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Gullett

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[54] **LIQUID METERING DEVICE WITH CONCENTRIC PISTONS AND UNIDIRECTIONAL LIQUID FLOW**

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[52] **U.S. Cl.** **222/309,** 417/402

[51] **Int. Cl.** **G01f 11/06**

[58] **Field of Search** 222/309, 253, 259, 389, 222/260, 261, 390; 417/402

[56] **References Cited**

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[57] **ABSTRACT**

A liquid metering device is provided for transferring a measured batch of liquid from a supply container. The device includes an outer casing and an inner casing located within the outer casing and defining an annulus therebetween. A first piston is located in the annulus for sliding movement therein in response to fluid flow in and out of the annulus. A spring is provided within the outer casing for urging the first piston into an upper position, means is provided for directing fluid flow into the annulus to actuate the first piston into a lower position in opposition to the spring. A second piston is located within the inner casing for sliding movement therein, and is secured at its lower end to the first piston so that the first and second pistons move within their respective casings in unison. The second piston and inner casing define therebetween a liquid chamber in communication with a liquid outlet. Liquid communication means is provided between the liquid supply container and the liquid chamber. Upon actuation of means provided for terminating fluid flow into the annulus and for venting fluid contained therein to atmosphere, the pistons are moved to an upper position in response to the spring so that liquid is discharged from the liquid chamber into the liquid outlet.

4 Claims, 7 Drawing Figures

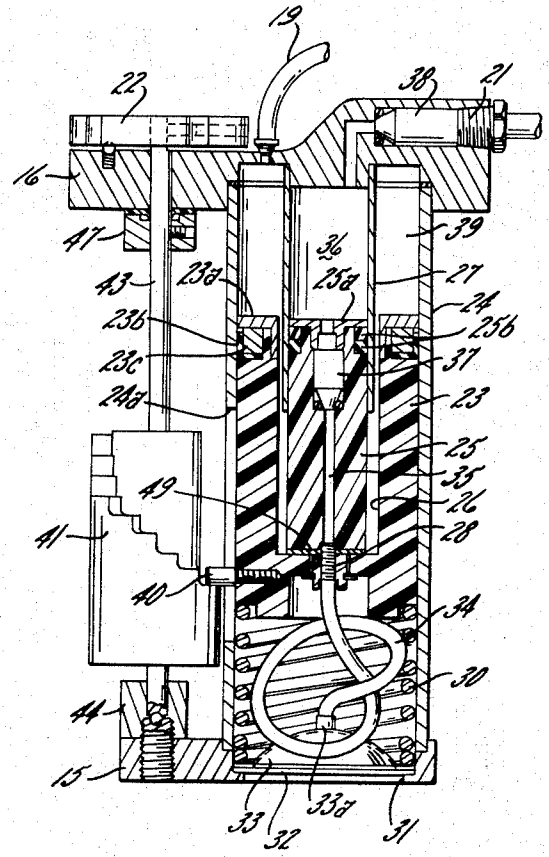


Fig. 1.

