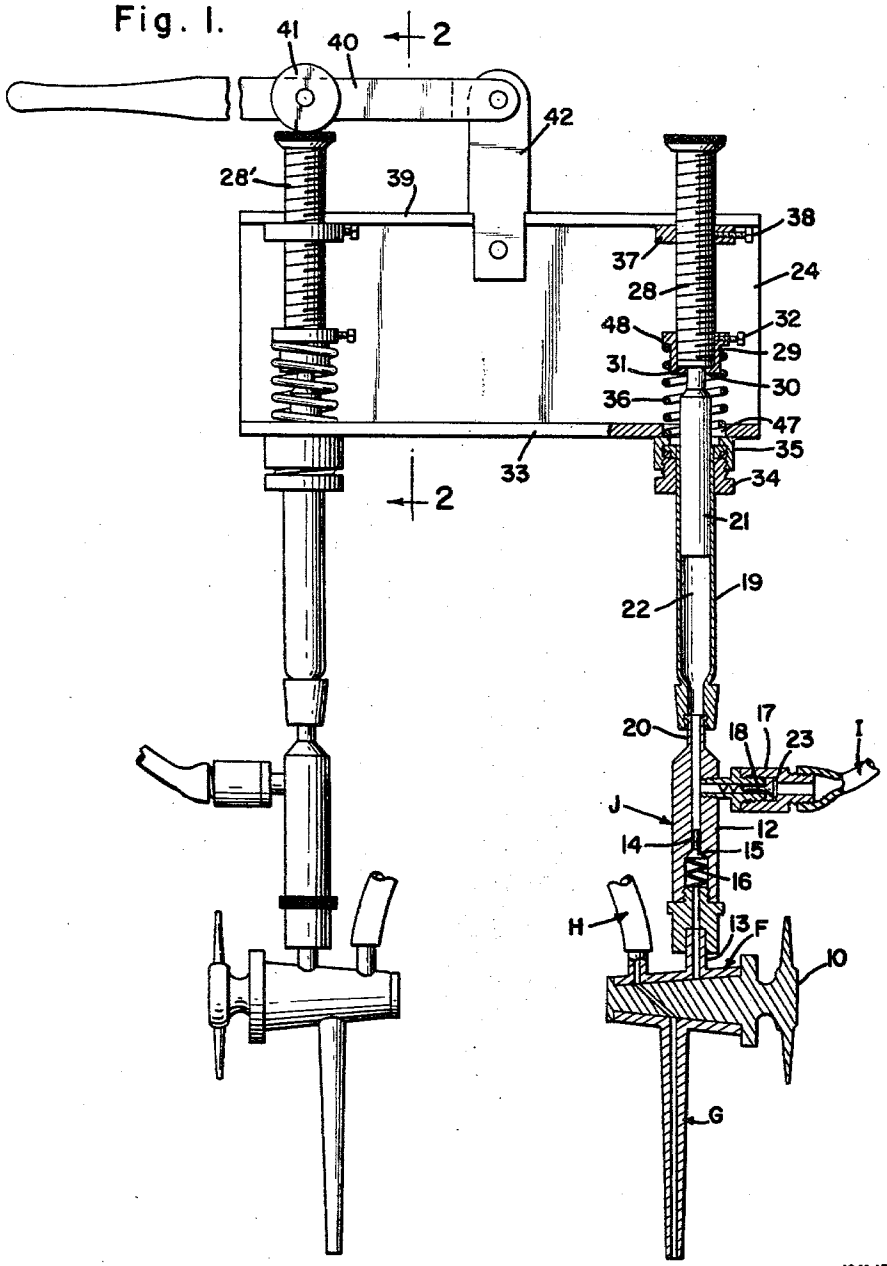
May 18, 1965 S. T. NERENBERG 3,184,122

SEMI-AUTOMATIC DILUTION PIPETTE

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Fig. 1.



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Fig. 2.

