

Dec. 28, 1965

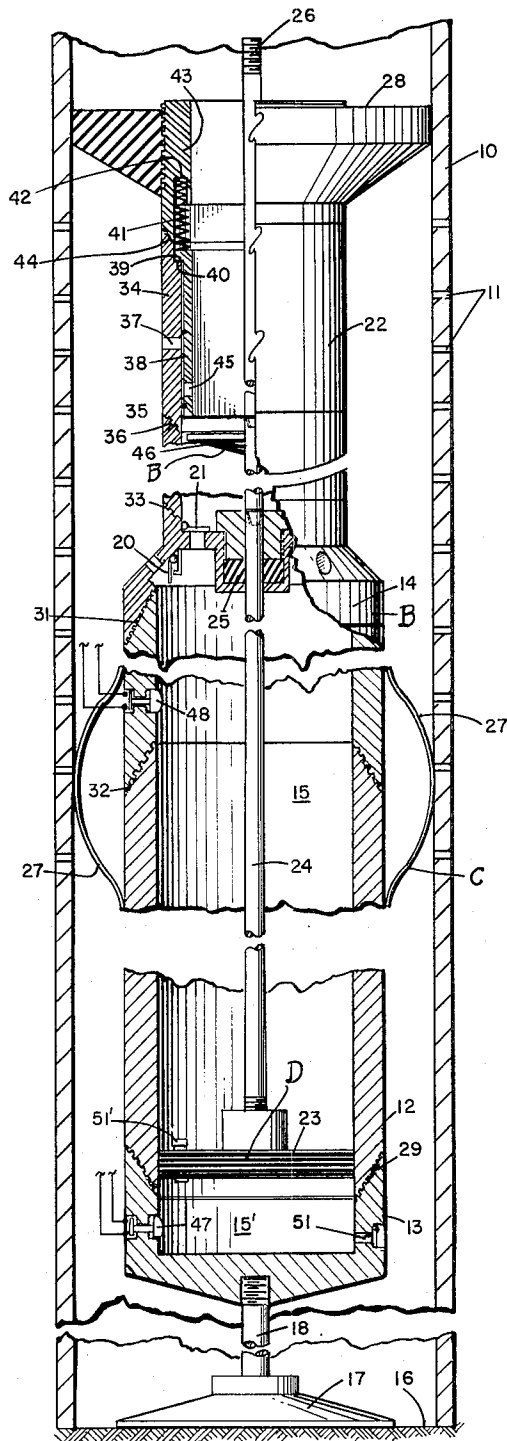
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3,225,697

