Oct. 21, 1958 R. B. SAALFRANK 2,856,857

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Filed June 5, 1953 2 Sheets-Sheet 1

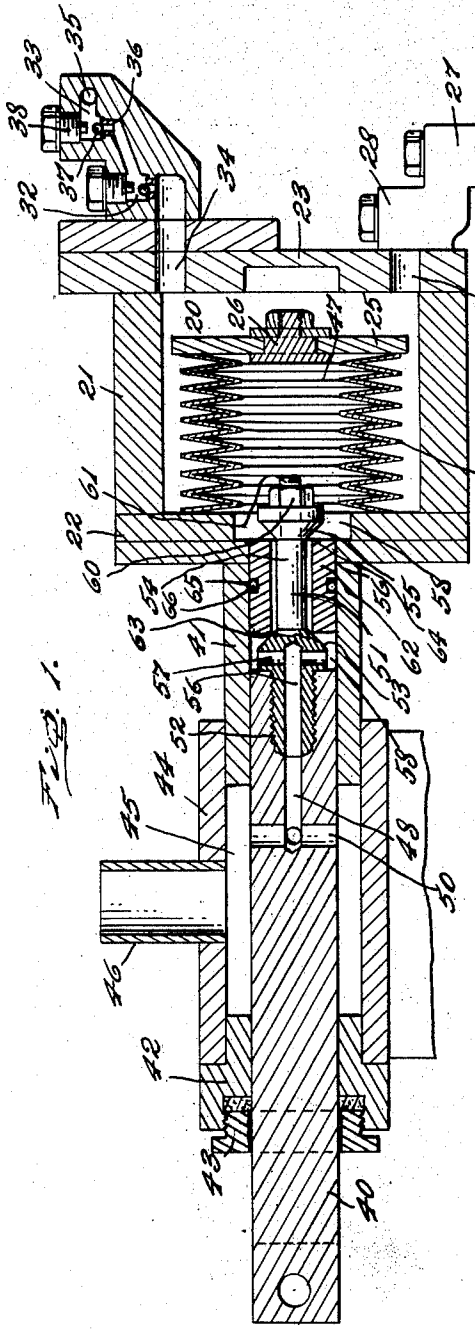


Fig. 1.

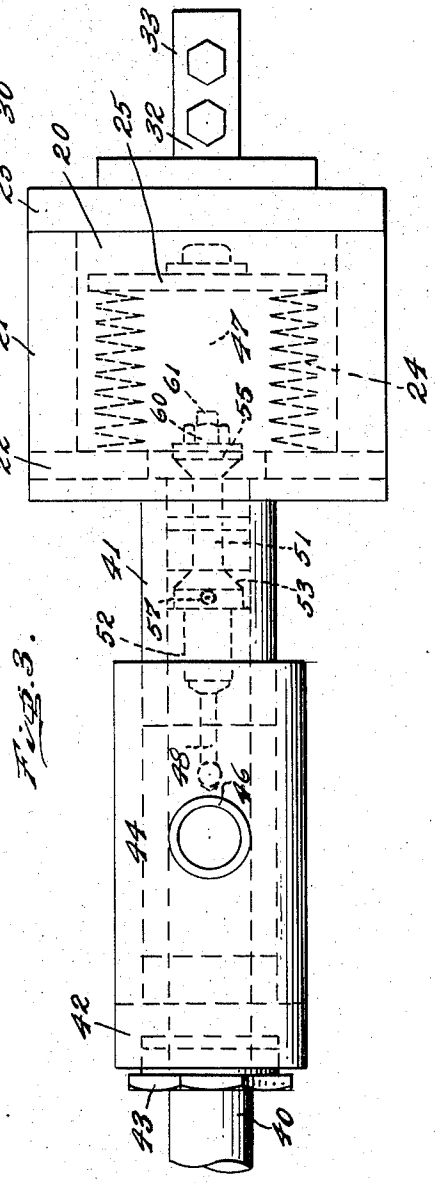


Fig. 3.

