

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
27 July 2006 (27.07.2006)

PCT

(10) International Publication Number
WO 2006/078377 A1

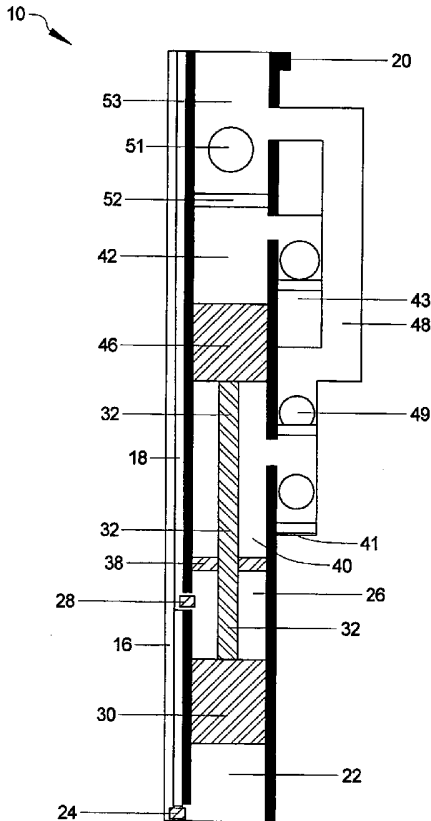
- (51) International Patent Classification:
F04B 35/02 (2006.01)
- (21) International Application Number:
PCT/US2005/045305
- (22) International Filing Date:
13 December 2005 (13.12.2005)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
11/010,641 13 December 2004 (13.12.2004) US
- (63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 11/010,641 (CIP)
Filed on 13 December 2004 (13.12.2004)
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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US (patent), UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

[Continued on next page]

(54) Title: HYDRAULICALLY DRIVEN PETROLEUM RECOVERY DEVICE AND METHOD OF USE



(57) Abstract: An improved hydraulic downhole oil recovery system that incorporates an above ground hydraulic pumping unit and a submersible, bi-directional, reciprocating downhole hydraulic slave cylinder-based pumping unit. Water, rather than hydraulic fluid, is responsible for actuating the reciprocating downhole pump unit. The water is transferred through the system using seamless, coil tubing.

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- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments* *For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

APPLICATION UNDER THE PATENT

COOPERATION TREATY

TITLE: HYDRAULICALLY DRIVEN PETROLEUM RECOVERY
DEVICE AND METHOD OF USE

5 INVENTOR: CRAWFORD, Joe

CITATION TO PARENT APPLICATION(S)

This is a continuation-in-part with respect to U.S. Patent Application 11/010,641 filed 13 December 2004 and
10 of U.S. Patent Application No. 10/884,376, filed on July 2, 2004, from both of which priority is claimed pursuant to 35 U.S.C. 120, and with respect to U.S. Application 11/010,641, priority is claimed pursuant to the Patent Cooperation Treaty.

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BACKGROUND OF THE INVENTION1. Field of The Invention

Applicant's invention generally relates to an improved downhole oil recovery system.

20

2. Background Information

Conventional oil recovery systems are hampered by limitations on both the depth and volume of oil that can be

recovered. The present invention does away with these presently accepted limitations. In fact, known oil recovery systems can generally recover 400 barrels of oil per day, at a depth of 1000 feet, using full-sized standard surface pumps. However, embodiments of applicant's invention will be able to recover 1500 barrels per day, using a fraction of the energy consumed by conventional systems. Particular embodiments of the present invention allow certain embodiments of the system to be maintained on solar energy, which is not feasible with known downhole oil recovery systems.

Conventional oil recovery systems are relatively short-lived and require a high level of maintenance in view of the present device. Current systems rely on large, cumbersome parts that are prone to leaking and causing wear and tear of standard production tubing. However, Applicant's invention provides a much smaller surface unit, with less moving parts, and incorporates coil tubing. As such, the maintenance and the risk of leaks are reduced.

A large portion of the problems associated with known oil recovery systems come from the secured-production tubing configuration of those systems. Specifically, reciprocation

of the sucker rod within the production tube causes wear and tear of the tubing. As a result, leaks often originate within the tubing at the secured reciprocation location. This leads to both inefficiency and environmental
5 contamination. Such problems are exaggerated in the common case of deviated oil wells. As will be further discussed, Applicant's invention eliminates these common problems through the novel use of coil production tubing.

