March 22, 1932. H. F. WATKINS 1,850,484

WELL PUMP

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FIG. 2.

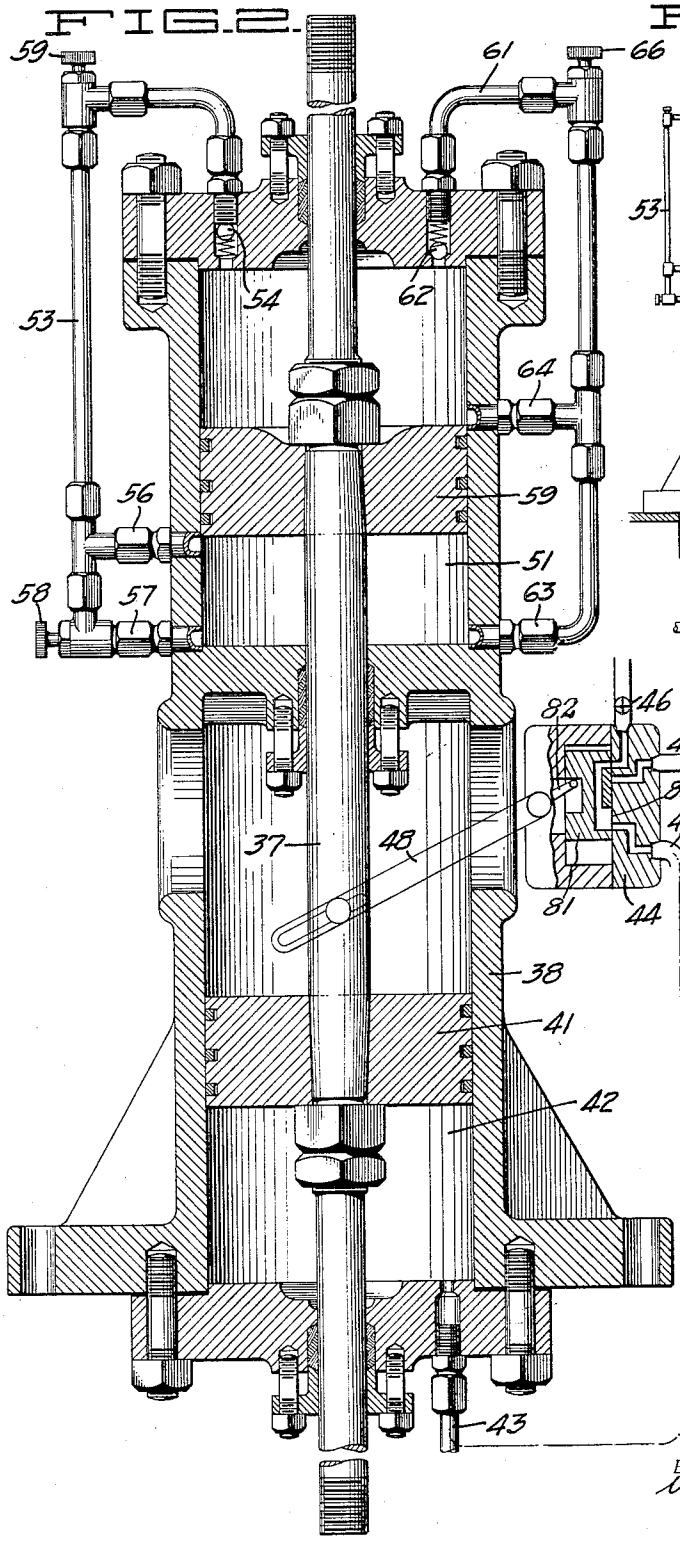
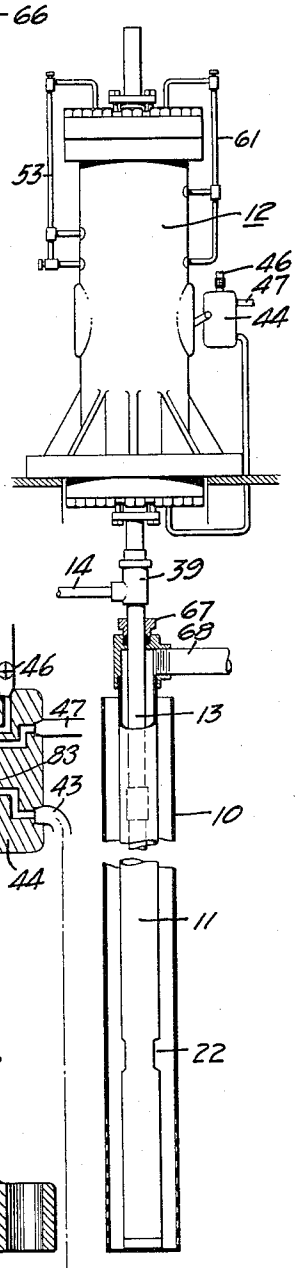


