



US 20070292277A1

(19) **United States**(12) **Patent Application Publication**
Grenke(10) **Pub. No.: US 2007/0292277 A1**(43) **Pub. Date: Dec. 20, 2007**(54) **WELLHEAD DRIVE BRAKE SYSTEM**(52) **U.S. Cl. 417/212**(76) **Inventor: Edward Grenke, Edmonton (CA)**

Correspondence Address:

DIMOCK STRATTON LLP**20 QUEEN STREET WEST SUITE 3202, BOX****102****TORONTO, ON M5H 3R3 (CA)**(21) **Appl. No.: 11/757,639**(22) **Filed: Jun. 4, 2007**(30) **Foreign Application Priority Data**

Jun. 9, 2006 (CA) 2,550,066

Publication Classification(51) **Int. Cl.****F04B 49/00**

(2006.01)

(57) **ABSTRACT**

The present invention provides in one aspect a braking mechanism for slowing the release of torsional potential energy in a rod string of a wellhead drive system on the shutdown or power failure thereof. The braking mechanism, without using a slip clutch, slows the backspin of the rod string by using the rotational energy of the rod string to turn a fluid pump to pump fluid through a constriction orifice in a closed fluid circuit. The present invention reduces the space required for the braking mechanism and moreover reduces the number of moving parts within the braking mechanism which may reduce the likelihood that the braking mechanism will require maintenance or fail, as well as reduce the manufacturing cost. In another aspect, the present invention provides a wellhead drive system for driving a rotary downhole pump which includes the inventive braking mechanism described above.

