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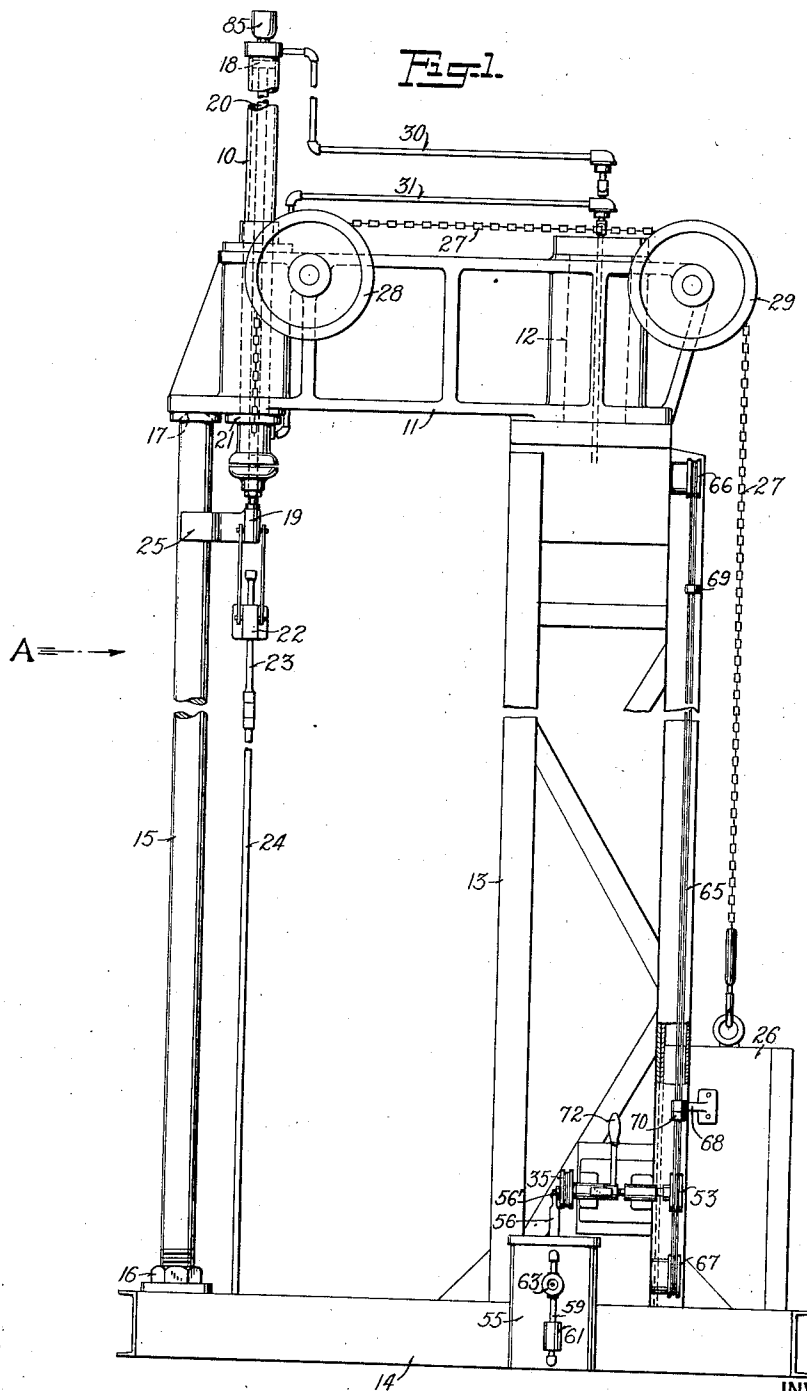
L. A. BARRETT ET AL

