June 17, 1958 R. BACCHI 2,838,910

HYDRAULIC PUMPING JACK

Filed Aug. 18, 1955 6 Sheets-Sheet 1

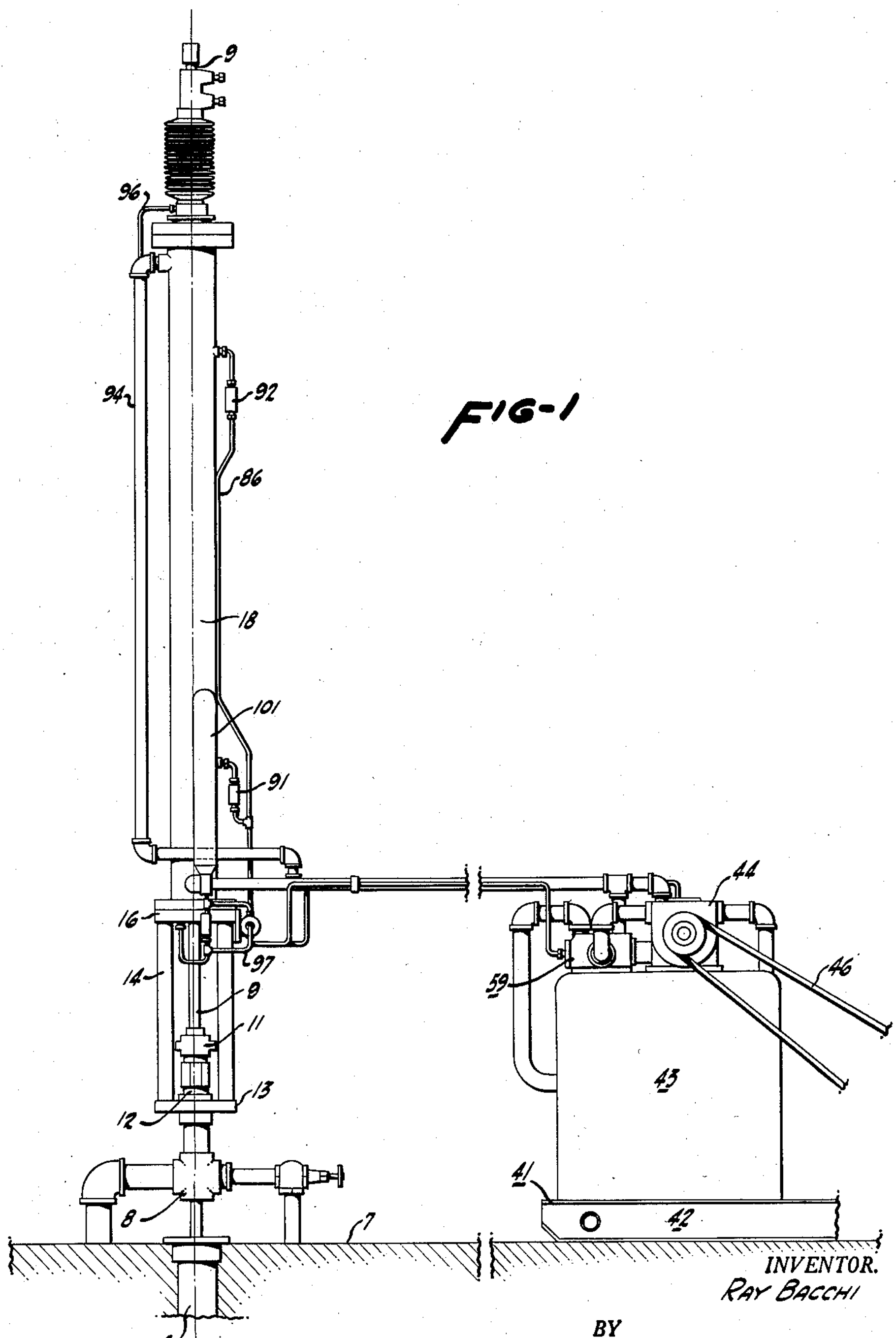

FIG-1

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FIG-2

