March 21, 1967 S. W. WILBURN 3,310,002

PIPETTE PUMP

Filed Oct. 18, 1965

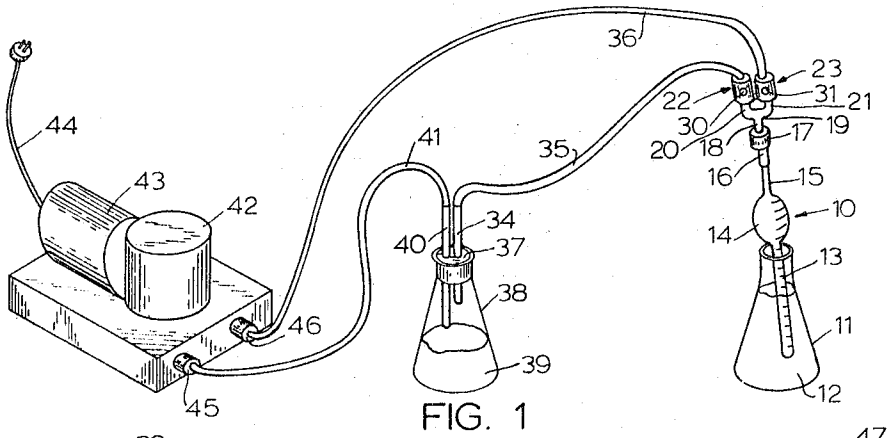


FIG. 1

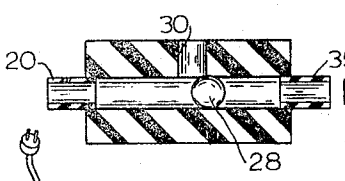


FIG. 5

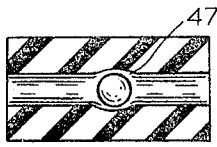


FIG. 6

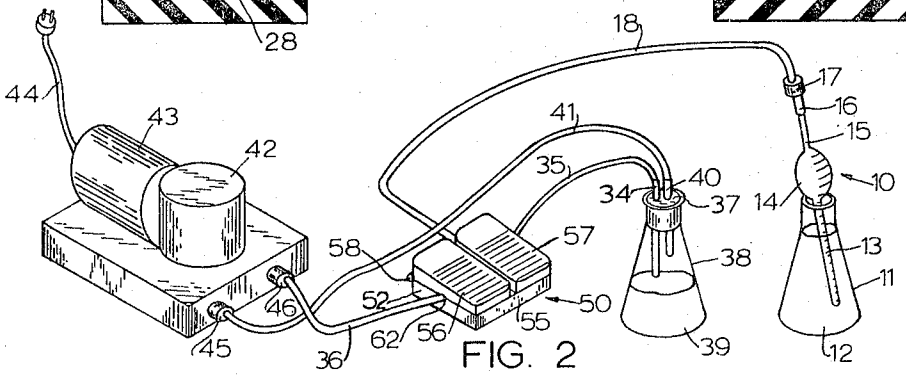


FIG. 2

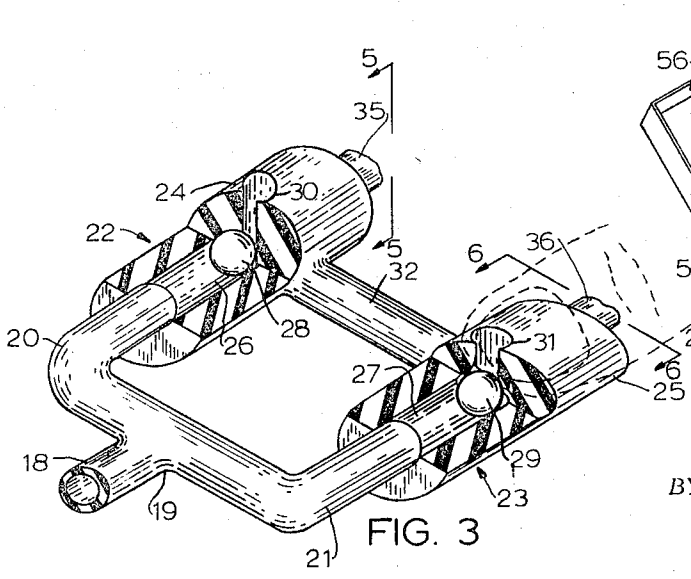


FIG. 3

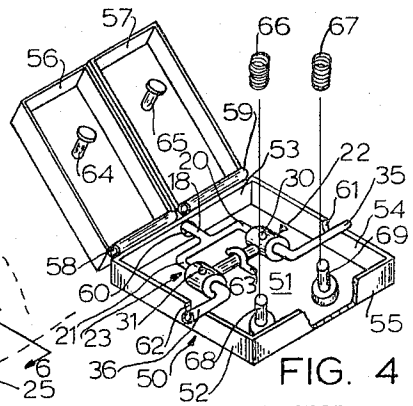


FIG. 4

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PIPETTE PUMP

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This invention relates generally to an apparatus for withdrawing liquids from an expelling liquids into a container and, more particularly, to an apparatus for rapidly withdrawing from specimen tubes, for purposes of analysis, precisely measured quantities of serum for delivery to a second container.

Drawing precisely measured quantities of serum into a pipette is generally effected by removing the air from the other end of the pipette by means of a suction which may be induced with the mouth or by special suction devices such as a rubber ball or a pump. Drawing a liquid into the pipette with the mouth always present the risk of the fluid or vapor therefrom finding its way into the mouth and ultimately into other areas of the body. If the fluid is corrosive, poisonous or mixed with bacteria serious damage may result. Also, it is difficult to see the fluid when the same is being drawn by mouth; therefore, one must draw the liquid up above the desired mark on the pipette, close the upper end thereof with a finger or thumb and then let the fluid escape back into its original container until the level thereof coincides with the mark on the pipette. Such an adjustment of volume of fluid in the pipette is difficult for it requires a delicate sense of touch. The mechanical apparatus currently in use is not sensitive to the degree required and consequently, the level of fluid desired in the pipette cannot be regulated satisfactorily.