FIG. 1.



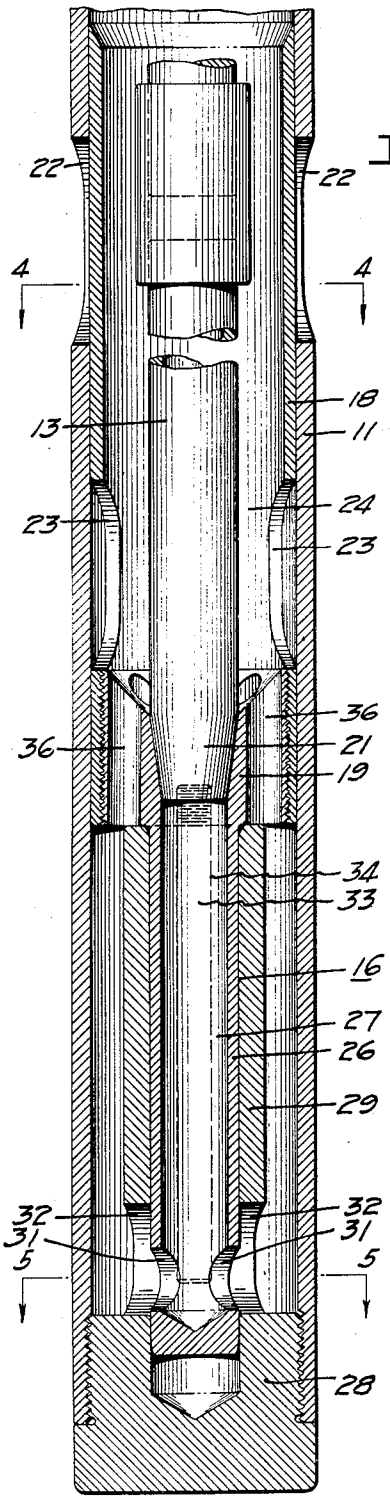
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WELL PUMP

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FIG. 3.



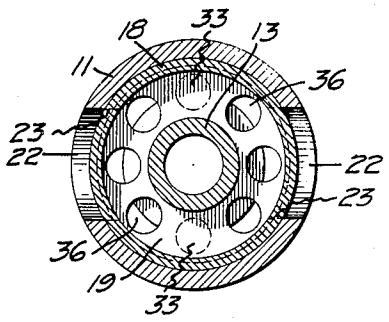
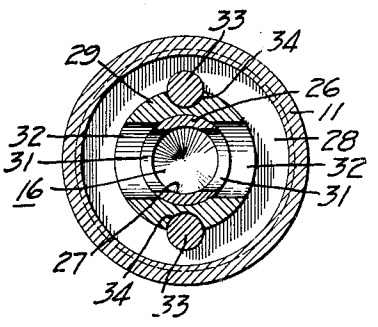


FIG. 4.

FIG. 5.



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WELL PUMP

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FIG. 6.

