Dec. 4, 1956 P. R. G. BIEDERMANN 2,772,931

PISTON FOR RECIPROCATING PUMPS

Filed Nov. 6, 1953

FIG. 1.

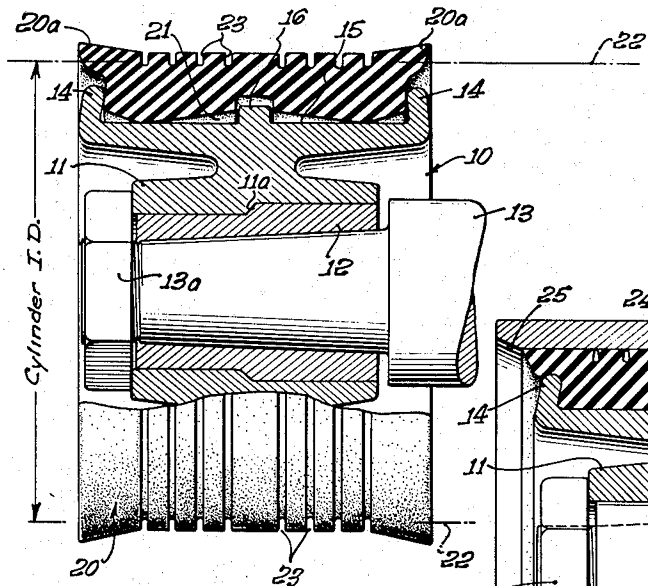


FIG. 2.

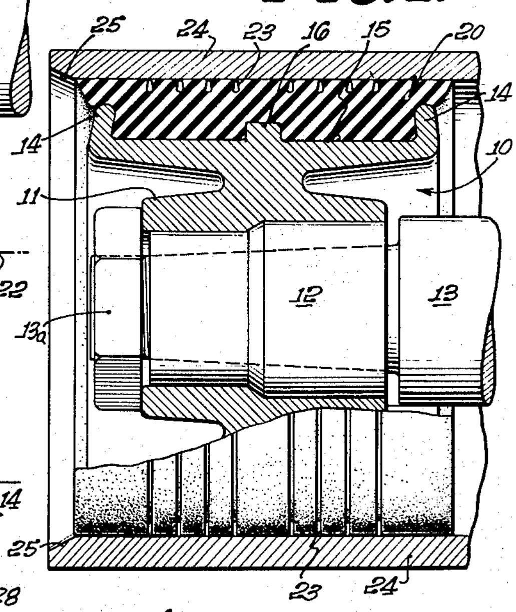


FIG. 3.

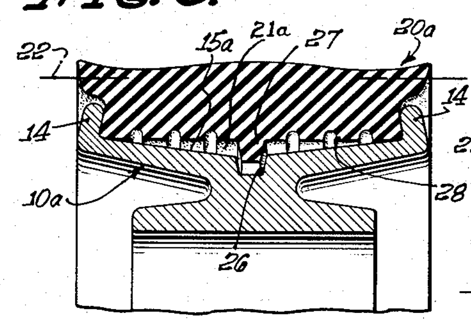


FIG. 4.

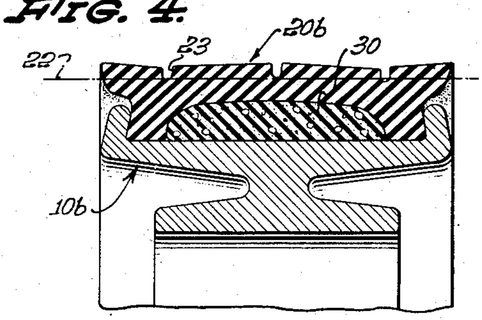
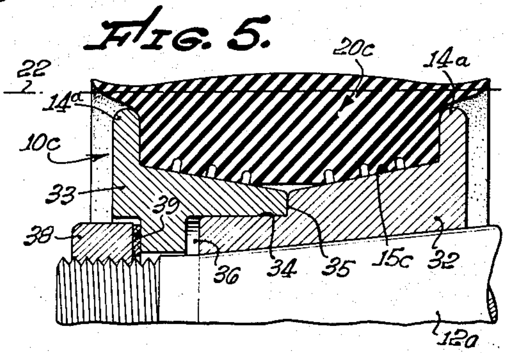


FIG. 5.