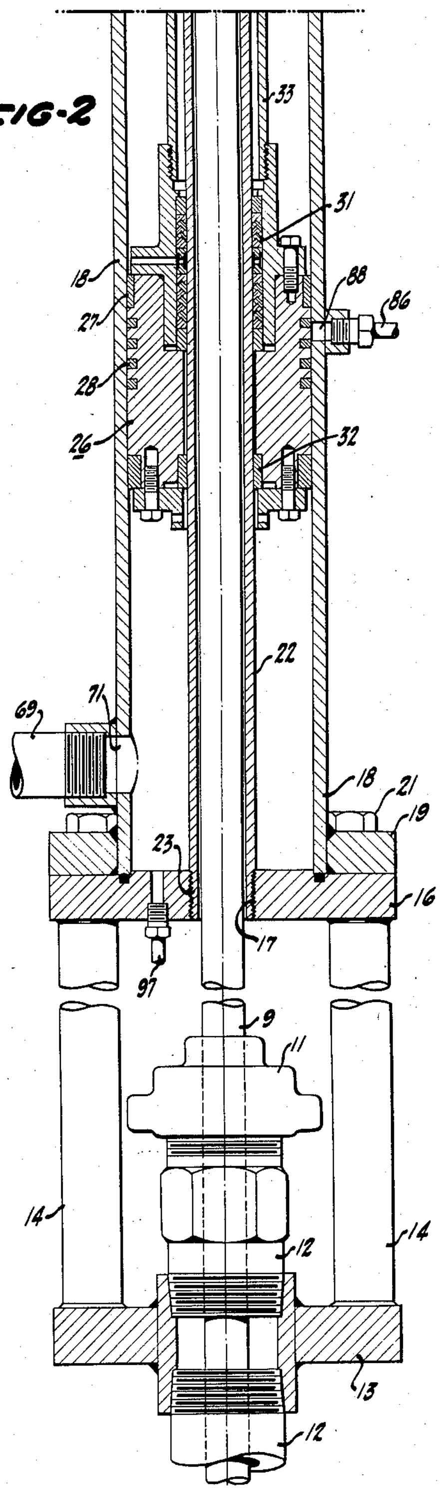

FIG-3

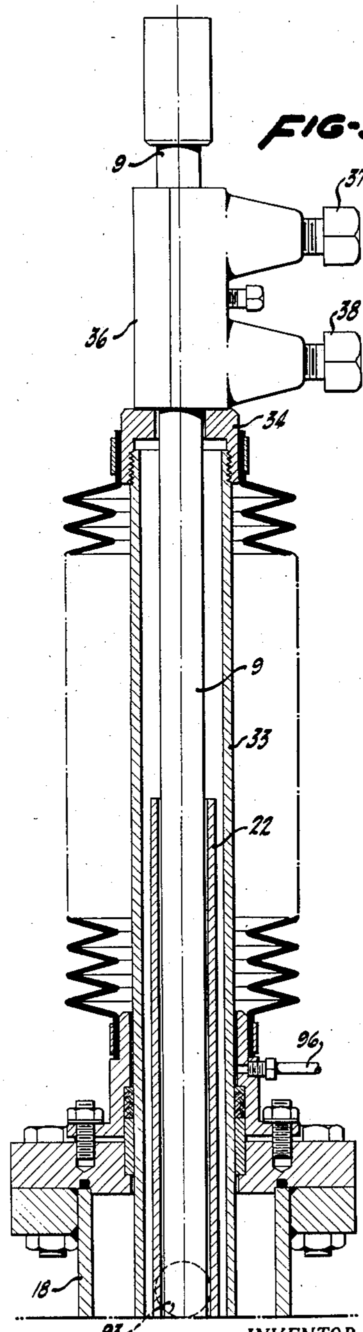

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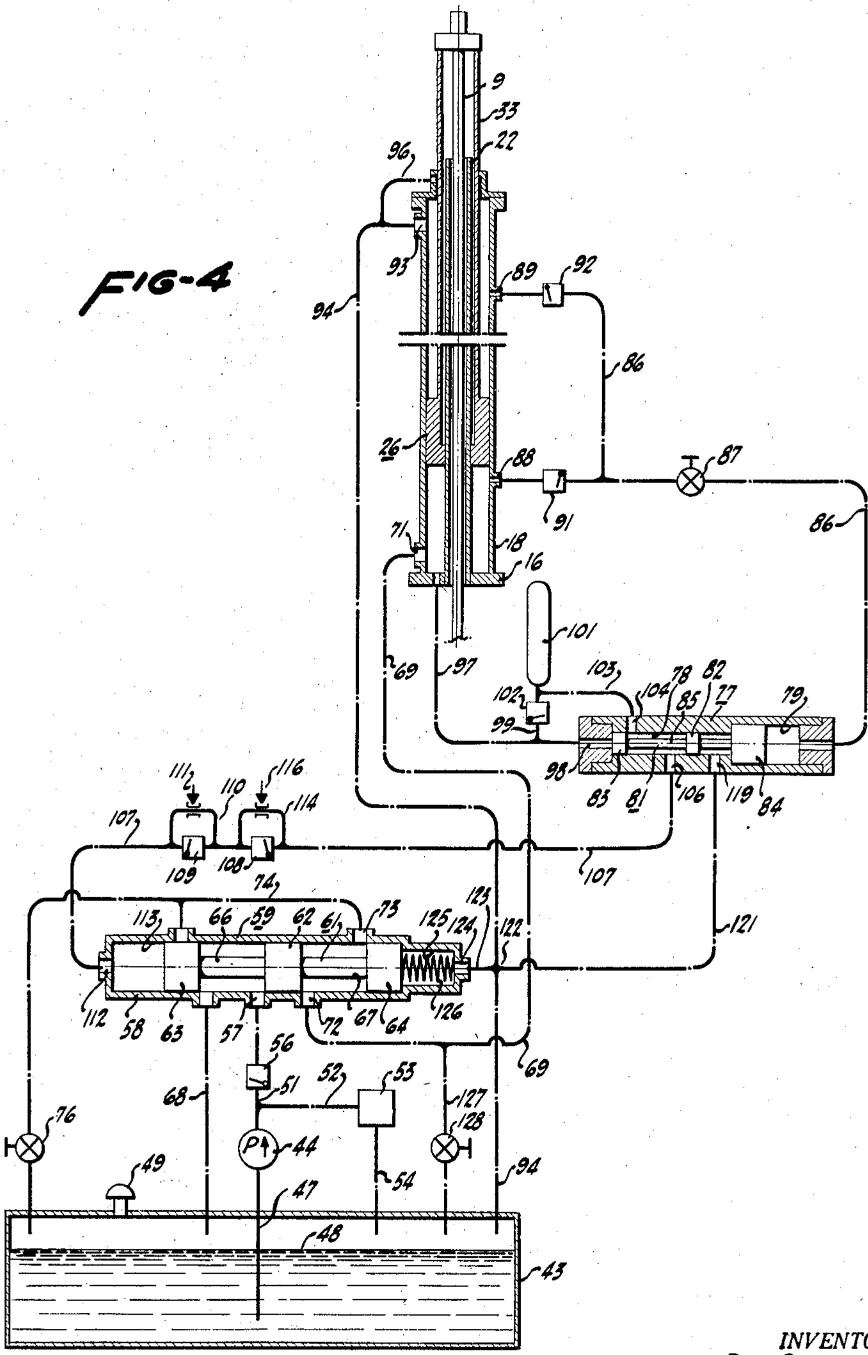
