May 12, 1942. R. R. MAST 2,282,977

HYDRAULIC OPERATING MECHANISM FOR A PUMP

Filed Sept. 9, 1939 3 Sheets-Sheet 1

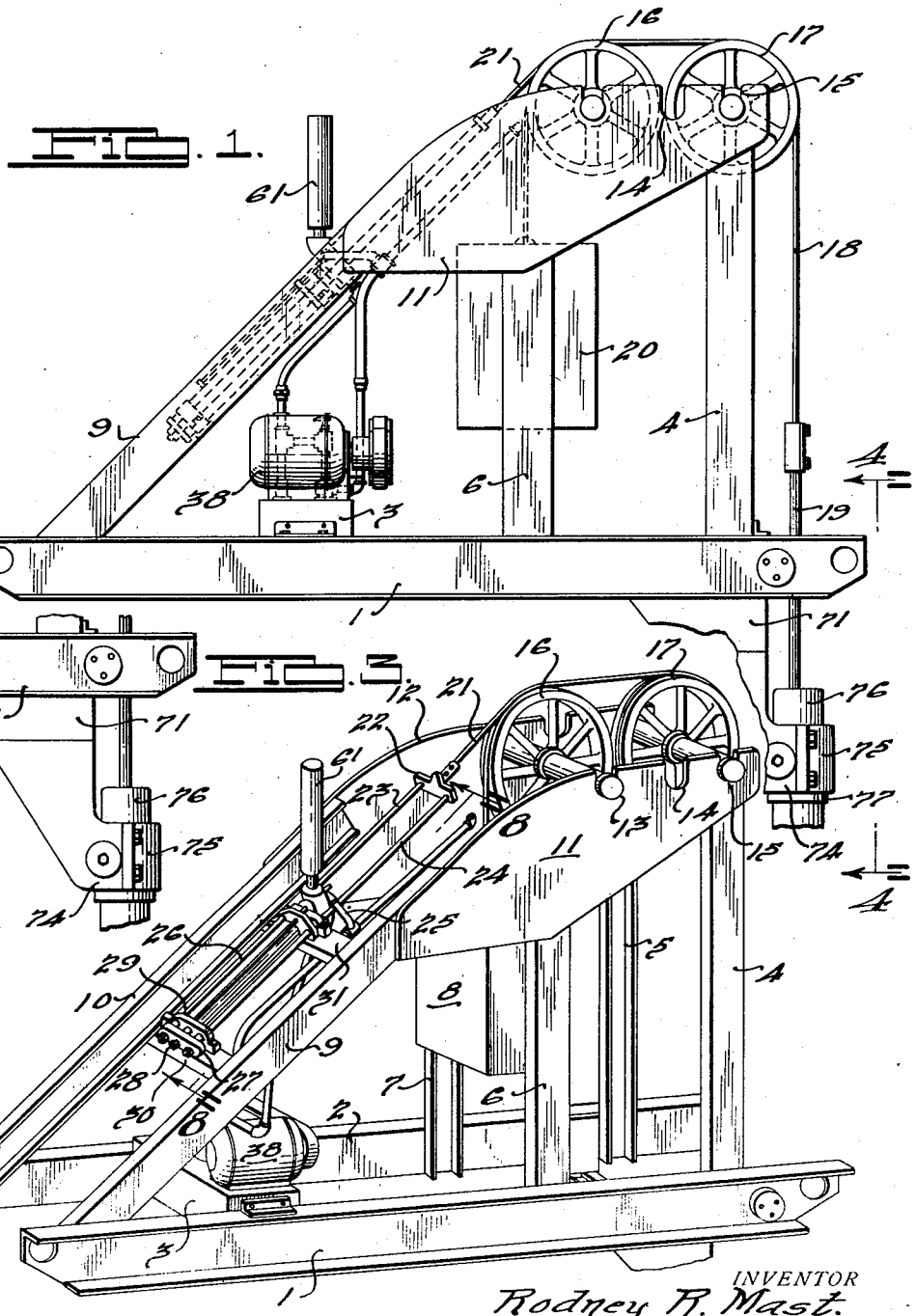

FIG. 1.

FIG. 2.

