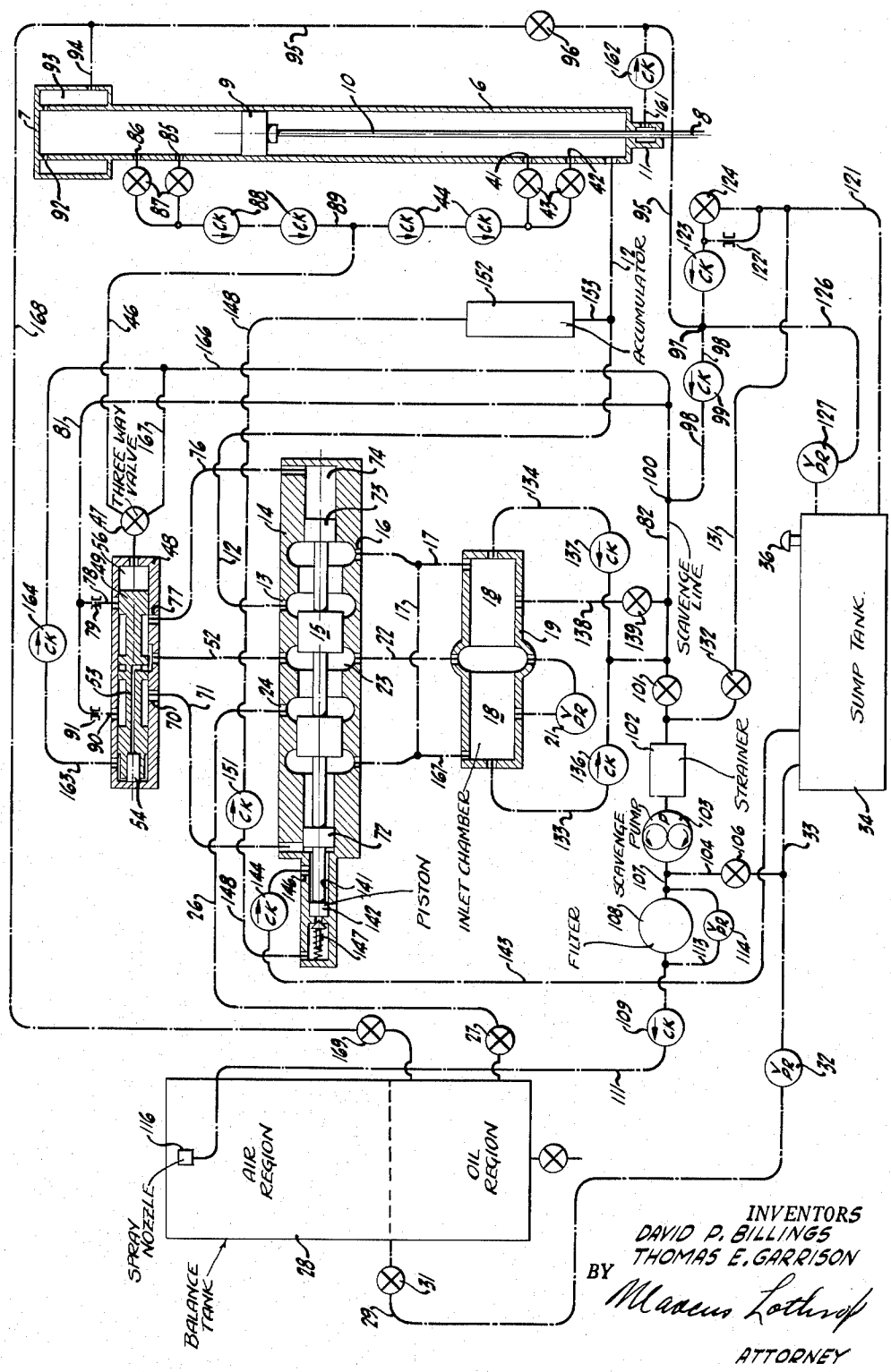
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MANUALLY CONTROLLABLE PUMPING JACK

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# MANUALLY CONTROLLABLE PUMPING JACK

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Our invention relates to hydraulically actuated, reciprocating jacks for operating remotely located pumps, usually mechanical pumps, at the bottom of oil wells and is of the type of structure shown in the patent to Ira Morgan White, No. 2,617,256, dated November 11, 1952, and entitled "Hydraulic Pumping Jack Control."

