

Sept. 5, 1939.

F. E. SCHEIDER ET AL

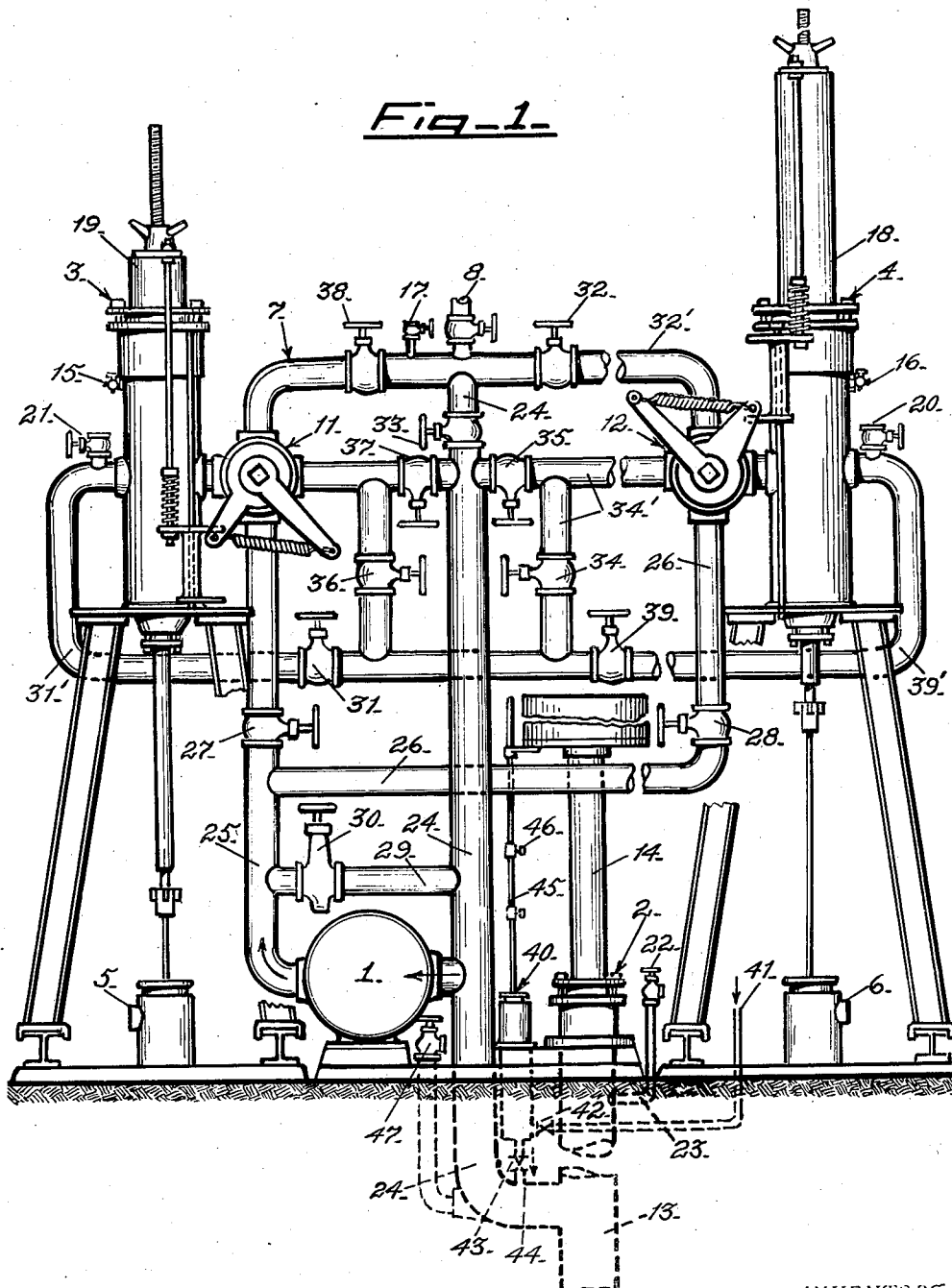
2,172,016

APPARATUS FOR PUMPING WELLS

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2 Sheets-Sheet 1

Fig. 1.