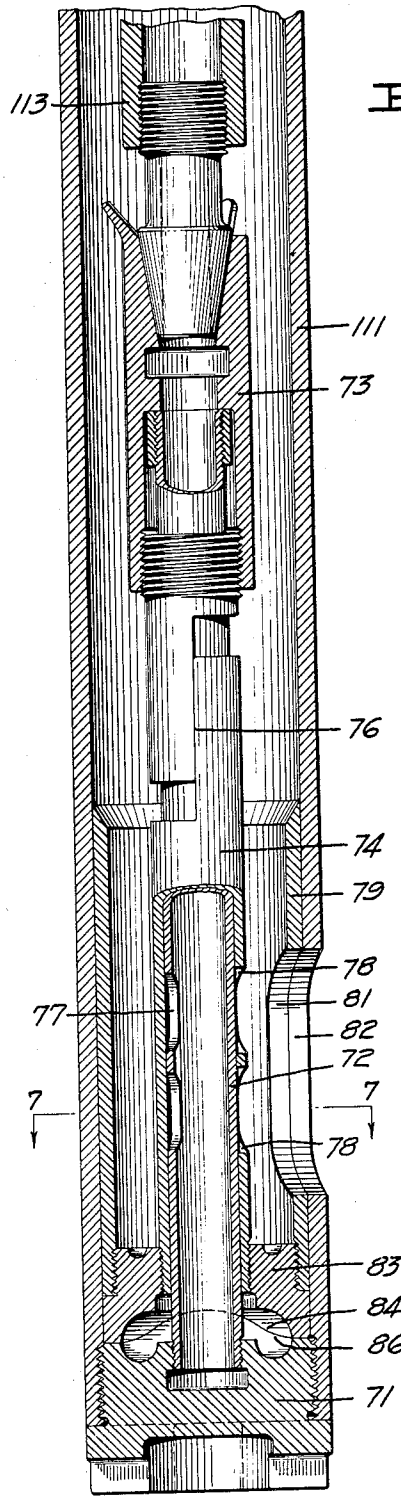


FIG. 7.

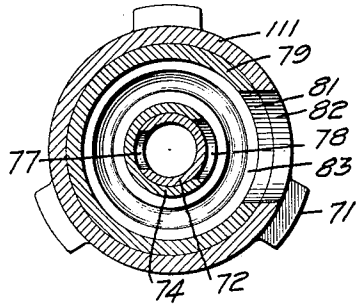
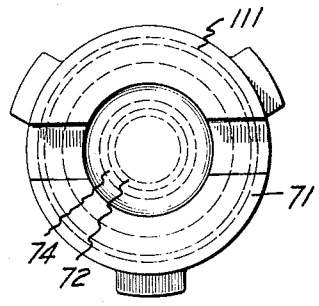


FIG. 8.



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UNITED STATES PATENT OFFICE

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WELL PUMP

Application filed July 20, 1927. Serial No. 207,099.

This invention relates generally to devices for lifting liquids from earth wells and is particularly applicable to the pumping of crude petroleum from oil wells.

It is an object of this invention to devise an oil well pump of the air lift type which will not emulsify the oil being discharged.

It is a further object of this invention to devise a liquid well pump which will utilize valve mechanism controlled from the surface of the well for alternately permitting the introduction of liquid and gas, into the lower portion of the discharge pipe line.

It is a further object of this invention to devise a well pump of simple construction which will require a minimum of power to operate and which will be reliable in operation.

Further objects of this invention will appear from the following description in which I have set forth the preferred embodiment of my invention. It is to be understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawings:

Figure 1 is a side elevational view showing the assembled well pump introduced into an earth well.

Fig. 2 is a side elevational view partly in cross section, illustrating the actuating and timing mechanism for the pump valve mechanism.

Fig. 3 is an elevational view in cross section illustrating the lower portion of the well pump and the valve mechanism associated therewith.

Fig. 4 is a cross sectional view taken along the line 4—4 of Fig. 3.

Fig. 5 is a cross sectional view taken along the line 5—5 of Fig. 3.

