

[54] PIPETTE

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23/259; 141/26, 286

[56] **References Cited**

UNITED STATES PATENTS

3,285,296 11/1966 Kenzo Ishimaru et al. 141/26

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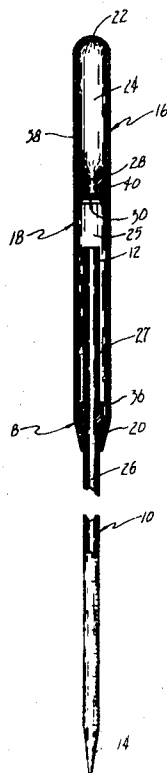
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[57]

ABSTRACT

A pipette in which an open ended tube is filled with or emptied of liquid by compressing or releasing a compressible bulb sealed to one end of the tube. The bulb includes a restrictor that diminishes the air flow into and out of the bulb to limit the maximum rate at which the liquid can be flowed into and out of the tube substantially irrespective of the pressure applied to the bulb. The filter is so mounted that it is not contacted by the fluid in the tube.

11 Claims, 6 Drawing Figures



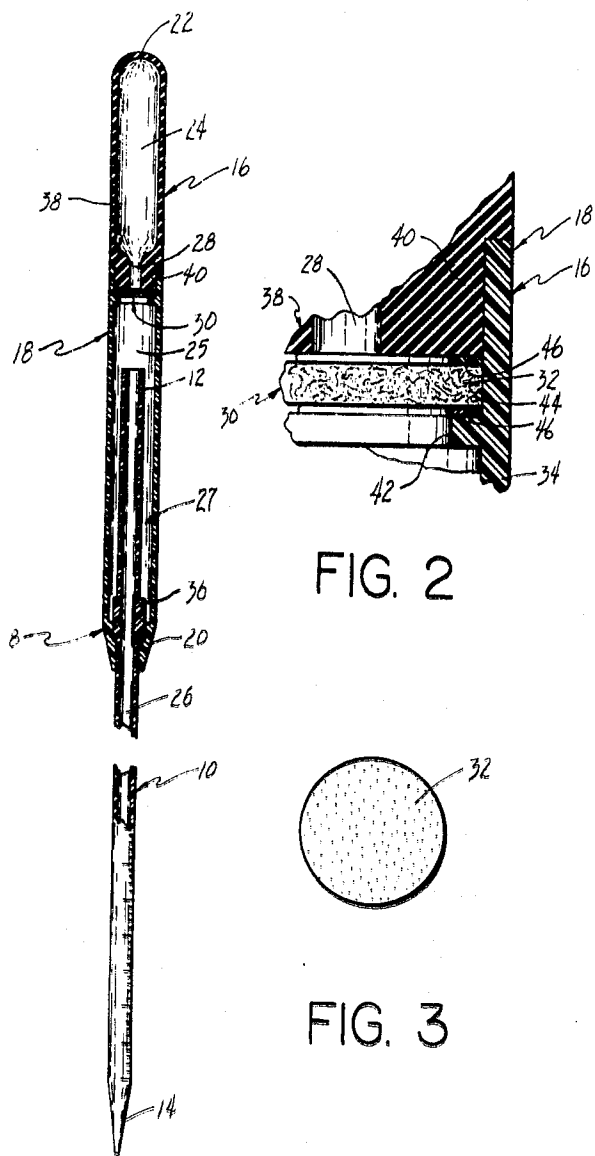


FIG. 2

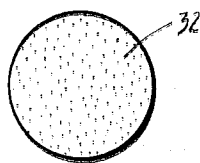


FIG. 3

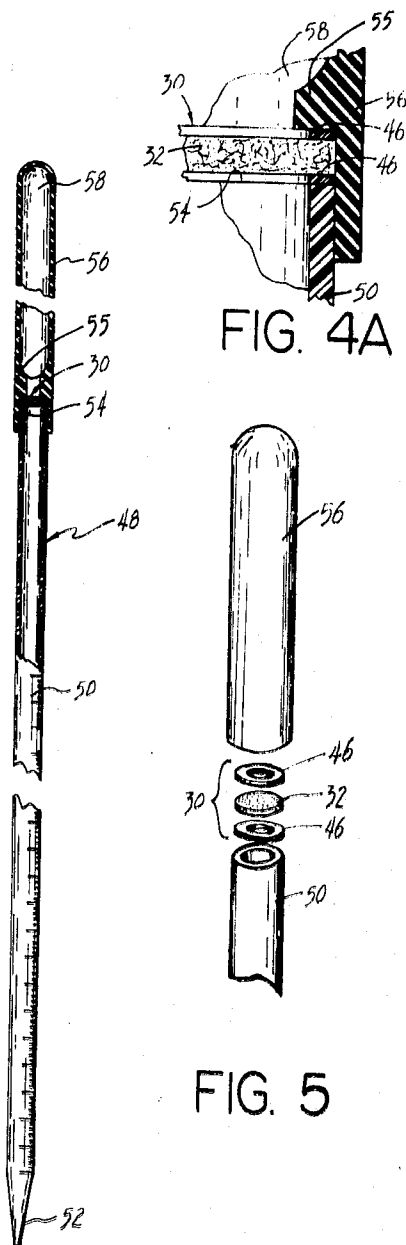


FIG. 4A

FIG. 5

FIG. 1

FIG. 4

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PIPETTE

BACKGROUND OF THE INVENTION

Pipettes, constructed of an open ended tube and a resilient, hollow bulb secured to one end of the tube are presently in wide use for metering small amounts of liquids. The bulbs usually have an elongate, essentially cylindrical configuration and are constructed of a readily deformable resilient material such as soft rubber or plastic. They are operated by grasping the bulb and compressing it to discharge fluid from the tube. They are filled by compressing the bulb, inserting the free tube end in the liquid and then releasing the bulb so that a vacuum forms inside the bulb and draws liquid into the tubular member.

Usually, the quantities drawn into or discharged from the tube are minute, that is in the order of a few milliliters. The tube includes graduations so that the operator can ascertain the precise quantity discharged or drawn into the pipette. Since the operator holds the pipette by grasping the bulb and simultaneously operates it by compressing the bulb, and since the quantity discharged from or drawn into the tube is directly proportional to the air volume displaced in the bulb, it is often difficult and requires substantial skill to operate pipettes for the discharge of small fluid quantities. The problem is compounded by the fact that the primary resistance against compression comes from the bulb material and is thus a function of the bulb material and not of the displaced volume. Unless the same bulb is employed, it is difficult to obtain a "feel" for the liquid quantity discharged or drawn into the pipette. Moreover, the operator might accidentally apply excess pressure to the bulb which immediately results in a discharge of excess material. In instances where that discharge is into containers holding other fluids this might be highly undesirable since such fluids can then no longer be recovered.

In the prior art, it is known to employ various media to prevent the accidental discharge of excess fluid described in the preceding paragraph. Most commonly, a porous membrane or filter is placed across the opening of the liquid storage container, e.g. the pipette or a bottle, which permits the passage of limited quantities of the liquid per unit time for any given pressure applied upstream of the filter. The danger of accidental liquid discharge at a more controlled rate is possible. However, such prior art flow control devices are often undesirable or unusable since they entail a contact between the liquid and the filter material. Such contact can result in the contamination of one or both of the filter and the liquid and becomes increasingly undesirable as the viscosity of the liquid increases.

SUMMARY OF THE INVENTION

The present invention provides a pipette in which the quantity of air discharged from or drawn into the interior of a fluid containing tube of the pipette pipette controlled and takes place at a rate which is substantially less than the rate with which such air exchange would take place in prior art pipettes and the like. Briefly, a pipette constructed in accordance with the invention comprises a bulb constructed of a resilient material and airtightly secured to an end of an elongate container such as a glass tube. The bulb includes an interior air storage chamber which can be emptied by compressing the bulb and filled by releasing the resil-

ient compressed bulb. Gas flow regulating means is disposed between the chamber and the tube and limits the flow rate of the gas between the chamber and the tube to prevent generally uncontrolled rapid fluid discharges from and intakes into the container due to relatively large gas flow rates. Contacts between the fluid in the container and the flow regulating means in the bulb are prevented to eliminate contamination of either or both and to thus assure long, trouble free service of the pipette.

In the preferred embodiment of the invention, the flow regulating means comprises a porous disc constructed of a plastic material such as porous nylon (although other materials such as porous cellulose, porous polyimids and the like can equally well be used), in which the diameters of the pores fall within the range of about 0.0002 to about 0.02 millimeters. Operable porous members can have pore sizes as small as 0.00005 millimeters to as large as 0.15 millimeters.

In the preferred embodiment of the invention, the porous air flow control member is a relatively thin disc placed between the interior bulb chamber and the bulb end. The invention further provides simple, relatively inexpensive means for firmly securing the air flow control member in place so that pressure differentials between the sides thereof cannot move it out of position and tilt it.

A pipette constructed in accordance with the invention enables the slow discharge of controlled quantities of fluid from the pipette tube. Even if the operator substantially instantaneously and fully compresses the bulb, the rate at which the fluid is discharged from the tube remains substantially constant because such a bulb compression merely results in a slight increase in the flow rate of air past the air flow control member. The slow fluid discharge (or intake) from a pipette thus requires substantially less skill than prior art pipettes. Moreover, there are substantially no variations in the liquid discharge from the pipette due to variations of the rigidity and resiliency of the bulb material. Furthermore, contaminations of the air flow control member and/or the fluid due to a contact between the two is prevented and the flow control member can be employed irrespective of the viscosity of the fluids in the pipette.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary elevational view, partially in section, and illustrates a pipette including an air flow regulator constructed in accordance with the invention;

FIG. 2 is an enlarged, fragmentary elevational view and illustrates the manner in which the regulator is secured to the bulb of the pipette;

FIG. 3 is an enlarged plan view of the air flow regulator;

FIG. 4 is a fragmentary side elevational view, partially in section, similar to FIG. 1 and illustrates another embodiment of the invention;

FIG. 4A is a fragmentary, enlarged side elevational view similar to FIG. 2 but illustrates the embodiment of the invention shown in FIG. 4 in greater detail; and

FIG. 5 is a fragmentary, exploded side elevational view of the embodiment of the invention shown in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. 1 through 3, a pipette 8 constructed in accordance with the invention comprises a cylindrically tubular container 10 that terminates in open ends 12 and 14 and that can hold the desired volume of a fluid. As seen in FIG. 1, end 14 is tapered to a point of small diameter. A generally cylindrically rigid, tubular member 18 has a first end 20 airtightly secured to the middle body of container 10 and another end to a bulb 16 which is constructed of a readily deformable resilient material such as soft rubber or plastic. The bulb defines an interior space or chamber 24 that communicates with interior space 25 of tubular member 18 and an interior space 26 of tube 10 via a passageway 28.

Pipette 8 is used by compressing bulb 16 to evacuate air from chamber 24 past passageway 28, interior tube space 26 and out through open end 14 of the tube. Tapered end 14 is then immersed in a liquid (not shown) and bulb 16 is released. The resilient nature of the bulb material forces the bulb back into its original shape whereby a vacuum is formed in the chamber and liquid is drawn through tapered tube end 14 into interior space 26 until the bulb has fully returned to its relaxed position. The liquid entering tube 10 ascends in interior space 26 until it reaches the upper end 12 of the tube where it overflows and eventually collects in bottom part 27 of interior space 25 of the rigid tubular member 18. An exact, predetermined volume of liquid is now held within container 10. To prevent an excessive liquid overflow accumulation in the interior space of tubular member 18, the bulb volume is constructed so that it is approximately 1.1 - 1.7 times, preferably 1.3 - 1.5 times the volume of interior tube space 26. When the bulb is manually depressed, approximately two-thirds of its volume is evacuated therefrom so that upon its release the same two-thirds volume is drawn into space 26. Oversizing the chamber as above indicated allows tube 10 to be exactly filled without excessively spilling liquid into the tubular member 18.

An air flow restrictor or regulator 30 is placed between interior space 26 of tube 10 and chamber 24. The restrictor substantially reduces the air flow between that space and the chamber from what it would be if no such restrictor were provided to prevent rapid and relatively uncontrollable liquid discharges or intakes into tube 10. The restrictor comprises a porous, substantially circular disc 32 which has a multiplicity of pores or paths that extend from one side of the disc to the other. The paths are sufficiently small so that they substantially impede the air flow therethrough. A rapid compression of bulb 16 which correspondingly decreases the volume of chamber 24 thus results in a pressure buildup in the chamber instead of a substantially instantaneous large gas flow from the chamber into the fluid holding tube 10. The pressure buildup in the chamber results in a flow of gas through the paths which is relatively slow and extends over an appreciable time period. The flow can be stopped at any time by releasing the compression of the bulb and permitting it to partially or fully return to its original configuration. In this manner, small quantities in the order of a fraction of one millimeter can be discharged without taxing the operator's skills.

In a presently preferred embodiment of the invention the bulb is secured to rigid tube section 18 that is secured to tubular container 10 such as by interengaging end 20 of the section with an annular protrusion 36 on the exterior of tubular container 10. The bulb is defined by a cartridge-like insert 38 that defines chamber 24 and passageway 28 and which includes a reduced diameter axial protrusion 40 that extends into the open end of tube section 18 and there secured to the tube section such as by cementing it, providing a friction fit, threading the tube sections and the axial protrusion, and the like.

Spaced some distance towards tubular container is an inwardly extending annular ring 42 which projects from tube section 18 and defines an annular groove 44 into which porous disc 32 is fitted to securely hold and position the disc and prevent its movements when its sides are subjected to pressure differentials. A retaining ring 46 is disposed in the groove on each side of the disc and facilitates the firmness with which the disc is grasped, particularly when the disc lacks rigidity as when it is constructed of a deformable material. The retaining rings further enhance the seal between the disc periphery and the groove to assure that no air passes from chamber 24 to tube interior 26 without passing through the pores in disc 32.

The clamping of restrictor disc 32 between bulb 16 and tube section 18 enables a quick replacement of the disc should it become damaged or clogged with dust particles or the like. Moreover, it provides a convenient expedient for mounting the porous disc some distance above the end of tubular container 10 secured to the bulb so that even if more fluid than can be held by the container and the tube section is drawn, and therefore spills over into the tube section, it is prevented from contacting the restrictor and contaminating or plugging it.

A typical construction of a pipette which has a fluid holding capacity of about 0.2 to 5 milliliters without spilling over the upper end of the tubular pipette container employs a bulb which defines a compressible air chamber of a volume that is 1.1 - 1.7 times, preferably 1.3 - 1.5 times the volume of the fluid container. The porous member that restricts the air flow between the chamber and the tube container is so constructed that it permits an air flow of about 0.16 to about 0.5 milliliters per second, at an air pressure differential between the two sides of the disc of between about 3 psi to about 10 psi. Assuming the disc to have a total area of approximately 0.25 square centimeters, the desired flow rate is about 40 milliliters to about 120 milliliters per cm² per minute. This is, for example, obtainable with a disc constructed of porous nylon that has a thickness of about 0.1 millimeters and an average pore size of about 0.0002 millimeters. For a disc yielding the same flow rate but constructed of a different material, having a different thickness, and/or different diameter pores one or more of the parameters have to be suitably adjusted. Such adjustment in the dimensioning of the disc are readily within the purview of those skilled in the art.

Referring to FIGS. 4 through 5, a pipette 48 constructed in accordance with another preferred embodiment of the invention is illustrated and comprises a tubular container 50 that is identical to container 10 illustrated in FIG. 1 except that annular protrusion 36 on the tube exterior is deleted. Container 50 terminates in a discharge end 52 and an open upper end 54 over

which a generally cylindrical tubular bulb 56 of uniform wall thickness is placed. One end of the bulb is closed and the open end is secured to upper end 54 of tube 50 by suitable means such as a clamp (not shown), a friction fit or the like. The bulb defines an air chamber 58 and is constructed of a readily deformable, resilient material. Air flow restrictor 30 is incorporated by placing porous disc 32 above upper end 54 of tube 50 against an inwardly extending annular support 55. The disc is preferably spaced from the upper tube ends by clamping ring 46 and another, inner clamping ring 46 is provided on the other side of the disc to retain the disc in the position in which all air flowing between the chamber and the tube must pass through the pores and the disc and to prevent the disc from falling out of the bulb when the bulb is removed from the tube. To assure a firm connection between the porous disc and the interior of the bulb the periphery of the disc and of the clamping rings 46 are such that the natural resiliency of the bulb presses against them to generate friction forces between them. Pipette 48 illustrated in FIGS. 4 through 5 is operated in precisely the same manner as pipette 8 illustrated in FIGS. 1 through 3. Porous disc 32 impedes the air flow between chamber 58 and tubular container 50 so that a slow fluid discharge from or intake into the container can be attained irrespective of the speed with which bulb 56 is compressed or released.