Pumping jacks of this sort are characterized by the provision of a generally upright, hydraulic jack cylinder within which a jack piston reciprocates throughout a relatively long stroke under the control of automatic valving devices so that the pumping jack operates automatically and continuously, usually in a remote location and with little or no supervision. Included in the jack actuating device is an oil pump which transfers oil from a balancing tank to the jack cylinder and back again under automatically timed cycles.

It sometimes happens that in the servicing of a pumping jack it is desirable to move the jack piston at a rate which is other than that at which the jack normally operates and it is sometimes the situation that the jack stroke, after having been relatively short for some time, should for some reason or other be lengthened. In parts of the cylinder that have not been used theretofore, it may occur that the initial motion of the piston into the previously unused portion results in a mechanical sticking and the piston jams in the cylinder. This seizing is particularly unfortunate if it occurs at the upper end of the cylinder. Also, the jack is sometimes uncoupled from the well sucker rod either for servicing or for transfer to another well. The hydraulic fluid contains enough gas to be quite elastic and may produce sudden, unexpected motion of the jack when the load is uncoupled.

It is therefore an object of our invention to provide means for manually regulating the speed of motion of the jack piston.

Another object of our invention is to provide means under manual control for dislodging a piston which is stuck in the cylinder head end.

Another object of our invention is to provide means for preventing unexpected motion of the jack during uncoupling.

A further object of our invention is to provide a pumping jack in which the usual pumping jack equipment is utilized, with some modification, in order to produce easy servicing operations of a jack remotely located and only seldom attended.

A still further object of the invention is to provide a generally improved, manually controllable pumping jack.

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

The figure is a diagram showing the interconnections of the various components of a manually controllable pumping jack constructed in accordance with our invention.

While the pumping jack is in most rspects similar to that shown in the mentioned White patent and can be embodied in numerous different forms, it has successfully been embodied as shown herein. In this arrangement there is provided a pumping jack cylinder 6 disposed upright and having a head end 7 and a rod end 8. The cylinder is usually located immediately above the sucker rod of a deep well pump. Adapted to operate within the cylinder 6 is a jack piston 9 connected to a piston rod 10 projecting from the rod end 8 of the cylinder through a packing gland 11.

In the position of the parts shown in the drawing, the jack piston 9 is descending or is on a lowering cycle and oil within the cylinder 6 therefore flows out through a conduit 12 into an inlet port 13 of a reversing valve 14. A valve shuttle 15 within the reversing valve occupies either one of two extreme positions. In the position shown, the flow from the port 13 is through the body of the valve and out a port 16 to an inlet manifold 17 connected to the inlet chambers 18 of an oil pump 19 driven by any suitable sort of motor, not disclosed. In the pump 19, the inlet oil from the chambers 18 is increased to a higher pressure. If the pressure is too high, a relief valve 21 opens to short circuit the pump automatically. The valve 21 is also operable by hand for special cases. Oil at the proper pressure flows from the pump through an outlet pipe 22 into a central chamber 23 in the reversing valve. In the illustrated position of the valve shuttle, the pressure oil from the chamber 23 goes through a port 24 into a conduit 26 having a main valve 27 therein to discharge into the bottom or oil region of a balance tank 28.

The balance tank is a pressure vessel designed to operate at approximately the mean of the maximum and minimum pressures within the cylinder 6, the oil within the lower region of the balance tank being maintained under pressure by air supplied to the tank at the upper portion thereof. During normal operation, the pressure within the balance tank 28 is maintained below a predetermined value since excessive pressure bleeds off through a line 29 having a hand valve 31 therein and having also a regulating valve 32 therein set at the desired pressure. The discharge from the regulating valve goes through an extension 33 of the line 29 into a sump tank 34 designed to receive overflow oil and having an opening 36 to the atmosphere so that its internal pressure is always atmospheric.

