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(54) LIQUID SAMPLING APPARATUS AND METHOD OF USING SAME

(76) Inventors: **Peter E. Rising**, Brightwaters, NY (US); **Brian H. Rutledge**, Eldersburg, MD (US)

Correspondence Address:
NATHANIEL T. WALLACE
24 EVARTS LANE
MADISON, CT 06443 (US)

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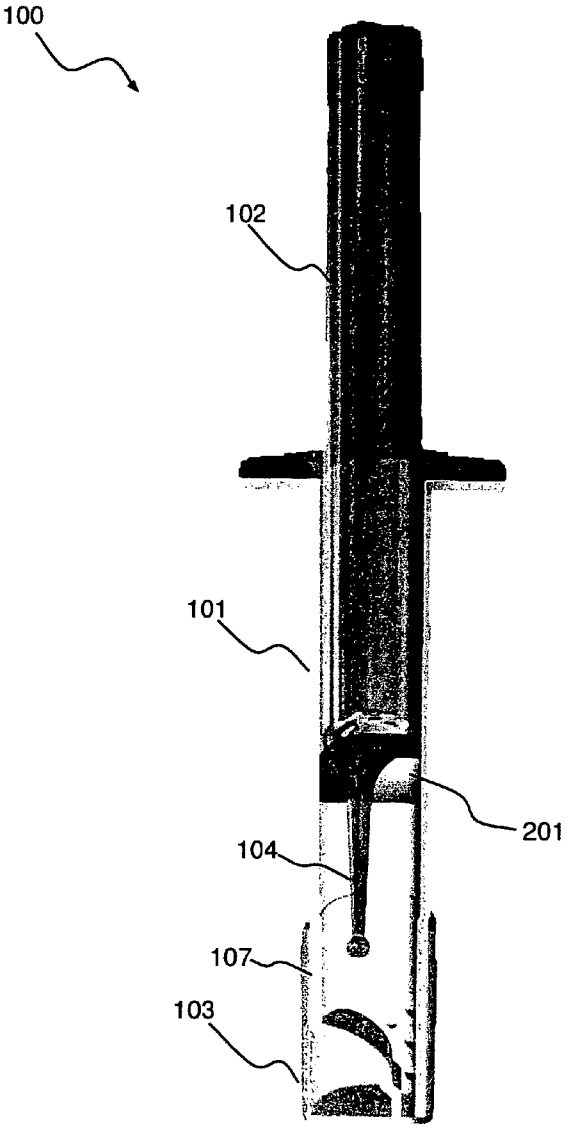
(57) ABSTRACT

A sampling apparatus includes an ampoule barrel for receiving an ampoule through a first opening, the ampoule barrel comprising a second opening adapted to flow a liquid into the ampoule barrel and a structure adapted break a frangible tip of the ampoule.