Common oil recovery systems also present significant
10 problems at the surface. Surface pumps are loud, cumbersome, visually offensive, dangerous, and environmentally unfriendly. As such, restrictions are placed on both where and when these systems can be used. Prohibitive zoning restrictions are often based on the way the pumps look, how
15 they sound, and the inconvenience they cause to people in their proximity. Further, it is widely known in the art that conventional surface pumps are prone to leaking both oil and hazardous fumes. As such, environmental concerns are very high and periodic maintenance is required, all the while
20 cost of operation increases while efficiency decreases.

Surface pumps are also dangerous; each year, there are several injuries and deaths that result from the operation

of such pumps. These casualties often involve children who make their way to the pumps, drawn by curiosity, only to get caught in the moving parts.

Applicant's invention provides a refreshing solution to the problems mention above and avoids the worst characteristics associated with known surface pumps. The present invention uses only a fraction of the energy required for standard surface pumps. As such, the present invention is much smaller and quieter, is easily housed and insulated, and greatly reduces the likelihood of leaks and need for maintenance. Further, the present invention eliminates the dangers associated with surface pumps as there are no large, cumbersome moving parts.

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SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of the present invention to provide an oil recovery system that pumps oil to the surface during both its upstroke and its downstroke.

It is another object of the present invention to provide an oil recovery system that has an oil production to energy consumption ratio.

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It is another object of the present invention to provide an oil recovery system that eliminates conventional tubing wear and tear.

It is another object of the present invention to provide
5 an oil recovery system that eliminates weak tubing link unreliability.

It is another object of the present invention to provide an oil recovery system that eliminates surface leaks.

It is another object of the present invention to provide
10 an oil recovery system that eliminates pumping unit liability.

It is another object of the present invention to provide an oil recovery system that eliminates submersible pump inefficiencies.

15 It is another object of the present invention to provide an oil recovery system that may exceptionally useful in deviated oil wells.

It is another object of the present invention to present
invention to provide an oil recovery system that produces and
20 maintains relatively high volume lift in relatively low production wells.

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It is another object of the present invention to provide an oil recovery system that may be used in environmentally sensitive locations.

5 It is another object of the present invention to provide an oil recovery system that may be safely used in urban environments.

It is another object of the present invention to provide an oil recovery system that may be used in corrosive environments.

10 It is another object of the present invention to provide an oil recovery system that may be used in remote locations.

It is another object of the present invention to provide an oil recovery system that contains a surface adjustable lift capacity.

15 It is another object of the present invention to provide an oil recovery system that may be used to recover particularly deep oil deposits.

It is another object of the present invention to provide an oil recovery system that can be powered by solar energy
20 or other alternative power sources.

It is another object of the present invention to provide an oil recovery system that employs the use of coil production tubing.

It is another object of the present invention to provide
5 an oil recovery system that maintains its power piston below its production piston.

It is another object of the present invention to provide an oil recovery system that employs the use of pressure controlled surface pumps.

10 It is another object of the present invention to provide an oil recovery system that requires an exceptionally low amount of service.

It is yet another object of the present invention to provide an oil recovery system that has an exceptionally long
15 running life.

In satisfaction of these and related objects, and as will be discussed in the specification to follow, practice of the present invention involves a pressure-type pump
20 surface unit. This surface unit is modified to read and react to pressure measurements during pump cycles so that when pressure builds past a certain point at the completion

of a cycle, the unit "switches" to begin the next cycle. As mentioned, the surface unit of the present invention is of a pressure-type, and therefore is much smaller, quieter, and cleaner than standard oil well surface units.

5 The surface unit of the present invention is connected to a downhole apparatus by a pair of hydraulic power lines. The downhole unit of the present invention primarily consists of a power piston, a production piston, a connecting rod, and a series of inlets, valves, and reservoirs. Operation of the
10 system is initiated when power fluid is alternately pumped through each power line, thereby actuating a downhole power piston between a top position and a bottom position. Specifically, as fluid is pumped through the upstroke power
15 piston expands, thereby forcing the power piston upward. During the following downstroke, fluid is pumped through the downstroke power line, and the fluid volume of the reservoir above the power piston expands thereby forcing the power
piston downward.