1,890,244

PUMP RIG

Filed Feb. 1, 1926

3 Sheets-Sheet 1



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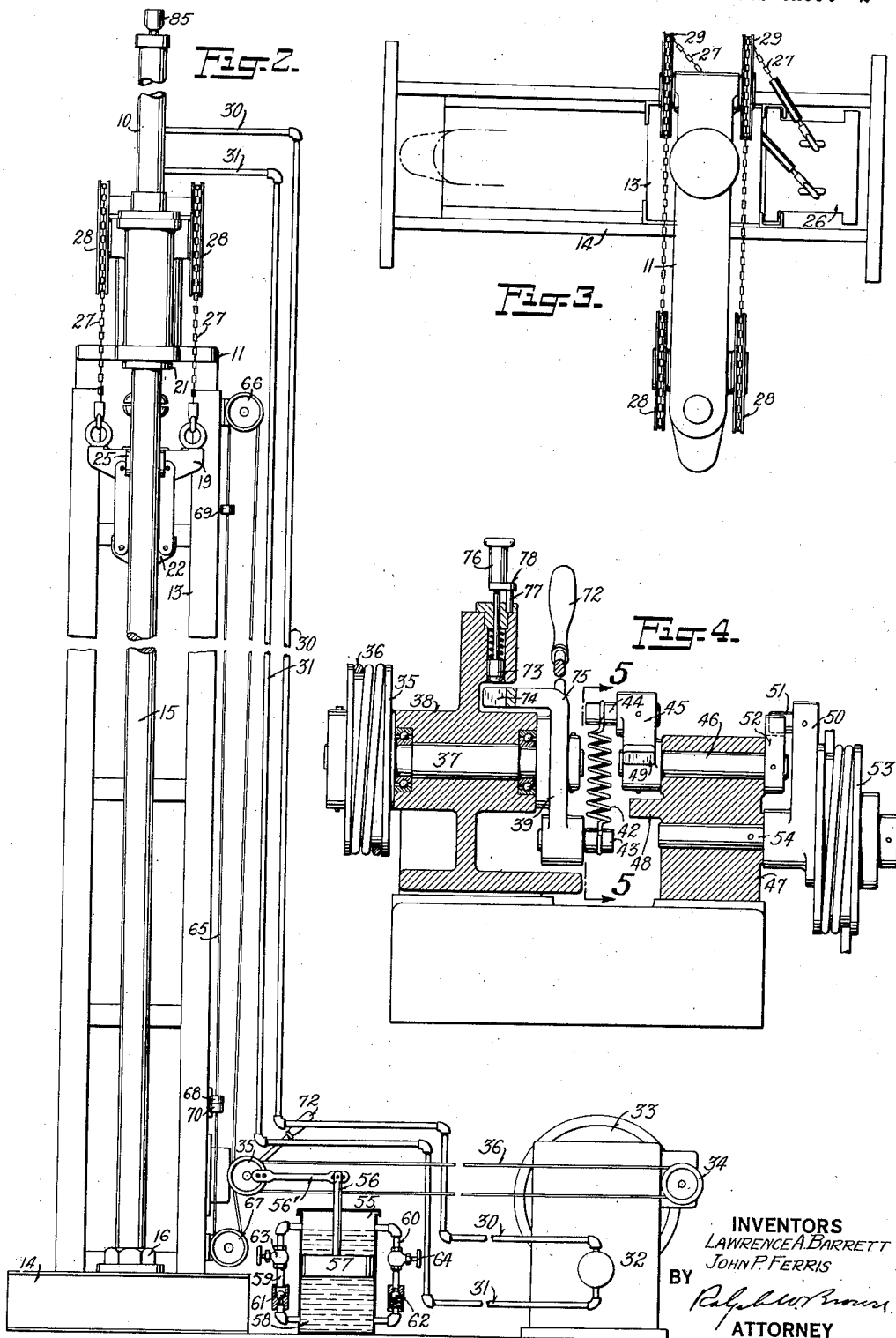
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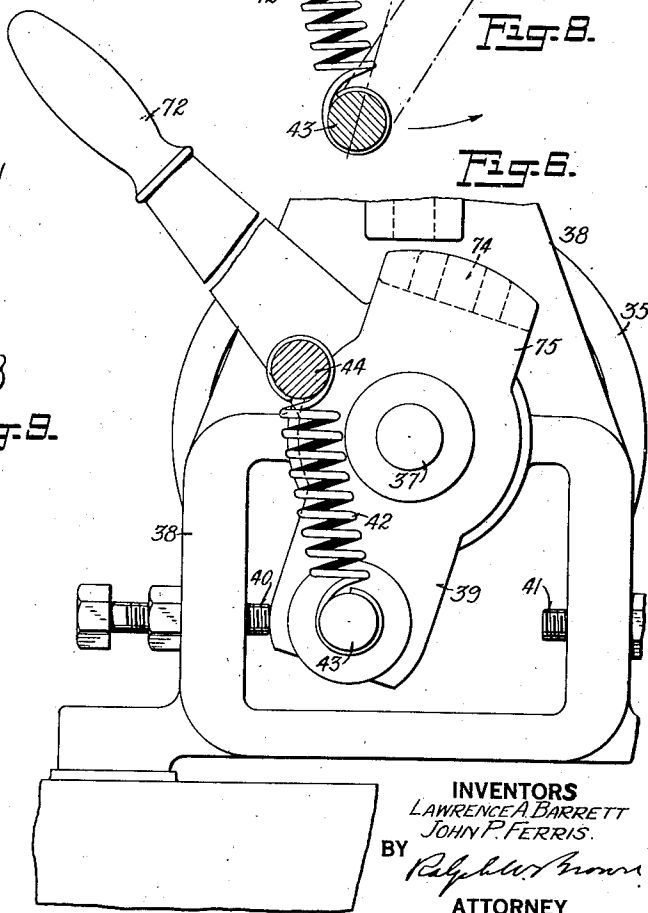
