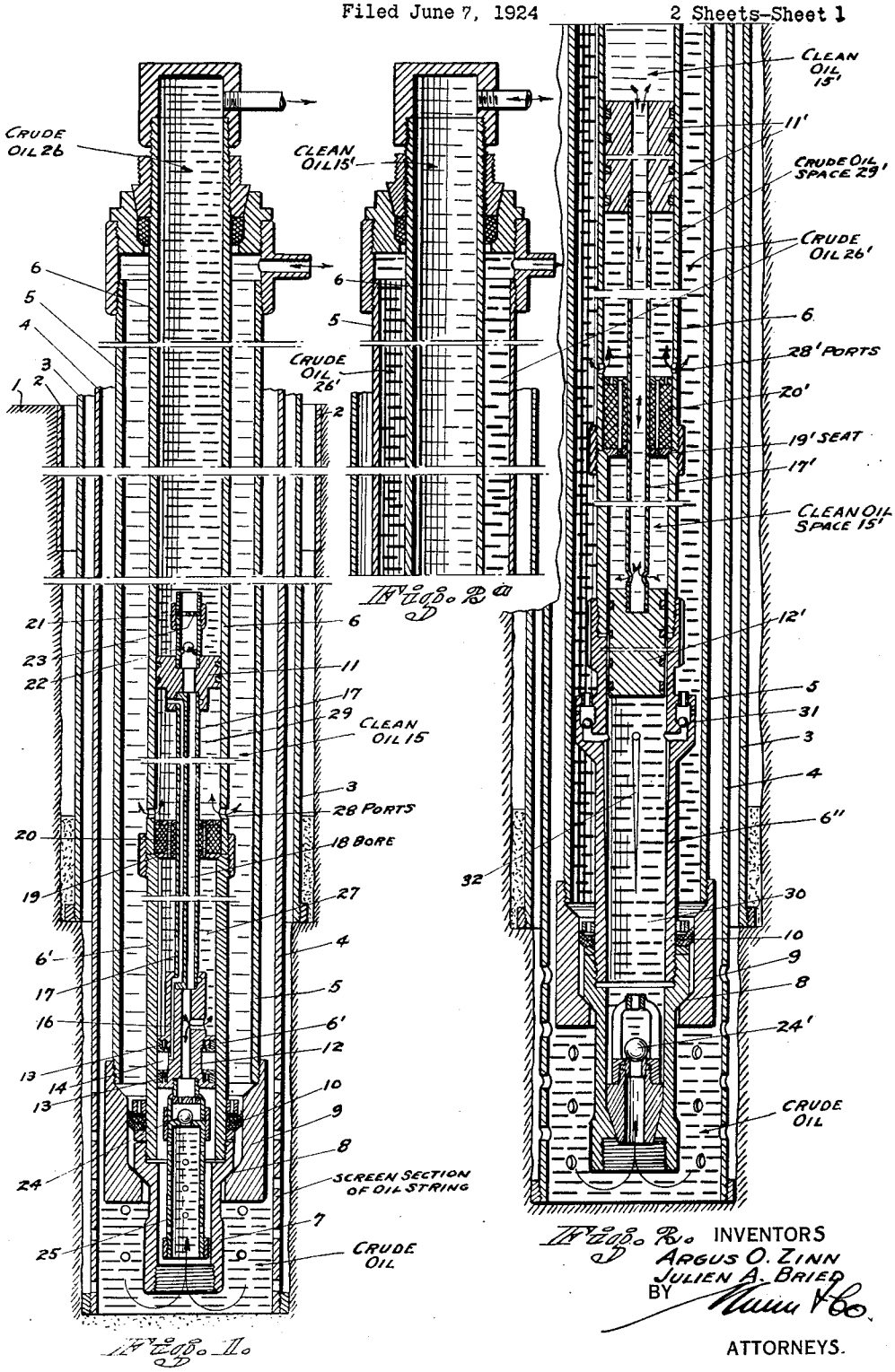
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APPARATUS FOR PUMPING OIL WELLS