20 A connecting rod extends from the power piston to the production piston. In holding the power piston and production piston fixed with respect to one another, the

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connecting rod traverses both a hydraulic power fluid reservoir and an oil containing reservoir. Importantly, the connecting rod, in combination with the pump barrel, forms a fluid-tight seal between the power fluid reservoir and the
5 oil reservoir. This feature allows the connecting rod to actuate between a top position and a down position while keeping the "dirty" oil environment separate from the "clean" power fluid environment.

The production piston rests along the top surface of the
10 connecting rod and is actuated between a bottom position just above the power fluid reservoir and a top position just below a one way-valve. These one-way valves are standard, "check" valves as known in the art. That is, each valve consists of a loosely seeded bearing that rests about a grooved slot.
15 Each bearing may become unseeded, thereby allowing fluid to flow in a given direction yet returns to a seeded position to prevent backflow of any fluid.

As the production piston is actuated from a bottom position to a top position, oil is cycled from a first inlet,
20 positioned below the production piston, to a first reservoir positioned between the power fluid reservoir and the production piston. During this stage, production oil

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located in a second reservoir, positioned between the production piston and a one way check valve, is forced through the check valve and to the rest of the system. Specifically, the bottom valve remains in the seeded position
5 as it rises, forcing oil through the top valve. As the bottom valve begins to lower, the top valve returns to the seeded position, preventing fluid from returning. This action also creates the vacuum that is responsible for sucking the oil through the production shaft and above the bottom valve.
10 This process is repeated through a series of valves until the oil is cycled to the surface.

As the production piston is actuated from a bottom position to a top position, oil is cycled from a second inlet, positioned above the production piston, into a second
15 reservoir positioned between the production piston and a one way check valve. During this stage, production oil located in the first reservoir, positioned between the production piston and the power fluid reservoir, is forced through an adjacent shaft leading from the first reservoir to a location
20 above the second reservoir separate by a one way valve. Said adjacent shaft also contains its own one way valve so that

fluid only flows through the shaft during the downstroke, and no backflow is permitted.

It is important to note that the general operation and the effectiveness of the present system does not depend on the exact arrangement of the component parts. Specifically,
5 the power piston may be placed below or above the production fluid reservoirs. It is easily seen that production oil may still be pumped on both an upstroke and a downstroke, with only minor changes needed in the arrangement of the system.
10 In each arrangement, the efficiency of the present system is preserved.

As mentioned, Applicant's invention circulates a water-based fluid, rather than hydraulic fluid, throughout the system. This substitution promotes both the novel design and
15 great efficiency of the present invention. More specifically, the use of water-based fluid provides for a much greater operating efficiency. That is, typical hydraulic fluid is compressible and therefore requires significantly more pump strokes to "pressure up" than a
20 column of water-based fluid. As a result, the efficiency of hydraulic fluid decreases over any appreciable distance as its compression causes wasted pump strokes, which directly

translates to lost power. Because the present system uses incompressible water-based fluid, problems associated with fluid compressibility have been eliminated. Specifically, power loss is avoided as there is no appreciable loss in efficiency due to the compression of the circulated production fluid.

Other useful embodiments of the invention are thought to utilize additives that may increase the viscosity of the water-based hydraulic fluid. Such may involve the use of "oils" to form emulsions. These embodiments are thought to be particularly useful in further reducing fluid friction and further improving operating efficiency.

However, the benefits associated with the present system do not end with use of water-based fluid. The novelty of the present invention further lies in the placement and action of the downhole pump. The downhole pump is placed below the production oil, as such, the surface unit is in a mechanically superior alignment. That is, the surface unit is responsible for actuating only the downhole pump, rather than cycling the entire production string through the production tube. This feature alone, and in conjunction with

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an efficient surface unit, provides for an extreme decrease in the energy used during production.

Devices of the past have not been successful in using coil tubing, as it has proven too difficult to incorporate
5 such tubing within the production tube itself. However, Applicant has cleared that hurdle. The present system provides for the coiled, flexible tubing contained within the production tube all the while circulating water-based fluid from the surface to the downhole pump unit. This feature
10 alone, and particularly in combination with coil production tubing, allows the present invention to be useful in deviated wells that otherwise be inaccessible.

