May 5, 1942. A. G. GAGE 2,281,933

DIFFERENTIAL PUMP

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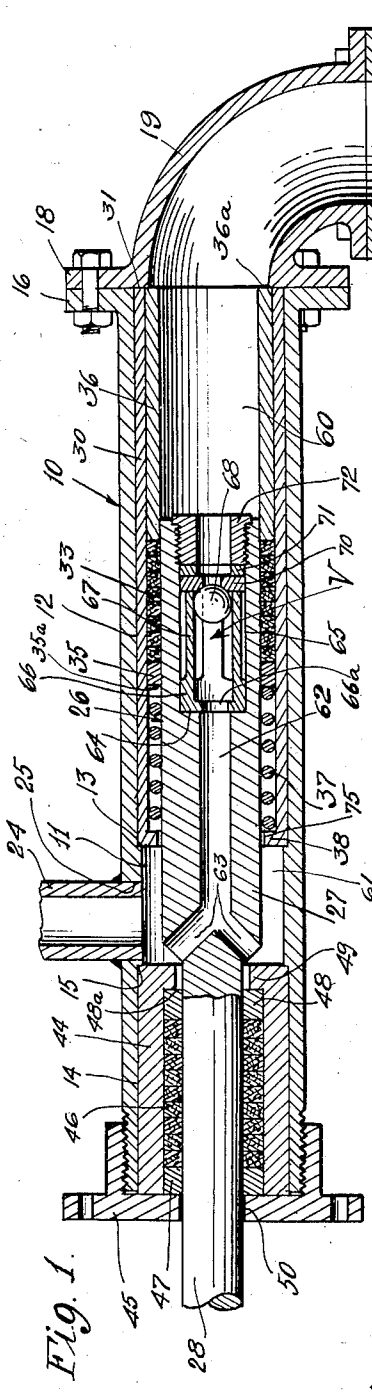


Fig. 1.

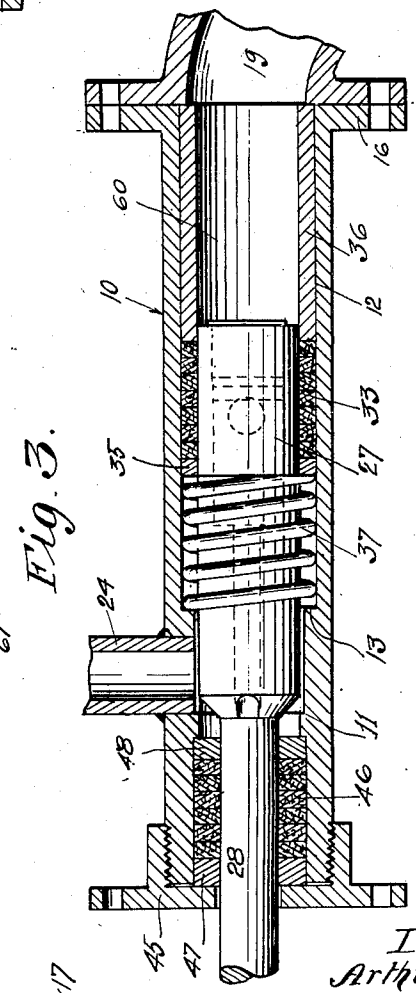


Fig. 3.

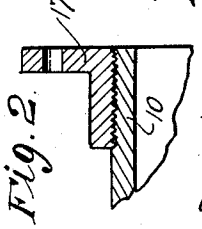


Fig. 2.

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DIFFERENTIAL PUMP

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22 Claims. (Cl. 103—195)

This invention relates generally to reciprocating plunger fluid pumps, and more particularly to reciprocating plunger pumps of the differential type. Such pumps, as is well known, are single action as regards intake but double action as regards discharge.

A primary object of the invention is to provide an inexpensive differential pump of exceptionally simple and improved construction, capable of being inexpensively manufactured, and highly efficient in action.

It is a further object of the invention to provide a pump of the type mentioned with improved means for packing the reciprocating plunger at the two ends of the pump cylinder.

A feature of the pump provided by the present invention is that the pump cylinder may, if desired, consist of a suitable length of pipe, as well tubing, requiring but a small amount of machine work to adapt it to the purpose. Such a length of tubing, after being provided with suitable inlet and outlet fittings, is simply fitted at its two ends with a special form of packing means in accordance with the invention and provided with a suitable reciprocating plunger. A feature of the invention consists in the improved packing means, which is held in tight working position by the pressure of the fluid passing through the pump.

