

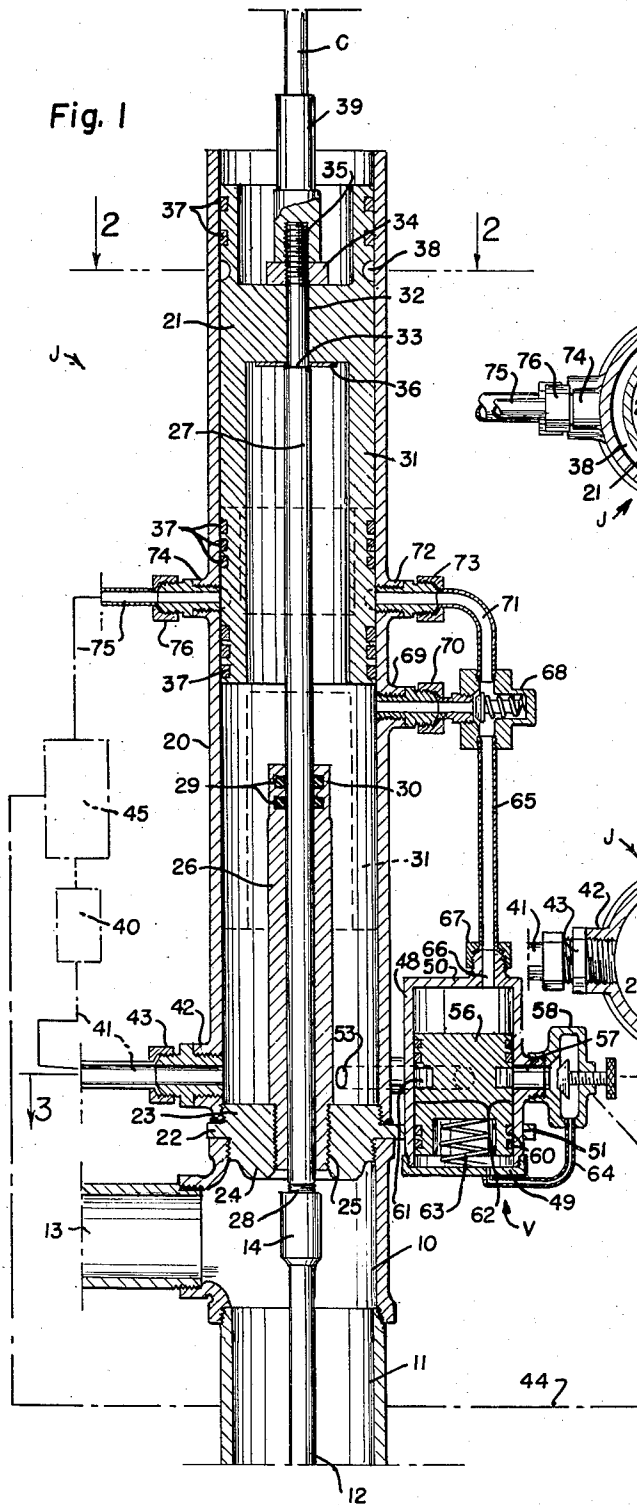
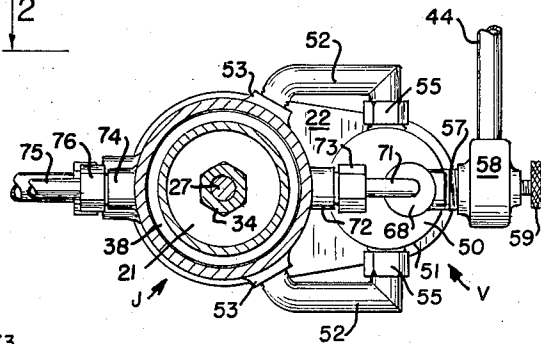
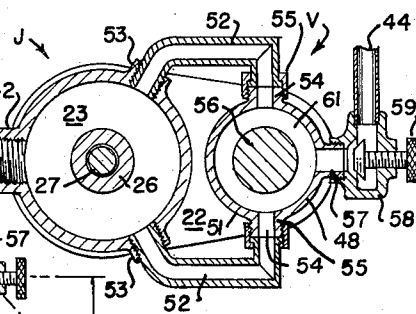
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2,852,001

PUMP JACK

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2,852,001

PUMP JACK

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12 Claims. (Cl. 121—150)

This invention relates to pump jacks, used for brevity to refer to apparatus for producing upward and downward reciprocatory movement of a pump rod in an oil or water well, or any other type of apparatus in which such type of movement is desired, to which my copending application Serial No. 388,400, filed October 26, 1953, also relates.