LIQUID PUMP FOR DEEP WELLS

Filed March 1, 1962

3 Sheets-Sheet 1



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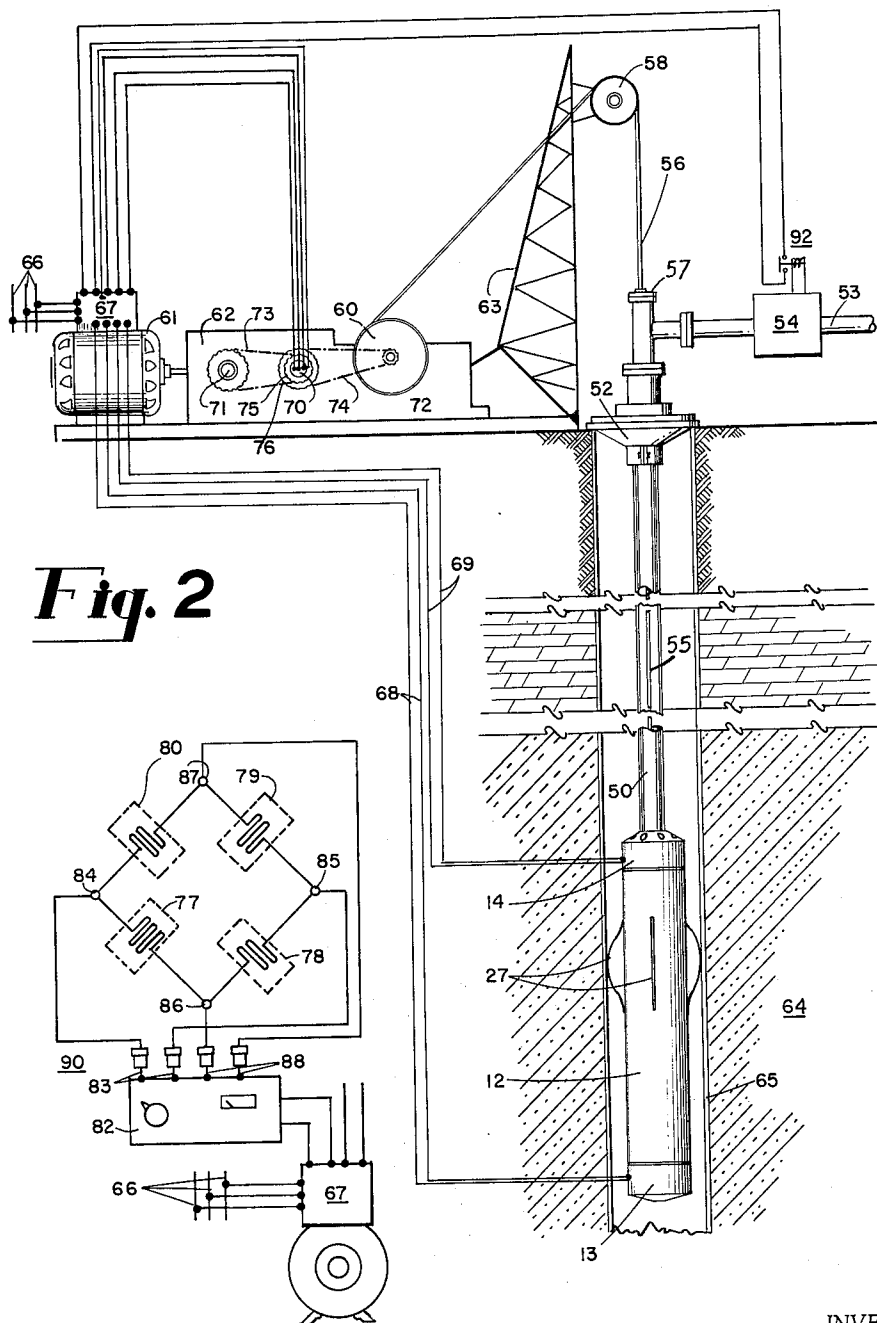


Fig. 3

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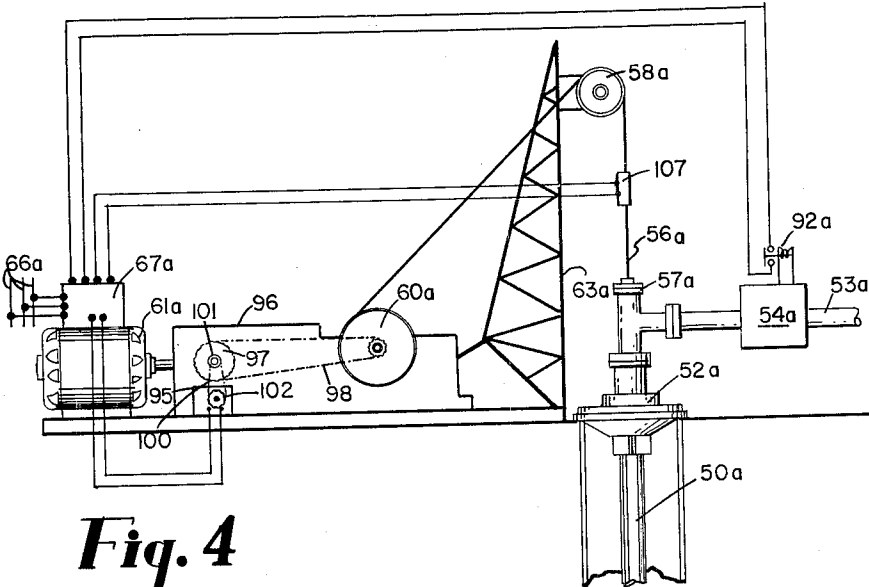


Fig. 4

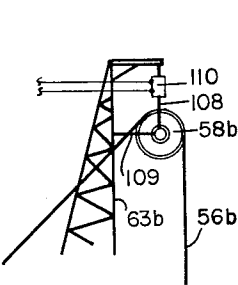


Fig. 6

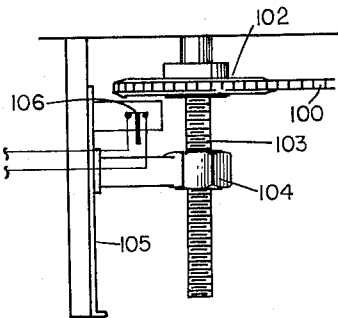


Fig. 5

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LIQUID PUMP FOR DEEP WELLS

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12 Claims. (Cl. 103-25)

This invention relates to liquid pumps and particularly to an improved pump for facilitating the production of liquid petroleum or other liquids from deep wells.