An object of this invention is to provide a novel apparatus for rapidly withdrawing serum from specimen tubes into a pipette in precisely measured amounts for delivery into a second container.

Another object of this invention is to provide a pipette pump for drawing serum into a pipette by means of a negative pressure and for expelling the liquid into a second container by means of a positive pressure.

A further object of this invention is to provide an apparatus for transferring serum from one container to another without exposing the serum to the contaminating elements in the atmosphere.

Still another object of this invention is to provide a pipette pump of the type described herein which is compact in design and is readily movable from one location to another.

A still further object of this invention is to provide a pipette pump which may be operated by hand or by foot.

Yet another object of this invention is to provide a pipette pump with a liquid trap which prevents the liquid being drawn into the pipette from entering the suction inducing means.

Other objects and advantages of this invention will become apparent when the following detailed description is read in conjunction with the appended drawings, specifications and claims. Preferred embodiments of this invention will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a perspective view of this invention incorporating the novel features therein and showing the same adapted to be hand operated;

FIGURE 2 is a pictorial view of this invention showing the various elements which adapt the device to be operated by the foot;

FIGURE 3 is a partial sectional, pictorial view of the hand operated valve which controls the suction and pressure lines;

FIGURE 4 is a pictorial view of the valve arrangement being encased in a foot operated pedal system;

FIGURE 5 is a sectional view taken along lines 5—5 of FIGURE 3 showing the valve having been actuated to allow passage of air around the valve ball;

FIGURE 6 is a sectional view taken along lines 6—6 of FIGURE 3.