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PISTON FOR RECIPROCATING PUMPS

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8 Claims. (Cl. 309—4)

The present invention relates generally to the art of fluid pumps and more particularly to improvements in the construction of pistons for use in reciprocating pumps in which the fluid being pumped carries abrasive particles and is also often pumped at very high pressures.

In drilling oil wells, a fluid mixture consisting of various clays in an aqueous or oil vehicle and often having a specific gravity as high as 80–90 pounds per cubic foot, commonly referred to as drilling fluid or simply "mud," is circulated in the well during the drilling operations. This drilling fluid is pumped down the hollow drill stem, passes outwardly through the drill bit in the vicinity of the contact between the cutters and the earth formation, and passes upwardly in the well around the drill stem, carrying up with it the cuttings removed from the earth formation.

Use of drilling fluid has several purposes, the relative importance of which may differ from one well to another. Some types of mud are particularly well adapted to sealing off the walls of the hole by forcing particles of clay into the pores of the earth formation by the hydrostatic pressure. However, in general a primary purpose is to cool the drill bit and to flush away from the bottom of the hole the cuttings from the earth formation as they are formed. These articles of earth removed as the bit progresses are then carried upwardly to the surface in the rising stream of the drilling fluid. At the surface of the ground, the particles of sand or rock are removed, as far as practicable, either by settling or by various other separating means. Nevertheless, a considerable percentage of the particles are so small as to be retained in suspension and circulated along with the drilling fluid through the pumps. These particles of sand or rock are very highly abrasive in character and cause very severe wear on the pistons and cylinder linings of the circulation pumps.

As oil wells are being drilled deeper and deeper the load on the circulation pumps becomes greater. Not only are higher unit pressures required in order to obtain adequate circulation of the drilling mud but the importance of continuous and uninterrupted circulation becomes greater. All of this emphasizes the great importance of dependable, trouble-free operation of the pumps and the need for pistons which are particularly constructed to meet the peculiarly severe conditions of a high abrasive content combined with high pressures rarely found in other services.

Because of the abrasive qualities of these particles carried in the fluid, metal rings of any kind cannot be used on the pump pistons. The metal-to-metal contact of rings with the cylinder linings is not sufficient to exclude these abrasive particles which, when trapped between the ring and the liner, cause severe scoring or wear of the metal parts. For this reason it has become general practice to use pistons which include a sealing member made of rubber or rubber compounds or other resilient material to engage the cylinder walls. The resilient character of materials of this kind make it possible to avoid excessive

wear from the abrasive particles in the fluid by wiping the particles from the metal walls of the cylinder by the leading edges of the resilient member.

Of course, some wear inevitably takes place between the pistons and the cylinder wall; and in the past various efforts have been made to produce a piston having means for expanding the piston to compensate for this wear. However, so far as is known, these devices have all failed to be successful in practice. Mechanisms of this type which fail in operation produce more leakage either through the piston or around the piston than would be the case without them so that from a practical standpoint they have failed to achieve their objective.

In the operation of any reciprocating pump the wear is divided between the piston surface and the liner or cylinder wall. Also, the piston generally costs only one-half as much as the liner and only a fraction as much as a cylinder, and further, the piston is the most readily replaced unit. Accordingly, the pump or especially the piston, should be so constructed, that, first, the piston minimizes wear by its inherent characteristics, and second the part subjected to the most wear is the one that can be replaced most easily and at minimum cost.

Because of the high unit pressure employed, the circulation pumps for oil wells are generally reciprocating piston pumps in which the piston reciprocates horizontally and the weight of the piston causes an undue amount of wear on its under side. This is particularly true at the end of the stroke when the piston rod is extended to the maximum distance beyond the stuffing box since the piston rod then offers very little support to the piston itself. This concentration of wear on the lower side of the piston causes a high percentage of piston failures because it is conducive to leakage between the top of the piston and the cylinder wall. As soon as a passage of even the most minute dimensions is open, permitting fluid to flow around the piston, the high pressures encountered in the pump cause the fluid to enlarge this passage rapidly and it is but a short time before the piston is useless.

Accordingly, it becomes a general object of my invention to provide a piston construction for use in a pump handling abrasive fluids which includes an expansible ring of rubber or a rubber-like material which provides an improved seal between the piston and the cylinder wall and automatically compensates for wear occurring between these two members.

Another object of my invention is to provide a piston construction with an expansible sealing member which will expand to compensate automatically for the greater wear occurring on the under side of the horizontally moving piston and so keep the piston always concentric of the cylinder bore.

