United States Patent

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[72] Inventor Wallace H. Coulter
Miami Springs, Fla.

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[73] Assignee Coulter Electronics, Inc.
Hialeah, Fla.

[54] VESSEL HAVING INTERSAMPLE ANTICONTAMINATION CONSTRUCTION
5 Claims, 3 Drawing Figs.

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[51] Int. Cl. G01n 1/10, G01n 21/16
[50] Field of Search ..... 356/39—41, 102—104, 207—208, 244, 246; 250/218; 23/292

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Primary Examiner—Ronald L. Wibert
Assistant Examiner—Warren A. Sklar
Attorney—Silverman & Cass

ABSTRACT: A vessel particularly constructed to separate each of a sequence of liquids, such that each liquid is free of intersample contamination by a prior liquid. Such contamination, which could be caused by residue of the prior liquid adhering to the walls of the vessel, particularly near its drain, or because of inadvertent liquid or gas bubble backflow from the drain, is obviated by an isolation chamber interposed between a primary chamber of the vessel and its drain. A necked passageway or surface of connection between the two chambers is of such proportions that pressure differentials and surface tension hold a major portion of the fluid in the primary chamber and create a gas barrier between the two chambers.

A preferred embodiment of the improved vessel is useful as a cuvette in making hemoglobin determinations and includes a housing having an integral overflow reservoir, drain, and receptacles for radiant energy transmitting and receiving apparatus.