In pumping oil from oil wells, a reciprocating pump is placed in the well at a depth such that the oil will flow into the pump and the pump is reciprocated by means of a pump rod which extends upwardly through the pumping tube to the collar or top of the well. Due to the depth of oil wells, such as from several hundred to several thousand feet, the weight of the pump rod itself, in addition to the weight of the oil in the pumping tube, is often considerable, such as several tons, and this weight must be lifted at each stroke of the pump. The stroke of the pumps normally used for pumping oil wells may vary between one foot and five feet, depending upon the lift required at each stroke to produce the desired rate of flow, and the number of strokes per minute are relatively small, such as from five to fifteen per minute. Previously, extremely heavy and cumbersome gear driven apparatus has been used to reciprocate oil well pump rods. Such apparatus conventionally includes a large heavy walking beam, moved upwardly and downwardly by a crank actuated from a motor or engine through a gear train. In addition, the crank is formed as part of or attached to a heavy counter-weight which tends to balance the weight of the pump rod and the oil in the well. Even with the use of a counter-weight, the force required to lift the pump rod at each stroke of the pump is considerable, and such apparatus is therefore usually quite expensive, each such apparatus or pump jack often costing several thousands of dollars. In addition, the problems of adequate lubrication and wear require constant attention and considerable sums for upkeep.

Among the objects of the present invention are to provide a novel and improved apparatus for producing vertically reciprocating movement, particularly a pump jack; to provide such apparatus which is hydraulically operated and thereby permits a small driving unit of nominal horsepower to operate against the heavy but slow moving load imposed upon the pumping rod in operation; to provide such apparatus which may be adjusted to any desired rate of stroke and is thereby adapted to control the rate of reciprocation of the well pump rod for any desired optimum period of time; to provide such apparatus which is especially adapted to be mounted upon a conventional terminal T of the pumping tube; to provide such apparatus which is easy to set up and readily adjusted for operation; to provide such apparatus which is effective,

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dependable, and economical to operate and requires a minimum of maintenance; to provide such apparatus which is compact, light in weight and constructed simply of few parts so that it may be easily disassembled for maintenance and repair; and to provide such apparatus which is rugged and constructed so that no parts tend to be overstressed.

With the foregoing in view, as well as other objects which will become hereinafter apparent, the invention comprises certain combinations and arrangements of parts and elements as herein described and defined in the appended claims, and illustrated in a preferred embodiment in the accompanying drawing, in which:

Fig. 1 is a vertical section taken through the longitudinal vertical axis of a pump jack constructed in accordance with this invention, with different positions of certain movable parts indicated by broken lines and additional parts to form a more complete apparatus indicated diagrammatically by dot-dash lines;

Fig. 2 is an upper horizontal section, taken from the position of line 2—2 of Fig. 1; and

Fig. 3 is a lower horizontal section, taken from the position of line 3—3 of Fig. 1.

Referring to the drawing, a pump jack constructed in accordance with this invention is adapted to be mounted upon the upper end of a conventional terminal T 10 of a pumping tube 11 of a well pumping assembly, such an assembly including also a pump rod 12 extending within the tube 11 to a pump below (not shown) and a pipe 13 which is connected to the outstanding leg of T 10 for discharging oil or water pumped upwardly from the well through tube 11. The pump rod 12, which moves upwardly and downwardly within the tube 11 during operation, is preferably of such length that it terminates within the T 10 at the upper limit of the pumping stroke, as at a coupling 14 which may be internally threaded for a purpose hereinafter described. For installation, maintenance, dismantling or repair of the pump jack, pump rod 12 may be held at its upper limit of movement within T 10 by removing the pipe 13 and inserting a fork or tongs, not herein illustrated, into the side opening of the T 10, to engage the pump rod below the coupling 14.