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HYDRAULIC OPERATING MECHANISM FOR A PUMP

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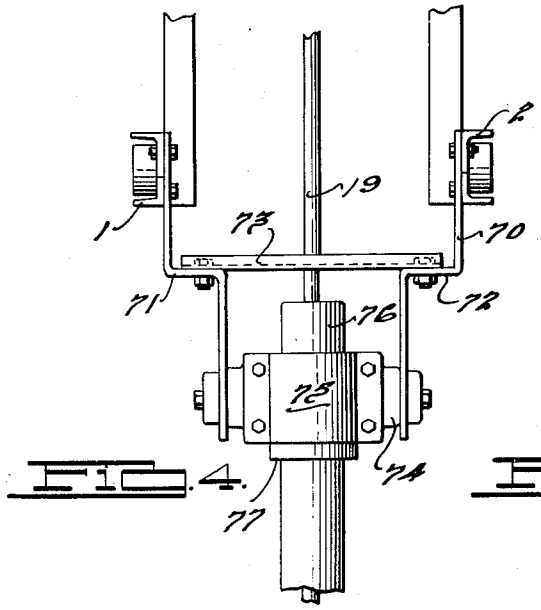

FIG. 4.

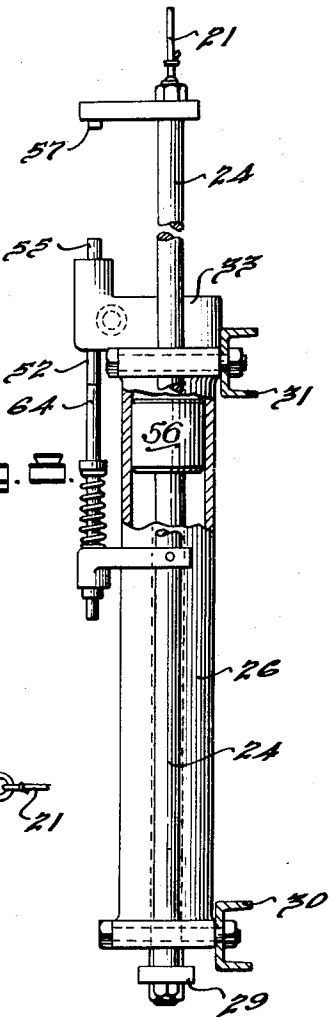

FIG. 6.

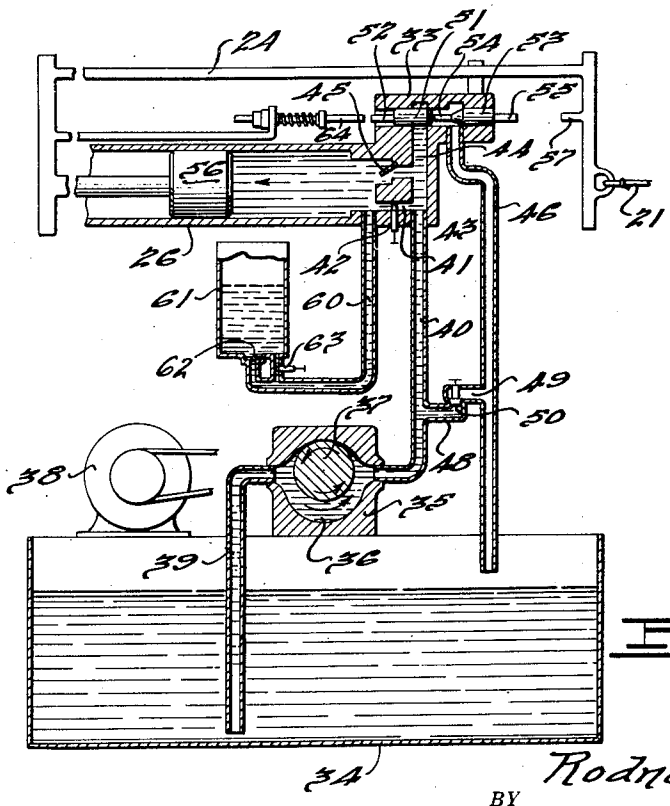

FIG. 5.