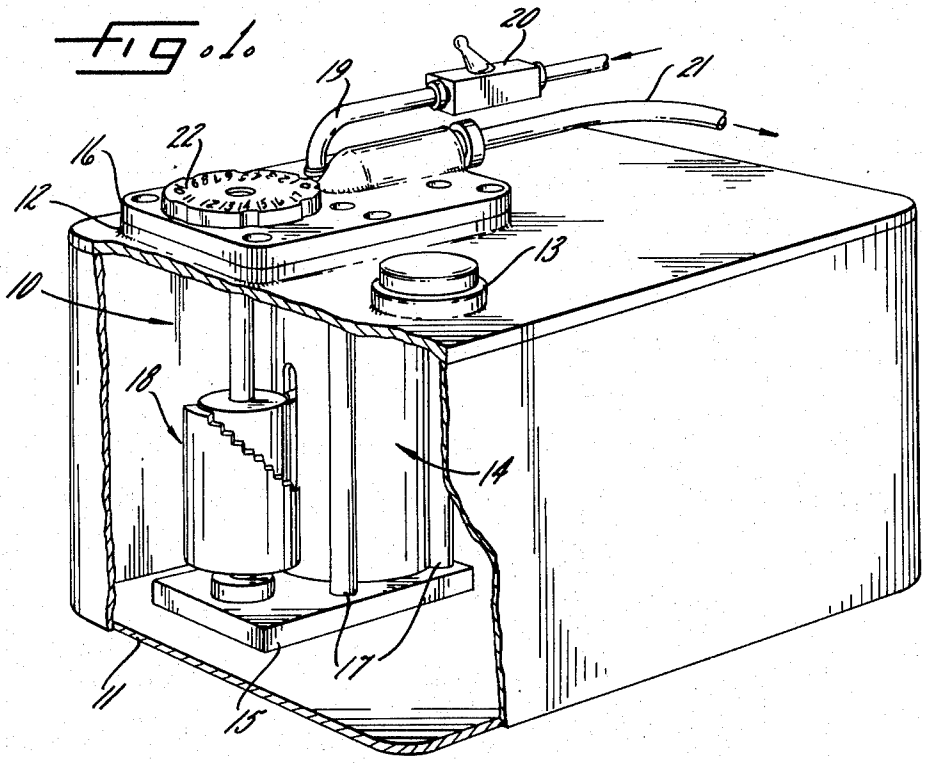


Fig. 3.

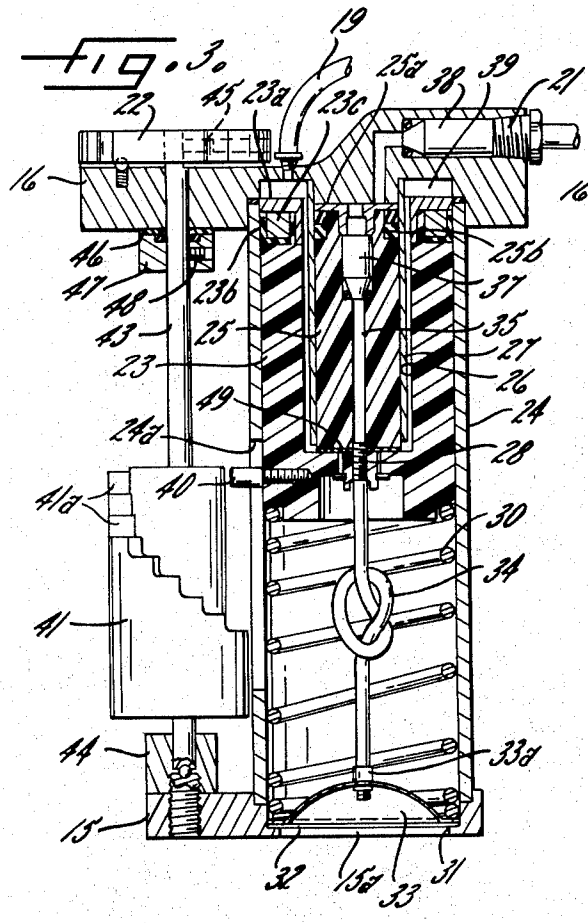


Fig. 4.