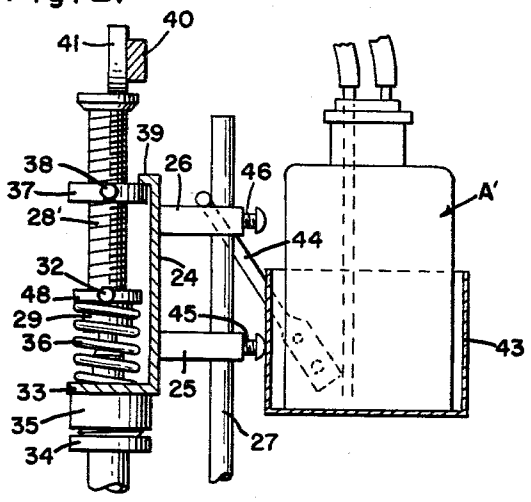


Fig. 3.

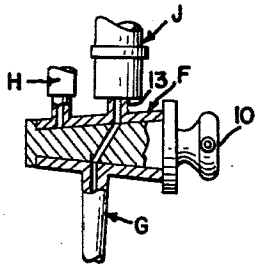
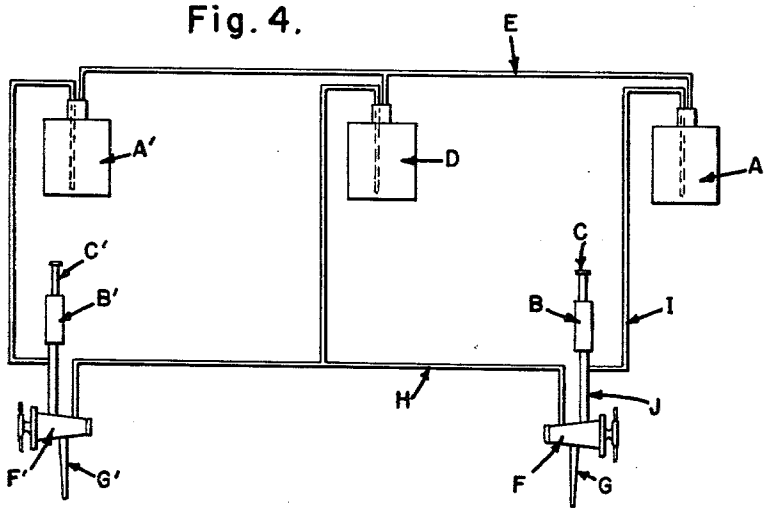


Fig. 4.



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SEMI-AUTOMATIC DILUTION PIPETTE

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4 Claims. (Cl. 222—255)

This invention relates to dilution devices. More particularly it relates to dilution pipettes of the type capable of discharging a constant volume of sample and a variable known volume of diluent therefor.

Briefly, in the preferred embodiment the present device includes a pipette calibrated for holding and discharging a known volume of sample solution. A predetermined volume of diluent is supplied from a diluent metering chamber of adjustable volume to said pipette for discharge in conjunction with the sample solution and dilution thereof to a calculable concentration.

The diluent is supplied to the diluent metering chamber from a diluent storage chamber. The diluent storage chamber is linked by means of a conduit to a vacuum chamber so that the vacuum chamber and diluent storage chamber are in air communication only with each other. The vacuum chamber is linked for fluid communication with the pipette by a conduit. When diluent is removed from the storage chamber for supplying the metering chamber, a partial vacuum or negative pressure is created in the storage chamber. The partial vacuum is in turn created in the vacuum chamber. This vacuum may be used for drawing sample solution into the pipette since the pipette is linked thereto. Suitable valves are provided between the various members so that air and liquid may be urged into and from the various chambers in proper sequence. Pumping means is provided for moving the fluids to their appropriate locations.

In the accompanying drawings there is shown in:

FIG. 1 a side view partially in section of part of the device of the present invention including a pair of pipettes, cylinders and plungers and associated valves.

