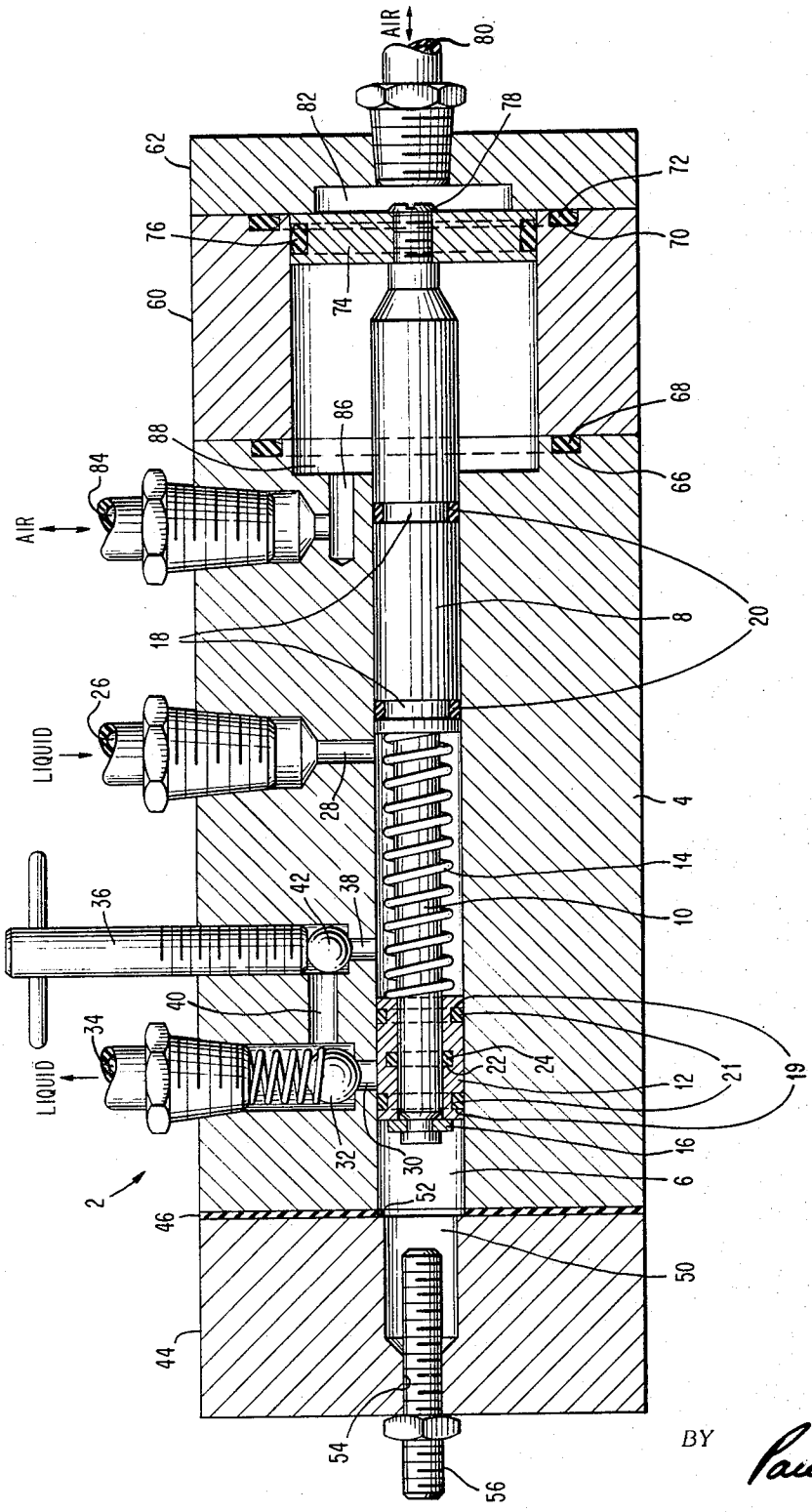
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POSITIVE-DISPLACEMENT PUMP FOR METERING FLUIDS

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POSITIVE-DISPLACEMENT PUMP FOR METERING FLUIDS

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ABSTRACT OF THE DISCLOSURE

The pump of the invention comprises a main piston with a shaft extending from its compression end. A secondary ring-type piston is slidably mounted on the shaft. A compressible spring around the shaft extends from the compression end of the main piston to the secondary piston which is thereby held against a limit fixed on the free end of the shaft. Adjustable means are provided for varying the forward movement of the main piston. The difference between the movements of the main and secondary pistons controls the amount of fluid dispensed.