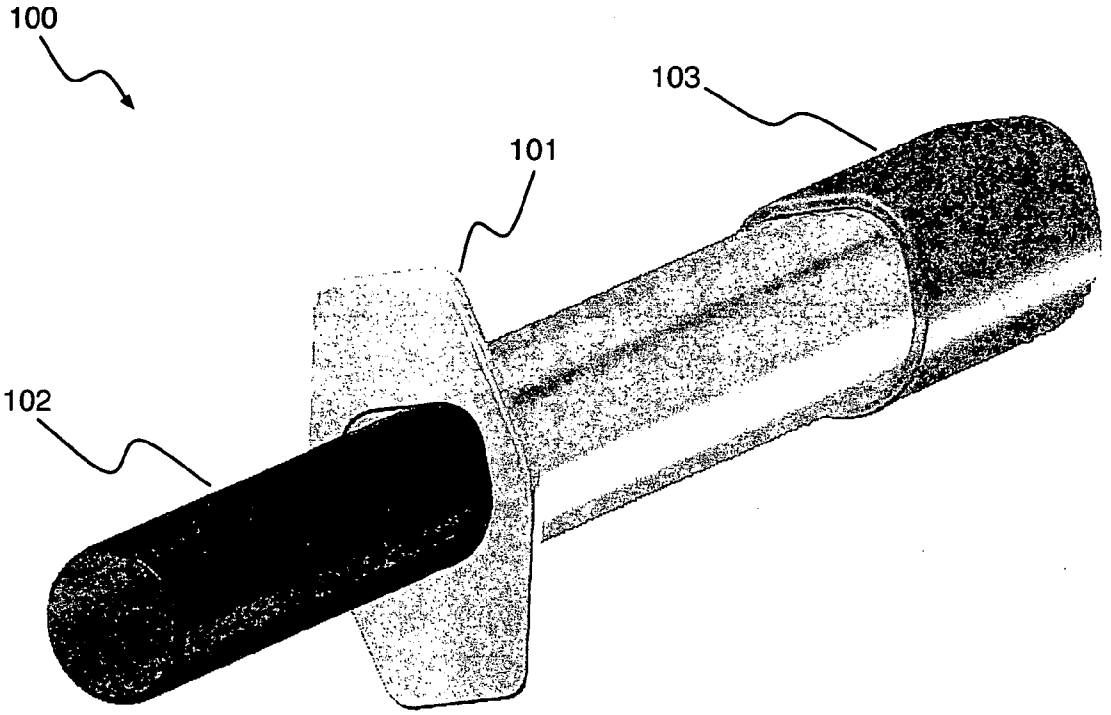


FIGURE 1A

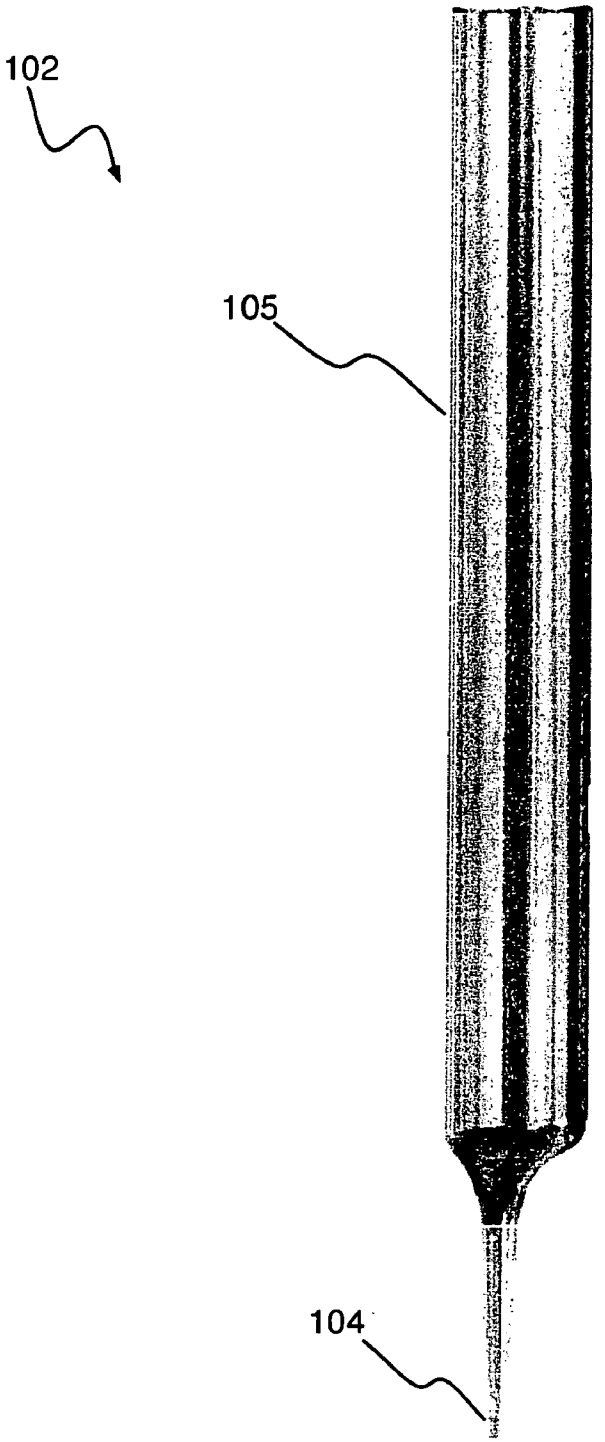


FIGURE 1B

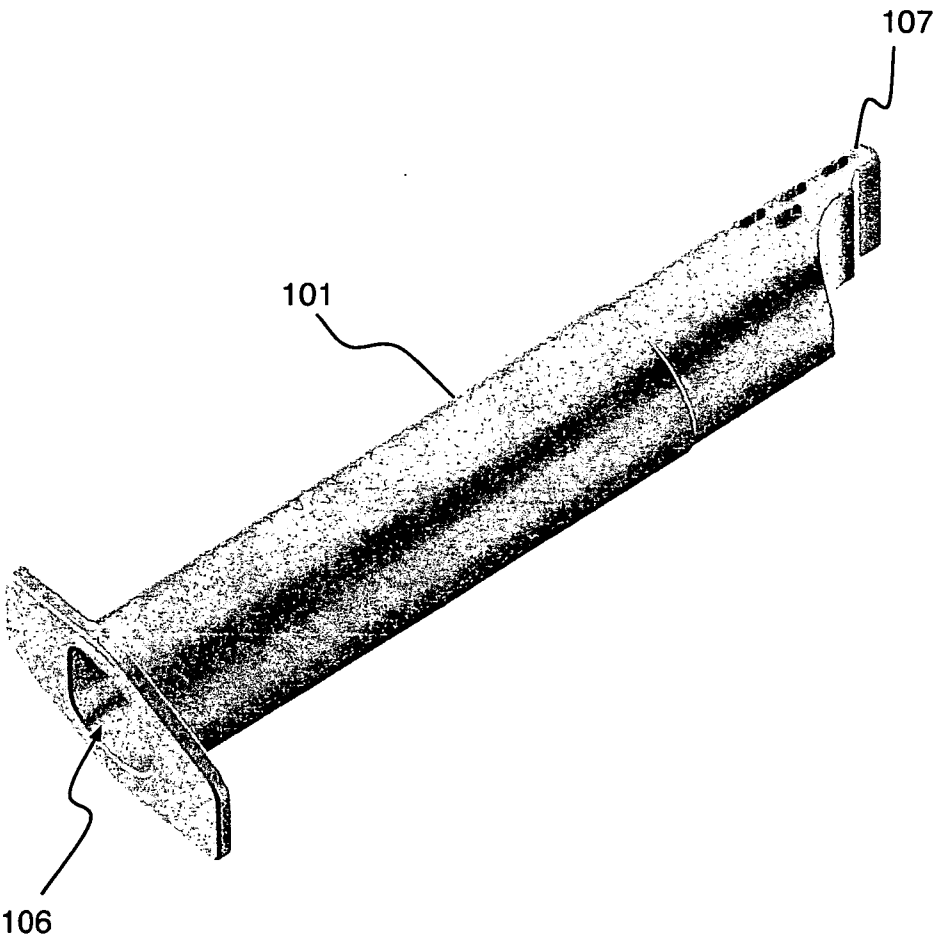


FIGURE 1C

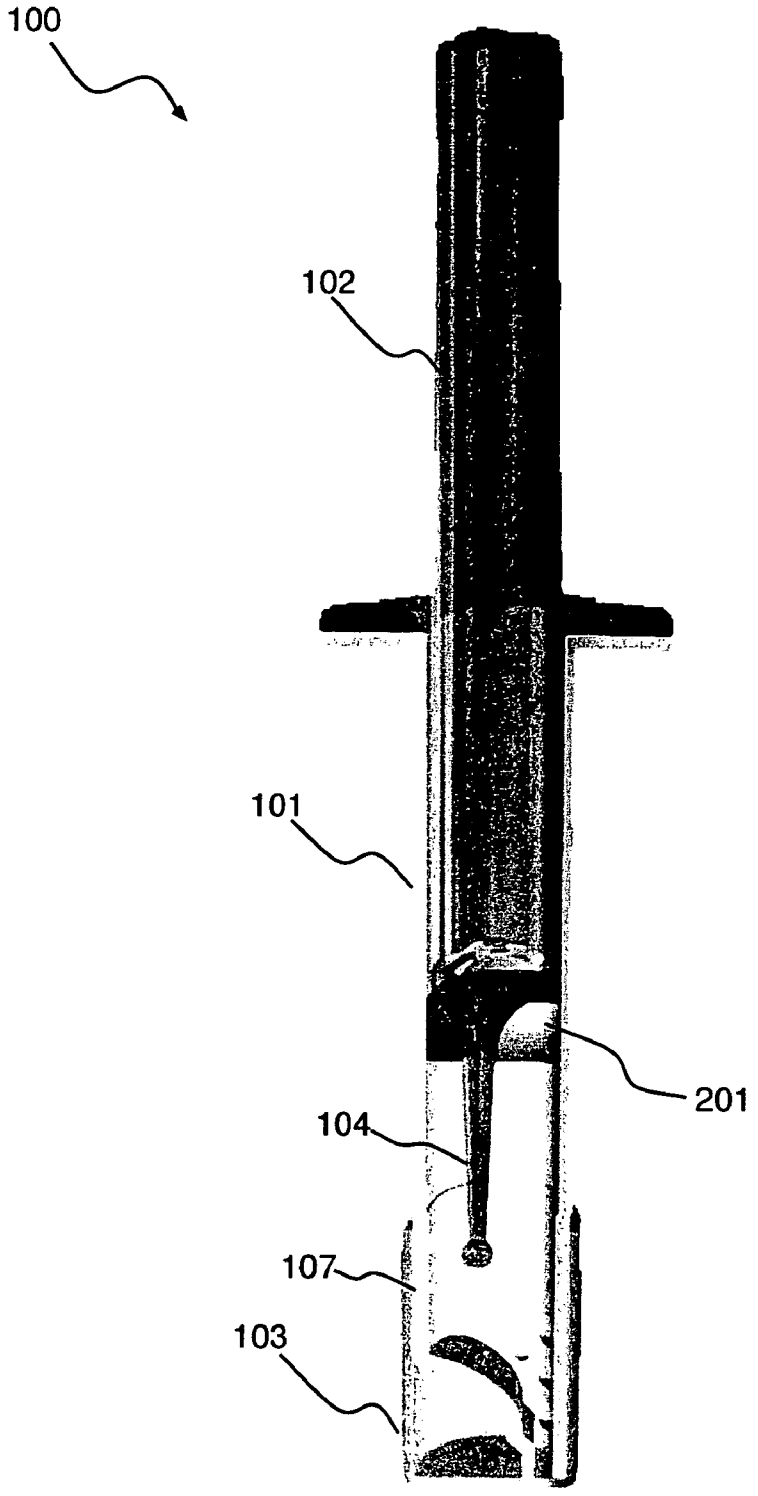


FIGURE 2

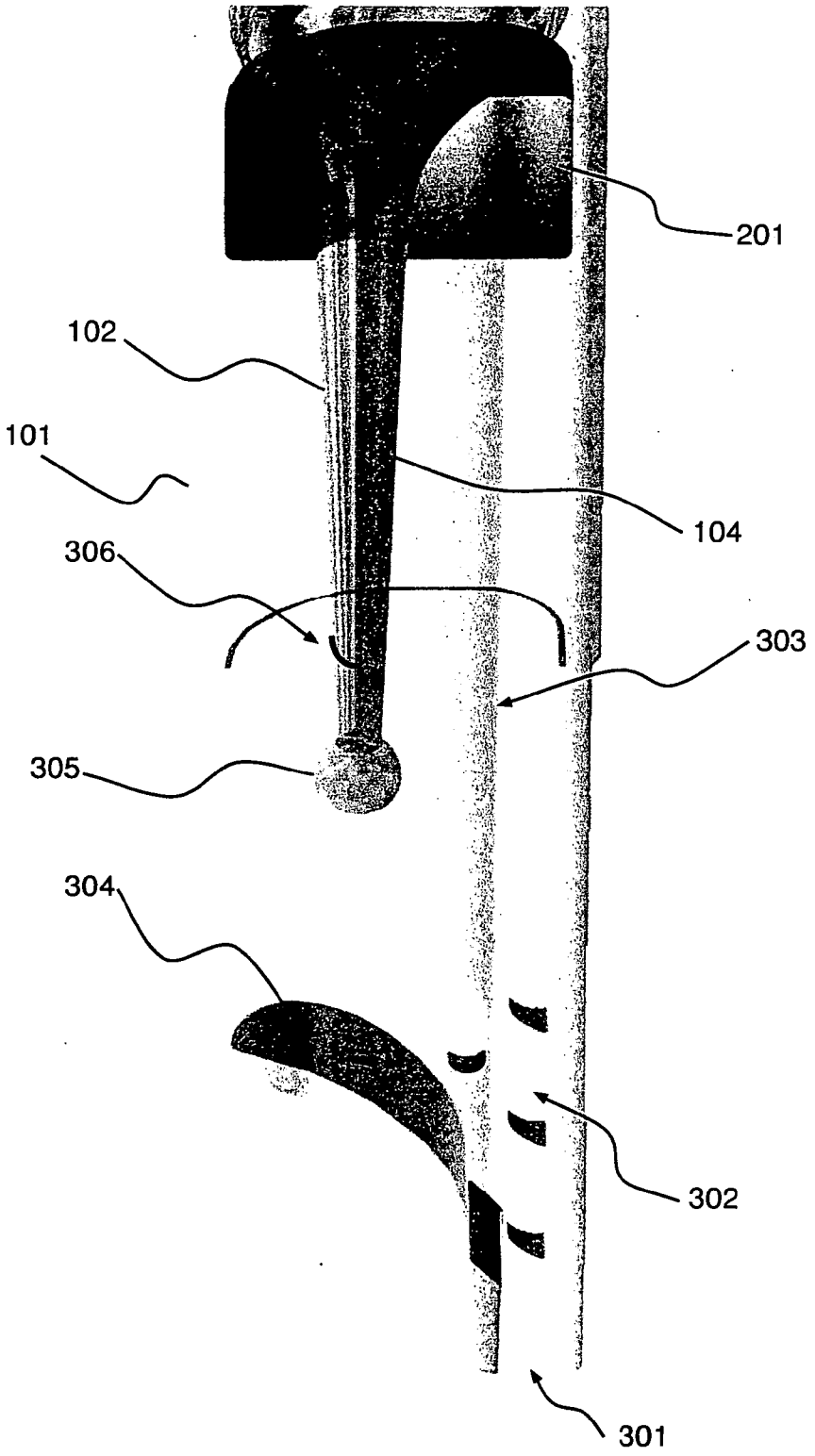