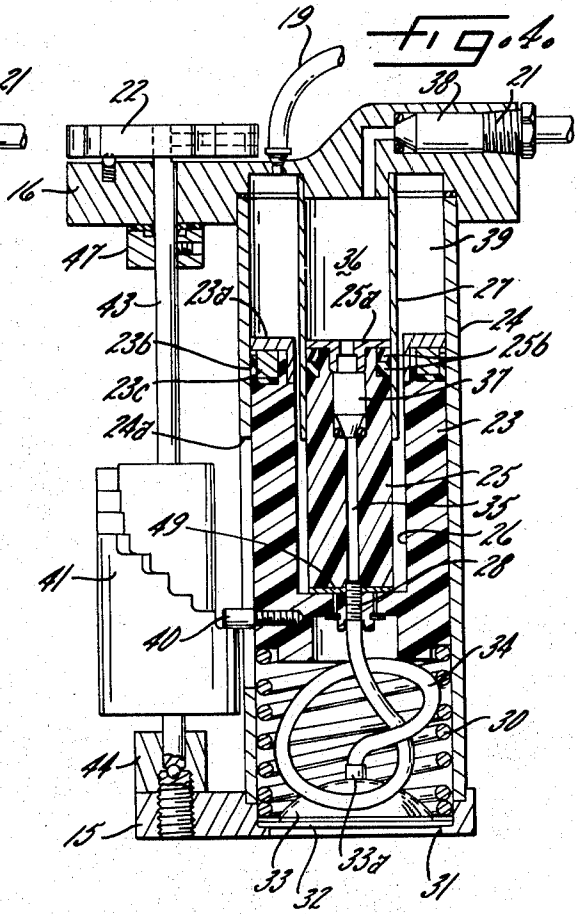


FIG. 2

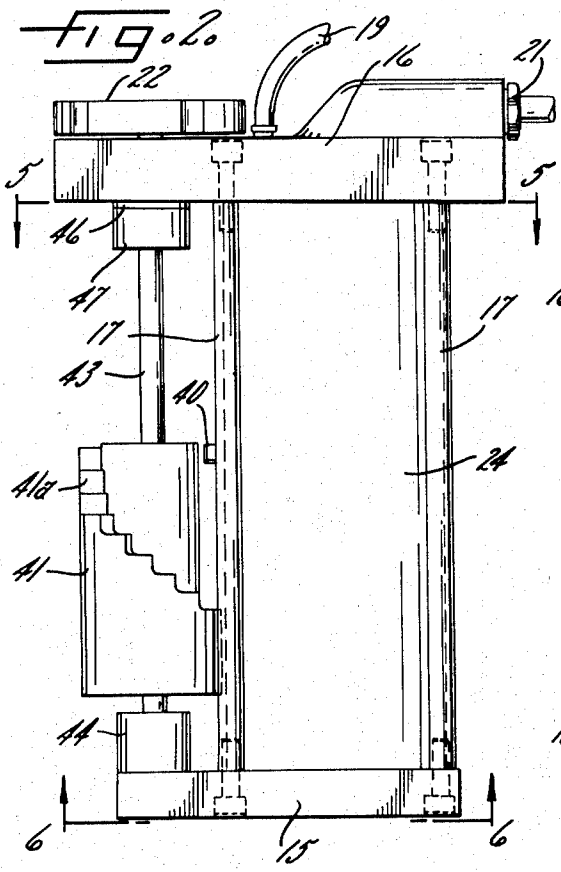


FIG. 5

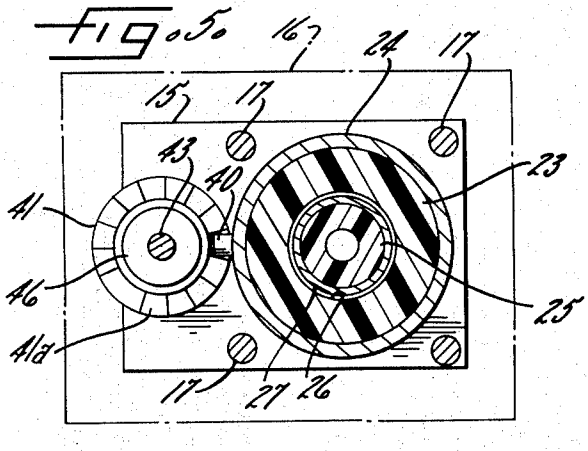


FIG. 6

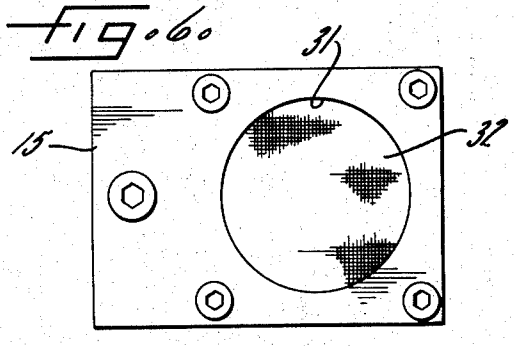
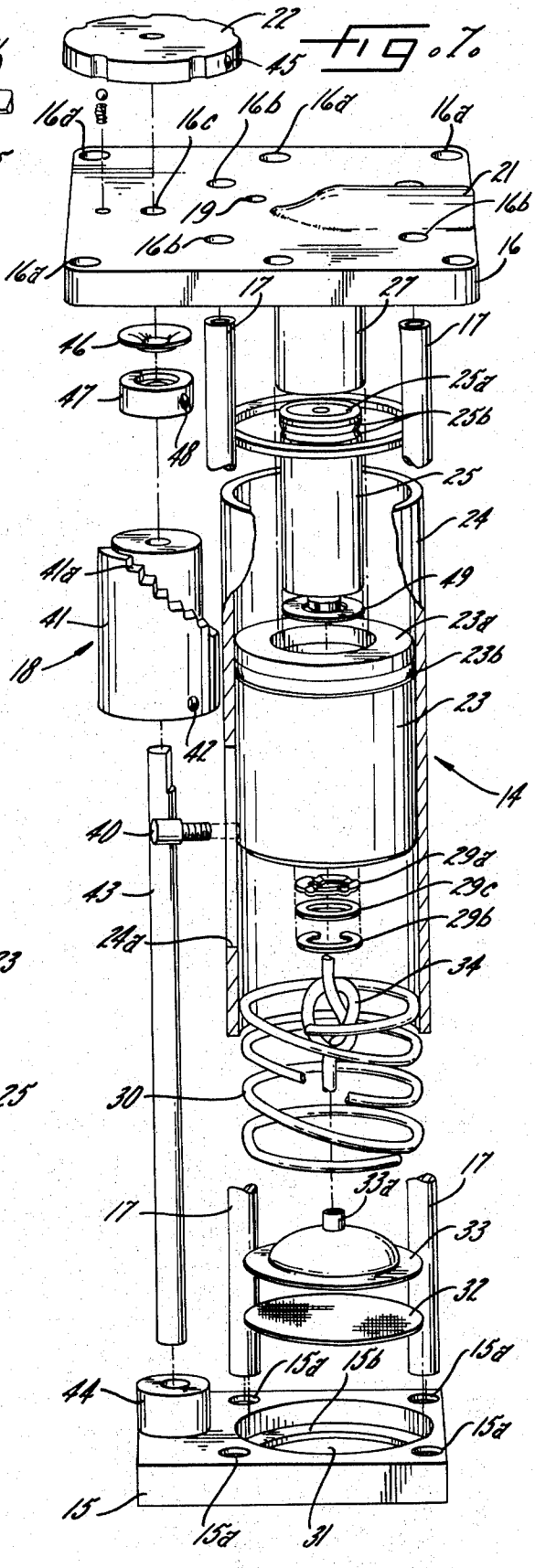


FIG. 7



LIQUID METERING DEVICE WITH CONCENTRIC PISTONS AND UNIDIRECTIONAL LIQUID FLOW

DESCRIPTION OF THE INVENTION

The present invention relates generally to a liquid pumping device, and more particularly to such a device for pumping adjustably metered batch quantities of liquid.

The device of the present invention is particularly useful for pumping metered batch quantities of various liquids used in apparatus for the preparation of samples for radioactive isotope tracer studies. Such liquids include liquid scintillators and liquid trapping agents for carbon dioxide. A sample preparation apparatus with which the liquid metering devices of the present invention are particularly useful is described and illustrated in pending Kaartinen Applications Ser. No. 242,481 filed April 10, 1972.

It is a primary object of the present invention to provide an improved liquid metering device which efficiently pumps batch quantities of liquids of preselected size, even when the liquid quantities amount to only a few milliliters or less. A related object is to provide such a liquid metering device which is operable when fully submerged within the liquid to be pumped.

