

Feb. 29, 1944.

C. W. SMITH

2,342,906

PUMP

Filed April 1, 1941

3 Sheets-Sheet 1

Fig. 1.

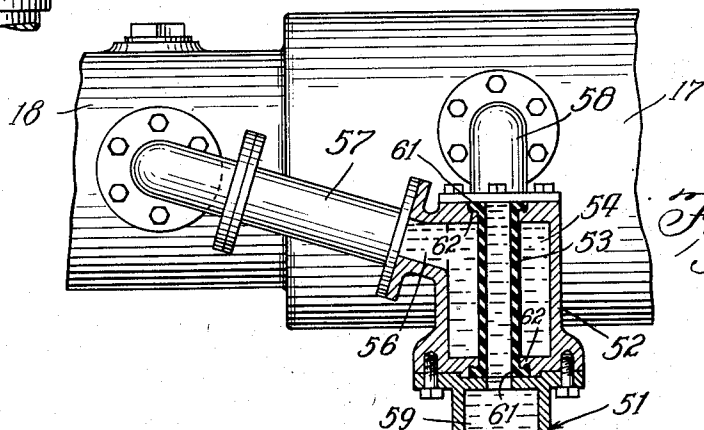
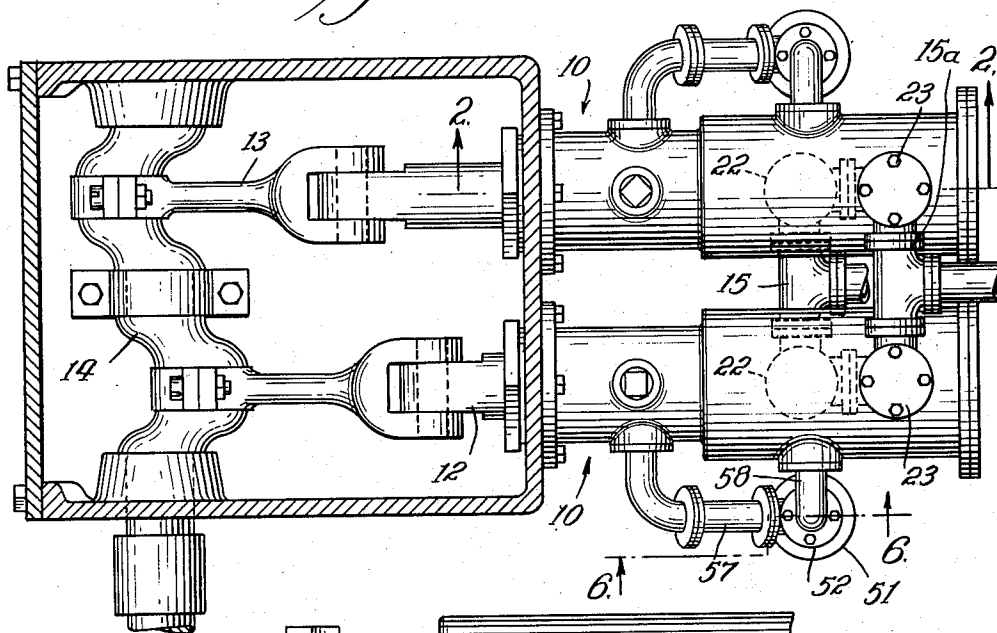


Fig. 6.

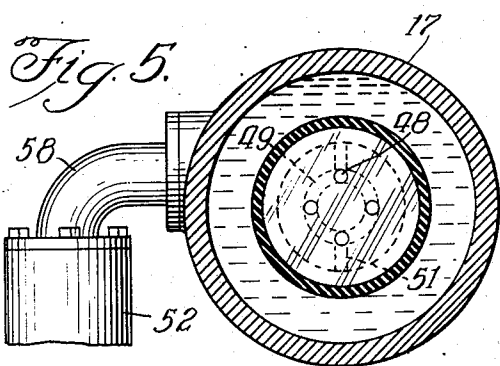
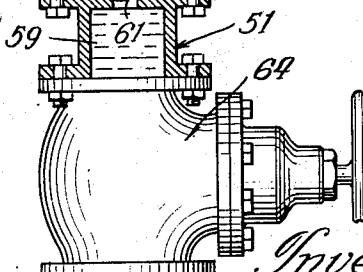


Fig. 5.