The invention, as well as various objects and features not preliminarily mentioned, will be more fully understood from the following detailed description of a present preferred embodiment thereof, reference for this purpose being had to the accompanying drawing, in which:

Fig. 1 is a longitudinal vertical section taken through the improved pump of the present invention;

Fig. 2 is a detail showing a modification; and

Fig. 3 shows a modified form of the invention.

In the drawing the pump cylinder is designated by the numeral 10, this cylinder having a central bore 11, a counterbore 12 extending inwardly from its inlet end, providing a shoulder at 13, and a counterbore 14 extending inwardly from its opposite end, providing a shoulder at 15. In the instance here shown, cylinder 10 is provided with an integrally formed flange 16 at its inlet end; if the pump cylinder is made up of a length of tubing not having such an integrally formed flange 16, a flange member such as 17 may be screwthreaded onto the end of the cylinder, as in Fig. 2. Bolted to this flange 16 is a flange 18 of an inlet L fitting 19, which is here shown as connected to a pipe 20 having foot or standing valve 21 of any conventional type.

In the embodiment of the invention here shown, the fluid outlet of cylinder 10 is formed simply by welding an outlet pipe 24 within an opening 25 drilled through the wall of cylinder 10 into communication with bore 11. Plunger 26 plays through cylinder 10, and consists of a plunger head 27 and a plunger rod 28 extending rearwardly from head 27 out through the end of the cylinder. Plunger rod 28 is substantially one-half of the cross-sectional area of plunger head 27. This plunger rod 28 may be reciprocated within proper limits by any reciprocating mechanism, not shown.

The packing for plunger head 27 consists, in the specific form of the invention shown in Fig. 1, of a gland sleeve 30 inserted within cylinder counterbore 12 and positioned between the aforementioned cylinder shoulder 13 and a shoulder 31 provided by the face of fitting flange 18, as clearly shown. The packing material 33 for plunger head 27 is placed between this sleeve 30 and the surface of the plunger head, and is confined at its ends between a follower ring 35 and a follower sleeve 36, as shown. This packing material may consist of hemp or any usual packing material suitable to the purpose. A coil compression spring 37 placed between the plunger head and sleeve 30 bears at one end against inwardly extending flange 38 formed on the inner end of sleeve 30, and at its other end against packing follower ring 35. Packing follower ring or sleeve 36 is confined within sleeve 30 by engagement with surface 31 of flange 18, in the manner illustrated. The engaging surfaces between the end of sleeve 36 and surface 31 are not provided with a machine fit, and pressure fluid therefore acts on substantially the total end area 36a of sleeve 36.

The outer diameters of packing follower ring 35 and sleeve 36 are preferably substantially equal to one another, while the inside diameter of ring 35 is slightly less than the inside diameter of sleeve 36. For instance, though without intention of imposing any limitation on the invention, I may state that there may be a clearance of .002 inch on a side between the plunger head and ring 35, and a clearance of .008 inch on a side between the plunger head and sleeve 36. The reason for these differential clearances between rings 35 and 36 and the plunger, and the differential of pressure on the rings, will be more fully described at a later point in the specification.

The packing at the opposite end of cylinder 10 embodies a packing gland sleeve 44 inserted within the end of the cylinder and confined between cylinder shoulder 15 and a cap member 45 screw-threaded on that end of the cylinder, as shown. Packing material 46 of any usual nature, as hemp, is provided between plunger rod 28 and the inner surface of sleeve 44, being confined at its ends between an outer packing follower ring 47 and an inner packing follower ring 48, the latter engaging and being positioned by an inwardly extending annular flange 49 on the inner end of sleeve 44, as shown. Outer follower ring 47 is engaged by cap 45, as illustrated. Plunger rod 28 passes with good clearance through an opening 50 in cap 45. Packing rings 47 and 48 are of the same outside diameter, but the inside diameter of ring 47 is greater than the inside diameter of ring 48, thus providing a greater clearance between ring 47 and the plunger rod than between ring 48 and the rod. For instance, though without necessary limitation thereto, there may be a clearance of .002 inch on a side between ring 48 and the rod, and a clearance of say .008 inch between ring 47 and the rod.

