

Oct. 9, 1956

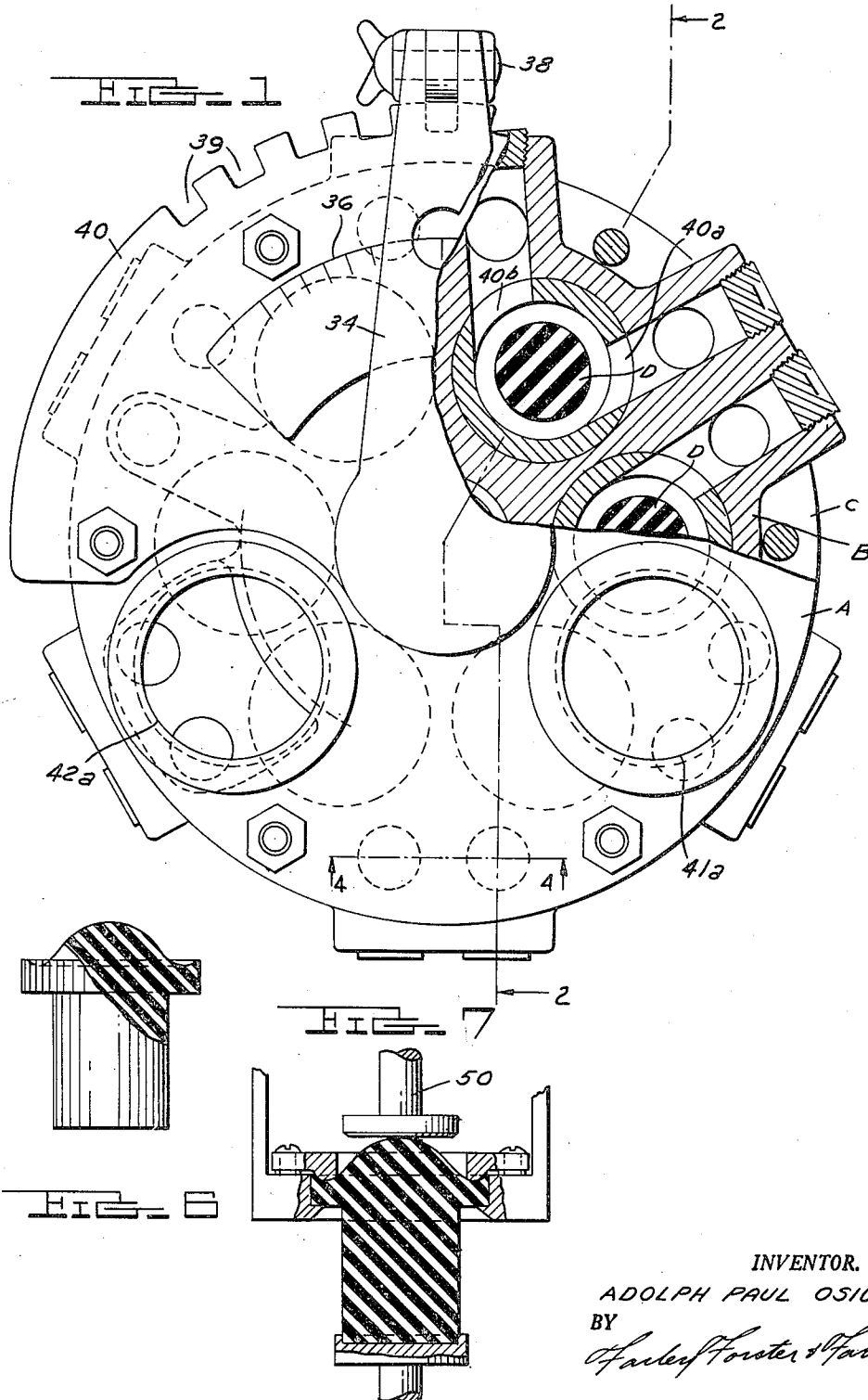
A. P. OSIUS

2,765,751

FLUID PUMP

Filed Jan. 21, 1953

3 Sheets-Sheet 1



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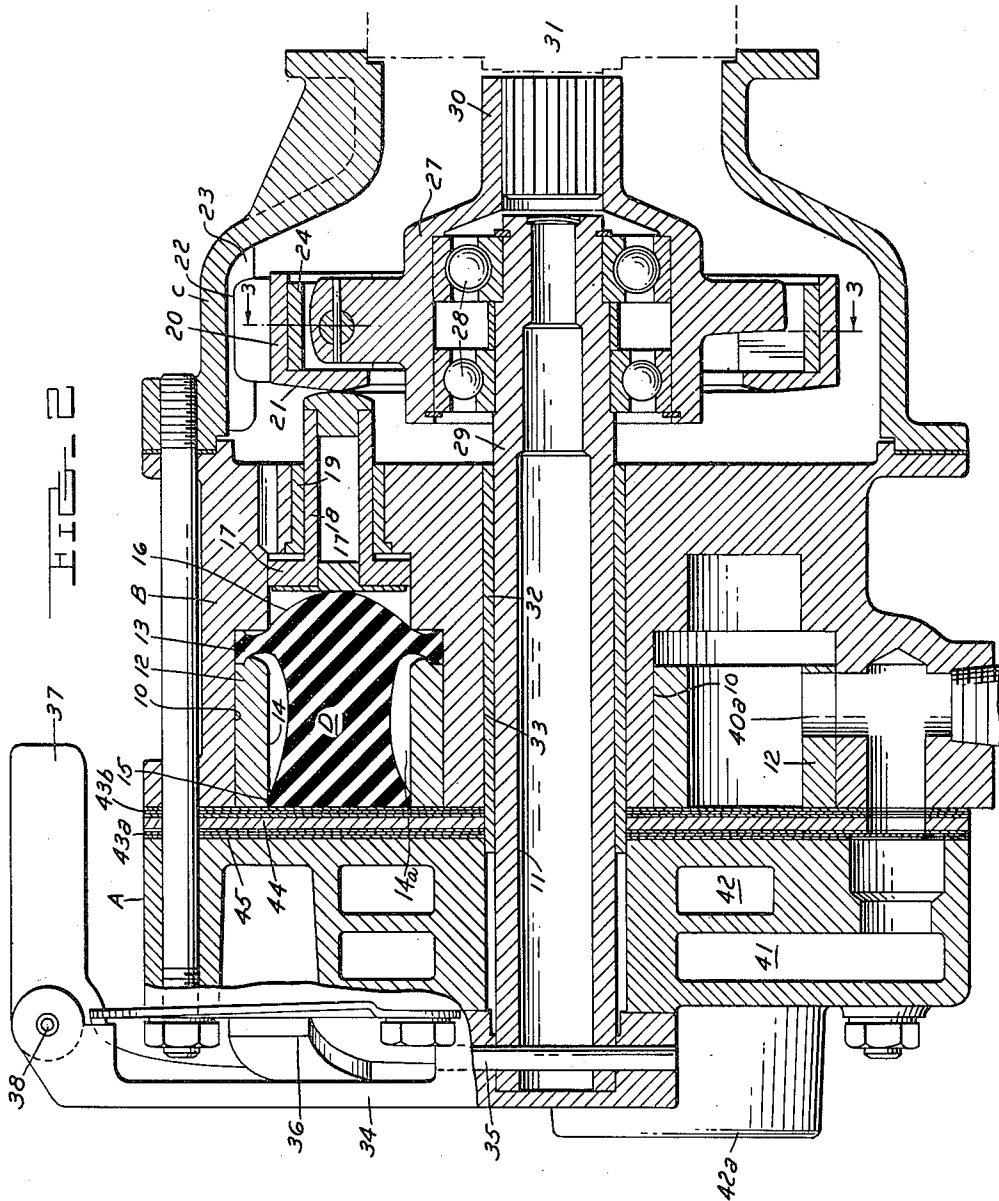
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