FIGURE 3

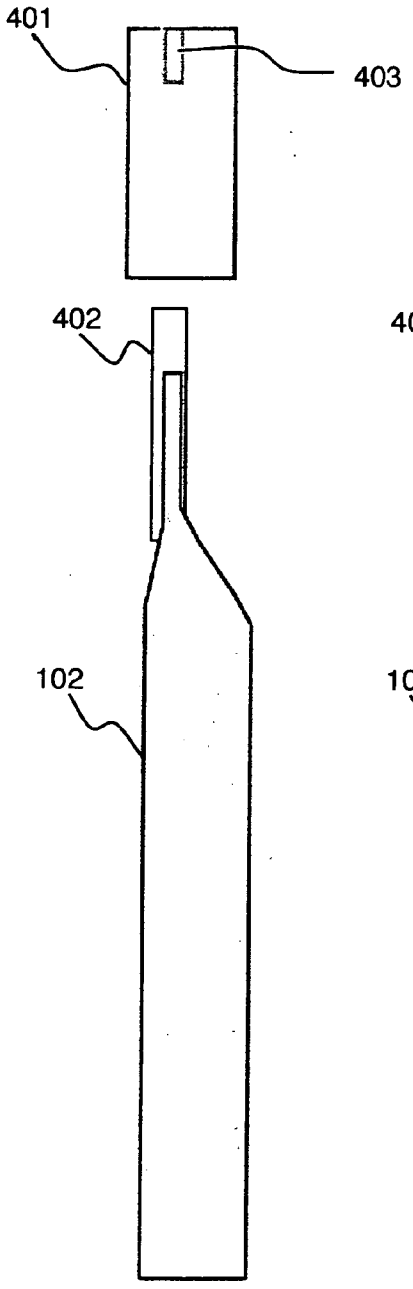


FIGURE 4A

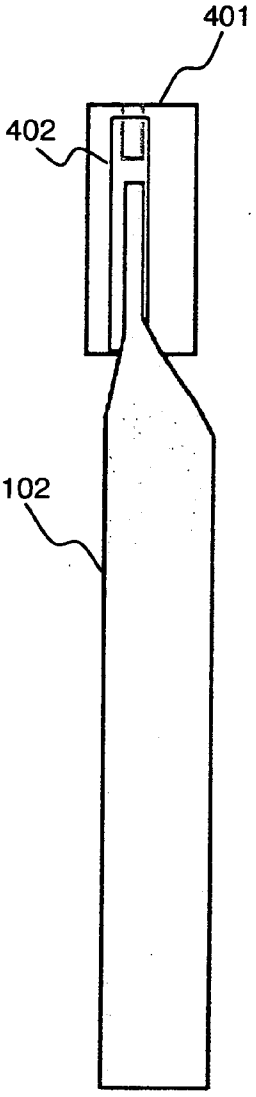


FIGURE 4B

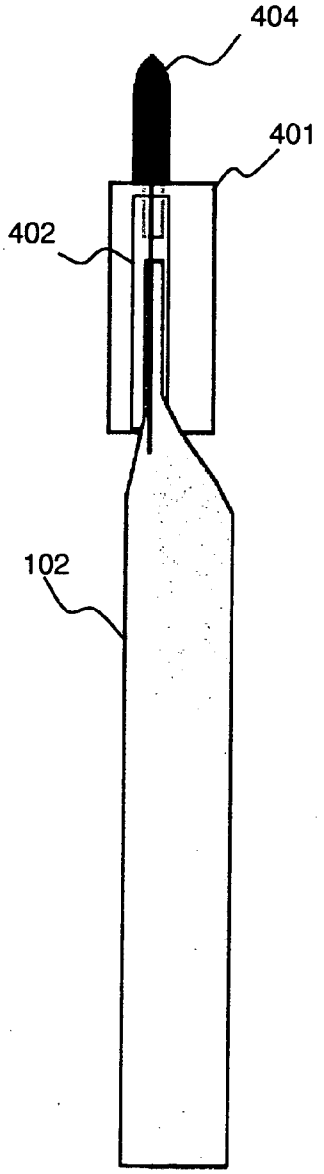


FIGURE 4C

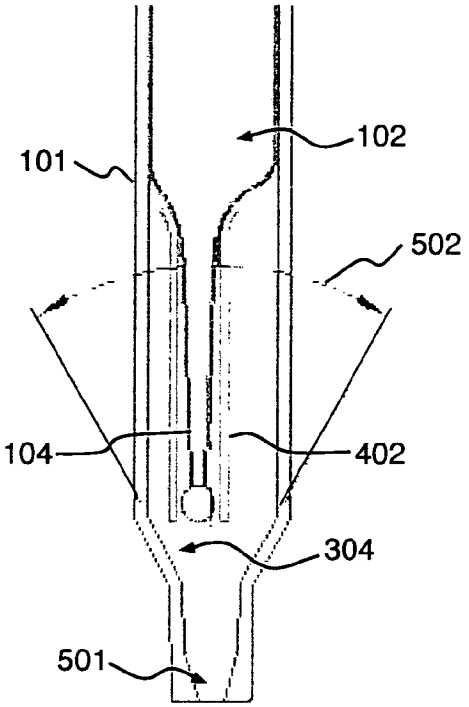


FIGURE 5A