The cylinder chambers at the intake and outlet sides of the plunger head are designated by numerals 60 and 61, respectively. Extending longitudinally through plunger head 27 is a fluid passageway 62, which opens at its inner end to cylinder chamber 61, as indicated at 63. Extending inwardly from the outer end of the plunger head is a counterbore 65 meeting bore or passageway 62 to provide a shoulder at 64, and received within this counterbore 65 and positioned against shoulder 64 is the cage 66 of a ball valve generally designated at V. The inner end of this cage member 66 is formed with a fluid passageway 66a opening to passageway 62, and the cage is provided with longitudinal guide members 67 for valve ball 68. Engaging the ends of guide members 67 is a seat ring 70 for ball 68, and this seat ring 70 is positioned and backed up by a spacer ring 71 and a bushing 72 which is screwthreaded within the outer end of counterbore 65, all as clearly illustrated in Fig. 1.

The operation of the pump is as follows: On the initial in-stroke (to the left) fluid is drawn into chamber 60; on the out-stroke valve 21 closes and the fluid in chamber 60 passes through valve V and passageway 62 to chamber 61. Since, however, the displacement volume of plunger rod 28 is one half that of plunger head 27, a volume of fluid equal to one half that so introduced to chamber 61 will be discharged at 24. On the next in-stroke, a volume of fluid equal to the remainder introduced to chamber 61 on the out-stroke will then be discharged at 24, while chamber 60 is being re-filled through open valve 21. Thus the pump takes in a given volume of fluid on each intake or suction stroke, and discharges a quantity of fluid equal to half of the intaken volume during the suction stroke, and a like volume during the succeeding out-stroke. The work done per cycle is thus the same as though the pump were single acting, but the delivery is divided equally between the suction stroke and the outstroke of the plunger.

It will be evident that the fluid pressure on the inner surface 48a of packing follower ring 48 will be constant while the pump is in operation, and will press said ring in an outward direction to compact and maintain in a tight condition the packing material 46 between said ring 48 and the follower ring 47 at the outer end of the cylinder. It will be remembered that the clearance between follower ring 48 and plunger rod 28 is made less than the clearance between follower ring 47 and the rod. Accordingly, any pressure fluid from chamber 61 which has leaked to the packing by passing outwardly between ring 48 and the plunger rod will be enabled to leak still more easily between outer follower ring 47 and the rod, thus preventing complete equalization of pressure between the pressure fluid which has leaked to the packing and the pressure fluid in chamber 61 acting on ring 48, which condition, as will be evident, would relieve entirely the pressure on the packing exerted by the pressure fluid in chamber 61 acting on ring 48. On the other hand, the leakage path between ring 47 and the rod is sufficiently restricted to hold a certain back pressure within the packing, such that a certain proportion of the fluid pressure acting outwardly on ring 48 is balanced by pressure due to the pressure fluid which has leaked into the packing. If such an equalization of a certain proportion of the outward pressure on ring 48 is not provided, the outward pressure on the packing may become so great as to cause binding of the rod by the packing. Therefore, in accordance with the present invention, the two rings 48 and 47, are provided with such differential clearances, or fluid leakage paths, that a certain proportion of the outward fluid pressure on inner ring 48 is equalized, leaving a desirable component of pressure acting outwardly on ring 48 and the packing material to pack the plunger rod to the necessary extent but without undesirable binding. Obviously, the differential clearances required to accomplish this result will depend on the fluid pressure within the inner chamber, the diameter of the rod to be packed, etc., and must be determined for any given set of circumstances. The principle in all cases, however, is to establish such differential leakage paths to the packing and from the packing as will equalize sufficient of the outward pressure on the inner ring to avoid binding of the plunger, while providing for sufficient resultant outward pressure on the inner ring to pack the packing material to the necessary degree of tightness. It will be evident that this resultant outward pressure on the packing will be approximately proportional to the total outward pressure exerted on the inner ring 48 multiplied by the difference of end areas of the inner ring 48 and the outer ring 47, or in other words to the pressure multiplied by the differential of clearance spaces.