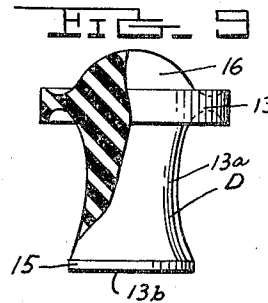
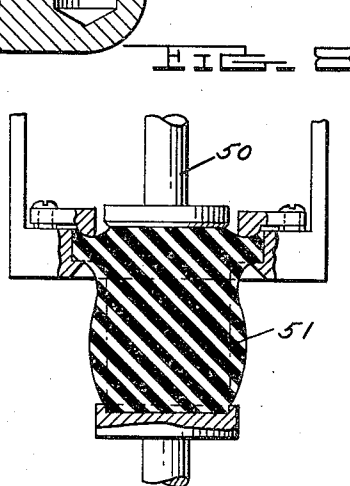
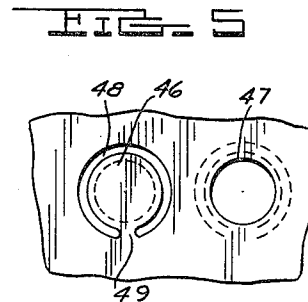
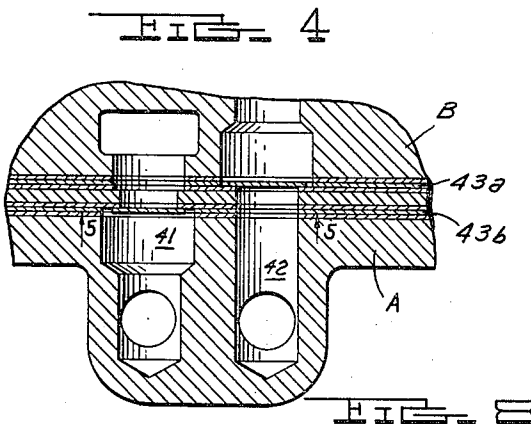
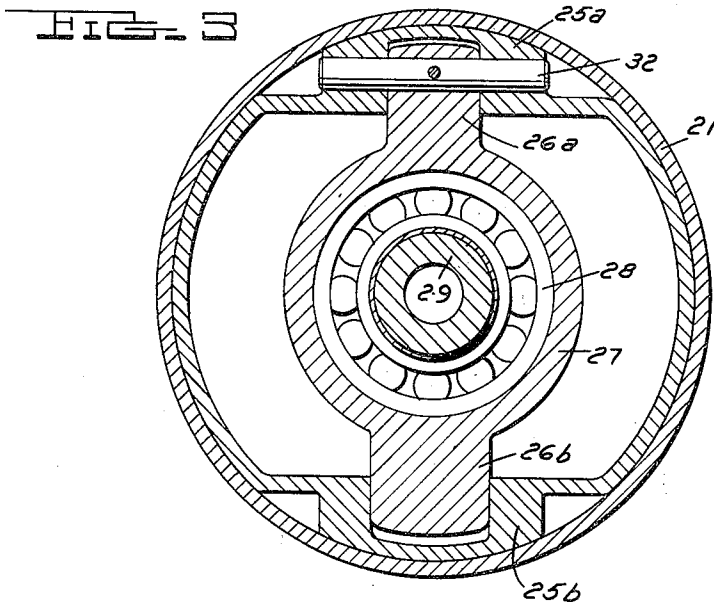
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3 Sheets-Sheet 3