In performing volumetric chemical analysis, a known quantity of serum is withdrawn from its housing container into a pipette and is transferred to a second container in which the analysis thereof is to be completed. To expedite the transferral of large quantities of serum, this invention contemplates inducing a vacuum in the pipette for rapidly drawing the serum therein and thereafter subjecting the pipette containing the serum to a positive pressure which rapidly drives the serum therefrom into a second container. Since such chemical analysis must be conducted with a high degree of accuracy and care, it is essential that precautions be taken to avoid contamination of the serum and that a valve arrangement be used which is sensitive to the movement of small quantities of air therethrough which either cause the serum to be drawn into or be expelled from the pipette. Since the serum may contain harmful chemicals or bacteria such as pleuropneumonia-like organisms which produce infection in humans, a membrane filter should be located in the line to prevent these toxic elements from escaping the area substantially defined by the pipette. Furthermore, since it is desirable to guard against the negligence of the laboratory technicians in overfilling the pipette, a serum trap is provided in the suction line which receives all liquid overflow and prevents the same from entering the suction producing media. To provide the positive and negative pressures required by this system, it is contemplated that a diaphragm pump in combination with an electric motor is to be used. The diaphragm pump has an inlet and an outlet which respectively pull air therein under the negative pressure and force air therefrom under a positive pressure.

In this invention, a diaphragm pump is provided with an inlet and an outlet tube in which negative and positive pressures are respectively induced. The positive pressure tube and the negative pressure or suction tube are each provided with a ball valve unit which controls the pressurized air passing therethrough. Each ball valve unit is comprised of a cylindrical and flexible housing having relatively thick walls. Each flexible housing is provided with an elongated circular passageway having a common axis with that of the flexible tube. A circular opening in each housing extends at a right angle to the elongated passageway and places the elongated passageway in communication with the atmosphere. A solid obstruction, preferably a round ball, is seated in the elongated passageway and is exposed to the laterally extending opening. The suction and positive pressure lines after continuing from the flexible tube for a distance are joined and form a primary conduit which is connected to a standard pipette. A filter means is located in the primary conduit substantially adjacent the pipette and a fluid trap is located in the suction line between the diaphragm pump and the ball valve unit. The apparatus is made operable by energizing the diaphragm pump which in turn creates a negative and positive pressure in the respective tubes leading therefrom. By covering a selected perpendicularly positioned opening in the ball valve unit and applying pressure thereto which causes the flexible material of the ball valve joint to spread around the ball, the operator may allow air to traverse the opening created by the pressure applied thereto and

may thereby selectively raise or lower the level of the liquid in the pipette.

The invention is illustrated in connection with the accompanying drawings in which the figures are illustrative of the preferred embodiments of the invention.

In FIGURE 1, a pipette 10 is positioned by the user in a volumetric flask 11 which contains a liquid 12. Pipette 10 is of the standard type and is calibrated to receive a predetermined amount of liquid; pipette 10 is comprised of a liquid engaging extension 13, a reservoir bulb 14 and a stem 15. A flexible tube 16 is securely fastened on stem 15 and is adapted to communicate a positive or negative pressure thereto. Tube 16 connects pipette 10 with a membrane filter 17 which is of a standard type and may be purchased from the Mullipore Filter Corporation, Bedford, Mass. Filter 17 acts to remove all bacteria and toxic gases carried by the air which has been associated with liquid 12 to prevent the same from entering the system and ultimately contaminating the liquid of another test series. Primary conduit 18 which is connected to filter 17 branches at intersection 19 to form suction or negative pressure line 20 and positive pressure line 21.

Suction line or conduit 20 and positive pressure line or conduit 21 lead to and are connected with ball valve units 22 and 23, respectively. Ball valve units 22 and 23 are respectively comprised of cylindrical and resilient housings 24 and 25 which are made from any material such as rubber which has the characteristic of resuming its original shape after having been deformed. Cylindrical housings 24 and 25 are respectively provided with elongated and circular passageways 26 and 27 which are concentrically mounted therein and are in communication with suction line 20 and positive pressure line 21, respectively. Passageways 26 and 27 are respectively provided with solid round spheres or balls 28 and 29 which are securely seated therein and which normally block passageways 26 and 27 thereby preventing any movement of air along the length of passageways 26 and 27. Cylindrical housings 24 and 25 are respectively provided with perpendicularly mounted openings 30 and 31 which are preferably parallel with each other and which serve to connect passageways 26 and 27 with the atmosphere. Openings 30 and 31 should intersect passageways 26 and 27 on the side of balls 28 and 29 to prevent air communication between openings 30 and 31 and primary conduit 18. Support bar 32 integrally connects cylindrical housings 24 and 25 and thereby stationarily positions one relative to the other.