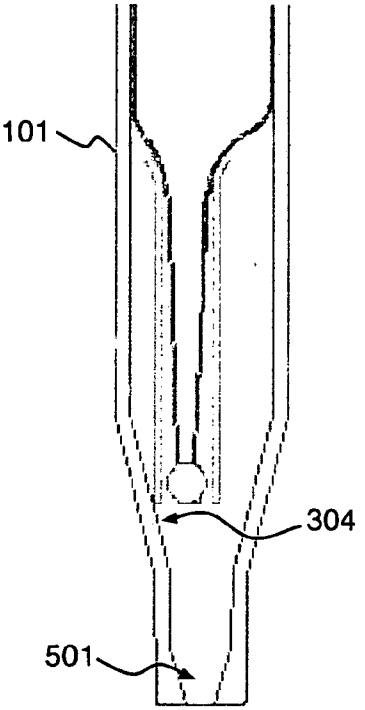


FIGURE 5B

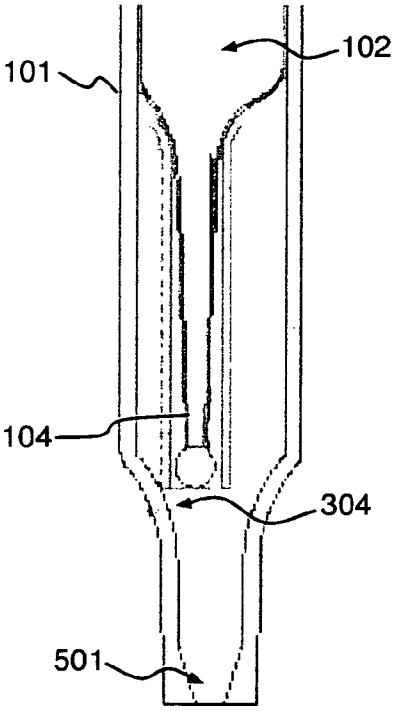


FIGURE 5C

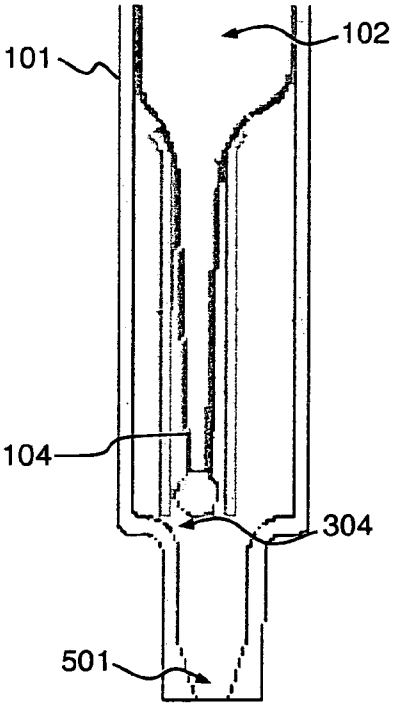


FIGURE 5D

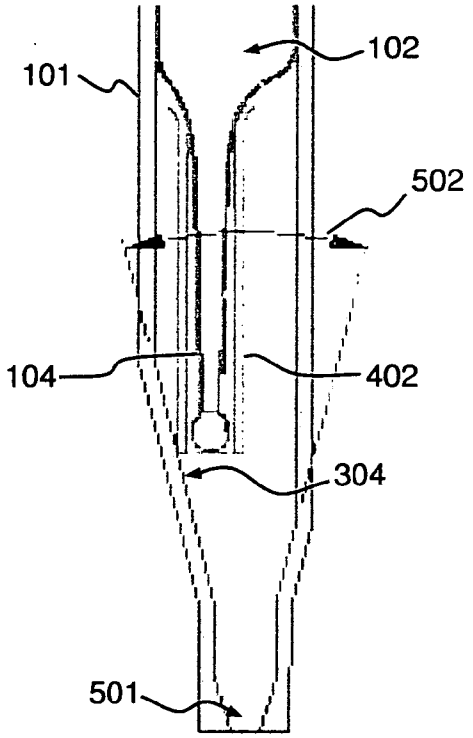
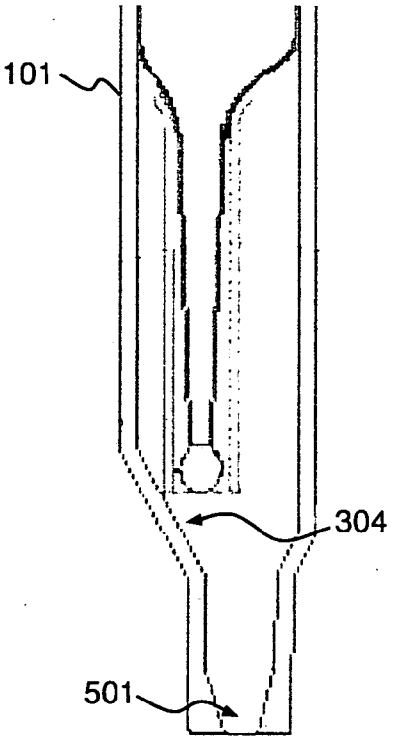