There is a narrow range of hydraulically operated oil recovery systems known in the art. Yet, of these known
15 systems, none are believed to be operative (or operable) in reality, and at best are not able to match the advantages provided by Applicant's invention. For instance, Schulte (5,494,102) discloses a downhole operated pump having a power piston reciprocated by alternating pressurized hydraulic
20 fluid flow controlled at the surface by a hydraulic power control system which quickly reverses the flow direction.

As will be discussed below, the present inventor's invention is distinguished from Schulte in a number of ways. While Schulte teaches an apparatus having a power piston above the production piston, the present invention provides
5 for a power piston below the production piston. Such configuration provides greater efficiency and allows the present system to be operated on much less energy.

Schulte teaches a power piston that runs along the well bore itself. However, the present invention provides for a
10 power piston/production piston configuration whereby each piston is actuated within a removable housing located within the well bore. This feature provides for a straightforward maintenance or replacement scheme that is simply not available with devices known in the art.

15 Applicant's invention also provides a scheme whereby either the volume of the power piston or the volume of the production piston may be changed with respect to one another. As such, the power piston/production piston ratio may be manipulated to vary the power fluid/output fluid ratio for
20 different situations. For example the size of the power piston may be increased with respect to the production piston. This scheme will allow the present system to be

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operated on an extremely small amount of power. In fact, such embodiments are thought to operate within the range of solar power sources- this feature is not available with any known products. Alternatively, the size of the production
5 piston could be increased with respect to the power piston. This scheme will allow the present system achieve rates of oil production not generally possible. For example, the present system will be able to produce 700-800 barrels of oil per day while accepted limitations fall around 400 barrels
10 of oil a day. As mentioned, the components are housed in a removable tubing, as such, the power piston/production piston ratio may be changed in accordance with changing amounts and depths of available oil.

Applicant's invention further provides a tremendous
15 improvement in oil production efficiency. Traditional oil well pump devices can only pump oil to the surface during an upstroke. However, the present system, through employment of a double acting pump and a novel component configuration, allows for oil to be continuously pumped to the surface.
20 That is, oil is sent to the surface during both the upstroke and the downstroke. Perhaps of even greater importance, this "double action" is achieved with no greater expenditure of

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power. So, while production is double, energy consumption remains constant!

The present invention incorporates the use of coil tubing throughout the system. Coil tubing is known in the industry and is typically used to clean sand from well bores; however, no known products have been able to incorporate such tubing to transfer power fluid and provide housing for system components. In the past, fitting system components and power fluid tubing within coil tubing has proven to be too difficult. Applicant's invention, however, provides for the novel use of such tubing to transfer power fluid and house components. This feature makes Applicant's invention particularly useful in deviated oil wells when compared to presently available products.

The present invention is further distinguished over the prior art in general, and the Schulte patent in particular, by the use of water-based fluid rather than hydraulic fluid to actuate the downhole reciprocating pump unit. The substitution of water-based fluid for hydraulic fluid may appear to be a subtle distinction at first glance. Nevertheless, the use of water-based fluid in the present system has virtually eliminated the most common problems

associated with presently proposed, but impractical hydraulic recovery systems, including: the compression of production fluid circulated through the system, inflexible fluid transfer lines, fluid friction during downhole and return flow cycles,
5 and fluid viscosity.

In view of the limitations and hazards associated with traditional oil recovery systems, and the defects in presently proposed hydraulically operated oil recovery systems, a great need exists for a system that can operate
10 efficiently and safely. Through use of coil tubing, water-based fluid rather than hydraulic fluid, and a unique combination of system components, Applicant's invention eliminates problems associated with known recovery systems and provides tremendous progress in view of those systems.

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BRIEF DESCRIPTION OF THE DRAWINGS

Applicant's invention may be further understood from a description of the accompanying drawings, wherein unless otherwise specified, like referenced numerals are intended
20 to depict like components in the various views.

Fig. 1 is a schematic, cross sectional view of the downhole pumping unit of the downhole oil recovery system of the present invention.

5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to figure 1, down-hole pump portion of the improved hydraulic down-hole oil recovery system of the present invention is identified generally by the reference number 10.

10 Referring to Figure 1, the system of the present invention includes a surface pump unit (not depicted in the drawing). Surface pump unit sends a power fluid 14 (the water-based hydraulic fluid used according to the present invention) through upstroke power line 16 during one of two
15 cycles, and sends power fluid 14 through downstroke power line 18 in a following downstroke cycle.