It is also an object of my invention to provide a piston construction of this character in which the weight of the piston is reduced to a minimum and the area of contact between the piston and the cylinder produced by built-in expansion is at a maximum at all times in order to prevent leakage and consequent abrasive wear.

A further object of my invention is to provide a piston construction for a pump handling abrasive fluids in which a rubber ring is of a design making it easily replaceable, thus reducing the cost and the time involved in replacing the ring and improving the reliability of the service provided by a pump.

It is a still further object of my invention to provide a piston construction having a rubber sealing ring which provides a comparatively large area of contact between the piston and cylinder wall and is of a configuration to effect substantially uniform pressure over the entire area of contact in order to minimize the ill effect resulting from the weight of the piston in a horizontally reciprocating pump.

It is still another object of my invention to provide a piston equipped with an interchangeable adapter, which will fit various tapers of different piston rods though the outside piston diameter may be the same, thus aiding the supply stores and field forces to meet emergency requirements more readily and at lesser costs.

These and other objects of my invention have been achieved by providing a piston construction that comprises a centrally located metal body of minimum weight which is adapted to be attached to the piston rod. This body has a pair of spaced, radially extending flanges which are at opposite sides of an annular recess extending around the body. In this recess is a sealing ring of a rubber-like material which extends radially beyond the flanges to engage the inside walls of the cylinder. In its normal or unrestrained condition, the outside diameter of the sealing ring is greater than the inside diameter of the cylinder. Likewise the inside diameter of this sealing ring is preferably greater over most of its area than the outside diameter of the piston recess so that there is a slight clearance between the sealing ring and the piston body. Alternatively or in combination with such a structure, one or more cavities may be formed in the sealing ring or in the metal piston body, or in both, which serve the same purpose.

When the piston is inserted in the cylinder, the sealing ring is compressed radially by engagement with the cylinder wall. This deformation brings the sealing ring into fluid tight engagement with the piston body. Since the material of the ring is resilient, radial compression of the ring produces internal strains that tend to expand the ring to its normal diameter; and this inherent expansive force within the ring brings it into firm contact with the cylinder wall over the entire area of the ring, positioning it concentrically of the cylinder and allowing it to compensate for wear that occurs locally.

The expansive character of the sealing ring causes it to press tightly at all points around the cylinder; and even if some wear occurs on the underside of the piston in a horizontal cylinder, the piston does not drop down a corresponding amount in the cylinder thereby reducing the tightness of the seal at the top of the piston. Rather the natural expansion of the sealing ring keeps the piston concentric within the cylinder and exerts equal opposing forces against the cylinder walls at the top and bottom sides of the piston. The activated force exerted by the ring against the cylinder walls is enough to offset the decreased support given the piston by the piston rod at the end of its outward stroke.

Although I prefer to make the piston body in a single piece in order to obtain minimum weight and simplest construction, in a variational form of my invention the body is made in two parts. By bringing the two parts together while in contact with the inside face of the sealing ring, the ring may be expanded in size to a diameter which is larger than the diameter of the cylinder before it is inserted in the cylinder. As mentioned above, the sealing ring is then compressed as it is inserted in the cylinder to reduce its maximum diameter to that of the internal diameter of the cylinder. This combination is particularly adapted to cylinders worn oversize or out of round as it permits of an even greater amount of expansion of the sealing ring.

For simplicity I prefer a piston having a unitary body and a single ring, but my invention is not limited thereto. Just as the body may be made in two parts, two or more similar rings may be mounted on a single unitary body.

How the above objects and advantages of my invention, as well as others not specifically referred to herein, are attained will be more easily understood by reference to the following description and to the annexed drawings, in which:

Fig. 1 is a combined side elevation and median section through a piston embodying a preferred form of my invention as seen when removed from a cylinder;

Fig. 2 is a view similar to Fig. 1 showing the position occupied by the sealing ring of Fig. 1 when inside the cylinder so that the ring is confined or radially restrained;

Fig. 3 is a half-section of a piston showing a modified form of my invention;

Fig. 4 is a half-section showing another variational form of my invention; and

Fig. 5 is a half-sectional view showing another modified form of my invention in which the piston body is made in two parts.

There is shown in Figs. 1 and 2 a presently preferred form of my invention in which the metal body of the piston is of unitary design. This unitary construction is preferred since it permits a maximum strength for a given weight of metal in the body and also reduces to a minimum the number of engaging faces which offer possible leakage paths for fluid within the piston. It particularly fits oil field needs because of its simplicity.

