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D. A. MURPHY

3,326,092

PISTON STRUCTURE

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FIG. 1

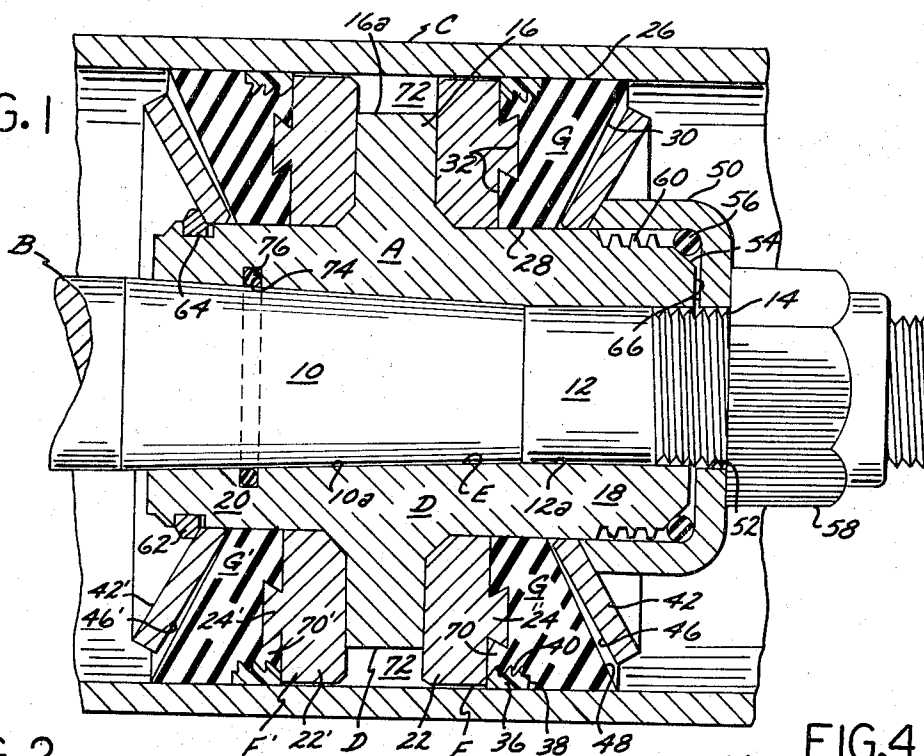


FIG. 2

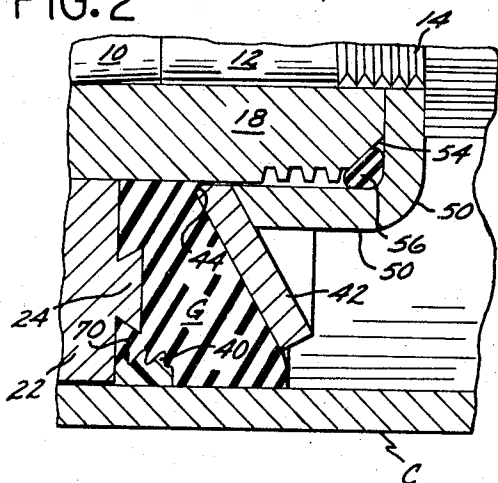


FIG. 3

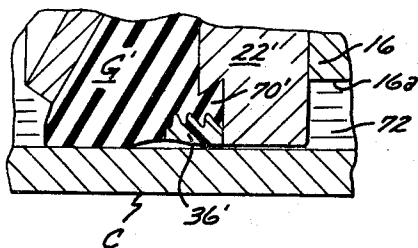


FIG. 4

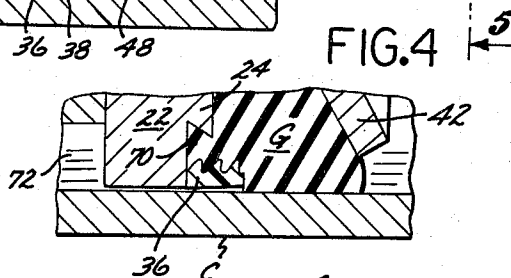
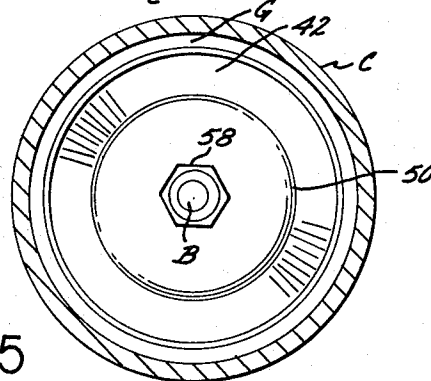


FIG. 5



INVENTOR
DEMERY A. MURPHY
 BY
William C. Babcock
 ATTORNEY

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3,326,092

PISTON STRUCTURE

Demery A. Murphy, 1398 Greenwood St.,
Torrance, Calif. 90501

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The present invention relates generally to the field of hydraulic devices, and more particularly to an improved expansible and replaceable sealing assembly for use on a reciprocating piston.