Another object is to provide a liquid metering device which is compact, has few moving parts, and is easily operated automatically.

Other objects and advantages of the invention will become apparent from the following detailed description and upon reference to the accompanying drawings, in which:

FIG. **1** is a perspective view, partly cutaway, showing a liquid metering device illustrative of the present invention disposed within a typical liquid supply container or tank.

FIG. **2** is an elevational view of the illustrative liquid metering device.

FIGS. **3** and **4** are elevational views, partly in section, showing liquid unloaded (FIG. **3**) and liquid fully loaded (FIG. **4**) positions of the illustrative liquid metering device.

FIG. **5** is a sectional view taken along the line **5—5** in FIG. **2.**

FIG. **6** is a sectional view taken along the line **6—6** in FIG. **2.**

FIG. **7** is an exploded, perspective view showing the component parts of the illustrative liquid metering device.

While the invention will be described in connection with certain preferred embodiments, it will be understood that it is not intended to limit the invention to these particular embodiments. On the contrary, it is intended to cover all alternatives, modifications and equivalent arrangements as may be included within the spirit and scope of the invention as defined by the appended claims.

Turning now to the drawings, an illustrative liquid metering device **10** is shown in FIG. **1** disposed in a typical supply container or tank **11** containing liquid to be metered and pumped to another location. The fully enclosed type supply tank **11** shown has an opening defined by a flange **12** in the top for receiving the liquid metering device **10,** and is provided with a liquid fill inlet **13** closed by a suitable cap.

As will be seen, the liquid metering device **10** includes a generally cylindrically shaped pump assembly **14** mounted between rectangular base and top plates **15** and **16,** respectively, by means of vertical supports **17** (four as shown). Also mounted between the plates **15** and **16,** and located alongside the pump assembly **14,** is a metering assembly **18** which functions to adjustably set the volume of liquid to be metered and pumped by the device **10.**

The top plate **16** of the liquid metering device **10** is provided with holes **16***a* for alignment with corresponding holes (not shown) in the tank flange **12** and for receiving suitable fasteners (not shown) for securing the metering device **10** within the tank **11.** The plate **16** also includes holes **16***b* for receiving the upper ends of the vertical mounting supports **17** and fasteners (not shown) therefore (corresponding holes **15***a* are provided in the base plate **15** for the lower ends of the supports **17**).

For receiving a suitable pressurized gas (e.g. 25 psi. pressure), such as air or an inert gas such as nitrogen, the top plate **16** is provided with a gas inlet **19** having an on-off switch type valve **20.** The valve **20** includes a vent (not shown) for releasing the gas pressure when desired (i.e. to discharge liquid from the pump when it is loaded, as described below). The top plate **16** is also provided with a liquid outlet **21** which directs the metered liquid to its ultimate destination. Mounted above the top plate **16** is a dial **22** associated with the metering assembly **18** to permit manual adjustment of the pumping volume (as described in more detail below).

Directing attention now to the pump assembly **14,** as shown in the drawings it includes a large cylindrical piston **23** disposed within an outer cylindrical casing **24,** and a small cylindrical piston **25** removably secured within a recess **26** provided in the center of the large piston. The small piston **25** moves up and down within an inner casing **27** which is secured to and extends part way down from the top plate **16** into an annular space provided between the small piston **25** and the recess **26** in which it is housed. The two pistons **23** and **25,** which are secured together through a threaded connection **28,** move up and down together at all times. In order to permit alignment of the small piston **25** within its casing **27,** the connection **28** between the pistons **23** and **25** includes a wave washer **29***a* which produces spring tension between the two pistons, a lock washer **29***b*, and an intermediate regular washer **29***c*. As shown, the small piston **25,** which may advantageously be formed of teflon or similar corrosion resistant, low-friction material, presents a round piston face **25***a* facing upwardly toward the top cover plate **16.** Annular seals **25***b* are provided around the periphery of the piston **25** to assure liquid-tight sealing engagement between the piston and its casing **27.**

Like the small piston **25,** the large piston **23** also presents an upwardly facing piston face **23***a*, in this instance annularly shaped to fit between the outer **24** and inner **27** casings. Once more the piston **23** may be formed of teflon or the like, and includes an annular seal **23***b* held in place by a suitable seal retaining ring **23***c*.

