

PATENT APPLICATION**SUCTION PORT LOCK NUT WITH STUB BUTTRESS THREADS****CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims priority to and the benefit of co-pending U.S. Provisional Application Ser. No. 61/138,776, filed December 18th, 2008, the full disclosure of which is hereby incorporated by reference herein.

1. Field of the Invention:

[0002] The present invention relates in general to reciprocating pumps and, in particular, to an improved apparatus for a locking nut in a reciprocating pump.

2. Description of Related Art

[0003] In oil field operations, reciprocating pumps are often used for various purposes. Some reciprocating pumps, generally known as "service pumps," typically pump service fluids used for downhole operations such as cementing, acidizing, or fracing a well. These service pumps may typically operate for relatively short periods of time, but on a frequent basis such as several times a week. Often they are mounted to a truck or a skid for transport to various well sites.

[0004] The oil field reciprocating pumps typically include a plunger that reciprocates within a cylinder for pumping fluid through a cylinder. The cylinder generally includes a fluid inlet and a fluid outlet. An opening in the pump provides access to an interior of the cylinder. The opening is typically sealed with a threaded suction cover that can be removed from the cylinder.

Summary of the Invention

[0005] Disclosed herein is reciprocating pump assembly that includes a block body, a cylinder chamber in the block body, a plunger reciprocatingly disposed in the block body, an opening in the block body adjacent the cylinder chamber, threads formed in the opening, a cover plate in the opening, and a threaded surface on the outer periphery of the cover plate engaging the threads formed within the opening and projecting within the block body past the threads on the opening. The threaded surface on the cover plate may include at least two unloaded threads that project within the block body past the threads in the opening. The threaded surfaces on the cover plate can have a length of loaded threads that engage the threads in the opening, and a length of unloaded threads that project within the block body past the threads in the opening and the length of loaded threads is greater than the length of the unloaded threads. The threaded surface on the outer periphery of the cover plate can include threads having a root portion with a curved profile. The threaded surface on the outer periphery of the cover plate may have British Butt threads. The threaded surface on the outer periphery of the cover plate can include threads having a thread depth that is from about 60% to about 70% of the thread pitch. The threaded surface on the outer periphery of the cover plate can include threads having a truncated crest. At least some of the unloaded threads can be substantially identical to the loaded threads. The threaded surface on the outer periphery of the cover plate may include threads having a rear flank disposed along a path oriented at an angle of about 45° with respect to the angle of the cover plate axis.

[0006] Also described is a reciprocating pump assembly that includes a cylinder block, cylinder chambers formed in the block, a plunger reciprocatingly disposed in each cylinder chamber, circular openings in the block at an end of each chamber, a thread formed in the openings, and cover plates. Where each cover plate has a thread formed on its outer circumference, at least a portion of the length of the thread being fully formed and at a maximum depth, the cover plates

coaxially coupled into each opening so that the maximum depth portion of each cover plate thread engages the portion of each thread in the openings proximate the ends of each chamber. Part of the maximum depth portion of each cover plate thread can be out of engagement with and further inward from the thread in the opening.

[0007] In an optional embodiment, a pump assembly is described having, a block body, a cylinder chamber in the block body, a plunger reciprocatingly disposed in the block body, an opening in the block body adjacent the cylinder chamber, threads formed in the opening, a cover plate in the opening, a threaded surface on the outer periphery of the cover plate engaging the threads formed within the opening and having at least two unloaded threads projecting within the block body past the threads on the opening, and a length of loaded threads that exceeds the length of the unloaded threads.

Brief Description of the Drawings:

[0008] Figure 1 is a side perspective view of a reciprocating pump in accordance with the present disclosure.

[0009] Figure 2 is a side partial sectional view of the pump of Figure 1.

[0010] Figure 3 is an enlarged side sectional view of a portion of the valve stop assembly of Figure 2.

[0011] Figure 4 is a side sectional view of a retainer nut of the valve stop assembly of Figure 3.

[0012] Figure 5 is an enlarged sectional view of a threaded portion of the retainer nut.

Detailed Description of the Invention:

[0013] The apparatus and method of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. This subject of the present disclosure may, however, be embodied in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout. For the convenience in referring to the accompanying figures, directional terms are used for reference and illustration only. For example, the directional terms such as "upper", "lower", "above", "below", and the like are being used to illustrate a relational location.