Flexible tubes 35 and 36 respectively are connected to and communicate with passageways 26 and 27. Flexible tube 35 is then connected to a glass tube 34 which is embedded in a stopper 37 that resides in the neck of a volumetric flask 38. Volumetric flask 38 contains a liquid 39 in the lower portions thereof which is adapted to dissipate any of liquid 12 which has overflowed pipette 10. Stopper 37 is provided with a second glass tube 40 which is in air communication with glass tube 34 by means of the void area above liquid 39 in volumetric flask 38. Glass tube 40 is securely connected to flexible tubing 41. Flexible tubes 41 and 36 are connected to inlet 45 and outlet 46, respectively, of diaphragm pump 42 which is a conventional type and which is covered by Patent No. 2,575,398. Diaphragm pump 42 is connected by a standard linkage (not shown) to a standard electric motor 43 and is driven thereby upon the energization of motor 43. Electric motor 43 is connected to a power source by means of cord 44. Flexible tube 35 may be directly connected to inlet 45 of pump 42 when there is no danger of liquid 12 overflowing pipette 10.

To fill pipette 10 with liquid 12 contained by volumetric flask 11, motor 43 and diaphragm pump 42 are energized thereby creating a negative pressure in flexible tubes 41 and 35 and a positive pressure in flexible tube 36. Until the system is further disturbed, atmospheric air enters opening 30 of ball valve unit 22 and proceeds

through passageway 26 into flexible tube 35. The air then enters volumetric flask 38 through glass tube 34 and is withdrawn from volumetric flask 38 through glass tube 40 and flexible tube 41 into the inner recesses of diaphragm pump 42 through inlet 45. Diaphragm pump 42 then forces the air out through outlet 46 into flexible tubing 36 and into passageway 27 of ball valve unit 23 and out into the atmosphere through opening 31. It can be seen that the air in the pipette has not as yet been disturbed and liquid 12 has not been drawn into pipette 10 for the system is now open and balls 28 and 29 block air communication between pump 42 and primary conduit 18. To draw liquid 12 into pipette 10, the user's finger is placed over opening 30 thereby closing that side of the system and pressure is applied to flexible housing 24 which results in a spread of cylindrical housing 24 around the area containing ball 28 thereby establishing an air passageway 47 (as shown in FIGURE 6) which connects flexible tubing 20 with flexible tubing 35. Since flexible tubing 35 is under negative pressure, flexible tubing 20 also becomes under a negative pressure which is transferred to flexible tubing 18 and flexible tubing 21. Since no pressure has been applied to ball valve unit 23, ball 29 sufficiently blocks passageway 27 and thereby prevents air communication between flexible tube 21 and opening 31 or flexible tubing 36. However, since the negative pressure does exist at this stage in flexible tubing 18, a negative pressure is induced in pipette 10 thereby drawing liquid 12 therein to the desired level whereupon the pressure having been exerted on ball valve unit 22 is released and the system including flexible tubing 20, 21 and 18 is closed by balls 28 and 29 which block passageways 26 and 27, respectively. Since no air is entering flexible tube 18 from flexible tubes 20 and 21, the liquid level in pipette 10 remains constant.

To expel liquid from pipette 10, opening 31 of ball valve unit 23 is covered after which a pressure is applied thereto which causes cylindrical housing 25 to spread in the area adjacent ball 29 thereby communicating flexible lines 36 with flexible tubing 21 by means of passageway 27. Since the air in flexible tubing 36 is under a positive pressure, the same is communicated to flexible tubing 21, flexible tubing 20 and flexible tubing 18. Since there is no pressure on ball valve unit 22, ball 28 blocks passageway 26 and prevents air communication between flexible tube 20 and either the atmosphere or diaphragm pump 42. Therefore, all of the pressurized air is directed down through tubing 18 into pipette 10 thereby expelling the liquid contained therein into an appropriate container. With the liquid expelled from pipette 10, the system is again ready to receive liquid from another source.