Background of invention

Compared with the pump of the present invention, all of the prior devices have one or more of the following limitations or disadvantages: (a) the pump will not operate correctly in all positions such as when device is held vertically instead of horizontally; (b) the pump is designed to operate only at atmospheric pressure; (c) the pump is designed to operate with the fluid reservoir located above the discharge spout; (d) the pump allows air to mix with the liquid being dispensed; and (e) the pump is manually operated and therefore the volume of liquid dispensed per stroke is not constant. Contrarily, the present pump operates properly: (a) irrespective of its position or orientation; (b) in any atmospheric environment including a vacuum; (c) irrespective of the position of the fluid reservoir; (d) without mixing aid with the liquid being dispensed; and (e) automatically controlled to dispense accurately and repeatedly a desired volume. In addition, the present pump is infinitely variable between a very minute amount and the maximum capacity of the pump.

Description of invention

It is an object of the invention to provide a positive-displacement pump which accurately meters controlled amounts of pressurized fluids. A further object is to provide a common source of gas pressure both to operate the pump mechanism and to feed the liquid to the pump. Another object is to provide a pump that will operate on pumpable liquids of a wide range of viscosities in any desired amount independent of the pump position.

The pump construction has (a) a central section having a bore along its length with inlet and outlet ports communicating with the bore near its opposite ends, a main piston with a shaft projecting from its compression end and a secondary piston in the form of a ring slidably mounted on the shaft and both pistons being slidably operable within the bore; (b) a housing attached near the outlet port on the central section to provide both a fixed stop and an adjustable stop to limit the strokes of the secondary and main pistons, respectively; and (c) drive means for the pump, preferably an air cylinder located on the opposite end of the central section with a separate piston aligned with and attached to the main piston to actuate the dispensing pistons within the central section of the pump.

Since many liquids corrode common metals, the pump may be constructed of stainless steel or other non-corrodible materials to increase its life and to guard against contamination of the liquid being dispensed. The pump is particularly useful in dispensing fairly viscous fluids such as pastes or gelatinous materials. For positive feeding of viscous liquids, it is preferred to use pressurized gas over the liquid in a closed reservoir. However, a liquid of low viscosity could be fed to the pump by gravity from a suitably positioned reservoir.

For a better understanding of the invention, reference is now made to the accompanying drawing which is a sectional elevation of a preferred embodiment of the pump of this invention.

Pump **2** comprises cylindrical housing **4** having elongated bore **6** along its axis. Slidably operable within bore **6** is main piston **8** having elongated shaft **10** extending from its compression end. Secondary piston **12** in the form of a ring or sleeve is slidably mounted on the free end of shaft **10** for movement on shaft **10** within bore **6**. Compression spring **14** also mounted on shaft **10** between the compression end of main piston **8** and secondary piston **12** flexibly holds secondary piston **12** against retainer **16** on the free end of shaft **10**. Main piston **8** and secondary piston **12** have pairs of peripheral grooves **18** and **19**, respectively, to accommodate piston rings or O-rings **20** and **21** which serve as both seals and bearing surfaces between the respective pistons and bore **6**. Secondary piston **12** has inner groove **22** on its inner surface to hold O-ring or piston ring **24** which serves as a seal and bearing surface between shaft **10** and secondary piston **12**. Inlet port **26** admits a pressurized fluid into bore **6** through orifice **28** which is located close to the compression end of main piston **8** when positioned at the start of the compression stroke. The pressurized fluid is dispensed from bore **6** through orifice **30** past one-way ball valve **32** and outlet port **34** after secondary piston **12** has moved past orifice **30** during the forward or compression stroke of main piston **8**. Actually, no fluid is pumped until secondary piston **12** hits its stop at shoulder **52** and at the same time main piston **8** continues its travel. The amount of over-travel of main piston **8** until it is stopped by adjustable screw **56** determines the amount of liquid forced out through outlet **34**. Orifice **30** is sealed by the side of secondary piston **12** when pressurized fluid is charged into bore **6** through orifice **28**. As main piston **8** moves forward orifice **28** is sealed by the side of main piston **8** and as the pressurized fluid is pushed ahead by the compression end of main piston **8**, orifice **30** simultaneously is uncovered or opened to permit the discharge of the fluid as the side of secondary piston **12** moves past orifice **30**. On the return stroke, outlet orifice **30** is again covered or sealed by secondary piston **12** and inlet orifice **28** is uncovered or opened for a new charge of the pressurized fluid. Thus, only a controlled amount of the fluid will be discharged on any given forward stroke and no excess can be dispensed because the inlet is sealed immediately after the charge and the outlet is sealed immediately after the discharge.