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HYDRAULIC OPERATING MECHANISM FOR A PUMP

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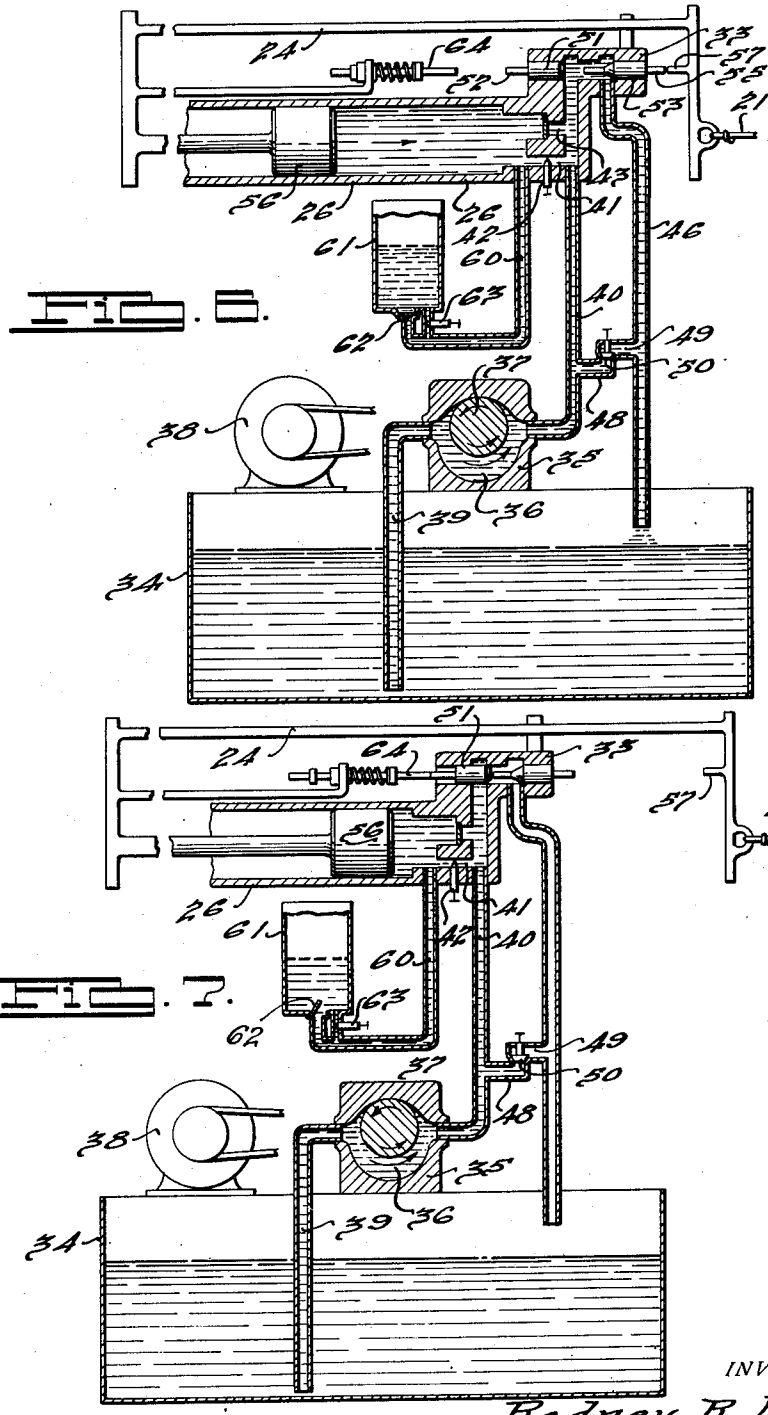

FIG. 6.

FIG. 7.

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UNITED STATES PATENT OFFICE

2,282,977

HYDRAULIC OPERATING MECHANISM FOR PUMPS

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Application September 9, 1939, Serial No. 294,151

1 Claim. (Cl. 60—52)

This invention relates to hydraulic operating mechanism for a pump such as used for pumping oil wells or other wells of considerable depth and wherein the pump is located at the well.

The principal object of the invention is to provide a hydraulic operating mechanism for a pump of a character to regulate and control the speed of the pump to suit the varying conditions at any given time or any given well so that the speed of operation of the pump automatically conforms to the rapidity with which oil or liquid of other character can flow into the well.