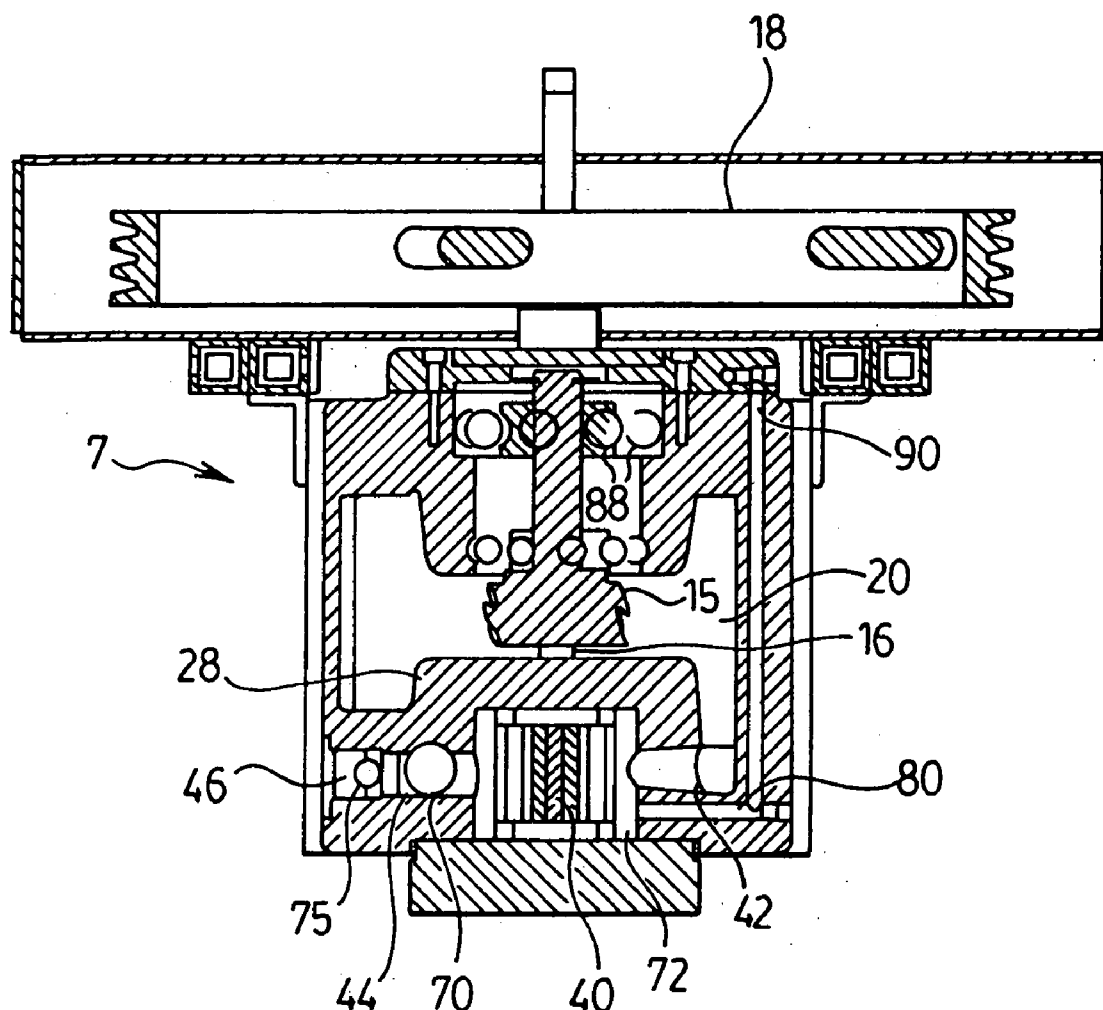
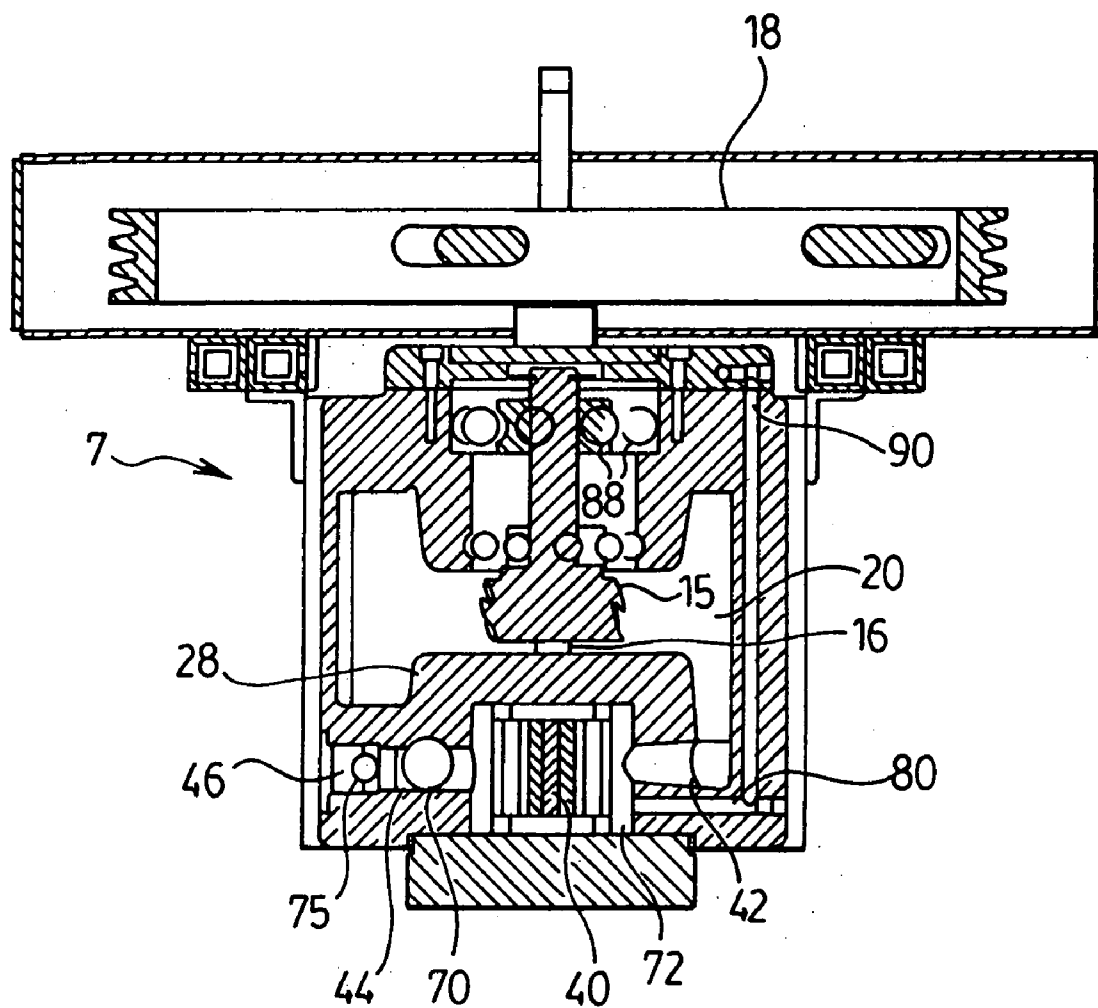


FIG. 2.