Means may be provided to bleed air from the pump before a liquid is charged to the pump. Such air bleed-off may be achieved with valve step **36** and steel ball **42** disposed in cylindrical housing **4** between inlet port **26** and outlet port **34**; bleed-off orifice **38** communicates with bore **6** near the trailing end of secondary piston **12** when it is disposed at the start of the compression stroke. Hardened stainless steel ball **42** closes orifice **38** when valve stem **36** is turned down tight. Bore **40** connects orifice **38** with outlet **34** so that when valve stem **36** is turned up entrapped air followed by liquid from orifice **38** flows through bore **40** to outlet **34**. In short, with pump pistons

8 and 12 in the charge position, turning up valve stem 36 to the open position allows pressurized liquid entering bore 6 through orifice 28 to bleed air from the pump through orifice 38, bore 40 and outlet port 34.

Cylinder cover 44 with gasket 46 is attached to the outlet end of housing 4 by screws (not shown). Bore 50 of reduced diameter extending partially through cover 44 along its central axis aligns with bore 6 of housing 4 and forms shoulder 52 which acts as a stop to the movement of secondary piston 12. The length of secondary piston 12 is not greater than the distance between shoulder 52 and the edge of orifice 30. During the forward stroke the outer face of secondary piston 12 comes into contact with shoulder 52 and the inner face of piston 12 is then just past orifice 30 thus forming an end wall of bore 6. Threaded hole 54 is aligned to communicate with bore 50 and holds adjustable screw 56 which acts as stop for shaft 10 to provide an adjustable limit for the stroke of main piston 8. The setting of screw 56 determines the amount of forward stroke of main piston 8 after secondary piston 12 has been stopped by shoulder 52 thereby controlling the amount of pressurized fluid dispensed from bore 6 through orifice 30.

An air-actuating mechanism attached on the inlet end of cylindrical housing 4 comprises cylinder 60 capped by cylinder cover 62 both of which are held firmly against cylindrical housing 4 by screws (not shown). Circular groove 66 on the end of housing 4 is fitted with O-ring 68 as gasket between cylinder 60 and housing 4. Similarly, cylinder 60 contains groove 70 to accommodate O-ring 72 as gasket between cylinder 60 and cylinder cover 62. Piston 74 has piston ring or O-ring 76 circumferentially fitted in a peripheral groove and is slidable within cylinder 60. The free end of piston 8 which extends from bore 6 through cylinder 60 has piston 74 attached thereto by screw 78. Compressed air is charged into the actuating mechanism through inlet port 80 to circular antechamber 82 in the inner face of cylinder cover 62. Piston 74 is forced forward in cylinder 60 which in turn pushes main piston 8 of the pump. As main piston 8 moves forward, orifice 28 is closed and simultaneously orifice 30 is opened. The pressurized fluid already within bore 6 is pushed forward and dispensed through orifice 30 after secondary piston 12 has been stopped by shoulder 52. The amount of fluid forced out through orifice 30 is related to the amount of over-travel of main piston 8 after secondary piston 12 has been stopped by shoulder 52. To actuate the return stroke, pressurized air enters port 84 at the inlet end of housing 4 and flows through orifice 86 to circular afterchamber 88 in the face of housing 4 opposite the forward end of piston 74 and forces piston 74 to make its return stroke as well as that of piston 8. When retainer 16 again contacts secondary piston 12 during the return stroke of piston 8, piston 12 also executes its return stroke thereby sealing orifice 30. At the end of the return stroke, orifice 28 is again opened because main piston 8 has moved past this orifice. Thus, a fresh charge of pressurized fluid is admitted through orifice 28 into the annular space between bore 6 and shaft 10, the length of the annular space being the distance between the compression face of main piston 8 and the trailing face of secondary piston 12 when the latter abuts retainer 16.

