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AUTOMATIC PIPETTE

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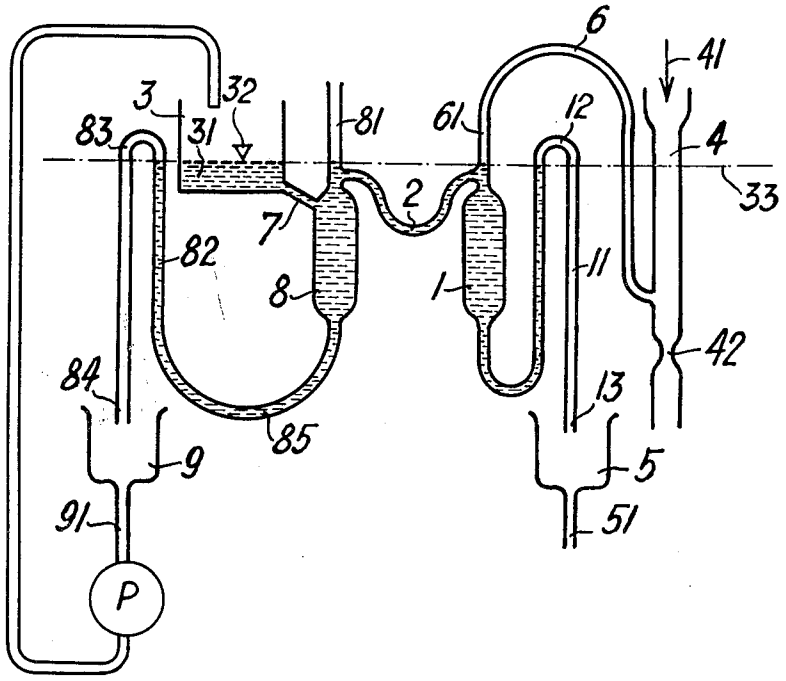

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AUTOMATIC PIPETTE

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This invention relates to automatic pipettes for the measuring and discharge of fixed amounts of liquid, and more particularly to a pipette, discharge of which is triggered by a brief pulse of fluid pressure.

This invention is more specifically concerned with an automatic pipette capable of discharging a predetermined amount of a liquid and of refilling itself from a storage vessel by gravity responsive to a pneumatic signal.

An important object of the invention is the provision of such an automatic pipette in which the measurement and discharge of relatively large amounts of liquid is triggered by a very brief and weak pneumatic signal.

Another object is the provision of an automatic pipette in which the duration of the pneumatic signal may be very much shorter than the time required for discharging the measured liquid from the volumetric vessel of the pipette.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the accompanying drawing wherein the sole FIGURE is an elevational sectional view of a pipette arrangement according to this invention.

In the drawing there is seen a pipette including a bulb 1, and S-shaped syphon tube 11 communicating with the bottom of the bulb 1 and having a bight portion 12 substantially higher than the bulb 1 and a pressure tube 6 connected to the top of the bulb 1.

The pressure tube is upwardly arched above the level of the syphon portion 12, and connects the bulb 1 with a pneumatic pulse generating pump 4. The pump is a vertically disposed tube connected to a source of fluid under pressure in a conventional manner not further illustrated for passage of fluid through tube 4 in the direction of the arrow 41. A constriction 42 in the tube 4 generates positive air pressure in the tube 4 ahead of the constriction 42 in the direction of the arrow 41 when fluid passes through the tube 4.

A storage tank 3 contains a body of the liquid 31 which is to be dispensed by the pipette. It is provided with known means for maintaining the liquid 31 at a constant level 33, such constant level means being represented by a float 32 but not otherwise illustrated. The float is connected with means for admitting additional liquid 31 to the tank 3 when the liquid drops below the desired level 33. Contacts closed by downward movement of the float from the illustrated position, and a solenoid valve in series circuit with the contacts and a source of current are one well-known example of a constant level device which will admit liquid from a reserve supply at a higher level to the tank 3. It is preferred, however, to arrange the aforementioned contacts in the actuating circuit of a pump P which raises the liquid from a dump to the tank when the float 32 drops.