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FLUID PUMP

Adolph Paul Osius, Detroit, Mich.

Application January 21, 1953, Serial No. 332,419

9 Claims. (Cl. 103—149)

This invention relates to fluid pumps and is characterized by pumping elements of a rubber or like material having deformable, substantially incompressible and elastic recovery properties.

It is an object of the invention to provide such elements with a configuration susceptible of the application of external pressure to produce internal distention in a manner whereby a positive seal may be provided between the fluid pumping chamber and the external actuating mechanism; whereby any frictional rubbing between the pumping elements and the fluid chamber walls may be eliminated; whereby the stresses imparted to the pumping elements may be rendered substantially entirely compressive in nature; whereby a complete evacuation of the pumping chamber may be effected with each pumping stroke; and whereby the elastic recovery properties of the pumping elements may be employed to effect intake to the pumping chamber.

It is a further object to provide novel actuating means of a variable swash plate principle to generate reciprocal movement for sequentially actuating a series of such pumping elements in a series of radially disposed pumping chambers providing a variable discharge and/or pressure pump which may be driven at either uniform or variable speed.

Another object is to provide a method for constructing such resilient pumping elements which will insure desired operating characteristics notwithstanding irregularities or nonuniformity in the composition of the material employed.

Another object is to provide a construction for such pumping elements which will avoid the requirement for accurate machining of metal parts associated with the pumping chambers while nevertheless assuring positive sealing and other desirable characteristics such as enumerated above.

These and other objects will be apparent from the following detailed description of a particular embodiment and from an examination of the drawings forming a part hereof wherein:

Fig. 1 is an end elevation of a pump incorporating the principles of my invention partially broken away to show interior construction.

Fig. 2 is a sectional side elevation of the pump taken along the line 2—2 of Fig. 1.

Fig. 3 is a sectional end view taken along the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary sectional view of a pair of inlet and outlet ports taken along the line 4—4 of Fig. 1.

Fig. 5 is a fragmentary view of a check valve disc taken along the line 5—5 of Fig. 4.

Fig. 6 is a side elevation of a pumping element blank prior to forming its main body contour.

Fig. 7 is a lathe fixture for forming the main body of a pumping element.

Fig. 8 is a view of the same fixture with pressure applied to the dome to distend the main body to a degree

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comparable to the maximum distention stroke in the pump and showing the distended configuration of the main body before forming in solid line and after forming in dotted line.

Fig. 9 is an elevational view, with parts broken away and in section, of a finished pumping element.

Referring to Fig. 2 it will be seen that the preferred embodiment of the pump incorporates three main housings including a manifold A, an annular housing B for the pumping elements, and an annular housing C for the actuating mechanism. The housing B incorporates a plurality of radially disposed cylindrical bores 10 each having an axis parallel with the main centerline 11 of the pump.

Within each of the bores 10 a cylindrical sleeve 12 engages the lipped flange 13 of a resilient rubberlike pumping element D, the main body of which in its relaxed position, as shown in the drawing, has a necked portion which together with the inner wall 14 of the sleeve provides a fluid pumping chamber sealed at one end by engagement of the closely fitting end 15 of the pumping element and at the other end by the flange 13. A dome portion 16 of the pumping element is engaged and actuated by a solid piston head 17 having a plunger 18 adapted to reciprocate in a bushing 19 suitably mounted in the pump body B. The element D includes the terminal dome portion 16, the radially enlarged flange 13, a radially reduced medial or central portion 13a, an end surface 13b bottomed within the chamber, and the closely fitting end 15. The enlarged sealing surfaces provided by the end 15 and the flange 13 cooperate with the reduced central portion to form an element of generally spool-like configuration. The element D cooperates with the sleeve inner wall to define an annular fluid space 14a therebetween.

The actuating mechanism includes an annular ring 20 having a face 21 adapted to engage the end of each plunger 18. Such ring is held against rotation by one or more lugs 22 projecting between a pair of guides 23 secured to the inner wall of the housing C. An inner ring 24 is adapted to rotate within the outer ring 20. As best shown in Fig. 3, slotted bosses 25a and 25b within opposite sides of the ring 24 are adapted for driving engagement by radially projecting members 26a, 26b of an annular driving hub 27 rotatably mounted with antifriction bearings 28 on a nonrotating axially displaceable shaft 29. The driving hub 27 is provided with an internally splined necked portion 30 for axially displaceable drive from the splined drive shaft 31 of a motor or other suitable source of power, not shown.

A pin connection 32 through the drive member 26a and ring boss 25a fixes the longitudinal position of one side of the drive ring 24 while the other side is capable of tilting displacement relative to the drive member 26b about the axis of the pin connection 32. When the shaft 29 is in the axial position shown in Fig. 2, rotation of the drive hub 27 and ring 25 will produce no pumping displacement of the ring 20. However, when the shaft 29 is displaced axially to the left moving the hub 27 to a position closer to the pumping housing B, a pumping displacement of each piston 17 equal to such axial movement will be produced upon each revolution of the driving ring 24 while the resilient recovery properties of the pumping elements D reacting against their pistons at points circumferentially spaced from the instantaneous position of the connecting pin 32 will cause a tilting displacement of the nonrotating ring 20 and rotating ring 24 to permit a return stroke for each piston.

The drive adjustment shaft 29 moves within a sleeve 32 seated in a cylindrical bore 33 of the housing B and is axially displaced by rotation of an adjustment arm 34

pinned at 35 to the end of the shaft 29. The arm 34 is adapted to engage a fixed cam surface 36 on the end of the housing A and is held in any given position by the engagement of a handle 37 pivoted at 38 within any of a series of slots 39 in a fixed annular adjustment segment 40, the last of which slots 39 corresponds to a maximum pumping displacement position.