In the conventional counterweighted and crank actuated beam pump for oil wells, the sucker rod assembly attached thereto is forced to return to the bottom of the well at times when there is a gas pressure sufficient to force the oil to the top of the well and it is therefore desirable to allow the pump to dwell or stop entirely during such period of gas pressure. A feature and object of this invention therefore is to provide a means automatically controlling movement of the sucker rod so that it may dwell or stop on the down stroke at any time the gas pressure is sufficient to lift the oil to or toward the top of the well. A further object of the invention resides in the means providing a regulated uniform movement of the sucker rod on either the upward or the downward stroke and in the means providing for control of the speed of operation of the apparatus and proper balance between the counterweight and sucker rod.

It is further an object and feature of the invention to provide a means for attaching the frame of the hydraulic operating mechanism to the well casing thereby avoiding the difficulties encountered in the conventional method of bolting the pump to concrete or heavy timber foundations which involves added expense in frequent levelling and adjusting required in soft ground to maintain the direction of pull on the sucker rod in line with the well casing.

These and other objects and features of the invention are hereinafter more fully described and claimed and the preferred form of a pumping apparatus embodying my invention is shown in the accompanying drawings in which—

Fig. 1 is a side elevation of my improved pump.

Fig. 2 is a perspective view thereof, more clearly showing the hydraulic mechanism.

Fig. 3 is a side elevation of the anchoring means for attaching the pump frame to the well casing.

Fig. 4 is a front elevation thereof of the anchoring means taken on line 4—4 of Fig. 1.

Fig. 5 shows the hydraulically controlled mechanism in diagrammatic form in the position of parts when the pump is on the lift stroke.

Fig. 6 is a similar diagram showing the hydraulic control part in the position assumed on the return stroke.

Fig. 7 is a similar view showing the condition of the hydraulic apparatus at the instant of reversal.

Fig. 8 is a side elevation partly in section of the pump element of the hydraulic apparatus.

My improved hydraulic operating mechanism comprises a frame having the side rails or runners 1 and 2 which may be tied together in any approved manner as by a cross member 3 or additional connecting members as may be desired. Also vertical members 4 and 5 are provided at the forward end of the side members and additional vertical elements 6 and 7 provide guides for a counterweight 8. A pair of spaced frame elements 9 and 10 are attached at the bottom ends to the ends of the respective rails 1 and 2 and extend forwardly and upwardly inclined and terminate in forwardly extending plates 11 and 12 having horizontal edges each provided with three notches 13, 14 and 15. There is provided a spiral grooved pulley 16 having a shaft normally supported in the notches 13 of the opposite plates 11 and 12. There is likewise a pulley 17 the shaft of which is supported in the notches 15 of the plates 11 and 12. Over these pulleys rides a cable 18 connected to the sucker rod 19 at its upper end and thence over the pulley 17 and around the spiral grooved pulley 16 to a counterweight 20. Attached to this cable is a comparatively short length of cable 21 attached at one end to the cable 18 and at the other end to a yoke consisting of a cross bar 22 and side rods 23 and 24 these rods extending through a cast head 25 and along the side of the cylinder 26 to a cross bar 27 at the lower end of the cylinder and to which is attached the piston rod 28. The cylinder extends between the forward head 25 and a rear head 29 and is mounted on cross bars 30 and 31 extending between and spacing the inclined frames 9 and 10.

There is a piston 56 in the cylinder 26, as shown in Fig. 8, the mechanism hereinafter described controlling the reciprocation of the piston and as the piston is connected with the rods 23 and 24 reciprocation of the piston causes reciprocation of the rods 23 and 24 lifting the sucker rod 19 by the cable 21 attached to the pump cable 18. Attached to the head of the cylinder 26 is a valve housing 33 by which the flow of oil

operating the piston is controlled as will be more clearly understood from the diagrams Figs. 5, 6 and 7.

The member 3 which may conveniently provide a cross member between the side rails 1 and 2, as shown in Fig. 2, forms an oil reservoir 34. On this reservoir as shown in the diagrams in Figs. 6, 7 and 8 is mounted a pump 35 having a chamber 36 and a rotary impeller 37 driven by an electric motor 38. The pump intake conduit is shown at 39 and an outlet conduit at 40 which leads to the head of the cylinder 26. This cylinder 26 has a passageway 41 at the forward end controlled by the adjustable valve 42 and there is also a passageway 43 opening to the interior of the cylinder 26 on pressure in the conduit 40 and the extension 44 thereof provided in the cylinder head. A check valve 45 closes the passageway 43 on the pressure in the cylinder 36 as is indicated in Fig. 6. The extension 44 opens to the valve chamber in the valve head 33 and there is also a conduit 46 opening to the said chamber and discharging to the reservoir 34, the conduit 46 being parallel with the conduit 40.