A similar condition exists within the packing at the other end of the cylinder, although here pressure is exerted during each outstroke of the plunger on the outer exposed end area 36a of packing follower ring 36. As illustrated, there is a clearance at 75 between annular flange 38 and the plunger head so that pressure fluid acts constantly against the outer or exposed end area 35a of ring 35. During each outstroke of the plunger, fluid under the same pressure acts on the end area 36a of outer ring 36, and during each instroke of the plunger, the pressure on area 36a is relieved. Accordingly, during each instroke, conditions are substantially the same as at the other end of the cylinder, any pressure fluid that leaks to the packing by way of the clearance between ring 35 and the plunger, leaking still more easily by way of the greater clearance between sleeve 36 and the plunger, and so relieving a proportion of the back pressure in the packing such as would otherwise tend to

complete equalization of the outward pressure on inner ring 35. At the same time the clearance between the outer ring and the plunger is sufficiently restricted to hold a certain back pressure, so that a certain proportion of the total outward pressure on inner ring 35 is equalized, and a proper resultant outward pressure on the packing is obtained. During the outstroke, however, the fluid in chamber 60 to the right of the plunger is under the same pressure as the fluid in chamber 61 to the left of the plunger, and substantially the same fluid pressure acts in opposite directions on the end surfaces of ring 35 and sleeve 36. The spring 37 serves at this time to keep an excess of pressure on ring 35, so that the packing is again forced toward the right.

It will be understood from the foregoing that the packing provided by the present invention is maintained in a properly tight working condition at all times, that excess of pressure on the packing is positively prevented, and that necessity for adjustment of the pressure exerted on the packing by manual means is entirely avoided. It will be evident that the pressure on the packing is determined by the fluid pressure in the pump, the end area of the inner packing follower rings, and by the differential of clearance spaces provided between the inner and outer packing follower rings and the plunger. The factors being properly related for any given pump installation, proper pressures on the packings at both ends of the cylinders are automatically maintained by the pressure of the fluids passing through the pump, the plunger is constantly lubricated by the leakage fluid, and no attention need be given the packing until replacement becomes necessary.

Fig. 3 shows a modification, in which the packing gland sleeves 30 and 44 are eliminated. For convenience, corresponding parts of the pumps of Figs. 1 and 3 are identified by corresponding reference characters, and in Fig. 3 the plunger is shown in elevation, it being understood that the plunger of Fig. 3 may be exactly the same as that of Fig. 1. In the instance of Fig. 3, the wall of cylinder 10 is shown as somewhat thicker than in Fig. 1, and the shoulder 13 cut within the cylinder is somewhat deeper and serves to confine the end of spring 37. The packing follower rings and packing which surround the plunger lie immediately adjacent the inner surface of cylinder 10, as shown. Otherwise the pump is substantially the same as the embodiment previously described, the packing rings and ring clearances being as described in connection with Fig. 1, and the operation of the two pumps being exactly the same.

I have now illustrated and described certain preferred specific embodiments of my invention; it is to be understood, however, that various changes in design, structure and arrangement may be made without departing from the spirit and scope of the broad invention as claimed.

I claim:

1. In a fluid pump having a pump cylinder and a plunger member reciprocable therethrough: packing means for the plunger member comprising a pair of spaced packing rings in said cylinder surrounding said plunger member, the inner one of said packing rings being movable in a longitudinal direction in the pump cylinder and being exposed at its inner end to the pressure fluid within said pump cylinder, means supporting the outer packing ring against movement in an outward direction in the pump cylinder, said outer packing ring fitting the plunger member with greater clearance than does the inner packing ring, and packing in said cylinder surrounding the plunger member between said packing rings.

2. In a fluid pump having a pump cylinder and a plunger member reciprocable therethrough: packing means for the plunger member comprising a pair of spaced packing rings in said cylinder surrounding said plunger member, the inner one of said packing rings being movable in a longitudinal direction in the pump cylinder and being exposed at its inner end to the pressure fluid within said pump cylinder, means supporting the outer packing ring against movement in an outward direction in the pump cylinder, and packing in said cylinder surrounding the plunger member between said packing rings, said inner and outer packing rings being so formed as to allow a greater path for pressure fluid between the outer packing ring and the plunger member than between the inner packing ring and the plunger member.