In the portion of the cycle described, the pump 19 is effective to transfer oil from the cylinder 6 through the reversing valve 14 to the balance tank 28, and so permits the piston 9 to lower by gravity. When the piston 9 gets near the bottom of its stroke, it uncovers one or both of a pair of ports 41 and 42. These afford access through the open one of related hand valves 43 and then through appropriate check valves 44 to a line 46. A three-way valve 47 in normal position connects the line 46 to a pilot valve 48 in which a pilot valve shuttle 49 operates.

Pressure tending to drive the shuttle 49 toward the right in the figure is continually maintained by a conduit 52 leading to the interior of the casing 48 and communicating with the chamber 23 under maximum pump pressure. An orifice 53 within the shuttle 49 leads to an internal cylinder in the end of the shuttle within which stationary piston 54 is disposed. Hence, the pump pressure is always maintained upon the area of the piston 54. If the total pressure existing within the chamber 56 at the right-hand end of the pilot valve is superior to the total pressure on the shuttle adjacent the piston 54, the valve shuttle is sent to and held in the left-hand position, as shown in the figure. If the pressure within the chamber 56 is relatively low, then the constant pressure acting upon the shuttle adjacent the piston 54 drives the pilot valve shuttle 49 to its right-hand extreme position, opposite that shown in the figure. Consequently, when the piston 9 uncovers the one of the ports 41 and 42 which is open to the line

46, the pressure within the chamber 56 is immediately lowered substantially to the low pressure within the cylinder 6 above the piston 9. The chamber 56 consequently discharges and the pilot valve is forced to shift ends. When that occurs, pressure fluid from the line 52 is transferred through a port 70 in the pilot valve body 48 and through a line 71 to be exerted on the end of a piston 72 forming part of the reverse valve shuttle 15.

The pressure on the piston 72 then shifts the reverse valve shuttle from the left-hand position shown in the figure into the opposite extreme or right-hand position. This motion causes a piston 73 at the right end of the reversing valve shuttle to displace fluid from its cylinder 74 through a line 76 and into an appropriate port 77 in the pilot valve body. Flow is thence around the pilot valve shuttle 49 and out through a line 78 having a restriction 79 therein. The rate at which the reversing valve moves to its extreme right position is therefore governed by the rate of escape of liquid from the cylinder 74 as permitted by the restriction 79. The escaping oil travels through a pipe 81 which leads to a scavenge line 82 operating at low pressure.

Since the pilot valve has shifted ends and the reversing valve has shifted ends, the pump 19 is then effective to discharge pressure fluid through the duct 22 into the line 12 and into the cylinder 6 beneath the piston 9. During this time, the inlets 18 of the pump receive liquid through the line 26 and through the valve 27 from the oil region of the balance tank 28. The introduction of liquid beneath the piston 9 drives it upwardly toward the head end 7 of the cylinder until such time as the piston 9 uncovers the active one of a pair of ports 85 and 86. These are controlled by hand valves 87 and are connected through check valves 88 and through a pipe 89 to the conduit 46. Thus, when the piston 9 travels over the active one of the ports 85 or 86, the high pressure of the liquid beneath the piston is transmitted to the lines 89 and 46. The pressure within the chamber 56 is then changed from a low value to a high value. This displaces the pilot valve shuttle 49 from its right-hand position back into its left-hand position, as shown in the figure. This change in the pilot valve causes pressure fluid to flow from the pressure line 52 through the port 77 and through the line 76 into the chamber 74, thus displacing the reversing valve shuttle 15 from its right-hand position back into the left-hand position shown in the figure. As the shuttle 15 moves to the left, it displaces liquid through the line 71 and the port 70. Flow is then around the shuttle 49 and through a pipe 90, having a restriction 91 therein, into the pipe 81. The rate at which the reversing valve moves to the left is therefore controlled by the rate of flow through the restriction 91. In this fashion, a complete downward and upward cycle of the jack is accomplished.