Pumping elements D are so constructed that a maximum displacement of a piston 17 will cause axial displacement of the domed portion 16 producing an outward distension of the necked portion of the pumping element to fully engage the inner wall surface 14 of the pumping chamber sleeve 12 and substantially completely evacuate fluid from the pumping chamber. Each of the sleeves 12 is provided with a pair of ports 40a and 40b located at the portion of the sleeve last contacted by the pumping element D at the end of a pumping stroke. Such ports are respectively connected by suitable passages to an outlet manifold 41 and an inlet manifold 42. The passages between the pumping elements and manifolds each pass through a pair of check valve discs 43a and 43b which are interposed between the ends of the housings A and B together with an intermediate separator disc 44 and a pair of gasket discs 45 on either side of each of the check valve discs 43. Each of the check valve discs is constructed of thin spring steel provided with a plurality of alternate one-way check valves 46 and open apertures 47 radially disposed to align with the respective inlet and outlet ports. Each check valve is formed by stamping a circumferential slot 48 which leaves the circular check valve portion 46 connected to the disc at a single point 49 as best shown in Fig. 5. As shown in Fig. 4, the check valves in disc 43a permit outflow and block inflow while those in disc 43b permit inflow and block outflow. The respective manifolds communicate with main pump outlet and inlet ports 41a, 42a at the end of the manifold housing A.

A single pumping element D in its relaxed form is shown in Fig. 9. Such elements are preferably constructed of molded rubber or other suitable material having physical properties of substantial incompressibility, deformability, elastic recovery and suitable durometer values correlated with the maximum pressures for which the pump is designed to operate.

In developing a pattern for the pumping element for a particular application, a blank such as shown in Fig. 6 of the same material as to be used in the pumping elements is inserted in a lathe fixture such as shown in Fig. 7 having a plunger 50 adapted to engage and displace the domed portion of the blank to a position such as shown in Fig. 8 corresponding to the maximum stroke of the piston in the particular pump for which the pumping element is designed thereby causing an outward distension of the side walls beyond the final form of the inner wall 14 of the pumping chamber sleeve 12 shown in dotted line at 51 in Fig. 8. With the resilient blank thus distended, the excess material may be machined off leaving a distended form corresponding exactly to that of the inner wall of the chamber sleeves 12. When the blank is then released from the mixture it will have the required relaxed form shown in Fig. 9 necessary to bring about the complete evacuation of the pumping chamber when fully distended, as well as a form which will produce such evacuation without any relative rubbing movement between the pumping element and the pumping chamber wall. In critical applications where nonuniformity of material in the molded pumping elements may lead to objectionable minor errors in the final distended form, the blank for the pattern may be machined to a slightly over-sized dimension and each of the molded elements may be individually finish machined in a similar production fixture to that described for machining the pattern blank.

It will be understood that the complete evacuation of the cylinder obtained by the above construction may be very desirable in such cases as the pumping of liquid food stuffs, insuring sanitation, or where exact calibration of volume is required. The elimination of any sliding or

frictional movement between the displaceable member and the walls of the pumping chamber adapts the pump to handle abrasive fluids without wear or damage to the pump. In addition, the complete sealing of fluid in the pump from the actuating mechanism may be highly desirable from a sanitation standpoint in pumping foodstuffs or from a safety standpoint in pumping dangerous gases, chemicals or the like.

While a preferred embodiment has been described above in detail it will be understood that numerous modifications may be resorted to which will fall within the scope of my invention as defined in the following claims.

I claim:

1. A unitary pumping element comprising a resilient, deformable, substantially incompressible member of generally spool-like configuration and having axial end surfaces constructed for receiving the application of compressive forces and a radially reduced outwardly distensible medial portion responsive to the application of said compressive forces for distortion to at least a substantially cylindrical shape.