FIG-4



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HYDRAULIC PUMPING JACK

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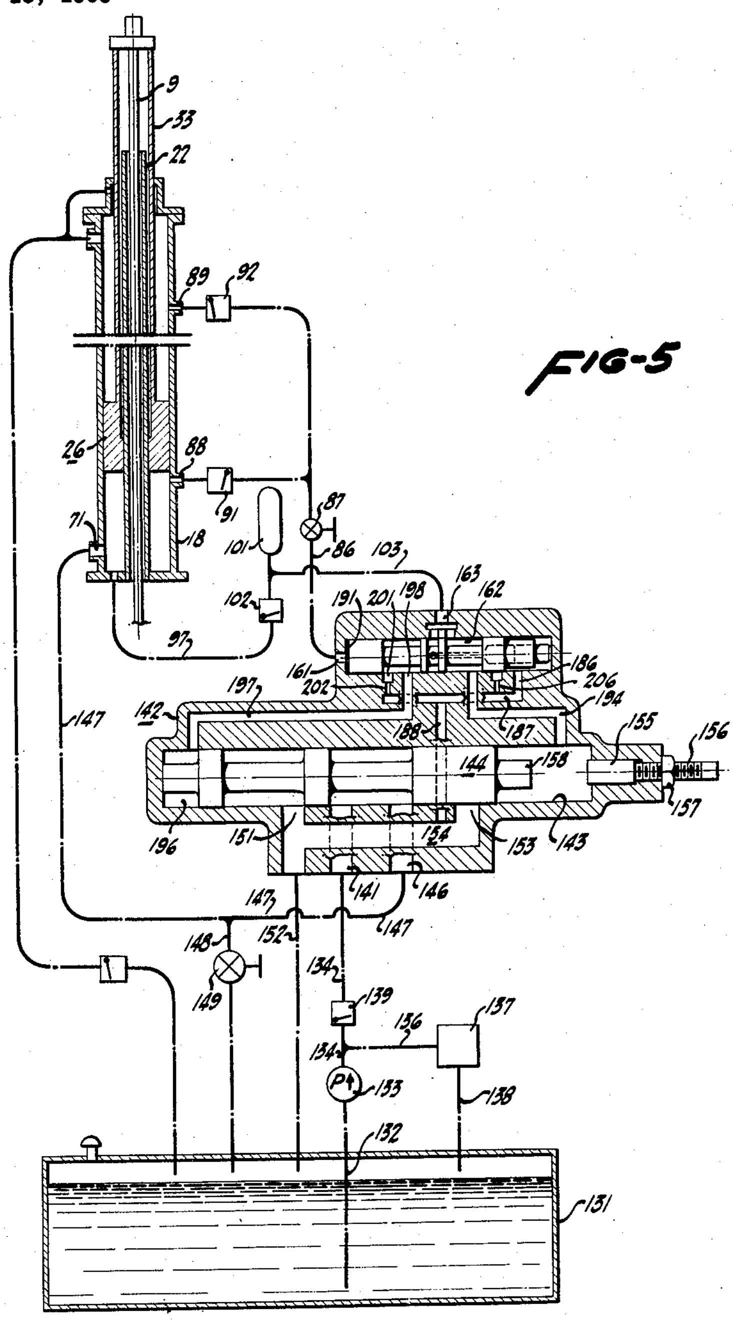