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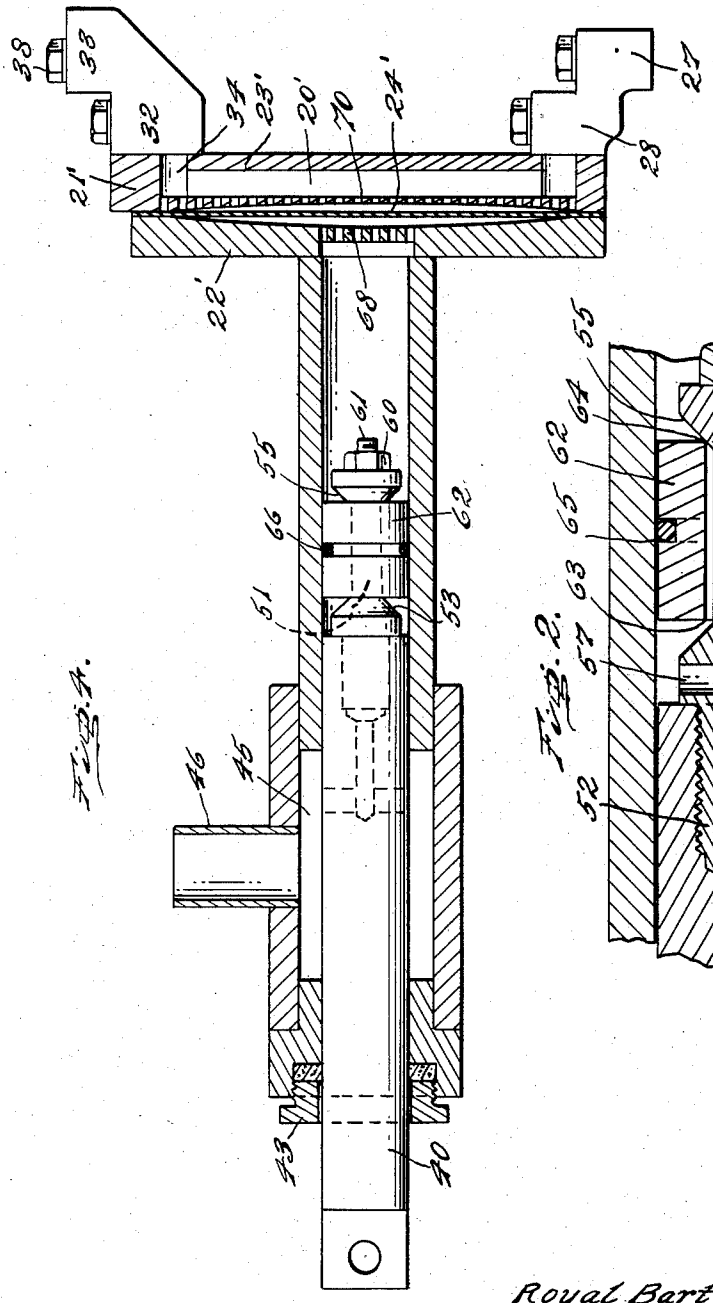


Fig. 3.

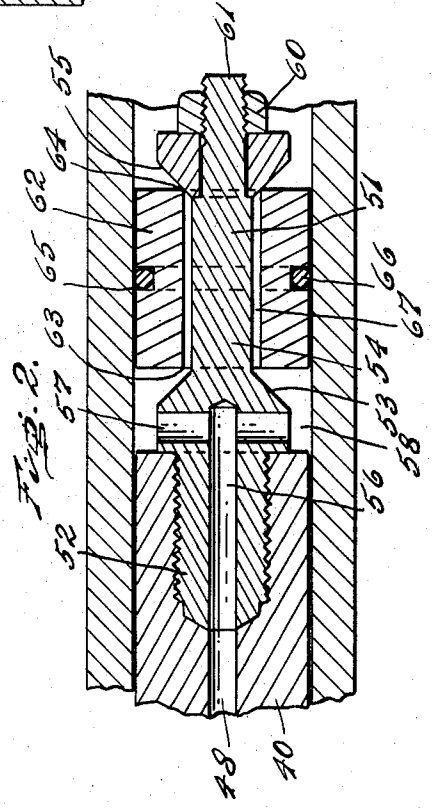


Fig. 2.