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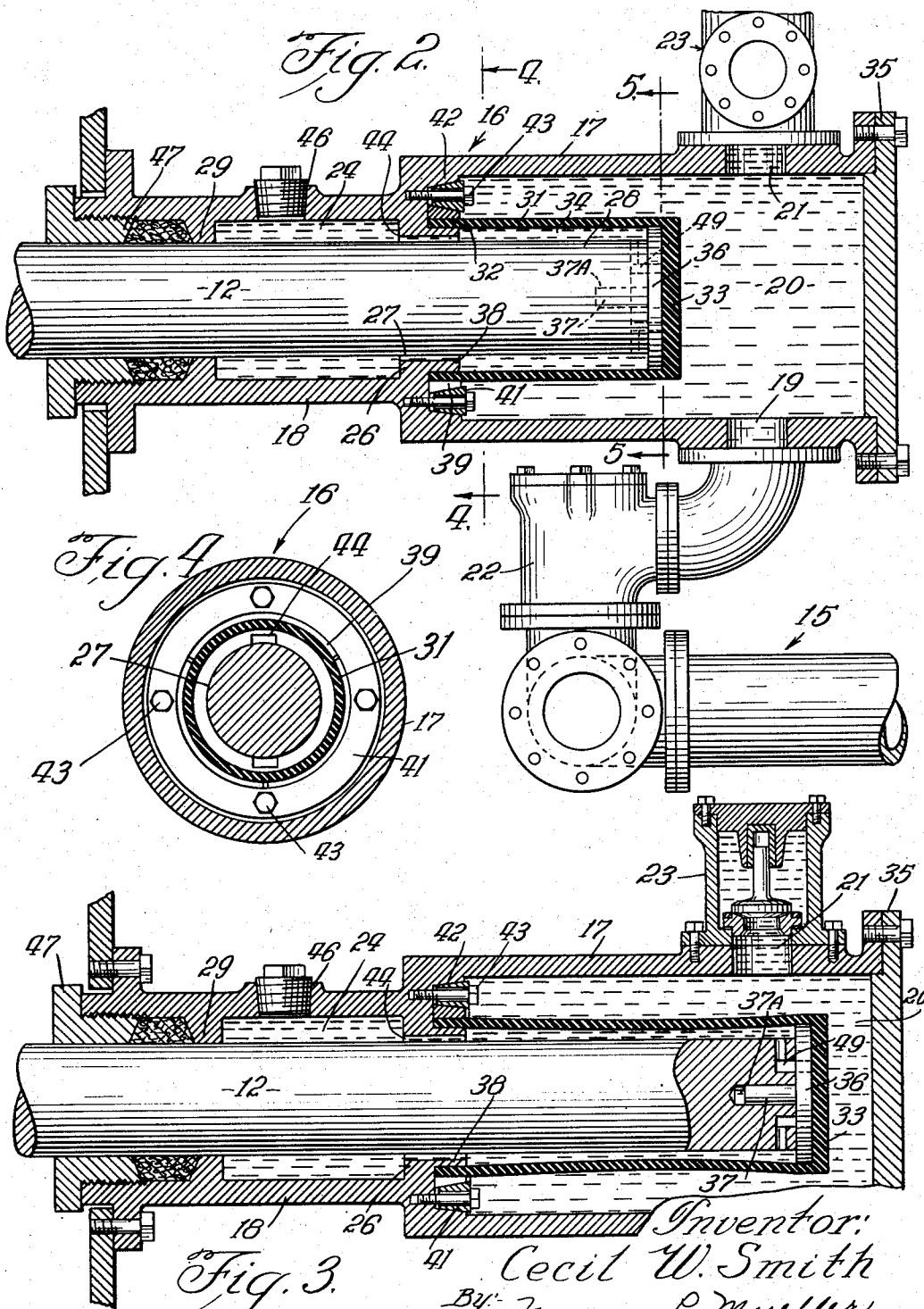
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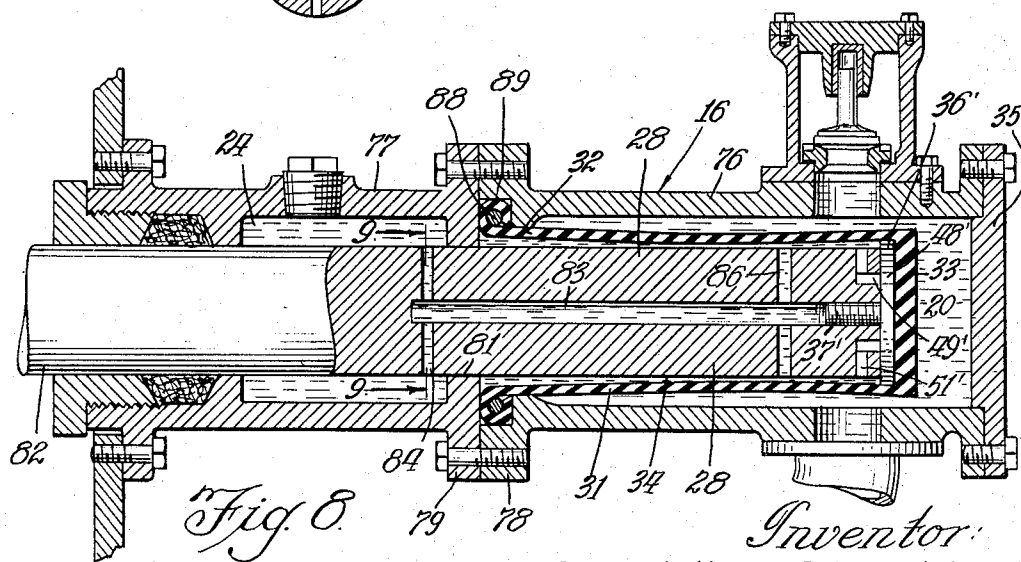
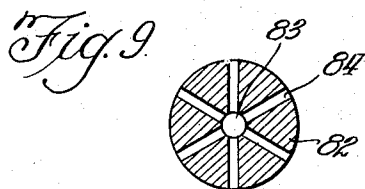
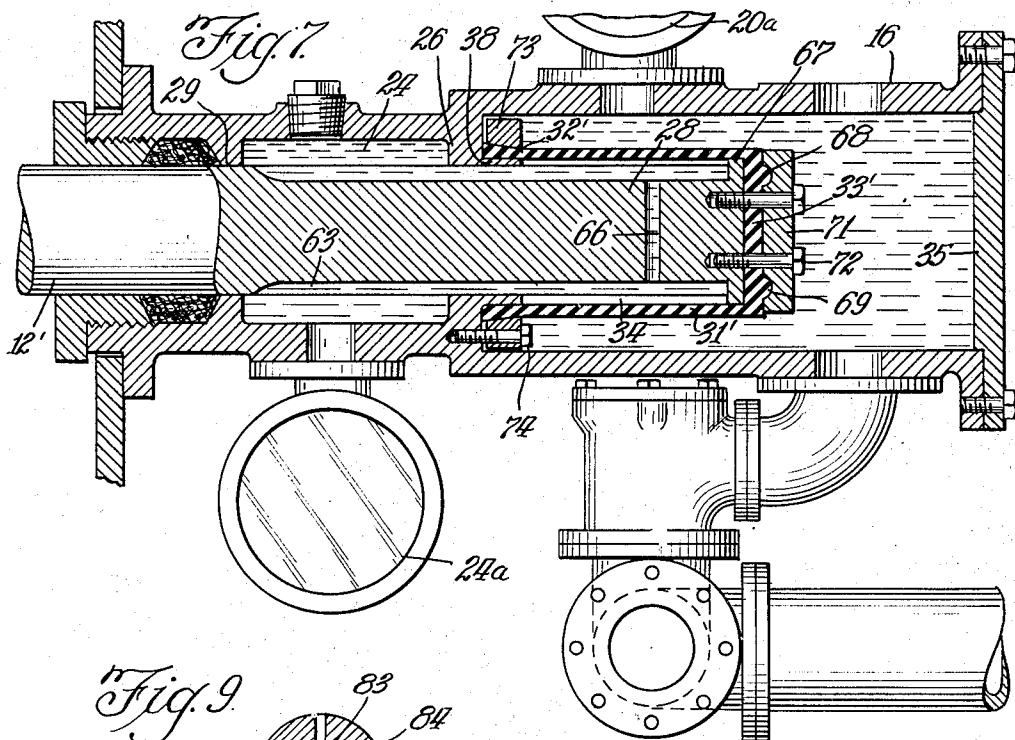
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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PUMP

Cecil W. Smith, Waterman, Ill.

Application April 1, 1941, Serial No. 386,329

20 Claims. (Cl. 103—148)

This invention relates generally to pumps and in particular to an improved pump in which the working fluid is prevented from contacting the pump piston.