[0014] It is to be understood that the subject of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments of the subject disclosure and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0015] A reciprocating pump assembly 10 is illustrated in FIG. 1 in a side perspective view. The assembly 10 includes a pump section 12 coupled to a fluid cylinder portion 11. A crankshaft housing 13 is shown covering the pump section 12 and shielding its components. A plunger or plunger rod 16 assembly is shown projecting from a side of crankshaft housing 13 to the cylinder section 11. Stay rods 15 adjacent the rod assembly 16 anchor the cylinder section 11 to the pump section 10. The cylinder section 11 includes a cylinder block 17 having multiple cylinder chambers 39 (shown in dashed outline). Each cylinder chamber 39 is shown herein in alternating

fluid communication with a fluid inlet 19 and a fluid outlet 21. Each cylinder chamber 39 end is capped with a suction cover plate 22. An opening 18 is formed in the cylinder block 17 configured to receive a cover plate 22. The pump assembly 10 can easily be mounted to a trailer that can be towed between operational sites, or to a skid such as for offshore operations.

[0016] Referring now to FIG. 2, an example of the pump assembly 10 is illustrated in a side sectional view. In this example, a plunger 35 is shown reciprocatingly disposed within one of the cylinder chambers 39. Although a single plunger 35 is illustrated, each cylinder chamber 39 may include a corresponding plunger 35. Each cylinder chamber 39 and plunger 35 comprise what may be referred to as a plunger throw, thus the pump assembly 10 of FIG. 1 comprises three plunger throws. Pump assembly 10 embodiments exist having other than three plunger throws (i.e. a triplex), such as pump assemblies having four or more plunger throws.

[0017] A rotatable crankshaft 25 is shown within the crankshaft housing 13 and as will be described in more detail below, reciprocates the plunger 35 within the cylinder chamber 39 when it is rotated. The crankshaft 25 includes a main shaft 30 that connects to and is rotated by a motor (not shown). In one embodiment, a flywheel gear 24 is illustrated mechanically connecting to the crankshaft 25. Teeth on the flywheel gear 24 mesh with teeth on a drive gear 26, and the drive gear 26 is attached to the motor. A crank pin 28 attaches to the main shaft 30, shown offset from and substantially parallel to the axis A_X of the crankshaft 25. An elongated connector rod 27 is depicted having an end anchored around the crank pin 28 with a bearing surface therebetween enabling the crank pin 28 to rotate with respect to the connector rod 27. In the embodiment of FIG. 2, the crank pin 28 is offset from the axis A_X of the crankshaft 25, so when the crankshaft 25 rotates, the crank pin 28 orbits the axis A_X of the crankshaft 25. The rotatable connection between the end of the connector rod 27 and crank pin 28 causes the connector rod 27 to reciprocate.

[0018] A cross head pin 31 attaches the connector rod 27 to a cross head 29 on the end of the connector rod 27 opposite where it attaches to the crank pin 28. As shown in FIG. 2, the connector rod 27 is substantially horizontally oriented; as the crankshaft 25 rotates, the connector rod 27 will be oblique to horizontal. The cross head pin 31 allows the connector rod 27 to pivot with respect to the crosshead 29. The crosshead 29 is shown disposed within a horizontally oriented crosshead housing 32. Thus as the crank pin 28 orbits with crankshaft 25 rotation, the attached connector rod 27 pivots and moves laterally back and forth within the housing 13 to reciprocate the crosshead 29 within the crosshead housing 32. A plunger rod 33 is illustrated connected between the crosshead 29 and the plunger 35, thus when the crosshead 29 is reciprocated by the rotation of the crankshaft 25, the plunger 35 is also reciprocated within the cylinder chamber 39.

[0019] An example of an inlet valve 41 is depicted within the cylinder block 17 and controls fluid from the fluid inlet 19 into the cylinder chamber 39. The inlet valve 41 can open as the plunger 35 reciprocates out of the chamber 39 to introduce fluid into the chamber 39, and as the plunger 35 reciprocates back into the chamber 39, the inlet valve 41 closes to isolate the chamber 39 from the fluid inlet 19. As plunger 35 moves longitudinally away from cylinder chamber 39, the pressure of the fluid inside chamber 39 decreases creating a differential pressure across inlet valve 41, which actuates valve 41 and allows the fluid to enter cylinder chamber 39 from fluid inlet 19. The fluid being pumped enters cylinder chamber 39 as plunger 35 continues to move longitudinally away from cylinder block 17 until the pressure difference between the fluid inside chamber 39 and the fluid in fluid inlet 19 is small enough for inlet valve 41 to actuate to its closed position.