For the reciprocating action of the air-actuating mechanism, it is obvious that ports 80 and 84 must alternately act to charge pressurized air into and exhaust pressurized air from antechamber 82 and afterchamber 88, respectively, of cylinder 60. On the forward stroke of all the pistons 74, 8 and 12, pressurized air is charged into antechamber 82 from port 80 while air is simultaneously exhausted from afterchamber 88 through port 84. On the return stroke of pistons 74, 8 and 12, pressurized air is charged into afterchamber 88 through port 84 while air is simultaneously exhausted from antechamber 8 through port 80.

A typical installation and operation of the pump of this invention has been described in applicant's copending application Ser. No. 593,609, filed of even date herewith. FIGURE 3 of the copending application shows that compressed air flows from a regulator at a pressure of about 40 pounds per square inch to a supply port of a four-way solenoid valve which has two of its other ports connected to the two ports of the air-actuating mechanism of the pump of this invention. In the present application, ports 80 and 84 would be so connected to two of the ports of the four-way solenoid valve; the remaining port of the solenoid valve is for venting air from cylinder 60. Hence, in one of the two positions of the four-way solenoid valve, the compressed air enters the valve through the supply port and flows through the port connected to port 80 of cylinder 60 while air in cylinder 60 escapes through port 84 which is connected to another port of the valve that is then in communication with the venting port of the valve. In the other position of four-way solenoid valve, the compressed air from the supply port flows to the port connected to port 84 while air in cylinder 60 passes through port 80 to the connecting port of the valve which is then in communication with the venting port.

FIGURE 3 of the copending application also shows that compressed air from the same source used to operate the air-actuating mechanism of the pump of this invention may be used to pressurize a liquid in a closed vessel that is connected by a pipe extending from the liquid reservoir in the closed vessel to the inlet port of the pump, herein designated as port 26.

As already pointed out, a feature of the pump of the invention is the large variation that may be made at will in the amount of fluid discharged per compression stroke of the pump. The amount discharged may be infinitely reduced from the full design capacity of the pump to the minutest desired amount such as 0.01 cubic centimeter. It is also well to note that the pump can handle highly viscous liquids and emulsions as well as fluids of low viscosity.

Those skilled in the art will readily visualize changes and modifications that may be made in the embodiment of the invention described and illustrated without departing from the spirit and scope of the invention. Hence, the claims should not be interpreted in any restrictive sense other than that imposed by the limitations recited within the claims.

What is claimed is:

1. A positive-displacement pump for metering fluids which comprises:

(a) a pump housing having an elongated bore;

(b) an inlet and an outlet communicating through said housing with said bore, respectively, near opposite ends of said housing for charging a fluid into, and dispensing said fluid from said bore;

(c) a main piston having a coaxial shaft of reduced diameter extending from the compression face of said main piston which is slidably operable within said bore;

(d) a secondary piston in the form of a ring being slidably operable on said shaft and within said bore;

(e) a retainer on the free end of said shaft to keep said secondary piston on said shaft;

(f) stop means on the outlet end of said housing to limit the stroke of said secondary piston; and

(g) an adjustable member on said outlet end of said housing aligned with said free end of said shaft so as to be contacted thereby and thus limit the compression stroke of said main piston;

the relative positions of said pistons within said bore being such that at the start of said compression stroke said main piston leaves said inlet open while said secondary piston keeps said outlet closed and during said compression stroke said main piston closes said inlet while said secondary piston opens said outlet.

2. The pump of claim 1 wherein a compression spring

is mounted around the coaxial shaft between the main and secondary pistons to hold them flexibly apart.

References Cited

UNITED STATES PATENTS

2,517,952	8/1950	Welling	103—166
2,817,417	12/1957	Cunningham	103—37
2,955,539	10/1960	Gardner	103—38
3,011,451	12/1961	Griffin	103—166
3,250,247	5/1966	Beaman	103—88

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,386,383 June 4, 1968

Hans C. Dreher

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 41, "aid" should read -- air --; Column 2, line 62, "step" should read -- stem --. Column 3, line 73, "8" should read -- 82 --. Column 4, line 2, "593,609" should read -- 593,069 --.

Signed and sealed this 14th day of October 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents