

- [54] PUMP
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128, 130, 168

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[57] **ABSTRACT**

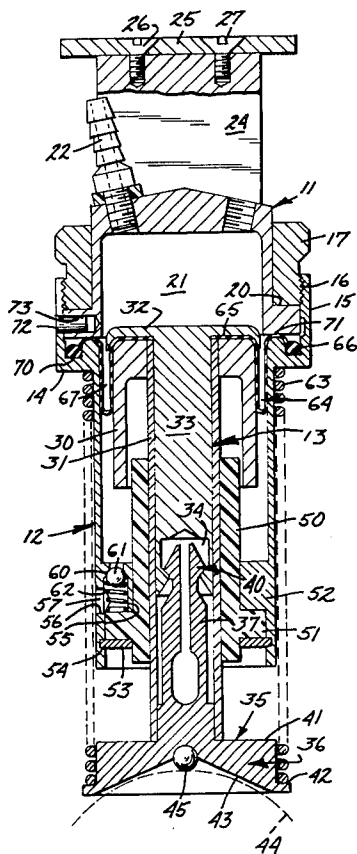
An improved pump structure, for use in pharmaceutical manufacturing, particularly designed to prevent contamination of the liquid being pumped by particulate matter, to operate under continuous pressure without leakage, and to be easily disassembled for cleaning and sterilization. It comprises a cylinder and cylinder head defining a space within which a piston assembly is reciprocated. A rolling diaphragm is part of the piston assembly, and is clamped between the cylinder and cylinder head to divide the space into separate portions. The check valve produces a negative pressure in one of the portions, ensuring proper operation of the diaphragm in the space between the piston and the cylinder. Inlet and outlet connections are made at the cylinder head, to that the cylinder and piston assembly are readily removable for servicing.

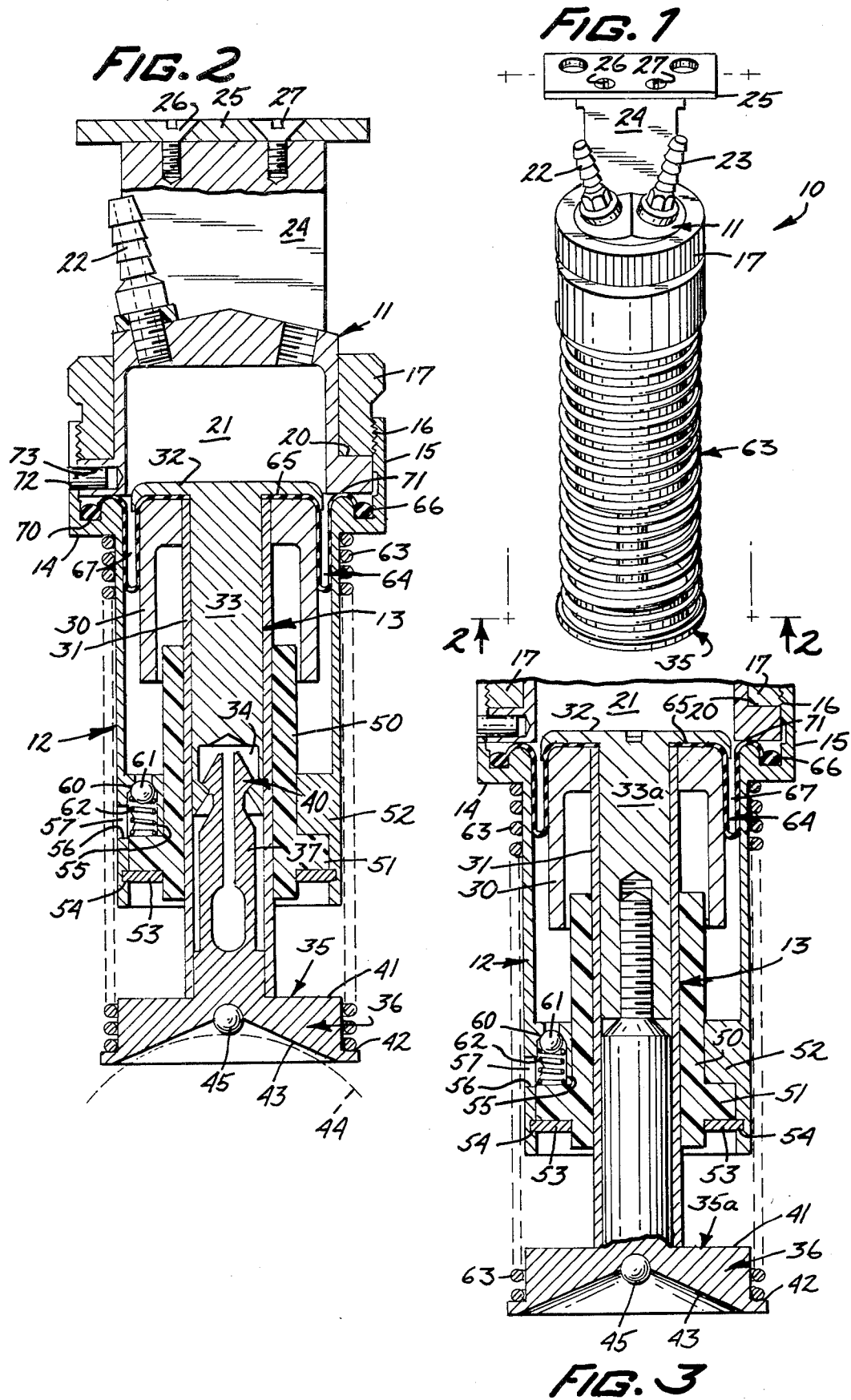
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**10 Claims, 3 Drawing Figures**