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HYDRAULIC PUMPING JACK

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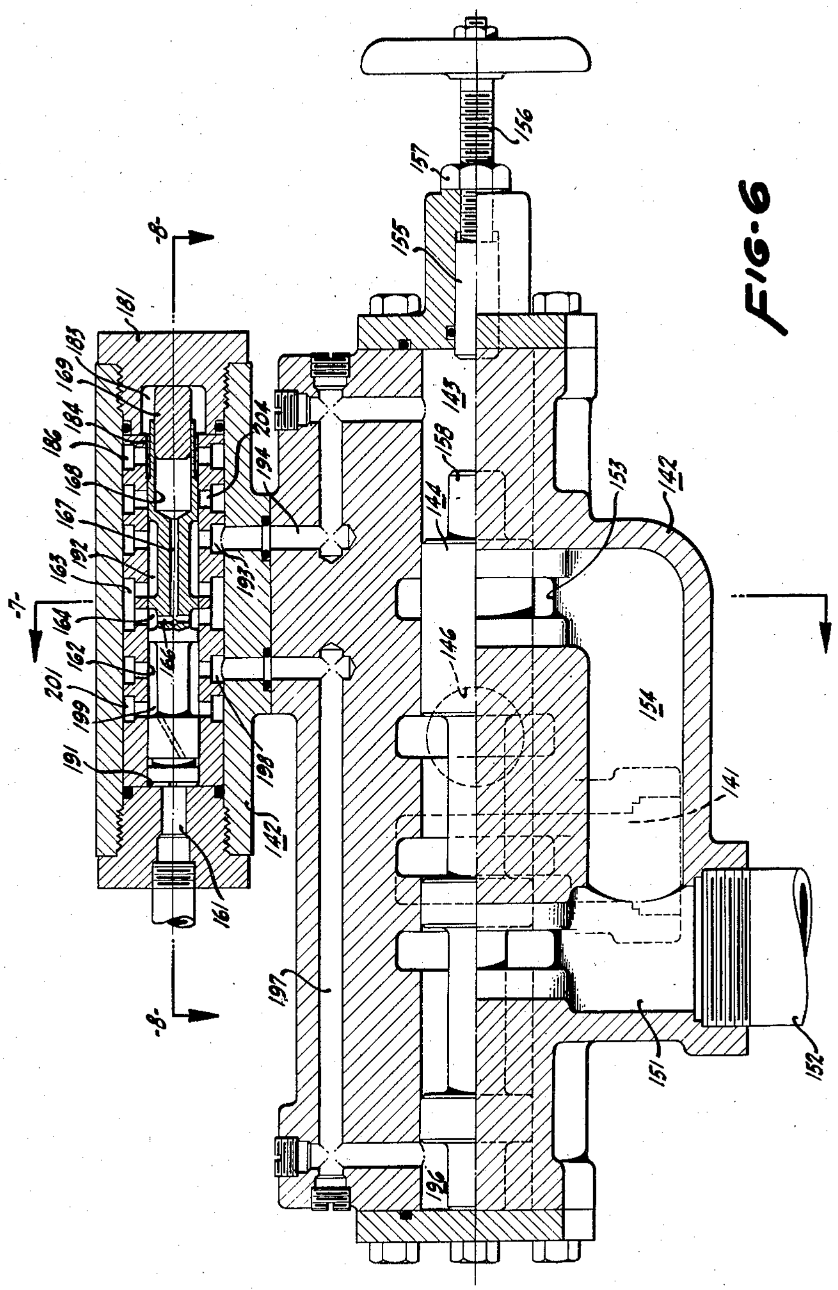

