

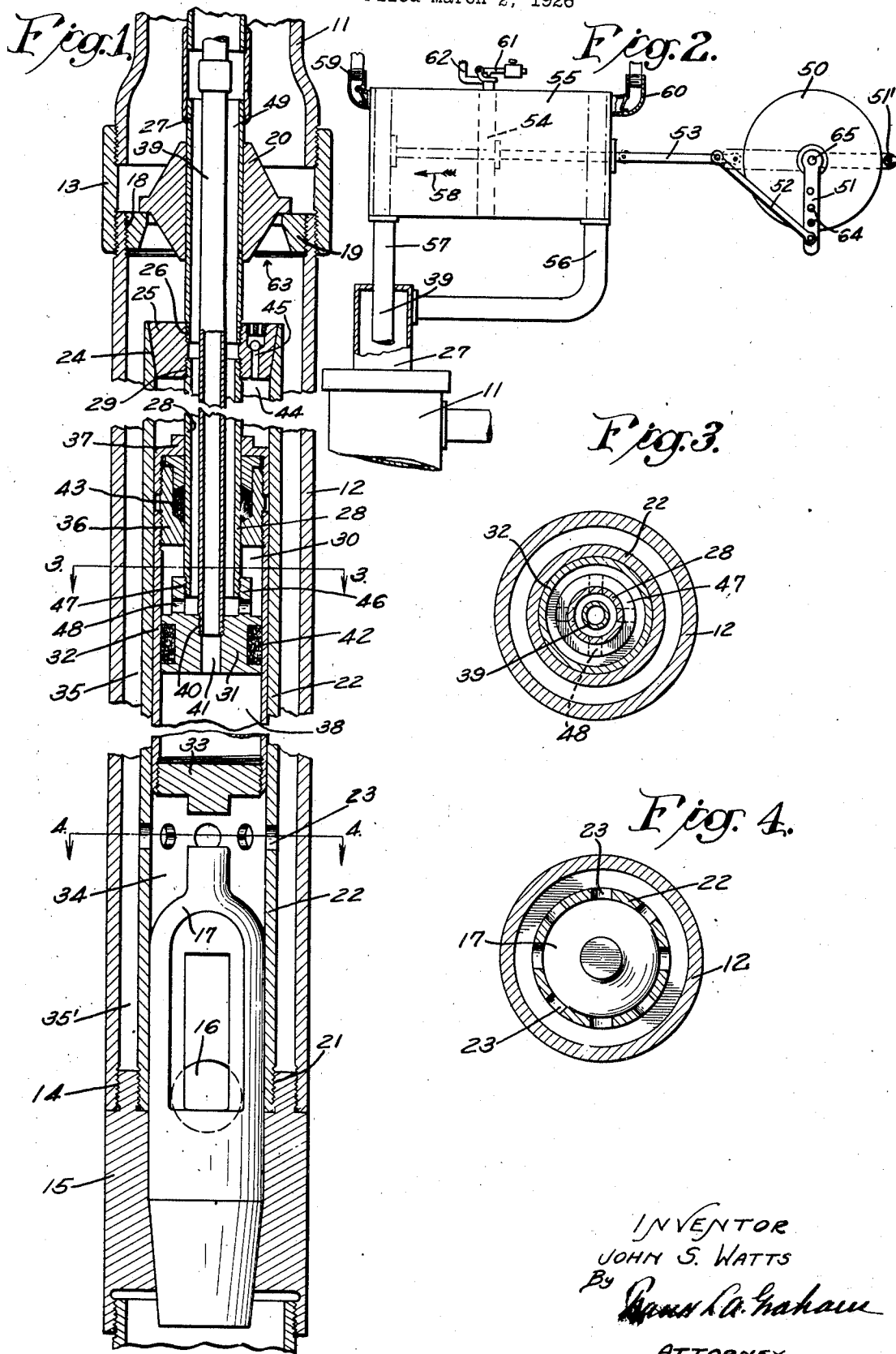
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HYDRAULIC DEEP WELL PUMP

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HYDRAULIC DEEP-WELL PUMP.

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The general character and purpose of this invention being indicated by the above title, I may state, at the outset, that my present invention relates particularly to a reciprocating pump organization in which use of ordinary sucker rods is obviated by the employment of reciprocating columns of an operating fluid, such as water; and, in preferred embodiments of my invention, in which a movable cylinder serving as a plunger within an oil pump may be reciprocated by alternate admissions of water, or the like, above and then below a fixed piston internally cooperating with said movable cylinder, the water or other power liquid may be reciprocated within stationary pipes, concentrically disposed, and carried upward through a delivery string of tubing, or the like.