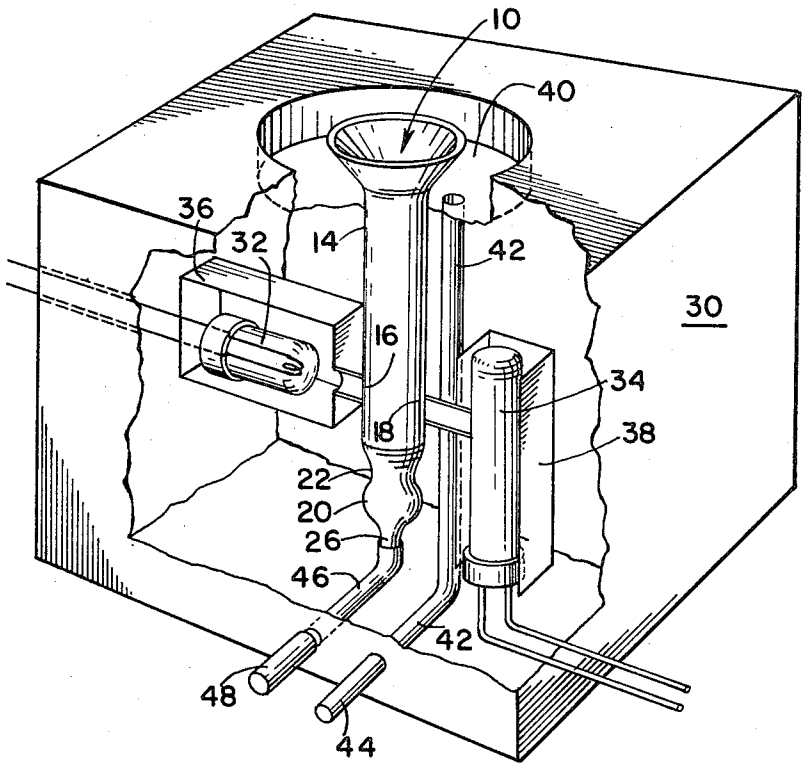


FIG. 1

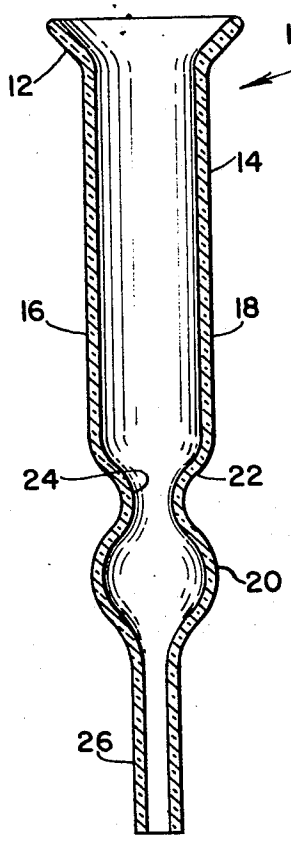


FIG. 3

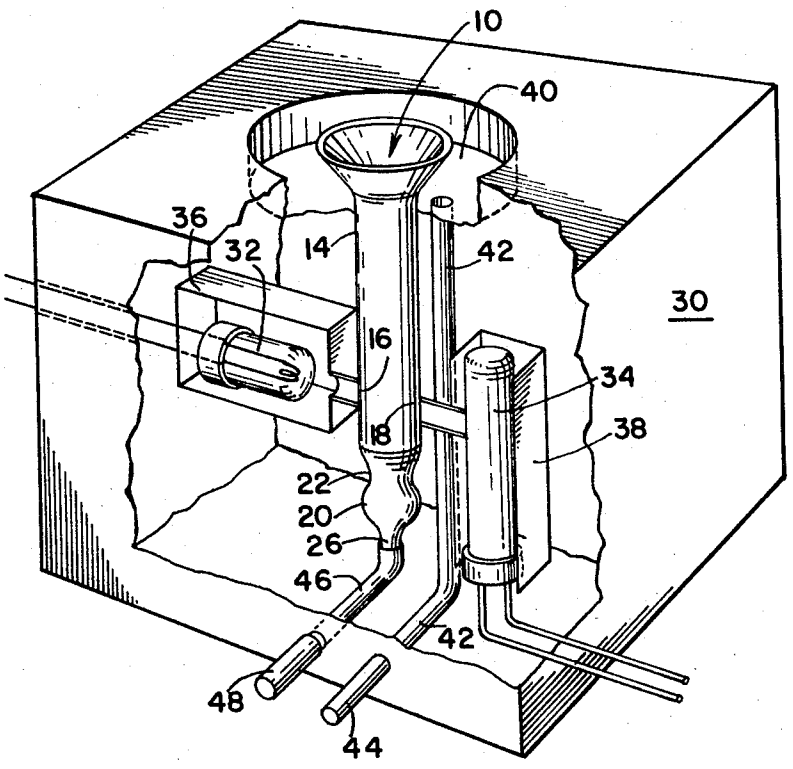
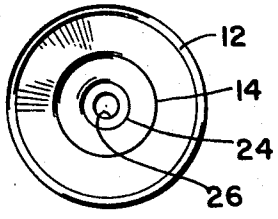


FIG. 2



Inventor
WALLACE H. COULTER
BY Silverman & Cass
ATTYS.

VESSEL HAVING INTERSAMPLE ANTICONTAMINATION CONSTRUCTION

FIELD OF THE INVENTION

The invention relates to an improved vessel and particularly concerns the isolation of a liquid sample in a primary chamber of the vessel from contamination caused by prior samples and rinsing liquids.

This vessel is particularly well suited for use as a cuvette for radiant analysis of liquid samples, such as by absorbance measurement.

DESCRIPTION OF THE PRIOR ART

Vessels, particularly of the flow-through type and cuvettes, have a long history in the field of liquid analysis, both scientific and industrial. In recent years, the need for especially precise analysis of relatively small liquid samples has grown considerably. To meet this need, numerous vessel configurations have been developed. A prime prerequisite of many fluid systems is freedom of contamination of the sample, especially contamination by prior liquids that were run through the system as samples and even rinses. As simple as this prerequisite seems to be, it is often difficult to achieve, even when the cost of the fluid system is not to be considered a limitation.

With reference to a cuvette, its nature is to receive a sequence of samples, each not exactly the same as the next, and it is essential that the cuvette be free of any residue or intersample contamination from prior liquids. Heretofore, repeated flushing and rinsing with solvents and diluents between sample analysis has been tried with some success. However, since the rinsing solutions themselves are different from the next to be analyzed sample, contamination by their residue is still an undesired factor.

Also known in the art are airstream flushing and methods of increasing the wettability of the cuvette walls. Structures designed to decrease the formation of air and gas bubbles, which themselves are contaminants and also create back pressures are also well known. Some cuvettes are specially configured to produce a swirling effect in an effort to sweep away prior samples.

In all, numerous complex and expensive cuvette structures are known; however, the prior art lacks the teaching of the subject inexpensive and simplified vessel which meets the prime requirements above mentioned.