The tank 3 communicates with a substantially closed transfer vessel 8 through a narrow pipe 7. An air vent tube 81 connects the top of the vessel 8 with the atmosphere. An approximately U-shaped connecting tube 2 connects a portion of the vent tube 81 closely adjacent the top of the vessel 8 with a portion of the pressure tube 6 closely adjacent the top of the bulb 1. An S-shaped syphon tube 82 communicates with the bottom of the transfer vessel 8 and has an upper bight portion 83 which

is slightly above the common normal liquid level 33 in the tank 3, the vent tube 81, the pressure tube 6, and the syphon tube 11.

The syphon tubes 11 and 82 have respective terminal discharge orifices in their free end portions 13 and 84 which communicate with the atmosphere and are located above a receiving vessel 5 and a dump vessel 9 respectively. The receiving vessel 5 has an outlet 51 which may lead to a reaction chamber where the liquid 31 may be reacted with another liquid in an automatic titration process or for other purposes which will readily suggest themselves to those skilled in the art.

The liquid discharged from the dump vessel 9 through an outlet 91 may be returned to the tank 3 through the afore-mentioned pump P the operation of which is controlled by the float 32. The vessels 5 and 9 have been conventionally illustrated, and their shapes and sizes may be modified to suit specific conditions.

The bulb 1 and syphon tube 11 together with a straight portion 61 of the pressure tube 6 contiguously adjacent the bulb 1 constitute a first tubular syphon arrangement having an upper orifice above the level of the bight portion 12 where the afore-mentioned portion 61 of the pressure tube 6 is integrally joined to the remainder of the pressure tube, and a lower terminal orifice in the end portion 13 below the level of the lower bight portion 13 of the syphon tube 11.

The transfer vessel 8 together with the event tube 81 and the syphon tube 82 constitutes a second tubular syphon arrangement having an upper terminal orifice in the vent tube 81 above the level of the bight portion 83, and a lower terminal orifice in the end portion 84 of the syphon tube 82, below the level of the lower bight portion 85 of the syphon tube 82.

The normal liquid level 33 in the tank 3 in the illustrated non-operative position of the apparatus is thus slightly below the upper bight portions 12 and 83, and above the connecting tube 2. The feed pipe 7 which is narrower than any other conduit in the two syphon arrangements directly communicates with the transfer vessel 8 below the level of the junction between the connecting tube 2 and the vent tube 81.

The afore-described apparatus operates as follows:

A fluid passing through the tube 4 in the direction of the arrow 41 forces air under a pressure higher than atmospheric pressure into the pressure tube 6. This pressure lowers the liquid level in the straight pressure tube portion 61 and the bulb 1, and forces liquid to flow through the connecting tube 2, thereby briefly raising the liquid level in the vent tube 81. The pressure rise in the tube 6 must be sufficient to drive liquid from the first syphon arrangement through the bight portion 12. The remainder of the liquid will then be automatically syphoned off into the receiving vessel 5.

The pressure pulse in the tube 6 also must be sufficient to raise the liquid level in the vent tube 81 above the bight portion 83. Since the vent tube 81 and the bight portion 83 communicate, a corresponding liquid level rise will occur in the bight portion 83, and the contents of the second syphon arrangement are drained into the dump vessel 9 at a rate determined by the dimensions of the second syphon arrangement.

While the two syphon arrangements are being emptied, additional liquid is admitted through the narrow pipe 7, but not fast enough to balance the loss of liquid through the syphon tube 82. The additional supply of liquid from tank 3 however permits the first syphon arrangement to be drained faster than the second one if both have approximately the same volume. When air is eventually sucked into the syphon tubes 11 and 82, the discharge of liquid is stopped. This occurs in the first syphon arrangement at least a short time before it occurs in the second

one. The gradual flow of liquid from the storage tank **3** then fills the apparatus again to the extent shown in the drawing, and it is ready to discharge the next measured amount of liquid from the pipette **1**.

As soon as the liquid level in the syphon tubes **11**, **82** has been raised beyond the bight portions **12** and **83**, the apparatus completes its operating cycle regardless of the length of time during which the pressure pulse is effective. Return to the starting condition illustrated, however, is predicated on interruption of the gas flow from the tube **4**. While the bight portions **12** and **83** have been shown for the sake of clarity to be elevated beyond the normal liquid level by a distance greater than the internal diameter of the syphon tubes **11**, **82**, this distance may be chosen to be extremely small if very short or weak applications of pressure through the tube **6** are desired.