Since the advent of deep well drilling the slush pumps generally available and adapted for work of this type have been entirely inadequate to operate efficiently for any appreciable period of time without requiring frequent servicing or replacement of parts. In some instances of drilling, the foreign material in the fluid possesses such cutting characteristics that the usual pump piston, if unprotected, is rendered entirely useless within but several hours of pump operation. Efforts in the prior art to provide pumps capable of operating satisfactorily with abrasive fluids have resulted in the use of diaphragm type pumps, pumps having a pair of expansible chambers operatively associated with common piston means, and reciprocating pumps having the pistons thereof separated from the working fluid by elastic protecting members. However, the diaphragm pumps are generally so restricted in operation as to be entirely inapplicable for well drilling. The pumps utilizing expansible chambers are restricted in operation to relatively low pressures. Another disadvantage of these latter pumps is found in the fact that the fluid pumped back and forth in the expansible chambers by the common piston tends to leak past the piston and collect in one of the expansible chambers. Because of this leakage, the chambers not only operate unevenly, but in some instances, the leakage to one of the chambers may be such that breaking thereof occurs through over expansion.

In some of the prior art pumps of reciprocating type, the piston is slidably supported in a bearing portion formed in one of the walls of the pumping chamber, with the working portion of the piston extending into the chamber. The elastic protecting member is positioned about this working portion of the piston. As the piston reciprocates, therefore, the elastic member is stretched so that the working portion is always covered by the protecting member. These attempts, however, to thus shield or protect the piston in the reciprocating type pumps have not been entirely satisfactory, particularly where high operating pressures are encountered, be-

cause of the tendency of the expansible portions of the elastic member to seize on the piston. When this seizing occurs, the elastic member is torn and must be replaced if permanent damage and injury to the piston and its bearings is to be avoided.

It is an object of this invention, therefore, to provide an improved pump.

Another object of this invention is to provide an improved pump for pumping abrasive fluids.

A further object of this invention is to provide an improved pump capable of pumping abrasive fluids under high pressures over a prolonged operating period with a minimum of servicing.

Another object of this invention is to provide a pump which is simple and rugged in construction, efficient in operation over a wide range of operating pressures, and relatively inexpensive in initial cost and upkeep.

Yet a further object of this invention is to provide a pump for abrasive fluids in which the piston and its bearings are entirely separated from the abrasive fluid and operated at all times in an oil bath, whereby friction and wear in the pump are reduced to a minimum.

Yet another object of this invention is to provide a pump having a protecting elastic member enclosing the working portion of the pump piston in which means are provided in a space intermediate the piston working portion and the sleeve adapted to effect a counter pressure therein for all operating positions of the piston which is substantially equal to the operating pressure in the pumping chamber.

A particular feature of this invention is found in the provision of a pump in which the pump piston is protected by an elastic member extending about the piston but radially spaced therefrom. One end of the elastic member is sealed to a portion of the pumping chamber and about the piston bearing, while its opposite end extends over the working end of the piston. The space between the elastic member and the piston wall is filled with a substantially non-compressible fluid which serves to retain a spaced relation between the elastic member and the piston wall for all operating positions of the piston regardless of the fluid pressures in the pumping chamber. Any seizing between the elastic member and the piston wall is thus completely eliminated.

More particularly, the invention provides means for preventing the seizing of any expansible portion of the elastic member by a moving piston within the elastic member in a manner such that the member might be torn.

Further objects, features and advantages of this invention will become apparent from the following description when taken in connection with the accompanying drawings, in which:

Fig. 1 is a plan view of a complete assembly of the invention;

Fig. 2 is an enlarged longitudinal view partly in section taken along the line 2—2 in Fig. 1;

Fig. 3 is a longitudinal sectional view illustrated similarly to Fig. 2 and showing parts thereof in a changed position;

Fig. 4 is a transverse sectional view taken along the line 4—4 in Fig. 2;

Fig. 5 is a view as seen along the line 5—5 in Fig. 2;

Fig. 6 is a fragmentary sectional view as seen along the line 6—6 in Fig. 1;

Fig. 7 is a longitudinal sectional view of a modified form of the invention;

Fig. 8 is a longitudinal sectional view of yet another modification of the invention; and

Fig. 9 is a transverse sectional view as seen along the line 9—9 in Fig. 8.

The invention as illustrated includes a pair of similar pump units operated in the usual manner from common driving means through a crank shaft and connecting rods. Each unit includes a pumping chamber and a fluid chamber having a separating wall with a bearing portion therein. The pump piston is slidably supported in the bearing portion and positioned across the fluid chamber, with its working end extending into the pumping chamber, while its opposite end is operatively connected with a corresponding one of the connecting rods above mentioned. An elastic or rubber sleeve is positioned about the working end of the piston but is radially spaced therefrom with one end sealed to the separating wall. On reciprocal movement of the piston, therefore, the sleeve member is stretched to provide at all times a protective wall about the piston and its bearing portion located in the separating wall. The fluid chamber is in fluid communication with the space within the rubber sleeve, this space and the fluid chamber being entirely filled with a substantially non-compressible fluid. During the reciprocation of the piston a counteracting pressure occurs in the space for all operating positions of the piston, which is substantially equal to the operating pressure in the pumping chamber so that a spaced relation between the sleeve and the piston is retained regardless of the magnitude of the operating pressures in the pumping chamber. Because of this fluid space all expansible portions of the rubber sleeve are positively prevented from seizing the piston. It is contemplated that this fluid have lubricating characteristics so as to provide for the operation of the piston in an oil bath which is completely closed from the atmosphere and from the working fluid in the pump.

With reference to the drawings, the invention is shown in Fig. 1 as comprising two similar pump units 10 having pistons 12 operatively connected with corresponding connecting rods 13 which are connected for reciprocal movement to a crank shaft 14, driven by suitable motor means (not shown). Since each pump unit 10 is of similar construction, only one of such pump units will be referred to in the following description.

Each pump unit 10 (Fig. 2) includes a casing member 16 of substantially tubular shape and formed with an enlarged portion 17 and a portion 18 of reduced section, the portion 17 having a pumping chamber 20 therein with an inlet 19 and an outlet 21 controlled by suitable valve means indicated as 22 and 23, respectively. The inlets 19 and outlets 21 for each unit 10 are connected to a common intake 15 and discharge 15a, respectively. A fluid chamber 24 is formed in the reduced portion 18 and is separated from the pumping chamber by a wall or inwardly extending annular shoulder 26 provided intermediate the two casing portions 17 and 18. The piston 12 is slidably supported in a bearing 27 formed by the inner circumference or periphery of the wall 26, and is positioned across the fluid chamber 24 with its working or end portion 28 extending into the pumping chamber 20. The piston is also slidably supported in a bearing portion 29 formed in another wall of the fluid chamber 24 and is thus seen to be slidably supported in the casing 16 for reciprocal movement axially thereof and into the pumping chamber 20. It is well known in the pumping of abrasive fluids that the pump piston and its bearings are to be prevented from coming into contact with the working fluid to prolong their service life and to assure a positive and efficient operation of the pump. This protection of the piston 12 and bearings 27 and 29 is accomplished in the present invention by means now to be fully described.