To facilitate sliding movement of the pistons **23, 25** within their respective casings **24, 27,** it may be advantageous to construct the casings of metal having an interior coating of low friction material such as teflon or

the like. Such a coating may also desirably be resistant to corrosion by the liquid being pumped.

For urging the two pistons **23** and **25** normally upwardly and into an unloaded (with liquid) position (see FIG. 3), a coil spring **30** is located inside the lower portion of the outer casing **24** interposed between tue bottom support plate **15** and the underside of the piston **23.** The position of the coil spring **30** when fully compressed (see description below) is shown in FIG. **4.**

Communicating passages for the liquid passing through the liquid metering device **10** are provided as follows. Liquid enters the device **10** through a submerged suction inlet **31** provided in the bottom of the base plate **15.** The inlet **31** is covered by a protective screen **32** supported between a shoulder **15***b* defining the inlet **31** and a dished upper retaining cup member **33** against which the coil spring **30** rests. Liquid entering the inlet **31** passes upwardly into the underside of the dished member **33** and into a flexible tubing **34,** which may also be formed of teflon or the like. The tubing **34** is suitably secured at one end to a central opening **33***a* provided in the dished member **33,** and at the other end to an internal channel **35** which runs longitudinally through the small piston **25.** As will be seen, the channel **35** communicates between the flexible tubing **34** and an inner chamber **36** located adjacent the operating face **25***a* of the small piston. The upper end of the chamber **36** opens into the liquid outlet passage **21** provided in the top plate **16.** For preventing backward flow of liquid through the pump, a pair of one-way (up and out only) check valves **37** and **38** are provided in the channel **35** and outlet **21,** respectively.

Liquid flowing through the metering device **10** thus enters at the inlet **31,** passes through the screen **32** (to filter out any particles of foreign matter that may be present), into the dished member **33** and thence through the tubing **34,** the channel **35,** check valve **37** and into the pumping chamber **36** from which it is ejected (as will be described below) through the liquid outlet **21.**

On the pressurized gas side of the device **10,** gas entering through the gas inlet **19** impinges on the piston face **23***a* and thereby forces both pistons **23** and **25** downwardly against the bias of the coil spring **30.** As this occurs, the entering gas passes into and occupies an annular chamber **39** formed between the inner **27** and outer **24** casings. As the pistons **23** and **25** move downwardly, a vacuum is created within the smaller chamber **36;** this vacuum draws the liquid upwardly from the tank **11** through the liquid inlet **31** and into the chamber **36** as previously described. When the entering gas supply is terminated by shutting off the valve **20,** the trapped pressurized gases in the chamber **39** are vented through the valve and the pistons **23** and **25** return to their upper position in response to the urging of the coil spring **30.**

For limiting the extent of downward movement of the unitary pistons **23, 25,** the lower portion of the piston **23** carries a stop pin **40** (shown threaded into the piston body) which extends through a vertical slot **24***a* provided in the casing **24** and is adapted to cooperate with the metering assembly **18,** as will now be described. The assembly **18** includes a stepped drum **41** fixedly mounted by means of a set screw **42** onto a vertical spindle **43** extending between a collar **44** carried by the base plate **15** and an opening **16***c* provided in the top plate **16.** The upper end of the spindle **43** extends through the opening **16***c* where the manually operable dial **22** is affixed to it by means of a set screw **45.** A seal ring **46** and retaining collar **47** are fixed to the spindle **43** (by set screw **48**) just beneath the top plate **16.**