FIG. 2 shows in end elevation the means for selecting and limiting the extent of withdrawal of the plunger from the cylinder so that the volume of the cylinder may be adjusted and is taken along the line 2—2 of FIG. 1.

FIG. 3 shows in side elevation with portions broken away a second position of the 2-way valve shown on the right hand side of FIG. 1.

FIG. 4 shows schematically the device of the present invention.

The primary object of the present invention is to provide a dilution pipette capable of rapid repetitive use that is of sufficient mechanical simplicity so that it may be constructed at a relatively low cost while remaining substantially free from stoppages.

A more specific object is to provide a dilution pipette wherein the pipette is filled with sample solution to be diluted by means of negative pressure and the negative pressure is provided internally and automatically by operation of the device itself.

A further object is to provide a dilution device wherein the volume of diluent supplied per volume of sample solution is adjustable so that the concentration of diluted sample solution may be selected as desired.

A further object is to provide a dilution device wherein the volume of diluent to be supplied may be adjustably fixed for rapid and rigid operation without the necessity of adjusting the dilution volume for each volume of sample solution to be diluted.

Further objects, features, and advantages of the present invention will become apparent upon reading the following detailed specification when read in conjunction with the accompanying drawings.

With respect to the schematic diagram shown in FIG. 4 the general mode of operation of the present device will be illustrated first. Diluent is stored in diluent storage chamber A. A portion of the diluent is drawn into diluent metering chamber B by withdrawal therefrom of pumping means or plunger C. The volume of diluent drawn into diluent metering chamber B will be determined by the extent of withdrawal of plunger C.

When a portion of the diluent is removed from diluent storage chamber A, a partial vacuum is created in diluent storage chamber A above the level of the liquid diluent therein. This partial vacuum is in turn imparted to vacuum chamber D through conduit E.

A 2-way valve F is provided for alternately linking calibrated pipette G with diluent metering chamber B and vacuum chamber D. When 2-way valve F links pipette G with vacuum chamber D and pipette G is immersed in a source of sample solution, the sample solution will be drawn so as to fill pipette G and into conduit H which links pipette G with chamber D. Positioning of 2-way valve F so that diluent metering chamber B is then placed in communication with pipette G permits the discharge of sample solution in pipette G with the diluent in diluent metering chamber B by actuation or downward movement of plunger C. Suitable valves are positioned in conduits I and J as will be explained hereinafter so that liquids are movable only in the aforementioned paths and are not permitted to be forced into the wrong conduits.

Vacuum chamber D serves as a sample liquid trap so that the diluent is not contaminated in diluent storage chamber A. Any suitable device which serves to trap excess sample fluid from pipette G but allows negative pressure from storage chamber A to reach valve F may be used.

Also illustrated in FIG. 4 at the left hand side is another cooperating set of a pipette G', valve F', cylinder B', plunger C', storage chamber A', and corresponding linking conduits. This corresponding unit is linked to the aforesaid described unit in common with vacuum chamber D. By having such a plurality of units it is possible to provide different diluents in readiness for diluting the same or different sample solutions.

More specifically with respect to FIGS. 1–3, the present preferred embodiment includes pipette G of known volume in fluid communication with 2-way valve F. When valve F is in its second position with valve plug 10 vertically aligned as shown in FIG. 1, pipette G is placed in fluid communication with vacuum chamber D (as in FIG. 4) through conduit H. When 2-way valve F is placed in its first position by rotation thereof so that valve plug 10 is horizontal as illustrated in FIG. 3, pipette G is placed in fluid communication with conduit J.

Conduit J includes a tubular body 12 fitted on projection 13 of 2-way valve F. Interiorly of tubular body 12, a check valve 14 is urged against valve seat 15 by spring 16. Flow of fluid toward pipette G moves valve 14 against spring 16 to open the valve and permit fluid to flow through tubular body 12 to pipette G when 2-way valve F is in its first position. For reasons that will become clear hereinafter, when negative pressures are developed on the side of valve 14 away from pipette G, valve 14 is drawn against valve seat 15 preventing fluid flow through tubular body 12.