A piston and cylinder assembly J of the pump jack includes an upstanding cylinder 20 having a suitable internal diameter and wall thickness to withstand the pressures and stresses imposed upon it with a length sufficient to accommodate movement of a piston 21 mounted therein. In general, a suitable hydraulic fluid is supplied at a suitable pressure at all times to the interior of cylinder 20 and controlled by a valve V so that hydraulic pressure will force piston 21 upwardly during the "up" stroke, when the valve V is in closed position, thereby moving upwardly with it pump rod 12 and the pump connected to the lower end of rod 12. On the "down" stroke, hydraulic fluid is supplied to cylinder 20, but merely flows therethrough with the valve V in open position, so that the weight of oil or water in tube 11 and the weight of pump rod 12 will pull the cylinder 21 downwardly, such weight producing a force tending to move pump rod 12 in one direction. The valve V is automatically shifted between open and closed positions as the piston 21 reaches the end of its downward and upward strokes, respectively, in a manner hereinafter described.

In accordance with this invention, cylinder 20 is fixedly attached at its lower end to a base plate 22, as by being threaded on and then welded to an upper boss 23 thereof, while a lower boss 24, concentric with upper boss 23, is removably attached, as by threads, in the top opening of the T 10. As will be evident, cylinder 20 is thereby axially aligned with the pump tube 11 and pump rod 12, while cylinder 20 and plate 22 are attachable to and removable from T 10 as a unit.

A threaded aperture 25, axially aligned with cylinder 20, extends through base plate 22 and the opposing bosses, for attachment of an axially centered guide tube 26 for a piston rod 27, which reciprocate in guide tube 26. The lower threaded end 28 of piston rod 27 is attached to pump rod 12 in coupling 14, while rod 27 extends upwardly into the cylinder 20 for connection with piston 21, as hereinafter described, thereby operatively connecting piston 21 with the pump rod 12. Suitable O-ring gaskets 29 may be mounted within internal circumferential grooves on the inside of the upper end 30 of guide tube 26 to prevent leakage from the cylinder through the tube 26 and past the rod 27, while the exterior of the upper end 30 of guide tube 26 may be hexagonal to permit a wrench to be applied thereto. Such a wrench may be similar to the socket wrenches utilized in turning on and off water valves and the like, which are disposed deep within an access pipe, thus preferably having a long shank so as to be insertable through the open upper end of the cylinder and provided at its lower end with a hexagonal socket adapted to fit over the inner end of the guide tube and at its upper end with a handle extending cross-wise to the shank. Due to the fact that the threaded connection between the guide tube 26 and the base plate 22 is subjected to full pressure of fluid within the cylinder 20, such as between 500 and 1,000 pounds per square inch, a tight joint between guide tube 26 and the threaded aperture 25 is preferably obtained so that a heavy pull is exerted in finally tightening the guide tube, a similarly heavy pull thus being required when the guide tube is removed. A suitable sealing compound also may be applied to the lower end of the guide tube 26 and the threaded aperture 25, so as to provide a more effective seal.

The piston 21 preferably has a sliding fit with the cylinder 20 and is preferably formed with a depending skirt 31, which provides sufficient body length to increase stability and also to assist in control of the operation of valve V, as hereinafter described, the upper position of the piston 21 being shown in full lines and the lower position being shown in broken lines. The rod 27 extends within the pocket below the piston formed by the skirt 31 and through an axial hole 32 in the body of the piston, being firmly seated against the piston at a shoulder 33, which cooperates with a nut 34 engaging the upper end 35 of the rod 27. The connection between rod 27 and piston may also be rendered leak-proof by a gasket type washer 36, or in any other suitable manner. The piston 20 is also provided with two or more series of circumferential grooves, as adjacent each end, in which sealing rings 37 are installed. Piston 20 is further provided with a circumferential groove 38 near the top for the passage of fluid for control of the operation of valve V, as hereinafter described.

A coupling 39 for a counterweight cable C may also be connected to the threaded upper end 35 of rod 27, whenever it is desirable to offset some of the weight of the pump rod and liquid in the well. Such a cable C may be connected to a counterweight in the manner disclosed in my copending application Serial No. 388,400, and therefore need not be described in detail here. It is to be noted that the weight of the pump rod and liquid will vary from well to well and that for relatively shallow wells counterbalancing may be unnecessary and coupling 39 and cable C may therefore be omitted.