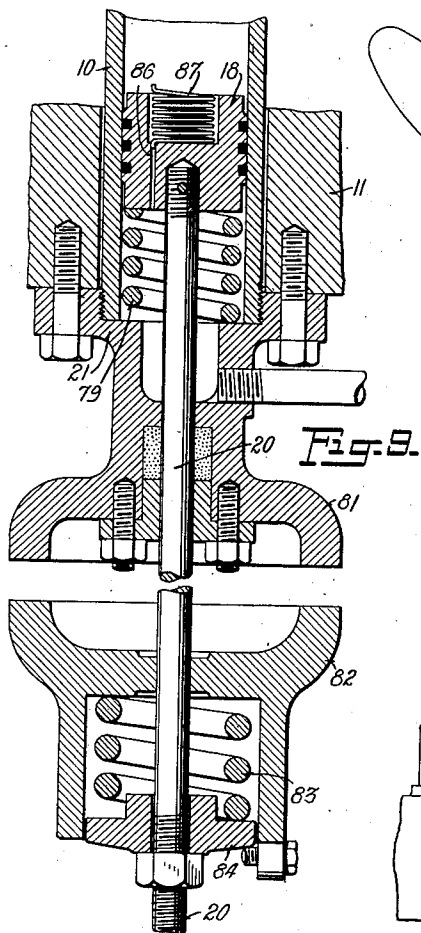
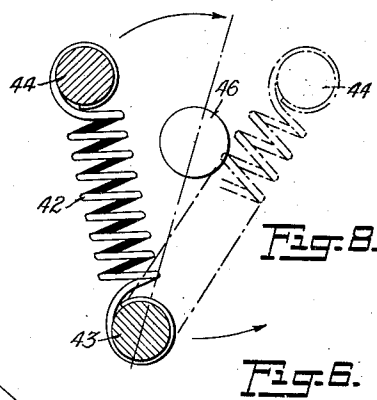
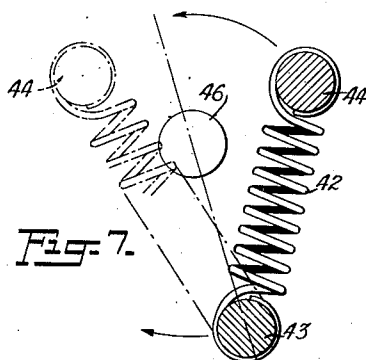
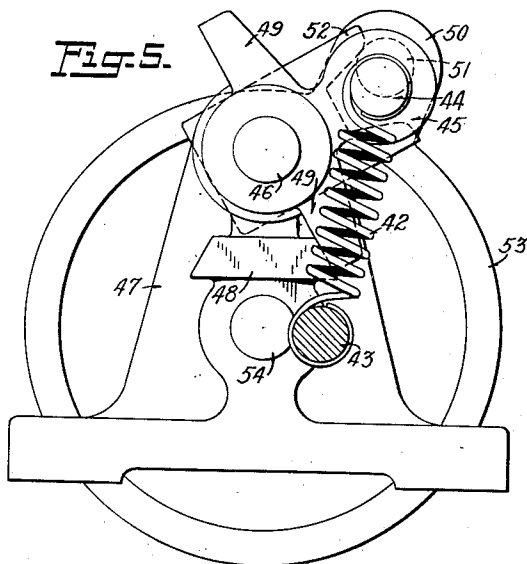
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UNITED STATES PATENT OFFICE