The piston portion 28 extending into the pumping chamber 20 is enclosed by an elastic member or sleeve 31 of substantially tubular shape having an open end 32 and a closed end 33. The inner diameter of the elastic member 31 is greater than the diameter of the piston 12 so that in its piston enclosing position a space 34 is formed intermediate the peripheral surface of the piston portion 28 and the sleeve 31 over the entire axial length of such portion. In one commercial embodiment of the invention, this radial spacing between the piston portion 28 and sleeve 31 is about $\frac{1}{8}$ of an inch. However, any radial spacing therebetween may be satisfactorily employed.

To define the space 34 intermediate the sleeve 31 and the piston portion 28 there is provided at the end of this piston portion a plate or disc 36 of a diameter equal to the inner diameter of the sleeve 31, and having an axially extending projection 37 adapted to fit into a mating bore 37a formed in the end of the piston 12. It is apparent, therefore, that when the sleeve 31 is positioned about the piston portion 28 that its sides are supported from such portion by the disc 36 which is in abutting engagement with the elastic sleeve 31 over the entire closed end 33 thereof. The open end 32 of the elastic or rubber sleeve 31 is positioned about an annular axially extending shoulder portion 38 of the bearing 27, the outer diameter of the shoulder 38 being substantially equal to the inner diameter of the sleeve 31. With its end 32 positioned about the shoulder 38, the sleeve 31 is moved inwardly toward the separating wall 26 until it is in engagement therewith. A sectional ring 39 (Fig. 4) illustrated as formed of three sections, extends about the sleeve 31 opposite the shoulder 38, its inner periphery being of flat form and engaging the sleeve 31, while its outer periphery is tapered for mating engagement with one side of a tapered or expansion ring 41, the opposite side of

the ring 41 being in mating engagement with a tapered shoulder portion 42 provided on the casing member 16. On bolting of the ring 41 to the separating wall 26, as by screws 43, the sides of the sleeve 31 at its open end 32 are wedged into a sealing engagement with the partition wall 26 about the bearing 27.

The assembly of the sleeve 31 about the piston portion 28 and its sealing engagement with the separating wall 26 is easily accomplished through the open end of the pumping chamber 20 which is normally closed with a cover plate 35. When the cover plate 35 is removed ample working space is provided between the piston portion 28 and the inner diameter of the casing portion 17 for positioning of the sectional ring 39 and expansion ring 41 about the sleeve 31 and for a tightening of the screws 43.

From a consideration of Fig. 2, therefore, it is seen that the sleeve member 31 completely encloses the piston portion 28 and the bearing 27 so as to prevent the contact of these parts with the working fluid in the pumping chamber 20. The space 34 is connected with the fluid chamber 24 through key ways or openings 44 formed in the bearing 27 and extended through the separating wall 26. In practice it is contemplated that the fluid chamber 24 and space 34 be filled with a substantially non-compressible fluid having lubricating characteristics so that the piston 12 operates in an oil bath which is completely closed from both the atmosphere and the working fluid in the pump. The lubricating fluid is supplied through the opening 46 formed at the top of the fluid chamber 24, this opening being plugged when the space 34 and chamber 24 are completely filled. A packing gland 47 is provided for the bearing 29 so that any leakage of the lubricating fluid from within the space 34 and chamber 24 is practically eliminated.

The piston 12 is illustrated in Fig. 2 as being in its suction or rest position. On movement of the piston 12 to its working position, shown in Fig. 3, the sides of the elastic member 31 are stretched or extended by virtue of the abutting engagement of the disc 36 with the closed sleeve end 33. When the piston is in its working position, the sleeve 31 may possibly flex radially inwardly a small amount. As was previously mentioned, the fluid chamber 24 and space 34 are completely filled with a substantially non-compressible fluid. Thus, although the space 34 is dimensionally reduced somewhat in a radial direction on movement of the piston 12 to its working position, it is also extended axially so that the lubricating fluid substantially fills the spaces 34 and 24 regardless of the operating position of the piston. As a result any pumping pressure which occurs in the pumping chamber 20 is counteracted by a substantially equal pressure in the chamber 24 and space 34, by virtue of their substantially constant volume and the non-compressibility of the fluid therein. This counteracting pressure in the space 34 intermediate the sleeve 31 and the piston portion 28, is always substantially equal to the operating pressure in the chamber 20 for all operating positions of the piston, and is never greater than the working pressure since it is responsive directly to such pressure. It is apparent, therefore, that the forces applied on the rubber sleeve 31 by the operating pressure on the outside, and the resulting counteracting pressure on the inside act opposite to

each other and radially of the sleeve 31 so as to cancel each other with respect to producing any stretching effects on the sleeve 31. Consequently, the operating stresses on the sleeve 31 during the operation of the pump are limited only to those stresses arising from the stretching thereof by the movement of the piston 12.

Where a pair of pump units, such as illustrated in Fig. 1 are operated with a common intake and a common manifold, it is readily apparent that the effecting of a counter pressure in the space 34, which is at all times equal to the operating pressure in the chamber 20 for all operating positions of the piston prevents injury to that piston which is at its suction stroke, should a rock or the like be lodged beneath one of the inlet or outlet valves. When this occurs during operation, it is of course obvious that the operating pressure from one of the units will be immediately transmitted through the valve which is held opened into the pumping chamber 20 of the other unit, regardless of the fact that the piston for such other unit is at its suction stroke. However, since the counteracting pressure is substantially equal to the operating pressure at all times, it is immaterial in the present invention as to what the magnitude of the operating pressure is relative to the stroke position of the piston.

By virtue of the above-described assembly of the piston portion 28 and the sleeve 31, the expansible portions of the sleeve 31 are always prevented from contacting or seizing the piston for all operating positions of the piston. Tearing of the sleeve is thus completely eliminated regardless of the working pressures in the pumping chamber. In one commercial embodiment of the invention, pressures as high as 1500 pounds per square inch were developed in the pumping chamber 20 without in any manner impairing the sleeve 31. This elimination of freezing or seizing of the expansible portions of the sleeve 31 with the piston provides for an efficient operation of the pump over prolonged periods of service without requiring frequent replacements of the sleeve 31 due to tearing or of the piston and bearings resulting from any abrading action. Also, the non-compressible fluid in the fluid chamber 24 and space 34 functions not only to provide for a counter pressure in the space 34 equal to the operating pressure in the cylinder 20, but because of its lubricating characteristics serves also to provide for an appreciable reduction in the mechanical friction of the pump.