Filed June 7, 1924 2 Sheets-Sheet 1



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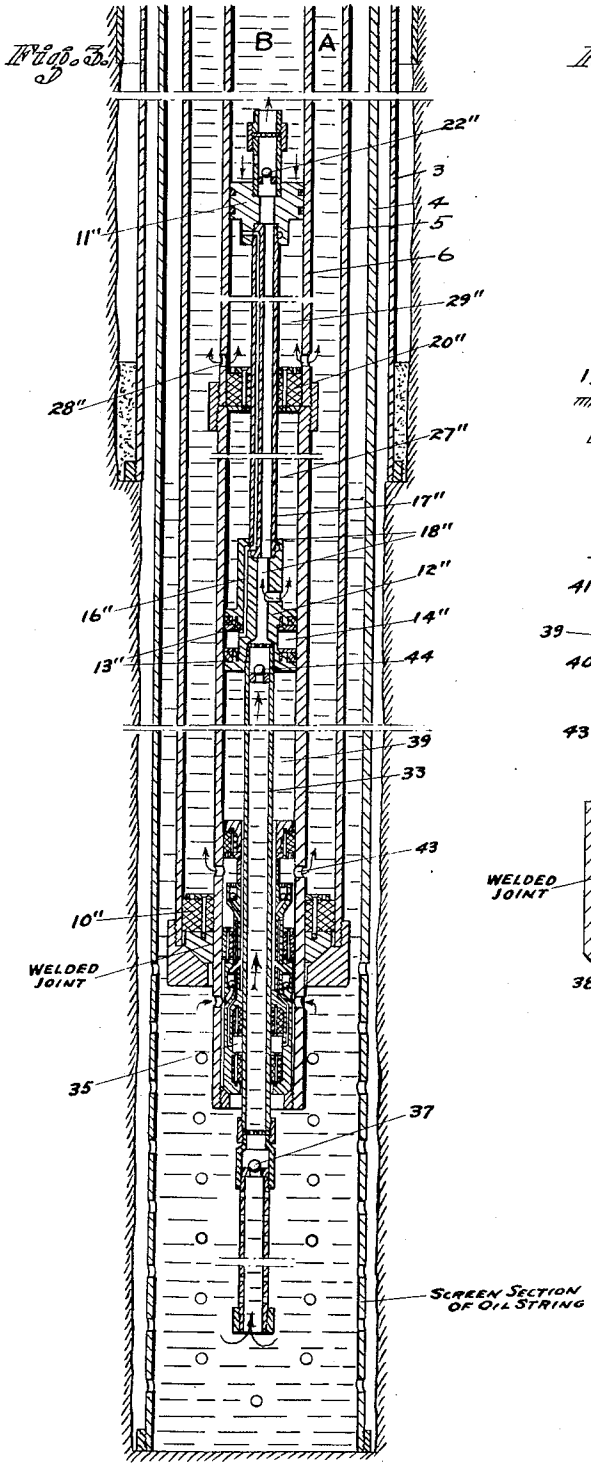
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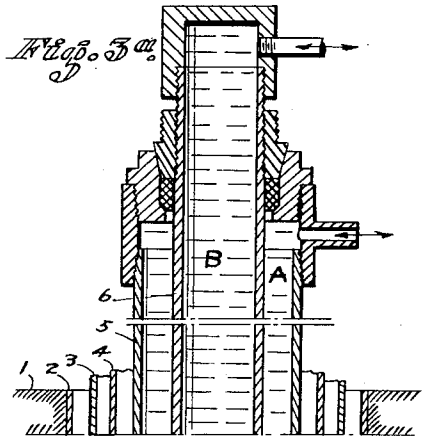
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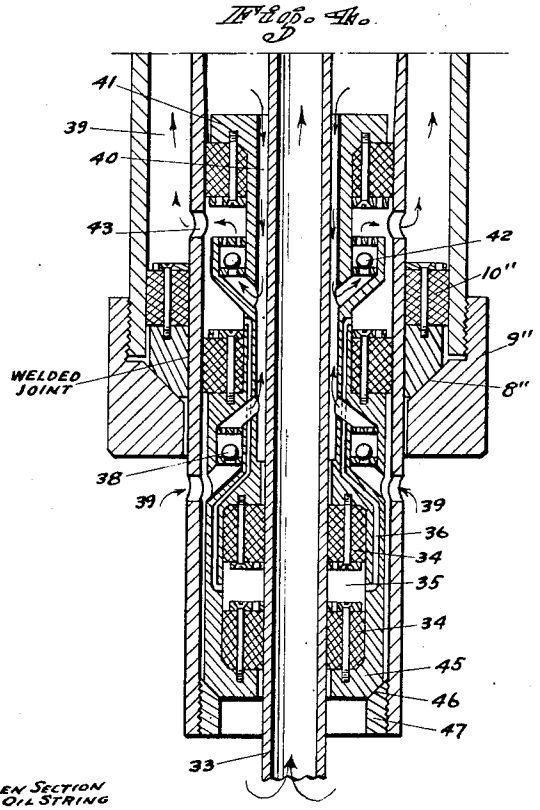
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APPARATUS FOR PUMPING OIL WELLS