The hydraulic fluid is supplied at a suitable pressure,

such as 500 to 1000 pounds per square inch, through a pressure line 41 to the bottom of the cylinder 20, the pump 40 being shown wholly and line 41 being shown partially diagrammatically in dot-dash lines in Fig. 1. Line 41 is connected to an inlet 42 of cylinder 20 by conventional fittings 43. From the cylinder 20, on the down stroke, the fluid flows through control valve V and thence through a return line 44 to a fluid reservoir 45, which is interconnected with the intake of the pump 40 to complete the circuit, the line 44 and reservoir 45 also being shown diagrammatically in dot-dash lines in Fig. 1. The operation of the unit is thus regulated by the control valve V, since when the valve is closed, fluid is pumped into the cylinder to raise the piston and lift the pump rod 12, while when the valve V is open, fluid flows from the cylinder and through the return line 44, with the weight of the pump rod and fluid pulling the piston downwardly.

The control valve V is a pressure-actuated spool valve having a cylindrical body 48 closed at its lower end 49 and its upper end 50, either of which may be integral with the body and either or both of which may be removable, such as the lower end cap 49 which may be removably attached to the body 48 by threads as shown, or by cap screws or in any other suitable manner. Valve body 48 may be mounted in an upright position in an aperture 51 in the base plate 22 alongside the cylinder 20, or valve V may be supported in any other suitable manner, as by tubes 52 which extend between outlets 53 at the lower end of cylinder 20 and inlets 54 of valve body 50, by which valve V communicates with the cylinder 20. Tubes 52 may be threaded into suitable bosses on the face of the cylinder and attached to diametrically opposed bosses on the face of the body 50 by conventional fittings 55, the aforesaid position of valve inlets 54 providing a balanced pressure on a piston or spool 56 within the body 48. An exhaust passage 57 from the valve V is in radial alignment with valve inlets 54, while an auxiliary or needle valve 58 having an adjusting screw 59 is preferably mounted upon the valve body and connected with passage 57, with the return line 44 being connected to the exhaust side of the auxiliary valve.

The spool 56 is adapted to move upwardly and downwardly within the body 48, the spool having suitable piston rings 60 in circumferential grooves at each end to eliminate leakage, a circumferential groove 61 and a solid exterior portion 62 below the groove. Downward movement of spool 56 causes groove 61 to register with the inlets 54 and exhaust passage 57, so that the valve V will be in "open" position, the spool 56 thus being in the position shown in Fig. 1. Upward movement of spool 56, to the closed position of valve V, shifts the solid portion 62 upwardly to cover the inlet and exhaust openings, thereby restricting flow from cylinder 20, so that substantially the full pressure of fluid supplied by pump 40 will be exerted against piston 21, to raise pump rod 12. A spring 63 is positioned within the body 48 underneath the spool to move spool 56 upwardly to a normally closed position, while a bleed line 64 from the chamber within the body 48 below the spool is preferably provided to prevent an accumulation of fluid therein from interfering with the desired movement of the spool, such line 64 being conveniently connected to the discharge side of the auxiliary valve 58.

To thrust the spool downwardly to open position automatically when piston 21 reaches the top of its stroke, a control line 65 is connected to a pressure control inlet 66 in the top 50 of the valve body, as by conventional fittings 67. Control line 65 extends upwardly to a check valve 68 which is connected to a pressure control port 69 of the cylinder 20, as by fittings 70. Pressure control port 69 is positioned at a point which will be immediately below the lower rim of the piston skirt 31 when the piston 21 reaches its upper limit of movement, as shown in full in Fig. 1, to permit a flow of pressurized fluid from within the cylinder 20 through line 65 to enter

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the top of the valve body 48 and depress the spool 56 against the pressure of spring 63. This produces a positive movement of spool 56 downwardly to the position of Fig. 1, thereby releasing the pressure within the cylinder 20, so that piston 21 will start its descent. Whenever a quick release of pressure in cylinder 20 tends to reduce the pressure in line 65 and above spool 56 so that spring 63 might move spool 56 upwardly, before the skirt 31 can cover port 69 as piston 21 starts down, check valve 68 will close to prevent a return flow from the valve body 48 to the cylinder 20, thereby trapping fluid under pressure which holds the spool 56 in the depressed position, i. e., the open position of valve V, throughout the downward stroke of the piston.

