

[54] **GAS SAMPLING DEVICE**

[76] Inventor: **John R. Boehringer**, 427 Parkview Dr., Wynnewood, Pa. 19096

[22] Filed: **Oct. 15, 1973**

[21] Appl. No.: **406,235**

[52] U.S. Cl. **73/421.5 R; 73/425.6; 141/83**

[51] Int. Cl. **G01n 1/24**

[58] Field of Search **73/421.5, 422, 425.6; 141/83, 18, 1, 4, 5, 7; 220/DIG. 7; 222/92, 106; 128/DIG. 5**

[56] **References Cited**

UNITED STATES PATENTS

1,128,669	2/1913	Ellison	73/421.5 R
3,618,393	11/1971	Principe	73/421

Primary Examiner—S. Clement Swisher

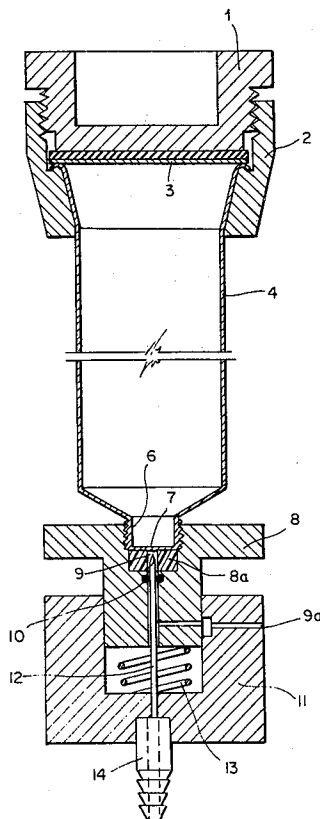
Attorney, Agent, or Firm—Paul & Paul

[57] **ABSTRACT**

Sealed crushable tube includes a puncturable segment

and a removable, snugly fitted internal piston and a reasonable closure for an opening through which the piston is removable from the tube. An uncontaminated gas sample is taken by removing the piston from the tube in the atmosphere, exercising the piston to secure a thoroughly mixed and typical sample to be sampled, and resealing the opening through which the piston is removed. The closed tube may then be transferred long distances by mail or parcel service to a gas analysis device where the gas is transferred to the device by a tubular member which penetrates the puncturable segment and delivers the sampled gas to the gas analysis apparatus with a minimum of contamination. Various closure means and auxiliary features are also disclosed. Generally, the device is constructed of a metal or some other material inert and non-absorbent with respect to the gas to be treated. An important feature of the system is a gas tight fixed seal, and the ability to urge the gas out of the container by crushing the container thus eliminating sliding seals which leak.