2. In a pump, a plurality of cylindrical pumping chambers having parallel axes circumferentially spaced at equal radial dimensions about the center line of the pump, pumping elements associated with each of said chambers, members reciprocable along the axis of each of said chambers for actuating said pumping elements, an annular, tiltable, nonrotatable contact ring for engaging said reciprocable members, and rotatable means for progressively tilting said ring to produce sequential reciprocation of said members, said last-named means including a rotatable bearing member for engaging said contact ring, means for rotatably driving said bearing member comprising a rotatable member having a fixed axis of rotation, and a pivotal connection between said last-named member and said bearing member radially spaced from said axis of rotation, said last-named rotatable member including two diametrically spaced driving projections, said bearing member including two diametrically spaced recesses for receiving said driving projections, a transverse pivot pin passing through said bearing member and one of said driving projections, said bearing member being capable of longitudinal movement relative to the other of said driving projections.

3. In a pump, a plurality of cylindrical pumping chambers having parallel axes circumferentially spaced at equal radial dimensions about the center line of the pump, pumping elements associated with each of said chambers, members reciprocable along the axis of each of said chambers for actuating said pumping elements, an annular, tiltable, nonrotatable contact ring for engaging said reciprocable members, rotatable means for progressively tilting said ring to produce sequential reciprocation of said members, said last-named means including a rotatable bearing member for engaging said contact ring, means for rotatably driving said bearing member comprising a rotatable member having a fixed axis of rotation, and a pivotal connection between said last-named member and said bearing member radially spaced from said axis of rotation, said last-named rotatable member including two diametrically spaced driving projections, said bearing member including two diametrically spaced recesses for receiving said driving projections, a transverse pivot pin passing through said bearing member and one of said driving projections, said bearing member being capable of longitudinal movement relative to the other of said driving projections, and an axially adjustable shaft for varying the plane of rotation of said rotatable drive member to produce adjustable variation in the effective stroke of said contact ring.

4. A unitary pump element comprising a resiliently deformable substantially incompressible member having a pair of axially spaced radially enlarged sealing surfaces adjacent the ends thereof, respectively, axial end surfaces adapted to be subjected to compressive forces, and a radially reduced medial portion intermediate said

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sealing surfaces radially outwardly distensible to a substantially cylindrical shape in response to the application of compressive forces to said end surfaces.

5. A unitary pump element comprising a member formed of a resiliently deformable substantially incompressible material, said member being of spool-like configuration and having axial end surfaces constructed for receiving the application of compressive forces, one of said end surfaces being in the form of a bulbous dome, and a radially reduced outwardly distensible medial portion, the dome being axially displaced in response to the application of said compressive forces to accommodate radially outward distension of said medial portion to at least a substantially cylindrical shape.

6. A pump element as defined in claim 5, wherein a radially enlarged peripheral sealing flange is interposed between said medial portion and said dome.

7. In a pump, a piston, means including the piston defining a chamber axially aligned with the piston, means for axially advancing the piston, a substantially incompressible resiliently deformable body bottomed in said chamber and having a free end extending axially toward said piston for contact therewith, said body normally partially filling said chamber radially to define an annular fluid space interposed between said body and said chamber defining means, inlet and outlet ports communicating with said fluid space, axial advancement of the piston resiliently deforming the body to distend the same radially, thus reducing the volume of said fluid space and subjecting fluid therein to pressure.

8. In a pump, a displaceable plunger element, means including the plunger element defining a chamber longitudinally aligned with said plunger element and having a generally fixed inner peripheral surface, a pumping element disposed in said chamber to be retained therein and comprising a unitary resiliently deformable substantially incompressible member having an end surface in contact with said plunger element and a peripheral surface having a first portion sealingly engageable with said inner surface and a second portion of lesser peripheral extent than the inner surface to define therebetween a peripheral space adapted to receive and discharge fluid, inlet and outlet ports communicating with said fluid

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space, said member being resiliently deformable upon displacement of said plunger element to expansively distend said second peripheral portion toward said inner surface, thereby reducing the volume of said peripheral space.

9. In a pump, a piston, means including the piston defining a chamber axially aligned with the piston, means for axially advancing said piston, a substantially incompressible, resiliently deformable body bottomed in said chamber and having a free end provided with a terminal bulbous dome extending axially toward said piston and in constant contact therewith, said body normally only partially filling said chamber radially to define an annular fluid space interposed between the body and the chamber defining means, and inlet and outlet ports communicating with said fluid space, axial advancement of the piston resiliently deforming the body by displacement of said terminal dome to expansively distend the body radially, thus reducing the volume of said fluid space and subjecting fluid therein to pressure, the recovery of said body from such resilient deformation axially returning the piston and contracting said body radially.

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