3. In a fluid pump embodying a pump cylinder having intake and outlet ends, and a plunger working in said cylinder, said plunger having a valved fluid passage opening within the cylinder, means for packing said plunger between the intake and outlet ends of the pump cylinder comprising a pair of spaced packing rings in said cylinder surrounding said plunger, packing surrounding said plunger between said rings, means supporting the packing ring nearest the fluid intake end of the cylinder against outward movement in the cylinder, the said ring being exposed at its outer end to the pressure fluid in the intake end of the cylinder, the other packing ring being movable in a longitudinal direction in the pump cylinder, and its inner end facing the fluid outlet end of the cylinder being exposed to the pressure fluid in the outlet end of the cylinder, there being a leakage path for pressure fluid from the outlet end of the cylinder past said rings and packing to the intake end of the cylinder.

4. In a fluid pump, the combination of a pump cylinder, a packing gland sleeve fitted within one end of said cylinder, a plunger member reciprocable through said sleeve and cylinder, a pair of spaced packing rings slidably fitting the inner surface of said sleeve, the inner of said rings being exposed at its inner end to the pressure fluid within the pump cylinder, the outer of said rings being supported against movement in an outward direction in the cylinder beyond a fixed limiting position, and packing surrounding the plunger member between said packing rings and engaging the inner surface of said sleeve, there being provided a greater fluid leakage path from the packing between the outer packing ring and the plunger member than between the inner packing ring and the plunger member.

5. In a fluid pump, the combination of a pump cylinder, a plunger member reciprocable therethrough, said plunger member embodying a plunger head and a reduced plunger rod, there being clearances between the plunger head and rod and the surrounding interior surfaces of the cylinder, packing means positioned within one end of the cylinder for packing the plunger rod, packing means positioned within the other end of the cylinder for packing the plunger head, said two packing means supporting the plunger rod and plunger head out of sliding contact with the cylinder, a fluid inlet communicating with

the plunger head end of the cylinder, a check-valved fluid passageway in said plunger head for conveying fluid from said fluid inlet to the interior of the cylinder between the packing means at its two ends, and a fluid outlet leading from the interior of the cylinder at a point located between said packing means.

6. In a fluid pump, the combination of a pump cylinder, a plunger member reciprocable therethrough, said plunger member embodying a plunger head and a reduced plunger rod of substantially one half the cross-sectional area of the plunger head, there being clearances between the plunger head and rod and the surrounding interior surfaces of the cylinder, packing means positioned within one end of the cylinder for packing the plunger rod, packing means positioned within the other end of the cylinder for packing the plunger head, said two packing means supporting the plunger rod and plunger head out of sliding contact with the cylinder, a fluid inlet communicating with the plunger head end of the cylinder, a check-valved fluid passageway in said plunger head for conveying fluid from said fluid inlet to the interior of the cylinder between the packing means at its two ends, and a fluid outlet leading from the interior of the cylinder at a point located between said packing means.

7. In a differential pump, the combination of a pump cylinder, a plunger member reciprocable therethrough, said plunger member embodying a plunger head and a reduced plunger rod, there being clearances between the plunger head and rod and the surrounding interior surfaces of the cylinder, a fluid inlet communicating with the plunger head end of the cylinder, a check-valved fluid passageway in said plunger head for conveying fluid from said fluid inlet to the interior of the cylinder, a fluid outlet leading from the interior of the cylinder, packing means within the plunger rod end of the cylinder for packing the plunger rod, packing means within the plunger head end of the cylinder for packing the plunger head, said last mentioned packing means comprising a pair of spaced packing rings surrounding said plunger member, the inner one of said packing rings being movable longitudinally in the cylinder and being exposed at its inner end to the pressure fluid within the interior of the cylinder, means supporting the outer packing ring against movement in an outward direction in the pump cylinder, and packing in said cylinder surrounding and supporting the plunger head between said packing rings.

8. In a differential pump, the combination of a pump cylinder, a plunger member reciprocable therethrough, said plunger member embodying a plunger head and a reduced plunger rod, there being clearances between the plunger head and rod and the surrounding interior surfaces of the cylinder, a fluid inlet communicating with the plunger head end of the cylinder, a check-valved fluid passageway in said plunger head for conveying fluid from said fluid inlet to the interior of the cylinder, a fluid outlet leading from the interior of the cylinder, packing means within the plunger rod end of the cylinder for packing the plunger rod, packing means within the plunger head end of the cylinder for packing the plunger head, said last mentioned packing means comprising a pair of spaced packing rings surrounding said plunger member, the inner one of said packing rings being movable longitudinally in the cylinder and being exposed at its inner end to the pressure fluid within the interior of the cylinder, means supporting the outer packing ring against movement in an outward direction in the pump cylinder, and packing in said cylinder surrounding and supporting the plunger head between said packing rings, there being a leakage path for said pressure fluid from the interior of the cylinder past said packing rings and packing to the outer end of said cylinder.