For release of the fluid pressure above spool 56 of valve V, when piston 21 reaches the lower end of its downward stroke, an exhaust control tube 71, which may be considered as a continuation of the line 65, extends from the check valve 68 to an exhaust control port 72 in cylinder 20 above the pressure control port 69, tube 71 being connected thereto in a suitable manner, as by fittings 73. Diametrically opposite port 72 is located another exhaust control port 74, to which a bleed line 75 may be connected, as by fittings 76, the bleed line 75 returning to the reservoir 45. The position of the ports 72 and 74 is such as to register with the groove 38 on piston 21, when the piston reaches the downward limit of its movement, as shown in broken lines in Fig. 1. In such position, the line 65, tube 71, port 72, groove 38, port 74 and bleed line 75 form a direct communication from the chamber in the top of valve body 48 to the reservoir 45, thereby releasing the pressure of fluid in the valve body above spool 56 and permitting the spool to be moved upwardly by spring 63, to move the valve V to closed position and permit the upward stroke of the piston to commence.

To recapitulate briefly, the operation of the pump jack of this invention is based upon the continuous operation of the pump 40 to supply pressurized fluid to the cylinder 20. With the spool 56 in the upper or valve closed position, moved thereto by spring 63, the pressure of fluid in the cylinder raises the piston 21. At the top of the piston stroke, fluid from cylinder 20 moves through port 69, past check valve 68, through line 65 and into the top of the body 48 of the valve V, depressing the spool 56. This moves the spool 56 downwardly to open the valve and release the pressure with all fluid movement from the cylinder then being through return line 44, while the fluid trapped in the top of valve V holds it in open position until the piston reaches the bottom of the stroke, whereupon the groove 38 registers with ports 72 and 74 to connect line 65 and tube 71 with the bleed line 75, thereby releasing the pressure in the top of valve V to permit the spool to be raised again by spring 63 to close the valve V. As will be evident, repetition of these operations will proceed automatically. If the rate of upward movement of piston 21 is to be changed, a higher pressure produced by pump 40 will increase such rate, while a lower pressure will reduce it. Thus, pump 40 preferably has an adjustable outlet pressure, which may be accomplished by utilizing a variable pressure pump or by driving the pump by an adjustable speed motor or gas or oil engine. Also, if the rate of downward movement of piston 21 is to be changed, auxiliary valve 58 may be opened to increase the rate, or closed to decrease it. Thus, the number of strokes per unit of time is readily adjusted. If desired, the valve V may be incorporated within the piston 21, but without affecting control by the piston and particularly the movement thereof, of the opening and closing of the valve V.

The pump jack of this invention is readily assembled and disassembled, both initially and at the well. It is to be noted that the plate 22 is removably attached to the upper end of the T 10, while the cylinder 20 is preferably permanently attached to the plate 22, as by weld-

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ing. Also, the piston 21 is slidable through the open upper end of the cylinder 20. For assembling the pump jack at the well, the pump rod 12 may be supported in the manner described previously, i. e., by a fork or tongs, and if the piston rod 27 is not attached to the piston, the piston rod may be attached to the coupling 14 of the pump rod 12. Then, the cylinder 20 may be slipped over the piston rod 27 with the guide tube 26 sliding down the piston rod 27. Then, the plate 22 may be engaged by a suitable wrench or the like to screw the threads on the lower boss 24 into the threads at the upper end of the T 10. This threaded connection is, of course, subjected only to the pressure of fluid being pumped up from the well, so that the pressure thereagainst is not very great and a gasket or other sealing device is therefore normally unnecessary. After the cylinder and piston rod have been thus placed in position, the piston 21 may be slipped into the upper end of the cylinder until the shoulder 33 of piston rod 27 is engaged, gasket 36 conveniently being placed on the shoulder before the piston is slipped into the cylinder. Then, the nut 34 may be tightened to attach the piston rod 27 securely to the piston 21. Or, the cylinder may be attached to the T 10 and the piston 21 and the piston rod 27, if previously attached together as a unit, slipped into the piston. The skirt 31 of the piston will hold the piston rod concentric to the cylinder 20 so that the lower end of the piston rod will readily slide into the guide tube 26. As soon as the lower end of the piston rod contacts the coupling 14, a wrench having a suitable extension may be inserted within the upper end of the piston to engage nut 34, to turn the piston 21 and rod 27 as a unit and thereby screw the lower end 28 of piston rod 27 into coupling 14. Similarly, when disassembling the pump jack, as for repair, inspection or the like, the wrench may be placed on the nut 34 to unscrew the piston 21 and rod 27 as a unit, which may be lifted with the cylinder, after plate 22 is unscrewed, although if the repairs are to be made only to the piston 21, such as the replacement of one or more of the piston rings 37, the cylinder 20 may be left in place. However, if the O-rings 29 require replacement, the cylinder 20 may be removed by unscrewing the plate 22 from the T 10, after which the guide tube 26 may be removed and the sealing rings repaired or replaced. As will be evident, the valve V may remain attached to the cylinder 20 when the plate 22 is screwed into or out of the T 10, since the pipe 13 will have been removed to permit the fork or tongs to support the pump rod 12 and the valve V will clear the fork or tongs during rotation of the cylinder 20. Thus, the only connections necessary to take apart, when disconnecting the cylinder from the pump rod assembly, are merely the pressure supply line 41, the return line 44 and the bleed return line 75, which may readily be disconnected by detaching the fittings by which the first two are connected to the cylinder 20 and detaching a union which is preferably installed in line 44 adjacent valve 58. In the event that a number of pump jacks are in operation, it may be desirable, whenever one of them needs attention, merely to substitute another pump jack for the one to be inspected or repaired. Due to the fact that the lines 41, 44 and 75 are readily disconnected and the entire pump jack then may be removed merely by unscrewing piston rod 27 and plate 22, such an exchange operation may be done in a matter of only a few minutes, thereby preventing the well from being shut down for any period of time.