## BACKGROUND OF THE INVENTION

This invention relates to the general field of pumps, and more particularly to pumps for use with pharmaceutical liquids in the distribution and particularly packaging of sera, antigens, viruses, and similar therapeutic substances. The usual construction for pumps in this field has been a conventional metal piston smoothly and tightly fitting in a metallic cylinder. These structures are however subject to wear, which results in small but undesirable particulate contamination of the liquid being pumped as well as slight and unavoidable leakage of fluid past the piston. Materials to be used must be biologically inert and resistant to attack by many different liquids and solvents. A specially significant factor in pumps of this sort is the necessity of frequent cleaning and autoclaving, with the concomitant need for a structure which can be readily and conveniently disassembled into elements adapted to sterilization by commercially available methods.

## SUMMARY OF THE INVENTION

We accomplish the above objectives by a pump in which a separable cylinder and cylinder head define a space in which a piston assembly is mounted for reciprocation, the piston assembly including a rolling diaphragm for clamping between the cylinder and cylinder head to divide the space into first and second portions close to and remote from the cylinder head respectively. Inlet and outlet connections for the pump are both made to the cylinder head to which the rest of the pump is releasably secured. Valving is accomplished by means not a part of the present invention. A ball check valve is located in a passage through the cylinder wall and functions to maintain a slight negative pressure in the portion of the space remote from the cylinder head.

It is accordingly a principal object of the invention to provide a new and improved pump for pharmaceutical liquids.

Another object is to provide such a pump which is free from particulate contamination and leakage and which is easily disassembled for cleaning and sterilization.

Various other objects, advantages, and features of novelty which characterize our invention are pointed out with particularity in the claims annexed hereto and forming a part hereof. However, for a better understanding of the invention, its advantages, and objects attained by its use, reference should be had to the drawing which forms a further part hereof, and to the accompanying descriptive matter, in which there are illustrated and described certain preferred embodiments of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawing FIG. 1 is a perspective view of a pump according to our invention;

FIG. 2 is a generally longitudinally section taken along the line 2—2 of FIG. 1; and

FIG. 3 is a fragmentary sectional view of a modification.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawing shows our pump 10 to comprise a cylin-

der head 11 and a cylinder 12 which define a space in which a piston assembly 13 may be reciprocated. Cylinder 12 has an external shoulder 14 and is enlarged at one end 15 and internally threaded at 16 to receive a knurled clamp collar 17 externally threaded for that purpose. Cylinder head 11 has an external shoulder 20 against which collar 17 bears to secure the head to the cylinder.

Head 11 is inwardly concave at 21 and is tapped to receive a pair of tubulatures 22 and 23 which comprise the inlet and outlet of the pump respectively. Integral with head 11 is a bracket 24 secured to a mounting plate 25 by machine screws 26 and 27.

Piston assembly 13 is shown to comprise a skirted piston 30 carried on a hollow piston rod 31. A piston head 32 having a shank 33 extends into rod 31, and at its end is formed with a shaped opening 34.

A tappet 35 has a head 36 and a shank 37, the latter fitting within rod 31 and having a reduced, bifurcated, double tapered end 40 which resiliently engages opening 34. Head 36 has a first shoulder 41 which engages the end of rod 31, a second shoulder 42, and an inwardly conical end surface 43 for receiving a tappet actuating roller, suggested at 44: actual contact between the roller and the tappet occurs at a hardened steel ball 45 inset into the tappet.

Rod 31 slides in a Teflon insert 50 having an external shoulder 51 which is secured in cylinder 12 between an internal shoulder 52 of the cylinder and a snap ring 53 resiliently contained in a groove 54 in the cylinder. Shoulder 52 and the wall of cylinder 12 are bored at 55 and 56 respectively to provide a right angle passage 57 through the cylinder having a seat 60 for the ball 61 of a check valve. The ball is held by one end of a spring 62, of which the other end is supported by shoulder 51 of insert 50.

A compression spring 63 acts between shoulder 14 of cylinder 12 and shoulder 42 of tappet 35 to urge the tappet and hence the piston assembly in a downward direction as seen in FIG. 2. The force exerted by spring 63 is less than that required to extract the shank of tappet 35 from opening 34.