The formation pressures and liquid flow rates in many oil wells are such that the oil may be produced only by pumping. Even in relatively shallow wells difficulties are encountered in the continuous production of oil. Furthermore, when production rates are low the pumping operation becomes correspondingly uneconomical; the motors driving conventional pumps are required to lift the weight of the iron sucker rod which actuates the pump on a low production short cycling and overloading of the motors may result.

Another troublesome difficulty is encountered in conventional pump operation when gas is present with the oil and accumulates in the pump cylinder sufficiently to cause gas locking. "Gas locking" is the result of gas in the cylinder at sufficient pressure to prevent the spring pressed intake valves from opening; the piston thus operates with a volume of gas in the cylinder which remains there and prevents the further intake of fluids thereby rendering the pump ineffective.

Further difficulties are encountered which arise from the pressure of gas in the formation which is released upon the reduction of pressure resulting from operation of the pump; this gas release produces cooling of the formation liquids and paraffin, asphalt and other solids may be formed. Such solids tend to seal or plug the formation and greatly reduce the flow of fluids there-through.

It is an object of the present invention to provide an improved liquid pump for oil wells and the like and which may be operated substantially at reservoir formation pressure.

It is another object of this invention to provide a liquid pump for deep well operation and the like including an improved arrangement for facilitating the production of liquid for low production wells.

It is another object of this invention to provide an improved liquid pump for oil wells and the like which is not subject to gas locking during production of oil from gas bearing formations.

It is another object of this invention to provide a liquid pump for oil wells and the like including an improved control system for effecting reliable and economical operation thereof.

It is a further object of this invention to provide an improved liquid pump of simple and rugged construction for facilitating the production of liquids from deep wells.

It is a still further object of this invention to provide an improved liquid pump for effecting economical production of oil from low production wells.

It is still another object of this invention to provide an improved liquid pump for oil wells and the like which may be easily installed in a well casing and does not necessitate the use of a separate production tube.

It is an additional object of this invention to provide a liquid pump for deep wells and the like including an improved and simple arrangement for changing the capacity of the pump per stroke of the piston.

Briefly, in carrying out the objects of this invention in one embodiment thereof, an elongated pump body of a size readily introduced into a well or well casing is arranged to be positioned in a well and held adjacent the formation to be produced. An elongated cylinder is

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provided in the body and a piston is mounted for free movement in the cylinder, a piston rod extending up through the body for operation of the piston. The intake and discharge valves are arranged in the body near the top of the cylinder; the intake valves are of a normally open type.

When the piston is in an upper position in the cylinder and the piston rod is released, the piston descends and formation fluids enter the cylinder through the open intake valves. When a predetermined weight of liquid has been accumulated the pump control starts the motor at the well head and lifts the piston to discharge the liquid from the cylinder. The pump may be operated by a flexible line, because the piston does not require power on its downstroke. The control system includes sensing devices responsive to the weight of accumulated liquid in the cylinder, a flow responsive device, and may also include arrangements for predetermining the length of stroke of the piston, as well as limit controls for preventing excessive movement thereof. Other embodiments include arrangements employing production tubes, arrangements for sealing off a portion of the well casing and producing the liquid through the casing, and arrangements for effecting ready release and removal of the pump from the well.

The features of novelty which characterize the invention are pointed out with particularity in the appended claims; the invention itself, however, both as to its organization and manner of operation, together with further objects and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a somewhat diagrammatic elevation view, partly in section and partly broken away, of a pump embodying the invention;

FIG. 2 is a diagrammatic elevation view of a pumping equipment installed in a well and illustrating the control system embodying the invention and employed with a pump of essentially the same construction as that of FIG. 1;

FIG. 3 illustrates diagrammatically a strain gauge torque responsive control suitable for use in the system of FIG. 2;

FIG. 4 is a view similar to that of FIG. 2, with the downhole portions not shown, illustrating another embodiment of the power apparatus and control system;

FIG. 5 is an enlarged plan view of a portion of the system of FIG. 4; and

FIG. 6 is a view of a portion of a rig similar to those shown in FIGS. 2 and 4 illustrating a further embodiment of the control system.

Referring now to the drawings, FIG. 1 illustrates the pump of this invention positioned at the bottom of a well within a casing 10 having a multiplicity of perforations 11 for communication with the producing portion of the reservoir formation. The pump comprises a cylindrical main body portion 12 having a bottom closure cap 13 and a top cap or header 14 providing a closed pump chamber indicated generally at 15. The pump rests on the bottom of the well indicated at 16 on a foot 17 connected to the bottom cap 13 by a rod 18, the length of which is adjusted to position the pump at the required elevation from the bottom 16.

