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PRECISION PUMP

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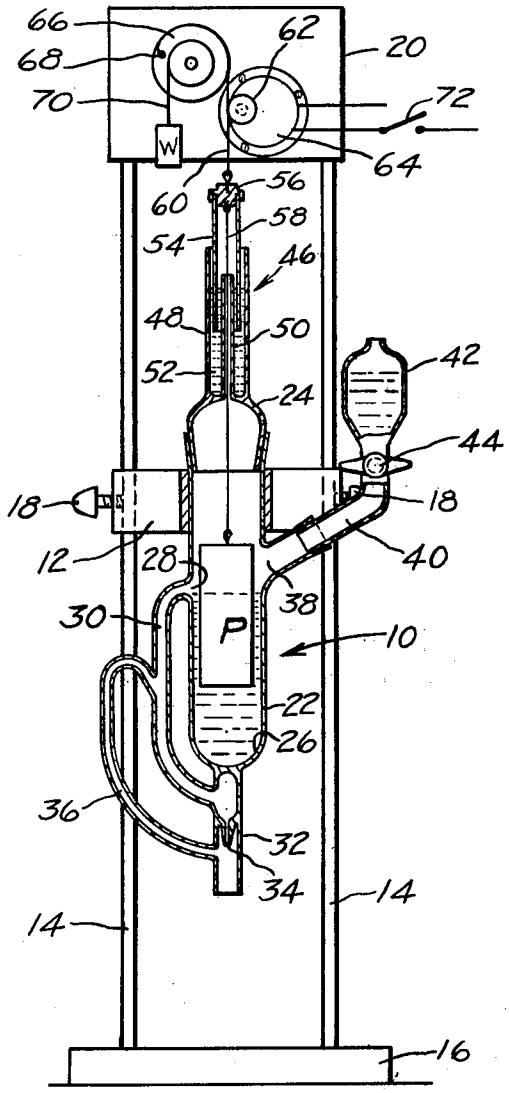

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PRECISION PUMP

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This invention relates to precision pumps, and more especially to pumps for feeding fluid in small amounts with a high degree of accuracy, both as to the quantity and rate of feed.

Industry is requiring, more-and-more, means for supplying fluid in small measured quantities at a very low rate of feed however there are no commercially available devices satisfactory for this purpose. Conventional displacement pumps do not provide very high accuracy and are effected adversely by small amounts of dirt; gear pumps do not provide a constant output and are subject to vapor lock which stops delivery; and peristaltic pumps are subject to deterioration and inaccuracy due to temperature changes. Valves are impractical because of the difficulty of reproduction and the tendency of tiny openings to become blocked by gas, bubbles, droplets, dirt and the like. A common gas rotameter has been used to control the rate of flow however at low rates of flow they are more effected by viscosity, friction and the presence of bubbles than they are by the actual flow. Moreover, they are restricted in use to mere atmospheric conditions. The foregoing and such other means as are available are for the most part unreliable for flow below 5 cubic-centimeters per minute.

The objects of this invention are to provide a precision pump for delivering fluid in accurate amounts and at accurate rates; to provide a pump which will maintain a high degree of accuracy at low rates of flow, for example at cubic centimeter per minute and less; to provide apparatus in which the delivery is not effected by dirt, or changes in temperature; to provide apparatus which is corrosion-proof; and to provide apparatus which may be employed in closed systems without being effected by back pressures therein. Still other objects are to provide apparatus which is of simple design and easy to construct from metal or non-metallic materials.

As herein illustrated, the pump comprises a barrel having a well for holding a quantity of liquid, a discharge opening at the upper end of the well through which the liquid in the well may be ejected by displacement from the well, a piston supported in the barrel for movement into the well, and means for moving the piston into the well at a precisely controlled rate and a predetermined amount, the piston operating to displace a volume of liquid from the well through the opening which is equal to that portion of the piston moved into the well. There is a duct connected to the discharge opening for conducting the liquid to a place of use and there is means associated therewith to maintain the pressure within the pump barrel equal to that at the discharge end of the duct. The upper end of the barrel has a gland through which the means for supporting the piston passes and the latter is flexible element in the form of a cord, connected at one end to the upper end of the piston and at its opposite end to a supporting pulley. Intermediate the supporting pulley and the gland the cord is wound once around the drive pulley of a timing motor, the latter being operable to pay the cord out at a predetermined rate and/or amount. There is a filling opening in the barrel above the well, a duct connected thereto and to a reservoir, and a valve cock operable to permit flow of fluid from the reservoir into the barrel to refill the well.

The apparatus will now be described with reference to

the accompanying drawing which is an elevation of the pump partly in section.

The pump comprises a cylindrical barrel **10** supported by a horizontally disposed clamp **12**, the latter being mounted for vertical adjustment on spaced parallel rods **14—14** fixed at their lower ends in a suitable rigid base **16**. Set screws **18** are provided for fixing the clamp at a suitable height on the rods. The upper ends of the rods are fastened to the rear side of a headblock **20**.

The pump barrel **10** is closed at its ends and is comprised of upper and lower parts **22** and **24**, the lower part **22** containing a well **26** for holding a quantity of fluid, which is adapted to be displaced therefrom by downward movement of a piston P suspended in the upper part above the well. A discharge opening **28** is provided in the wall of the barrel, at the top of the well, through which liquid in the well may be discharged by lowering the piston in the well as will appear hereinafter. A duct **30** is connected at one end to the discharge opening and at its other end to a discharge nozzle **32** at the lower end of the barrel. As herein shown, the nozzle **32** is formed integral with the lower end of the barrel however it may be a separate element attached to the duct **30**, which may be flexible so that the nozzle can be moved relative to the barrel for inserting it into the mouth of a receptacle or inlet opening in the system to which the fluid is to be delivered. The nozzle contains an orifice **34**. A vent tube **36** is connected at its upper end to the duct **30** at the upstream side of the orifice and at its lower end to the nozzle at the downstream side of the orifice. This construction provides for maintaining the same pressure within the pump barrel as the vessel or system to which the fluid is being delivered so that back pressure developed in the vessel or system will not interfere with free-flow of the liquid.