In the operation of the pump, it sometimes occurs that the fluid from the space 34 passes about the rim of the plate 36 and accumulates between the disc 36 and the closed sleeve end 33. It seems that this accumulation of fluid is the result of a pumping action of the disc 36 relative to the sides of the sleeve 31 at the end 33. It is readily apparent that the fluid thus collected may assume proportions such that the closed end of the sleeve 33 would be stretched or distended to a dangerous degree. To eliminate any accumulation or collection of fluid resulting from this pumping action, the disc 36 (Fig. 5) is formed with a plurality of axially extending apertures 48 circularly spaced and in registry with an annular groove 49 formed in the end of the piston 12 concentric with the bore 37a. The annular groove 49 is in fluid communication with the space 34 through radially extending holes 51 also formed in the piston. Any liquid therefore, which might be

collected or passed between the disc 36 and the closed end 33 is thus immediately returned through the above-defined fluid passages to the space 34 so that the disc 36 is always in flush engagement with the closed sleeve end 33.

In some instances of pump operation, it sometimes occurs due to the fluid leakage from the chamber 24 about the piston 12, or for some other reason, that the fluid after a period of pump operation does not completely fill the chamber 24. It is sometimes desirable, therefore, to use a pressure equalizing chamber such as that designated generally as 51 and illustrated in detail in Fig. 6. The pressure equalizer includes a housing or casing member 52 having an elastic expansible member 53 of substantially tubular shape open at each end thereof and extending across an equalizing chamber 54 in the member 52. It is contemplated that the pressure equalizer 51 be arranged adjacent the casing member 16 and below the center longitudinal plane thereof. The chamber 54 is provided with an opening 56 which is connected with the fluid chamber 24 through a conduit 57. One end of the expansible member 53 is connected by a fluid line or pipe 58 with the pumping chamber 20, its opposite end being connected with a sediment collecting member or bowl 59. Each end of the expansible member 53 is formed with a radially extending annular flange 61 having an axially extending portion 62 thereon for mating engagement with complement recesses formed in the casing 52, the connecting line 58 sealing the annular flange 61 at the upper end of the member 53 while the casing for the bowl 59 is adapted for sealing the flange 61 at the lower end of the expansible member 53. The member 53, therefore, although extending across the equalizing chamber 54 is thus completely sealed therefrom.

When the pressure equalizer 51 is used with the pump, sufficient fluid is added through the opening 46 in the chamber 24 to completely fill the equalizing chamber 54, the fluid connecting line 57, the space 34, and the chamber 24. On operation of the pump, therefore, the operating pressure in the chamber 20 is transmitted into the expansible member 53 which expands and applies a pressure equal to the operating pressure to the fluid in the equalizing chamber 54, this pressure in turn being transmitted to the chamber 24 and into the space 34 intermediate the sleeve 31 and the piston portion 28 to counteract the operating pressure. It is readily apparent that when the chamber 24, space 34, and equalizing chamber 54 are not completely filled with oil, that an air space may be formed in the chamber 24. However, under normal conditions the expansion of the member 53 in response to the operating pressure in the chamber 20 will always be sufficient to compensate for this slight deficiency in the volume of fluid. Because of this compensating action of the expansible member 53 a counteracting pressure within the space 34 substantially equal to the operating pressure in the chamber 20 is always assured. In practice it is contemplated that suitable pressure gauges 24a and 20a (Fig. 7) be connected with the fluid chamber 24 and with the pumping chamber 20, respectively. Since the counteracting pressure is always substantially equal to the operating pressure, these gauges will indicate the same readings when there is sufficient fluid in the chamber 24. However, when the fluid in the above-defined chambers decreases to an extent such that the expansible portions of the sleeve

31 approach a contacting position with the piston portion 28, this decrease in the counteracting pressure will be readily indicated by a lower reading on the gauge 24a relative to the gauge 20a so that fluid may be supplied to these chambers before any damage occurs to the sleeve 31 or the piston 12.

By virtue of the connection of the expansible member 53 with the pumping chamber 20, it is readily apparent that the abrasive materials in the working fluid will tend to accumulate in this member. Since any appreciable accumulation of sediment or material in the tube would impair its function in effecting a pressure in the space 34 counter to the operating pressure in the chamber 20, it is desirable that the expansible member be kept relatively clean at all times. This cleaning of the tube 53 is accomplished in the present invention by the sediment collecting bowl 59 previously mentioned, connected to the bottom of the expansible member 53 and adapted to be completely flushed or cleaned on opening of a valve 64 connected thereto. It is obvious, of course, that a thorough cleaning of the expansible member 53 and bowl 59 is readily and quickly obtained by simply opening the valve 64 when the pump is in operation.

The modified forms of the invention illustrated in Figs. 7 and 8 are substantially similar in all respects to the invention as described relative to Figs. 2 and 3. Similar numerals of reference, therefore, will be used to designate similar parts. With reference to Fig. 7, that portion of the piston 12' which extends within the fluid chamber 24 and operating chamber 20 is formed in the periphery thereof with a pair of diametrically arranged axially extending grooves 63. The grooves 63 are connected together in the piston portion 28 by a diametrically extending aperture 66. The piston portion 28 is integrally formed at its outer end with a radially extending annular flange 67 having an outer diameter which is substantially equal to the inner diameter of the rubber sleeve member 31'. The closed end 33' of the sleeve 31' is formed with an axially projecting circular rim 68 on the outside thereof which is adapted to be received in mating engagement in an annular recess 69 formed in a holding plate 71. Within the closed end 33' of the sleeve 31' positioned between the piston portion 67 and the holding plate 71, screws 72 are extended through the plate and sleeve member for threadable engagement in the end of the piston 12', whereby to rigidly hold the piston portion 67 against the closed end 33' of the sleeve. The piston flange 67 serves to space the sides of the sleeve 31' radially from the piston portion 28 to provide a space 34 which extends completely about the piston portion 28 and intermediate such portion and the sleeve 31'.