9. In a differential pump, the combination of a pump cylinder, a plunger member reciprocable therethrough, said plunger member embodying a plunger head and a reduced plunger rod, there being clearances between the plunger head and rod and the surrounding interior surfaces of the cylinder, a fluid inlet communicating with the plunger head end of the cylinder, a check-valved fluid passageway in said plunger head for conveying fluid from said fluid inlet to the interior of the cylinder, a fluid outlet leading from the interior of the cylinder, packing means within the plunger rod end of the cylinder for packing the plunger rod, packing means within the plunger head end of the cylinder for packing the plunger head, said last mentioned packing means comprising a pair of spaced packing rings surrounding said plunger member, the inner one of said packing rings being movable longitudinally in the cylinder and being exposed at its inner end to the pressure fluid within the interior of the cylinder, means supporting the outer packing ring against movement in an outward direction in the pump cylinder, and packing in said cylinder surrounding and supporting the plunger head between said packing rings, there being a leakage path for said pressure fluid from the interior of the cylinder past said packing rings and packing to the outer end of said cylinder, and the leakage path past said outer packing ring being of greater area than the leakage path past said inner packing ring.

10. In a fluid pump having a pump cylinder and a plunger member reciprocable therein, packing means around the plunger member including a pair of spaced packing retaining members, one of said members comprising a packing ring movable longitudinally with regard to said cylinder and being exposed at one end to fluid pressure within said cylinder, the other of said members being fixed against movement in a direction away from said ring, and packing around said plunger between said members, said members being so formed and arranged as to allow leakage of fluid therepast, and a greater leakage past the fixed packing retaining member than past the movable packing ring.

11. In a fluid pump embodying a pump cylinder having intake and outlet ends, and a plunger working in said cylinder, said plunger having a valved fluid passage opening within the cylinder, means for packing said plunger between the inlet and outlet ends of the pump cylinder comprising a pair of spaced packing rings in said cylinder surrounding said plunger, packing surrounding said plunger between said rings, means supporting the packing ring nearest the fluid intake end of the cylinder against outward movement in the cylinder, the other packing ring being movable in a longitudinal direction in the pump cylinder, and its inner end facing the fluid outlet end of the cylinder being exposed to the pressure fluid in the outlet end of the cylinder, there being a substantial leakage path provided for pressure fluid from the outlet end of the cyl-

inder past said rings and packing to the intake end of the cylinder, and a spring pressing the last-mentioned packing ring toward the intake end of the cylinder.

12. In a fluid pump embodying a pump cylinder having intake and outlet ends, and a plunger working in said cylinder, said plunger having a valved fluid passage opening within the cylinder, means for packing said plunger between the inlet and outlet ends of the pump cylinder comprising a pair of spaced packing rings in said cylinder surrounding said plunger, packing surrounding said plunger between said rings, means supporting the packing ring nearest the fluid intake end of the cylinder against outward movement in the cylinder, the other packing ring being movable in a longitudinal direction in the pump cylinder, and its inner end facing the fluid outlet end of the cylinder being exposed to the pressure fluid in the outlet end of the cylinder, the packing ring nearest the intake end of the cylinder fitting the plunger with greater clearance than does the packing ring nearest the outlet end of the cylinder, and a spring pressing the last-mentioned packing ring toward the intake end of the cylinder.

13. In a fluid pump having a pump cylinder with intake and discharge ends and a plunger member reciprocable therein to pump fluid from said intake to said discharge end of said cylinder, packing means for the plunger member comprising a pair of spaced packing rings, one of said packing rings being movable in a longitudinal direction with reference to the axis of the cylinder, and being exposed at one end to the pressure fluid from the discharge end of said cylinder, means supporting the other packing ring against movement in a direction away from the first packing ring, and packing between said packing rings embracing said plunger, there being a substantial leakage path provided for said pressure fluid from the discharge end of said cylinder past said movable packing ring to the packing, and from the packing past said fixed packing to the intake end of the cylinder.