The head 14 is provided with a plurality of normally open inlet valves 20 and a plurality of normally closed discharge valves 21. A cylindrical riser 22 of reduced diameter as compared with the cylinder 12 extends upwardly from the head 14 and encompasses the discharge valves 21. A reciprocable piston 23 is provided in the cylinder 15 and is connected to a suitable lifting mechanism by a piston rod 24 which passes through a packing 25 in the head 14 and extends upwardly above the riser

22 and terminates in a threaded end 26 or other suitable connecting element.

The pump cylinder or body 12 is centered in the wall casing 11 by a plurality of flexible stabilizers 27 and the extension 22 is provided with a swab cup 28 of flexible rubber-like material which centers the extension 22 in the casing 10 and seals the extension to the casing to separate the area above the swab cup from the area below which surrounds the pump and to which fluids are admitted from the formation through the holes 11. The head 13 is connected to the lower end of the cylindrical pump casing 12 by threads as indicated at 29 and the head 14 is similarly connected to the upper end of the cylindrical casing by threads 31. The pump body 12 is constructed in two portions as indicated, these portions being separated by threads 32 so that the lower portion between the threads 29 and 32 may readily be replaced by other portions of varying lengths so that the stroke capacity of the pump may easily be changed by insertion of different lengths of casing.

In a similar manner the extension 22 is connected to the head 14 by a threaded connection 33 and is made in two portions, an upper portion 34 and a central portion 35 connected by threaded connection 36. The upper portion 34 of extension 22 is provided with a plurality of ports 37 providing communication between the inner and outer walls of the portion 34 and which are closed by a slide valve or sleeve 38 having an annular shoulder 39 engaging a shoulder 40 formed on the inner circumference of the upper portion 34. The sleeve 38 is biased downwardly by a plurality of compression springs one of which is indicated at 41 and which are positioned between the upper end of the sleeve and a groove or seat 42 formed in an enlarged top portion of the extension 22; this top portion is indicated at 43 and is threadedly connected to the portion 34 as indicated at 44. The sleeve valve 38 is provided with ports 45 which are arranged to register with the ports 37 when the sleeve is moved upwardly. This provides an arrangement for equalizing the pressure above and below the swab cup 28 so that after equalization of pressures the entire assembly may readily be lifted from its position within the casing.

In order to actuate the sleeve valve and move the ports 45 into registry with the ports 37, a multiple radial arm assembly or spider 46 is rigidly secured to the piston rod 26 within the extension 22. The arms of the assembly are spaced to provide ample free area for the passage of fluids through the extension. The spider is positioned so that, when the piston is moved upwardly to an extreme position, the spider will engage the sleeve 38 and will lift the sleeve against the weight of the pump assembly until the sleeve moves upwardly and the shoulder 40 engages the bottom inner edge of the top portion 43 which acts as a stop. Thereupon further movement of the sleeve is prevented and the entire assembly is lifted from the position in the well, the swab cup being released so that it slides readily upon equalization of the pressure through the ports thus opened in registry.

The pump is controlled and operated so that power is applied solely on the upstroke. When the piston rod 26 is released and allowed to descend by its own weight, fluids pour into the cylinder 15 through the normally open intake valves 20 and the piston moves downwardly to its lowermost normal position. In order to limit the extreme movements of the piston the pump as shown in FIG. 1 has been provided with a lower limit switch 47 and an upper limit switch 48, which switches are engaged and actuated by the piston 23 in its lowermost and uppermost positions, respectively, to prevent further movement toward the ends of the cylinder. When the lower limit switch 47 is closed the power control apparatus (not shown) is actuated to stop the downward movement of the lifting mechanism. When the piston reaches its extreme upper position as determined by the position of the limit switch 48, this switch is closed and the control ap-

paratus is actuated to release the piston and allow it again to descend in the chamber 15.

The portion of the cylinder below the piston 23 and indicated at 15' normally contains gas, and possible other fluids due to leakage past the piston, and this gas is rarefied when the piston rises thereby producing a low pressure in the portion of the cylinder below the piston. This low pressure facilitates the quick return of the piston when the mechanism is released to allow it to descend. In order to prevent the undue accumulation of fluids and particularly liquids below the piston, a check valve 51 is provided in the bottom cap 13 through which liquids accumulating in the chamber 15' below the piston will be released when the piston reaches its lower position provided they are in excess quantity. In addition a valve 51' is provided to release liquid at excess pressure from the top chamber 15 at the top of the piston to the chamber 15' below the piston, this being a safety provision for abnormal conditions of operation.