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2,856,857

PUMP

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Application June 5, 1953, Serial No. 359,843

8 Claims. (Cl. 103—44)

The present invention relates to pumps, and particularly to accurate metering pumps of positive displacement type for use in dispensing chemicals and other liquids.

A purpose of the invention is to connect a mechanical drive including a plunger to a moving wall of a pump such as a diaphragm or bellows by means of a motion-transmitting liquid, and to correct on each cycle of pump operation for expansion and contraction of the liquid so as to prevent any error due to this cause.

A further purpose is to provide a passage to atmosphere from the liquid interconnecting a pump plunger and a moving wall, and locate a check valve in this passage so that during the suction stroke the liquid is connected to atmosphere and adjustment due to expansion and contraction can occur.

A further purpose is to lead the expansion and contraction adjustment passage through the plunger and place the check valve itself in the plunger.

A further purpose is to provide drag between the valve element and the side wall and to manipulate the valve opposite to the direction of motion of the plunger by the drag so that the valve closes in one direction when the plunger advances to prevent escape of fluid from the space ahead of the plunger and closes in the opposite direction when the plunger retracts, but is momentarily fully open at the end of each stroke.

Further purposes appear in the specification and in the claims.

In the drawings, I have chosen to illustrate a few only of the numerous embodiments in which my invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a central vertical longitudinal section of a pump in accordance with the invention, shown on the compression stroke.

Figure 2 is an enlarged fragmentary view similar to Figure 1, showing the suction stroke.

Figure 3 is a top plan view of Figure 1.

Figure 4 is a central vertical longitudinal section corresponding to Figure 1 but showing a variation.

In the chemical industry extensive use is being made of pumps which meter and accurately dispense liquids such as chemical solutions to processing equipment and the like. It is very desirable to have a high degree of accuracy in such cases, in order to improve the control of the process employed. Pumps having moving walls such as diaphragms and bellows are extensively employed for this purpose.

Mechanical interconnection to bellows or diaphragms, however, is objectionable, as it subjects the moving wall to vibrational forces present in the drive, restrains the moving wall and thus is likely to cause earlier failure, and subjects the moving wall to any irregularities of motion due to imperfections in the driving mechanism. It is very desirable, therefore, to interpose a driving

liquid between a reciprocating member such as a plunger and the moving wall so that mechanical variations can be smoothed out and operation can become more uniform, with increased life of the diaphragm or bellows.

Unfortunately, however, the liquid employed in the drive is subject to variations in temperature, both due to change in ambient conditions and also on account of the temperature of the liquid pumped and heat developed from friction in the driving liquid itself and in the related equipment.

Whenever the temperature of the driving liquid changes, its volume changes due to expansion or contraction, and the volume discharge on each cycle of the pump changes, introducting an error which in some cases is serious and in all cases objectionable.

In accordance with the present invention, I connect the driving liquid to atmosphere at least once in each cycle and thus allow for correction due to expansion or contraction, since the quantity of liquid in the driving space can readjust.

As shown in Figures 1 to 3, a pump chamber 20 has a suitably cylindrical fixed wall 21, end walls 22 and 23 and a moving wall or bellows 24 which extends in from and is secured to the end wall 22 and has its forward end closed by a head 25 and a plug 26. The bellows is suitably a resilient metallic bellows of beryllium copper Phosphor bronze, stainless steel or the like.