LAWRENCE A. BARRETT AND JOHN P. FERRIS, OF MILWAUKEE, WISCONSIN; SAID FERRIS ASSIGNOR TO THE OILGEAR COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN

PUMP RIG

Application filed February 1, 1928. Serial No. 85,207.

This invention relates to pump rigs for deep wells, such as oil wells, and particularly to drives therefor.

The standard commercial form of pump rigs for oil wells comprises a vertically reciprocating pump element at the bottom of the well, actuated from a walking beam at the head of the well, through a long string of sucker rods connected end to end. The wells frequently exceed three or four thousand feet in depth, and the string of rods, though less than an inch in diameter frequently weigh as much as five or six thousand pounds and more. The rods are called upon not only to sustain their own weight and inertia reactions, but also the load and inertia reactions of the long column of oil in the well. The beam is operated by a crank and ordinarily produces about twenty four strokes per minute with a throw of about thirty inches.

Such rigs are objectionable in that they produce a jerky action, which sets up wave-like stresses in the string of rods, resulting in a pronounced whip. This is the direct cause of frequent rod breakage with consequent expensive repairs and loss of production. Furthermore the slack and stretch of the rods, aggravated by the whip, causes a distinct loss in efficiency, in that the actual stroke at the bottom of the well is ordinarily only about one half to two thirds of the stroke of the beam.

Various attempts heretofore made to overcome these difficulties have not proven entirely successful. In the main such efforts have been directed to the lengthening of the stroke, but the jerky action, characteristic of the crank motion applied to the beam, has not been overcome.

The primary aim of the present invention is the provision of a drive mechanism capable of operating the string of rods smoothly, without jerk or shock, and at a rate sufficient for high production. This is accomplished by the use of a piston and cylinder, operatively connected to the string of rods, and actuated by a driving liquid delivered thereto at a measured rate. The liquid delivery means is preferably in the form of a positive pump

whose displacement may be nicely regulated to obtain the desired operating speeds and to effect a smooth deceleration and acceleration of the rods at the end of each stroke to thereby eliminate the whip.

Another object of the present invention is the provision of means automatically operable at the end of each stroke to effect an accurately controlled regulation of the rate and direction of liquid fed to the cylinder.

Another object is the provision of a support for the rod operating piston and cylinder so constructed as to permit adjustment of the cylinder into position where it will not interfere with the withdrawal of rods and tubing from the well.

Other objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

In the drawings:—

Figure 1 is a side elevation of a pump operating mechanism constructed in accordance with the present invention.

Fig. 2 is a front elevation looking in the direction of arrow A in Figure 1.

Fig. 3 is a plan view, on a smaller scale, with parts adjusted into inactive position.

Fig. 4 is a longitudinal sectional view of a control mechanism shown in Figures 1 and 2.

Fig. 5 is a sectional view on a larger scale taken substantially along the line 5—5 of Figure 4 in the direction of the arrows.

Fig. 6 is a sectional view taken substantially along line 5—5, looking in the opposite direction.

Figs. 7 and 8 are diagrammatic views illustrating the action of the control mechanism.

Fig. 9 is a sectional view of the lower end of the motor cylinder, illustrating certain shock absorbing mechanisms and an air bleed mechanism associated therewith.

The pump operating mechanism selected for illustration includes a motor cylinder 10, normally disposed in vertical position over the well, and so mounted as to permit the same to be swung laterally into position where it will not interfere with the withdrawal of rods and tubing from the well. The cylinder is shown fixed in a rigid horizontal arm 11, mounted to swing about a

post 12, projecting vertically from the top of an appropriate upright frame 13. The frame 13 is rigidly mounted upon an appropriate base frame 14. The arm 11 is supported mainly by the frame 13 and post 12, although an additional support, in the form of a column 15, is preferably provided in order to better sustain the severe operating stresses. The column 15 is threaded into and supported by an appropriate nut 16, journaled in the base frame 13, the upper end of the column being normally engaged in an appropriate socket 17 on the bottom of the arm 11, adjacent the cylinder 10. The column 15 may be lowered out of engagement with the socket 17, by rotating the nut 16, and in such lowered position, the arm 11, carrying the cylinder 10, may be swung horizontally about the post 12 from the dotted line position of Figure 3, over the well, into the full line position, where it will not interfere with the withdrawal of rods and tubing from the well.

The pump element at the bottom of the well is actuated by a piston 18 reciprocating in the cylinder 10. The piston is connected to a cross-head 19, through a piston rod 20, extending through the lower end head 21 of the cylinder. The cross-head 19 carries the usual clamp 22 for gripping a short sucker rod 23 which is screwed into the polished rod 24 in the usual manner. The polished rod 24 extends through the usual packing gland at the head of the well and at its lower end is fixed to the string of sucker rods leading to the pump element at the bottom of the well. This method of connecting the cross-head 19 to the pump element through the elements just mentioned is not unlike the methods heretofore used for connecting the walking beam to the pump element, and a further or more detailed description of the same is deemed unnecessary for a complete understanding of the present invention. The cross-head 19 is preferably guided by any appropriate means such as a fork 25 thereon loosely engaging the column 15.