Fig. 6 is a cross sectional view similar to Fig. 3, but illustrating a modified form of pump.

Fig. 7 is a cross sectional view taken along the line 7—7 of Fig. 6.

Fig. 8 is a bottom view of the pump.

The invention may be outlined briefly as comprising a pair of pipe lines which are adapted to be lowered into an earth well, and which have a valve mechanism associated with their lower ends. One pipe line serves the purpose of introducing gas under pressure into the lower portion of the well while the other pipe serves as a passage for discharge of a column of oil. The valve mechanism is operated by motive means under control of the operator at the surface of the well, and this mechanism performs two distinct functions. When in one position it permits free flow of oil from the well casing into the discharge pipe line, while in another position it interrupts flow of oil into the discharge pipe line and permits introduction of compressed gas into the same. This compressed gas forms in effect a pneumatic plunger which lifts the column of oil above it. The valve mechanism may be reciprocatory or may be actuated by rotary motion, and in the drawings I have illustrated both forms.

Referring to the drawings for a complete description, I have shown the device positioned within an oil well 10, a pipe line 11 extends down a well casing and has its lower end terminating a substantial distance below the normal liquid level. Positioned at the surface of the well there is a combined actuating and timing mechanism designated generally at 12.

Referring now to Figs. 2 and 3 for a detailed description of the valve mechanism and the associated pipe lines, extending down within the pipe line 11 from the actuating mechanism 12 there is a second pipe line 13. The upper portion of pipe line 13 is connected to a source of gas under pressure, as by means of pipe or conduit 14, while the lower portion is mechanically connected with a valve mechanism designated generally at 16, so as to actuate the same.

The valve mechanism is constructed so as to be actuated by the reciprocatory motion of pipe line 13, or by rotary motion, or by a combination of both motions. In that modification of the invention shown in Fig. 3, the valve mechanism is operated by up and down movement of pipe line 13, or in other words by reciprocatory motion. The valve mechanism itself may be constructed in a number of different ways and in Fig. 3 I have shown

the same as including a sleeve 18 which is slidably fitted within the lower portion of pipe line 11. Connected to the lower portion of sleeve 18 there is a suitable coupling member 19 with which the lower end of pipe line 13 has a quick detachable connection 21. That portion of the pipe line 11 adjacent the sleeve 18 is provided with one or more ports 22 which are adapted to register with one or more cooperating ports 23 in the sleeve 18. When ports 22 and 23 are in registered position, oil from the well is permitted to flow into the lower portion 24 of the pipe line 11, this lower portion 24 forming what may be termed a displacement chamber.

Depending from the coupling member 19, there is another valve member 26 which is provided with a passageway 27 communicating with the interior of the pipe line 13. The lower end of pipe line 11 is provided with a closure or plug 28 and extending upwardly from this plug there is a sleeve 29 within which the valve member 26 is slidably fitted. Valve member 26 is provided with one or more ports 31 which are adapted to cooperate with one or more ports 32 in the sleeve 29. In order to prevent relative rotation between the valve mechanism and the pipe line 11, I have shown a pair of guide members 33 which have their upper ends mounted or secured to the coupling member 19, and which slidably engage in grooves 34 provided along the sides of sleeve 29. Coupling member 19 is provided with a plurality of ports 36, whereby gas introduced thru ports 31 and 32 may flow upwardly thru pipe line 11.

Any suitable apparatus may be employed for effecting reciprocating movement of pipe line 13 to actuate the valve mechanism. A novel form of mechanism for performing this function is shown in Fig. 2 and includes a reciprocating rod 37 disposed within a housing 38. Housing 38 may be mounted at the surface of the well as shown in Fig. 1 so that the rod 37 is in vertical position, whereby the lower end of rod 37 can be provided with a suitable coupling connection 39 with the upper end of the pipe line 13. Rod 37 is preferably reciprocated hydraulically or pneumatically, and for this purpose I have shown a pneumatic piston 41 fitted within a suitable cylinder 42. Gas under pressure is admitted to the cylinder 42 thru pipe 43, the admission being controlled by means of a valve control mechanism indicated generally at 44. This mechanism 44 is associated with a pipe 46 which connects with a source of gas under pressure, and with a suitable exhaust pipe 47. It is controlled by movement of the rod 37 thru an interconnecting actuating lever 48. When piston 41 reaches the bottom of its stroke compressed gas is admitted to cylinder 42 by means of valve mechanism 44, and piston 41 is forced upwardly. When at the upper limit of its travel, valve mechanism 44 interrupts communication between pipe 43 and pipe 46, and exhausts pipe 43 thru pipe 47, thus permitting the piston to return under the force of gravity.