Two inlet ball check valves 27 and 28 in series connect from an inlet connection 30 to an inlet port 31 into the pump chamber near the bottom. Similarly, two outlet ball check valves 32 and 33 in series connect from an outlet port 34 near the top of the pump chamber to an outlet connection 35. The valves are suitably all alike and comprise upwardly directed seats 36 and balls 37 on the seats limited in upward motion by limiter plugs 38 which are suitably threaded into the valve casings above the balls.

There is suitably a continuous upward flow of the pumped liquid from the inlet connection through the pump to the outlet connection.

The pump is desirably driven from any suitable drive, desirably a motor through gearing to a crank and connecting rod (not shown) as well known, which reciprocates a pump plunger 40 suitably of cylindrical shape guided in a forward guide or cylinder 41 and a rearward guide 42 to move toward and away from the moving wall. Suitable packing is provided at 43 to prevent leakage of the driving liquid. Around the plunger inside a housing 44 an oil or other liquid reservoir 45 is provided having a stand pipe connection 46 to the atmosphere at the top, extending above the inside space of the bellows.

A passage extends from the reservoir 45 to space 47 inside the bellows which is filled with the driving liquid. The driving liquid will ordinarily be oil but in certain cases special liquids may be used, such as mixtures of glycerine and water in any proportions or any other suitable hydraulic liquid.

On the forward end of the plunger is mounted a valve stem or projection 51 threaded at 52 into the end of the plunger, having a conical seat 53 which is nearest the end of the plunger, having an intermediate barrel 54 and having an opposed conical seat 55 which is most remote from the end of the plunger. The passage 48 is extended at 56 through the male threaded portion of the seat projection, and communicates with radial passages 57 which connect the passage 48 with the space 58 ahead of the plunger and around the seat 53. The seat 55 is preferably removable, being held in place by nut 60 on the end of threaded stud 61 extending from the barrel 54. The opposed seats 53 and 55 are coaxial.

A valve element 62, suitably a metallic sleeve, sur-

rounds the barrel and has exposed shoulders **63** and **64** which in opposite positions engage and seal against the respective seats **53** and **55**.

An annular groove **65** extends around the middle of the outside of the valve sleeve, and receives an O-ring **66** suitably of rubber or synthetic rubber which frictionally engages the inside wall of the tubular guide **41**, thus acting as a restraining means on the valve sleeve by tending to make the valve sleeve move in the direction opposite to the motion of the plunger due to frictional drag.

In operation of the form of Figures 1 to 3, it will be understood that when the pump is operating the space **47** inside the bellows and all of the passages through to the reservoir and the lower part of the standpipe are filled with hydraulic liquid. This includes space **67** inside the valve sleeve and between the valve sleeve and the barrel **54**. At each reciprocation when the plunger reverses direction the valve sleeve travels to the position of engagement with the opposite seat, since the plunger is moving and the O-ring **66** causes the valve to frictionally drag on the inside wall of the guide **41**. Thus in Figure 1 on the compression stroke where the plunger is moving toward the right, and valve shoulder **63** is closed against valve seat **53**. On the other hand in Figure 2 when the plunger is moving to the left, on the suction stroke of the pump, the drag of O-ring **66** shifts the valve sleeve to the right, closing shoulder **64** against seat **55**.

At the end of each stroke when the plunger is reversing for a short interval the valve is open at seat **53** and also at seat **55** and during this interval volume changes by expansion or contraction of the hydraulic liquid take place, thus correcting automatically for any effect of change in temperature or change in volume.