Simplification is not the primary goal of this invention, since simplification is easily accomplished, if one is willing to sacrifice accuracy in the face of contamination. For example, a microburette could be employed; however, it would be especially difficult to remove contaminants remaining within the drain portion due to wetting of the walls, backflow, etc. If the drain was coupled to tubing which in turn was connected to a pump or the like, as is known in some flow-through cuvette systems, change of temperature of entrapped air bubbles in the tubing, or valve characteristics could create a liquid backflow of the prior sample or rinse liquid.

The present invention makes possible a vessel which is simpler in construction than a microburette, but avoids the drawbacks of even the much more complex flow-through cuvettes and associated analysis systems.

SUMMARY OF THE INVENTION

This invention enables the construction of a unitary, flow-through vessel for the especially precise isolation of each of a series of small liquid samples. The vessel which characteristically would have an open-mouthed sample-receiving primary chamber and a drain connected thereto, is improved by this invention by an interposed isolating chamber and surface of connection. The surface of connection is a narrow neck of such proportions that when a new sample is poured into the primary chamber, the first few drops remove any trace of contaminants from the neck as the initial influx passes into the isolating chamber. Hence, the primary chamber is voided of prior liquids as a source of contaminants.

Most importantly, since the drain is to be closed before the entry of each new fluid, the isolating chamber becomes an air or gas trap which, in combination with the narrow surface of connection creates a barrier to the further downward flow of liquid from the primary chamber; hence, total absence of communication with any contaminants in the drain or bottom of the isolating chamber. Any backflow from the drain because of the closing of the valve or otherwise is not detrimental and in fact only increases the desired gas pressure in the neck between the two chambers.

In a preferred embodiment, the vessel is employed as a cuvette and is provided with a housing having an integral overflow reservoir and drain, the former annularly surrounding the input mouth of the cuvette. The housing also internally mounts radiant energy transmitting and receiving elements for passing a beam of energy normal to the analysis chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is, in magnified scale, a median sectional view through a preferred embodiment of a vessel incorporating the subject isolating construction;

FIG. 2 is a top plan view of the vessel of FIG. 1, showing the relative inside diameters of the several portions; and

FIG. 3 is a perspective view of the vessel of FIG. 1 employed as a cuvette in a special housing, broken in part to reveal the cuvette and associated components.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIGS. 1 and 2, a vessel **10** improved by the subject invention conveniently has a flared mouth or entrance port **12** which leads directly into a primary chamber **14**, shown generally of tubular form and circular internal cross section. It is not essential for this chamber to have a precise configuration; however if it is to be employed as a cuvette, it should possess a pair of aligned parallel wall portions **16** and **18** through which a transverse radiant beam can pass with fairly minimal distortion. The relative length and diameter of the primary chamber partly depends upon the sample volume and partly upon the requirement that, as a sample is being introduced, its first few drops should flow over the entire inner surface of the chamber and carry downward in a rinsing action any residue from prior liquids or the like. Thus, all of the liquid, subsequent to the first few drops can be retained in the primary chamber and will not be contaminated by substances which would otherwise adhere to said wall portions and the upper areas of the primary chamber.

An isolating chamber **20** is integral with the primary chamber and possesses a curved surface of connection **22** which defines a narrowed passageway or neck **24** between the two chambers. As shown, the surface **22** is smoothly formed so as to minimize deceleration of passing liquid.

Preferably, the major portion of the isolating chamber has the form of a prolate spheroid, because of the ease in which such shape adapts itself to smooth liquid flow and also the ease of geometric mating with the primary chamber **14**, the surface of connection **22**, and a drain **26**. Even if the isolating chamber were to be of other general configuration, due to environmental and/or sample considerations, a primary design criterion is the formation of a connecting portion, such as the neck **24**, which is free of abrupt discontinuities and is small enough to permit the formation of an undersurface maintained by surface tension and supported by a moderate increase of air pressure; yet is not so small as to subject the exiting liquid to large forces of acceleration, which would tend to break up the liquid and leave drops behind.

The precise diameter of the drain **26** is no longer a critical matter, as is frequently the case in the prior art, with respect to capillary attraction, surface tension, etc. Hence, it can be small enough to conveniently connect to exhaust equipment via tubing of less than 5 mm. diameter. Accordingly, the drain **26** is smaller than all other portions of the curvette as shown in FIG. 2.

However, the diameter relationship between the drain **26** and the isolating chamber **20** is relatively significant, such that any environmentally generated back pressures and backflows, as by air bubbles, are dissipated upon entry into the much larger diameter and volume of the isolating chamber. Hence, contaminants from below the isolating chamber are isolated from the sample in the primary chamber.