A major object of the present invention is to provide a self-sealing and self-lubricating piston particularly adapted for pumps used in the drilling of oil wells in which the fluid being pumped, such as rotary mud, carries substantial quantities of grit and silt which offers a detrimental abrasive action to metallic surfaces.

Another object of the invention is to supply a piston, which by changing the seal assemblies thereon, may be employed in cylinders of varying internal diameters.

A further object of the invention is to furnish a piston that provides lubrication at the time a pump is started, to eliminate possible scoring of the cylinder or piston before the cylinder is filled with fluid.

Yet another object of the invention is to provide an improved piston structure that can be fabricated from standard, commercially available materials which is of simple mechanical structure, requires no elaborate plant facilities for the production thereof, and will substantially lower the maintenance costs of a pump in which it is installed.

Still a further object of the invention is to furnish an improved piston structure that can be advantageously used in hydraulic lifts, presses, and the like.

These and other objects and advantages of the present invention will become apparent from the following description of a preferred form thereof, and from the drawing illustrating the same, in which:

FIGURE 1 is a longitudinal cross-sectional view of the piston structure prior to exertion of an axial force thereon;

FIGURE 2 is a fragmentary portion of the invention shown in FIGURE 1 after an axial force has been applied thereto;

FIGURE 3 is a fragmentary portion of the invention shown in FIGURE 1 illustrating the location at which high pressure wear takes place on the piston;

FIGURE 4 is a fragmentary portion of the view in FIGURE 1 showing the location at which low pressure wear takes place on the bottom side only of the piston; and

FIGURE 5 is an end elevational view of the piston structure, taken on the line 5—5 of FIGURE 1.

With continuing reference to the drawing for the general arrangement of the invention, it will be seen that the piston structure A is mounted on an end portion of a rod B, which rod and piston structure are reciprocally movable in a cylinder C.

The rod B has a tapered end portion 10 which develops into a cylindrical end 12 on which threads 14 are formed. A metallic hub D is provided that is divided by a ring-shaped flange 16 into forward and rear sections 18 and 20 respectively. A bore E extends longitudinally through hub D and is defined by a tapered section 10a and cylindrical surface 12a that are complementary to rod portions 10 and 12 which are in abutting contact therewith.

The diameter of flange 16, as can be seen in FIGURE 1, is substantially less than the internal diameter of cylinder C, for reasons which will be explained hereinafter. Two identical sealing assemblies F and F' are provided which are removably supported on the hub portions 18 and 20 respectively, as shown in FIGURE 1.

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Inasmuch as assemblies F and F' are of identical structure, only the assembly F will be described in detail.

Seal assembly F includes a metallic ring 22, the external diameter of which is such that the ring slidably and snugly engages the interior surface of cylinder C. Ring 22 abuts against flange 16, and a circular rib 24 of dovetail cross section projects outwardly from the side of ring 22 most distant from the flange.

An annular body G of a resilient material, preferably Hycar manufactured by the B. F. Goodrich Company of Akron, Ohio, is provided, which is defined by outer and inner cylindrical surfaces 26 and 28, an inwardly tapering outer surface 30, and a surface 32 that is bonded to ring 22 and rib 24. A circular sealing member 36 of Teflon, or like material, having a low coefficient of friction and which is self-lubricating when in contact with a metallic surface is embedded in the outer portion of body G adjacent ring 22. Sealing member 36 is permanently bonded to the surface 32, a surface 38 on body G, as well as to teeth or serrations 40 formed on body G.

A rigid tapered pressure ring 42 is slidably mounted on hub section 18. A chamfered edge 44 of ring 42 is disposed adjacent to the resilient body G. A surface 46 of ring 42 is at an angle slightly greater than that at which the surface 30 is disposed. When ring 42 exerts no longitudinally directed force on body G, the surfaces 30 and 46 are separated by a narrow wedge-shaped space 48.

A cup-shaped rigid member 50 in which a bore 52 is formed extends over the forward portion 18 of hub D, as shown in FIGURE 1. Rod portion 12 extends through bore 52. A forwardly and inwardly extending circular seat 54 is provided on hub section 18, and an O-ring 56 is forced into sealing engagement with seat 54 when member 50 is moved to the left at the time a nut 58 is tightened on threads 14. Threads 60 are formed on hub section 18, and these threads are used in pulling the piston structure A from rod B after nut 58 has been disengaged from threads 14.

The sealing assembly F' is illustrated in FIGURE 1 as mounted on hub section 20. The component parts comprising assembly F' are identified in the drawing by the same numerals used with assembly F, but to which a prime has been added. Pressure ring 42' is held in position on hub section 20 by a resilient snap ring 62 which removably engages a circumferentially extending groove 64 formed in this hub section.