During the normal cycling of the jack, some leakage oil escapes upwardly past the piston 9, valving oil from the pilot valve chamber 56 discharges into the cylinder 6 above the piston 9 and so means are provided for carrying this oil away. The upper end of the cylinder 6 is provided with a number of apertures 92 opening into a jacket 93 itself connected through a line 94 to a conduit 95 having a hand valve 96 therein. Beyond the hand valve, the conduit 95 extends to a junction 97 with a pipe 98 having a check valve 99 therein. The pipe 98 has a junction 100 with a scavenge line 82. Since in normal operation the hand valve 96 is open, the pressure within the jacket 93 and within the upper part of the cylinder 6 is low and excess oil can drain from above the piston 9 into the scavenge line 82.

The scavenge line 82 is lead through a hand valve 101 and a strainer 102 to a scavenge pump 103. This is a mechanically rotated pump which serves generally to maintain a low pressure on the line 82. The scavenge pump can discharge through a line 104 in which a hand



valve 106 is situated back into the line 33 and to the sump tank 34. Normally, however, the valve 106 is closed and the scavenge pump 103 discharges through a line 107 into a filter 108. Clean oil from the filter flows through an appropriate check valve 109 into a line 111. A shunt line 113 extends around the filter and is provided with an automatic pressure relief valve 114 so that in the event the filter resistance is high, due to clogging, the oil flow will continue. The line 111 preferably extends into the upper portion of the balance tank 28 and the returned oil is discharged therein through a spray nozzle 116. Thus the scavenge pump can discharge the drained oil either back into the balance tank 28, which serves as a reservoir under pressure, or back to the sump tank 34 which serves as a reservoir at atmospheric pressure.

Oil is continuously withdrawn from the sump tank 34 and sent to the balance tank 28 from which any excess overflows through the lines 29 and 33 and returns to the sump tank, in this fashion maintaining circulation.

To provide for this circulation, a line 121 extends from near the bottom of the sump tank 34 and through an orifice 122 and through a check valve 123 to the junction 97. Preferably, a hand valve 124 shunts the orifice 122. Normally the valve 124 is fully closed, but for oil make-up purposes, the valve 124 is temporarily opened.

When the piston 9 descends, it tends to draw a vacuum above it within the cylinder 6 and this low pressure permits the flow of oil from the sump tank 34 through the line 121 and the orifice 122 to the junction and into the line 95. If an excess of oil is present, some may flow through the line 94 into the chamber 93 but normally oil merely surges in the line 95. This is because on the following upstroke of the piston 9 the pressure rises and the flow is in the reverse direction to the junction 97 and from there into the scavenge pump 103.

Should there be a great excess of return oil, enough to raise the pressure at the juncture 97 to a high value (say, 100 p. s. i.), then flow can occur through a relief line 126 and a relief valve 127 to the sump tank 34. If desired, oil can be rapidly added to the balance tank 28 from the sump tank 34. For this purpose, there is provided a line 131 which joins the line 121 and through a hand valve 132 joins the line 82 just in advance of the strainer 102. Also joined to the line 82 are drain lines 133 and 134 connecting through check valves 136 and 137 with the pump shaft packings (not shown). Another drain line 138 connects the pump interior with the scavenge line 82 through a normally closed valve 139.

It is also desired to provide a means for supplying the balance tank 28 with air under pressure. For that reason, one end of the reversing valve casing 14 is provided with a cylinder 141 within which operates a piston 142 integral with the reversing valve shuttle 15. An inlet line 143 is connected into the upper portion of the sump tank 34 above the oil therein and draws its air from the atmosphere through the inlet 36. Air in the line 143 flows through a check valve 144 to an intake port 146 in the wall of the cylinder 141. When the piston 142 travels to the right in the figure, it draws a vacuum and when the port 146 is uncovered, then air rushes in. Upon the return movement of the piston 142, the check valve 144 is closed, the port 146 is covered and the trapped air is forced through an outlet check valve 147 into a line 148 provided with a supplementary check valve 151 and thence into an accumulator 152.