From the foregoing, it will be evident that a pump jack constructed in accordance with this invention fulfills to a marked degree the requirements and objects hereinbefore set forth. As will be evident, such a pump jack is hydraulically operated and is adapted to be utilized for reciprocating a pump rod in an oil or water well. Since the usual rate of reciprocation of pump rods is normally relatively slow, a hydraulic pump requiring only a relatively small horse power motor or engine to

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drive the same may be utilized to actuate the pump jack. Due to the positive movement of the control valve by the springs in one direction and by full hydraulic pressure in the opposite direction, and further due to the locking of pressure in the valve in the open position, the action of the pump jack is effective and certain. As described previously, the number of strokes per unit of time is readily adjusted. Due to the fact that when the cylinder and piston rod are accurately centered with respect to the pump rod, the lateral stresses on the hydraulic piston and cylinder are minimized. By using comparatively high hydraulic pressures, such as up to 1,000 pounds per square inch, a large upwardly directed force can be produced without requiring extremely heavy operating parts. As will be evident, the pump jack may be readily be disassembled for repair or inspection. Also, all of the parts may be readily handled by one workman, in the manner described. Due to more certain and effective operation and also due to the fact that the hydraulic fluid may act also to lubricate the moving parts, the pump jack of this invention tends to require a minimum of attention and upkeep. As will also be evident, the pump jack may be made from readily procurable parts at a reasonable cost.

Although a specific embodiment of this invention has been described and illustrated, it will be understood that other embodiments may exist and that various changes may be made, without departing from the spirit and scope of this invention.

What is claimed is:

1. Apparatus for producing upward and downward reciprocatory movement of a pump rod in an oil well and the like, said pump rod being subject to a force tending to move said pump rod in one direction, comprising a cylinder mounted in substantial alignment with the pump rod; a reciprocable piston within said cylinder; a piston rod connected to said piston; means connecting said piston rod with said pump rod; means for continuously supplying fluid under pressure to the interior of said cylinder between said piston and one end of said cylinder; means including a valve for controlling the flow of fluid from said cylinder; and at least partly hydraulic means operable in response to the movement of said piston for controlling said valve and constructed and arranged to close said valve when said piston nears said cylinder end and thereby permit fluid flowing into said cylinder to move the piston away from said end and move said pump rod in a direction opposite to said force, and to open said valve when the piston moves a selected distance within the cylinder to permit such force on said pump rod to move the piston back to the initial position near said end of said cylinder.

2. Apparatus as defined in claim 1, wherein said valve control means includes a port in the wall of said cylinder and cooperating with said piston.

3. Apparatus as defined in claim 1, wherein said valve includes a cylindrical body and a spool movable axially therein, intake and discharge ports in radial alignment in said body, a circumferential groove in said spool movable into alignment with said ports at one position of the spool and an exteriorly solid portion spaced from said groove and adapted to close said ports at another position of said spool.