During normal operation of the pump illustrated in FIG. 1, a control system is provided which actuates the piston so that it moves between positions intermediate the limit switches 47 and 48, these switches being provided solely to actuate the control in the event of excessive movement of the piston 23. The control system employed with the pump is arranged to actuate the power equipment to raise the piston 23 and discharge liquid from the pump when a predetermined quantity of liquid has accumulated above the piston within the chamber 15. By this control the pump is operated only when the predetermined quantity of liquid has accumulated and thus power is employed only when the pump has accumulated an effective quantity of liquid, and economy in operation is secured. A pump of this type may thus be employed in low production wells and may, for example, complete only one stroke in a period of one day or more. In other applications it may, of course, be operated at greater frequency, the frequency of operation depending solely on the rate at which liquid is available. The control and the manner in which it operates are described below.

The pump as constructed in FIG. 1 will, of course, receive any gas present in the formation at the intake valves 20. This gas which flows into the pump is discharged ahead of the liquid on the rise of the piston and there can be no gas locking of the pump. In the event of excessive pressure within the formation, gas will move directly through the intake and discharge valves. And whenever liquid accumulates in the casing 10 about the pump and above the intake valve 20, the liquid will flow into the chamber 15 to the exclusion of gas which may rise and accumulate within the zone of the casing 10 above the intake valve and below the swab cup 28.

A control system embodying the invention and suitable for the operation of the pump of FIG. 1 is illustrated in FIGS. 2 and 3. In this application the pump of FIG. 1 is employed with the supporting pedestal 17 and rod 18 removed and with the upper extension 22 replaced by a string of conventional production tubing 50. In this system the pump is introduced in the well and is removed therefrom on the string 50 in the conventional manner. During operation of the pump the entire assembly is supported on a well head fitting 52 through which the produced fluids are conducted to a production line 53 through a flowmeter 54.

The pump piston 23 is connected through its rod 24 and its upper connection element 26 to a suitable line or sucker rod 55 which is provided with an upper section 56 which acts as a polish rod and passes through a suitable liquid seal 57 at the top of the well head assembly 52. The length of the polish rod section of the sucker rod or line is sufficient to allow for the full stroke of the pump piston. The flexible sucker rod or line passes over a pulley 58 and is reeled onto a drum 60 by operation of a motor 61 through a transmission assembly indicated

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generally at 62 and which is located at the well head adjacent the derrick or rig assembly 63 on which the pulley 58 is mounted. In this arrangement the pump casing is located on the tubing 50 adjacent a selected production zone of the formation, indicated generally at 64, and is centered in the well casing indicated at 65 by the stabilizers 27. Further centering devices may be provided if desired; however, the swab cup assembly of FIG. 1 is not employed in this application.

Because the power stroke of the piston is effected only on the upward movement thereof, and the piston assembly returns to its lower position by its own weight assisted somewhat by the vacuum or low pressure existing in the chamber 15' below the piston, it is not necessary to employ a rigid sucker rod for driving the piston and flexible rods or lines may be employed. By way of example, the pump may be operated by a nylon rope. In other applications where greater loads are required to be carried by the line, a steel wire coated with nylon or other protective plastic may be employed.

The motor 61 is arranged to be connected to a suitable source of three-phase power indicated at 66 through operation of a control indicated generally at 67 which includes the starting, stopping and reversing functions of the control system of the motor. The limit switches 47 and 48 are connected to the control 67 through suitable electrical leads indicated at 68 and 69, respectively.

In the operation of this system, when a predetermined quantity of liquid has not been accumulated and the piston has descended to its bottom position, the motor is stopped by operation of the limit switch 47. The motor then remains in its inactive condition until liquid has accumulated in the chamber 15 to a quantity sufficient to produce a predetermined tension in the line 56. This tension in the line produces torque in a shaft 70 in the transmission 62, the shaft 70 being an intermediate shaft between a drive shaft 71 and a shaft 72 of the drum 60. Connections to the shaft 70 are made by a sprocket and chain 73 between the shafts 70 and 71 and a sprocket and chain assembly 74 between the shafts 70 and 72. The chains 73 and 74 engage sprockets 75 and 76 which are mounted in spaced relationship and rigidly to the shaft 70 thereby providing a portion of the shaft between the sprockets, so that torque is produced between the sprockets and tends to twist this portion of the shaft 70.