The apparatus is adaptable to be operated by the foot as shown in FIGURES 2 and 4. Ball valve units 22 and 23 along with flexible tubes 20 and 21 are received by pedal housing 50 which includes a floor 51 and vertically extending sides 52, 53, 54 and 55 which are joined at right angles to substantially form a rectangular and open box. Side 53 receives foot pedals 56 and 57 by hinges 58 and 59, respectively. Flexible tube 18 extends through a slot 60 in side 53 and flexible tubes 35 and 36 extend through slots 61 and 62 which are located in sides 54 and 52, respectively. Floor 51 may be provided with a clamp 63 which is rigidly mounted thereon and which receives support bar 32 thereby holding ball valve units 22 and 23 securely in place in pedal housing 50. Pedals 56 and 57 have rigidly mounted thereon stoppers 64 and 65, respectively which are in pivotal alignment with and positioned to cover openings 31 and 30, respectively, when pedals 56 and 57 have been pivoted downwardly and pressed toward floor 51. Pedals 56 and 57 are normally suspended by springs 66 and 67 which are mounted on shafts 68 and 69 so that stoppers 64 and 65 are normally positioned slightly above openings 31 and 30, respectively.

To draw liquid 12 into pipette 10, diaphragm pump 42

is actuated and the user, by means of his foot, applies pressure to pedal **57**. By overcoming the force of spring **67**, stopper **65** engages opening **30** thereby closing off the entrance of atmospheric air into ball valve unit **22** and ultimately to diaphragm pump **42**. As the user increases the pressure on housing **24** by means of stopper **65**, portions of housing **24** which are in contact with ball **28** are forced outwardly from the sides thereof (as shown in FIGURE 6) which results in the creation of a passageway **47** around ball **28** which communicates flexible tube **35** with flexible tube **20** by means of passageway **26**. The vacuum which has been created in flexible tube **35** by diaphragm pump **42** is transferred to flexible tubing **20** and to flexible conduit **18** thereby inducing a negative pressure in pipette **10** which draws liquid **12** into the inner recesses thereof. To expel liquid **12** from pipette **10**, pedal **56** is pressed which causes an opening around ball **29** and thereby transfers the positive pressure in flexible tube **36** to flexible conduits **21** and **18**. The positive pressure in conduit **18** is transferred to pipette **10** which forces liquid **12** therefrom and into a container. It can be seen that a slight pressure on housing **24** or **25** results in a small opening around balls **28** and **29** and thereby only a small amount of air is allowed to pass through passageways **26** and **27**. The volume of air passing thereby is proportionately increased by the amount of pressure applied on the respective housings. Therefore, liquid may be drawn up or expelled from pipette **10** either very rapidly or discretely.

Many different embodiments of this invention may be made without departing from the scope and spirit thereof. Furthermore, it is to be understood that the invention is not to be limited to the specific embodiments shown and described herein, except as defined in the appended claims.

I claim:

1. An apparatus for drawing measured quantities of a liquid into and expelling the same from a pipette which is partially submerged in said liquid comprising:

a primary conduit connected at one end to said pipette and branching at the other end to form a first and a second conduit;

an air displacement pump having an inlet and an outlet, said inlet and said outlet having a first and a second tube respectively connected thereto and extending outwardly therefrom, said pump when energized being effective to simultaneously create a negative pressure in said first tube and a positive pressure in said second tube, said first and second tubes being associated respectively with first and second openings normally communicating said first and second tubes with the atmosphere; and

flexible valve means having a first passageway connecting said first conduit with said first tube and a second passageway connecting said second conduit with said second tube, said first and said second passageways each having a ball securely seated therein, said balls normally blocking air communication between said tubes and conduits, said pump normally forcing air to flow into said first opening and out said second opening, said first passageway when selectively flexed, with said first opening being closed, being effective to communicate said first tube with said first conduit to draw liquid into said pipette and said second passageway when selectively flexed, with said second opening closed, being effective to communicate said second tube with said second conduit to expel liquid from said pipette.

2. The apparatus of claim **1** wherein said primary conduit receives a membrane filter for removing toxic particles from the air passing through the same.

3. The apparatus of claim **2** wherein said first tube is provided with a liquid trap for receiving any liquid which may have escaped said pipette and was inadvertantly drawn into said apparatus.