4. Apparatus as defined in claim 3, wherein said control means includes a compression spring within said valve body at one end of said spool for normally shifting said spool to a position closing said ports; and a fluid line to said body at the other end of said spool and connected with a port in said cylinder at a point remote from said closed end, said port being closed by said piston until said piston has moved to the end of its stroke in a direction away from said one end.

5. Apparatus as defined in claim 4, including a check valve in said fluid line adapted to prevent a return flow

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from said valve body as the fluid pressure drops within said cylinder responsive to the opening of said valve.

6. Apparatus as defined in claim 4, wherein said cylinder is provided with spaced ports; said fluid line is connected also to one of said ports; an exhaust line is connected to another of said ports; and said piston is provided with a groove connecting said ports when said piston reaches the end of its stroke adjacent said one end.

7. Apparatus for producing upward and downward reciprocatory movement of a pump rod in an oil well and the like, said pump rod being subject to a force tending to move said pump rod in one direction and said pump rod being movable vertically in a tube having a terminal T at the top thereof, comprising a base plate removably mounted upon said T; a cylinder upstanding from and attached to said base plate in substantial axial alignment with said pump rod and having an inlet at the bottom and an outlet; a guide tube upstanding from said base plate within said cylinder and having a passageway there-through; a piston within said cylinder; a piston rod extending through said guide tube and connecting said piston and said pump rod, said guide tube having sealing means for said piston rod; means for continuously supplying fluid to said cylinder inlet at the bottom thereof; a valve for controlling flow of fluid from said cylinder outlet; and means for opening and closing said valve in response to the position of said piston in said cylinder.

8. Apparatus as defined in claim 7, wherein said base plate is threadedly attached to said T and said cylinder is welded to said base plate.

9. Apparatus for producing upward and downward reciprocatory movement of a pump rod in an oil well and the like, said pump rod being subject to a force tending to move said pump rod in one direction, comprising a cylinder mounted in substantial alignment with the pump rod and having the end adjacent to said pump rod closed except for a central passage therethrough; a reciprocable piston within said cylinder; a piston rod slidably extending through said passage and connecting said piston with said pump rod; means for continuously supplying fluid under pressure to the interior of said cylinder between said piston and said closed end; means including a valve movable to different positions for controlling the flow of fluid from said cylinder; and means operable in response to the movement of said piston for controlling said valve, and constructed and arranged to close said valve when said piston nears said cylinder closed end and thereby permit fluid flowing into said cylinder to move the piston away from said end and move said pump rod in a direction opposite to said force and to open said valve when the piston moves a selected distance within the cylinder to permit such force on said pump rod to move the piston back to the initial position near the closed end of said cylinder, said means including a port in said cylinder for supplying fluid pressure to said valve for moving said valve to one position and hydraulic means cooperating with said piston for releasing such pressure so that said valve can move to the opposite position.

10. Apparatus as defined in claim 9, wherein said hydraulic means cooperating with said piston includes spaced ports in said cylinder in circumferential alignment and a circumferential groove in said cylinder disposed to connect said spaced ports when said piston moves to a predetermined position.

11. Apparatus as defined in claim 9, wherein said valve control means includes a port in the wall of said cylinder which is uncovered by said piston for supplying fluid pressure to said valve for moving said valve to said one position.

12. Apparatus for producing upward and downward reciprocatory movement of a pump rod in an oil well and the like, said pump rod being subject to a force tending to move said pump rod in one direction, comprising a cylinder mounted in substantial alignment with the pump rod and having at one end thereof an inlet and an outlet

spaced from said inlet; a reciprocable piston within said cylinder; a piston rod connected to said piston; means connecting said piston rod with said pump rod; means for continuously supplying fluid under pressure to the interior of said cylinder at said inlet and between said piston and said one end of said cylinder; means including a valve for controlling the flow of fluid from said cylinder outlet; and at least partly hydraulic means operable in response to the movement of said piston for controlling said valve and constructed and arranged to close said valve when said piston nears said cylinder end and thereby permit fluid flowing into said cylinder to move the piston away from said end and move said pump rod in a direction opposite to said force, and to open said valve when the piston moves a selected distance within

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the cylinder to permit such force on said pump rod to move the piston back to the initial position near said end of said cylinder.

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