The thickness of the sides of the tube 31' near its open end 32' are progressively increased in one direction, so that such sides are outwardly tapered at the end 32'. This open end 32' of the sleeve is positioned about the axially extending portion 38 of the piston bearing 27 with the extreme end of the sleeve 31' engaging the separating wall 26 dividing the fluid chamber 24 and the pumping chamber 20. A sealed engagement of the sleeve 31' with the wall 26 is accomplished by an expansion ring 73 which has a taper formed on its inside periphery corresponding to the taper on the sleeve 31' at its end 32'. It is obvious, of course, that as the ring 73 is drawn toward the separating wall 26, as by screws 74, the sides of

the sleeve 31' at its end 32' are wedged or pressed between the bearing projection 38 and the ring 73 for sealed engagement relative to the separating wall 26. Since the grooves 63 extend at all times into the space 34 within the sleeve 31' and into the fluid chamber 24, it is readily apparent that the space 34 and chamber 24 are in fluid communication for all operating positions of the piston 12. In the assembly of this modified form of the pump, ready access is had to the sleeve 31' and to its sealing means on removal of the cover plate 35 hereinabove fully described.

The operation of this modification is similar to the operation above described for the pump illustrated in Fig. 2, and a further description of such operation is believed to be unnecessary.

With reference to Fig. 8 the casing member 16 is seen to be comprised of a pair of separable casing portions 76 and 77 which are coupled together at mating engaging flange portions 78 and 79, respectively. The flange portion 79 is extended inwardly of the casing portion 77 to provide a bearing 81 for the piston 82, the piston being further slidably supported in the bearing 29 formed in a wall of the fluid chamber 24. The piston 82 over that portion thereof which extends within the fluid chamber 24 and operating or pumping chamber 20 is formed with an axially extending bore 83. Radially extended through the piston 82 for registry with the bore 83 are apertures 84 (Figs. 8 and 9) which are arranged so as to be positioned within the fluid chamber 24 for all operating positions of the piston 82. Apertures 86 are similarly formed near the opposite end of the bore 83 and positioned so as to be arranged within the space 34 intermediate the piston portion 28 and the elastic sleeve member 31. It is thus seen that the space 34 and the fluid chamber 24 are in fluid communication for all operating positions of the piston 82.

The piston portion 28, which is within the operating chamber 20, is provided with a disc 36' having a threaded portion 37' adapted to be threaded in the end of the bore 83. The disc 36' is of a diameter substantially equal to the inner diameter of the sleeve 31 and is in abutting engagement with the closed sleeve end 33 and is similar in all respects to the disc 36 above described. The sides of the sleeve 31 at its open end 32 are rolled back or folded about a ring member 88 which is then positioned in an annular recess 89 formed in the inner peripheral surface of the casing portion 76 at the flange 78, the recess 89 being open on that side of the flange which engages the flange 79. With the open end 32 of the sleeve 31 thus assembled with the ring 88 and positioned in the recess 89 a positive sealing of the sleeve 31 with the flange 79 is accomplished on the coupling together of the casing portions 76 and 77, as is clearly obvious from a consideration of Fig. 8. The piston portion 28 and the bearing 81 are thus entirely enclosed by the sleeve 31 and prevented from coming into contact with any of the working fluid in the chamber 20. During the operation of the pump the apertures 48' and 51' and the annular recess 49' function in a manner similar to that fully described above for the similar piston parts of Figs. 2 and 3.

In the modified forms of the invention shown in Figs. 7 and 8, it is to be understood that a counteracting pressure is effected in the space 34 intermediate the elastic sleeve members and the piston which functions at all times of pump operation to prevent any seizing of the piston with the expansible portions of the sleeve. Also, these

pumps may be operated with or without the pressure equalizer 51 fully explained above and illustrated in Fig. 6. It is, of course, obvious that the lubricating fluid used in the chambers 24 and 34 has characteristics, such as, for example, those characteristics of castor oil, which will not in any way injure the elastic protecting members for the pump pistons.

The invention is thus seen to provide a pump in which the pump piston and its supporting bearings are prevented from coming into contact with the working fluid, and which operate at all times in a completely enclosed oil bath. This lubricating oil is utilized in a chamber which is formed intermediate the elastic protecting sleeve member and the peripheral surface of the working end of the piston, to provide for a counteracting pressure in such space which is at all times substantially equal to the operating pressure in the pumping chamber. By virtue of this counteracting pressure which occurs for all operating positions of the piston, the piston is always spaced radially from the sleeve so that any seizing of the piston with the expansible portions of the rubber sleeve is positively eliminated regardless of the magnitude of the operating pressures in the pumping chamber.

Although the present invention has been described with reference to several preferred embodiments thereof, it is to be understood that it is not to be so limited since modifications and alterations therein can be made which are within the full intended scope of this invention as defined by the appended claims.

I claim:

1. In a pump including a chamber having a wall portion, a reciprocating piston slidably supported in said wall portion and having a portion thereof extending into said chamber, an elastic covering concentrically positioned in a radially spaced relation about said piston portion having one end sealed to said wall portion and its opposite end supported at the end portion of said piston portion, with said covering being distended in a substantially axial direction on reciprocation of said piston, and means intermediate said piston and covering for retaining said spaced relation and preventing the extensible portions of said covering from seizing the piston for all operating positions of said piston.

2. A pump including a casing having a fluid chamber and a pumping chamber, partition means separating said two chambers having a bearing portion therein, a piston slidably supported in said bearing portion, positioned across said fluid chamber and having a portion extending into said pumping chamber, and an elastic covering concentrically arranged in spaced relation about said piston portion and having one end in sealed engagement with said partition means, with its opposite end being closed and supported at the end of said piston portion so that said covering is expanded axially on movement of said piston, said piston having axially extending grooves in the periphery thereof fluid connecting said fluid chamber with the space between said elastic covering and said piston, with said fluid chamber and space being filled with a substantially non-compressible fluid to provide for a pressure in said space which is substantially equal to the working pressures in said pumping chamber so that the expansible portions of said covering are held away from said piston portion for all operating positions of said piston.

3. A pump including a casing having a pump-

ing chamber and a constant volume fluid chamber, bearing means arranged between said two chambers, a piston slidably supported in said bearing means for reciprocal movement positioned in said fluid chamber and having a portion in said pumping chamber, an elastic covering concentrically arranged in a spaced relation about that portion of the piston in said pumping chamber, means sealing one end of said covering about said bearing means, with the opposite end of said covering being closed and supported at the end of said piston portion with said covering being axially extended on movement of said piston, and means fluid communicating said fluid chamber with the space between said covering and piston portion, with the fluid in said space being substantially non-compressible so as to retain said spaced relation and prevent any seizing of the extensible portions of said covering with said piston portion for all operating positions of said piston.