Body **10** includes a hub portion **11** which is provided with a central bore that may be either cylindrical or tapered, but is here shown as having two cylindrical sections of different diameters joined by a sloping shoulder **11*a***. The hub fits over an adapter sleeve **12** mounted on the end of piston rod **13** which is preferably tapered, the bore of the adapter sleeve matching the taper of the piston rod. A nut **13*a*** on the end of the piston rod engages one end of the hub in order to secure the piston in place on the piston rod. Use of a sleeve **12** is a simple means for fitting a piston body to any one of a number of piston rods of different dimensions. Pumps made by different manufacturers have piston rods of different sizes and shapes at the point of connection of the piston, even for pumps of the same size of cylinder. A supply of adapters **12** with different inside bores to fit different piston rods can all have the same external dimensions to fit a piston of a given size. This reduces the number of pistons of different styles required to be carried in stock at a supply house to meet all demands.

At each end of body **10** is a radially extending flange **14** which extends outwardly beyond the rest of the body. This pair of spaced flanges define the ends of an annular recess that goes entirely around the body. The third wall of this recess is the outside or peripheral surface **15** of the body lying between the flanges. In this form of my invention, the external surface **15** of the body is cylindrical in shape except where it is interrupted midway between the two flanges **14** by a rib **16** which preferably extends around the body.

The sealing ring generally indicated at **20** is made of rubber or a rubber compound or of some similar material having rubber-like characteristics. There are various synthetic compounds which are resistant to the action of hydrocarbons and therefore may be preferable in some instances to natural rubber itself; yet these compounds are all sufficiently similar to rubber in their physical properties of being easily deformable and being resilient that they may be included in the term "rubber-like material."

Sealing ring **20** is a continuous annular member mounted upon metal body **10** in the recess between spaced flanges **14**. The ring extends radially outwardly beyond flanges **14** so that the outer surface of the ring comes into contact with the cylinder walls and the outer ends of the flanges are slightly spaced from the cylinder walls but afford endwise support and engagement with the sealing ring up to a short distance from the cylinder wall.

In Fig. 1 the sealing ring is shown as it is when mounted upon the piston body but the piston is outside of the cylinder in which it is to be used. This is referred to as the normal or unrestrained position of the ring since it is free of any peripheral confinement by the cylinder. It will be noted that the normal outside diameter of the sealing ring is slightly greater than the inside diameter of the cylinder in which it is to be used, the inner face of the cylinder walls being indicated by the broken lines **22**. The exact amount by which the normal diameter of the sealing ring exceeds the diameter of the cylinder depends to some extent upon various factors including the physical characteristics of the material from which the ring is made and also the diameter of the cylinder. In a typical case the diameter of the ring for a piston for a 6" cylinder when unrestrained exceeds the diameter of the cylinder by about ¼" or about 4%. However, with a larger diameter or a relatively softer material or by making changes in dimensions of the body, displacement of portions of the sealing ring becomes easier so that the proportional amount of oversize may be increased.

The outside diameter of the sealing ring preferably is a little greater at each end to improve contact of the ring with the cylinder walls at the ends of the ring and provide a wiping action over the cylinder wall which cleans off abrasive particles. It may also be greater at the center where the space between the body and the ring is greatest. The result is a slightly convex profile for the sealing ring as seen in Fig. 1.

In its unrestrained or normal condition, it will be noticed from Fig. 1, the insider diameter of the sealing ring is at most points in excess of the outside diameter of the piston body at points between flanges **14**. This leaves an annular space **21** between the body and the ring which may be of variable size. In the embodiment of Fig. 1, the inside surface of the sealing ring lightly engages the surface **15** of the recess in the metal body near each end of the ring. At either side of this area of engagement, the inner surface of the sealing ring has a slight inclination relative to surface **15** of the piston body so that the space between the sealing ring and the metal body is greatest at the center of the ring and is tapered when viewed in cross section. The sealing ring is centrally recessed in order to receive body rib **16** which reduces longitudinal strains due to high pressures and frictional resistance.

The outside surface of sealing ring **20** is preferably provided with a number of circumferential grooves **23** which extend into the body of the ring for a short distance. The width and depth of these grooves should be such that they do not completely close when the ring is inside the cylinder and thereby they form a plurality of annular edges which each have a wiping action over the cylinder wall as the piston reciprocates, similar to the wiping action of the leading edges **20*a***.