Valves which will perform the functions required of mechanism 44 are well known in the art. As an example of the same I have shown diagrammatically a slide type of valve consisting of a valve member 81 movable intermittently by crank 82, which in turn is movable together with lever 48. Member 81 cooperates with a valve seat 83 ported to cooperate with suitable ports in member 81.

For timing movements of the rod 37, I preferably employ hydraulic means in the form of a double acting hydraulic piston 49 connected to the upper end of rod 37, and operating within a hydraulic cylinder 51. An arrangement of by-pass pipes and valves is provided so that when piston 49 is moving upwardly, liquid is by-passed from above the piston to the lower side thereof, and conversely when the piston 49 is moving downwardly, liquid is by-passed from the lower portion of the cylinder to the upper portion thereof. For example there is provided a by-pass pipe 53 which has communication with the upper portion of cylinder 51 thru the check valve 54, and which communicates with the lower portion of the cylinder thru a plurality of pipe connections 56 and 57. The lowermost pipe connection 57 is preferably provided with a control needle valve 58, while the check valve 54 is positioned so as to permit inflow of liquid from pipe 53 into the upper portion of the cylinder 51. Another needle valve 59 may be provided in the main by-pass pipe 53. When piston 49 slides downwardly from the top of its stroke, its rate of movement will depend upon the rate of flow of liquid from below the piston thru the by-pass pipe 56, and this rate may be controlled by means of needle valve 59. When piston 49 passes below the pipe 56, it moves at a slower rate of speed for the remainder of its movement due to the fact that all of the liquid below the pistons must then pass thru pipe 57 which is controlled by needle valve 58. For checking the upward movement of piston 49, there is provided a by-pass pipe 61 which communicates with the upper end of cylinder 51 thru a suitable check valve 62. By-pass 61 communicates with the lower portion of the cylinder thru pipe connection 63, and with an intermediate portion of the cylinder thru pipe connection 64. A suitable check valve can be incorporated in connection 64 to permit flow of liquid only in a direction from the cylinder. Flow of liquid thru by-pass 61 may be controlled as by means of a needle valve 66. When piston 49 starts to move upwardly, it meets with substantially no resistance as the fluid above the same is freely by-passed between pipe connections 63 and 64.

However as the piston passes pipe connection 64, substantially all of the liquid must flow thru the check valve 62 and thru the needle valve 66, so that the piston movement is limited to a certain value depending upon the setting of valve 66. It is obvious that with the actuating and timing mechanism described above any desired rate of movement of the rod 37 may be obtained.

In installing a pumping device such as described above, the pipe lines 11 and 13 are assembled together with the valve mechanism 16, and lowered into the well casing. A suitable packing gland 67 is disposed at the upper end of pipe line 11, to pack the joint between this pipe and the reciprocating pipe line 13. The upper end of pipe 11 is likewise connected to a suitable discharge conduit 68. Conduit 14 is connected to a source of gas under pressure, as for example natural gas or compressed air, and the actuating mechanism is initiated into operation. Because of the manner in which the rod 37 is timed, this rod remains near the end or limit of its movement a comparatively long time so that ports 22 and 23 are first brought into registry for a substantial period and then pipe line 13 is lowered and kept at the lower limit of its movement a substantial period to keep ports 31 and 32 in registry. Assuming that ports 22 are substantially below the level of liquid within the well, liquid will flow into the lower portion of pipe 11, or into the displacement chamber 24 when ports 22 and 23 are in registry. When ports 22 and 23 are closed and ports 31 and 32 are brought into registry, compressed air or other gas from pipe 13 is introduced thru ports 31 and 32 into the lower portion of the displacement chamber 24, and this gas forms in effect a pneumatic plunger which lifts the column of oil above it, thus discharging the oil from the top of the well thru conduit 68. Compressed gas introduced into the oil in this manner does not cause an emulsion to be formed, as is the case with ordinary air lift pumps in which the compressed gas is continuously introduced into a column of oil thru nozzles. The air introduced by the pump of my invention does not break into small bubbles, but forms large charges of air which remain intact to form a pneumatic plunger which rises and thus forces the oil above it to the surface of the well.