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2 Sheets-Sheet 2

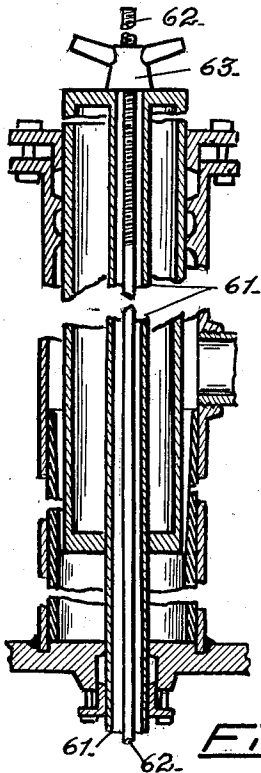


Fig. 2

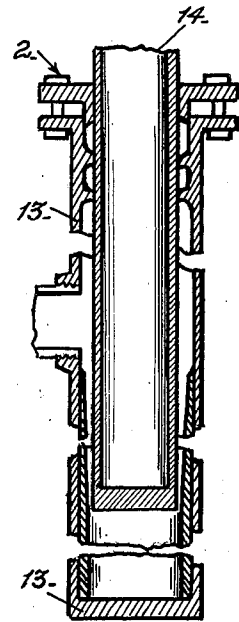


Fig. 3

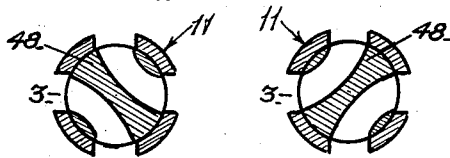


Fig. 6 Fig. 6a

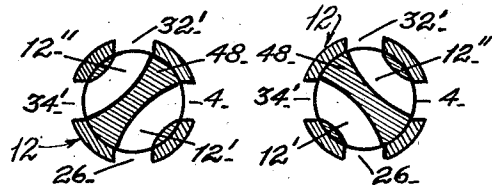


Fig. 7 Fig. 7a

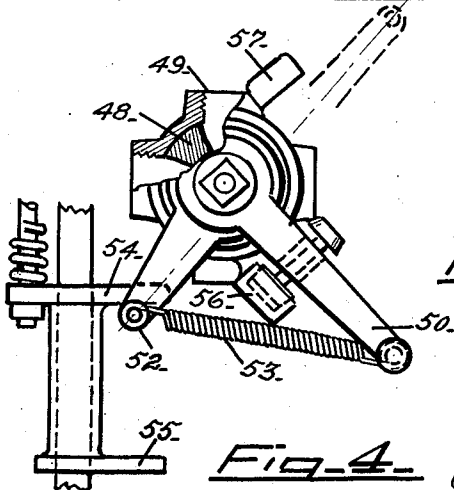


Fig. 4

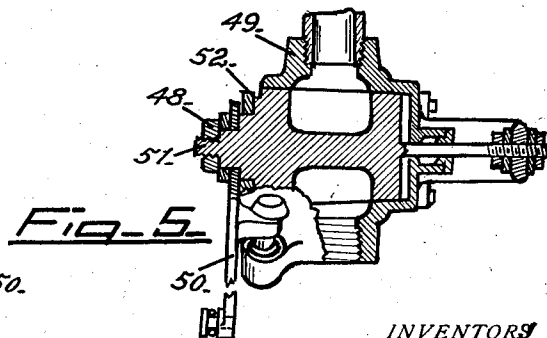


Fig. 5

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APPARATUS FOR PUMPING WELLS

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2 Claims. (Cl. 60—52)

The present invention relates to an improved apparatus pertaining to the pumping of wells, particularly oil wells.

5 An object of the invention is to reduce the operating costs and increase the output of wells.

Another object of the invention is to provide for an efficient operation of a plurality of wells with a single power unit or prime mover.