The piston, consisting of metal body **10** with sealing ring **20** mounted upon it, is forced endwise into the cylinder against the resistance offered by the oversized ring. In order to facilitate insertion of the piston, it is preferable that the ends of the cylinder liner **24** be beveled or tapered as indicated at **25** in Fig. 2. Movement of the piston axially over this inclined surface **25** gives a wedging action which progressively compresses the piston ring as it is moved axially into the cylinder.

As may be seen from a comparison of Figs. 1 and 2, when the sealing ring is confined by the walls of the cylinder, the ring is deformed with respect to its unrestrained shape by having most parts of it, though not necessarily every portion, displaced radially inward. Although this may be regarded as compressing the ring because the outside diameter is reduced, the total volume of the ring may remain substantially unchanged since the rubber-like material is itself substantially incompressible. Actually, there is a radially inward displacement of most of the sealing ring which is accompanied by a certain amount of axial displacement of portions of the ring. Thus it will be noticed that in Fig. 2 displacement inwardly of the ring from its normal or unrestrained position brings it into liquid-tight contact with outside surface **15** of the piston body and also with the opposing faces of flanges **14**. These opposing faces of the two flanges are given a slight inclination so that they converge outwardly in order to resist any tendency of the ring to move out of the recess around the body.

Axial displacement of portions of the ring is limited by flanges **14** which also prevent relative axial movement of the ring and body when the piston is in operation. Axial displacement of the outer portions of the sealing ring beyond flange **14** is relatively unlimited as shown by the fact that the overall axial dimension of the ring at its periphery is slightly greater than that of the metal body **10** whereas in the free or normal condition, the ring and body have substantially the same maximum axial dimension. As shown in Fig. 2, grooves **23** are narrowed down at their outside ends, the material in the ribs between the grooves being displaced into the grooves to some extent as a result of the confinement of the ring by the cylinder wall. The amount of axial elongation is variable and can be controlled by the design.

When the assembled piston is forced into the cylinder, the outside diameter of the sealing ring is reduced and the material of the ring is placed under compression at all positions because of the confinement of the ring by the cylinder wall. This produces within the body of the ring internal strains which tend to expand the ring to its normal diameter and thus the ring presses tightly against the cylinder wall at all times. This tendency of the ring to expand against the wall is a result of the inherent characteristics of the rubber-like material and is created by the compression of the ring when it is forced into the cylinder. This expansive tendency remains for a considerable time since the ring as a whole would necessarily be worn down until its normal outside diameter when unrestrained becomes equal to the internal diameter of the cylinder before relieving these strains tending to expand the ring. The ring wears evenly around its entire circumference thus providing an effective pressure-tight fit for as long as outward tension acts. This tendency to expand presses the ring into fluid-tight engagement not only with the cylinder walls but also with the outside surfaces of the piston body, thus assuring a continuous pressure-tight seal with the ring at all locations.

It is preferred, although not necessary, to provide rib **16** to assist flanges **14** in applying axially directed forces to the ring to move it within the cylinder as the piston reciprocates.

At and just behind the leading edges **20*a*** the ring is preferably made with a greater diameter than at the central portion because the ring is long enough at these ends to overhang the metal body, as seen in Fig. 2. Since the ring is thinner here and not backed up by the more or less semi-rigid portion of the ring between flanges **14**, this portion can be more easily displaced inwardly, thereby conforming readily to variations in the cylinder diameter at all stages of piston movement, and providing an effective wiping action against the cylinder wall that prevents abrasive particles from being forced between the sealing ring and cylinder wall. Fluid pressure acts to force the leading edges against the cylinder wall.

There is shown in Fig. 3 a modified form of the invention in which body **10*a*** of the piston is the same as already described except that body rib **16** has been omitted and replaced by a recess **26**. A complementary internal rib **27** has been provided on sealing ring **20*a*** to be received in the recess to transmit axially directed forces to the sealing ring.

Change in the body shape has been made by sloping the peripheral surface **15*a*** from the ends of the body towards the central recess **26**, so that the two halves of surface **15*a*** are oppositely inclined with respect to each other. In this case, the inner surface of sealing ring **20*a*** is made cylindrical, or substantially so. As a consequence, the sealing ring and piston body engage each other at or near flanges **14** but are normally slightly spaced apart at **21*a*** over most of the length of the ring thus creating a cavity substantially as shown. Space **21*a*** between the ring and the body is tapered, viewed in cross-section, with its greatest dimension at or near the center of the ring and body.