In Figs. 6 to 9 inclusive I have shown another form of valve mechanism which is actuated by rotary motion of the inner pipe line. In this instance the lower portion of the pipe line 111, which corresponds to the pipe line 11 described above, is provided with a closure plug 71 to which is fixed the lower end of an outwardly extending pipe 72. The upper end of pipe 72 is provided with a lost motion connection to a member 73 which in turn is connected to the lower end of the pipe line 113. Fitted upon the pipe 72 there is a valve sleeve 74, the upper end of which has a spline connection 76 with the coupling member 73, whereby valve sleeve 74 is rotated upon rotation of the pipe line 113. Pipe 72 and valve sleeve 74 are provided with cooperating ports 77 and 78 respectively. Fitted within the lower portion of the pipe line 111, there is another valve sleeve 79, which is provided with ports 81 adapted to cooperate with ports 82 in the pipe 111. Valve sleeves 74 and 79 are connected to a common member 83 whereby they are rotated simultaneously. When ports 81 and 82 are brought into registry to permit flow of oil into pipe line 111, ports 77 and 78 are closed to prevent introduction of compressed gas from pipe line 113. However when pipe line 113 is rotated 180 degrees, ports 77 and 78 are brought into registry to permit the introduction of a charge of compressed gas, while ports 81 and 82 are closed to prevent inflow of oil.

In order to insure proper registry of the ports of the valve mechanism, I have provided the lower face of member 83 with a cam surface 84 adapted to rest upon and cooperate with a complementary cam surface 86 provided upon the upper face of the closure plug 71. These cam surfaces are designed as indicated so that while the valve sleeves are being rotated between open positions they are lifted with respect to the pipe lines 111 and 113, and are permitted to drop to a lowered position when the ports are in registry. This provides in effect a means tending to bias the valve sleeves to port registering positions. The up and down movement of the valve sleeves during rotation thereof is taken up by means of the spline connection 76.

For rotating the pipe line 113 I may utilize a mechanism similar to that previously described with reference to Fig. 2. The only modification necessary is that instead of directly connecting the rod 37 to the pipe line 113, it is connected thru a suitable rack and pinion or other means whereby reciprocating movement of rod 37 is converted to rotary movement of pipe line 113.

It will be obvious from the above description that I have provided a well pump of great mechanical simplicity which will operate to pump large volumes of liquid with a minimum of power. The compressed gas necessary for its operation may frequently be obtained from adjacent natural gas wells, so that no engines or electrical motors of any kind need be provided. Furthermore only a small amount of power is necessary for reciprocating or rotating the pipe lines 13 and 113. When the reciprocating type of valve mechanism is utilized, rod 37 may be counterbalanced to further reduce the power necessary for its operation. Because the valve mechanism is controlled from the surface of the

well, it is positive in operation and will not readily become inoperative thru clogging by sand or paraffine deposits.

I claim:

1. In a well pump of the air lift type, a pair of pipe lines adapted to be lowered into a well, a source of gas under pressure associated with the lower portions of said lines, a valve mechanism associated with the lower portions of said lines, said mechanism being movable in one position to admit gas from the one pipe into the other and to prevent flow of liquid from the well into the other pipe, and movable to another position to prevent admission of gas from the one pipe to the other and to admit liquid from the well to the other pipe, and means located at the surface of the well for directly applying motion to said mechanism, said admission of gas serving to pump liquid unaided by other pumping means.