In the preferred embodiment, the surface pump unit is a hydraulic pressure pump, modified to contain a "switch off pressure sensor" which reads the pressure at the surface pump
20 on both the upstroke and the downstroke. At the point each stroke is carried out, pressure increases beyond a preset "switch off" point where the sensor sends a signal to the

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surface pump to begin the next stroke. Further, the surface unit transfers fluid 14 by alternating pressure on both power line 16 and power line 18. Such pressure changes may be carried out in a number of ways which are known in the hydraulic arts.

In the preferred embodiment, power fluid 14 is water-based fluid. As previously discussed in the specification, the use of water-based fluid in conjunction with system 10 provides its user with a number of advantages.

Upstroke power line 16 and downstroke power line 18 both extend from surface pump unit and follow along the length of production tubing 20 in a well.

In the preferred embodiment, upstroke power line 16 and downstroke power line 18 are comprised of coiled, substantially seamless tubing. As previously discussed in the specification, power line made of this material allow the present invention to be particularly useful in deviated oil wells, but, perhaps more importantly, avoids the problems otherwise associated with the use of particularly long, jointed tubes in a hydraulic power line context.

Upstroke power line 16 leads to upstroke reservoir 22 and is connected thereto by upstroke fitting 24. Downstroke

power line 18 leads to downstroke reservoir 26 and is connected thereto by downstroke fitting 28. Both fitting 24 and fitting 28 are standard tube fittings as known in the art.

5 As the surface pump unit sends power fluid 14 through upstroke power line 16, power fluid 14 fills upstroke reservoir 22 such that its fluid volume increases, thereby actuating power plunger 30 in an upward direction so that the fluid volume of downstroke reservoir 26 decreases. Likewise,
10 as surface pump unit 12 sends power fluid 14 through downstroke power line 18, power fluid 14 fills downstroke reservoir 26 such that its fluid volume increases, thereby actuating power plunger 30 in a downward direction, so that the fluid volume of upstroke reservoir 22 decreases.

15 Again referring to figure 1, power plunger 30 is actuated between a top position and a bottom position (power piston first and second positions, respectively) where plunger 30 reaches a position just above upstroke fixture 24 at completion of the downstroke in the bottom position; and
20 where plunger 30 reaches a position just below downstroke fixture 28 at completion of the upstroke in the top position. The pressure changes in power lines 16 and 18, and resulting

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fluid volume change in reservoirs 22 and 26, respectively, is the mechanism responsible for actuating power plunger 30.

In the preferred embodiment, power plunger 30 is a "spray metal" plunger, or made of some suitable alloy and is shaped so as to form a fluid-tight fit with device 10's outer casing.

Connecting rod 32 is attached to power plunger 30 and extends therefrom. Rod 32 is of such length that connection rod 32 extends beyond pump barrel seal 38 during both the downstroke and the upstroke. Rod 32 is actuated between a top position and a bottom position where its top portion rests just above pump barrel seal 38 in a bottom position, at completion of a downstroke; and where its bottom portion rests just below pump barrel seal 38 in a top position, at completion of an upstroke.

The combination of rod 32 and pump barrel seal 38 form, in the preferred embodiment, a metal-to-metal, fluid-tight seal with approximately a 1/1000 inch clearance. As such, downstroke reservoir 26 remains completely sealed from first reservoir 40 during both the upstroke and downstroke, and more typical gasket materials, with their erosion in such harsh conditions as are typically found "down-hole" are

avoided. The resulting substantially fluid-tight seal is particularly beneficial in that it separates the clean environment of power fluid 14 from the dirty environment of the oil cycled by device 10. As previously discussed in the specification, this has not been possible with known hydraulically-driven systems.

In the alternative, a slightly "looser" fitting may be selected, whereby power fluid 14, by design, is ejected in some measure as a means for insuring lack of invasion of outside, perhaps corrosive fluids into the power piston and cylinder assembly. Such an alternative arrangement may be found appropriate in situations where particulates might score the tighter, substantially fluid-tight, metal-to-metal seal. Also, some form of corrosives-resistant "boot" , through which connecting rod 32 extends as by which it is "wiped" as it cycles, may be provided to protect the seal from particulate contamination.