WELLHEAD DRIVE BRAKE SYSTEM

FIELD OF THE INVENTION

[0001] This invention relates to oil production equipment. In particular, the invention relates to an improved braking mechanism for a wellhead drive system and a wellhead drive system including said improved braking mechanism.

BACKGROUND OF THE INVENTION

[0002] In the past, many conventional oil wells were serviced by a downhole pump at or close to the bottom of the well, the pump being of a conventional reciprocating kind actuated by a rod string, in turn reciprocated vertically by a pump jack.

[0003] Many of these older reciprocating pumps have been replaced by rotary-drive progressive cavity pumps. Such rotary pumps are particularly suited for the production of crude oil laden with sand and water.

[0004] However, because of the typical depth of an oil well, the torque applied at the top of the rod string, and the resistance of the pump at the bottom, can cause the rod string to wind up like a spring, thus storing the torque energy. Whenever there is a power failure or the system is shut down, this stored torque energy, along with the energy created by the fluid head on the pump, must release itself. Without any control on the rate of backspin of the rod string, serious problems have occurred, for example:

[0005] the motor, connected to the rod string through a reducer and a sheave and pulley arrangement, may reach reverse speeds exceeding safe limits. These speeds tend to damage the motor, and may even cause it to explode;

[0006] one or both of the sheaves can reach speeds exceeding their limits;

[0007] on drive configurations in which the polish rod extrudes out the top of the drive, the projecting portion can bend and break, and the broken-off portion will then be flung away from the installation, due to centrifugal force; and/or

[0008] without some form of braking, the rod string could uncouple, with the result that the rod string and the pump would be lost down the hole.

[0009] U.S. Pat. No. 6,152,231 issued Nov. 28, 2000 to Grenke, which is incorporated herein by reference, addresses the above problem and describes a braking mechanism for controlling the release of energy in a rod string for a down-well rotary pump. The braking mechanism incorporates a rotary member positioned in the energy loop from a motor to the top end of the rod string, requiring that the rotary member rotate at a consistent speed ratio and direction with respect to the top end of the rod string. The rotary member drives a fluid pump through a slip clutch so that when the top end of the string rotates in the normal direction, the clutch slips and does not run the fluid pump. However, when the top end of the rod string seeks to rotate in the opposite direction, for example on shut down or power failure, the fluid pump is operated to pump fluid from a reservoir and back to the reservoir in a closed loop which includes a mechanism for restricting fluid. The fluid pump is separate from the wellhead drive system and connected via the clutch and couplings.

[0010] Although an effective safety feature, the slip clutch requires additional moving parts, increasing the cost and maintenance requirements for the drive device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In drawings which illustrate by way of example only a preferred embodiment of the invention,

[0012] FIG. 1 is a sectional view of the wellhead drive system according to the preferred embodiment; and

[0013] FIG. 2 is a sectional view of the braking mechanism according to the preferred embodiment, taken at right angles to the section of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

[0014] In one aspect, the present invention provides a braking mechanism which, without using a slip clutch, slows the backspin of a rod string by using the rotational energy of the rod string to turn a fluid pump to pump fluid through a constriction orifice in a closed fluid circuit. As compared to the prior art described in the background, the present invention reduces the space required for the braking mechanism and moreover reduces the number of moving parts within the braking mechanism which in turn may reduce the likelihood that the braking mechanism will require maintenance or fail, as well as reduce the manufacturing cost.

[0015] In another aspect, the present invention provides a wellhead drive system which employs the inventive braking mechanism in a wellhead drive system for driving a pump, for example a progressive cavity pump.

