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CYLINDER HEAD ARRANGEMENTS

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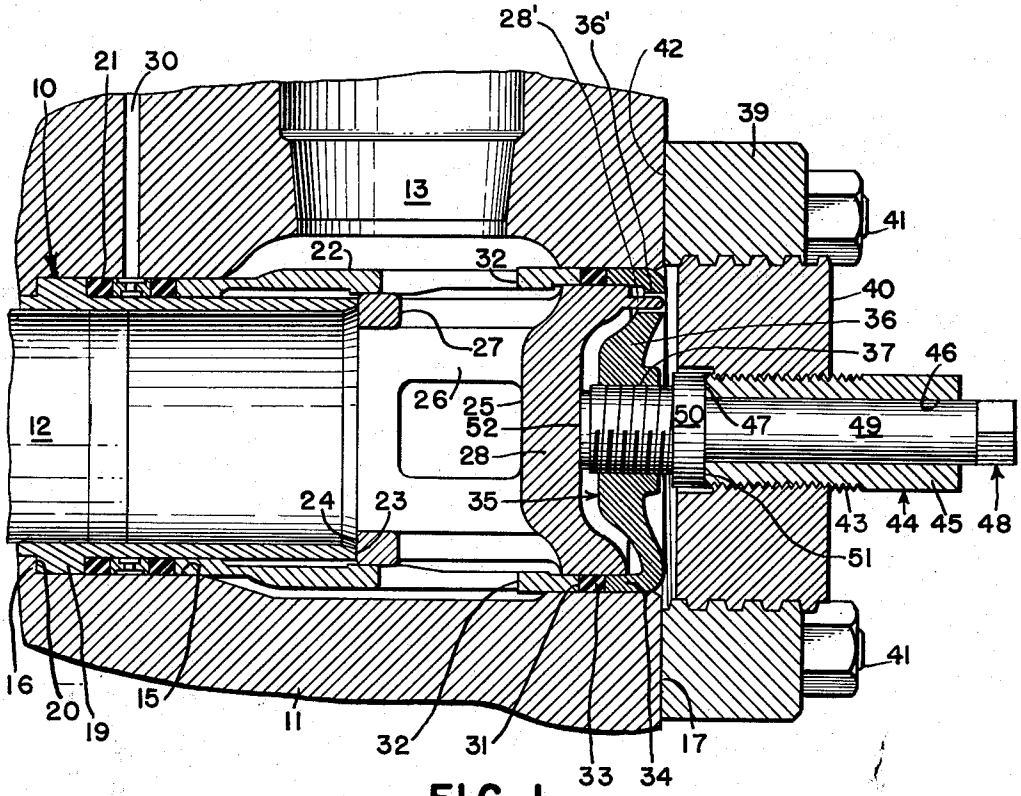


FIG. 1.

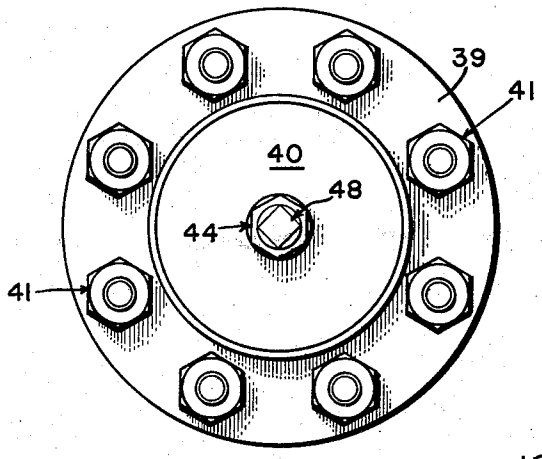


FIG. 2.

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CYLINDER HEAD ARRANGEMENTS

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This invention relates to cylinder head arrangements. While not limited thereto, the invention has particular application to slush pumps, i.e., pumps used in the oil well industry to pump drilling mud and the like into a well bore.

It is customary to construct slush pumps so that each piston reciprocates in a liner which is inserted into and removed from the bore of the cylinder through an opening in the cylinder head. The liner and the cylinder head are packed off to prevent leakage during operation of the pump.

During operation of the pump, the frictional engagement between each piston and its associated liner and the pressure reversals within the cylinder tend to reciprocate the liner along the axis of the cylinder and produce forces which loosen or wear out the packing and thereby cause fluid leakage. Thus, it is either necessary to tighten the packings or to replace such packings and to increase the hold down force applied to the liner so that the forces tending to move it are effectively opposed.