When the piston structure A is disposed as shown in FIGURE 1, the interior surface of member 50 and extremity of hub section 18 are separated by a space 66. When the nut 58 is tightened on threads 14, the member 50 moves to the left on rod portion 12 to close the space 66 and deform O-ring 56, whereby a fluid tight seal is effected between seat 54 and member 50. As member 50 so moves to the left, pressure ring 42 likewise moves to the left to exert a force on body G to cause a three-dimensional deformation of the same.

Deformation of body G brings a portion thereof into abutting sealing contact with the chamfered surface 44, additional exterior surface of hub portion 18, and the surface 46, as shown in FIGURE 2. This deformation of the body G, together with the sealing attained with the deformed O-ring 56, prevents flow of grit-bearing liquid through the interior of the piston structure A, and the cutting-out thereof, as occurs in many present day pistons.

Three-dimensional deformation of body G causes the body to tend to expand radially and force the exterior surface of the body into sliding sealing contact with the interior surface of cylinder C. The part 70 of body G between the outer surface of rib 24 and the inner surface of sealing member 36 is substantially less in volume than

the balance of body G. Accordingly, three-dimensional deformation of the part 70 results in exertion of a substantially lesser radial force on sealing member 36 than that exerted on the balance of body G. That portion of the sealing member 36 bonded to the surface 32 is, of course, in a static position and cannot expand radially.

Thus, the greatest radial deformation of the sealing member 36 occurs on the right-hand portion thereof as viewed in FIGURES 1 and 2. Obviously, this is the portion of sealing member 36 that is in the greatest frictional pressure contact with the interior surface of cylinder C, and the portion at which maximum wear would be expected to occur. In actual practice, such wear of sealing members 36 and 36' do take place in this manner as shown in FIGURES 2, 3 and 4.

The snap ring 62 is so disposed relative to pressure ring 42' that the body G' and sealing member 36' are deformed in the same manner as body G and sealing member 36. Should it be desired, the cup-shaped member 50 could be eliminated, and a snap ring 62 and groove 64 (not shown) substituted in their stead to cause pressure ring 42 to exert a deforming force on body G and sealing member 36. The exterior surface 16a of flange 16, the adjacent surfaces of rings 22 and 22', and the interior surface of cylinder C cooperatively provide a ring-shaped confined space 72 that can be filled with a suitable lubricant (not shown) to assure that the cylinder C or piston structure A is not scored, should the piston assembly be reciprocated therein when the cylinder is dry. To prevent any high pressure fluid carrying grit or silt therewith from flowing longitudinally left to right between rod B and hub D, a transverse, circumferentially extending groove 74 is preferably formed in hub bore E in which an O-ring 76 of resilient material is disposed, as shown in FIGURE 1.

When the piston structure A is used in pumping low pressure fluids, at 1000 pounds per square inch or less, the sealing members 36 and 36' wear on the lower portions thereof only (FIGURE 4). Utilization of the piston structure A in pumping fluid at high pressure, such as around 1850 pounds per square inch, wear occurs completely around the sealing members 36 and 36', as shown in FIGURE 3.

The piston structure A of the present invention is employed in the same manner as a conventional piston, and a description of the use thereof is not considered necessary. Should it be desired to use the hub D with a cylinder C of a different diameter, the nut 58 is loosened, the member 50 removed from the position shown in FIGURE 1, and the threads 60 engaged by a puller to separate the piston structure A from rod B. Rings 22, bodies G, and sealing members 36 of an appropriate size for cylinder C in which they are used are then mounted on hub D, and the hub affixed to the piston rod associated with the different cylinder.

Although the present invention is fully capable of achieving the objects and providing the advantages hereinbefore mentioned, it is to be understood that it is merely illustrative of the presently preferred embodiments thereof and I do not mean to be limited to the details of construction herein shown and described, other than as defined in the appended claims.

I claim:

1. The combination with a cylinder in which a rod reciprocates of an improved piston structure, comprising:

- (a) a hub including first and second portions that are separated by a ring-shaped flange;
- (b) means for supporting said hub at a fixed longitudinal position on said rod;
- (c) first and second rigid rings mounted on said first and second hub portions in abutting contact with said flange, which first and second rings are of slightly lesser diameter than the interior diameter of said cylinder;

(d) first and second ring-shaped resilient bodies bonded to said rings;

(e) first and second resilient self-lubricating sealing rings embedded in said bodies adjacent said rigid rings and bonded to said rings and bodies; and

(f) first means for applying axially directed forces to said first and second bodies to three-dimensionally deform the same and radially expand said sealing rings and bodies into slidable sealing contact with the interior surface of said cylinder.