The torque produced in the portion of the shaft between the sprockets 75 and 76 is sensed by a suitable strain gauge control system, one form of which is diagrammatically illustrated in FIG. 3. In this control arrangement four strain gauge elements 77, 78, 79 and 80 are connected in a bridge to which an input voltage is supplied from a control assembly indicated generally at 82 through leads 83 connected to opposite terminals of the bridge 84 and 85. The opposite pair of terminals of the bridge indicated at 86 and 87 are connected by output leads 88 to the control assembly 82. The leads 83 and 88 are connected to the shaft through a suitable slip ring assembly indicated generally at 90 so that the circuits to the rotating parts may be maintained continuously during operation of the system.

The strain gauges 77, 78, 79, and 80 are preferably of the bonded type which are suitably cemented or otherwise secured to the shaft portion in positions such that, when they are connected in the bridge circuit, any bending or distortion of the gauges due to thrust strains or bending of the shaft will cancel out while the effects of torque in the shaft will be additive and will produce an unbalance of the bridge. This unbalance is proportional to the torsional strain and is employed by the torque control unit 82 to effect control of the motor control assembly 67 to initiate operation of the motor and raise the piston 23 when a predetermined torque exists as measured by the torque sensing elements. The amount of torque to which the control is effective for

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starting operation of the motor in this manner is selected so that it represents a predetermined load of liquid on the piston 23. This load is selected so that when the cylinder 15 is substantially full the piston will be operated to discharge the accumulated liquid through the discharge valves 21.

The amount of liquid discharged from the pump is measured by the flowmeter 54 and, when a predetermined amount of liquid has been discharged which is equal to the volume of the cylinder between the normal working positions of the piston, the flowmeter 54 operates to close a relay 92. This closes a circuit in the control assembly 67 of the motor 61 to stop the motor and reverse it to allow the piston to return to its lower position again. In the event the piston 23 should overstroke on its upward movement, the limit switch 48 will effect the stopping of the motor and its reversal.

It will now be apparent that during the operation of the pump the piston may be allowed to remain in its low position for long periods of time pending the accumulation of sufficient liquid to produce the required torque in the control 82 as sensed by the strain gauges 77, 78, 79 and 80 and that, therefore, the motor 61 is required to operate only when sufficient liquid has accumulated in the pump chamber 15 to warrant operation of the pump. The result of this control system is thus an economical use of electric power, short cycling of the pump being avoided and production being effected at whatever rate the well is producing.

It will readily be understood that the control system of FIGS. 2 and 3 may be employed with the pump regardless of the manner in which the pump is connected to deliver the produced liquids to the well head. Thus the control system applies equally to the pump as shown in FIG. 2 and when employed to produce directly through the casing as illustrated in FIG. 1. In both of the applications the pumps are actuated through tension lines or cables which are relatively light as compared with the heavy sucker rods employed with conventional pumps. This light assembly avoids the necessity of employing amounts of power such as are required for moving heavy sucker rod assemblies.

Furthermore, since the pump assembly of the invention may be provided with a long pump cylinder or barrel, the usual short stroking of the conventional pump is avoided. The barrel of a pump embodying this invention may, for example, vary in length from relatively short cylinders to cylinders as much as say 300 feet in length. When some of the lighter materials such as plastics are employed for the rod or rope, the buoyancy of the material in the produced petroleum liquids renders the rod in effect relatively weightless. This is an advantage in the control and facilitates the operation with less power consumption.

The pump of this invention is particularly well suited to the production of oil wells which are low producers or "strippers." Wells such as these are generally uneconomical and many are abandoned for this reason. With the present invention it is possible to operate these wells economically since the pump may stand idle for long periods of time and is operated only when sufficient liquid has entered the pump to warrant such operation. For example, in a well producing only half a barrel a day the pump chamber could be made capable of holding a barrel of oil and would then stroke only once every two days. It would thus run for a very short interval of time during the stroke and would remain idle again for another two-day period.

In another system of control using essentially the same system as that of FIG. 2 and a system wherein the line 56 is preferably a light line such as a nylon rope, the control can be effected by operating the strain gauge system in two stages. In the first stage when the motor is reversed to return the piston to its lowermost position the strain gauge is calibrated so that, when the load com-

prising the piston, piston rod and line is lost upon bottoming of the piston in the cylinder, the torque strain gauge control operates the motor to return the piston a short distance from the bottom and there stops it; the piston then remains in this stopped position until the predetermined liquid load has been reached as in the previously described modification; thereupon the operation of the system to pump the liquid is the same as that heretofore described.