2. In a well pump of the air lift type, a pair of pipe lines adapted to be lowered into a well, a source of gas under pressure associated with the lower portions of said lines, a valve mechanism associated with the lower portions of said lines, said mechanism being movable in one position to admit gas from the one pipe into the other and to prevent flow of liquid from the well into the other pipe, and movable to another position to prevent admission of gas from the one pipe to the other and to admit liquid from the well to the other pipe, means located at the surface of the well for directly actuating said mechanism, and means for timing said mechanism, said introduction of gas serving to pump liquid unaided by other pumping means.

3. In a well pump of the air lift type, a pair of pipe lines adapted to be lowered into a well, a source of gas under pressure associated with the upper portion of one of said lines, a valve mechanism associated with the lower portions of said lines, said mechanism being movable in one position to admit gas from the one pipe into the other and to prevent flow of liquid from the well into the other pipe, and movable to another position to prevent admission of gas from the one pipe to the other and to admit liquid from the well to the other pipe, and means located at the surface of the well for directly actuating said mechanism, and means for timing said actuating means, the gas admitted to said other pipe serving to effect pumping of liquid unaided by other pumping means.

4. In an oil well pump, a gas pipe string extending into the well, an oil discharge pipe string also extending into the well, valve means associated with the oil pipe below the normal oil level of the well and serving in one position to permit flow of oil from the well into the oil pipe and in another position to interrupt such flow, means for intermittently introducing charges of gas under pressure into said gas pipe, whereby each charge forms an upwardly expanding pneumatic piston in the oil pipe immediately above said valve means and which shifts the column of oil above the same, and means for positively mechanically operating said valve means from the surface of the well whereby said valve means is closed during introduction of a gas charge.

5. In a well pump, oil and gas pipe strings adapted to extend into an oil well, valve means associated with said pipes and located within the well for effecting intermittent pumping of oil by gas under pressure introduced thru the gas pipe string, said means including relatively movable parts having ports adapted to register for one position of the same, and cam means for insuring registration of said ports.

6. In a well pump, oil and gas pipe strings adapted to extend into an oil well, valve means associated with said pipes and located within the well for effecting intermittent pumping of oil by gas under pressure introduced thru the gas pipe string, said means including relatively movable parts having ports adapted to register for one position of the same, means located at the surface of the well for effecting cyclic movement of said parts, and cam means located adjacent said parts for insuring registration of said ports.

7. In a well pump, oil and gas pipe strings adapted to extend into an oil well, valve means associated with said pipes and located within the well for effecting intermittent pumping of oil by gas under pressure introduced thru the gas pipe string, said valve means including relatively rotatable parts having ports adapted to register for one position of the same, and means including a cam tending to bias said parts to a position in which said ports are in registry.

8. In a well pump, oil and gas pipe strings adapted to extend into an oil well, valve means associated with said pipes and located within the well for effecting intermittent pumping of oil by gas under pressure introduced thru the gas pipe string, said means including relatively rotatable parts having ports adapted to register in one position of said parts and to be out of registry for another position of said parts, means for effecting relative rotation between said parts, and means tending to urge said parts toward either one of said positions from an intermediate position.

9. In an earth well pump, oil and gas pipe strings extending down into the well for a substantial distance below the normal level of liquid in the same, said gas pipe string being adapted for connection with a source of gas under pressure at the surface of the well, and valve means for controlling communication between said pipe strings below said normal level and for controlling flow of

oil from the well into said oil pipe string, and means located at the surface of the well for effecting cyclic operation of said valve means whereby for periodic intervals said pipe strings are placed in communication below said normal level and whereby during periods between said intervals flow of oil from the well into said oil pipe string is permitted.

In testimony whereof, I have hereunto set my hand.

HAROLD F. WATKINS.