FIG. 6

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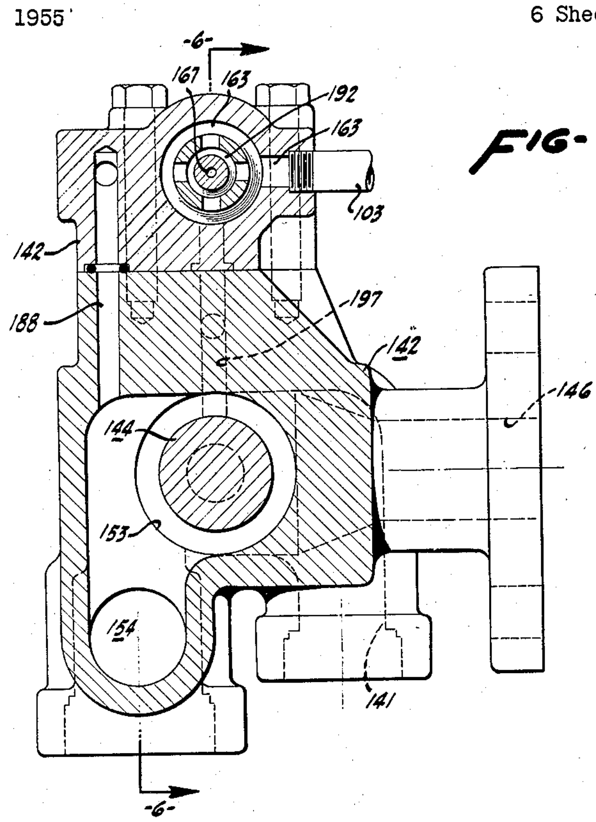

FIG-7

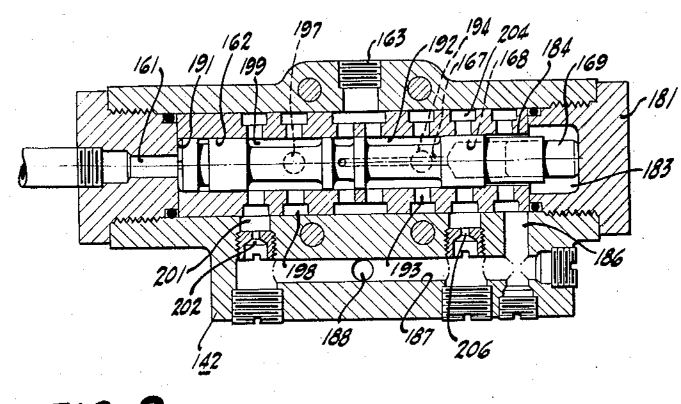

FIG-8

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Patented June 17, 1958

2,838,910

HYDRAULIC PUMPING JACK

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Application August 18, 1955, Serial No. 529,241

1 Claim. (Cl. 60—52)

My invention relates to means for reciprocating the polish rod of a well, usually an oil well, in which the polish rod is connected to a pump near the bottom of the well. Many devices have been proposed and are utilized for this purpose. Some of them utilize hydraulic fluid furnished under pressure by a power driven pump, but in many instances the amount of mechanism is so extensive and the cost of the pumping jack is so high that it is not economical to utilize on wells in which the output is not very great. It is sometimes economically feasible to pump such wells, generally referred to as "stripper" wells, providing the necessary mechanism is not elaborate, does not require extensive supervision or servicing and can be reliably and economically made and installed.

It is therefore an object of my invention to provide a pumping jack complying with the indicated requirements.

It is another object of my invention to provide a pumping jack which dispenses with the use of a balancing tank and is generally simplified in important particulars.

Another object of my invention is to provide an economical pumping jack for relatively light service on various different wells at different times.

An additional object of my invention is to provide a pumping jack which can readily be assembled on and removed from an existing well without requiring extensive superstructure or supporting or surrounding mechanism.

A still further object of my invention is, in general, to improve pumping jacks.

Other objects, together with the foregoing, are attained in the embodiments of the invention described in the accompanying description and illustrated in the accompanying drawings, in which

Figure 1 is a side elevation of a pumping jack, constructed in accordance with my invention, as it is installed on a "stripper" well.

Figure 2 is a cross section on a diametrical plane through the lower part of the pumping jack adjacent the well casing.

Figure 3 is, in effect, a continuation of Figure 2, being a cross section on the same plane through the upper portion of the pumping jack, a certain part being broken away to reduce the size of the figure.

Figure 4 is a diagrammatic layout showing the piping and valving arrangements of the pumping jack.

Figure 5 is a piping and layout diagram similar to Figure 4, but showing a somewhat modified form of piping and valving arrangement incorporating an integral pilot and main valve structure.

Figure 6 is a cross section of the integral pilot and main valve structure, the planes of section being indicated by the lines 6—6 of Figure 7.

Figure 7 is a cross section, the plane of which is indicated by the line 7—7 of Figure 6.

Figure 8 is a cross section, the plane of which is indicated by the line 8—8 of Figure 6.

In the usual instance, the pumping jack of my invention is installed on a well **6**, such as an oil well, which terminates at the level of the ground **7** in a well casing member **8**. Projecting from the casing member **8** is a polish rod **9** of considerable length. By suitable means this is joined to the pump at the bottom of the well. In its lowermost position and in its uppermost position the polish rod **9** extends substantially above the casing member **8**.

The polish rod **9** is usually provided with some sort of packing gland **11**, joined by fittings **12** to the casing member **8**. A suitably extending flange **13** is connected to a lantern frame **14** or base frame including at least two uprights joining the lower flange **13** with an upper flange **16**. This is also designed to serve as a cylinder head and encompasses the polish rod **9** by means of a central threaded aperture **17**.