FIGURE 6A



FIGRE 6B

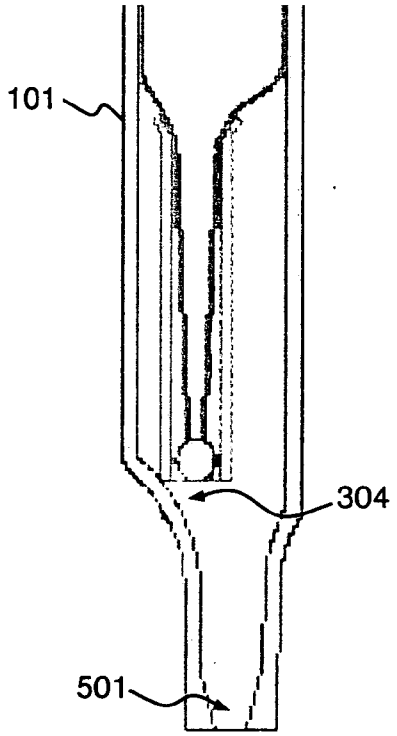


FIGURE 6C

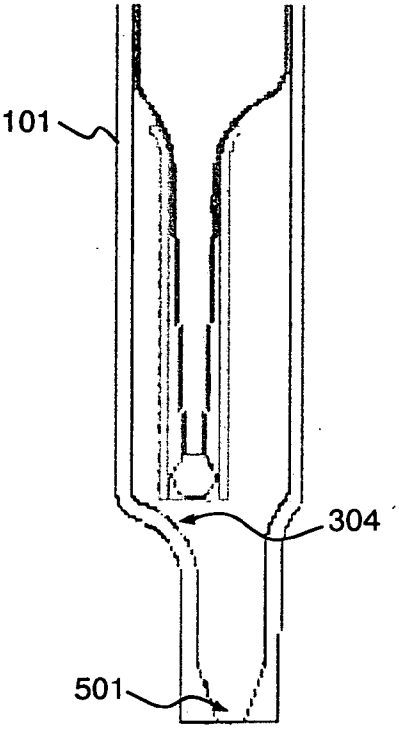


FIGURE 6D

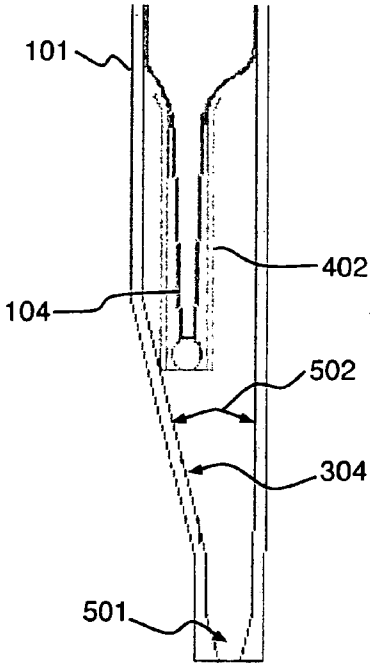


FIGURE 7A

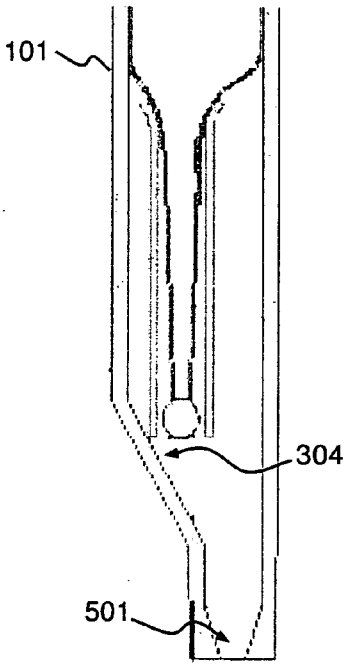


FIGURE 7B

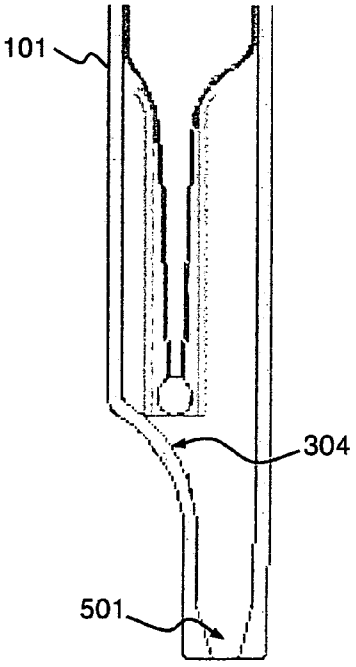


FIGURE 7C

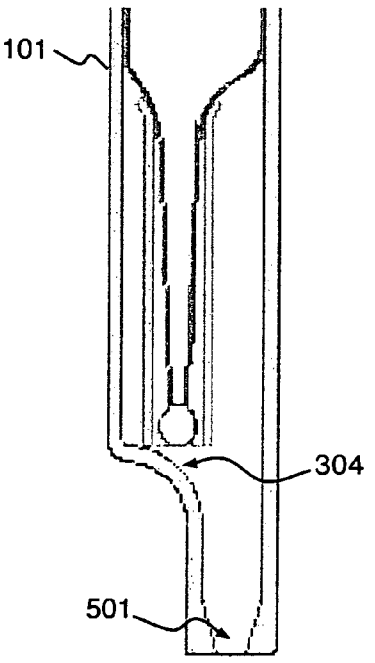


FIGURE 7D

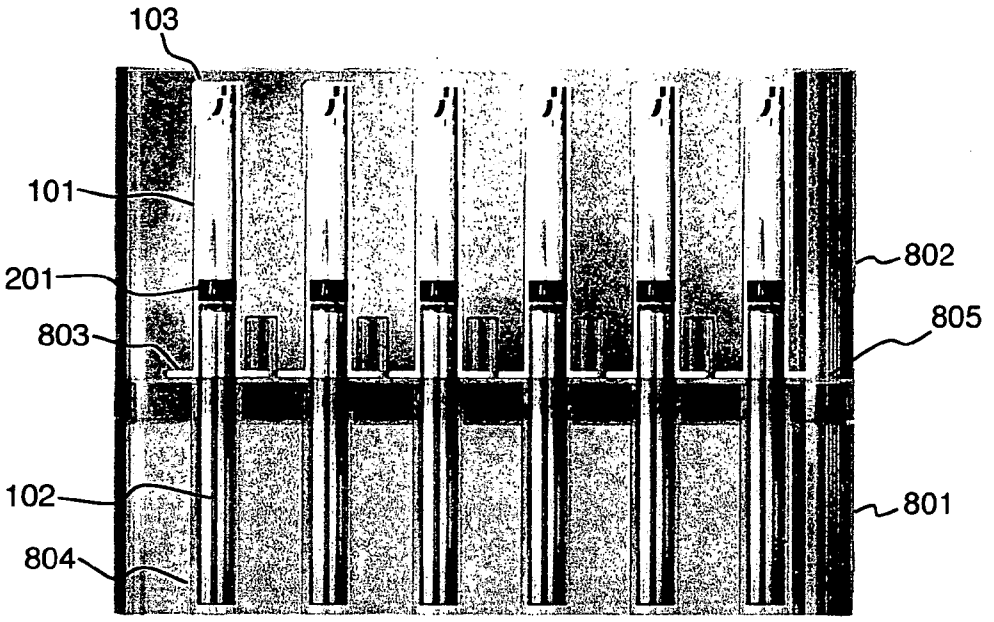


FIGURE 8A

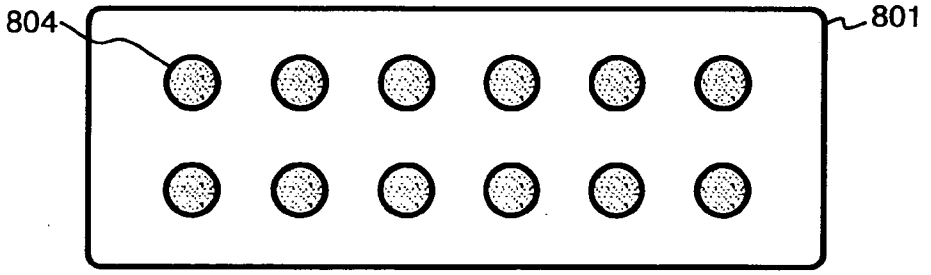


FIGURE 8B

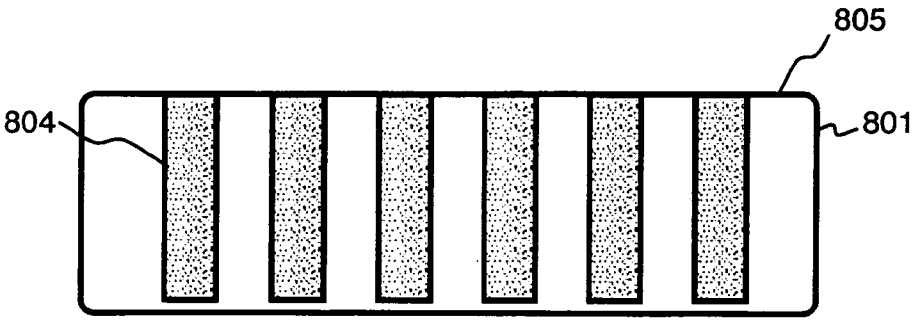


FIGURE 8C

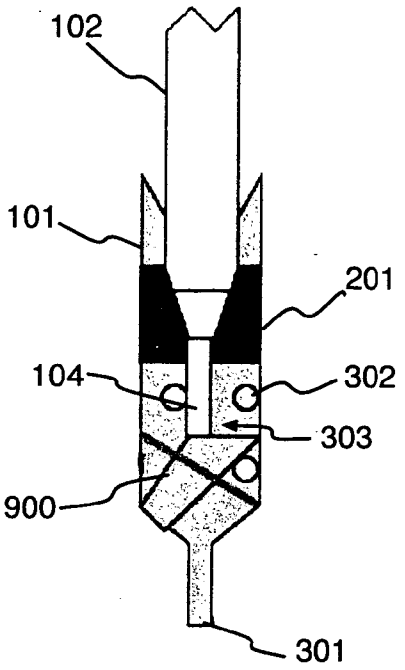


FIGURE 9A

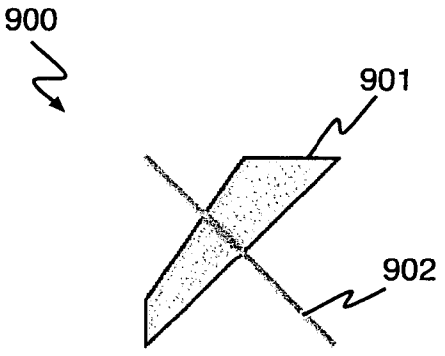


FIGURE 9B

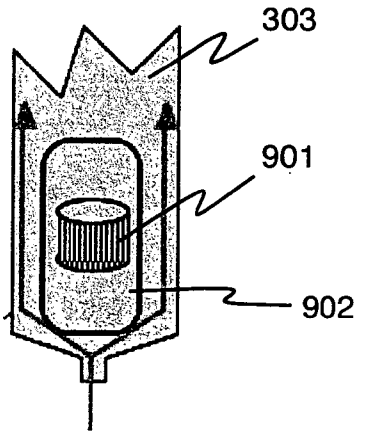


FIGURE 9C

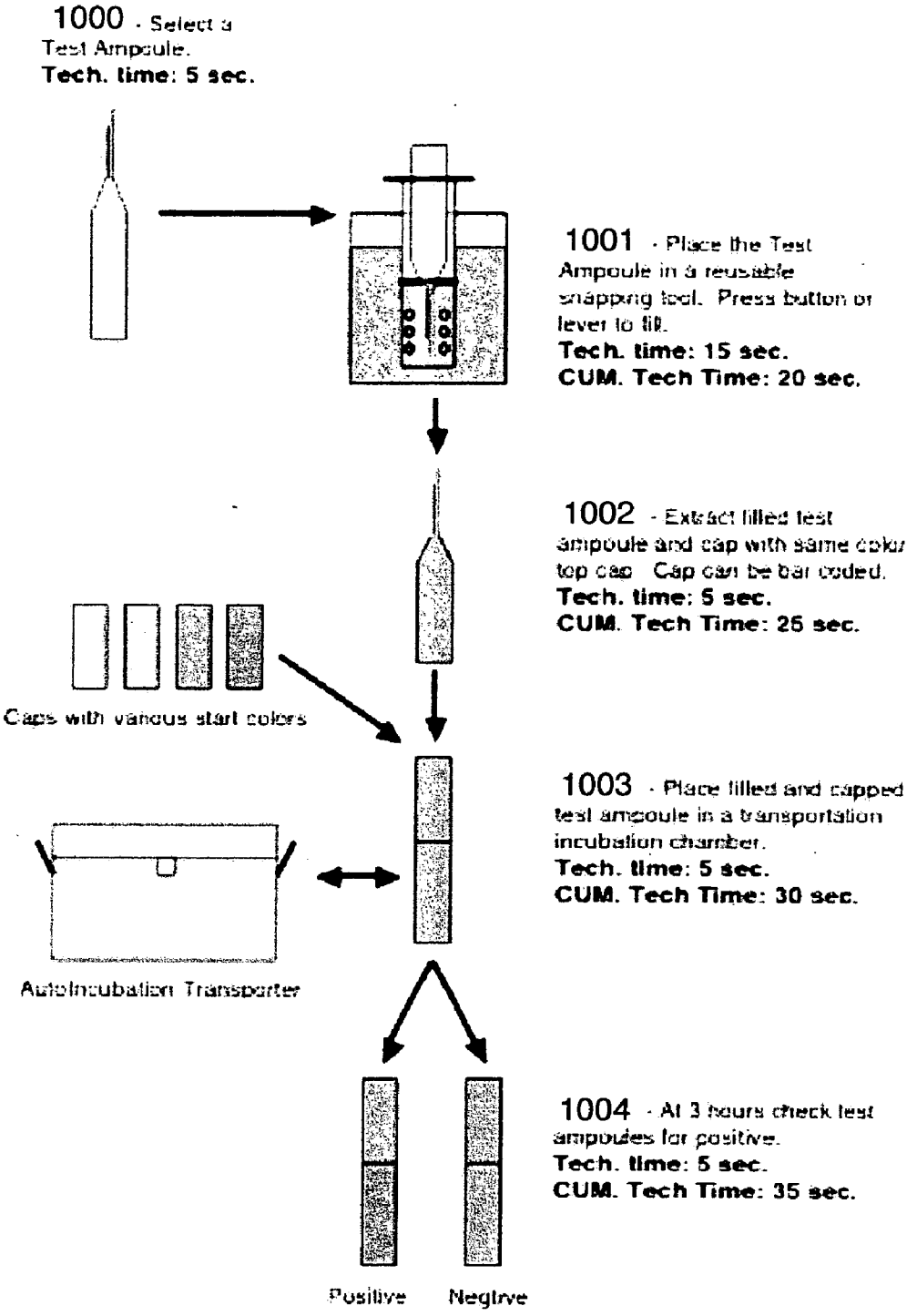

1000 - Select a Test Ampoule.
Tech. time: 5 sec.
1001 - Place the Test Ampoule in a reusable snapping tool. Press button or lever to fill.
Tech. time: 15 sec.
CUM. Tech Time: 20 sec.
1002 - Extract filled test ampoule and cap with same color top cap. Cap can be bar coded.
Tech. time: 5 sec.
CUM. Tech Time: 25 sec.
Caps with various start colors
1003 - Place filled and capped test ampoule in a transportation incubation chamber.
Tech. time: 5 sec.
CUM. Tech Time: 30 sec.
AutoIncubation Transporter
1004 - At 3 hours check test ampoules for positive.
Tech. time: 5 sec.
CUM. Tech Time: 35 sec.
Positive
Negtive

Figure 10

LIQUID SAMPLING APPARATUS AND METHOD OF USING SAME

[0001] This application claims priority to U.S. Provisional Application Ser. No. 60/550,743, filed on Mar. 5, 2004, which is herein incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to sampling liquids, and more particularly, to an apparatus for sampling a liquid and automatically performing a test.

[0004] 2. Discussion of Related Art

[0005] Sampling methods for liquids typically involve drawing a sample into a pipet, syringe, or other container from a cup. Such a sampling method exposes the sample taker to the liquid. Limiting a sample taker's exposure to a sample may be desirable, such as in urine analysis. Further, sampling methods may include exposing the sample to contaminants leading to, for example, sampling errors.

[0006] Therefore, a need exists at least for a system and/or method for reducing exposure to a sample, reducing sampling errors and limiting contamination of test samples.

SUMMARY OF THE INVENTION

[0007] According to an embodiment of the present disclosure, a sampling apparatus comprises an ampoule barrel for receiving an ampoule through a first opening, the ampoule barrel comprising a second opening adapted to flow a liquid into the ampoule barrel and a structure adapted break a frangible tip of the ampoule.

[0008] The ampoule is a sealed container having a negative pressure therein for drawing a predetermined volume of liquid into the ampoule, wherein a flow rate of the ampoule is less than or equal to a flow rate of the second opening.

[0009] The sampling apparatus includes a seal located between an outer surface of the ampoule and an inner surface of the ampoule barrel. The seal prevents the liquid from passing into an upper portion of the ampoule barrel.

[0010] The frangible tip is scored to promote a break in the frangible tip in a predetermined direction. The predetermined direction is substantially perpendicular to a descent of the ampoule into the ampoule barrel. The frangible tip includes a rounded terminus. The frangible tip is offset from a longitudinal center of the ampoule.

[0011] The sampling apparatus includes a cap for covering the second opening of the ampoule barrel.

[0012] The sampling apparatus includes a carrier, wherein the carrier comprises a trench receiving an end portion of the ampoule, opposite from the frangible tip, and an upper surface supporting the ampoule barrel, wherein a distance between a bottom of the trench and the upper surface is adapted to prevent the descent of the ampoule into the ampoule barrel.

[0013] According to an embodiment of the present disclosure, a method for taking a liquid sample comprises selecting a test system including an ampoule barrel and an ampoule comprising a desired reagent, immersing a portion of the ampoule barrel in a liquid, and breaking the ampoule within the ampoule barrel, wherein the ampoule draws the liquid sample.

[0014] The method includes extracting the ampoule from the ampoule barrel.

[0015] The method includes determining a test result according to the reagent and liquid sample.

[0016] According to an embodiment of the present disclosure, an ampoule barrel comprises a first opening for receiving an ampoule, a tip, offset from a longitudinal center of the ampoule barrel, the tip including an elongated second opening for flowing a liquid into the ampoule barrel, and an inner surface effective for breaking a tip of the ampoule.

[0017] The inner surface is disposed at an angle is between about 15 degrees and about 30 degrees from the longitudinal center of the ampoule barrel. The inner surface is a convex radius relative to an interior of the ampoule barrel.

[0018] The ampoule barrel includes at least a third opening on a sidewall of the ampoule barrel for flowing the liquid into the ampoule barrel.

[0019] The ampoule barrel includes a flange at an end portion, opposite the tip.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Preferred embodiments of the present invention will be described below in more detail, with reference to the accompanying drawings:

[0021] FIGS. **1**A-C are an illustration of a test system according to an embodiment of the present disclosure;

[0022] **FIG. 2** is a cross-section view of the test system of **FIG. 1**;

[0023] **FIG. 3** is a cross-section view of a tip area of the test system of **FIG. 1**;

[0024] FIGS. **4**A-C are illustrations of a sampling cap, sheath and ampoule according to an embodiment of the present disclosure;

[0025] FIGS. **5**A-D are illustrations of an ampoule barrel having no offset according to an embodiment of the present disclosure;

[0026] FIGS. **6**A-D are illustrations of an ampoule barrel having an offset according to an embodiment of the present disclosure;

[0027] FIGS. **7**A-D are illustrations of an ampoule barrel having an offset according to an embodiment of the present disclosure;

[0028] FIGS. **8**A-C are illustrations of a carrier for a test system according to an embodiment of the present disclosure;

[0029] FIGS. **9**A-C are illustrations of a breaking mechanism according to an embodiment of the present disclosure; and

[0030] **FIG. 10** is a flow chart of a method according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0031] A test system according to an embodiment of the present disclosure is a self-contained total microbe test. Referring to **FIG. 1A**, a test system **100** includes an ampoule barrel **101**, an ampoule **102** and a cap **103**. The ampoule **102** may be removed from the ampoule barrel **101**.

[0032] Referring to **FIG. 1B**, the ampoule **102** includes a frangible tip **104**. The frangible tip **104** may be offset from a center of a main body **105** of the ampoule **102**. The ampoule **102** is a sealed container, which is opened open breaking the frangible tip **104**. The interior of the ampoule **102** is a vacuum-sealed environment. Upon breaking the tip **104**, the ampoule **102** is adapted to draw a predetermined volume of liquid according to an internal pressure of the ampoule **102**.