Furthermore, since the material being pumped is highly abrasive, the piston and the liner wear out after relatively short periods of use so that it is necessary to replace these parts.

Accordingly, one of the objects of the invention is to provide an improved cylinder head arrangement for slush pumps.

Another object is to provide a cylinder head arrangement which facilitates assembly and disassembly so that the pistons and liners can be replaced within a relatively short period of time.

Still another object is to provide an improved cylinder head arrangement wherein the packings and the cylinder liner can readily be retightened during operation of the pump.

A further object is to provide a cylinder head arrangement with novel and approved means for developing the necessary actuating forces to energize the packing and to hold down the cylinder liner.

In order that the manner in which these and other objects are attained in accordance with the invention can be understood in detail, reference is had to the accompanying drawings, which form a part of this specification, and wherein:

FIG. 1 is a longitudinal sectional view through a portion of the fluid end of a slush pump embodying the invention; and

FIG. 2 is an end elevational view of the right end of the device illustrated in FIG. 1.

Referring now to the drawings, there is illustrated a slush pump which comprises a removable cylinder liner 10 disposed in a cylinder 11. A piston 12 is reciprocable within the cylinder liner along the axis thereof for pumping liquid in the usual fashion through passageways 13, the flow of liquid through the passageways being controlled by the usual inlet and outlet valves (not shown).

Cylinder 11 has a cylindrical bore 15 provided at a medial section with an annular, flat, transversely-extending shoulder 16 which faces toward the front of the cylinder and is concentric to the axis thereof. Adjacent to its forward end, bore 15 is enlarged to provide suitable clearance for the flow of the liquid being pumped. Bore 15 opens through the cylinder head and is surrounded at its front end by a flat, transversely-extending face 17.

Liner 10 is coaxial with bore 15 and includes a medial, radially outwardly extending flange 19 which has a flat, annular, rearwardly facing surface 20 which abuts and is substantially the same size and shape as the front face of shoulder 16. The outer diameter of flange 19 is approximately the same as the inner diameter of the adjacent portion of bore 15, so that the liner flange 19 is closely embraced by the walls of bore 15. The forward end of the liner, i.e., the portion in front of flange 19, is of lesser outer diameter than the inner diameter of the adjacent portions of bore 15 so as to provide a space for liner packing 21 and a liner packing cage member 22. At its front end, liner 10 has a flat, annular, transverse forwardly facing surface 23 which engages a flat, annular, transverse rearwardly facing surface 24 located at the rear end of a liner hold down cage member 25.

Cage member 25 is cup-shaped and comprises a cylindrical, tubular side wall 26 having a plurality of openings 27 through which the liquid being pumped flows. The rear end of cage member 25 is open and is of a diameter approximating that of liner 10. The front end of cage member 25 includes a circular end wall 28 which extends transversely of and coaxially with bore 15, a central portion of end wall 28 being dished rearwardly and having a flat, forwardly facing central surface.

Liner packing 21 is annular and surrounds liner 10 in front of flange 19. Packing 21 engages both the liner and the adjacent portion of bore 15 and is of the type which, upon the application of longitudinally-extending, compressive forces thereto, is energized into sealing engagement with and packs off the liner in the bore. The rear face of packing 21 engages the front face of flange 19 and the front face of the packing engages the rear face of cage member 22 so that the energizing forces acting on the packing are developed between flange 19 and cage member 22. A tell-tale hole 30 extends through the cylinder and through the walls of bore 15 in the vicinity of the packing for indicating whether or not the packing is leaking.

Cage member 22 is tubular and is concentric to the axis of the cylinder. Cage member 22 surrounds the front end of the cylinder liner 10 and is in sliding engagement therewith. Cage member 22 also surrounds a portion of cage member 25 and terminates at its front end in a flat, annular, transversely-extending face 31 which lies adjacent to the periphery of end wall 28 and extends between the periphery of end wall 28 and the adjacent portion of bore 15 to substantially fill the space therebetween. Cage member 22 is provided with a plurality of openings 32 through which the fluid being pumped can flow.

An annular cylinder head packing 33 is disposed in front of and in contact with annular face 31 of cage member 22 and is operative, upon the application of longitudinally-directed, compressive forces thereto, to pack off the space between end wall 28 and the adjacent portion of bore 15 so that the portion of the bore in front of the end wall 28 is at a relatively low pressure, compared to the pressure to the rear of end wall 28, during operation of the pump.