Thus, the operator of the liquid metering device may adjust the batch volume of liquid to be pumped by simply turning the dial **22** until the desired step **41***a* is located adjacent the casing slot **24***a.* The downward stroke of the pistons **23, 25** then will continue only until the stop **40** carried by the pistons engages the selected step **41***a,* at which time the pressurized gas valve **20** may be actuated to release the gas pressure and thereby cause ejection of the measured quantity of liquid from the chamber **36** into the outlet line **21.** The number and spacing of the steps **41***a* may be varied as desired to provide the necessary liquid batch sizes for each particular application. e

One of the features of the illustrative device resides in the provision therein of means for preventing liquid leakage into the pressurized gas chambers. To this end a porous washer **49,** preferably formed of teflon felt or like material, is provided within the recess **26** at the base of the small piston **25.** In the event of liquid seepage past the piston seals **25***b* and into the recess **26,** the pressurized gas in the recess **26** forces such liquid through the porous washer **49** and back into the tank **11.**

Another feature of the illustrative arrangement resides in the manner in which provision is made for the pistons **23, 25** to move downwardly in the casing **24** and compress the spring **30,** without at the same time pinching or otherwise restricting flow of liquid through the tubing **34.** As will be seen from the drawings, the tubing **34** is provided with a loose knot which, because of the flexibility of the tubing, is capable of self loosening during downward piston travel (see FIG. **4**) and self-tightening during upward piston travel (see FIG. **3**). It has been found that pinching of the tubing **34** is avoided if the mean slope of the knot is arranged opposite to the spiral of the spring **30,** as shown in the drawings.

I claim as my invention:

1. A device for transferring a metered batch of liquid from a supply container comprising, in combination, an outer casing, an inner casing located within the outer casing and defining an annulus therebetween, a first piston located in the annulus for sliding movement therein in response to fluid flow in and out of the annulus, spring means within the outer casing for urging the first piston into an advanced position, means for providing fluid flow into the annulus to move the first piston into a retracted position in opposition to said spring means, a second piston located within the inner casing for sliding movement therein and secured at one end to the first piston so that the first and second pistons move within their respective casings in unison, said second piston and inner casing defining therebetween a liquid chamber in communication with a liquid outlet, liquid communication means extending between the liquid supply container and the liquid chamber, a first check valve between said liquid supply container and said liquid chamber for passing liquid from said supply container to said chamber during retracting movement of said pistons and for blocking the flow of liquid from said chamber to said supply container during advancing movement of said pistons, a second check valve connected to said liquid outlet for passing liquid dis-

charged from said liquid chamber via said outlet during advancing movement of said pistons and for blocking the flow of liquid into said chamber via said outlet during retracting movement of said pistons, and means for terminating fluid flow into the annulus and venting fluid contained therein to atmosphere whereby the pistons are moved to an advanced position in response to the spring means so that liquid is discharged from the liquid chamber into the liquid outlet.

2. The device of claim **1** in which the liquid communication means includes a flexible tube located within the spring means and provided with a loose knot having the mean slope of the knot arranged opposite to the spiral of the spring.

3. The device of claim **1** in which means is provided for adjustably limiting the stroke of the pistons to thereby limit the volume of liquid transferred to a predetermined volume.

4. A device for transferring a metered batch of liquid from a supply container comprising, in combination, an outer casing, an inner casing located within the outer casing and defining an annulus therebetween, a first piston located in the annulus for sliding movement therein in response to fluid flow in and out of the annulus, spiral spring means within the outer casing for urging the first piston into an upper position, means for providing fluid flow into the annulus to actuate the first piston into a lower position in opposition to said spring means, a second piston located within the inner casing for sliding movement therein and secured at its lower end to the first piston so that the first and second pistons move within their respective casings in unison, said second piston and inner casing defining therebetween a liquid chamber in communication with a liquid outlet, liquid communication means extending between the liquid supply container and the liquid chamber, said liquid communication means including a flexible tube located within the spring means and provided with a loose knot having the mean slope of the knot arranged opposite to the spiral of the spring means and means for terminating fluid flow into the annulus and venting fluid contained therein to atmosphere whereby the pistons are moved to an upper position in response to the spring means so that liquid is discharged from the liquid chamber into the liquid outlet.

* * * * *