The accumulator is not provided with any bag or piston but is simply an enlarged chamber, at its lower end connected by a pipe 153 with the line 12. The effect of this mechanism is to provide a supply of air to the accumulator from which air flows out through the line 153 into the oil conduit 12 when the pressure within the oil conduit is relatively lower as it is on the down stroke. Thus air from the accumulator is picked up in the line 12 on the down stroke of the jack piston 9 and

travels through the reversing valve 14 to the balance tank 28. Any excess air is blown off from the balance tank through the regulating valve 32 back to the sump tank 34 and so to the atmosphere. In this fashion, a set air pressure is kept at all times in the balance tank and in the accumulator 152.

During at least part of each cycle, the pressure adjacent the junction 97 in the scavenge system is below atmospheric. Advantage is taken of this to assist in preventing leakage of oil to the air around the packing gland 11. This gland is preferably in two parts with an intermediate space. A line 161 from the space in the packing gland passes through a check valve 162 to the line 95. When the pressure within the line 95 is relatively low, the pressure within the packing gland 11 is also relatively low but if the pressure within the line 95 builds up, the check valve 162 closes. Thus, the packing 11 is maintained at a relatively low pressure for much of the time in order that leakage oil will not travel to the atmosphere but rather will return through the line 161 to the scavenge system. Similarly, leakage around the pilot valve shuttle 49 and around the piston 54 flows out through a line 163 and through a check valve 164 into a line 166 extending to the junction 100 with the line 82 leading to the scavenge pump 103. All leakage oil is thus normally returned to the scavenge pump.

In accordance with the invention, means are provided for interrupting the described automatic operation of the jack, especially for servicing operations, and, among other things, so that a lifting movement of the jack can be assured even though the jack might be automatically set for a lowering movement, as shown in the drawing. With the parts as shown, it is possible to interrupt the automatic cycle and to produce an immediate lifting of the piston 9 by manually operating the three-way valve 47 interposed in the line 46 leading to the pilot valve 48. This three-way valve has a connection 167 to the line 166 leading back to the scavenge pump 103.

When the valve is turned into a position opposite that occupied in the drawing, the pressure beneath the piston 9, which has theretofore been exerted through the check valves 88 and the line 89 and through the line 46 onto the shuttle 49 to urge it into its left-hand position as shown, is immediately relieved. The released pressure oil flows from the chamber 56 through the three-way valve and through the conduit 167 into the line 166. The high pressure in the chamber 56 is thus dropped to a low value. The continuing pressure from the pump outlet, the line 52 and the bore 53 on the shuttle area opposite the piston 54 is then effective to translate the pilot valve shuttle 49 to its extreme right-hand position. This immediately shifts the reversing valve shuttle 15 to its right-hand position and so reverses the direction of motion of the piston 9 and drives the piston 9 upwardly. Another reversal of the three-way valve 47 restores the parts to the position shown in the figure.

Sometimes the lower reversing port 85 near the top of the cylinder is utilized for a protracted period so that the stroke of the jack terminates adjacent that point. Due to continued cylinder wear, due to some corrosion in parts of the cylinder not traversed by the piston, and for other reasons, the cylinder above the customary short piston stroke is not particularly receptive to the piston. Then, if a longer stroke is subsequently attempted by closing the lower one of the valves 87 and utilizing the upper one so that the port 86 then becomes effective, the piston 9 responds to pressure beneath it and is driven up into a higher portion of the cylinder than it previously has occupied. Upon occasion the piston becomes mechanically stuck in its new, top position. The only force normally available on the piston 9 to lower it is the force of gravity acting on the jack parts and the rod and the deep well pump. This is sometimes not sufficient to dislodge the stuck piston 9. We therefore provide a means for imposing hydraulic power to force the piston out of its upper position.