A shallow, dish-shaped packing energizer 35 is disposed in front of cage members 22 and 25 and includes a rearwardly extending, tubular side wall 34 which fits over the front end of end wall 28 and abuts the front face of packing 33. Packing energizer 35 includes a transversely-extending, annular, central wall 36 having an axial, threaded bore 37. A plurality of interlocking projections 28′ extend axially from the front face of cage 25 and pass through axially aligned projection receiving apertures 36′ in energizer 35. The apertures 36′ have a larger diameter than the projections 28′ so that the energizer 35 and cage 25 can be moved axially relative to each other but cannot be rotated relative to each other.

The rear face of energizer 35 has the same configuration as the front face of end wall 28 so that the two parts can fit snugly together and occupy a minimum amount of space in an axial direction. Normally, though, the two parts are positioned as shown in the drawing, so that there is a small gap between the adjacent transverse faces of energizer 35 and cage member 25.

A cylinder head comprising a ring 39 and a cap or plug 40 covers the front end of the cylinder. Ring 39 is annular and has an internal thread of slightly greater diameter than the adjacent, front end of bore 15. Ring 39 is bolted to the cylinder by a plurality of nut and stud combinations 41 so that the flat, rearwardly facing surface 42 of the ring abuts face 17.

Plug 40 is annular and is both internally and externally threaded, the external thread being engaged with the internal thread of ring 39. The internal thread of plug 40 is engaged with the externally threaded portion 43 of a screw member 44.

Screw member 44 is tubular and has a hexagonal head 45 adapted to be gripped by a wrench or other tool for rotating and imparting a torque to screw member 44. Screw member 44 has a smooth-walled, axially-extending bore 46 and a flat, annular, transverse, rearwardly-facing surface 47.

A screw member 48 has an elongated shank 49 which extends through bore 46, the front end of the shank being square, so that screw member 48 can be gripped by a wrench or other suitable tool for rotating and imparting a torque thereto. Screw member 48 has a thrust collar 50 provided with a flat, annular, forwardly-facing shoulder 51 engaged with and similar in size and shape to surface 47. Adjacent to its rear end, screw member 48 is externally threaded and is received in threaded bore 37 of packing energizer 35. At its rear end, screw member 48 has a flat, circular, transverse, rearwardly-facing surface 52 which abuts the center of the front face of end wall 28 for imparting from screw member 48 to cage member 25 a rearwardly-directed, axially-extending force of sufficient magnitude to hold down the cylinder liner 10.

Screw member 44 exerts on screw member 48 via thrust collar 50 a force of sufficient magnitude to both hold down the liner and to energize packings 21 and 33. This force is divided so that the hold down force is exerted on cage member 25 by the surface 52 and the packing energizing force is exerted on the packing energizer 35 by the threaded portion of screw member 48.

At least cage member 25, screw members 44 and 48, plug 40, ring 39, bolts 41 and the cylinder are of metal so that the liner is held down solely by metal-to-metal contact.

The cylinder head arrangement thus far described is easy to both assemble and disassemble. To assemble the arrangement, liner packing 21 is placed on cylinder liner 10 in engagement with flange 19 and the resultant sub-assembly is inserted into bore 15 until flange 19 engages shoulder 16. Then cage members 22 and 25 are inserted into bore 15 in operative engagement with packing 21 and liner 10, respectively. After the cage members are in place, packing 33 is positioned around end wall 28 in front of face 31 of the cage member 22.

At some point in the assembly procedure, ring 39 is bolted via studs 41 to the face 17 of the cylinder and packing energizer 35 is threaded onto screw member 48 as far as it will go, i.e., until the front face of energizer 35 engages the rear face of thrust collar 50. After packing 33 is installed, the sub-assembly of the energizer 35 and the screw member 48 is inserted into the cylinder, with the apertures 36' of the energizer 35 in alignment with the interlocking projections 28' on cage 25. It will be apparent that in this position the energizer can be moved axially relative to the packing 33 but will be prevented from rotating relative to the cylinder assembly by the interlocking projections 28'. Next, plug 40 is screwed into the ring 39 and the screw member 44 is placed over the end of the screw member 48 and is threaded into the plug 40 until the cylindrical face 52 engages the end wall 28 of the cage 25. Further rotation of screw member 48 will slide cage 25 to seat the rear surface 24 against the front surface 23 of the liner 10 with the forces thus produced firmly seating the rear surface 20 against the shoulder 16. While the screw member 44 is rotated, the screw member 48 is restrained from rotation to keep the front face of energizer 35 adjacent the rear face of the thrust collar 50. In this position the tubular rear end of the energizer 34 is spaced a small distance from the packing 33 since no forces have been applied to energize the packing.