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR PUMPING OIL WELLS.

Application filed June 7, 1924. Serial No. 718,583.

This invention relates to the pumping of deep wells in general, but in particular to oil wells, as it solves some of the problems of oil well pumping not solved by the present equipment.

The principal objects of my invention are to provide means of pumping whereby the pumping cable or pump rods which extend down the well are dispensed with and the oil is pumped out of one pipe from the well by liquid pressure applied through another pipe to pumping equipment at the bottom of the well, also an apparatus by which the oil is pumped alternately from the two pipes by pressure applied at reverse alternations to the liquid within the pipes, also a concentric arrangement of the two pipes which alone makes it possible to apply our apparatus to a deep oil well, also pumping mechanism suited for operation by such alternate pressures, also such mechanism which will be single acting or respond to a pressure in one of the pipes only and eject from the other, also such a single acting pressure responsive mechanism which will eject from the inner or outer of the concentric pipes, also such mechanism which may be inserted into the well after the casing and tubing are in place, also such mechanism which may be pulled from the well, also of an arrangement of mechanism parts which will put a tension only on the hollow piston rod of the submerged pump during the pumping stroke, and also an apparatus for preventing the destructive effect of sand upon the pump packings of such mechanisms by the maintaining of a pressure on one side of, or a slight flow of clean oil through, the packed seat against the ingress of sand, thus making the apparatus practicable in the handling of sandy oils.

The realization of the above objects together with other improvements in the construction details of the equipment is carried out in the arrangement of apparatus shown in the drawings hereto and in which:—

Figure 1 is a broken and shortened sectional elevation of an oil well with our single acting concentric tube pump at the bottom and arranged to pump crude oil from the central tube and receive its actuating liquid pressure from the space between the central and next tube.

Figure 2 is a similar well and submerged pump, but arranged to receive its actuating liquid pressure from the central tube and discharge it from the next or surrounding tube space.

Figure 2A shows the upper part of the well shown in Figure 2.

Figure 3 shows our apparatus used in conjunction with a double acting submerged pumping mechanism arranged to alternately discharge from the inner tube and surrounding space upon the reverse application of liquid pressure to the mechanism through the tube and space respectively.

Figure 3A is the upper end of the well shown in Figure 3, and Figure 4 is an enlarged view of the lower portion of the plunger mechanism of Figure 3 so as to more clearly show the relation of the valves, packings and liquid passages.

Briefly described, our invention consists primarily of an arrangement of concentric tubes extending down a well with an entirely detached floating plunger at the bottom of the inner tube, and of forcing liquid down one of the tubes and thereby moving the plunger and forcing upward in the other tube a quantity of liquid greater than the amount of liquid displaced in the pressure applying tube.