It is an object of this invention to provide, in an organization of the general character referred to, means whereby the opposing pressures upon pump parts, and the consequent load upon a motor or an engine at the surface of the ground, may be approximately equalized; and, in preferred embodiments of my invention, all moving parts may be so enclosed and supported as to permit the same to be vertically withdrawn, at will, as for purposes of replacement or adjustment or repair,—the upper end of a pump cylinder being preferably slightly flared or outwardly tapered in such manner as to afford initial guidance and permanent support for a correspondingly tapered head member, to which both the outermost of said concentric pipes (extending thereabove) and the fixed piston (disposed therebelow) may be secured.

It is a further object of my invention to provide a combined pump and hydraulic motor involving few moving parts,—no valves being required either in the moving cylinder (serving as a pump plunger) or in the fixed piston, to opposite sides of which water or another power mixture is alternately delivered. The outlet valve from the mentioned pump is preferably adapted to slide upon one of the mentioned fixed pipes; and said valve may be provided with a seat having an opening so wide as to permit the upward withdrawal of a power cylinder, with the mentioned piston therein, directly upward therethrough,—the respective pipes which terminate in or below the mentioned tapered head and/or corresponding piston being preferably formed from substantially uniform sections so disposed that, instead of breaking joints, the couplings of the outer power pipe, when two power pipes are employed, come practically opposite the couplings of the inner power pipe.

It is a further object of my invention to provide, for the general purposes referred to, complete installations comprising, in addition to the mentioned moving and fixed or standing parts (constituting what I may term an oil pump with a self-contained hydraulic motor) within a well hole, energy-supplying means such as a motor or rotating member, at or near the top of the well, operating what I may term a "transmission pump" or column-reciprocator,—means being preferably provided to assure complete filling of all parts of the resultant hydraulic system and the maintenance of a predetermined pressure throughout the same,—and more than one pump being optionally run from a single source of power.

Other objects of my invention, including optional use of an outer or pump cylinder within a shell which extends from the level of an inlet valve to the level of an outlet valve (said cylinder being preferably secured only at its lower end and being provided with lateral openings near said inlet valve) and optionally including also means whereby actual changes in the effective volume of an interior organization (within which a vacuum may be intermittently produced) are effective in advancing oil past said valves, may be best appreciated from the following description of an illustrative embodiment of my invention, taken in connection with the appended claims and the accompanying drawings, in which—

Fig. 1 is a vertical section through the below-ground operating parts of an embodiment of my invention, parts being broken away.

Fig. 2 is a diagrammatic elevational view, with parts broken away, showing above-ground parts suitable for use in conjunction with a below-ground organization such as is illustrated in Fig. 1.

Figs. 3 and 4 are respectively horizontal sections in planes such as are indicated by lines 3—3 and 4—4 of Fig. 1.

Referring to the details of that specific embodiment of my invention chosen for purposes of illustration, 11 being a string of tubing for the upward delivery of pumped oil or the like, I show at 12 an outer cylindrical shell, connected directly or indirectly to said tubing,—as by means comprising a coupling 13: and the lower end of said shell may be secured, as by means of a threaded connection indicated at 14, to a standing valve body 15, shown as containing a standing valve organization comprising a ball 16, confined within a cage 17.

The upper end of the cylindrical shell 12 is shown as internally threaded at 18, to receive a transverse plate 19, providing a seat for a vertically movable outlet valve 20; and means such as an interior thread 21, near the upper end of the standing valve body 15, or its equivalent, may be employed to secure, within the mentioned shell, a pump cylinder of any preferred type,—the illustrated cylinder 22 being provided with valveless lateral openings 23 into a peripheral space, communicating with the interior of the oil delivery string by way of the valved opening in the mentioned transverse plate 19, and the unattached upper end of said pump cylinder being preferably flared or tapered as at 24, in such manner as to afford guidance and support for a similarly tapered head 25, adapted to interfit therewith and to carry operating parts and interior pipes of the general character hereinafter described, or of any preferred character.

I show the head 25 as having, at 26, an interior threaded connection with a pipe 27, through which water or another power fluid may be downwardly delivered (as by means of a pipe extension 28, shown as engaging, at 29, another interior thread in the head 25) to a space 30, above a fixed piston 31, within a movable cylinder 32,—this cylinder, by reason of the closure of the lower end thereof, as by means of a plug 33, being adopted to operate as a plunger, within the pump cylinder 22.

Although the pipe 27 and its extensions 28 are intended to remain stationary during the reciprocation of the plunger 32, or its equivalent, it will be understood that the valve 20 is intended to be slidable upon the pipe 27, to permit oil, or the like, as forced from the inner pump chamber 34, to pass through openings 23 and through a peripheral space 35, upwardly into the string 11; and, in order to admit the power fluid alternately into (a) the upper power chamber 30, shown as closed by a plug 36 (provided with a packed gland comprising a threaded cap 37) as for the purpose of elevating the cylinder 32, and into (b) a lower power chamber 38, between the piston 31 and the plug 33, I may employ means such as an inner pipe 39, shown as concentric with the pipe 27 (which,

in turn is shown as concentric with the delivery string 11) and as engaging, at 40, interior threads in the piston 31,—which may be provided with a central communicating passage 41.

Packing, of any preferred type, may be provided to obviate or minimize leakage between relatively moving parts,—as suggested at 42 and 43; and, in order to provide exit for any water or oil or other fluid which may nevertheless find entrance into an annular space 44, between the head 25 (by which the described interior parts may be largely or entirely supported) and a cap 37, movable with the interior or power cylinder 32 (serving as the pump plunger) I may provide said head with means such as a valved passage 45, through which liquid may be forced, upward and outward, incidentally to the reciprocation of said inner cylinder.

I show the standing piston 31 as provided, on its upper surface, with a collar 46, threaded at 47, to receive the lower end of the extension 28 of pipe 27, and as provided with lateral openings 48, to permit the exit of the power fluid into the upper power chamber 30, for the purpose of elevating the cylinder-plunger 32,—the subsequent descent of said cylinder plunger, as by the admission of the power fluid, through the innermost pipe 39, into the lower power chamber 38, simultaneously with an upward withdrawal of the power fluid from upper power chamber 30 through the pipe 27, being effective to force said cylinder plunger downward, with a consequent delivery of oil, or the like, by the indicated path, past the valve 20; and it will be noted that, in this described embodiment of my invention, the mentioned advances of oil, alternately upward past the valve 16 into the pump chamber 34, and from said pump chamber upward past the valve 20, result from an actual change in the effective volume of an interior organization which may be regarded as comprising so much of the pump cylinder 22 as lies above the openings 23, together with all fixed and moving parts therein.—an actual or partial vacuum being, in this embodiment of my invention, formed in the annular space 44 during each downward movement of the cylinder-plunger 32.

Although another operating fluid may be employed, as preferred, under particular conditions of use, I may, as indicated above, ordinarily fill the pipe 27 and 39 with a substantially incompressible liquid such as water; and I may impart reciprocatory movement to the respective columns of water (within a space 49 between said pipes and within the pipe 30) by means located at or near the top of the well containing the delivery string 11, or its equivalent.

For example, as suggested in Fig. 2, I may transmit motion from a motor or rotat-

ing element 50, by means of a crank 51 and a pitman 52, to a rod 53 connected with a piston 54, reciprocable within a cylinder 55,—the opposite ends of this cylinder, assumed to be filled with the mentioned power fluid, being respectively connected (as by means of a curved fitting 56 and an exterior section 57) with pipes 27 and 39,—so that, as water or another power fluid is forced downward through the pipe 39, incidentally to a movement of the piston 54 in the direction of the arrow 58, a corresponding quantity of said power fluid, forced out from the upper power cylinder 30 incidentally to the downward movement of the cylinder-plunger 32, may be permitted to rise within outer power pipe 27 and enter through the pipe 26 into the opposite end of the cylinder 55, or its equivalent.

In order to keep the entire system filled with the preferred power fluid or power fluids, regardless of some unavoidable leakage and/or temperature changes, and/or the expansion of pipes and other parts in consequence of comparatively high pressures, as may be suitable to the pumping of oils from very deep wells, I may provide the cylinder 55, or its equivalent, with one or more inlets, as suggested at 59 and 60, each of these inlets being shown as provided with an inwardly opening valve; and I may use therewith any desired means, such as a pressure relief valve 61 at any suitable point in the system, permitting a limited and conditional outflow of the pressure fluid, as through a pipe 62, to prevent internal pressure from rising above a predetermined maximum.

The general mode of operation of my hydraulic pumping system having been completely indicated in connection with the description of the respective parts thereof, I comment that the described construction entirely obviates the use of reciprocating sucker rods within deep wells,—the elasticity of said rods and the wear unavoidably incidental to the use thereof, with consequent leakage and breakage and expensive delays, being well known; and, as intimated, I prefer to provide a central opening 63 in the plate 19, constituting a seat for the valve 20, of sufficient amplitude to permit the vertical withdrawal of head 25, cylinder plunger 32, and all parts connected therewith, as for purposes of expansion, adjustment, repair or replacement.