10 An additional object is to provide for counterbalancing the sucker rod and liquid column weight of a well.

15 With the above and other objects in view the invention consists in the novel combination of parts hereinafter described, illustrated in the accompanying drawings, and set forth in the claims hereto appended, it being understood that various changes in form, proportion, size and minor details of construction within the scope of the claims may be resorted to without departing from the spirit or sacrificing any advantages of the invention.

Referring to the drawings:

25 Figure 1 is a side elevation of the apparatus comprising one embodiment of the present invention as applied to two wells, and with which, the method of the invention may be carried out.

Figure 2 is an enlarged, part sectional, view of one of the hydraulic jacks.

30 Figure 3 is a fragmentary, part sectional, view of the accumulator.

Figure 4 is an enlarged, part sectional, view of the jack operating valve.

Figure 5 is a sectional view of the valve taken at right angles to Figure 4.

35 Figure 6 is a diagrammatic view showing the inlet position of the valve for the beginning of the up stroke of the "left hand jack" plunger.

Figure 6a is a diagrammatic view showing the outlet position of the valve for the down stroke of the "left hand jack" plunger.

Figure 7 is a diagrammatic view showing the inlet position of the valve for the beginning of the up stroke of the "right hand jack" plunger.

Figure 7a is a diagrammatic view showing the outlet position of the valve for the down stroke of the "right hand jack" plunger.

Primarily this invention, as will be seen with reference to the accompanying drawings and following description, contemplates the counterbalancing of the sucker rod and liquid column of a well to such extent that the pumping operation may be effected with a minimum of power and a consequent lower cost.

As here shown we have coupled the hydraulic sucker rod lifting jacks of two independent wells

with a closed hydraulic circulatory system which functions to alternately counterbalance the liquid column weight of said wells by means of a pressure accumulator, comprising essentially a column of liquid on which a heavily weighted 5 plunger operates, and further inasmuch as said hydraulic system connects the well operating jacks, it causes the sucker rod elements of the wells (insofar as their respective weights are concerned) to substantially counterbalance each 10 other.

In the present embodiment of the invention the prime mover or power unit comprises a motor or power operated pump which requires considerably less power for effective operation than any 15 pumping power unit such as would be employed for the conventional pumping operation of a well.

The embodiment of the invention, shown in Figures 1 to 7a inclusive of the accompanying drawings, essentially comprises the power unit including a circulating pump 1 and an accumulator or compensator 2, which are connected with the hydraulic lifting jacks 3 and 4 of wells 5 and 6 by means of the circulation system 7 of valved conduits or pipes having the liquid filling intake valve 8. 25

As here shown the circulator system 7 is controlled by valves 11 and 12 operated by and upon movement of the jacks 3 and 4 respectively as will be hereinafter more fully explained. By means of these valves the wells may be alternately pumped using either one of these valves as the control medium. Furthermore the apparatus may be adjusted at will to operate but one well while the other is at rest. 35

When operating two wells alternately the accumulator 2, which consists primarily of a hydraulic cylinder 13 in which the weighted plunger 14 operates, serves to substantially counterbalance the liquid column weight of the flowing well. 40

With the apparatus set up as shown in Figure 1 with two wells and assuming that both jacks and both valves are in the positions in which jack 3 and valve 11 are shown in said figure, also assuming the plunger 14 of the accumulator is in the down position, the filling of the system with the operating liquid is now necessary. This is accomplished by introducing the liquid from a suitable source through the intake valve 8, while the air vent valves 15, 16 and 17 as well as all other hand operated valves of the system are open, until the entire system is filled, following which all hand operated valves are closed. 50

To bring the apparatus into the operative positions shown in Figure 1 with the plunger 18 of jack 4 at end of the up stroke, and plunger 19 of the jack 3 to the position shown as that of the end of the normal down stroke; which is up and out of the dashpot portion of the structure of the lower end of each jack cylinder (Figure 2 later described), and to raise the weighted plunger 14 of the accumulator 2 to operative position such as to compensate for liquid displacements occurring during operation, attention is directed to the hand operated valves 20, 21 and 22. These valves and associated conduits serve, to admit or shut off, the system filling liquid which is under a pressure source (not shown) sufficient to raise each jack plunger with its suspended load or the weighted plunger of the accumulator. As above defined all valves are closed after preliminary venting and filling of the system through the valve 8. Having opened the valve 20, the plunger 18 of the jack 4 is raised (by admission of the liquid) to the position shown in Figure 1. Valve 20 is then closed.

It is worthy of note that at completion of the act of raising the plunger 18 to the end of the up stroke the automatic valve 12 has assumed the position, shown in Figures 1 and 7a, normally evacuating of the liquid from the cylinder for the down stroke, but, whereas all hand operated valves of the system are closed, the plunger and its suspended load remain up until such time as the pumping operation is begun. Valve 21 is now opened, whereupon the plunger 19 of the jack 3 is raised to the height illustrated in Figure 2 which is the position of the plunger at the end of the normal down stroke, the plunger being cushioned by the body of liquid beneath it. Valve 21 is then closed. The valve 22, communicating through the conduit 23 with the cylinder 13 of the accumulator 2, is now opened and the weighted plunger 14 raised to a height sufficient to compensate for liquid volume displacements as above defined, whereupon valve 22 is closed and the system ready for operation. To repeat, all hand operated valves are now closed and as no circulation of the liquid is possible the apparatus will "stand" in the positions defined as ready for operation.

The circulation system, hand operated valves and their respective conduits of one well are duplicates of the other to illustrate the vice versa control of either well by the other.

The prime mover or circulating pump 1 has its inlet connected to the common return conduit 24. The outlet side of the pump discharges into the conduits 25 and 26 (terminating in the valves 11 and 12) and opened or closed by means of the hand operated valves 27 and 28. The discharge conduit 25 is by-passed to the common return conduit 24 by the conduit 29 having the relief valve 30 set to control the pressure desired for operation and relieve or by-pass any volumetric inequalities arising from operation, or serves to circulate the pump displacement volume. In conjunction with the pump 1 the common return 24 is also connected to the cylinder 13 of the accumulator 2 whence pressure exercised upon, or a flow of liquid therethru, is assimilative by either the pump or accumulator.

As the plunger 18 of the jack 4 is illustrated as lifted (as described) to the height of a full up stroke, this jack and its automatic control valve 12, with its port passages positioned as shown in Figure 7a, will be used to define the

pumping action of the system as applied to two wells.

The prime mover or circulating pump 1 is now started with the consequence that, as all valves are closed, the liquid displaced by the pump circulates through the relief valve 30 and the pump. Next, valves 28, 31 and 32 are opened as preparatory to actual starting of the pumping cycle begun upon the combined opening of valves 33 and 34, whereupon the liquid under pressure of the accumulator 2 and sucker rod weight on the jack 4 plus a power increment derived from the power driven circulating pump 1 causes the liquid to raise the plunger of the jack 3 with consequent pumping action on the well 5.

Referring to the valve position diagrams Figures 7 and 7a, the automatic action of the valve 12 (later described) with the plunger 18 at the end of the up stroke has caused the valve ports to assume the position shown in Figure 7a and the flow of liquid is as follows. The liquid in the jack 4 is expelled under pressure of the plunger and its suspended sucker rod weight in the well. The liquid in the jack 4 is thus forced (by descent of the plunger 18) through the conduit 32' valves 32 and 33 into the common return 24 and thence into the pump 1. Simultaneously the circulating pump assimilates this liquid volume and pressure and together with the force of the accumulator and a power increment, provided by the prime mover acting on the pump, raises the plunger 19 of the jack 3 with its suspended sucker rod-liquid column load.

The direction and flow of the liquid from the pump 1 is accomplished through the conduits 25, 26 and valve 28, port 12' of the valve 12 (Figure 7a) and thence through conduit 34' valves 34 and 31 and conduit 31' to the cylinder of jack 3.

As the plunger 18 of jack 4 descends and reaches the limit of the down stroke the valve 12 is turned counter-clockwise and the ports of the valve 12 are reversed, by suitable means later described, to the position shown in Figure 7, whereupon the direction of flow of the liquid from the pump and the now raised plunger 19 are reversed. Namely, discharge from the pump 1 enters the jack 4 through the port 12' causing the plunger 18 to rise. Simultaneously the liquid in jack 3 is forced back (through the conduits and hand valve path described for the up stroke of plunger 19) to the valve 12 and through the port 12'', conduit 32', valves 32 and 33 to the common return 24 and the inlet side of pump 1, controlled by the accumulator, from whence it is forced by the pump into jack 4 to raise the plunger 18.

This reverse movement and functioning of the liquid is accomplished under the same existing physical conditions as those above described as beginning the operation cycle.

During the cycles of operation just described the weighted plunger 14 of the accumulator 2 has "stood" upon the "load" acting as a compensator for any inequalities of liquid displacement occurring during movement through the system.

If for any reason it is desired to pump but one well; as for example the one operated by the jack 4 for which the circulating cycle of the liquid has been defined as controlled by the valve 12, procedure is as follows. The system circulating the liquid involves the employment of conduits 25 and 26 manually controlled by the valve 28 and terminating in the automatic valve 12 from which leads the conduit 32' connected to 75

the common return conduit 24 and provided with the manual control valve 32. Further, conduit 34' is connected to the return conduit 24 through the manually operated valve 35.

5 With all hand operated valves of the system closed, the plunger 18 of the jack 4 is raised in the manner above described and the accumulator plunger 14 is also raised sufficiently to "stand" on the liquid column and allow vertical
10 travel sufficient to accommodate the liquid volume capacity of the jack cylinder. Valves 28 and 35 are now opened and the pump 1 started, whereupon the liquid from the pump circulates freely through these valves and associated conduits, the ports of the valve 12 standing as shown
15 in Figure 7a with the port 12' open to the passage of the liquid from conduit 26 to 34' and through the valve 35 into the return 24. To begin actual movement of the plunger 18 it is
20 now only necessary to open valves 32 and 33 whereupon the plunger 18 descends thereby forcing the liquid out through the port 12'' (Figure 7a) thence through conduit 32' valve 32 and the common return 24 to the cylinder 13 of the accumulator thereby raising the weighted plunger
25 14 of the accumulator a distance equivalent in volume to that of the descending stroke of the jack plunger.

When the plunger 18 reaches the limit of its
30 down stroke, the valve 12 is turned counter-clockwise by the plunger actuated valve operating means to be hereinafter described, and the parts of said valves assume the position shown in Figure 7 whereupon the liquid from the outlet of
35 the pump 1 passes through pipes 25 and 26, port 12' into the jack 4 and raises the plunger 18. At the end of the up stroke of plunger 18 the valve 12 reverses and assumes the position shown in Figure 7a whereby to cause the plunger to
40 descend as hereinbefore described. On this down stroke, the outlet side of the pump is out of communication with the jack 4, but the valve 12 through the port 12'' (Figure 7a) and pipe 32' communicates the jack 4 with the return pipe
45 line 24, whereas the pump outlet line 26 is also connected to the return line 24, through the port 12' pipe 34' and the then open valve 35. The operating liquid from the pump therefore circulates freely but the liquid displaced by the descending plunger flows into the accumulator and raises the plunger 14 as aforesaid. Thus it is
50 seen that when a single jack is operated, the valve means in one position, communicates the outlet of the rotary pump 1 with the jack and when in its other position shuts off the outlet connection to the jack while connecting the inlet of the pump with both said outlet and said jack.

60 For the purpose of providing control of either one of two pumping jacks by the other, each is equipped with duplicate automatic valves and duplicate hand valve systems such as illustrated in Figure 1. In the description of operation above
65 presented the automatic valve 11 of jack 3 has played no part for the reason that jack 4 and its automatic valve 12 have controlled the pumping action of jack 3. With reference directed to Figure 1 it will be seen that with valves 27, 36,
70 37 and 38 closed, valve 11 has no effect upon the circulation system 7 and may be either disconnected as to movement by its operating mechanism or be allowed to move idly without affecting the apparatus. Further, with reference to
75 Figure 1, the valve 39 and conduit 39' bear the

same relation to jack 4 as did valve 31 and conduit 31' to jack 3 in the aforesaid description.

As either automatic valve (11 and 12) with associated hand valve and conduit systems is a duplicate of the other and as the filling system,
5 pump 1 and accumulator 2 are common to both, it is evident that the method of operation above described for the one jack (4) will serve (with reference to the valve position diagrams Figures 6 and 6a) for the other and needs no further
10 description.

The accumulator 2 also operates to automatically replenish the operating fluid which may have leaked from the system. This is accomplished by the plunger pump 40 filled from the
15 supply line 41 having a check valve 42 which opens into the pump. The liquid is forced from the pump 40 through an outwardly opening check valve 43 and thence into the accumulator as at
20 44. The pump 40 is operated by the plunger rod 45 having the adjustable stop 46 arranged to be engaged by the accumulator plunger 14 which on the down stroke of plunger 14 operates to force liquid into the system upon the occurrence
25 of such down strokes of the accumulator that pass a fixed limit. The valve cleanout drain 47 is connected to the lower end of the conduit 24 of the accumulator cylinder 13.

The control valves 11 and 12, Figures 4 and 5, are identical and each consists of the four-way
30 plug 48 in similar bodies 49 and having the operating lever 50 fixed on the stem 51. Another lever 52 is mounted freely rotatable on the plug stem 51 and has a spring link connection 53 to the end of the lever 50. The lever 52 is actuated
35 by spaced jack plunger carried abutments 54 and 55 which respectively engage and swing the lever 52 during the up and down strokes of said plunger. The spring link will stretch until the lever 52 is past center of the axis of the valve plug whereupon the action of the spring link will pull the
40 plug lever 50 toward it whereby to move the valve to predetermined positions shown in Figures 6 to 7a inclusive. The movement of lever 50 is limited by the dashpots 56 and 57 as well as by the
45 coils of the spring link 53 abutting one another at the end of the swing of the levers 50 and 52.

It will be noted that the operating means for the valve 11 of jack 3 rotates the valve clockwise at the end of the down stroke of plunger
50 19, whereas the valve 12 for jack 4 is rotated counter-clockwise by its operating means when the plunger 18 reaches the end of its down stroke, and Figures 6a and 7a show the positions assumed by valves 11 and 12 when thus operated.
55

The plungers 18 and 19 of the jacks, Figure 2, are provided with the tubular center portion 61 through which passes the threaded rod 62 provided with the nut 63. The lower end of the
60 rod 62 is secured to the sucker rod in any conventional manner and by means of the nut 63 adjustment of the stroke position, up or down relative to the well parts, may be made.

We claim:

1. In apparatus of the character described, a
65 hydraulic jack, a rotary pump having an inlet and an outlet, a valve means, piping connecting said valve means, said jack, and said inlet and outlet with one another, said valve means and
70 said piping being arranged so that when said valve means is in one position, said outlet will be communicated with said jack, and when in another position, said outlet will be shut off from communication with said jack, and said inlet
75 will be communicated with said jack and said

outlet, means for alternately moving said valve means into said positions, and a hydraulic accumulator connected, and at all times, in communication with said inlet and said piping.

5 2. In apparatus of the character described, a hydraulic jack, a rotary pump having an inlet and an outlet, a valve means, piping connecting said valve means, said jack, and said inlet and outlet with one another, said valve means and
10 said piping being arranged so that when said valve means is in one position, said outlet will

be communicated with said jack, and when in another position, said outlet will be shut off from communication with said jack, and said inlet will be communicated with said jack and said outlet, means operated by said jack for alternately moving said valve means into said positions, and a hydraulic accumulator connected, and at all times, in communication with said inlet and said piping.

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