Mounted on the cylinder head **16** is a jack cylinder **18** having a lower flange **19** fastened by bolts **21** to the cylinder head flange **16** so that the jack cylinder is firmly connected to the base frame. Within the cylinder **18** and surrounding the polish rod **9** is a tube **22**, at its lower end provided with a threaded connection **23** securely mounted in the internally threaded aperture **17**. The tube **22** has adequate running clearance with the polish rod **9** and extends upwardly from the cylinder head **17** to a point considerably above the base frame **14** at which, as especially shown in Figure 3, the tube terminates.

Designed to reciprocate within the cylinder **18** and likewise to reciprocate relative to the tube **22**, is an annular piston **26**, around its external periphery having adequate bearing and packing rings **27** and **28**, respectively. On its inner periphery the piston has a comparable packing structure **31** and bearing structure **32**, so that the annular piston is positioned and substantially sealed with respect to the wall of the cylinder **18** and also with respect to the wall of the tube **22**.

Secured to the piston at its upper end is a sleeve **33** concentric with the tube and with the cylinder as well as with the polish rod **9**. The sleeve **33** extends upwardly to a screw coupling **34** underlying a securing means **36**, preferably in the form of a clamp secured by heavy set screws **37** and **38** to the upper end of the polish rod **9**. By virtue of this connection, the reciprocation of the annular piston **26** within the cylinder **18** is communicated to the polish rod **9** and the load of the pumping mechanism and the polish rod **9** is imparted to the piston **26**.

To reciprocate the piston and the polish rod, there is provided a hydraulic mechanism preferably forming a unit **41** separately mounted on skids **42**. The unit **41** incorporates a sump tank **43** serving also as a support for additional structure. The connections between the hydraulic unit **41** and the pumping jack cylinder **18** are preferably only relatively small tubes or pipes.

As especially shown at the right-hand portion of Figure 1 and in the diagram of Figure 4, the sump tank **43** supports a hydraulic pump **44** driven, for example, through a belt **46** by an electric motor or internal combustion engine or other suitable source of power (not shown). The pump **44** is provided with an inlet **47** extending below the level **48** of the pumping liquid within the sump tank. The level is maintained by filling the tank from time to time through a filler opening **49** affording free access to the atmosphere so that the sump tank always operates under atmospheric pressure.

The pump **44** is provided with a discharge conduit **51**, to which is connected a pipe **52** leading to a pressure relief valve **53**. When the pump pressure is below the desired amount, the relief valve **53** is closed. If, under abnormal conditions, the pump **44** pumps an excess of liquid, this raises the pressure and causes the relief valve

53 to open and to discharge the excess into a return line 54 leading back into the sump tank 43.

Fluid under regulated pressure flows from the pipe 51 through a check valve 56 into the inlet port 57 in the casing 58 of a main valve 59. Within the casing 58 is provided a main valve shuttle 61 effective to move between two extreme positions, the valve shuttle being shown in Figure 4 in its right-hand extreme position for the downstroke of the pumping jack piston 26. The shuttle 61 is provided with a central land 62, a left-hand land 63 and a right-hand land 64, these lands being connected by spindles 66 and 67. In the valve position shown, the inlet port 57 is connected around the spindle 66 to a discharge line 68 extending back to the sump tank 43 so that the entire output of the pump is returned to the sump tank under little or no pressure.

A conduit 69 which enters the cylinder 18 below the piston 26 at an aperture 71 is in free communication with a port 72. In this position of the main valve, flow is from the port 72 around the spindle 67 and through an outlet port 73 into a duct 74 leading back to the sump tank through a normally open manual valve 76. In this position of the parts, the weight of the polish rod structure on the reciprocating piston 26 discharges the oil from the cylinder 18 into the sump tank and the piston descends in the cylinder.

This downstroke continues while the main valve is in the position shown in Figure 4. The main valve is maintained in downstroke position by a pilot valve 77 having a relatively small interior bore 78 and also a relatively large interior bore 79 fitted by a shuttle 81 having a small central land 82, a small left-hand land 83 and a relatively large right-hand land 84, these lands being appropriately connected by a spindle 85. As the piston 26 descends, the pressure beneath it is relatively low, and the pilot valve shuttle 81 is in the extreme position shown in Figure 4. In this position, the relatively large land 84 is held by liquid pressure exerted thereon through a branched pipe 86 extending through a normally open hand valve 87 to a pair of ports 88 and 89 in portions of the wall of the cylinder 18 traversed by the piston 26. The port 88 is controlled by a check valve 91 which closes against superior pressure within the cylinder whereas the port 89 is controlled by a check valve 92 which closes under the influence of superior pressure in the pipe 86.