To facilitate the connection and disconnection of the respective sections or stands into which the pipes 27 and 39 may be "broken" incidentally to the withdrawal of working parts in the indicated manner, and in order to permit unrestricted flow of the operating or power fluid past couplings, in said pipes, the respective sections or lengths of pipe used in the strings 27 and 39 may

advantageously be substantially identical; and the couplings thereon may be kept opposite one another, somewhat as suggested near the top of Fig. 1,—and optionally also opposite couplings in the delivery string 11; and, although the openings 23 in the pump cylinder 22 may be provided at any preferred level between the top of the standing valve body 15 and the lower limit of movement of the plug or cap or end 33 of the inner cylinder 32, I consider it advantageous to position the same, as shown, at a sufficient elevation to provide a space 35', within which sand or the like, may be permitted to settle, to minimize wear upon, or interference with the operation of, the valves 16 and/or 20 and/or other moving parts.

It is of course important that each of the power chambers 30 and 38 shall be of sufficient capacity to receive the power liquid forced from the cylinder 55, or its equivalent, by each stroke of the piston 54,—or by the operation of an equivalent column-reciprocator, driven by any preferred means. I consider the use of a crank, as provided by the arm 51, having a constant angular velocity, as advantageous, by reason of the resultant harmonic motion of the rod 53 and the piston 54; and, when a plurality of column-reciprocators, respectively connected with and supplying energy to pumps having self-contained hydraulic motors in different wells, are to be operated from a common prime mover or rotating member 50, I suggest that cranks, such as are indicated at 51 and 51' (each being optionally provided with a series of holes 64, to permit variations in the attachment of pitmen 52) may advantageously be spaced at an angular interval (as, at an angle of 90°) on a shaft 65, or otherwise so positioned as approximately or completely to equalize the load upon the motor or rotating element 50.

Although I have herein described a single complete embodiment of my invention, it should be understood not only that various features thereof may be independently used but also that numerous modifications might be made by those skilled in the art to which this case relates, without the slightest departure from the spirit and scope of this invention, as the same is indicated above and in the following claims.

I claim as my invention:

1. In deep well pumping means: a string of tubing for the delivery of a pumped liquid; a shell secured at one end of said string and provided with an inlet valve and an outlet valve; pipes, for an operating fluid, terminating within said shell; and an exterior pumping organization, to which said pipes extend, said pumping organization comprising a standing piston and a reciprocable cylinder serving as a plunger within a pump cylinder within said shell.

2. In deep well pumping means: a string of tubing for the delivery of a pumped liquid; a shell secured at one end of said string and provided with an inlet valve and an outlet valve; pipes, for an operating fluid, terminating within said shell; and an interior pumping organization, to which said pipes extend, said pumping organization being alternately expansible and contractible in response to varying pressures produced by reciprocations of a power liquid admitted to parts thereof through said pipes.

3. In a pumping organization responsive to alternations in pressure of a power fluid: a pump cylinder one of whose ends is closed by a head through which extends a pipe for the admission of a power fluid; a power cylinder reciprocable as a plunger within said pump cylinder; a piston within said power cylinder; and means whereby alternate admissions of said power fluid, above and below said piston, are effective to reciprocate said power cylinder as a plunger within said pump cylinder.

4. An organization of the general character defined in claim 3 in which said piston is held stationary during reciprocation of said power cylinder.

5. An organization of the general character defined in claim 3 in which a plurality of concentric passages within said pipe communicate respectively with separate chambers provided above and below said piston.

6. An organization of the general character defined in claim 3 in which one of said power chambers is closed by a plug.

7. An organization of the general character defined in claim 3 in which one of said power chambers is closed by a plug movable therewith and cooperating with a fixed head in the definition of an annular space provid-

ed with an outwardly opening valved passage.

8. For use in a deep well pumping organization of the general character described, energy-supplying means comprising a cylinder provided with an outlet pipe near each end thereof; and means, within said cylinder, for forcing a power fluid alternately out through one of said pipes, while admitting a corresponding quantity of said fluid through the other of said pipes.

9. For use in a deep well pumping organization of the general character described, energy-supplying means comprising a cylinder provided with an outlet pipe near each end thereof; means, within said cylinder, for forcing a power fluid alternately out through one of said pipes, while admitting a corresponding quantity of said fluid through the other of said pipes; and means for maintaining a substantially constant fluid pressure throughout the system comprising said cylinder and said pipes.

10. For use in a deep well pumping organization of the general character described, energy-supplying means comprising a cylinder provided with an outlet pipe near each end thereof; and means, within said cylinder, for forcing a power fluid alternately out through one of said pipes, while admitting a corresponding quantity of said fluid through the other of said pipes, each of said pipes being in continuous communication with a power chamber within a movable cylinder-plunger containing a standing piston and reciprocable within a pump cylinder.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 11th day of February, 1926.

JOHN S. WATTS.