For the double acting embodiment of my invention the actuating pressure is applied alternately to the liquid within the two tubes and alternately there is forced upward a greater amount in the discharging tube than is forced downward in the pressure applying tube.

At first glance it would seem that the liquid forced downward in the one tube by any means; say as by a piston at the top of the tube; would only force upward in the other tube a quantity equal to the amount displaced by the forcing piston in the first tube, and this would be so if the plunger were simple, but the plunger is compound and has a suction chamber filled on the return stroke and the contents of which are also forced upward in the discharging tube in addition to the normal displacement effected by the moving plunger.

In the double acting arrangement the functions are duplicated at each stroke, and in either arrangement it is only the liquid in

excess of the downwardly displaced liquid which constitutes the stroke capacity of the pump.

In the figures, 1 is the ground surface, 2 the conductor casing, 3 the water string, 4 the oil string, 5 the outer tubing, 6 the inner tubing. Sometimes additional strings of casings are used, depending on conditions, and the manner of supporting the various pipes or casings one within the other, of cementing off the water strings, etc., being all well known and constituting no feature of the present invention, have been mostly omitted from the drawings and need not be described.

In Figure 1, showing the single acting central or inner tube discharge arrangement, the inner tubing 6 has a working barrel 6' of slightly smaller internal diameter at its lower end screwed into an extension sleeve 7 resting on a tapered seat 8 in a casting 9 secured to the lower end of the outer tubing 5, and just above the extension 7 is a packer 10 tightly fitting within the bore of the casting 9, all in such a manner that the inner tube, sleeve, and packer may be pulled or placed at one time.

Within the inner tube is a compound plunger comprising an upper piston 11 working within the tubing 6 and a lower piston 12 working within the working barrel 6'.

The upper piston may be of simple construction with suitable packing rings as indicated, but the lower piston preferably has two spaced packing rings 13 which may be cup leathers or any other suitable construction and the space 14 between the rings is designed to receive clean oil under pressure from the actuating clean oil column 15 through a suitable port 16 extending from the oil space through the lower piston and through a hollow piston rod 17 connected to both pistons. The oil pressure passage 16 is separate from the main channel 18 of the hollow rod and opens through the side of the upper piston to the upper piston clean oil space 29, and the main channel 18 extends through both pistons.

Between the two pistons and seated on the shoulder 19, effected through the reduced bore of the working barrel, is a fixed cylinder head 20 consisting essentially of packing material clamped between two flanges or otherwise arranged in such a manner that it may be lowered down the inner tube to its seat and when in place its larger upper area exposed to the weight of the clean oil column as against its reduced under surface exposed to the upward pressure of the crude oil during the pumping stroke insures it staying down, and the packing being spread through oil pressure above and below it thus gripping the inside of the tube will remain in place against the frictional pull of the piston rod sliding through it, though when it is desired to pull the complete plunger by means of a grapple this cylinder head will come with it upon the application of a force greater than normally exerted upwardly against it in use.

Above the upper piston is a suitable grapple connection 21 and within the connection a discharge valve 22 which upon being lifted opens the hollow rod to the inner tube above the upper piston through ports 23.

The hollow rod channel is open to the working barrel space 27 below the cylinder head 20 through the side of the piston 12, and also open to the standing valve or main suction 24 carried in a cage below the lower piston and from which extends an intake screen or gas pilot 25.

At the upper end the inner and outer tubes are led off from each other by any suitable means so that pressure may be applied to the outer tube liquid column 15 for actuating the pump plunger and the inner tube will serve to discharge the pumped crude oil 26 and also substantially balance the outer column.

In operation, clean or filtered oil free from sand is used to fill the outer tube space to serve as the pressure transmitting liquid for working the plunger as its force on the inside edges of the piston packing rings is exerted against the entrance of sandy crude oil into the packing joints, for wherever an appreciable clearance exists a slight current of clean oil flows into the crude oil to keep the joint clean, or where the fit is perfect the clean oil pressure on one side of the joint prevents the sandy oil from entering.