[0033] Referring to **FIG. 1C**, the ampoule barrel **101** includes an opening **106** for receiving an ampoule. The ampoule barrel **101** includes a tip **107** for allowing a liquid into the ampoule barrel **101**. The barrel tip **107** includes one or more ports for drawing the liquid into the ampoule barrel **101** under the vacuum of an ampoule. The tip **107** of the ampoule barrel may be off center relative to a longitudinal center of the ampoule barrel **101**. An off center tip **107** may be inserted into a sampling cup, wherein the sampling cup may be held on edge to pool a sample, increasing a depth of the sample. The off center tip **107** may be immersed in the pooled sample.

[0034] **FIG. 2** is a cross-section view of a test system **100**. An ampoule barrel **101** receives an ampoule **102**. A seal **201**, formed of for example, a rubber substance secures the ampoule **102**. A tip **104** of the ampoule **102** projects through the seal **201** and into a sample chamber. Upon placing the barrel tip **107** in a liquid, the seal **201** prevents the liquid from passing into an upper portion of the ampoule barrel **101**. The cap **103** is removable. The cap **103** prevents contaminants from entering the ampoule barrel **101** or contacting the barrel tip **107** prior to a test.

[0035] Referring to **FIG. 3**, the ampoule barrel **101** includes ports, e.g., **301** and **302**, for allowing a liquid to pass into a lower portion or sample chamber **303** of the ampoule barrel **101**. The ports may be located on an end, e.g., **301**, of the ampoule barrel **101** and/or on a side of the ampoule barrel, e.g., **302**. The seal **201** prevents the liquid form passing into an upper portion of the ampoule barrel **101**. The ampoule **102** includes a frangible tip **104**. The tip **104** includes a terminus **305**. The terminus **305** has a rounded structure. Above the terminus **305**, a score **306** is provided on a portion of the tip **104**. The score **306** is located to control the height at which the tip **104** breaks. The score **306** may be located on a portion, e.g., about 90 degrees or about 180 degrees, of the circumference of the tip **104**. For example, as shown in **FIG. 3**, the score **306** is located on a portion of the tip **104** away from the direction of the intended breakage. The ampoule **102** may be depressed into the ampoule barrel **101**, wherein the terminus **305** meets an angled face **304** of the ampoule barrel **101**. A pressure applied to the ampoule **102** causes the ampoule to descend into the ampoule barrel **101** with the seal **201**. The angled face **304** converts the pressure into a lateral pressure on the terminus **305** of the tip **104**. The tip **104** breaks at about the height of the score **306** under the lateral pressure. The terminus **305** breaks away from the tip **104** allowing the liquid in the lower portion **303** of the ampoule barrel **101** into the ampoule **102**. A flow rate at which the ampoule **102** draws liquid may be slower than a flow rate of the ports of the ampoule barrel **101**. The tip **104** may be sheathed, such that upon breaking the terminus **305**, a lower portion of the tip drop away into the ampoule barrel **101** and a remaining portion of the tip **104** is guarded within the sheath.

[0036] Referring to FIGS. **4A-C**, upon drawing a sample into the ampoule **102** a sampling cap **401** may be placed over a broken tip of the ampoule **102**. A sheath **402** guards any sharps. The sampling cap **401** includes a nipple **403**. The nipple **403** fits within the sheath **402**. The cap **401** reduces a potential for contact with the liquid in the ampoule **102**. The nipple **403** cooperates with the sheath **402**, securing the sampling cap **401** to the ampoule **102**. The nipple **403** may be a tube through which a syringe **404** or other device may gain access to the contents of the ampoule **102**.

[0037] Referring to **FIGS. 5-7**, various ampoule barrels are depicted. It should be noted that modifications and variations of the ampoule barrels are contemplated herein.

[0038] Referring to FIGS. **5A-D**, ampoule barrels **101** having a bottom port **501** with no offset relative to a centerline of the ampoule barrel **101** are shown. Referring to **FIG. 5A**, a lead in angle **502** of the face **304** is about 60 degrees. The ampoule **102** includes an offset tip **104**. The tip **104** is guarded by a sheath **402**. The offset tip **104** is aligned to meet the face **304** as the ampoule **102** descends into the ampoule barrel **101**. **FIG. 5B** illustrates an ampoule barrel **101** having a face **304** with a lead in angle of about 30 degrees. **FIGS. 5C and 5D** illustrate ampoule barrels **101** having a face **304**. The face **304** has a radius. For example, the radius of the face **304** in **FIG. 5C** is about 0.500 inches and the radius of the face **304** in **FIG. 5D** is about 0.110 inches. The radius of the face **304** converts the descent of the ampoule **102** into a lateral force that breaks the tip **104**.

[0039] Referring to FIGS. **6A-D**, a bottom port **501** of the ampoule barrel **101** is offset, for example, by 0.065 inches from a centerline of the ampoule barrel **101**. Referring to **FIG. 6A**, a lead in angle **502** of the face **304** is about 30 degrees. A height of the face is not uniform around the ampoule barrel **101**. The rotation of the ampoule **102** within the ampoule barrel **101** ensures that the tip **104** contacts the face **304** upon descending into the ampoule barrel **101**. The rotation may be adjusted manually. A mechanism, such as a cooperating shape of the ampoule barrel **101** and ampoule **102**, may secure an alignment. A sheath **402** may be implemented as a guard over the tip **104**. Referring to **FIG. 6B**, a lead in angle of the face **304** is about 60 degrees. Referring to **FIGS. 6C and 6D** a face **304** has a radius of about 0.500 inches and 0.250 inches, respectively.

[0040] Referring to FIGS. **7A-D**, a bottom port **501** of the ampoule barrel **101** is offset, for example, by 0.130 inches from a centerline of the ampoule barrel **101**. Referring to **FIG. 7A**, a lead in angle **502** of the face **304** is about 30 degrees. The angle of the face varies around the circumference of the ampoule barrel **101** between about 90 degrees and about 75 degrees. A height of the face is not uniform around the ampoule barrel **101**. The rotation of the ampoule **102** within the ampoule barrel **101** ensures that the tip **104** contacts the face **304** upon descending into the ampoule barrel **101**. Referring to **FIG. 7B**, a lead in angle of the face

304 is about 60 degrees. Referring to **FIGS. 7C and 7D** a face **304** has a radius of about 0.500 inches and 0.250 inches, respectively. A sheath **402** may be implemented as a guard over the tip **104**.

[**0041**] Referring to FIGS. **8**A-C, a test system **100** may be loaded into a carrier **801**. The carrier **801** may be capped by a top **802**. The carrier comprises one or more trenches **804** for receiving a portion of an ampoule **102**. The trench **804** has a depth adapted to support an unused system **100** such that the ampoule **102** is not pressed into the ampoule barrel **101**; a distance between a bottom of the trench and the upper surface **805** prevents the descent of the ampoule into the ampoule barrel. A flange **803** of the ampoule barrel **101** rests on an upper surface of the carrier **801**.

[**0042**] An ampoule **102** according to an embodiment of the present disclosure is a sterile vacuum packaging ampoule containing a dry, non-hazardous, test reagent system. The ampoule **102** prevents user contamination or hazard, has about a 4-year product shelf life, does not trigger transportation restrictions and does not need climate-controlled storage.

[**0043**] A test of a liquid may be performed using a test system **100** according to an embodiment of the present disclosure. A sample module or ampoule barrel **101** secures a test ampoule **102** for extracting a liquid sample. The ampoule barrel **101** limits a sample taker's exposure to the liquid. When used with a pre-dosed test ampoule **102**, the ampoule barrel **101** and test ampoule **102** automatically start a test of the sampled liquid under the pressure of the vacuum.

[**0044**] Referring to **FIG. 9A**, the sample chamber **303** houses an ampoule tip breaker assembly **900**. The ports or inlets, e.g., **301** and **302**, may be formed on the walls of the ampoule barrel **101** and at a tip of the ampoule barrel **101**. Any number of inlets may be used. The inlets allow the sample to freely enter the sample chamber at a rate at least as great as the sample enters the ampoule **102**. Thus, the sample may enter the ampoule **102** in a predetermined dose, substantially unaffected by suction or fluid resistance. The ampoule tip breaker assembly **900** is stabilized in the sample chamber **303** to receive a tip **104** of the ampoule **102**.