Piston head 32 passes through a central opening in a rolling diaphragm 64 having a central portion 65, a peripheral rib 66, and an intermediate portion 67 which is reentrantly received in the space provided therefor between cylinder 12 and the skirt of piston 30. The enlarged end 15 of cylinder 12 has an annular groove 70 to receive the peripheral rib of diaphragm 64, which is clamped by a flat surface 71 of head 11. A slot 72 in the cylinder and a pin 73 in the head are arranged to key head 11 and cylinder 15 together so that when collar 16 is to be tightened no sliding rotation of head 11 on diaphragm 64 takes place. The central part of diaphragm 64 is secured by piston head 32, and the assembly is maintained by the action of shank 40 gripping opening 34. Outward axial movement of piston assembly 13 under the influence of spring 63 is limited by contact between the inside of piston 30 and the end of insert 50.

The embodiment of FIG. 3 is like that of FIG. 2, except that the connection between members 35 and 32a is a screw threaded one.

## OPERATION

In operation inlet and outlet hoses are connected to tubulatures 22 and 23 and the pump is inserted in a dis-

pensing or other mechanism so that an actuating roller 44 is in operative relationship to tappet 35. This cyclically compresses spring 62 and forces piston assembly 13 upward in cylinder 12, forcing liquid out at 23, then allows spring 62 to expand, drawing liquid in at 22: valving in the tubes leading to the pump is accomplished by suitable means not forming a part of this application.

The space within cylinder 12 and head 11 is divided by diaphragm 64 into a first portion adjacent head 11 and a second portion remote therefrom. All possible wear of the pump takes place below the diaphragm, and hence there is no possibility of particulate contamination of the liquid passing through the pump. There is also no possibility of leakage of the liquid past the piston, since it is totally sealed by diaphragm 64, and hence the liquid system may be operated at a slight positive pressure if conditions warrant.

Each time the pump assembly moves downwardly as seen in FIG. 2 a small quantity of air may be expelled from the lower portion of the space, past check ball 61. This quickly results in the presence of a slight negative pressure below diaphragm 64 which is helpful in maintaining proper rolling operation of the diaphragm.

For use in pharmaceutical operations all materials contacting the liquid being pumped must be biologically inert: these include only 3 component elements. Cylinder head 11 and piston head 32 are made of stainless steel, and diaphragm 64 is of a silicone rubber. Other suitable combinations of material may be used as desired.

When it is desired to clean and sterilize the pump, torque is applied to the knurled surface of ring 17 and the ring is removed from cylinder 12. Actuator 44 being withdrawn, the cylinder and piston assembly are removable from the head as a unit. By application of additional force tappet 35 is disengaged from opening 34, and the piston, piston head, and diaphragm are at once separable.

Removable of the snap ring frees the insert and the check valve parts. Assembly is of course simply the reverse operation.

Numerous objects and advantages of our invention have been set forth in the foregoing description, together with details of the structure and function of the invention, and the novel features thereof are pointed out in the appended claims. The disclosure, however, is illustrative only, and changes may be made in detail especially in matters of shape, size, and arrangement of parts, within the principle of the invention, to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. In a pump, in combination:

a piston assembly including a hollow piston shaft, a hollow skirted piston mounted on one end of said shaft, and a piston head overlying said piston and including a central rod to be received in said shaft; a cylinder of larger internal diameter than the diameter of said hollow skirted piston;

a cylinder head having inlet and outlet ports; means removably securing said cylinder head to said cylinder;

guide means in said cylinder slidably mounting said piston shaft for linear reciprocation of said piston assembly in said cylinder;

a rolling diaphragm having an apertured central portion for clamping between said piston head and said hollow skirted piston, a peripheral portion for clamping between said cylinder head and said cylinder, and an intermediate portion reentrantly contained between said cylinder and hollow skirted piston, to divide the space within said cylinder and head into separate portions adjacent to and remote from said cylinder head;

a tappet member received in said piston shaft and releasably engaging said central rod of said piston head, for retaining said piston head in clamping relation to said piston and for imparting axial motion to said piston assembly;

and spring means acting between said cylinder and said tappet member to normally urge said piston assembly in a direction away from said cylinder head, so that upon releasing the first named means the tappet member, main spring, cylinder, and piston assembly may be removed as a unit.

2. Apparatus according to claim 1 together with means effective during operation of said pump to maintain a reduced pressure in the portion of said space remote from said cylinder head, to ensure controlled operation of said rolling diaphragm.

3. Apparatus according to claim 2 in which the last named means includes a ball check valve in a passage through the wall of said cylinder.

4. Apparatus according to claim 3 in which said guide means is removably mounted in said cylinder and retains said ball check valve in said passage.

5. Apparatus according to claim 1 together with means limiting the travel of said piston assembly under the action of said main spring.

6. Apparatus according to claim 1 which said guide means comprises a removable insert of material having a low coefficient of sliding friction.

7. Apparatus according to claim 1 in which said tappet member includes a concave outer end having a central convex spherical contactor.

8. Apparatus according to claim 1 in which said cylinder head includes means for suspending said pump over a tappet actuator.

9. Apparatus according to claim 1 in which said cylinder head and said piston head are of stainless steel and said rolling diaphragm is of silicone.

10. Apparatus according to claim 1 in which said tappet member includes a bifurcated double tapered end and said rod includes a shaped aperture to receive and release said double tapered end in response to axial force, applied between said tappet member and said rod, of greater magnitude than the force exerted by said main spring.

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