Immediately above pump barrel seal 38 is first reservoir 40 into which extends the production piston end rod end of connection rod 32, in turn, connected to plunger 46 of the production piston and cylinder assembly portion of the downhole pumping unit..

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Production plunger 46 is connected to and rests just above rod 32 and is of a generally solid cylinder-form. Production piston 46 is actuated between a top position and a bottom position where piston 46 rests just above pump
5 barrel seal 38 at completion of a downstroke in a bottom position; and piston 46 reaches just below one way valve 52 at completion of an upstroke, in a top position. As previously mentioned in the specification, the volume of both production piston 46 and power piston 30 may be changed with
10 respect to one another. This change in ratio between production piston 46 and power piston 30 has particular applicability in a low production energy context.

Adjacent to first reservoir 40 is first inlet 41. In the preferred embodiment, first inlet 41 includes a one way
15 valve that allows oil to flow into first reservoir 40 during an upstroke of piston 46 (effected by upstroke of power plunger 30), but does not allow backflow. During an upstroke, production fluid (oil from the production zone of the subject well) is drawn into device 10 through first inlet
20 41 where it travels through and fills first reservoir 40.

During a downstroke, oil is pushed from first reservoir 40 by plunger 46, and flows through adjacent conduit 48, through one way valve 49, and into upper reservoir 53.

While alternatives may be employed, all one way valves depicted in the preferred embodiment are of a standard ball valve type as are known in the art. These essentially consist of a loosely-seated metal ball or bearing resting upon a complementarily contoured orifice. When the ball is fully seated little or no fluid may pass through the orifice. When pressure is exerted from below the ball or bearing, it is unseated, and fluid may pass through the orifice. However, when pressure is exerted from above the ball, it is forced even more into a sealed configuration, and little or no fluid may pass.

Second reservoir 42 is positioned between piston 46 and one way valve 52. Adjacent to second reservoir 42 is second inlet 43. In the preferred embodiment, second inlet 43 includes a one way valve that allows oil to flow into second reservoir 42 during a downstroke cycle, but does not allow backflow. During an downstroke, production fluid is drawn into device 10 through second inlet 43 where it travels through and fills second reservoir 42. During an upstroke

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production oil is pushed from second reservoir 42 by piston 46, and flows through valve 52, and into upper reservoir 53.

While the preferred embodiment discloses first reservoir 40 and second reservoir 42 as being positioned above power plunger 30, other useful embodiments are envisioned where
5 first reservoir 40 and second reservoir 42, and their respective inlets, are positioned below power plunger 30. In such case, the general relationship between components remains the same, and the effectiveness of apparatus 10
10 remains the same. In fact, the apparatus 10 is still able to pump twice the amount of oil while expending the same amount of energy.

In the case of the present system, during an upstroke cycle, bearing 51 becomes unseated and allows oil to flow
15 from second reservoir 42, through valve 52, and into upper reservoir 53. During downstroke, bearing 51 remains seated as fluid flows into reservoir 53 from adjacent conduit 48. As device 10 completes a pumping cycle, oil is continuously pushed through reservoir 53 and adjoining reservoirs or
20 production tubing, separated by other one way valves, until the oil reaches the surface.

Pumping of production oil during both directions of travel (upstroke and downstroke cycles) is one of the very things (in combination with other claimed features) that set this invention apart from the prior art. Importantly, with
5 this configuration, production of oil is virtually doubled, with minimal increase in energy consumption, versus a single-action pump at the downhole level.

Although the invention has been described with reference to specific embodiments, this description is not meant to be
10 construed in a limited sense. Various modifications of the disclosed embodiments, as well as alternative embodiments of the inventions will become apparent to persons skilled in the art upon reference to the description of the invention. It is, therefore, contemplated that the appended claims will
15 cover such modifications that fall within the scope of the invention.