4. The apparatus of claim **1** wherein said first and second openings are provided in said valve means.

5. The apparatus of claim **4** wherein said flexible valve means is received by an open housing, said housing having a first and a second pedal pivotally connected thereto and normally being adapted to form a top for said housing, said first and second pedals each having stoppers extending downwardly therefrom in alignment with said first and second openings of said flexible valve means whereby upon selectively pressing said first pedal said stopper closes said first opening and flexes said first passageway and creates air communication between said first tube and said first conduit thus drawing liquid into said pipette and, alternatively, upon pressing said second pedal said stopper closes said second opening and flexes said second passageway and creates air communication between said second tube and said second conduit thus driving said liquid from said pipette.

6. The apparatus of claim **3** wherein said flexible valve means is received by an open housing, said housing having a first and a second pedal pivotally connected thereto and normally being adapted to form a top for said housing, said first and second pedals each having stoppers extending downwardly therefrom in alignment with said first and second opening of said flexible valve means whereby upon selectively pressing said first pedal said stopper closes said first opening and flexes said first passageway and creates air communication between said first tube and said first conduit thus drawing liquid into said pipette and, alternately, upon pressing said second pedal said stopper closes said second opening and flexes said second passageway and creates air communication between said second tube and said second conduit thus driving said liquid from said pipette.

7. An apparatus for drawing measured quantities of a liquid into and expelling the same from a pipette which is partially submerged in said liquid comprising:

a primary conduit connected at one end to said pipette and branching at the other end to form a first and a second conduit;

an air displacement pump having an inlet and an outlet, said inlet and said outlet having a first and a second tube respectively connected thereto and extending outwardly therefrom, said pump when energized being effective to simultaneously create a negative pressure in said first tube and a positive pressure in said second tube; and

a valve comprising a first and a second resilient cylindrical housing, said first and second cylindrical housings having first and second passageways respectively extending therethrough and connecting said first conduit with said first tube and said second tube with said second conduit, said first and said second passageways having a first and a second ball respectively seated therein, said balls being slightly larger than said passageways thereby normally prohibiting the passage of air between said tubes and said conduits, said first and second cylindrical housings being provided with first and second openings connecting said first and said second passageways with the atmosphere and positioned substantially adjacent said balls to communicate said first and said second tubes with said atmosphere; and

said pump normally forcing air to flow into said first opening and out said second opening and, selectively, drawing said liquid into said pipette by having said first opening closed and by establishing air communication between said first tube and said first conduit by flexing said first passageway around said first ball and, alternatively, expelling said liquid from said pipette by having said second opening closed and establishing air communication between said second tube and said second conduit by flexing said second passageway around said second ball.

8. The apparatus of claim **7** wherein said valve is

received by a housing which includes a floor, compression springs vertically mounted on said floor, walls extending upwardly from every surface edge of said floor and a first and a second foot pedal pivotally hinged to a selected wall and resting on said springs to form a top to said housing, said walls having openings therein for permitting the exit of said primary conduit and said first and second tubes, said first and second pedals having a first and a second stopper, respectively, extending downwardly therefrom in alignment with said first and second openings of said resilient housings whereby said pump draws liquid into said pipette by having said first pedal forced downwardly against said first resilient housing thereby closing said first opening and deforming said first passageway around said first ball to create air communication between said first tube and said first conduit and said pump alternately expels said liquid from said pipette by having said second pedal forced downwardly against said second resilient housing thereby closing said second opening and deforming said second passageway around said second ball to create air communication between said second tube and said second conduit.

References Cited by the Examiner

UNITED STATES PATENTS

1,204,368	11/1916	Lowy	73—425.6
1,413,796	4/1922	Shelor	103—235
2,463,481	3/1949	Ferraez	73—425.6
2,519,056	8/1950	Lang	73—425.6
2,575,398	11/1951	Schroeder	103—150
2,692,503	10/1954	Crecelius	73—425.4
2,728,232	12/1955	Bremmer	73—425.6
2,825,355	3/1958	Archer	103—235
3,044,466	7/1962	Henderson	251—7
3,219,417	11/1965	Klingbeil et al.	23—259

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