[0016] A preferred embodiment of the braking mechanism of the present invention is accomplished by providing for use with a pumping system in which a downhole pump has a rotor which is rotated by a rod string which is in turn rotated by a motor, a braking mechanism for slowing the release of torsional potential energy in the rod string when the motor stops, the mechanism comprising: a rotary member rotationally coupled to the top end of the rod string; a reservoir containing a dampening fluid; a fluid pump driven by the rotary member, interposed into a closed fluid circuit with the reservoir, the fluid circuit comprising: a one-way valve allowing dampening fluid to flow between the reservoir and the fluid pump in a first direction corresponding to normal operation of the downhole pump, the one-way valve including a valve orifice having a valve orifice area that does not substantially restrict the free flow of the dampening fluid during normal operation of the downhole pump; and a constriction orifice allowing the dampening fluid to flow between the reservoir and the fluid pump in a direction opposite to the first direction, the constriction orifice having an orifice area which substantially restricts the flow of the dampening fluid through the fluid circuit as potential torsional energy is released from the rod string; whereby if the motor stops the potential torsional energy in the rod string is dissipated by controlled rotation of the rod string in a direction opposite to the first direction.

[0017] A preferred embodiment of the wellhead driving system of the present invention is accomplished by providing a wellhead drive system for driving a downhole pump including a rotor comprising: a rod string having a top end and a bottom end, the bottom end being connected to, supporting and rotating the rotor; a motor providing torque energy for rotating the top end, whereby torsional potential energy is stored in the rod string during operation; and a

braking mechanism for slowing the release of torsional potential energy in the rod string when the motor stops, the mechanism comprising: a rotary member rotationally coupled to the top end of the rod string; a reservoir containing a dampening fluid; a fluid pump driven by the rotary member, interposed into a closed fluid circuit with the reservoir, the fluid circuit comprising: a one-way valve allowing dampening fluid to flow between the reservoir and the fluid pump in a first direction corresponding to normal operation of the downhole pump, the one-way valve including a valve orifice having a valve orifice area that does not substantially restrict the free flow of the dampening fluid during normal operation of the downhole pump; and a constriction orifice allowing the dampening fluid to flow between the reservoir and the fluid pump in a direction opposite to the first direction, the constriction orifice having an orifice area which substantially restricts the flow of the dampening fluid through the fluid circuit as potential torsional energy is released from the rod string; whereby if the motor stops the potential torsional energy in the rod string is dissipated by controlled rotation of the rod string in a direction opposite to the first direction.

[0018] FIG. 1 illustrates the wellhead drive system 5 according to the preferred embodiment. The wellhead drive system 5 operates with a pump, for example a progressive cavity pump (not shown), to pump well fluids to the surface. Rod string 34 comprises a long rod that transfers the torque derived from the motor 10 to the progressive cavity pump down the well. In the preferred embodiment, rod string 34 passes through a main hollow shaft 35 in gear box 36 and is connected to the top of the hollow shaft 35 by a drive cap 37 or clamp.

[0019] In the preferred embodiment shown in FIG. 1, the motor 10 has a substantially vertical drive shaft 12 carrying a first sheave 14. The main hollow shaft 35 comprises an elongate and substantially vertical body carrying a second sheave 18. A belt (not shown) is entrained over the first sheave 14 and the second sheave 18 so that the motor 10 may drive the rotation of the rod string 34. The motor 10 may alternatively drive the main hollow shaft 35 via any suitable means, including a chain drive or a gear drive.

[0020] During operation of the wellhead drive system 5, when the motor 10 is initially started the rod string 34 makes a number of turns before the progressive cavity pump starts to turn, building up torsional potential energy along the length of the rod string 34. When the system is shutdown for planned maintenance or due to a power outage, this torsional potential energy is released via the backspin of rod string 34.

[0021] In addition, the fluid head above the progressive cavity pump creates a back-pressure on the pump which adds to the backspin of the rod string 34. Depending on the viscosity of the fluid being pumped, this fluid head can push down on the progressive cavity pump with enough force to cause the downhole pump to act as a motor, rotating the rod string 34 in a direction opposite the direction of rotation during normal operation. The braking mechanism of the present invention allows for the torsional potential energy to be released in a controlled manner. As long as there is enough fluid above the downhole pump to cause the pump to turn in reverse, the braking mechanism will continue to operate, slowing the rate of backspin.