Conduit I links tubular body 12 with diluent storage chamber A. A valve housing 17 links conduit I with tubular body 12. A check valve 18 similar to valve 14 permits flow from conduit I into tubular body 12 while prohibiting fluid from flowing in the opposite direction.

A cylinder 19 is threadably engaged at neck 20 of tubular body 12. A plunger 21 is mounted for reciprocal

movement within cylinder 19. When plunger 21 is drawn upwardly, negative pressure is created in metering chamber 22 defined by cylinder 19. The negative pressure causes valve 14 to seat itself in valve seat 15 while causing valve 18 to open and fluid to be drawn through conduit I from storage chamber A into metering chamber 22 until the space vacated in chamber 22 by plunger 21 is filled with fluid from storage chamber A.

When plunger 21 is thereafter moved downwardly through metering chamber 22 of cylinder 19, the diluent fluid previously drawn therein during the upward withdrawal stroke of plunger 21 will be forced outwardly from chamber 22 through tubular body 12 and into pipette G when plug 10 of 2-way valve F is positioned horizontally as in FIG. 3. This action causes both discharge of sample solution which may be in pipette G and discharge of diluent through pipette G for mixture with the sample solution. Since the volume of pipette G is known, if the volume of metering chamber 22 is also known for each position or extent of upward withdrawal of plunger 21, the concentration of the sample of fluid when mixed with diluent may be readily calculated as will be obvious to those skilled in the art.

When the diluent in chamber 22 is being forced through pipette G during the downward stroke of plunger 21, the pressure created by the diluent forces valve 18 to close against valve seat 23 to prevent return of diluent to storage chamber A. At the same time the downward pressure of the diluent forces valve 14 away from valve seat 15 so that the diluent can pass into pipette G through valve F.

It should be noted that the entire volume of metering chamber 22 does not pass into pipette G since a portion thereof will remain in tubular body 12. However, since the amount of fluid remaining in tubular body 12 is constant, it will not interfere with the calibration of the volume of metering chamber 22 for the various positions of withdrawal of plunger 21 therefrom.

Cylinder 19 and plunger 21 may be conveniently mounted in vertical position on a bracket 24 supported by arms 25 and 26 which are in turn adjustably supported by screws 45, 46 on a stand, a segment of the upright portion of which is shown at 27 in FIG. 2. The top of plunger 21 is fixed to head 28 by coupling 29. Coupling 29 has an opening at 30 through which the top of plunger 21 is inserted and flanged over at 31 so that plunger 21 cannot be pulled downwardly out of coupling 29. A set screw 32 holds head 28 interiorly in fixed relative relation to coupling 29.

Cylinder 19 is supported on bottom leg 33 of bracket 24 by means of threadedly engaged members 34, 35. Member 34 is frictionally engaged with the upper end of cylinder 19 and member 35 is joined with the lower surface of leg 33.

By forcing head 28 downwardly, plunger 21 is simultaneously forced downwardly through hole 47 (defined in leg 33) into cylinder 21. A spring 36 inserted between lip 48 on coupling 29 and the top of member 35 appearing in hole 47 of leg 33 is compressed during this downward motion. When head 28 is released and no longer urged downwardly, spring 36 returns plunger 21 and head 28 to its upward position and thereby causes the withdrawal of plunger 21 from cylinder 19.

The extent of withdrawal of plunger 21 may be adjustably selected by means of collar 37 and set screw 38. By tightening set screw 38 and fastening collar 37 on head 28 at any particular position along the longitudinal axis of head 28, the position of maximum withdrawal of plunger 21 from cylinder 19 is determined. This is due to upper leg 39 on bracket 24. When head 28 is urged upwardly by spring 36, collar 37 engages leg 39 and further upward movement of head 28 is prevented. By fixing collar 37 on head 28 with set screw 38, plunger 21 may be operated repeatedly by urging downwardly on head 28 and the volume provided in metering chamber 22 will remain constant until collar 37 is moved to another position.