Provision is preferably made for counterbalancing the weight of the string of sucker rods and other parts supported by the cross-head 19. In this instance a counter-weight 26, guided for vertical reciprocation along the side of the upright frame 13, is employed for this purpose. The counter-weight is shown supported by a pair of chains 27, connected to the cross-head adjacent the opposite ends thereof, and each extending upwardly over a pair of sheaves 28 and 29, carried by the arm 11, and thence downwardly to the counter-weight. The counter-weight is preferably somewhat heavier than the weight of the parts supported by the cross-head so as to assist in lifting the column of oil in the well.

The piston 18 is actuated by liquid deliv-

ered to the cylinder 10 at a measured rate. In this instance the opposite ends of the cylinder communicate through pipes 30 and 31, respectively, with the opposite sides of a positive, variable displacement pump 32, of a well known type. The pump shown is fully described in the patent to Walter Ferris, No. 1,558,002, issued October 20, 1925. It will suffice here to say that the pump shown is of a rotary multiple piston type and is driven continuously at constant speed through a pulley 33 from a convenient power source. The stroke of the pump is varied and controlled through a pulley 34, so as to regulate the rate and direction of discharge from the pump. With the pulley 34 in neutral position, pump stroke is zero and there is no flow of liquid in the pipes 30 and 31. By rotating the pulley 34 in a counter-clockwise direction from this neutral position, the pump is adjusted so as to deliver liquid into pipe 30 and to receive liquid from pipe 31 at a rate proportional to the extent of rotation of the pulley 34 from neutral. By rotating the pulley 34 in a clockwise direction from neutral position, the pump is adjusted so as to deliver liquid into pipe 31 and to receive liquid from pipe 30 at a rate proportional to the extent of rotation of the pulley 34 from neutral. As the pulley 34 is rotated from one extreme position to the other, the rate of liquid discharged by the pump is progressively reduced to zero and then progressively increased, with a reversal in direction of flow as the pump is adjusted through zero stroke position. The rate of change in the flow is of course dependent upon the rate at which the pulley 34 is rotated.

In this instance, the pulley 34 is automatically controlled to effect reversal of the pump 32 as the piston 18 approaches each end of the stroke, to thereby effect a substantially continuous reciprocation of the pump element at the bottom of the well. A control mechanism well adapted for the purpose is shown in Figures 4 to 8. This mechanism includes a drum 35 operatively connected to the pulley 34, through an endless cable 36. The drum 35 is fixed to one end of a shaft 37, journaled in a bracket 38 supported at the side of the frame 13. The other end of the shaft 37 carries a depending crank arm 39, fixed thereto. The swing of the arm 39 is limited in both directions by any appropriate means such as stop screws 40 and 41, adjustably fixed in the base of the bracket 38. The extent of swing of the arm 39 in one direction, and consequently the extent of rotation of drum 35 and pulley 34 in one direction, may thus be regulated by the adjustment of screw 40. This determines the maximum rate at which liquid is discharged from the pump into pipe 30. Likewise the extent of swing of the arm 39 in the opposite direction, and consequently the extent of rota-

tion of drum 35 and pulley 34 in the opposite direction, may be regulated by the adjustment of screw 41. This determines the maximum rate at which liquid is discharged from the pump into the pipe 31.

The arm 39 is actuated in either direction through an appropriate spring 42, connecting a crank pin 43 carried by the arm 39 with a crank pin 44 carried by an upright crank arm 45. Arm 45 is fixed to one end of a rock shaft 46, journaled in a fixed bracket 47, in co-axial relation with the shaft 37. The swing of arm 45 is limited in both directions by an abutment 48 projecting from the bracket 47 and engageable with one or the other of a pair of lugs 49 projecting laterally from the arm 45. Shaft 46 is rocked in either direction by an arm 50, carrying a pin 51 engageable in a fork 52 fixed to the shaft. Arm 50 is fixed to a drum 53 rockably mounted upon a stub shaft 54 fixed in the bracket 47. Shaft 54 is preferably offset from shaft 46 and arm 50 is longer than the fork 52, so that, as the arm 50 is rocked about the shaft 54, the pin 51 describes a flatter arc than does the cooperating part of the fork, with the result that the pin 51 lifts out of the fork upon extreme rotation of the drum, thus rendering it impossible for the fork to be rocked beyond the position limited by the engagement of the abutment with either of the lugs 49.