Rotation of the screw member 48 to energize the packing is facilitated by backing off the screw member 44 very slightly to reduce the rotation opposing frictional forces between shoulder 51 and the rear face of the screw member 44, and between the surface 52 and the end wall 28 of the cage 25.

Next, screw member 44 is held against rotation and screw member 48 is rotated in a direction which causes energizer 35 to move inwardly of the cylinder into engagement with packing 33. The energizer is prevented from rotating with the screw by the interlocking projections 28' on cage 25. After the energizer engages the packing, further rotation of screw member 48 develops an axially directed force which directly energizes packing 33 and indirectly, by means of packing 33 and cage member 22, energizes packing 21. When both packings are energized, screw member 48 is held against rotation and screw member 44 is again rotated to develop the necessary hold down force on the liner 10 and to frictionally secure the screw member 48 against rotation. When screw member 44 is tightened, the axial forces between cylinder 11, liner 10, cage member 25, and the screw member will be great enough to produce frictional forces of sufficient magnitude to prevent these elements from rotating while the cylinder is in operation. With the cage 25 locked against rotation, the energizer 35 will also be prevented from rotating by the projections 28' which enter into the apertures 36' and will engage the sides of the apertures should energizer 35 begin to rotate. Hence, the energizer is positively locked which assures that the energizing pressure originally applied via screw member 48 will not change due to the rotation of the cage 35 while the cylinder is in operation. This interlock has the further advantage of permitting continued adjustment of energizer 35, even in the event that threads 37 become fouled or damaged. It will thus be apparent that, so long as the packings 21 and 33 are serviceable, they may be adjusted as required to prevent leaking.

To tighten the packings or increase the hold down force, it is merely necessary to manipulate both screw members 44 and 48. Obviously, the disassembly procedure is substantially the reverse of the assembly procedure.

While only one embodiment has been disclosed, it will be apparent to those skilled in the art that many changes can be made in the details and arrangements of parts without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a cylinder head arrangement, the combination of
a cylinder liner;
a cylinder liner hold down member engaged with said liner;
first packing means surrounding said liner for packing said liner;
second packing means surrounding said hold down member for packing the hold down member;
means for energizing said first and second packing means and including
a packing energizer disposed in front of said hold down member, said packing energizer having a centrally-located, axially-extending, internally-threaded bore;

a cylinder head having
a centrally located, axially extending, internally threaded bore;
a first screw member comprising
a tubular body having an externally threaded portion screwed into said threaded bore of said cylinder head,
an axially extending bore, and
a rearwardly facing surface; and
a second screw member having
a shank extending through said bore of said first screw member,
a thrust collar engaging said surface of said first screw member,
an externally threaded portion screwed into said threaded bore of said energizer, and
a rearwardly facing surface abutting said hold down member;
said first screw member exerting on said collar a force which, acting through said hold down member, is sufficient to hold down said liner and, acting through said energizer, is sufficient to energize said first and second packing means.

2. A cylinder head arrangement in accordance with claim 1 wherein each of said screw members includes a head exposed for engagement with a tool.

3. In a cylinder head arrangement, the combination of
a cylinder having a bore defining a forwardly-facing shoulder;
a cylinder liner disposed in said bore and having
a rearwardly facing portion engaged with said shoulder and
an annular, forwardly facing transverse flat surface;
first packing means disposed between said liner and the walls of said bore for packing off said liner;
a first, tubular, cylindrical cage member engaged with said first packing means for energizing the same;
a second, cup-shaped cage member disposed within said first cage member and engaged with said surface of said liner for applying to said surface an axially directed hold down force;
second packing means disposed between said second cage member and the walls of said bore for packing off said second cage member, said second packing means being engaged with said first cage member for transmitting to the same a force sufficient to energize said first packing means;
a cylinder head secured to said cylinder and having a central, axial, threaded bore;
a packing energizer disposed in said bore in front of said second cage member and engaged with said second packing means for transmitting to the same a force for energizing both of said packing means;
a first screw member screwed into said threaded bore of said cylinder head and having a rearwardly facing surface disposed inwardly of said cylinder head; and
a second screw member including
a shank extending axially through said first screw member and
a thrust collar engaged with said surface of said first screw member for transmitting to said second screw member from said first screw member a force sufficient to hold down said liner and to energize said packing means,
said second screw member abutting said second cage member for transmitting a hold down force thereto, and
said second screw member being threadedly engaged with said energizer for transmitting a packing energizing force thereto.