[0022] A braking mechanism 7 according to the preferred embodiment is illustrated in FIG. 2. The braking mechanism 7 includes a rotary member such as a pinion shaft 16. A pinion gear 15 is mounted on the pinion shaft 16. The pinion gear 15 engages a gear wheel 19 mounted to the main hollow

shaft 35. The pinion shaft 16 is an elongate shaft mounted parallel to the rod string 34, and extends through the interior of a reservoir such as reservoir 20. The reservoir 20 includes a bottom wall 28. The pinion shaft 16 passes through the bottom wall 28, but is sealed thereagainst to prevent leakage.

[0023] Shafts 16 and 35 may be operatively interconnected in various ways. The preferred embodiment, as shown in FIG. 1, uses a variant where each of the shafts 16 and 35 carries a gear, the two gears meshing in such a way that the ratio of rotation between the shafts 16 and 35 remains constant (with the shafts rotating in opposite directions). Another variant involves the provision of a sprocket on each of the shafts 16 and 35, along with a chain engaging both sprockets. In this second variant, the shafts 16 and 35 would rotate in the same direction. Other transmission means may also be suitable to rotate the pinion shaft 16 as the main hollow shaft 35 rotates.

[0024] Referring again to the preferred embodiment of the braking mechanism 7 shown in FIG. 2, a fluid pump such as a gear pump 40 is interposed into a closed fluid circuit with the reservoir 20. Gear pump 40 is disposed in a gear pump chamber 72 in fluid communication with a first conduit 42 and a second conduit 44. The gear pump 40 is connected directly to the pinion shaft 16, and rotates as the pinion shaft 16 is rotated by the main hollow shaft 35. It will be appreciated that the fluid pump does not need to be a gear pump, and a different type of pump may be used. A different transmission mechanism may also be used.

[0025] The second conduit 44 includes two orifices: a constriction orifice 75 and a free-flow orifice formed by a one-way valve such as a check valve 70. The cross-sectional area of the check valve 70 is preferably at least as large as the cross-sectional area of the conduits 42, 44, while the cross-sectional area of the constriction orifice 75 is considerably smaller, to restrict the flow of dampening fluid in the manner described below. The check valve 70 and the constriction orifice 75 are in communication with a conduit 49 (shown in FIG. 1) in fluid communication with the reservoir 20.

[0026] The reservoir 20 is filled with a preferably viscous dampening fluid, such as oil, to a level that immerses the pinion gear 15 in the fluid. The fluid is used to dampen or retard the backspin of the rod string 34 in the manner described below.

[0027] Gear pump 40 is able to turn in both directions. During operation of the wellhead drive system 5, when the gear pump 40 is turning during normal operation the dampening fluid is suctioned from the reservoir 20 through the conduit 49 and check valve 70, through the second conduit 44 and into the gear pump chamber 72. Fluid will also be suctioned through the orifice 75, which also flows through the second conduit 44 and into the gear pump 40 chamber 72. The gear pump 40 then pumps the dampening fluid back to the reservoir 20 through the first conduit 42.

[0028] When the wellhead drive system 5 shuts down for any reason, the rod string 34 will attempt to spin backwards as the torsional potential energy is released. This will cause rotation of the hollow shaft 35, which in turn will rotate the pinion shaft 16 through the meshing gears. When the rod string 34 goes into backspin, the gear pump 40 suctions dampening fluid from the reservoir 20 through first conduit 42 and into the gear pump chamber 72. The pinion shaft 16 rotates in reverse under the force of the back-spinning rod string 34, which drives the gear pump 40 in reverse, causing the dampening fluid to be suctioned from the reservoir 20

through the first conduit 42 and into the gear pump chamber 72. However, the check valve 70 does not permit the dampening fluid being discharged into conduit 44 to flow through the large orifice, so the gear pump 40 is constrained to pumping the fluid through the constriction orifice 75 in the second conduit 44 and back to the reservoir 20. Since the constriction orifice 75 has an orifice area that is significantly less than the valve orifice area of the orifice of the check valve 70, fluid flow rate is restricted commensurately and the resistance to the flow of the dampening fluid opposes the backspinning force of the rod string 34, causing the rod string 34 to unwind slowly, releasing the torsional potential energy in a controlled fashion.