The arrangement of the crank arms 39 and 45 is such that when arm 45 is swung from one extreme position to the other the spring 42 is so shifted as to cause the arm 39 to swing from one extreme position to the other. Both crank arms 39 and 45 normally assume positions on the same side of the axis of shafts 37 and 46, under the tension of the spring 42 connecting their respective crank pins 43 and 44. In Figures 5 and 7 both crank pins 43 and 44 are shown disposed on the right side of the shaft 46. By rotating the drum 53 in a counter-clockwise direction (Fig. 5) the pin 51 rocks the fork 52 in the same direction, causing the crank arm 45 to swing in the same direction until the crank pin 44 assumes the dotted line position of Figure 7. The spring 42 is thus shifted to the other side of the axis of shaft 46, and the tension therein causes the crank pin 43 to swing toward the left into the position of Figure 8. The crank arm 39, thus rocked, rotates the drum 35 and consequently the pulley 34 to reverse the pump. Then by rotating the drum 53 in the opposite direction, crank arm 45 is returned to the position of Figure 5, and the crank pin 44 is shifted from the full line position of Figure 8 to the dotted line position. The spring 42 is thus again passed across the axis of the shaft 46 so as to pull the crank pin 43 into the position shown in Figures 5 and 7. This movement of the crank pin 43 is transmitted through the arm 39 and drum 35

to the pulley 34 and the pump is again reversed.

Provision is preferably made for controlling the rate of rotation of the drum 35 from one extreme position to the other to thereby obtain a nice control of the rate of rotation of pulley 34 and consequently of the time required to reverse the pump from full delivery in one direction to full delivery in the opposite direction. This is accomplished in this instance by the use of an appropriate dashpot mechanism 55. The dashpot mechanism shown comprises a piston 57 reciprocating in a closed container 58 and immersed in a body of oil therein. Two pipes 59 and 60 establish by-pass connections between the bodies of oil above and below the piston 57. A check valve 61 prevents downward flow of liquid through pipe 59 and a check valve 62 prevents upward flow through pipe 60. A throttle valve 63 controls the rate of flow of oil upwardly through pipe 59 and a throttle valve 64 controls the rate of flow downwardly through pipe 60. The piston 57 is connected through a piston rod 56 with an arm 56' fixed to the drum 35. When the drum 35 is rotated in such direction as to force the piston downwardly such rotation is resisted by the body of oil beneath the piston, the rate of movement being controlled by the setting of the valve 63. Likewise the rate of rotation of the drum 35 in the other direction is controlled by the setting of the valve 64, which controls the rate of flow downwardly through pipe 60.

The drum 53 is actuated by an endless cable 65 trained about a pair of sheaves 66 and 67 and wrapped about the drum. The sheaves 66 and 67 are mounted upon the side of the frame 13, so that the cable 65 extends vertically adjacent the path of travel of the counter-weight 26. The counter-weight carries a lug 68, having an eye loosely surrounding the cable 65, and cooperating with stop collars 69 and 70 adjustably fixed to the cable. The position of the collars 69 and 70 determines the distance through which the counter-weight travels. As the counter-weight approaches the upper end of its stroke the lug 68 thereon engages collar 69 and forces the same upwardly to thereby operate the cable 65 in one direction; and as the counter-weight approaches the lower end of its stroke the lug 68 engages collar 70 and forces the same downwardly to thereby operate the cable 65 in the opposite direction. It will be noted that since the cross-head 19 reciprocates in unison with the counter-weight, the position of the collars 69 and 70 actually determines the extent of travel of the cross-head.

A brief description of the operation of the mechanism will now be given. The pump 32 is operated continuously through the pulley 33. The piston 18 and cross-head 19 are