Between the two conduits 40 and 46 is a cross conduit formed of two sections 48 and 49 and a valve 50 is provided between the two sections which may be manually set to provide for greater or a less speed of flow of oil through the conduits 48 and 49 from the conduit 40 to the conduit 46. A slidable piston valve 51 is provided in the chamber of the valve head which has a projecting stem 52 and likewise a similar piston valve 53 is provided in the said valve head having a projecting stem 54 on the inner end engageable with the valve 51 on movement thereof to the right or movement of the valve 53 to the left and this valve 53 has a projecting stem 55. The hydraulic apparatus takes oil from the reservoir 34 and discharges to the head of the piston 56 to raise the sucker rod by means of the rods 23 and 24 to which the cable 21 is attached at the forward end and to which the piston 56 in the cylinder 26 is attached at the rear end. The hydraulic mechanism therefore merely raises the sucker rod on the pumping stroke and the weight of the sucker rod assembly and column of oil reverses the stroke of the piston 56 in the cylinder 26.

With this understanding it is to be noted that a pump 35 delivers oil under pressure to one end of the cylinder 26 through the pipe 40 and extension 44 and through the passageway 43 and by regulation of the valve 50 oil may be by-passed in varying volume to the return conduit 46 and this regulates the rate of travel of the piston 56 throughout the pumping stroke and also permits the starting or stopping of the pumping stroke without stopping operation of the pump 35.

In Fig. 5 the pump 35 is supplying oil under pressure to the piston 56 and raising the sucker rod. This also shifts the frame elements 23 and 24 to which the cable 21 is attached. This frame element has a valve operating lug 57 at its forward end which is axially aligned with the projecting stem 55 of the valve 53 and as the piston 56 reaches the end of its stroke this lug 57 engages the stem 55 and moves the valve 53 to the left of the position shown in Fig. 5 thus moving the valve 51 to the left to the position shown in Fig. 6. This movement of the valve 51 opens the passageway 44 to the passageways in which the valves 51 and 53 are located and to the return passageway 46. This valve movement occurs at the time the well pump is practically finishing its up stroke and the sucker rod assembly and column of oil by weight on the cable portion 21 then moves the piston 56 in the direction of the arrow shown in Fig. 6 forcing oil through the passageway 41, the passageway 44 and to the return passageway 46 and maintains pressure in the air chamber 61 due to pressure of liquid in the cylinder. The speed of movement of the piston 56 and of the return of the sucker rod assembly in the well is controlled by the valve 42 due to the fact that the valve 45 is closed at this time by pressure in the cylinder. At the same time oil under pressure is passed through the conduit 60 past the check valve 62 into the chamber 61. The check valve 62 will close upon reduction in pressure in the chamber 61. Oil under pressure from the pump 35, under this return movement of the piston 56, is opposed to oil flowing in the direction of the arrow in the cylinder 26 which is being returned by weight of the sucker rod assembly.

This causes a momentary increase of pressure in the cylinder 26 which forces the oil into the chamber 61 through the check valve 62 and the oil that is forced into the chamber 61 is allowed to exhaust through a valve controlled by-pass 63 during movement of the piston 56 to the left on the pumping stroke. This arrangement of the chamber 61 and related parts described serves to control the rapidity of the return movement of the sucker rod assembly, it being borne in mind that the pump 35 is continuously operating. At the completion of the downward movement of the sucker rod assembly, the parts of the hydraulic apparatus are in the condition and position shown in Fig. 7. This movement of the piston 56 to the right brings the spring pressed rod 64 to contact with the projecting stem 52 of the valve 51 and moves the valve to the right thereby closing the conduit 40 to the valve chamber in the head 33. Upon this occurring the pressure of oil in the head of the cylinder 26 starts the piston 56 in a reverse direction at which time the cylinder 61 will become partially depleted of the oil content and the parts will then function to raise the sucker rod assembly as in the beginning and described relative to Fig. 5.