The system illustrated in FIG. 4 is generally similar to that illustrated in FIG. 2 and corresponding parts have been designated by the same numerals with the suffix letter "a." The system of FIG. 4 is similar to that of FIG. 2 in that the return stroke of the piston is initiated on the outflow of a predetermined quantity of liquid as measured by a flowmeter 54a which closes a switch 92a to energize a circuit in the control of the system 67a and reverse the motor so that the piston moves downwardly. The length of the downstroke in this embodiment is determined by providing a measuring control 95 which is set to effectively measure a predetermined length of the tension line 56a which is reeled on and off a drum 60a. This control is illustrated in enlarged detail in FIG. 5.

The transmission system for the drum 60a is indicated generally at 96 and comprises a gear and sprocket drive from a sprocket 97 driven by the motor 61a through a chain 98 to a sprocket on the drum 60a. A second chain and sprocket drive including a chain 100 and sprockets 101 and 102 is arranged to drive the calibrating control 95. As shown in FIG. 5, the chain 100 drives the sprocket 102 which is mounted on a threaded shaft 103 having threads of very low pitch; the shaft has mounted on it a traveling nut 104 which, upon rotation of the shaft, is moved along a guide track 105. The nut 104 moves away from the sprocket 102 as the piston of the pump rises, that is, as the line 56a is wound onto the drum 60a.

The control includes a normally closed switch 106 which is mounted for movable positioning along the guide 105 and is locked in a position determined by the desired bottom position of the piston. In calibrating the apparatus the switch assembly 106 is moved to a position so that it is open when the line has been paid out to place the piston in its lowermost desired position. The opening of this switch stops the motor, which thus holds the piston in its bottom position until such time as the pumping stroke is initiated.

In the system of FIG. 4 the pumping stroke is initiated by a strain gauge indicated diagrammatically at 107 and which is connected with the control unit 67a. The strain gauge 107 is responsive to the tension load in the line 56a and, when a predetermined load has accumulated on the piston of the pump, the signal from the strain gauge 107 results in operation of the control to initiate the upward movement of the line 56a by the winding of the line onto the drum 60a. The strain gauge 107 has been indicated diagrammatically as an element in the line 56a; however, it will be understood that the leads to the strain gauge in this arrangement will be incorporated in the line 56a and carried to suitable slip rings operating from the drum 60a so that the strain gauge may be included in the control circuit.

It will now be apparent that during operation of the system illustrated in FIG. 4 the upward stroke of the piston will be initiated by operation of the control in response to the strain gauge 107 whereupon the piston will rise and discharge the liquid through the conduit 53a through the flowmeter 54a which, upon discharge of a predetermined quantity of liquid, will actuate the control 67a to stop the motor 61a and effect its return operation to again lower the piston in the pump. When the piston has reached a predetermined position as set on the measuring apparatus illustrated in FIG. 5, the switch 106 will be opened and will stop the motor 61a through operation

of the control 67a. The pump will then remain idle until sufficient liquid has again accumulated to effect operation of the motor under control of the strain gauge 107.

The full details of the control circuitry of the systems illustrated in FIGS. 2 and 4 have not been included since many forms of circuits and sensing elements may be employed to effect the operation as described and a detailed illustration and description of the particular control devices is not essential to an understanding of this invention.

A still further embodiment of the invention is illustrated in FIG. 6 which is a view of the upper portion of the derrick designated in this assembly as 63b, the general arrangement being similar to that of the other figures and the suffix letter "b" being employed to designate the same parts. The pulley 58b of this embodiment is hung from the derrick 63b on a tension rod indicated at 108 and is held out from the derrick on a rod 109. In this modification the tension in the line 56b is sensed by a strain gauge unit 110 mounted on the tension member 108. This sensing assembly, including the strain gauge 110, operates in essentially the same manner as that of the strain gauge 107 of the modification of FIG. 4. The remaining elements of the control system may be the same.

It will readily be understood from the foregoing that the system provided in accordance with this invention operating with the pump as illustrated and described provides a simple and effective arrangement for producing petroleum or other liquids from deep wells, particularly from wells wherein the production is relatively low and economical operation is desired. The control elements of the system are such that variations in the system, for example stretching of the tension line between the piston and the drum, can be compensated by adjustment of the controls and do not affect the operation of the system. The system is automatic and reliable and may be operated over long periods of time with minimum attendance.

While the invention has been illustrated in connection with specific constructions and control arrangements, various modifications and other applications will occur to those skilled in the art. Therefore, it is not desired that the invention be limited to the details illustrated and described and it is intended by the appended claims to cover all modifications which fall within the spirit and scope of the invention.