4. In a pump including a casing having a pumping chamber and a fluid chamber arranged in substantially longitudinal alignment, bearing means arranged between said two chambers, piston means slidably supported in said bearing means, positioned across said fluid chamber and having an end portion extending into said pumping chamber, an elastic covering arranged about said piston portion and radially spaced therefrom, means sealing one end of said covering to said casing and about said bearing means, with the opposite end of said covering supported at the outer end of said piston portion, means fluid connecting said fluid chamber with the space intermediate said covering and piston portion, a pressure equalizing chamber having an expansible member therein sealed from said equalizing chamber, means connecting said fluid and equalizing chambers, and means connecting said expansible member with said pumping chamber, said expansible member being responsive to the pressures in said pumping chamber to apply a counteracting pressure to the fluid in said fluid chamber and space so that a radially spaced relation between said elastic covering and piston portion is retained for all operating positions of said piston.

5. In pumping means including a pumping chamber operatively associated with a reciprocating piston having an end portion extending into said chamber through a wall thereof, the combination of means for protecting said piston from the fluid being pumped including an elastic tubular member placed in a radially spaced relation about said piston portion, means sealing said member at one end with said chamber wall, with the opposite end of said sleeve being fluid tight and operatively connected to said piston portion, an equalizing chamber having an expansible member therein sealed from said equalizing chamber, means connecting said equalizing chamber with the space intermediate said elastic member and piston portion, and means connecting said expansible member with said pumping chamber, with said equalizing chamber and space being filled with a substantially non-compressible fluid, said expansible member being responsive to the operating pressures in said pumping chamber so that a counteracting pressure is provided in said space which is substantially equal at all times to said pumping chamber pressure whereby the said radially spaced relation between said tubular member and piston portion is retained re-

gardless of the magnitude of the operating pressures in such pumping chamber.

6. Means for pumping a fluid having abrasive materials therein including a pumping chamber operatively associated with a reciprocating piston having an end portion extending into said chamber through a wall thereof, an elastic covering positioned about said piston portion but radially spaced therefrom, means sealing said elastic covering at one end to said chamber wall, with its opposite end being fluid tight and operatively connected to said piston portion, with reciprocation of said piston distending said elastic covering, a pressure equalizing chamber having an expansible member therein sealed from said equalizing chamber, means connecting said equalizing chamber with the space intermediate said elastic covering and piston portion, with said space and equalizing chamber being filled with a substantially non-compressible fluid, means connecting said expansible member at one end with said pumping chamber, with said expansible member operating to apply a counter pressure in said space substantially equal to the pressure in said pumping chamber so that said radially spaced relation is retained at all times of pump operation, and a sediment collecting bowl connected to the opposite end of said expansible member so that said expansible member is always freely expansible over its entire length.

7. In a pump having a pumping chamber with a wall portion, bearing means in said wall portion, a reciprocating piston slidably supported in said bearing means with a portion thereof extending into said chamber, a tubular elastic member concentrically positioned about said piston portion, said elastic member being closed at one end and open at its opposite end, means on said piston portion for spacing said elastic member radially from said piston portion, means sealing the open end of said elastic member to said chamber wall portion and about said bearing means, with said elastic member being extended axially on reciprocation of said piston so that the volume of the space between said elastic member and piston portion is substantially constant for all operating positions of said piston, said space being filled with a substantially non-compressible fluid to continuously retain said spaced relation, and means for preventing fluid leakage from said space.

8. In a pump having a pumping chamber with a wall portion, bearing means in said wall portion having an annular flange extending axially into said chamber, a piston slidably supported in said bearing means with the working portion thereof positioned within said chamber, a tubular elastic member concentrically arranged in a spaced relation about the working portion of said piston with said elastic member being of an inner diameter at one end substantially equal to the outer diameter of said annular flange so as to be positioned thereon, and the outer periphery of said elastic member at said one end being tapered, a ring member having a tapered inner periphery adapted for mating engagement with the outer periphery of the elastic member at said one end, and means for drawing said ring member toward said wall portion to seal said one end relative to said bearing means, with the opposite end of said elastic member being fluid tight and operatively engageable with the outer end of the working portion of said piston.

9. In a pump having a pumping chamber with a wall portion having a bearing therein, a piston

slidably supported in said bearing with its working portion extending into said chamber, an elastic member radially spaced about said working portion, means sealing said elastic member at one end to said wall portion and about said bearing including a ring member having an inner diameter substantially equal to the outer diameter of the elastic member at said one end, with said one end being inserted in said ring and turned back thereon, retaining means positioned about said elastic member and having an annular recess therein adapted to receive said ring member with said one elastic member end turned thereon, and means for drawing said retaining means toward said wall portion to clamp said one elastic member end between said retaining means and wall portion and seal said one elastic member end relative to said wall portion, with the opposite end of said elastic member being supported at the outer end of said piston working portion.

10. In a pump having a casing with a pumping chamber therein, and a bearing in a wall of said casing having an axially extending annular portion projecting into said chamber, a piston slidably supported in said bearing means with the working portion thereof positioned in said chamber, an elastic member about said working portion but radially spaced therefrom, said elastic member being of an inner diameter at one end substantially equal to the outer diameter of said annular portion so as to be inserted thereover, ring means positioned about said elastic member at said one end, said ring means having an outer periphery of tapered form, a retaining ring with a tapered inner periphery adapted for mating engagement with the outer periphery of said ring means, and means for drawing said retaining ring toward said casing wall and against said ring means to seal said one elastic member end about said bearing, with the opposite end of said elastic member being closed and supported at the outer end of the working portion of said piston.

11. In a pump having a pumping chamber and a fluid chamber arranged in longitudinal alignment with said pumping chamber, separating means between said two chambers including a bearing portion, piston means slidably supported in said bearing portion, positioned across said fluid chamber and having a working portion thereof extending through said separating means into said pumping chamber, an elastic member positioned about said piston portion but radially spaced therefrom, said elastic member having an open end sealed to said separating means about said bearing portion, with its opposite end being fluid tight and operatively engageable with said piston working portion so that said elastic member is distended on operation of said piston, said working portion having an axially extending bore therein, with radially extending apertures connecting said bore with said fluid chamber and the space intermediate said elastic member and the piston working portion for all operating positions of the piston, with the fluid in said space and fluid chamber being substantially non-compressible and providing for a counter pressure against the pressure in said pumping chamber such that the distensible portions of said elastic member are prevented from seizing on said piston working portion at all times of pump operation.

12. In a pump having a pumping chamber with a wall portion, said chamber having a pressure therein, a reciprocating piston slidably supported in said wall portion having a working portion extending within said chamber, elastic means open

at one end for enclosing said working portion in a concentric radially spaced relation, means sealing said open end to said wall portion, with the opposite end of said elastic means being fluid tight and operatively connected with the end of said working portion so that the elastic means is axially extended on reciprocation of said piston, and means in the space intermediate said elastic means and working portion capable of continuously exerting a force radially outwardly over the inside portions of said elastic means which is equal and opposite to the force applied radially inwardly on said elastic means by the pressure in a chamber to retain said spaced relation and prevent seizing of the extensible elastic means portions with said piston working portion for all operating positions of said piston.