The volume of metering chamber 22 is suitably calibrated for the various positions of collar 37 on head 28 with respect to the longitudinal axis thereof. Suitable graduations may be placed on head 28 for indication of the volume of diluent which will be drawn into metering chamber 22 for discharge therefrom through pipette G.

Head 28 may suitably be urged downwardly by means of lever 40 and wheel 41. Lever 40 is pivotally mounted on supporting upright 42 which is in turn supported by bracket 24 and leg 39 thereof.

Diluent storage chamber A may be suitably positioned and supported in a convenient position behind bracket 24 on stand 27 by placing storage chamber A in box 43. Box 43 is hung on stand 27 and arm 26 by loop 44. Chambers D and A' may be similarly fitted and depended.

As illustrated in FIG. 1, the present device may be of the dual construction schematically illustrated in FIG. 4. The various components on the left hand side of the device as illustrated in FIG. 1 are in all ways similar to the device on the right hand side as described above. Both sides of the device may be suitably operated by lever 40 by first pivoting lever 40 about supporting upright 42 so that wheel 41 contacts and is in position for depressing head 28' as shown in FIG. 1. After depressing head 28', lever 40 may be pivoted to the right hand side so that wheel 41 engages head 28 for the downward stroke.

Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be practiced within the spirit of the invention as limited only by the scope of the appended claims.

What is claimed is:

1. A dilution pipette capable of repeatedly dispensing a constant volume of sample solution and a preselected volume of diluent therefor comprising a calibrated sample solution chamber having a port for ingress of sample solution and for subsequent discharge of the chamber volume of sample solution and a preselected volume of diluent, a diluent metering chamber of adjustable volume for holding diluent, conduit means establishing fluid communication between said diluent metering chamber and said sample solution chamber, a 2-way valve having first and second positions between said sample solution chamber and said diluent metering chamber permitting fluid communication therebetween when in said first position, valve means between said 2-way valve and said diluent metering chamber for pemitting fluid movement between said 2-way valve and said diluent metering chamber only towards said 2-way valve, a diluent storage chamber, a conduit establishing fluid communication between said diluent storage chamber and said diluent metering chamber, valve means between said storage chamber and metering chamber permitting fluid flow therebetween only toward said metering chamber, a vacuum chamber, a conduit for establishing air communication only between said storage chamber and said vacuum chamber, a conduit establishing fluid communication between said vacuum chamber and said sample solution chamber through said 2-way valve when the 2-way valve is in its second position, and pumping means operable to urge diluent from said storage chamber to fill said metering chamber to a preselected volume by creating negative pressure in said metering chamber which thereby creates a partial vacuum in said storage chamber and in turn in said vacuum chamber, said partial vacuum serving to draw sample solution into said sample solution chamber when said 2-way valve is in its second position, said pumping means then being operable to discharge a predetermined volume of the diluent urged into the diluent metering chamber through the sample solution chamber and its port along with the sample

solution in the sample chamber when said 2-way valve is in its first position.

2. A dilution pipette in accordance with claim 1 wherein said diluent metering chamber comprises a cylinder and said pumping means comprises a plunger inserted for reciprocal movement within said cylinder.

3. A dilution pipette in accordance with claim 2 wherein the volume of said diluent metering chamber is adjusted by selecting the extent of withdrawal of said plunger from said cylinder and including means for preselectively limiting the extent of withdrawal of said plunger from the cylinder for repeated filling and discharge of a constant volume from said diluent metering chamber to said sample solution chamber.

4. A dilution pipette in accordance with claim 1 and including a plurality of sets of sample chambers, diluent metering chambers, and diluent storage chambers and associated valves and conduits therefor arranged for cooperation as in claim 1 wherein each set of storage, metering, and sample chambers and associated valves and conduits therefor is in common fluid communication with said vacuum chamber of claim 1.

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