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CLAIMS

I claim:

1. An improved hydraulic downhole oil recovery system,
comprising:

5 elongate, substantially seamless fluid-transfer tubes;
a hydraulic surface unit in substantially sealed fluid
communication with a hydraulic surface unit end of
said fluid transfer tubes, said hydraulic surface
unit comprising pressurized fluid transfer means
10 for transferring a pressurized fluid through said
fluid-transfer tubes; and

a submersible downhole unit, in substantially sealed
fluid communication with said hydraulic surface
unit through a substantially sealed connection with
15 a downhole unit end of said fluid transfer tubes,
said submersible downhole unit comprising:

a power piston and cylinder assembly, a power
piston component of which is actuatable over
a range of motion to and between a first power
20 piston position and a second power piston
position by differential pressure exerted on

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either side of said power piston by said
pressurized fluid,

a connecting rod extending between said power
piston and a production piston and cylinder
assembly, a production piston component of
5 which is actuatable over a range of motion to
and between a first production piston position
and a second production piston position,
where said connecting rod holds said power
10 piston and said production piston in a fixed
position with respect to one another,

a plurality of valves configured in relation to
said a production cylinder portion of said
production piston and cylinder assembly for
15 sequentially and repetitively, upon actuation
of said production piston effecting, in
response to said actuation of said production
piston:

first drawing production fluid into a first
20 portion of said production piston and
cylinder assembly and substantially
simultaneously ejecting production fluid from

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a second portion of said production piston and cylinder assembly;

second drawing production fluids into said second portion of said production piston and cylinder assembly and substantially, simultaneously ejecting production fluid from said first portion of said production piston and cylinder assembly; and

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third drawing production fluid into said first portion of said production piston and cylinder assembly and substantially simultaneously ejecting production fluid from said second portion of said production piston and cylinder assembly;

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a first effluent tube and a second effluent tube, configured, respectively, for receiving said production fluid as ejected from said first and second portions of said production piston and cylinder assembly and conveying a combination of same to a production fluid collection receptacle; and

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a hydraulic fluid comprising water.

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2. The system of Claim 1 wherein water constitutes at least one-half by volume of the constituents of said hydraulic fluid.

5 3. The system of Claim 1 wherein said connecting rod extends from respective orifices of said power piston and cylinder assembly and said production piston and cylinder assembly through orifices, the margins of which orifices are metallic and are sized and shaped to form a metal-to-metal
10 seal between said connecting rod and said margins of said orifices.

4. A method of using an improved hydraulic downhole oil recovery system comprising the steps of selecting:

15 hydraulic downhole oil recovery system, comprising:
elongate, substantially seamless fluid-transfer tubes;
a hydraulic surface unit in substantially sealed
fluid communication with a hydraulic surface
20 unit end of said fluid transfer tubes, said hydraulic surface unit comprising pressurized fluid transfer means for transferring a

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pressurized fluid through said fluid-transfer tubes; and

a submersible downhole unit, in substantially sealed fluid communication with said hydraulic surface unit through a substantially sealed connection with a downhole unit end of said fluid transfer tubes, said submersible downhole unit comprising:

a power piston and cylinder assembly, a power

10 piston component of which is actuatable over a range of motion to and between a first power piston position and a second power piston position by differential pressure exerted on either side of said power piston by said pressurized fluid,

15 a connecting rod extending between said power piston and a production piston and cylinder assembly; a production piston component of which is actuatable over a range of motion to and between a first production piston position and a second production piston position, where said

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connecting rod holds said power piston
and said production piston in a fixed
position with respect to one another,
a plurality of valves configured in relation
5 to said a production cylinder portion of
said production piston and cylinder
assembly for sequentially and
repetitively, upon actuation of said
production piston effecting, in response
10 to said actuation of said production
piston:
first drawing production fluid into a first
portion of said production piston and
cylinder assembly and substantially
15 simultaneously ejecting production fluid
from a second portion of said production
piston and cylinder assembly;
second drawing production fluids into said
second portion of said production piston
and cylinder assembly and substantially,
20 simultaneously ejecting production fluid
from said first portion of said

33

production piston and cylinder assembly;

and

third drawing production fluid into said

first portion of said production piston

5 and cylinder assembly and substantially

simultaneously ejecting production fluid

from said second portion of said

production piston and cylinder assembly;

a first effluent tube and a second effluent tube,

10 configured, respectively, for receiving said

production fluid as ejected from said first

and second portions of said production piston

and cylinder assemble and conveying a

combination of same to a production fluid

15 collection receptacle; and

a hydraulic fluid comprising water;

positioning said hydraulic surface unit substantially

at ground level and near a well bore of an oil

well;

20 positioning said submersible downhole substantially

adjacent a production zone of said oil well; and

34

actuating said system for producing oil from said oil well.

5. The system of Claim 4 wherein water constitutes at least one-half by volume of the constituents of said hydraulic fluid.