As the piston 26 descends from its top positions, pressure fluid is trapped within the chamber 79 and the valve shuttle 81 is held in left extreme position until such time as the lowering piston over-runs the port 88. When that occurs, the low pressure space above the piston is available to receive discharge of the pressure fluid from the pipe 86 and the chamber 79. This discharged liquid eventually travels out through a port 93 at the upper end of the cylinder into a conduit 94 leading into the sump tank 43. Since this is a drain line, a packing drain pipe 96 is connected to it so that any spillage or overflow or packing leakage past the piston 26 to the upper end of the cylinder overflows through the port 93 and the drain pipe 96 into the drain line 94.

When the pressure is released in the line 86 as the port 88 is over-run, there is nothing further to maintain the pilot valve shuttle in its left-hand position. The pressure underneath the piston 26 in the cylinder 18 continues to act through a conduit 97 leading from the cylinder through the bottom cylinder head 16 into a bore 98 in one end of the pilot valve casing 77. There is some restriction to flow through the conduit 69 and its connections so that adequate pressure remains in the cylinder 18 to shift the shuttle by pressure against the small land 83. The pilot valve shuttle 81 is thereupon forced into its opposite or right-hand extreme position in accordance with the reciprocation of the pumping jack piston.

While the shuttle 81 is still in the extreme position shown in Figure 4, pressure fluid from beneath the pumping jack piston 26 is permitted to flow from the conduit 97 through a branch line 99 into an accumulator 101, back flow being prevented by a check valve 102. Pressure fluid from the accumulator or from the branch line 99 when the accumulator is charged then flows through a conduit 103 into a port 104 in the body of the shuttle valve and continues its passage through a port 106 into a line 107. The conduit 103, the ports 104 and 106 in the shuttle valve and the line 107 can all be considered as parts or extensions of the branch line 99.

In the line 107 there is interposed a check valve 108 opening in an appropriate direction to permit outflow in the line 107, but a check valve 109 precludes flow in that direction. A branch conduit 110 shunts the check valve 109. A variable orifice 111 in the branch conduit 110 controls the rate of flow in the outward direction from the conduit 107 into a port 112 leading into an end chamber 113 in the main valve casing 58. In this fashion, the pressure existing within the conduits 97 and 99 or within the accumulator 101 is made effective upon the left-hand land 63 of the shuttle 61 at a desired rate. If the cylinder pressure should drop before the pressure on the member 63 has had adequate time to act, the continuing pressure exerted by fluid flowing from the accumulator 101 insures that a complete stroke of the main valve is executed.

When the pilot valve moves toward its right hand or opposite extreme position (from that shown in Figure 4) the fluid against the member 63 flows back through the port 112 and the conduit 107 and partly through the restriction 111 but principally through the check valve 109 which freely opens thereto. The check valve 108 closes and diverts the flow through a branch conduit 114 having a manually adjustable restriction 116 therein. The rate of escape of fluid from the main valve and hence its rate of transfer from one to the other extreme position is regulated.

Fluid flowing in the branch conduit 114 reenters the conduit 107 and since the shuttle 81 has shifted, then flows into the port 106 and out a port 119. A conduit 121 connects to the port 119 and leads to a connection 122 with the conduit going to the sump tank 43. A pipe 123 leads to a port 124 opening into a chamber 125 at the opposite end of the main valve shuttle 61. The pressure is thus substantially equalized on the opposite sides of the shuttle so that a spring 126 is effective to shift the main valve into its opposite extreme position. This shift also is effective to uncover the outlet port 73 to the chamber 125 so that through flow of liquid can take place to the sump tank 43.

When the main valve shuttle has thus been reversed pursuant to the reversal of the pilot valve shuttle, the cycle is reversed. The described operations are repeated indefinitely to effectuate the desired pumping.

Occasionally, for servicing and the like, it is desired to permit the pumping jack to travel from its uppermost position to its lowermost position regardless of the operation of the pilot and shuttle valves. For that reason, to the conduit 69, there is connected a branch pipe 127 leading to the sump tank 43 through an interposed hand actuated valve 128. The valve 128 is normally closed but when open permits the entire fluid contents of the jack cylinder 18 to discharge directly to the sump tank as the pumping jack piston 26 descends by gravity.

The arrangement just described is commercially satisfactory, but it involves the use of a number of separate elements connected together by piping. For ease of manufacture, reliability in service, economy and other reasons, it is desirable to consolidate much of the apparatus, especially the valving, into a compact unit.

Especially shown in Figures 5, 6, 7 and 8, is a compact arrangement generally similar to the one already described. The operating fluid is contained in part in a sump tank 131 from which an inlet 132 leads through a power driven pump 133 to an outlet 134. A branch line 136 extends to a pressure relief valve 137 with an overflow line **138** leading back to the sump tank. The conduit **134** continues through a check valve **139** into an inlet port **141** of a combined or two-part valve body **142** having appropriate bores and passages therein.