shown at the upper end of their stroke in Figures 1 and 2, and the counterweight is at the lower end of its stroke, so that collar 70 is depressed and the control pulley 34 on the pump has been rotated in a counter-clockwise direction (Fig. 2) from neutral position. The pump has just been reversed and is delivering liquid at a measured rate through pipe 30 to the upper end of cylinder 10, and liquid discharged from the lower end of the cylinder is returning to the pump through pipe 31. The piston 18 and cross-head 19 have started their down stroke and the counter-weight 26 is rising. This movement of the parts continues until the lug 68 on the counter-weight engages the collar 69 on the cable 65 and forces the same upwardly. When this occurs the cable 65 rotates the drum 53 counter-clockwise (Fig. 5) so that the crank pin 44 travels from the right to the left side of the axis of shaft 46 as indicated in Figure 7. The spring 42 then pulls the crank pin 43 toward the left causing a clockwise rotation of drum 35 and pulley 34. This rotation of drum 35 and pulley 34 is retarded by the action of the dashpot mechanism 55, so that the actual rate of rotation of pulley 34 is determined by the setting of the valve 63. As the pulley thus rotates slowly toward neutral position pump displacement is gradually reduced and the piston 18 and cross-head 19 decelerate gradually until the pulley 34 reaches neutral position, when the piston and cross-head come to rest. The pulley 34 continues to rotate clockwise through the neutral position and the pump begins delivering liquid into pipe 31 at a gradually increasing rate. The piston and cross-head begin their upward stroke and are gradually accelerated during this continued rotation of the pulley 34, until the arm 39 engages the stop screw 41. This prevents further rotation of pulley 34 and the pump thereafter delivers liquid at a constant rate into pipe 31 and the piston and cross-head travel upwardly at a uniform rate, the counter-weight moving downwardly.

This movement continues until the lug 68 on the counter-weight again engages collar 70 and depresses the same. The cable 65 is thus actuated to rotate the drum 53 clockwise (Fig. 5) and thereby shift the crank pin 44 and spring 42 to the right side of the axis of shaft 46. The crank pin 43 is then pulled toward the right by the spring 42 causing a counter-clockwise rotation of drum 35 and pulley 34. Rotation of the drum 35 is again resisted however by the dashpot 55, and the rate of rotation of the pulley 34 is thus controlled by the valve 64. Again as the pulley 34 rotates counter-clockwise toward neutral position the rate of liquid discharged by the pump is gradually reduced and the piston and cross-head are gradually decelerated in their upward movement, until pulley 34 reaches

neutral position and the piston and cross-head come to rest. The continued slow rotation of pulley 34 through neutral position causes the pump to again deliver liquid into pipe 30 at a gradually increasing rate, thereby causing the piston and cross-head to begin a down stroke at a gradually increasing rate. Rotation of the pulley 34 continues and the piston and cross-head continue to accelerate until the arm 39 strikes the stop screw 40. Thereafter the pump continues to deliver liquid into pipe 30 at a constant rate and the piston and cross-head travel downwardly at a steady rate.

From the foregoing it will be noted that the length of stroke of the piston, and consequently of the pump may be adjusted by adjusting either or both of the collars 69 and 70 on the cable 65. The maximum rate of upward movement of the piston and cross-head may be regulated by adjusting the stop screw 40, and the maximum rate of downward movement of the piston and cross-head may be regulated by adjusting the stop screw 41. The rate of deceleration and acceleration of the piston and cross-head at the upper end of the stroke may be regulated by adjusting the valve 64, and the rate of deceleration and acceleration of the piston and cross-head at the lower end of the stroke may be regulated by adjusting the valve 63. It is thus possible to obtain a smooth operation of the sucker rods under all working conditions.

Provision is preferably made for controlling the pump by hand. In this instance a handle 72 is provided for this purpose. The handle shown is formed as an integral part of the crank arm 39, so that the drum 35 and pulley 34 may be made to respond to movement thereof. Provision is also made for releasably locking the drum 35 and pulley 34 in neutral position. In this instance a spring pressed latch element 73 is so mounted in the bracket 38, as to be engaged in a notch 74 formed in an element 75 constituting an extension of the crank 39. The latch is withdrawable from notch engaging position by a handle 76. The latch is normally retained in inactive position by the engagement of a pin 77 beneath an eccentric portion 78 of the handle 76. When the handle 76 is turned about its axis so as to adjust the eccentric portion away from pin 77, the latch may be engaged in the notch 74.

Appropriate buffer mechanism is preferably provided for preventing injury or damage to the operating parts in the event of an excessive throw of the piston 18. Mechanism for this purpose is shown in Figure 9. This mechanism includes a spring 79 within the lower end of the cylinder for yieldably resisting an excessive downward stroke of the piston. To cushion the parts against an excessive upward throw the lower cylinder head 21 is provided with an integral stop flange 81

cooperating with a similarly flanged buffer element 82 loosely mounted on the piston rod 20. The buffer element rests upon a spring 83, supported upon a collar 84, fixed to the piston rod 20 adjacent the lower end thereof. Upon an excessive upward stroke of the piston the buffer element 82 strikes the flange 81 and continued upward movement of the piston and rod 20, is yieldably resisted by the spring 83.

