closure member 80 carries a valve 81 and the valve housing 78 is provided with a valve 82. A tubular connection member 73 is joined by means of threads to the driving member 25 on the barrel 23 and the driven member 72 on the pump cylinder 71. A port 76*a* is provided in the connection member 73 for discharging into the tubing 10 fluid which accumulates in the annulus 77 via the port 78 in the piston rod 22. In the operation of the double acting production pump illustrated in Figure 4 upward movement of the cylinder 71 with respect to the stationary piston 70 reduces the volume in the lower chamber 83 and increases the volume in the upper chamber 84.

Accordingly, on the upstroke of the cylinder 71 well fluid which enters the central cavity 85 in the piston 70 via the passageways 86, 87 and 88, passes upwardly past the check valve 76 into the chamber 84, and at the same time fluid in the chamber 83 passes through the spring urged valve 81 into the space 88*a* within the lower end of the tubing 10. The quantity of well fluid passing into the space 88 through the valve passage 89 displaces a like quantity at the upper end of the tubing and thus production from the well is effected.

On the down stroke of the cylinder 71 the volume of the chamber 84 is decreased and the volume of the chamber 83 is increased with the result that fluid in the chamber 84 is trapped above the check valve 76, passes upwardly through the check valve 74 and into the passage 38 within the lower piston rod 22. The well fluid thus produced mixes with the exhaust pressure fluid and passes outwardly through the ports 78 and 76 into the tubing 10. During the down stroke of the cylinder 71 well fluid in the central cavity 85 passes by the spring urged check valve 82 and enters the chamber 83 by way of passage 90. From this description it will be understood that fluid is delivered from the central cavity 85 into the tubing 10 on both the upstroke and down stroke of the cylinder 71.

While I have illustrated in Figure 4 a preferred form of double acting production pump, it is to be understood that any other siutable or desirable form of double acting production pump may be employed if desired, since the parts of the production pump, except for its manner of connection to the hydraulic motor, form no part of my present invention.

It will be noted that the outside diameters of the piston rods 21 and 22 are substantially equal in order that substantially the same effective surface area on the closure members 24 and 25 may be provided. Since the effective areas are substantially the same, the axial forces applied to the reciprocable barrel 23 by the pressure fluid are substantially the same. This is a desirable condition when operating a double acting pump since approximately the same force is required on both the upstroke and downstroke.

In Figure 6 I have illustrated a single acting production pump which includes a stationary cylinder 100 and a reciprocable piston 101 adapted to operate therein. A traveling valve assembly 102 is provided on the piston and a standing valve assembly 103 is provided at the lower end of the cylinder 100. A tubular connector 104 is attached at its upper end to the reciprocating barrel 23 of the fluid motor and at its lower end is secured to the reciprocable piston 101. As the piston 101 rises within the cylinder 100 well fluid above the traveling valve 102 passes from the chamber 105 in the upper end of the cylinder 100 out through the port 106 and into the tubing 10. During such upward motion of the piston 101 well fluid passes upwardly through the passage 107 through the check valve assembly 103 and into the chamber 108 in the lower end of the cylinder 100. When the piston 101 descends well fluid is trapped within the chamber 108 above the standing valve assembly 103 and fluid passes upwardly through the traveling valve assembly 102 into the central cavity 109 and into the upper chamber 105 via the passage 110.

As shown diagrammatically in Figure 5, part of the exhaust fluid passing outwardly through the passage 38 in the lower piston rod 22 escapes through port 111 and the remainder passes downwardly through the central opening 112 in the tubular pull rod 104. A portion of the exhaust pressure fluid from the hydraulic motor is thus delivered into the upper end of the production pump and is directed from a central opening 112 into the lateral port 113 and thence into the upper chamber 105. The purpose of this arrangement is to agitate the well fluid within the upper chamber 105 to prevent settling of sand or other abrasive around the upper end of the piston 101. The accumulation of foreign matter such as sand within the chamber 105 above the piston 101 has a damaging effect on the sliding seal provided between the piston 101 and the cylinder 100. Delivery of a portion of the exhaust pressure fluid from the hydraulic motor serves to prevent the accumulation of such abrasive material by agitating it and causing it to be delivered into the tubing 10 by way of the port 106. While I have

shown and described a preferred form of single acting production pump, it is to be understood that any other desirable form of single acting production pump may be used if desired since this device with the exception of the arrangement for preventing settling of abrasive material forms no part of my present invention.

It will be observed by reference to Figures 5 and 6 that the single acting production pump requires a greater force to lift the piston **101** than to cause it to descend. In other words, the only work done by the pump is on the upstroke. Accordingly, the parts of the hydraulic motor **14** are proportioned so that a greater force is available on the downstroke than on the upstroke in order that optimum use may be made of the available pressure fluid. Thus the upper piston rod **21** as shown in Figure 5 is of substantially smaller diameter than the lower piston rod **22**, and hence the effective area of the annular surface **113** is substantially greater than the effective area of the annular surface **114**. Accordingly, pressure fluid in the upper chamber **26** exerts a substantially greater upward force on the barrel **23** than pressure fluid in the lower pressure chamber **27**.

When the hydraulic motor **14** is to be used for operating a single acting production pump, the upper chamber **26** is made larger than the lower chamber **27** by proportioning the sizes of the piston rods **21** and **22** as described above and the relative effective areas of the chambers **26** and **27** may vary in accordance with the depth at which the production pump operates. In shallow wells the effective area of the upper chamber **26** might be twice that of the lower chamber **27**, while in very deep wells the effective area of the upper chamber **26** may be three times that of the lower chamber **27**. The only work done by the pressure fluid in the lower chamber **27** is to overcome friction in returning the barrel **23**, tubular connector **104** and pump piston **101** back to the lower limit of the stroke. Accordingly, as this force to move the parts downwardly is a relatively constant one, the effective areas of the two pressure chambers may be changed to make a greater lifting force available for deep wells.