This means involves supplying oil under pressure above the piston 9. A body of oil above the piston, either maintained under pressure or trapped so that the piston cannot readily move, is of use in disconnecting the pumping jack from the well pumping mechanism. When the sucker rod is disconnected from the polished rod 8, considerable weight is removed. If the piston is left under oil pressure from below, a sudden upstroke of the rod 8 may occur and may be dangerous. If the pressure oil below the piston were incompressible, a short upstroke would relieve the pressure, but often sufficient gas is dissolved in the oil to require a long upstroke before the pressure drops.

So that the piston 9 can be forced down when necessary or can be blocked against rising when desired, an extension line 168 connects to the liquid or oil region of the balance tank 28 and is provided with a normally closed hand valve 169. When the piston 9 is stuck in the upper portion of the cylinder 6, the operator first closes the hand valves 27 and 96 and then opens by hand the valves 21 and 139 and the hand valve 169. This has the effect of transferring oil under pressure from the balance tank 28 through the line 168 and through the line 94 and the chamber 93 to exert its pressure on the upper face of the piston 9. This pressure is effective to drive the piston 9 downwardly, the oil beneath the piston flows through the conduit 12 to the reversing valve body 14. From there it flows through the manifold 17 or the outlet pipe 22 to the pump chamber 18 and then out through the drain line 138 and the valve 139 into the scavenge line 82. It is then picked up by the scavenge pump 103 and discharged through the line 111 into the balance tank 28. When the piston 9 has been satisfactorily dislodged, the hand valves 21, 139 and 169 are closed and the valves 27 and 96 are opened and normal operation proceeds.

When the piston 9 is not to be forced down, but is to be held in place against an accidental upstroke, it is merely necessary by a similar procedure to fill the cylinder 6 above the piston 9 with oil. When the various valves, such as 169 and 96 are closed, the oil is trapped in the filled cylinder. The piston 9 therefore cannot rise appreciably when weight is suddenly removed from the polished rod.

What is claimed is:

1. A manually controllable pumping jack comprising a jack cylinder, a jack piston reciprocable in said cylinder, a balance tank for oil under air pressure, an oil transfer pump, a reversing valve for controlling the transfer of oil between said balance tank and said cylinder through said pump, means depending upon the position of said piston in said cylinder for controlling the operation of said reversing valve, a conduit extending from the oil region of said balance tank to the head end of said cylinder, and a manually controlled shut-off valve in said conduit.

2. A manually controllable pumping jack comprising an upright jack cylinder, a jack piston reciprocable in said cylinder, a balance tank for oil under pressure, an oil transfer pump, a reversing valve for controlling the transfer of oil between said balance tank and said cylinder through said pump, means depending upon the position of said piston in said cylinder for controlling the operation of said reversing valve, means including a conduit from the oil region of said balance tank to the upper end of said cylinder for imposing a downward pressure on said piston, and means for shutting off said conduit.

3. A manually controllable pumping jack comprising an upright jack cylinder, a jack piston reciprocable in said cylinder, a balance tank for oil under pressure, an oil transfer pump, a reversing valve for controlling the transfer of oil between said balance tank and said cylinder through said pump, means depending upon the position of said piston in said cylinder for controlling the op-

eration of said reversing valve whereby said piston is raised by oil under pressure and is lowered by gravity, means including a conduit for oil under pressure connected to the upper end of said cylinder for imposing a downward pressure on said piston, and means for shutting off said conduit.

4. A manually controllable pumping jack comprising an upright jack cylinder, a jack piston reciprocable in said cylinder, a balance tank for oil under pressure, an oil transfer pump, a reversing valve for controlling the



transfer of oil between said balance tank and said cylinder through said pump, means responsive to high pressure in said cylinder for operating said valve to transfer oil from said balance tank to said cylinder below said piston, and manually controlled means for shutting off said high pressure from said responsive means.

**References Cited** in the file of this patent

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