13. In a pump including a pumping chamber having a wall portion, a piston slidably supported in said wall portion having a working portion reciprocally movable in said pumping chamber to working and rest positions, an elastic member concentrically positioned in a radially spaced relation about said piston working portion when the same is in said rest position, means for sealing one end of said elastic member to said wall portion, with the opposite end of said elastic member being fluid tight and supported at the end of said working portion, said space being filled with a substantially non-compressible fluid, with said elastic member on movement of said piston portion from a rest to a working position being extended in a substantially axial direction so that the radial dimension of said space is substantially constant for all operating positions of said piston, with said fluid being capable of retaining a radially spaced relation regardless of the pressure in said pumping chamber.

14. In a pump having a casing with a pumping chamber, a reciprocating piston slidably supported in said casing with a portion extending into said chamber, elastic means radially spaced about said piston portion, means sealing one end of said elastic means to said casing, with the other end of said elastic means being fluid tight and operatively connected with the end of said piston portion, with movement of said piston axially extending said elastic means so that the radial dimension of said space is substantially constant for all operating positions of said piston, said space being filled with a substantially non-compressible fluid, and means preventing fluid leakage from said space such as to undesirably reduce such space, said elastic means being responsive to the pressures in said pumping chamber to apply an equal counteracting pressure to the fluid in said space, with said fluid retaining a radially spaced relation between the extensible portions of said elastic means and piston portion for all operating positions of said piston.

15. A pump having chamber means including a pumping chamber and a fluid chamber of constant volume, a wall portion intermediate said two chambers, a reciprocating piston positioned across said fluid chamber and slidably supported in said wall portion and having a portion in said pumping chamber movable to a rest and working position, an elastic covering concentrically positioned in a radially spaced relation about said piston portion when the same is in a rest position, means for sealing one end of said covering to said wall portion, with the opposite end of said covering being supported on said piston portion to provide for a sealed space about said piston portion, means fluid connecting said space with

said fluid chamber, said space and chamber being substantially filled with a non-compressible fluid, and means preventing the leakage of said fluid from said chamber and space, said covering on reciprocation of said piston being extended in a substantially axial direction so that the radial spacing thereof remains substantially constant for all operating positions of a piston, whereby said spaced relation is retained by said fluid for all operating positions of said piston regardless of the pressures in said pumping chamber.

16. In a pump having chamber means including a pumping chamber with a pressure therein and a constant volume fluid chamber, with said two chambers being separated by a wall portion, bearing means in said wall portion, a reciprocating piston slidably supported in said bearing means and positioned across said fluid chamber with a portion thereof movable within said pumping chamber, elastic means open at one end and closed at the other end thereof concentrically positioned about said piston portion in a radially spaced relation, means sealing the open end of said elastic means, about said bearing means and with said wall portion, means operatively connecting the closed end of said elastic means, and said piston portion so that said sleeve is axially extended on reciprocation of said piston, means fluid connecting said space intermediate said elastic means, and piston portion with said fluid chamber, with said space and fluid chamber being filled with a substantially non-compressible fluid, and means retaining said fluid within said space and fluid chamber, with the pressure in said pumping chamber exerted radially against said elastic means, being rendered ineffective to substantially radially deflect the elastic means, toward said piston portion because of the equal counter-acting pressure produced in said space and fluid chamber by the fluid therein.

17. In a pump including in combination a wall defining a pumping chamber having an end and a piston movable in said wall having a portion in said pumping chamber, the means for protecting the circumferential surface of the piston in the pumping chamber including an elastic covering therefor supported at one end on said wall and at the other end on the piston at its end portion, with said covering spaced radially from said circumferential surface to provide a space therebetween and expansible substantially axially upon movement of the piston in said pumping chamber, fluid chamber means fluid-connected with said space, fluid in said fluid chamber means and in said space, expansible means within said fluid chamber means sealed against entry of said fluid but in contact with said fluid and having a chamber therein fluid-connected with the pumping chamber, with said expansible means being movably responsive to pressure in said pumping chamber and operating on said fluid in said chamber means and said space to maintain a counter-pressure in said fluid chamber means and said space corresponding to the pressure in the pumping chamber.

18. In a pump, the combination including a movable piston having a circumferential surface, piston bearing means including a wall, means

defining a fixed fluid chamber on one side of said wall and an expansible fluid pumping chamber on the other side of said wall with said expansible fluid chamber surrounding said circumferential surface of said piston on the other side of said wall, one end of said expansible fluid chamber being fixedly supported at the wall and the other end being supported on said piston and movable therewith, fluid in said fixed fluid chamber and in said expansible fluid chamber acting in said expansible fluid chamber to space the wall thereof radially from the corresponding surface of the piston covered thereby, said wall having aperture means therein fluid-connecting said two chambers, and with said expansible fluid chamber expanding in a substantially axial direction upon axial movement of the piston and said fluid in said expansible fluid chamber means meanwhile maintaining a spaced relation between the expansible fluid chamber wall and the corresponding surface of the piston.

19. In a pump which includes means defining a pumping chamber having an opening in one wall thereof, piston means having a portion extending within said chamber through said opening and means supporting said piston means for reciprocating movement; the combination for protecting said piston portion which comprises an elastic member having walls spaced apart from the outer surfaces of said piston portion, means providing a sealed connection between one end of said elastic member and said wall, said elastic member also being supported by said piston portion for distension axially of said piston portion in response to reciprocation of said piston means, and means intermediate said piston portion and said elastic member for maintaining the spaced-apart relationship between the outer surface of said piston portion and the walls of said elastic member during reciprocation of said piston means, thereby to prevent the walls of said elastic member from seizing said piston portion at any time during movement of said piston portion.

20. In a pump which includes means defining a pumping chamber having an opening in one wall thereof, piston means having a portion extending within said chamber through said opening and means supporting said piston means for reciprocating movement; the combination for protecting said piston portion which comprises a walled elastic member on said piston portion and having one end portion thereof engaged by the end of said piston portion, the walls of said elastic member being spaced apart from the side surfaces of said piston portion, means providing a sealed connection between the other end portion of said elastic member and said wall, whereby the walls of said elastic member are distended in response to reciprocation of said piston means, and means disposed between the side surfaces of said piston portion and the walls of said elastic member for maintaining the spaced-apart relationship between the walls of said elastic member and said side surfaces, thereby to prevent the walls of said elastic member from seizing said piston portion at any point in the movement of said piston means.

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