14. In apparatus comprising a housing and a cylindrically-shaped member therein, packing within said housing embracing said member, packing retaining means surrounding said member and engaging said packing at one end, and packing retaining means surrounding said member and engaging said packing at its opposite end, one of said packing retaining means being exposed to a fluid pressure greater than that to which the other is exposed, and there being provided pressure fluid leakage paths past said packing retaining means, of which the leakage path past the retaining means which is exposed to the greater fluid pressure is of lesser cross-sectional area than the leakage path past the other of said retaining means.

15. In apparatus comprising a housing and a cylindrically-shaped member therein, packing within said housing embracing said member, packing retaining means surrounding said member and engaging said packing at one end, and packing retaining means surrounding said member and engaging said packing at its opposite end, one of said packing retaining means being exposed to a pressure fluid greater than that to which the other is exposed, and there being a lesser clearance for leakage of pressure fluid between said packing retaining means which is exposed to the greater fluid pressure and said member than between the other packing means and said member.

16. In apparatus comprising a housing and a cylindrically-shaped member therein, packing within said housing embracing said member, packing retaining means surrounding said member and engaging said packing at one end, and packing retaining means surrounding said member and engaging said packing at its opposite end, one of said packing retaining means being movable longitudinally of said housing and being exposed to a fluid pressure greater than that to which the other is exposed, and said two packing retaining means being so arranged as to provide a lesser leakage path for said pressure fluid past said packing retaining means which is exposed to the greater fluid pressure than past said other packing retaining means, in such manner that pressure fluid leaking to said packing past said movable retaining means will be relieved past said other retaining means without causing substantial loosening of said packing.

17. In a fluid pump having a cylinder and a plunger operable therein, packing means in the cylinder around said plunger including spaced inner and outer packing members, and packing retained between said members, said packing members being so formed and arranged as to provide a restricted fluid leakage path past the inner member and a less restricted fluid leakage path past the outer member.

18. In a fluid pump, a cylinder, a plunger, clearances between said cylinder and plunger entirely around said plunger, packing means supporting the plunger entirely out of contact with the cylinder, said packing means including spaced inner and outer packing rings, and packing retained between said rings, said rings being so formed and arranged as to provide a restricted fluid leakage path past the inner ring and a less restricted fluid leakage path past the outer ring, and automatic means for feeding one of said packing rings toward the other as the packing wears.

19. In a fluid pump having a cylinder and a plunger operating therein, packing means in the cylinder around said plunger including spaced inner and outer packing members and packing retained between said members, the clearance between the plunger and the outer packing member being sufficiently greater than the clearance between the plunger and the inner packing member to pack the plunger to the necessary extent without undesirable binding.

20. In a fluid pump having a cylinder and a plunger operating therein, packing means in the cylinder around said plunger including spaced inner and outer packing members and packing retained between said members, the clearance between the plunger and the outer packing member being sufficiently greater than the clearance between the plunger and the inner packing member to prevent undesirable binding of the packing, said clearance between the plunger and the outer packing member being also small enough to retain sufficient fluid pressure between the packing members to pack the plunger to the necessary extent.

21. In a fluid pump having a cylinder and a plunger operating therein, packing means for said plunger including spaced inner and outer packing members and packing retained between said members, said inner member being exposed to pressure of fluid in said cylinder, the clearance between said plunger and the outer member

being sufficiently greater than the clearance between the plunger and the inner member to relieve fluid under pressure which has leaked into the packing sufficiently to prevent undesirable binding of the packing, said clearance between the plunger and the outer packing member being also small enough to retain sufficient fluid pressure between the two packing members to pack the plunger to the necessary extent, said inner packing member being pressed toward said outer packing member by pressure of fluid within the cylinder to compress the packing.

22. In apparatus comprising a housing and a cylindrically-shaped member therein, packing within said housing embracing said member, packing retaining means surrounding said member and engaging said packing at one end, and packing retaining means surrounding said member and engaging said packing at its opposite end, one of said packing retaining means being exposed to a fluid pressure greater than that to which the other is exposed, the two packing retaining means being so formed and arranged as to provide a restricted pressure fluid leakage path past the packing retaining means which is exposed to the greater fluid pressure and a less restricted pressure fluid leakage path past the other packing retaining means.

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