[0020] Fluid in the chamber 39 pressurized by the inwardly reciprocating plunger 35 is directed to a fluid outlet 21 shown formed within the cylinder block 17 and adjacent the cylinder

chamber 39. An outlet valve 43 is also shown in the cylinder block 17 set between the fluid outlet 21 and a cylinder block discharge 44. The outlet valve 43 controls fluid from the fluid outlet 21 to the cylinder block discharge 44. As plunger 35 begins to move longitudinally towards cylinder block 17, the pressure on the fluid inside of cylinder chamber 39 begins to increase, and continues to increase until the differential pressure across outlet valve 43 exceeds a set point. When the set point is exceeded, the outlet valve 43 opens to allow the fluid to exit cylinder block 17 through fluid outlet 21. In one embodiment, fluid is only pumped across one side of plunger 35, therefore pump assembly 10 is a single-acting reciprocating pump. Valves 41 and 43 can be spring-loaded valves actuated by a predetermined differential pressure.

[0021] A suction valve stop assembly 51 is illustrated in the cylinder block 17 adjacent the suction cover plate 22. The suction valve stop assembly 51 comprises two primary components: a suction valve stop 53 and suction cover 55. The suction cover 55 is generally cylindrical in shape and is designed to be mounted sealingly in opening 18 in the cylinder block 17.

[0022] Additional crank pins 28 may optionally be provided that are shown illustrated offset from the crankshaft axis A_X and at different locations around the circumference of the crankshaft 25. This alternates when fluid is pumped from each cylinder chamber 39 within the cylinder block 17. As is readily appreciable by those skilled in the art, alternating the cycles of pumping fluid from each of cylinder chambers 39 helps minimize the primary, secondary, and tertiary (et al.) forces associated with pump assembly 10.

[0023] Referring now to FIG. 3, illustrated is an enlarged side sectional view of the suction cover plate 22 coupled to the opening 18 within the cylinder block 17. The suction cover plate 22 includes threads 222 on its outer periphery shown mated with correspondingly formed threads 172 on the opening 18 circumference. As shown, the threads 222 extend the entire width of the suction cover plate 22 and exceed the axial distance of the threads 172 of the opening 18.

Accordingly, some portion of the threads 222 on the cover plate 22 do not engage threads 172 on the opening 18. Pressure within the cylinder chamber 39 exerts a force against an inner surface 23 of the cover plate 22, which transmits from cover plate threads 222 to the opening threads 172. The threads 222 that do not engage the opening threads 172 will not receive/transfer a load to the threads 172, and thus are referred to herein as unloaded threads 224. The threads 222 engaged with threads 172 can undergo a load and are referred to as loaded threads 223.

[0024] An arrow F illustrates the direction of the force applied to the cover plate 22 by the cylinder 39 pressure. Most of a load transferred between engaged threads concentrates on the first 2-3 threads adjacent the applied load; which in the example of FIG. 3 are the loaded threads 223 adjacent the unloaded threads 224. Since the first 2-3 of the loaded threads 223 are in roughly the middle portion of the plate threads 222, the thread depth is substantially constant, unlike the thread depth at either terminal end of the plate threads 222. The process by which threads are formed results in a thread depth typically being less at the terminal ends of a thread than at the thread middle portion. Thread depth is typically minimal at the terminal ends of the thread and increases to a fully formed thread having a maximum depth until reaching the opposite terminal end. In one exemplary embodiment, the loaded threads 223 transferring the load from the cover plate 22 to the cylinder block 17 are fully formed and at substantially the maximum depth. This minimizes a stress concentration within the threads 222 that might occur if the portion of the threads 222 directly adjacent the inner surface 23 were engaged with the opening threads 172. FIG. 3 provides an example of engaging threads in the inner portion of the thread 222 length to prevent loading on an end of the thread 222 length where the thread may not be fully formed. Preferably, unloaded threads 224 comprise at least the first two threads of the combined set of threads 223, 224. Unloaded threads 224 have the same form as loaded threads

223. The length of the loaded threads 223 is greater than the length of unloaded threads 224, preferably at least twice.

[0025] The diameter of the opening 18 reduces along a curved profile 174 or fillet past the inner surface 23 of the suction cover plate 22 adjacent to the suction cover 55, where the profile 174 has a defined radius. In one embodiment the radius ranges from about 10% to about 30% of the distance between the opening 18 front and the shoulder formed by the profile 174. An advantage provided by the profile 174 is it better distributes stress loading in the area of the cylinder block 17 where the opening 18 necks down to the suction cover 55. Unloaded threads 224 are located within a smooth cylindrical portion of opening 18 and do not touch the wall of opening 18

[0026] FIG. 4 provides a side sectional view of an example of the suction cover plate 22. The cover plate 22 is shown with threads 222 on its outer periphery and a socket 224 formed into the cover plate 22. The socket 224 is shown coaxial with the cover plate axis A_P ; the socket 224 can be profiled to receive a wrench for installing the cover plate 224 into the opening 18.