2. The combination as defined in claim 1 wherein the diameter of said flange on said hub is substantially less than the interior diameter of said cylinder, with said flange, first and second rings, and the interior surface of said cylinder cooperatively defining an annulus-shaped confined space in which a lubricant can be contained.

3. The combination as defined in claim 1 wherein said resilient bodies are of such shape that as they are three-dimensionally deformed said sealing rings are urged into pressure sealing contact with the interior surface of said cylinder at a lesser pressure than those portions of said bodies in direct contact therewith.

4. The combination as defined in claim 1 which further includes:

- (g) first and second rigid circular ribs that extend outwardly from said first and second rings into said bodies, which first and second ribs are spaced inwardly from said first and second rings, with those portions of said first and second bodies between said first and second ribs and first and second sealing rings expanding radially to a lesser degree than the balance of said bodies when said bodies are three-dimensionally deformed, and said first and second rings are urged into sealing contact with the interior surface of said cylinder at a pressure that is less than the pressure at which the balance of said bodies are urged into contact with said surfaces.

5. The combination as defined in claim 1 which further includes:

- (g) second means disposed adjacent the outer end of said hub to prevent the fluid being pumped from flowing longitudinally between said rod and said hub.

6. The combination as defined in claim 1 wherein said rings have chamfered edge surfaces adjacent said rod that cause said bodies to deform to define lips that are in sealing engagement with said rods and said chamfered surfaces when said bodies are three-dimensionally deformed.

7. The combination as defined in claim 1 which further includes:

- (g) a resilient O-ring seated in a transverse, circumferentially extending groove in said hub, which O-ring, together with said rod and hub, cooperatively provide a barrier to prevent longitudinal flow of the fluid being pumped to occur between said hub and rod.

8. The combination as defined in claim 1 wherein said first means includes:

- (g) a rigid cup-shaped member longitudinally movable on an outer end portion of said rod, which cup-shaped member has a circumferential edge which is in abutting contact with said first rigid ring;
- (h) second means for removably holding said hub at a fixed longitudinal position on said rod;
- (i) a nut that engages threads on that portion of said rod on which said cup-shaped member is mounted, with said nut when rotated in an appropriate direction moving said cup-shaped member and first rigid ring in a direction to three-dimensionally deform said first body; and
- (j) third means on said body for holding said second rigid ring in a position on said hub where said second body is three-dimensionally deformed.

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9. The combination with a cylinder in which a rod reciprocates of an improved piston structure, comprising:

- (a) a hub including first and second portions separated by a ring-shaped flange;
 - (b) means for supporting said hub at a fixed longitudinal position on said rod;
 - (c) first and second rigid rings mounted on said first and second hub portions in abutting contact with said flange, which first and second rings are of slightly lesser diameter than the interior diameter of said cylinder;
 - (d) first and second ring-shaped resilient bodies bonded to said rings, which bodies are in slidable sealing contact with the interior surface of said cylinder, with said bodies having circumferentially extending recesses formed therein that are in communication with said rings;
 - (e) first and second resilient self-lubricating sealing rings disposed in said recesses which are bonded to said rings and bodies; and
 - (f) means for applying axially directed forces to said first and second bodies to three-dimensionally deform the same and radially expand said sealing rings into slidable sealing contact with the interior surface of said cylinder.
10. The combination as defined in claim 9 wherein said first and second bodies are of such shape that as they are three-dimensionally deformed, they place the greatest radially directed force on those portions of said sealing rings most remote from said rigid rings.
11. The combination as defined in claim 9 wherein said first and second bodies each have inwardly tapering exterior surfaces, and said means for applying axially directed forces thereto comprise first and second rigid

pressure rings mounted on said first and second hub portions, with said first and second pressure rings having tapered surfaces which are in abutting contact with said tapering surfaces of said rings when said bodies are three-dimensionally deformed.

12. A sealing assembly for use on a piston, including:

- (a) a rigid ring;
- (b) a ring-shaped resilient body bonded to a first side surface of said ring; and
- (c) a resilient self-lubricating sealing ring embedded in said body and bonded to said body and said first surface of said rigid ring.

13. A sealing assembly as defined in claim 12 which further includes:

- (d) a rigid circular rib that projects from said first surface of said ring into said resilient body and is bonded thereto, which rib is of such diameter that a ring-shaped section of said body is disposed between it and said sealing ring.

14. A sealing assembly as defined in claim 13 which further includes:

- (e) a plurality of teeth defined in said body that extend into said sealing ring and are bonded thereto.

15. A sealing assembly as defined in claim 13 wherein said resilient body is defined by inner and outer radially spaced cylindrical surfaces, and an outwardly tapering side surface that is longitudinally spaced a substantial distance from the surface of said body bonded to said first surface of said rigid ring.

No references cited.

EDGAR W. GEOGHEGAN, *Primary Examiner.*