The apparatus illustrated has the advantage of triggering release of the liquid **32** in a measured amount whenever another liquid or gaseous reagent or sample is passed through the tube **4** into a reaction zone communicating with the vessel **5**, but brief pressure pulses of other origin may be employed to initiate liquid discharge. A small bellows arrangement actuated by depressing a button supplies sufficient gas under pressure to trigger the automatic pipette, and other modification of the pressure fluid source constituted by the tube **4** and the tube **6** can readily be devised following the above teachings.

The enlarged bore portions of the syphon arrangements constituted by bulb **1** and the transfer vessel **8** are convenient for holding relatively large bodies of liquid **32** in a small space, but both syphon arrangements may consist of tubing of uniform bore without altering the basic mode of operation of the apparatus. Other dimensional relationships may equally be altered, but it is important that the effective flow section of the pipe **7** be smaller than the effective flow section of the second syphon arrangement to prevent replenishment of liquid from the tank **3** at a rate similar or equal to the rate of discharge from the orifice in the end portion **84**. The bulb **1** thus is shut off from the liquid supply in the tank **3** while it is drained into the receiving vessel **5**. The amounts of liquid discharged from the first syphon arrangement are precisely uniform as long as the liquid level in the tank **3** is maintained constant.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention, and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

What I claim is:

1. An automatic pipette comprising, in combination:
   (*a*) a first tubular syphon arrangement;
   (*b*) a second tubular syphon arrangement, each of said arrangements being elongated and substantially S-shaped, each arrangement including in longitudinal sequence an upper vertically extending end portion, a lower bight portion, an upper bight portion, and a lower vertically extending end portion, said end portions having respective terminal orifices;
   (*c*) storage tank means;
   (*d*) means for maintaining in said tank means a body of liquid to a predetermined level lower than said upper bight portions;
   (*e*) a connecting conduit communicating with respective parts of the upper end portions of said syphon arrangements;
   (*f*) a feed conduit communicating with said tank means and with a portion of said second syphon arrangement intermediate said part thereof and said upper bight portion thereof for passage of said liquid therethrough by gravity from said tank means to said second syphon arrangement at a predetermined rate when said intermediate portion is empty of liquid; and
   (*g*) means for introducing a gas under a pressure greater than atmospheric pressure into the terminal orifice of the upper vertically extending end portion of said first syphon arrangement;
   (*h*) said second syphon arrangement being dimensioned for syphoning flow of liquid from the terminal orifice of the lower end portion thereof at a rate greater than said predetermined rate.

2. A pipette as set forth in claim 1, wherein the respective volumes of said syphon arrangements below said predetermined level are approximately equal.

3. A pipette as set forth in claim 1, wherein at least one of said syphon arrangements includes a tubular portion of enlarged bore below said level.

4. A pipette as set forth in claim 3, wherein said enlarged bore portion is interposed between the upper vertically extending end portion and the lower bight portion of said one syphon arrangement.

5. A pipette as set forth in claim 4, wherein said one syphon arrangement is said second syphon arrangement, and said feed conduit directly communicates with said enlarged bore portion.

6. A pipette as set forth in claim 1, wherein said connecting conduit has two end portions respectively communicating with said parts, and a portion intermediate said end portions, said intermediate portion of said connecting conduit being on a lower level than said end portions thereof.

7. A pipette as set forth in claim 1, wherein said gas introducing means include a fluid actuated pump communicating with said upper vertically extending end portion.

8. A pipette as set forth in claim 1, wherein the terminal orifice in the lower vertically extending end portion of at least one syphon arrangement is on a lower level than the lower bight portion of said one syphon arrangement.

9. A pipette as set forth in claim 1, wherein the terminal orifice in the upper vertically extending end portion of said second syphon arrangement directly communicates with the atmosphere.

10. A pipette as set forth in claim 1, wherein said liquid level maintaining means include means responsive to a lowering of said level for returning liquid discharged from the lower end portion of said second syphon arrangement to said tank means.

11. A pipette as set forth in claim 1, wherein said parts of said syphon arrangements communicating with said connecting conduit are below said predetermined level.

12. A pipette as set forth in claim 1, wherein the terminal orifices of said upper vertically extending end portions are above said predetermined level.

References Cited in the file of this patent

UNITED STATES PATENTS

2,788,157 Reynolds et al. ---------- Apr. 9, 1957