[0027] An example of the threads 222 is depicted in a side cross sectional view in FIG. 5. As shown, the threads 222 each include a root portion 226 that is curved for distributing forces along the curve rather than allowing a stress concentration that can occur if the cross section of the thread root defined an angle. The threads 222 include a load flank 228, shown optionally disposed angled at about 7° with respect to the cover plate axis A_P and a crest 230 that is truncated rather than elongated. Crest 230 appears flat in a sectional view. The rear flank 232 of the threads 222 extends from the crest 230 to the root 226 along a path that is at an angle oblique to the cover plate axis A_P . The angle between the rear flank 232 and cover plate axis A_P can be around 45° in one exemplary example. In one embodiment, the threads 172 on the opening 18 may be shaped and profiled as described in the embodiment of FIG. 5, and may be described as a

British Butt Thread. An advantage of employing the threads as depicted in FIG. 5 for use with the present device is reduced stress concentrations at the thread root, thereby reducing fatigue and enhancing component useful life.

[0028] While the invention has been shown in only one of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention.

Claims

What is claimed is:

1. A reciprocating pump assembly comprising:
 - a block body;
 - a cylinder chamber in the block body;
 - a plunger reciprocatingly disposed in the block body;
 - an opening in the block body adjacent the cylinder chamber;
 - threads formed in the opening;
 - a cover plate in the opening; and
 - a threaded surface on the outer periphery of the cover plate engaging the threads formed within the opening and projecting within the block body past the threads on the opening.
2. The reciprocating pump assembly of claim 1, wherein the threaded surface on the cover plate includes at least two unloaded threads that project within the block body past the threads in the opening.
3. The reciprocating pump assembly of claim 1, wherein the threaded surfaces on the cover plate comprises a length of loaded threads that engage the threads in the opening, and a length of unloaded threads that project within the block body past the threads in the opening and the length of loaded threads is greater than the length of the unloaded threads.
4. The reciprocating pump assembly of claim 1, wherein the threaded surface on the outer periphery of the cover plate includes threads having a root portion with a curved profile.

5. The reciprocating pump assembly of claim 1, wherein the threaded surface on the outer periphery of the cover plate comprises a British Butt threads.
6. The reciprocating pump assembly of claim 1, wherein the threaded surface on the outer periphery of the cover plate includes threads having a thread depth that is from about 60% to about 70% of the thread pitch.
7. The reciprocating pump assembly of claim 1, wherein the threaded surface on the outer periphery of the cover plate includes threads having a truncated crest.
8. The reciprocating pump assembly of claim 3, wherein at least some of the unloaded threads are substantially identical to the loaded threads.
9. The reciprocating pump assembly of claim 1, wherein the threaded surface on the outer periphery of the cover plate includes threads having a rear flank disposed along a path oriented at an angle of about 45° with respect to the angle of the cover plate axis.
10. A reciprocating pump assembly comprising:
 - a cylinder block;
 - cylinder chambers formed in the block;
 - a plunger reciprocatingly disposed in each cylinder chamber;
 - circular openings in the block at an end of each chamber;
 - a thread formed in the openings;
 - cover plates, each having a thread formed on their outer circumference, at least a portion of the length of the thread being fully formed and at a maximum depth, the cover plates coaxially

coupled into each opening so that the maximum depth portion of each cover plate thread engages the portion of each thread in the openings proximate the ends of each chamber; and

part of the maximum depth portion of each cover plate thread being out of engagement with and further inward from the thread in the opening.

11. The reciprocating pump assembly of claim 10, wherein an axial length of the thread in the openings, relative to an axis of the opening, is less than an axial length of each cover plate thread.

12. The reciprocating pump assembly of claim 11, wherein when in a secured position, an outer end of each cover plate thread is substantially flush with an outer end of the thread in the opening.

13. The reciprocating pump assembly of claim 10, further comprising a smooth cylindrical portion in each opening joining an inner end of the thread in the opening and wherein part of maximum depth portion of each cover plate thread is located within the smooth cylindrical portion.

14. The reciprocating pump assembly of claim 10, wherein the threaded surface on the outer periphery of the cover plate includes buttress threads having a truncated crest and rounded root.

15. A pump assembly comprising:

a block body;

a cylinder chamber in the block body;

a plunger reciprocatingly disposed in the block body;

an opening in the block body adjacent the cylinder chamber;

threads formed in the opening;

a cover plate in the opening;

a threaded surface on the outer periphery of the cover plate engaging the threads formed within the opening and having at least two unloaded threads projecting within the block body past the threads on the opening, and a length of loaded threads that exceeds the length of the unloaded threads.

16. The pump assembly of claim 15, wherein the threads on the cover plate comprise British Butt threads.
17. The pump assembly of claim 15, wherein the threads on the cover plate have a truncated crest.