6. The system of Claim 4 wherein said connecting rod extends from respective orifices of said power piston and cylinder assembly and said production piston and cylinder assembly through orifices, the margins of which orifices are metallic and are sized and shaped to form a metal-to-metal seal between said connecting rod and said margins of said orifices.

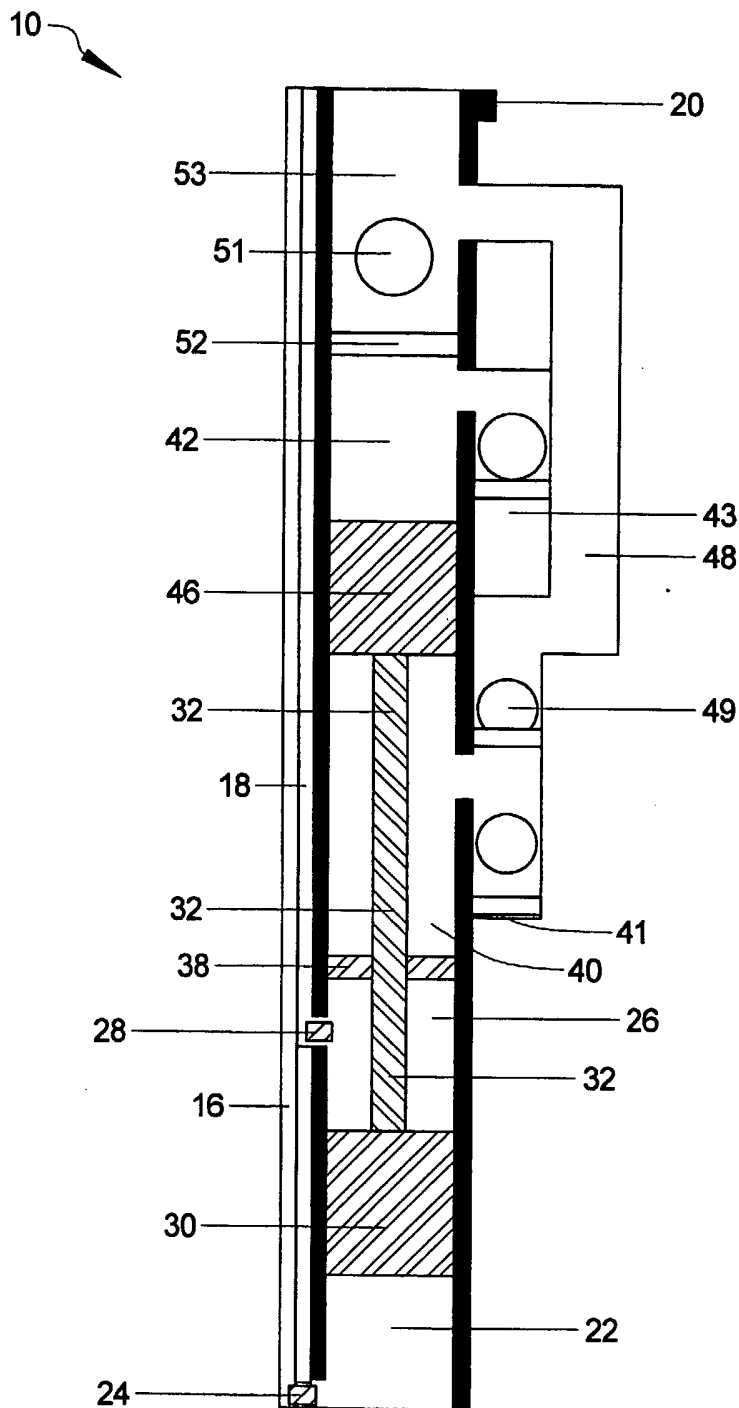


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US05/45305

A. CLASSIFICATION OF SUBJECT MATTER
 IPC: F04B 35/02(2006.01)

 USPC: 417/403,404
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 U.S. : 417/403,404

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,403,919 A (STANTON et al) 13 September 1983 (13.09.1983), see entire document.	1-6
X	US 1,851,801 A (BOONE) 29 March 1932 (29.03.1932), see entire document.	1-6

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:			
"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search: 06 May 2006 (06.05.2006)
 Date of mailing of the international search report: 07 JUN 2006

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