While I have described the preferred embodiments of my invention, I am not limited to any of the details herein set forth except as described in the following claims.

I claim:

1. In a hydraulically operated fluid motor assembly adapted to be lowered into a well bore with a mechanism driven thereby, the combination of a stationary plunger having an upper and a lower piston rod extending therefrom; a fluid supply conduit adapted to deliver pressure fluid to said plunger through the upper piston rod; valve means incorporated within the plunger and adapted to direct pressure fluid from said supply conduit alternately above and below the plunger; a tubular reciprocable barrel enclosing the plunger and slidably sealed on said piston rods to define annular pressure chambers above and below the plunger; the upper piston rod having a substantially smaller diameter than the lower rod, whereby the axial force applied to the barrel by the pressure fluid to move it upwardly is more than the similar force to move it downwardly; a portion of the barrel extending below the lower end of the lower piston rod; and a coaxial member connected with the lower end of the barrel for operating the driven mechanism.

2. In a hydraulically operated fluid motor assembly adapted to be lowered into a well bore with a mechanism driven thereby, the combination of a stationary plunger having an upper and a lower piston rod extending therefrom; a fluid supply conduit adapted to deliver pressure fluid to said plunger through the upper piston rod; valve means incorporated within the plunger and adapted to direct pressure fluid from said supply conduit alternately above and below the plunger; a tubular reciprocable barrel enclosing the plunger and slidably sealed on said piston rods to define annular pressure chambers above and below the plunger; the upper piston rod having a substantially smaller diameter than the lower rod, whereby the axial force applied to the barrel by the pressure fluid to move it upwardly is more than the similar force to move it downwarldy; a portion of the barrel extending below the lower end of the lower piston rod; a passageway in the lower piston rod for delivering exhaust fluid from said annular chambers to the driven mechanism; and a coaxial member connected with the lower end of the barrel for operating the driven mechanism.

3. A fluid-actuated pump, comprising in combination: a motor cylinder member having a piston member therein, said members being mounted for relative reciprocating movement, a pump cylinder having a piston reciprocable therein, an element connecting one of said members to said pump piston for simultaneous movement, the pump cylinder having a suction inlet and a discharge outlet for pump fluid, the motor cylinder member having an inlet for operating fluid and a discharge outlet for spent operating fluid, said last named discharge outlet including walls forming a passageway extending axially through said connecting element and communicating with the upper end of said pump cylinder whereby spent operating fluid from said motor cylinder member is discharged into and through the upper end of said pump cylinder and through said pump fluid discharge outlet.

4. A fluid-actuated pump, comprising in combination: a movable motor cylinder, a stationary piston mounted within the motor cylinder, a pump cylinder having a piston reciprocable therein and having a working stroke and a return stroke, a connecting element connecting the pump piston to the motor cylinder for simultaneous movement, said pump cylinder having a suction inlet and a discharge outlet for pump fluid, said motor cylinder having an inlet for operating fluid and a discharge outlet for spent operating fluid, and defining with said stationary piston a working stroke chamber of major area operable to effect the working stroke of said pump piston, and a return stroke chamber of minor area operable to effect the return stroke of said pump piston, said motor cylinder discharge outlet including walls forming a passageway extending axially through said connecting element and communicating with the upper end of said pump cylinder whereby spent operating fluid from said motor cylinder is discharged into and through the upper end of said pump cylinder and through said pump fluid discharge outlet.

5. In a fluid motor assembly insertable into a well as a unit with a single acting reciprocating pump driven thereby, the improvement comprising, in combination: a fluid pressure supply pipe extending into the well, a stationary plunger carried on the lower end of the supply pipe, a tubular barrel enclosing the plunger and adapted to reciprocate thereon, said barrel defining with said plunger an upper working stroke chamber and a lower return stroke chamber, said plunger having an exhaust tube extending below said return stroke chamber, means including valve means on said stationary plunger for directing the flow of motive fluid from said supply pipe alternately above and below the plunger into said working and return stroke chambers to reciprocate said barrel, a pump having a movable piston connected to said barrel, the pump having a stationary barrel enclosing the pump piston and adapted to seat in the bottom of the well, the pump having valve means for admitting well fluid into said pump barrel and through the pump piston.

6. In a fluid motor assembly insertable into a well as a unit with a single acting reciprocating pump driven thereby, the improvement comprising, in combination: a fluid pressure supply pipe extending into the well, a stationary plunger carried on the lower end of the supply pipe, a tubular barrel enclosing the plunger and adapted to reciprocate thereon, said plunger having a depending exhaust tube, said barrel defining with said plunger and lower end of said supply tube a working stroke chamber

and said barrel defining with said plunger and exhaust tube a return stroke chamber, means including valve means on said stationary plunger for directing the flow of motive fluid from said supply pipe alternately above and below the plunger to said working stroke and return stroke chambers thereby to reciprocate said barrel, a pump having a traveling piston connected to said motor barrel and a stationary pump barrel; and means for exhausting spent motive fluid from said exhaust tube into the well between said motor and pump, said pump having valve means for admitting well fluid below said pump piston and passing the fluid through said pump piston for discharge into the well between said pump and motor.

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