I claim:

1. Apparatus for use with a fluid storage container for varying air pressure in the container to fill the container with fluid and to discharge fluid therefrom at a slow, controlled rate, the apparatus comprising: bulb means constructed of a resilient material and having means for connecting the bulb means to the container, said connecting means providing an interior gas storage chamber between said bulb means and said container so that the pressure in the chamber can be varied by compressing the bulb means and releasing the compressed bulb means, the gas storage chamber acting as a collector for excess fluid drawn into said container when the compressed bulb means is released, gas flow regulating means between the chamber and the connecting means for limiting the flow rate of gas between the chamber and the connecting means, and means mounting the gas flow regulating means to the bulb means at a point sufficiently remote from the container so that contact between the fluid and the regulating means is prevented when fluid is drawn into the container upon the release of the compressed bulb means.

2. Apparatus according to claim 1 including a passage between the chamber and the connecting means, and wherein the regulating means is mounted in the passage and includes a plurality of paths extending from one side of the regulating means to the other side thereof, the paths having diameters in the order of between about 0.0001 to about 0.15 millimeters.

3. Apparatus according to claim 2 wherein the paths have diameters between about 0.0002 to about 0.02 millimeters.

4. Apparatus according to claim 1 wherein the regulating means comprises a porous plastic disc mounted to the bulb and permitting an air passage of no more than about 120 milliliters per square centimeter of disc area per minute when there exists a pressure differential between the sides of the disc of no more than about 10 pounds per square inch.

5. Apparatus according to claim 4 wherein the bulb means includes an interior groove having a width and a depth sufficient to firmly secure the disc to the bulb means so that substantially all air passing between the chamber and the connection means passes through the disc.

6. A flexible, resilient pressure applying apparatus for use on open ended tubular containers and the like to draw relatively small quantities of liquid into and to discharge such liquid from an open ended tubular container at a slow, controlled rate, the apparatus comprising a tubular member having a closed end for substantial air tight connection with an end of the container, the member including a bulb section defining an inner chamber communicating with one of the open ends, the bulb section being constructed of a resiliently deformable material so that upon compression of the bulb section the air pressure in the chamber is increased and air flows from the chamber to and past said one open end and upon release of the compressed bulb section a vacuum is formed in the chamber and air flows from the exterior of the apparatus past said one open end into the chamber, porous means independent of the member, separating the inner chamber from said one open end, spaced from said one open end, and providing the only passage for air from the inner chamber to said one open end of the container, the porous means having a number of pores and the pores having cross sections so that the normal, unobstructed air flow between said one open end and the inner chamber upon a sudden compression of the bulb section and upon the sudden release of the compressed bulb section is extended over a prolonged period of time substantially greater than the time period required by such normal flow, and means for firmly securing the porous means to the member between the chamber and said one open end to prevent dislocations of the porous means during use whereby the controlled, metered filling and emptying of the inner chamber with air substantially independent of the force applied to the bulb is possible.

7. Apparatus according to claim 6 wherein the member comprises a first part defining the chamber and an elongate, tubular second part engageable with the first part and defining the open end, wherein the securing means are defined by adjacent portions of the parts that define an interior groove, and wherein the porous means is disposed in the groove and positioned transversely with respect to the air flow direction between the chamber and the open end.

8. Apparatus according to claim 6 wherein the porous means has a disc shaped configuration and a periphery engaging an interior surface of the member, and wherein the securing means comprises an annular ring disposed on each side of the disc for positioning of the disc between the rings.

9. A pipette for metering small quantities of liquid comprising a tube having open ends, a manually operable bulb constructed of a flexible material and having an interior chamber, means for airtightly securing the bulb to the tube to thereby communicate the chamber and an interior of the tube for subjecting the tube interior to an elevated pressure or to a vacuum upon the compression of the bulb or upon the release of the compressed bulb, respectively, and a porous member secured to the bulb and positioned so that contact between the fluid and the member upon the release of the compressed bulb is prevented to thereby prevent a mu-

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tual contamination of the member and the fluid, the member having a number of pores and the pores having cross sections so that the normal, unobstructed air flow between the tube interior and the chamber upon a sudden compression of the bulb and upon the sudden release of the compressed bulb is extended over a prolonged period of time substantially greater than the time period required by such normal flow, whereby the controlled, metered filling and emptying of the pipette substantially independent of the force applied to the bulb is possible.

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10. A pipette according to claim 9 wherein the chamber has a volume of between about 1.1 to about 1.7 times the volume of the tube interior to limit the intake of a fluid volume substantially greater than the volume of the tube and to thus prevent contact between the fluid and the porous member mounted to the bulb.

11. A pipette according to claim 10 wherein the chamber has a volume of between about 1.3 to about 1.5 times the volume of the tube interior.

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