4. A cylinder head assembly according to claim 3 including means engaging said energizer to prevent rotation thereof relative to the cylinder assembly.

5. A cylinder head arrangement comprising
means defining a cylinder having ahead end,
a closure member for the head end of said cylinder,
a cylinder liner disposed in said cylinder, said cylinder liner being removable through the head end of said cylinder when said closure member is removed,
packing operatively arranged adjacent said cylinder liner for packing said cylinder liner,
means for energizing said packing and for holding said liner against axial movement relative to said cylinder, said means including
a first screw member and a second screw member,
said first screw member having a cylindrical body with an axially extending bore and an externally threaded portion,
said second screw member including a shank, a collar axially aligned with and fixed against axial movement relative to said shank, and a threaded portion axially aligned with said shank,
said closure member for the head end of said cylinder having a threaded bore extending axially of said cylinder liner,
said first screw member being screwed into said threaded bore of said closure member with said shank of said second screw member in said bore of said first screw member,
said collar of said second screw member being operatively arranged with said first screw member for transmitting axial movement of said second screw member to said first screw member,
means in engagement with said cylinder liner to transmit forces created by one of said screw members to said liner,
means in engagement with said packing to transmit forces created by the other of said screw members to said packing,
one of said screw members being operative upon rotation thereof to create an axially directed force which acting through said means in engagement with said cylinder liner is sufficient to hold down said liner, and
the other of said screw members being operative upon rotation thereof to create an axially directed force which, acting through said means in engagement with said packing is sufficient to energize said packing.

6. A cylinder head arrangement in accordance with claim 5 in which the force created by said first screw member, upon rotation, is sufficient to hold said cylinder liner against axial movement, and
the force created by said second screw member, upon rotation is sufficient to energize said packing.

7. In a cylinder head arrangement, the combination of:
a cylinder having a bore,
a cylinder liner disposed in said bore,
packing operatively arranged for packing said cylinder liner in said bore,
a cylinder head secured to said cylinder to close one end of said bore,
said cylinder head having a bore of a substantially smaller diameter than said cylinder extending generally axially of said cylinder,
a first screw member axially aligned with said bore of said cylinder head,
said first screw member having a cylindrical body with an axial bore, a threaded portion and a rearwardly facing surface; and
a second screw member including
a shank extending axially through the bore of said first screw member,
a forwardly facing surface fixed against axial movement relative to said shank in engagement with said rearwardly facing surface of said first screw member, and

a threaded portion adjacent the end opposite said shank,

said first screw member being operative to move said second screw member axially of said cylinder via said engaging forwardly and rearwardly facing surfaces to create forces sufficient to hold down said liner and to energize said packing,

first means in engagement with said cylinder liner for transmitting forces created by one of said screw members to said cylinder liner to hold said cylinder liner against axial movement,

second means in engagement with said packing for transmitting forces created by the other of said screw members to energize said packing,

one of said means being threadedly engaged with said threaded portion of said second screw member.

8. In a cylinder head arrangement, the combination of

a cylinder liner,

a cylinder liner hold-down member in engagement with said liner,

packing means for packing said liner,

an energizer for energizing said packing means,

a cylinder head having an axially extending, internally threaded bore,

a first screw member comprising

a cylindrical body having an externally threaded portion

a bore extending axially of said cylindrical body, and

a rearwardly facing annular surface on said cylindrical body; and

a second screw member having

a shank extending through said bore of said first screw member,

a forwardly facing annular surface fixed to said shank,

an externally threaded portion axially aligned with said shank, and

a rearwardly facing surface,

said first screw member being screwed into the internally threaded bore of said head and said second screw member being disposed with its shank in the bore of said first screw member and with the forwardly facing surface of said second screw member in engagement with said rearwardly facing surface of said first screw member,

said externally threaded portion of said second screw member being threadedly engaged with a threaded portion of said packing energizer,

said rearwardly facing surface of said second screw member being in abutting relation with said hold-down member,

said first screw member being operative to exert on said second screw member via said forwardly and rearwardly facing surfaces a force which, acting through said hold-down member is sufficient to hold down said liner and, acting through said energizer, is sufficient to energize said packing means.

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