A feature of the invention resides in the manner of securing the pumping apparatus at the well. Frequently apparatus of this character has to be set in wet and/or soft ground and previously concrete or other foundations are provided of sufficient area to support the pumping apparatus but due to the strains imposed thereon by the sucker rod assembly and weight of column of liquid lifted thereby, the foundation may shift or be deflected from the original position by frost and thus misaligns the apparatus so that the direction of pull on the sucker rod is not vertically aligned with the sucker rod.

To overcome this undesirable condition I provide an arrangement shown in Figs. 1, 3 and 4 for supporting the forward end of the pumping apparatus on the well casing. For this purpose I provide a bracket having arms 70 and 71 respectively attached to the rails 1 and 3 at the forward ends. Each bracket is provided with an offset 72 to which is attached the plate 73 apertured to receive the sucker rod 19. The lower ends of the brackets 70 and 71 are secured to a casing 74 having a removable cap 75 which tightly clamps the well casing 76 between the cap and casting. It may also be desirable to weld a ring 77 to the well casing on which the

member 14 and its cap 15 may rest. By this arrangement with or without the ring 17 the framework of the pumping apparatus is supported directly on the well casing thereby maintaining the direction of pull of the cable 18 over the pulley 17 in vertical alignment with the sucker rod 19.

It is oftentimes necessary to pull the sucker rod assembly for repair of the pump barrel or other parts within the well and as this requires that the sucker rod shall be moved vertically, the pulley 17 may be lifted from its bearing recesses 15 and the shaft therefor placed in the recesses 14 in which case the pulley 17 will be positioned at one side or the other of the pulley 16. This disposition of the pulley 17 permits the sucker rod to be moved vertically as the pulley is out of the path of the sucker rod movement.

It will be realized from the foregoing that, if the sucker rod assembly is supported by pressure in the well or restricted in its downward movement, the piston 56 will remain stationary or be restricted in its movement as operation of the hydraulic apparatus is dependent on the weight of the sucker rod assembly to bring the parts to a position to operate the valve and reverse the direction of pressure in the cylinder 26.

It is also to be observed that under normal conditions downward movement of the sucker rod assembly is controlled and is cushioned by the chamber 61 and that the sucker rod assembly is not subject to sudden jerks in the reversal of its direction of travel, but on the contrary a very smooth and uniform action or movement of the sucker rod assembly is secured; and further that the various parts are constantly under a regulated pressure control even under pressure developing in the well, as the piston 56 is not moved outwardly of its cylinder on the pumping stroke until the valves 51 and 53 have been moved from the position shown in Fig. 6 to the position shown in Fig. 7.

Having thus fully described my invention, its utility and mode of operation, what I claim and desire to secure by Letters Patent of the United States is:

Apparatus of the character described comprising a well casing, a sucker rod assembly reciprocable in the said casing, a cable connected therewith, a motor driven hydraulic apparatus including a constantly operating pump for providing liquid under pressure, a cylinder, a piston reciprocable therein, a frame attached to the piston and to the cable whereby reciprocation of the piston provides for reciprocation of the sucker rod assembly connected with the cable, a liquid supply source for the pump, a pump discharge conduit having an opening to the cylinder, a conduit for returning the liquid from the cylinder to the source of supply, a valve controlling the said opening operable by pressure in the discharge conduit to open the valve to permit flow of liquid into the cylinder from the pump, the said valve being closable by pressure of liquid developed in the cylinder by return movement of the piston, a valve controlled conduit for variably restricting discharge of liquid from the cylinder by the piston on the return stroke, valve means controlled through movement of the piston in the cylinder to close the discharge conduit to the return conduit whereby liquid under pressure is discharged through the said opening to the cylinder, the said valve means being operated by movement of the piston at the end of the pressure stroke to open the discharge conduit to the return conduit thereby relieving the piston of full pump pressure and permitting the same to be moved by the weight of the sucker rod assembly, an air chamber having a conduit in the bottom opening to the cylinder whereby on discharge of liquid to the cylinder, the air chamber is also supplied, a check valve associated with the air chamber for preventing direct return of the liquid to the chamber conduit, and a valve controlled by-pass from the said chamber to the said conduit discharging thereto for restricting the rapidity of flow from the air chamber.

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