The inner surface of the ring is provided with a plurality of annular grooves **28**, each of which forms a space or cavity into which adjoining portions of the ring may be displaced when the piston is confined within the cylinder. These grooves serve much the same function as space **21***a*, since all these spaces allow the ring to be displaced inwardly, filling up these spaces to a greater or lesser extent.

The outer surface of ring **20***a* is made smooth, the external grooves **23** of the previous form being omitted. The central portion of the ring is made a little thicker than at either side of the center. This causes a little greater stressing or compressing of the ring at the center to force rib **27** into recess **26**.

Another modified form of my invention is shown in Fig. 4 in which piston body **10***b* is essentially the same as shown in Fig. 1 except for the omission of rib **16**. Sealing ring **20***b* is likewise similar to the ring shown and described in connection with Fig. 1 except that the recess has been greatly enlarged in order to accommodate a body of sponge rubber **30** which is firmly glued to the inside cavity of the sealing ring.

In the form of piston shown in Figs. 1 and 2, the oversized sealing ring could be displaced inwardly when confined by the cylinder because of the space normally occurring between the body of the piston and the sealing ring when the latter is free or unrestrained. This condition exists in Fig. 4 because the body of sponge rubber **30** is compressible within its own volume, thus providing an equivalent to the space **21** between the ring and the metal body of the piston. However, this space occupied by the sponge rubber does not entirely disappear when the ring is confined it is simply reduced in size. It is at all times filled by the sponge rubber which continues to exert an outward pressure against the ring to expand it against the cylinder wall. At the same time the pressure of the sealing ring at its end-portions against the body of the piston and in the middle section against the sponge rubber body is adequate to provide a fluid-tight seal with the metal piston body.

In Fig. 5 is shown another modification of my invention in which the unitary body construction is replaced by a two-piece body. The piston body indicated generally at **10***c* comprises a section **32** having a tapered bore adapted to receive the tapered section on piston rod **12***a*. The second body section **33** has a central cylindrical bore adapted to slide upon the cylindrical portion of piston rod **12***a*. The two body sections **32** and **33** telescope on each other, have complementary cylindrical surfaces which slide on each other at **34**. The cylindrical surface on body section **32** is shorter than the corresponding surface on body section **33** so that the two body sections come into tight engagement along radial shoulder **35** but there is a small clearance left between them at **36**. A nut **38** is screwed on to the end of the piston rod to bear against section **33** and bring the two body sections into tight engagement at shoulder **35**. A fiber washer **39** may be introduced if desired between the nut and body section **33** as a more positive seal against fluid leakage at this point.

Each of body members **32** and **33** is provided with a radially extending flange **14***a* as and for the purposes already described, the only change being that the opposing faces of flanges **14***a* are here lying in radial planes. This is essential so that sealing ring may be expanded simultaneously inwardly and outwardly thus facilitating a pressure-tight fit even in a greatly worn or oversized cylinder.

Sealing ring **20***c* may be of any of the designs already described, but advantage is preferably taken of the division of the metal body into two parts to modify somewhat the diameter of the internal surface of the ring as compared with the outside diameter of the surfaces **15***c* of the body. If the body is made of slightly larger external diameter than the inside of the ring, then as the two halves of the body are moved axially together with the ring in position between flanges **14***a*, the inclined outer surfaces **15***c* of the body exert an expanding force on the ring. As a result, the ring and body are brought into fluid-tight engagement with each other. Also the ring can be expanded readily to compensate for excessive wear or oversize due to reboring. In practice it increases the volumetric factor of expansion by about 50%.

This is not intended to replace the oversize character of the ring, since it is originally made larger than the internal diameter of the cylinder and is then compressed radially inward, as described before, when the piston is inserted in the cylinder. However, the final amount of oversize may be somewhat increased by expanding the ring to larger than its original size by bringing the body sections together. This construction is particularly useful when liners or cylinders are considerably worn by abrasion and lightly scored or have been rebored to oversize.

From the foregoing description it will be apparent that various changes may be made in the detailed sizes or dimensions and arrangements of parts of my improved piston without departing from the spirit and scope of my invention. Also, it is contemplated that other changes than those specifically pointed out may be made while still within the practice of my invention. Accordingly, it is to be understood that the foregoing description is considered to be illustrative of, rather than limitative upon, the appended claims.