[0029] Since both the first conduit 42 and the second conduit 44 communicate with the interior of the reservoir 20, through sealed openings (not shown), which in the embodiment shown contains the pinion gear 16, the lubricating oil for the wellhead drive system 5 (which is used to lubricate the pinion gear 15 anyway) can be advantageously used as the dampening fluid. Thus, in the preferred embodiment a lubrication conduit 80 located downstream of the gear pump discharge during normal operation of the wellhead drive system 5 communicates a small portion of the oil to lubricate the top bearings 88 of the gearbox 36. Lubrication conduit 80 also includes a small one-way valve such as a check valve 90 that keeps air from entering the integral gear pump 40 during backspin of the rod string 34. However, in alternate embodiments a separate reservoir can be employed to contain a dampening fluid that is separate from the lubricating fluid.

[0030] According to the preferred embodiment of the braking mechanism 7, an adjustable flow control such as flow control valve 46 may be interposed upstream of the orifice 75 in the second conduit 44. This provides a manually adjustable control to the braking mechanism 7 in order to controllably restrict the flow of dampening fluid through orifice 75. Actuation of the adjustable flow control 46 allows the backspin of the rod string 34 to be varied from a controlled backspin to a virtual standstill. When the flow control valve 46 is substantially fully opened, the rod string 34 will be allowed to backspin at a relatively slow rate of rotation, as fluid from the reservoir 20 is continuously pumped in a closed loop by the gear pump 40. When the flow control valve 46 is substantially closed, the rod string 34 will be brought to a virtual standstill because the gear pump is stalled by the inability to pump fluid through the second conduit 44. The addition of the adjustable flow control 46 is optional and allows for visual inspection of the drive system 5 following a fault condition.

[0031] Various embodiments of the present invention having been thus described in detail by way of example, it will be apparent to those skilled in the art that variations and modifications may be made without departing from the invention. The invention includes all such variations and modifications as fall within the scope of the appended claims.

What is claimed is:

1. For use with a pumping system in which a downhole pump has a rotor which is rotated by a rod string which is in turn rotated by a motor, a braking mechanism for slowing the release of torsional potential energy in the rod string when the motor stops, the mechanism comprising:

a rotary member rotationally coupled to the top end of the rod string;

a reservoir containing a dampening fluid;

a fluid pump driven by the rotary member, interposed into a closed fluid circuit with the reservoir, the fluid circuit comprising:

a one-way valve allowing dampening fluid to flow between the reservoir and the fluid pump in a first direction corresponding to normal operation of the downhole pump, the one-way valve including a valve orifice having a valve orifice area that does not substantially restrict the free flow of the dampening fluid during normal operation of the downhole pump; and

a constriction orifice allowing the dampening fluid to flow between the reservoir and the fluid pump in a direction opposite to the first direction, the constriction orifice having an orifice area which substantially restricts the flow of the dampening fluid through the fluid circuit as potential torsional energy is released from the rod string;

whereby if the motor stops the potential torsional energy in the rod string is dissipated by controlled rotation of the rod string in a direction opposite to the first direction.

2. A wellhead drive system for driving a downhole pump including a rotor comprising:

a rod string having a top end and a bottom end, the bottom end being connected to, supporting and rotating the rotor;

a motor providing torque energy for rotating the top end, whereby torsional potential energy is stored in the rod string during operation; and

a braking mechanism for slowing the release of torsional potential energy in the rod string when the motor stops, the mechanism comprising:

a rotary member rotationally coupled to the top end of the rod string;

a reservoir containing a dampening fluid;

a fluid pump driven by the rotary member, interposed into a closed fluid circuit with the reservoir, the fluid circuit comprising:

a one-way valve allowing dampening fluid to flow between the reservoir and the fluid pump in a first direction corresponding to normal operation of the downhole pump, the one-way valve including a valve orifice having a valve orifice area that does not substantially restrict the free flow of the dampening fluid during normal operation of the downhole pump; and

a constriction orifice allowing the dampening fluid to flow between the reservoir and the fluid pump in a direction opposite to the first direction, the constriction orifice having an orifice area which substantially restricts the flow of the dampening fluid through the fluid circuit as potential torsional energy is released from the rod string;

whereby if the motor stops the potential torsional energy in the rod string is dissipated by controlled rotation of the rod string in a direction opposite to the first direction.