Under some circumstances, it may be advantageous to serially position two of the isolating chambers between the primary chamber **14** and the drain **26**.

The vessel could be of any of a variety of materials, depending upon the chemical nature of the liquids to be passed therethrough and, if a cuvette, the form of radiant energy employed for performing the analysis. For many commercial uses, glass would be well suited.

Although not illustrated, it is to be assumed that coupled to the drain **26** is valve means which is closed just prior to the introduction of new liquid into the primary chamber. Thus, there must be trapped gas in the system between the valve means and the passageway **24**.

Turning next to FIG. **3**, a practical embodiment of a vessel incorporating an isolating chamber **20** and surface of connection **22** is vertically mounted in a housing **30** which supports the vessel **10** as a cuvette relative to a radiant energy transmitter **32** and a radiant energy-transducing receiver **34**, respectively oriented in appropriately aligned receptacles **36** and **38** formed in the housing and which provide a radiant path communicating to the parallel wall portions **16** and **18**.

An annular reservoir **40** circumscribes the mouth of the cuvette in liquidtight abutment so as to provide an overflow basin. A drain channel **42** is formed in the housing between the reservoir and the lower portion of the housing such that exhaust tubing **44** can be attached for exterior removal of overflow liquids. Similarly, the drain **26** connects to an exit channel **46** and tubing **48**.

It is anticipated that those skilled in the art might find it advantageous to introduce modifications to the subject structure to suit particular environmental, testing and measuring needs, while at the same time remaining within the spirit and scope of the teachings herein. For instance, the primary chamber could be made generally spherical to minimize surface area, or could be given flat sides to facilitate entry and exit of radiated energy.

It is also apparent that the device could be used for other purposes, for instance, as a reaction chamber in automatic chemistry apparatus. In such an application, reagents could be poured manually or squirted automatically into the mouth **10**, contamination from previous reactions being prevented according to the invention. When enough time has elapsed for the desired reaction to take place, the contents could be routed next by the tubing **48** and suitable control valving if the contamination produced at the end of the reaction can be tolerated. Other uses for the apparatus will occur to those skilled in the art.

What I claim to be secured by Letters Patent of the United States is:

1. A vessel for sequentially receiving a plurality of different liquids, at least one of the liquids being a sample liquid, and for isolating the sample liquid from contamination by other of the plurality of liquids, said vessel comprising:

a generally tubular body having upper and lower ends,

a liquid entrance port proximate the upper end of said tubular body,

a liquid drain proximate the lower end of said tubular body,

a primary chamber intermediate said entrance port and drain,

at least one isolating chamber interposed between said primary chamber and said drain,

said isolating chamber constructed and arranged with respect to said primary chamber to initially receive an initial influx of sample liquid by gravity, which rinses said primary chamber clean of contaminants, and also retains gas of sufficient pressure to form a barrier to further receipt by said isolating chamber of sample liquid,

said isolating chamber further constructed and arranged with respect to said drain to inhibit the backflow into the primary chamber of liquids and other contaminants,

said primary chamber comprising a chamber of a first diameter,

said drain being generally of one diameter which is smaller than said first diameter,

said isolating chamber having a surface of connection with said primary chamber which narrows to a noncapillary second diameter, said second diameter being substantially less than said first diameter,

said isolating chamber, beyond said surface of connection, comprising a chamber which diverges to a diameter substantially greater than said second diameter, and

said isolating chamber comprising a chamber of greater diameter than said one diameter of said drain and having a noncapillary point of connection with said drain.

2. A vessel according to claim **1** in which said isolating chamber is generally a prolate spheroid.

3. A vessel according to claim **2** which is unitary and symmetric around an axis which passes through said isolating chamber.

4. A vessel according to claim **1** and in combination therewith

a housing for said vessel, said housing comprising:

means for securing said vessel in a vertical plane with said drain at the lower end of said housing and said port exposed at the upper end of said housing,

an annular, overflow reservoir circumscribing said port, and

drain means connecting said reservoir to the outside of said housing.

5. A vessel according to claim **4** in which

said primary chamber is transparent to radiant energy, and

said housing is constructed and arranged to house radiant energy transmitting and receiving means, such that a beam of radiant energy can be transmitted through said analysis chamber, normal to the axis of said tubular body, so as to define in combination a housed cuvette.