I claim:

1. A piston construction for use in a cylinder of a reciprocating pump or the like that comprises: a centrally located metal body adapted to be attached to a piston rod for reciprocation within a cylinder; and an annular sealing ring of rubber-like material surrounding and mounted upon the metal body, said ring having a normal diameter in excess of the cylinder diameter when free of externally applied compressive forces so that when in place on the body and confined within the cylinder the ring is under radial compression at all positions and has internal strains tending to expand the ring radially to its normal diameter.

2. A piston construction as in claim 1 in which the sealing ring has a plurality of circumferential grooves in the outside surface that reduce in size to permit relocation of peripheral portions of the ring when the ring is confined within the cylinder.

3. A piston construction for use in a cylinder of a reciprocating pump or the like that comprises: a metal body of unitary construction provided with a central bore to receive a piston rod for connection thereto, the body having a pair of fixed radially extending flanges spaced apart axially of the body and defining an annular recess around the body; and a sealing ring in the recess of resilient deformable material of substantially the same axial dimension as the spacing between said flanges and extending radially beyond the flanges to engage the inside wall of a cylinder when within and confined by the cylinder, the normal outside diameter of the ring when externally unrestrained being greater than the internal diameter of the cylinder.

4. A piston construction for use in a cylinder of a reciprocating pump or the like that comprises: a metal body of unitary construction with a central bore to receive a piston rod for connection thereto, the body having a pair of fixed radially extending flanges spaced apart axially of the body and defining an annular recess around the body; and a sealing ring in the recess of resilient deformable material of substantially the same axial dimension as the spacing between said flanges and extending radially beyond the flange to engage the inside wall of a cylinder when within and confined by the cylinder, the normal inside diameter of the ring when unrestrained being in general slightly greater than the outside diam-

eter of the body at said recess whereby there is normally a slight clearance between the body and ring within the recess.

5. A piston construction for use in a cylinder of a reciprocating pump or the like that comprises: a metal body provided with a central bore for connection to a piston rod, said body having a pair of spaced radially extending flanges with an intervening, outwardly facing surface; and a sealing ring of rubber-like material surrounding the body between the flanges and extending radially outward beyond the flanges, the normal outside diameter of the sealing ring when unrestrained being greater than the internal diameter of said cylinder, said ring having an inwardly facing surface; said surfaces normally being in contact at positions near said flanges and otherwise spaced apart with slight clearance when the ring is unrestrained, and said surfaces being in engagement over substantially their whole areas when the ring is within and externally restrained by said cylinder.

6. A piston construction for use in a cylinder of a reciprocating pump or the like that comprises: a metal body provided with a central bore for connection to a piston rod, said body having a pair of spaced radially extending flanges with an intervening, outwardly facing surface; and a sealing ring of rubber-like material surrounding the body between the flanges and extending radially outward beyond the flanges, the normal outside diameter of the sealing ring when unrestrained being greater than the internal diameter of said cylinder, said ring having an inwardly facing surface; one of said surfaces being formed in two sections oppositely inclined to the other surface whereby the two surfaces are in contact at positions near the ends of the surfaces and are spaced apart over their central portions when the ring is unrestrained, and said surfaces being in engagement over substantially their whole areas when the ring is within and externally restrained by said cylinder.

7. A piston construction as in claim 6 in which the metal body is formed in two relatively movable and separable parts of which one part is adapted to be mounted directly on the piston rod and the other part is mounted on the one part, and the outwardly facing surface of the body has two oppositely inclined sections formed one on each of the two body parts.

8. A piston construction as in claim 6 in which the inwardly facing surface of the ring is formed with a plurality of annular grooves forming spaces into which portions of the ring can be displaced when the ring is confined within the cylinder.

References Cited in the file of this patent

UNITED STATES PATENTS

1,358,628	Fisher	Nov. 9, 1920
1,531,242	Miller	Mar. 24, 1925
1,739,385	Bisbee et al.	Dec. 10, 1929
1,757,460	Hughes	May 6, 1930
1,840,880	Black	Jan. 12, 1932
2,019,757	Loweke	Nov. 5, 1935
2,142,624	Williams	Jan. 3, 1939
2,157,039	Hooydonk	May 2, 1939
2,318,757	Christenson	May 11, 1943
2,411,229	Pratt	Nov. 19, 1946
2,596,703	Maier	May 13, 1952