I claim:

1. A liquid pump for deep well operation and the like comprising an elongated body having a cylindrical chamber therein, a piston in said chamber, an intake valve at the top of said chamber providing communication with the outside above said chamber for admitting liquid to said chamber above said piston, a discharge valve at the top of said chamber, power means for lifting said piston, means dependent upon the accumulation of a predetermined quantity of liquid in said chamber above said piston for actuating said power means to lift said piston and discharge liquid through said discharge valve, and means dependent upon the discharge of said predetermined quantity of liquid for controlling said power means to stop the upward movement of said piston and initiate the return stroke thereof.

2. A liquid pump for deep well operation and the like as set forth in claim 1 including a tension line connecting said piston and said power means for actuating said piston and wherein said return stroke is effected by reverse movement of said line and the weight of the piston assembly.

3. A liquid pump for deep well operation and the like as set forth in claim 2 wherein said means dependent upon the accumulation of liquid in said chamber comprises a strain gauge responsive to the strain in said line.

4. A liquid pump for deep well operation and the like comprising a pump body having a cylinder therein and a piston freely movable in said cylinder between upper and lower positions therein, an inlet valve at the top of

said cylinder for affording a flow of liquid into the cylinder from the top, a discharge valve at the top of said cylinder, power means and a tension line connecting said piston and said power means for lifting said piston to discharge liquid from said cylinder, means dependent upon the strain in said line produced by the accumulation of liquid in said cylinder above said piston for initiating the operation of said power means to effect the movement of said piston toward its upper position, and means associated with said power means for returning said piston to the lower portion of said cylinder.

5. A liquid pump for deep well operation and the like comprising a pump body having a cylinder therein and a piston freely movable in said cylinder, an inlet valve at the top of said cylinder for affording a flow of liquid by gravity into the cylinder from the top, a discharge valve at the top of said cylinder, power means and a flexible tension line connecting said piston and said power means for lifting said piston to discharge liquid from said cylinder, control means connected with said power means and dependent upon the presence of a predetermined quantity of liquid in said cylinder above said piston for initiating the actuation of said power means to lift said piston, and means dependent upon the movement of said piston to a high position in said cylinder for operating said power means to release the tension in said line and afford downward movement of said piston and the filling of said cylinder with liquid by gravity flow.

6. A liquid pump for deep well operation and the like comprising a pump body having a cylinder therein and a piston freely movable in said cylinder, means for positioning said body in a well casing, an inlet valve at the top of said cylinder for affording a flow of liquid into the cylinder from the top, a discharge valve at the top of said cylinder, means for sealing the well casing to provide a production zone about said inlet valve, power means and a tension line connecting said piston and said power means for lifting said piston to discharge liquid from said cylinder, means dependent upon the strain in said line for controlling the movement of said piston, and a liquid discharge zone above said pump whereby liquid produced by operation of said pump is discharged upwardly through said casing.

7. A liquid pump as set forth in claim 6 including means for equalizing the pressures on the opposite sides of said sealing means for affording release of said seal and removal of said pump on said tension line.

8. A liquid pump as set forth in claim 7 wherein said pressure equalizing means comprises a sleeve valve mounted on said body above said discharge valve and providing communication between said two zones, said sleeve valve being downwardly biased to its closed position, and means dependent upon upward movement of said piston to a top position for engaging and opening said sleeve valve.

9. A liquid pump as set forth in claim 4 including a production tubing extending upwardly from said body to the well head and wherein said tension line is positioned within said tubing.

10. A liquid pump as set forth in claim 4 including a piston rod for said piston and wherein said tension line is constructed of a synthetic plastic and connects said power means and said piston rod.

11. A liquid pump as set forth in claim 4 wherein said tension line comprises a synthetic plastic rope and said strain dependent means comprises a strain gauge responsive to strain in a load carrying portion of said power means.

12. A liquid pump for deep well operation and the like comprising an elongated body having a cylindrical chamber therein, a piston in said chamber, an intake valve at the top of said chamber providing communication with the outside above said chamber for admitting liquid to said chamber above said piston, a discharge valve at the top of said chamber, power means for lifting said piston, control means connected with said power means and dependent upon the accumulation of a predetermined quantity of liquid in said chamber above said piston for initiating the actuation of said power means to lift said piston and discharge liquid through said discharge valve, means including a limit switch for controlling said power means to stop the upward movement of said piston at a predetermined position and initiate the return movement thereof, and means including a second limit switch actuated upon movement of said piston to a predetermined lower position for stopping said piston at its lowermost position.

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