[**0045**] Referring to **FIGS. 9B and 9C**, the ampoule tip breaker assembly **900** is formed such that the sample may flow around the assembly and enter the ampoule **102**. The ampoule tip breaker assembly **900** includes a surface disposed at an angle for breaking the frangible portion of the test ampoule. The surface may be a hollow tube **901** for receiving a tip **104** of an ampoule **102** and for breaking the tip **104**. The hollow tube **901** is disposed at an angle to apply a substantially lateral force against the tip to facilitate the breaking of the tip. **104** For example, the hollow tube may be disposed at about 45 degrees from the walls of the sample chamber. The assembly **900** includes a stabilizer support **902** disposed at an angle for supporting the hollow tube **901**, e.g., at about 90 degrees from the angle of the hollow tube **901**. The stabilizer support **302** and the hollow tube **901** may be formed as one piece. The hollow tube **901** may collect a broken portion of the tip of the ampoule **102** upon breaking away from the ampoule **102**.

[**0046**] The stabilized ampoule tip breaker **900** breaks the tip of the ampoule **102** upon the application of pressure to the ampoule **102**, forcing the test ampoule tip **104** to engage a surface disposed at an angle. The tip **104** of the ampoule **102** is submerged in liquid as to avoid suction entrained air and creating an unacceptable ampoule fill.

[**0047**] The test ampoule may be a hard-surfaced, self-filling container. The test ampoule includes mixed test indicators/media in predetermined quantities for performing a complete microbiological test. The test ampoules may be sealed, having a vacuum of about 20-30 inches of mercury or more. The test ampoule and contents may be insensitivity to storage conditions and may have a shelf life of about 4 years or more. The test ampoule includes a frangible area that can be broken, allowing a predetermined amount of sample to enter the test ampoule and be exposed to the test indicators/media.

[**0048**] The test ampoule may be an ampoule as described in U.S. Pat. Nos. 5,159,799 entitled VIAL WITH POWDERED REAGENT, 5,550,032 entitled BIOLOGICAL ASSAY FOR MICROBIAL CONTAMINATION, and 5,935,799 entitled BIOLOGICAL ASSAY FOR MICROBIAL CONTAMINATION, each patent being incorporated herein by reference in the entirety.

[**0049**] A test ampoule may be a pre-dosed, hermetically sealed, vacuum ampoule. The vacuum packaging of test ampoule preserves the reagent/media for years and needs no special storage conditions such as refrigeration. When the test is started, a aqueous sample of a predetermined volume, e.g., 7.5 ml, is automatically drawn into the test ampoule. The volume of sample drawn can be any predetermined amount, depending on, for example, the size of the test ampoule and the strength of the vacuum. The test may be concluded when the test ampoule turns a predetermined color, e.g., orange or red. The elapsed time from test start to test end determines the level of microbial contamination. Test results may come as fast as one (1) hour for concentrations of 201 or twelve (12) hours for 10^1 microbial concentrations. The test ampoule may be used as presence/absence test at 24 hours. A Triphenyltetrazoliumchloride (TTC) indicator may react to aerobic microbial activity in the sample to include facultative species. Fungi may also be detected. The presence of fungi may be indicated by floating red particles after 24 hours. Time/Concentration calibrations are based upon mixed microbial populations typically found in industrial and natural waters. Waters dominated by a particular species may use a one-time calibration adjustment. Each test ampoule comes complete with a sample/ampoule, snapping cup, dechlorinating solution, sample identification labels, waste-water instructions and a results/instruction chart. Test incubation temperature can be controlled, and may be set to, for example, 95° F. or room temperature. Test incubation can be performed manually by purchasing a reusable carry incubation tube or using a standard laboratory heat block or oven. Automatic incubation and end of test detection can accomplished using an incubator/auto-analyzer. Factory-prepared test calibrations/formulations and/or private labeling may also to used.

[**0050**] An insulated chamber, such as an autoincubation chamber, suitable to hold a plurality of test ampoules at a controlled temperature and for specific time initiates and maintains an incubation temperature for a period of time and may return to refrigeration. This chamber may be transportable for all operational phases of the test (refrigeration to

incubation back to refrigeration). The test ampoule, sample module, and insulated chamber may be pre-assembled into a clean or sterilized product that is operated by the sample technician or test initiator.

[0051] Referring to **FIG. 10**, an ampoule for a desired test is selected **1000**. The ampoule is placed in an ampoule barrel. The ampoule barrel is at least partially immersed in a liquid sample, and the tip of the ampoule is broken to begin a test **1001**. The ampoule containing a sample is extracted from the sample module **1002**. A cap may be placed over the broken tip of the test ampoule. The cap may include, for example, a bar code for tracking and/or a color chart for determining results. The test ampoule may be placed in an autoincubation testing chamber **1003**. The autoincubation testing chamber may be designed for shipping to a laboratory or other location, wherein the autoincubation testing chamber may be coupled to a power source. A control device of the autoincubation testing chamber controls a temperature profile (e.g., heating or cooling of samples under test). The control device may include a processor for outputting control signals to a heater or chiller, and memory device for storing, for example, temperature and time settings. The results may be checked at a predetermined end time **1004**. The timing shown in **FIG. 10** are provide as examples, actual times may differ depending on the test and procedures.

[0052] Having described embodiments for apparatus and method for sampling a liquid, it is noted that modifications and variations can be made by persons skilled in the art in light of the above teachings. It is therefore to be understood that changes may be made in the particular embodiments of the invention disclosed which are within the scope and spirit of the invention as defined by the appended claims. Having thus described the invention with the details and particularity required by the patent laws, what is claimed and desired protected by Letters Patent is set forth in the appended claims.

What is claimed is:

1. A sampling apparatus comprising an ampoule barrel for receiving an ampoule through a first opening, the ampoule barrel comprising a second opening adapted to flow a liquid into the ampoule barrel and a structure adapted break a frangible tip of the ampoule.

2. The sampling apparatus of claims **1**, wherein the ampoule is a sealed container having a negative pressure therein for drawing a predetermined volume of liquid into the ampoule, wherein a flow rate of the ampoule is less than or equal to a flow rate of the second opening.

3. The sampling apparatus of claim 1, further comprising a seal located between an outer surface of the ampoule and an inner surface of the ampoule barrel.

4. The sampling apparatus of claim 3, wherein the seal prevents the liquid from passing into an upper portion of the ampoule barrel.

5. The sampling apparatus of claim 1, wherein the frangible tip is scored to promote a break in the frangible tip in a predetermined direction.

6. The sampling apparatus of claim 5, the predetermined direction is substantially perpendicular to a descent of the ampoule into the ampoule barrel.

7. The sampling apparatus of claim 1, wherein the frangible tip includes a rounded terminus.

8. The sampling apparatus of claim 1, wherein the frangible tip is offset from a longitudinal center of the ampoule.

9. The sampling apparatus of claim 1, further comprising a cap for covering the second opening of the ampoule barrel.

10. The sampling apparatus of claim 1, further comprising a carrier, wherein the carrier comprises a trench receiving an end portion of the ampoule, opposite from the frangible tip, and an upper surface supporting the ampoule barrel, wherein a distance between a bottom of the trench and the upper surface is adapted to prevent the descent of the ampoule into the ampoule barrel.

11. A method for taking a liquid sample comprising:

selecting a test system including an ampoule barrel and an ampoule comprising a desired reagent;

immersing a portion of the ampoule barrel in a liquid; and

breaking the ampoule within the ampoule barrel, wherein the ampoule draws the liquid sample.

12. The method of claim 11, further comprising extracting the ampoule from the ampoule barrel.

13. The method of claim 11, further comprising determining a test result according to the reagent and liquid sample.

14. An ampoule barrel comprising:

a first opening for receiving an ampoule;

a tip, offset from a longitudinal center of the ampoule barrel, the tip including an elongated second opening for flowing a liquid into the ampoule barrel; and

an inner surface effective for breaking a tip of the ampoule.

15. The ampoule barrel of claim 14, wherein the inner surface is disposed at an angle is between about 15 degrees and about 30 degrees from the longitudinal center of the ampoule barrel.

16. The ampoule barrel of claim 14, wherein the inner surface is a convex radius relative to an interior of the ampoule barrel.

17. The ampoule barrel of claim 14, further comprising at least a third opening on a sidewall of the ampoule barrel for flowing the liquid into the ampoule barrel.

18. The ampoule barrel of claim 14, further comprising a flange at an end portion, opposite the tip.

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