The accumulation of air in hydraulic drives of the character hereinabove described has proven a menace to smooth operation. Provision is therefore made for ridding the system of accumulated air. In this instance an air bleeder 85 is mounted at the upper end of the cylinder 10. This bleeder is fully described in the co-pending application of Lawrence F. Young, Serial No. 699,588, filed March 15, 1924, so that it will suffice here to state that it comprises essentially a length of small diameter tubing which is in open communication with the cylinder and through which air may escape from the cylinder. The length of the tubing is such as to effectively resist the escape of liquid in any appreciable quantities therefrom. In order to permit the escape of air from beneath the piston 18 into the upper end of the cylinder, where it may escape through the bleeder 85, a small passage 86 is formed through the piston. This passage 86 communicates with a coil of small diameter tubing 87, similar to that used in the bleeder. The length of the tubing 87 is such as to effectively resist the flow of liquid in any appreciable quantities therethrough.

Various changes may be made in the embodiment of the invention hereinabove specifically described without departing from or sacrificing any of the advantages of the invention as defined in the appended claims.

We claim:—

1. A hydraulic drive comprising a hydraulic motor, means for delivering a smooth flow of driving liquid to said motor at a measured rate, means for varying the rate of delivery of driving liquid to said motor, and means for controlling the rate of action of said varying means to control the rate of change in the liquid flow.

2. A hydraulic drive comprising a hydraulic motor, a variable displacement pump for delivering a driving liquid to said motor at a rate proportional to pump displacement, means for varying pump displacement, and means for controlling the rate of action of said varying means to control the rate of change in pump displacement.

3. A hydraulic drive comprising a hydraulic motor, a reversible flow variable displacement pump for delivering a driving liquid to said motor at a rate proportional to pump displacement, means for varying pump displacement to vary the rate and direction of flow of liquid to said motor, and means for

controlling the rate of action of said displacement varying means to control the rate of change in pump displacement.

4. A hydraulic drive comprising a reciprocating member, a hydraulic motor for driving said member, a reversible flow variable displacement pump for delivering a driving liquid to said motor at a rate proportional to pump displacement, means for regulating pump displacement, means controlled by said member for actuating said regulating means to reverse said pump, and means for controlling the rate of action of said regulating means to control the rate of change in pump displacement.

5. A hydraulic drive comprising a reciprocating member, a hydraulic motor for driving said member, means for delivering a smooth flow of driving liquid to said motor at a measured rate, means for regulating the rate and direction of flow of said liquid, means controlled by said member for operating said regulating means to reverse said member, and means for controlling the rate of action of said regulating means to control the rate of change in the liquid flow.

6. A drive mechanism for deep well pumps comprising a piston and cylinder operatively connected with the pump, means for delivering a driving liquid to said cylinder to operate the pump, and a support for said piston and cylinder adjustable to move the piston and cylinder from operative position over the well into inactive position at the side of the well.

7. A drive mechanism for deep well pumps comprising a hydraulic motor for operating the pump, means for delivering a driving liquid to said motor, and a support for said motor adjustable to move said motor laterally from normal active position over the well.

8. In an oil well rig the combination of an upright frame rising above the well, a support adjustable thereon, a hydraulic motor on said support movable laterally from normal active position over the well, and means for supplying a driving liquid to said motor to operate the same.

9. In an oil well rig the combination of an upright structure rising above the well, a hydraulic motor normally disposed in active position over the well, means for delivering a driving liquid to said motor to operate the same and a support for said motor adjustably mounted on said structure to permit movement of said motor laterally of the well.

10. In an oil well rig the combination of an upright structure rising above the well, a motor normally disposed over the well, and a support for said motor pivotally mounted on said structure to swing laterally of the well.

11. In a hydraulic drive the combination of a reciprocating member, hydraulic means for driving said member, reversing means for

said hydraulic drive, a crank for operating said reversing means, a second crank, resilient means connecting said cranks and movable with said last named crank across the pivotal axis of said first named crank, and means controlled by said reciprocating member for actuating said last named crank.

10 12. In a hydraulic drive the combination of an upright cylinder, a piston reciprocable therein, means for delivering a driving liquid to said cylinder, a choke coil associated with said piston permitting the escape of air from the lower to the upper end of said cylinder, and means permitting the escape of air from the upper end of said cylinder.

15 In witness whereof, we hereunto subscribe our names this 30th day of December, 1925.

LAWRENCE A. BARRETT.

JOHN P. FERRIS.

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