The barrel has an inlet opening **38** above the discharge opening **38** to which there is connected the lower end of a duct **40**, through which liquid may be supplied to the barrel to refill the well. The duct **40** is connected at its upper end to a vessel **42** for holding a reserve quantity of liquid and there is a valve cock **44** in the duct by means of which the liquid may be allowed to flow from the vessel into the barrel to fill the well and then shut to maintain a pressure within the barrel corresponding to that at the end of the nozzle.

The upper part of the barrel **24** is in the form of a closure cap which has an upwardly extending gland **46** comprised of an outer tube **48** and an inner tube **50**. The inner tube is in communication with the inside of the barrel of the pump. The annular space between the tubes **48** and **50** is partially filled with mercury **52**. A tube **54** having a cap **56** at its upper end is disposed in the annular space between the tubes **48** and **50** so that its lower end is submerged within the body of mercury. A flexible cord **58** is attached to the inner side of the cap **56** and extends downwardly through the tube **50** into the barrel where it is attached to the upper end of the piston P. A flexible cord **60** is attached to the upper side of the cap **56**, is wound once around a drive pulley **62** on a timer motor **64** mounted on the headblock **20** and over a supporting pulley **66** also mounted on the headblock, to which it is attached at **68**. A weight W is suspended by a cord **70** on the support pulley **66** to counterbalance the weight of the piston in the barrel. The timer motor is connected to a suitable source of power by way of a switch **72** and is operable to turn the drive pulley **62** in a direction to lower the piston P into the well **26**.

The piston P is of known dimensions hence lowering it into the liquid within the well will discharge a corresponding volume of liquid from the well through the duct **30** to the nozzle **32**.

By using a pulley **62** of known diameter D_1 and a piston

P of known diameter D_2, the rate of discharge in cubic-centimeters per minute may be determined by the formula

$$R = \frac{N\pi^2 D_1 D_2^2}{2}$$

wherein N is the number of revolutions per minute and R is the rate of feed. Pumping rates of 0.1 cc. per minute and less can be accurately controlled with this apparatus. The rate may be varied by changing the diameter of the pulley **62** or the piston P.

The pump may be made of metal where corrosion is not a factor to be considered, however, if it is, metal alloys, glass, plastic, ceramic and the like, which are resistant to corrosion may be used. Since the pump does not contain valves or other closely fitting moving parts, temperature changes, pressure changes, the inadvertent presence of a few dirt particles and the like have no influence on its accuracy or upon the rate or amount of flow at very low velocity and in very small amounts. Moreover, the venting makes the pump independent of back pressure. Other advantages are that the pump is of simple construction, durable and easy to use.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A precision pump for supplying measured quantities of liquid at a predetermined rate comprising a two-part barrel, the lower part providing a well for holding a liquid and containing a discharge opening at a predetermined level from the bottom, means for supplying liquid to the well, a filling opening at a higher level, an injection nozzle at its lower end containing an orifice, and ducts connecting the discharge opening to the nozzle at both sides of the orifice, the upper part constituting a closure for the barrel and mounting a gland, a flexible element extending through the gland into the barrel above the well, a piston connected to the end of the flexible element within the barrel, means supporting that portion of the flexible element externally of the barrel, and a timer motor including a drive pulley about which a portion of the flexible element is wrapped operable to pay off the element at a predetermined rate.

2. A precision pump for supplying measured quantities of liquid at a measured rate comprising a barrel having a well for holding a quantity of liquid, means for supplying liquid to the well, a discharge opening at the upper end of the well through which liquid in the well may be ejected by displacement from the well, a piston supported in the barrel for movement into the well, means for moving the piston into the well at a precisely controlled rate, said piston operating to displace a volume of liquid from the well through the opening which volume is equal to that portion of the piston moved into the well, and a nozzle disposed below the level of the discharge opening of the barrel, a duct connecting the discharge opening to the nozzle, and a by-pass duct connected at one end upstream of the orifice and at its other end downstream of the orifice.

3. A precision pump according to claim 2, wherein there is a liquid-sealed gland at the upper end of the barrel and the support for the piston is a flexible element which extends through the gland into the barrel.

4. A precision pump according to claim 2, wherein there is a gland at the top of the barrel, the support for the piston is a cord passing through the gland, there is a timer motor including a drive pulley driven thereby and the cord is wrapped on the drive pulley for paying out at a measured rate.

5. A precision pump according to claim 2, wherein there is a gland at the top of the barrel, the support for the piston is a cord passing through the gland, there is a supporting pulley on which the cord is fastened, a timer motor having a driving pulley about which a portion of the cord between the gland and the supporting pulley is wrapped for paying out at a measured rate, and a weight connected to the supporting pulley to counterbalance the piston.

References Cited in the file of this patent

UNITED STATES PATENTS

207,841	Bates	Sept. 10, 1878
2,464,714	Petersen	Mar. 15, 1949
2,913,149	Cochrane et al.	Nov. 17, 1959

FOREIGN PATENTS

160,131	Germany	May 2, 1905