Upon descent of the plunger the valve 24 lifts through the vacuum produced in lower piston space 27 and the space fills with crude oil from the well; then upon applying pressure at the upper end of the clean oil column 15 the oil is forced through the ports 28 and reacting in the upper piston space 29 between the upper piston and the fixed cylinder head 20, forces the piston upward thereby lifting the column of crude oil above it and also forcing the crude contents of suction chamber 27 through the hollow rod bore 18 and through the valve 22 into the rising column of crude oil.

Thus the volume of crude oil forced upwardly in the inner tube by the compound pump plunger is considerably greater than the volume of clean oil forced downwardly in the outer tube to operate the plunger.

Assuming now that both the inner and outer tubes terminated as stand pipes, then upon release of pressure on the clean oil column, the crude oil column, having been elevated and, through the larger area of the upper piston exposed to the crude oil, would immediately fall and force the pump plunger downward for the suction stroke and also

return the clean oil from space 29 back into the clean oil column 15.

To hasten the return stroke, I optionally also apply a pressure, through any desired agency, to the upper end of the crude oil column at the end of each discharge stroke—thus pressure may be applied to the crude oil and to the clean oil columns alternately either by piston, pumps, air, or through means of an accumulator, and whichever arrangement is chosen would simply include a two-way valve on the discharge pipe to permit the excess or pumped crude oil to flow out at each stroke.

In the action of the pump shown in Figure 1 it should be observed that tension only is put upon the hollow rod 17 during the pumping stroke. This is very important as the hollow rod might be twenty feet in length and could not be made to stand the tons of pressure in a mile deep oil well if it were used longitudinally in compression instead of tension as it would be destroyed through excessive deflection, unless very heavy.

Upon the downward or suction stroke there is little or no compression as its work is merely to open the suction chamber 27 to the crude oil flowing in from the well.

In Figures 2 and 2A the showing is similar and the well casings, tubes, etc. are similarly numbered, but the pump plunger and valve arrangement is such as to receive the actuating pressure through the inner tube 6 in this case containing the clean oil column 15 and discharge crude oil 26′ from the outer tube space.

The cylinder head 20′ is held down to its seat 19′ through exposed larger upper area as before, but this time to the crude oil, and the position of crude and clean oil in upper and lower piston spaces 29′ and 27′ is reversed as against the showing of Figure 1, the pistons 11′ and 12′ are shown broken and with simple rings, the separated rings with a clean oil space between similar to the lower piston of Figure 1 may be used where the crude oil is very sandy. The hollow piston rod 17′ is open from the lower piston space clear through the upper end of the rod without valves as shown.

Below the lower piston the working barrel 6″ forms an extended suction chamber 30 with the suction valve 24′ at the bottom and several discharge valves 31 arranged around it just below the lowest position of the lower piston 12′ for discharge of the crude oil from the suction chamber 30 to the crude oil column 26′ in the outer tube space.

The suction chamber is elongated as shown to function as a shock absorber and to which end has one or more tapered channels 32 on its inner surface so that in event the plunger descended violently the oil would escape around the piston to the discharge valves 31 in diminishing quantity.

The feature of the lower sealed joint between the inner and outer tubes as expressed by numerals 8, 9 and 10 is the same as described for Figure 1.

In operation of this species the plunger is lifted for the suction stroke by pressure applied to the crude oil column 26′ entering through ports 28′ and acting against the under side of the upper piston. The pumping stroke is in this case downward and effected through pressure on the clean oil through the hollow rod 17′ against the upper end of the lower piston, as well as against the upper end of the upper piston.

It will be seen that the major stress on the rod 17′ is tension only as before thus making the use of very long rods possible and consequent long stroke and large capacity to the pump.

The pressure of clean oil forces past the rings or in direction to prevent entrance of sand to the piston packing joints, and the working plunger and cylinder head may be pulled as with the other species.

Figures 3, 3A and 4 show the double acting species of our pump employing our liquid impulse principle of pumping.

In these figures the well structure is numbered as before, but no clean oil is used as both inner and outer tubes alternately act as actuating pressure lines and discharge pipes.

This will be easily comprehended by studying the valves and ports shown.

The compound plunger has an upper portion similar to the one shown in Figure 1 in having an upper piston 11″, lower piston 12″ connected by a hollow rod 17″ having a separate tube 16 within the rod extending from the upper piston space 29″ to the packing space 14″ between the rings 13″ of the lower piston, but in addition has a hollow rod 33 extending downwardly through a series of valves and packings at the extreme lower end of the inner tube.

The inner tube is sealed from the outer tube and from the well at the part 8″ in the casting 9″ with packer 10″ above it forced tight by the outer tube oil column above it, though the inner tube is ported to the outer tube at 34 just above the packer 10″.

The extension rod 33 passes through a double packing 34 having an oil pressure space 35 between the packings similar in arrangement to the lower piston rings 13″ and is open to oil pressure from the outer tube space through the small channel ports 36.

At the lower end of the rod 33 is a suction valve 37 for entrance of oil on the downward stroke to the lower piston suction space 27″, and surrounding the rod 33 are other suction valves 38 ported through the sides of the inner tube at 39 and arranged to deliver oil upon the upward stroke of the plunger to the sublower piston suction space 39, the oil entering through channel 40

through the lower cylinder head 41, and upon downward stroke of the plunger being ejected through a plurality of check or discharge valves 42 through ports 43 to the outer tube space.

The lower piston suction space 27″ upon upward movement of the plunger discharges its contents back through bore 18″ in the hollow rod 17″ and through upper discharge valve 22″ to the inner tube column, an additional check valve 44 preventing its going down the rod.

The upward movement of the plunger is effected by pressure on the oil in the outer tube space A acting through ports 28″ against the under side of the upper piston 11″, and the downward stroke by pressure on the oil in the inner tube acting against the upper surface of the upper piston 11″.

In this double acting arrangement the upper portion of the hollow rod is subject to tension on the upward movement of the plunger, and a longitudinal compression on the downward stroke in ejecting the oil from the sublower piston space 39.

In the double acting arrangement the plunger and all valves may be pulled through the inner tube as the lower extending portion of hollow rod 33 acts as a garbutt to engage the extreme lower valve casting 45 which seats at 46 on a ring 47 secured to the inside of the inner tube.

Having thus described our invention it will be seen to comprise an apparatus for operating a pump at the bottom of a well through liquid pressure impulses above and of discharging the pumped oil through one or both of the impulse columns at the surface of the well, and it should be clearly understood with reference to the appended claims, that when we say "alternate" impulses in the liquid columns these may both be the result of power applied alternately at the top of the columns, or through power applied to one of the columns and the other impulse resulting from the falling of the other column after having been raised by the power impulse in the first column.

We claim:

1. Apparatus for pumping a well comprising a pair of concentrically arranged tubes extending down the well and open to a reciprocating plunger pump mechanism at the bottom of the well, a liquid column in each tube arranged to bear upon opposite ends of the plunger of said mechanism whereby the plunger may be reciprocated by pressure upon the columns in alternation and suction chambers associated with the plunger adapted to alternately receive liquid from the well at opposite movements of the plunger and being valved to discharge their contents, respectively, each to one of the liquid columns upon the application of a power impulse to the other column.

2. Apparatus for pumping a well comprising a pair of concentrically arranged tubes extending down the well, a reciprocable pump plunger at the lower end of the inner tube and having no operative connection, a communication from the outer tube to the inner tube under the plunger for lifting the same upon the application of liquid under pressure to the outer tube, a column of liquid in the inner tube for forcing the plunger downward, a suction chamber associated with the plunger adapted for filling with liquid from the well upon downward movement of the plunger and valved for discharge into the inner tube upon upward movement of the plunger, and a second suction chamber associated with the plunger adapted for filling with liquid from the well upon upward movement of the plunger and valved for discharge into the outer tube upon downward movement of the plunger.

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