The device is equally effective when used in connection with a diaphragm instead of a bellows. In Figure 4 I illustrate such a modification, with the same plunger, check valve and passage arrangement. The diaphragm **24'**, suitably of rubber in this case, forms the moving wall of the pump chamber **20'**, and the diaphragm is protected in its two limiting positions by spaced perforated walls **68** and **70** as well known. Except that the chamber varies in shape, having a short cylindrical portion **21'**, and large end walls **22'** and **23'**, the construction is generally similar to that of Figures 1 to 3, and the functioning of the check valve is the same.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

It will be evident of course that the valve may if desired be operated due to inertia or a combination of inertia and friction, or due to any other retarding force.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In pump mechanism, a pump having a moving wall and having a pump chamber on one side of the moving wall, a cylinder communicating with the side of the moving wall remote from pump chamber, a plunger reciprocable in the cylinder toward and away from the moving wall, there being a liquid extending from the plunger through the cylinder to the moving wall, a conduit connecting at one end with the liquid between the plunger and the moving wall and at the other end with the atmosphere, and a check valve in the conduit having opposed seats and interconnected opposed valve elements cooperating with the respective seats, said valve elements being carried by said plunger and reciprocable therewith relative to said moving wall.

2. In a pump mechanism, a pump having a moving wall and having a pump chamber on one side of the moving wall, a cylinder connecting with the side of the moving wall remote from the pump chamber, a plunger reciprocable in the cylinder toward and away from the moving wall, there being a liquid extending from the plunger through the cylinder to the moving wall, a conduit extending through the plunger connecting at one end with the liquid between plunger and the moving wall and at the other end with the atmosphere, and a check valve in the conduit having opposed seats and interconnected opposed valve elements cooperating with the respective seats.

3. A pump mechanism of claim 2, in which the moving wall is a bellows.

4. A pump mechanism of claim 2, in which the moving wall is a diaphragm.

5. A pump mechanism of claim 2, in combination with friction means on the valve elements engaging the interior of the cylinder.

6. A pump mechanism of claim 2, in which the opposed seats are connected by a stem and in which the valve elements are of ring formation surrounding the stem, in combination with a frictional element operating between the valve elements and the cylinder.

7. A pump mechanism comprising a pump having a moving wall and a pump chamber on one side of said moving wall, housing structure forming a chamber for a motion-transmitting liquid and communicating with the opposite side of said moving wall, a plunger reciprocable in said housing chamber toward and away from said moving wall, a motion-transmitting liquid in said housing chamber for transmitting motion from said plunger to said moving wall to operate said pump, a flow connection extending from a reservoir of said liquid which is open to atmosphere to a location in said housing chamber between said plunger and said moving wall, and valve means controlling said flow connection and carried by said plunger between said moving wall and said flow connection selectively to seal said liquid communicating with said moving wall with respect to atmosphere, said valve means being in closed position during the forward and reverse strokes of said plunger to close said flow connection with respect to said moving wall and seal said liquid within said housing chamber in communication with said moving wall between said valve means and said moving wall, said valve means being moved by said plunger during reversal at the end of each stroke to open position to open said flow connection with respect to said moving wall and connect said liquid in said housing chamber communicating with said moving wall with the reservoir and atmosphere to permit readjustment of the volume of said liquid in said housing chamber due to any expansion or contraction of said liquid.

8. A pump mechanism comprising a pump having a moving wall and a pump chamber on one side of said moving wall, housing structure forming a chamber having motion-transmitting liquid and communicating with the opposite side of said moving wall, a plunger reciprocable in said housing chamber towards and away from said moving wall, a motion-transmitting liquid in said housing chamber for transmitting motion from said plunger to said moving wall to operate said pump, a flow connection extending from a reservoir of said liquid which is open to atmosphere to a location in said housing chamber between said plunger and said moving wall, valve means in said flow connection and carried by said plunger selectively to seal said liquid communicating with said moving wall with respect to atmosphere, and restraining means effective on said valve means to cause said valve means to be moved by said plunger momentarily to open position at the end of a stroke independently of the pressure on said liquid communicating with said moving wall to open said flow connection with respect to said moving wall and connect said liquid in said housing chamber communicating with said moving wall with the reservoir and atmosphere at least once in each cycle of said pump to permit readjustment of the

volume of said liquid in said housing chamber due to any expansion or contraction of said liquid.

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