In one of the body bores **143** is a main valve shuttle **144** having various lands and spindles so that in one extreme position of the shuttle **144** (as shown in Figures 5 and 6), flow from the port **141** is led into a port **146** and thence into a conduit **147** extending to the port **71** of the pumping jack cylinder **18**. A branch line **148** extends from the conduit **147** to the sump tank **131** and is provided with a normally closed manual valve **149**. This valve is similar to the valve **128** and is opened and utilized only when the pumping jack is to be lowered by hand.

In the other extreme position of the main valve shuttle **144**, the port **141** is connected to a port **151** joined by a pipe **152** to the sump tank so that the entire outflow from the pump is diverted directly back to the sump tank. Also in this other extreme position of the valve shuttle, the conduit **147** is connected through the port **146** to a port **153** having a shunt duct **154** joining the return port **151**. As gravity lowers the jack piston **26**, the expelled oil from the cylinder **18** returns through the duct **152** to the sump tank.

The extent of the main valve shuttle stroke to the right (Figure 5) is governed by a variable stop plug **155**, the position of which is regulated by a screw **156** threaded into the body **142** and locked by a nut **157**. A lug **158** at the end of the main valve shuttle abuts the plug **155** so that the stroke of the shuttle is varied and the amount that it uncovers the ports **146** and **153** is regulated. Thus, there is a variable throttling by the main valve shuttle during the downstroke of the jack piston. This is a regulator or control for the return or downward stroke speed.

To regulate the operation of the main valve, the main cylinder ports **88** and **89** are connected through the check valves **91** and **92** to a pipe **86**, as before. The normally open manually controlled valve **87** is in the pipe **86**. In this instance, the pipe **86** leads into a port **161** in one end of a pilot valve bore **162** in the body **142**. Also, as before, the conduit **97** which opens into the bottom of the cylinder **18** leads through the check valve **102** to the duct **103** to which the accumulator **101** is connected. In this instance, the conduit **103** connects to the valve body **142** in a port **163** adjacent the center of the bore **162**. Fluid under pressure can flow from the port **163** into a circumferential groove **164** in the pilot valve shuttle and from there into a cross bore **166** leading to an axial bore **167** opening into a chamber **168**. A plug **169** fits the chamber snugly and bears at its other end against a closure cap **181** forming the end member of the valve body **142**. Surging liquid from a chamber **183** surrounding the plug **169** can flow through a narrow annular passage **184** around the reduced diameter of the valve shuttle into a passage **186** which extends into a cross passage **187**, in turn connected by a bore **188** to the drain or shunt conduit **154** leading back to the sump tank.

When pressure from the jack cylinder beneath the ascending piston **26** is transferred through the duct **86** into the port **161**, it is effective in a chamber **191** of considerably larger diameter than the chamber **168** so that the pilot valve shuttle is translated to its opposite extreme position. In the position shown in Figure 6, pressure fluid from the port **163** flows into an annular passage **192** leading to a port **193** joined by an appropriate bore **194** to the main valve end bore **143**. Also in this position of the pilot valve, the chamber **196** at the opposite end of the main valve is connected by a passage **197** to a port **198** which, in turn, gives on to an annular passageway **199** establishing communication with a port **201**. From this port, flow is into the cross passage **187** leading back eventually to the sump tank.

Interposed in the fluid line between the port **201** and the cross passage **187** is a restricted orifice **202** so that the return motion of the main pilot valve is controlled. When the pilot valve reverses from its position shown in Figure 6, the flow is then from the inlet port **163** into the passageway **199** and thence into the chamber **196**. The discharge from the chamber **143** then flows through the bore **194** and through the annular passage **192** into a port **204** into the cross passage **187** leading to the sump tank **131**. Interposed between the port **204** and the cross bore **187** is a restricted orifice **206** so that the speed of return of the main valve is regulated.

In both forms of the invention an improved pumping jack especially adapted for reliable, economical use on one or a succession of "stripper" wells has been provided.

What is claimed is:

A pumping jack comprising a jack cylinder, a piston reciprocable in said cylinder, an oil pressure pump, a sump tank, means connecting said sump tank and the inlet of said pump, a main valve, means connecting the outlet of said pump to said main valve, means effective in one position of said main valve for connecting the outlet of said pump to said cylinder beneath said piston, means effective in another position of said main valve for connecting the outlet of said pump to said sump tank, a pilot valve, means for positioning said main valve in accordance with the position of said pilot valve, a conduit connected to said cylinder beneath said piston for transmitting pressure to urge said pilot valve in one direction, a branch line connected to said conduit and extending through said pilot valve to said main valve for control of flow in said branch line by said pilot valve, a check valve in said branch line between said conduit and said pilot valve permitting flow only toward said pilot valve, an accumulator in said branch line between said check valve and said pilot valve, and means including a pipe connected to said cylinder at a point traversed by said piston for transmitting pressure to urge said pilot valve in the opposite direction.

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