15 Claims, 10 Drawing Figures



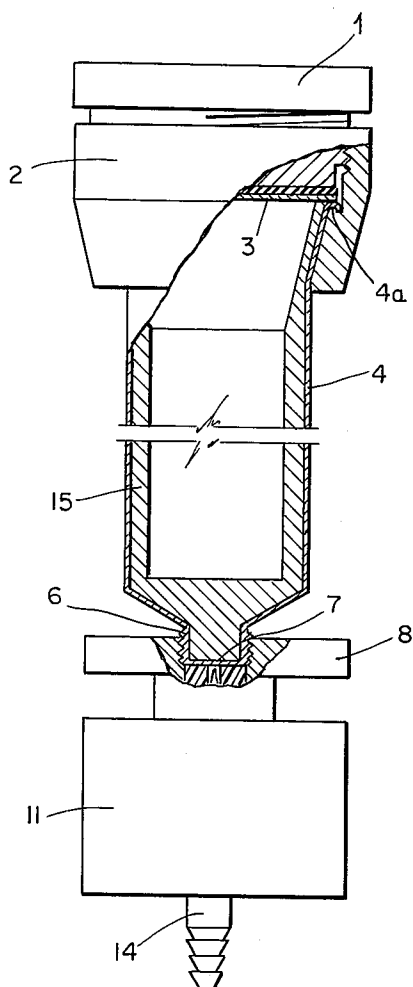


Fig. 1

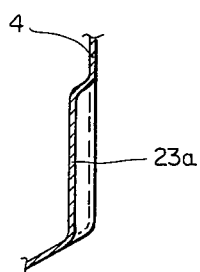


Fig. 3

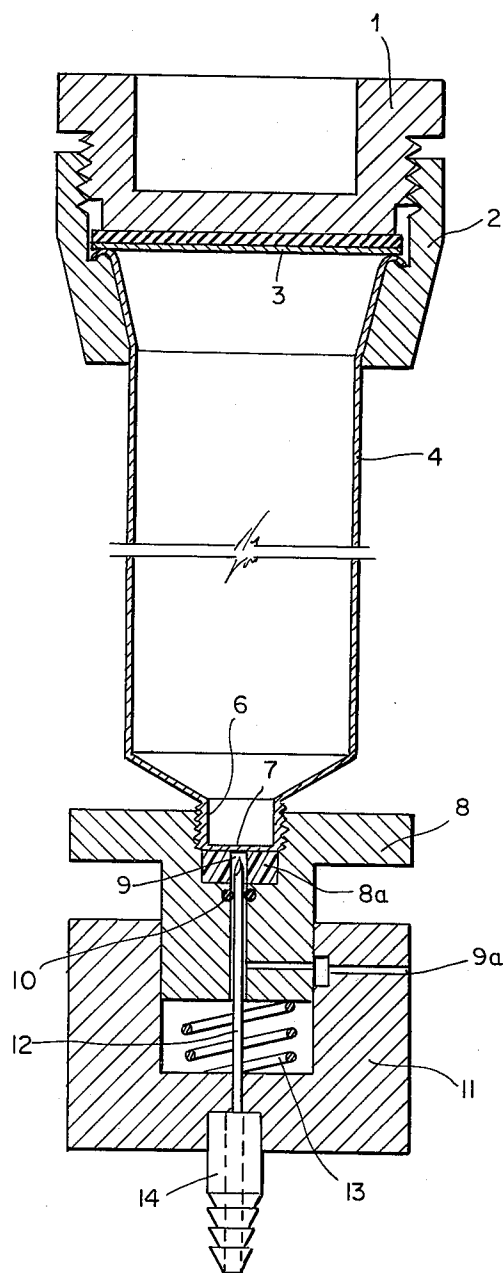


Fig. 2

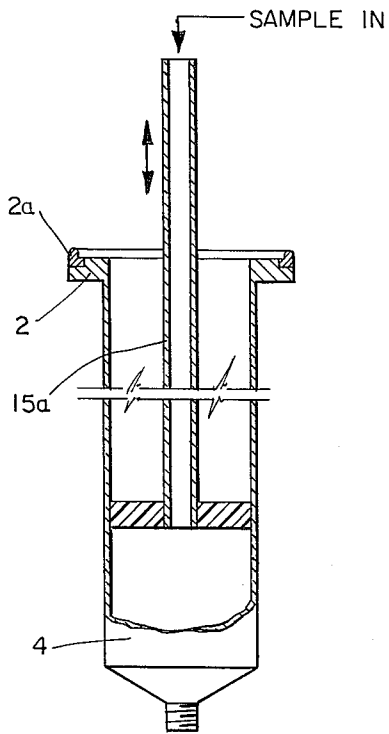


Fig. 4

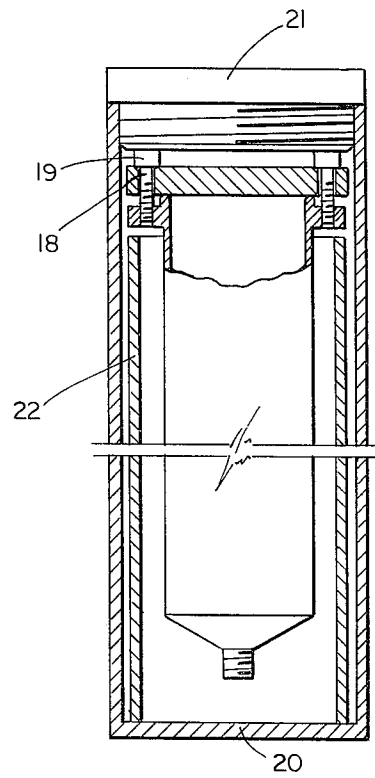


Fig. 5

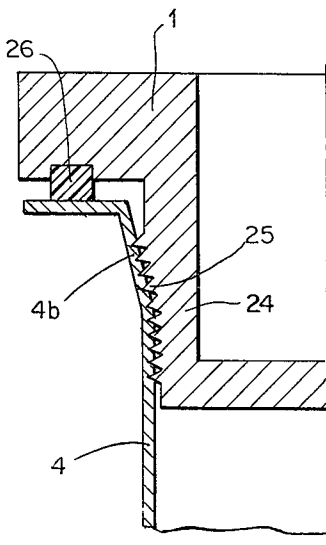


Fig. 6

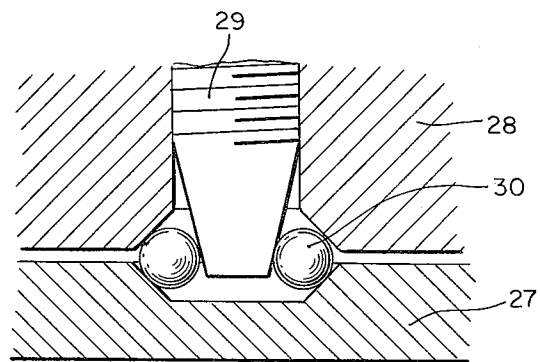


Fig. 7

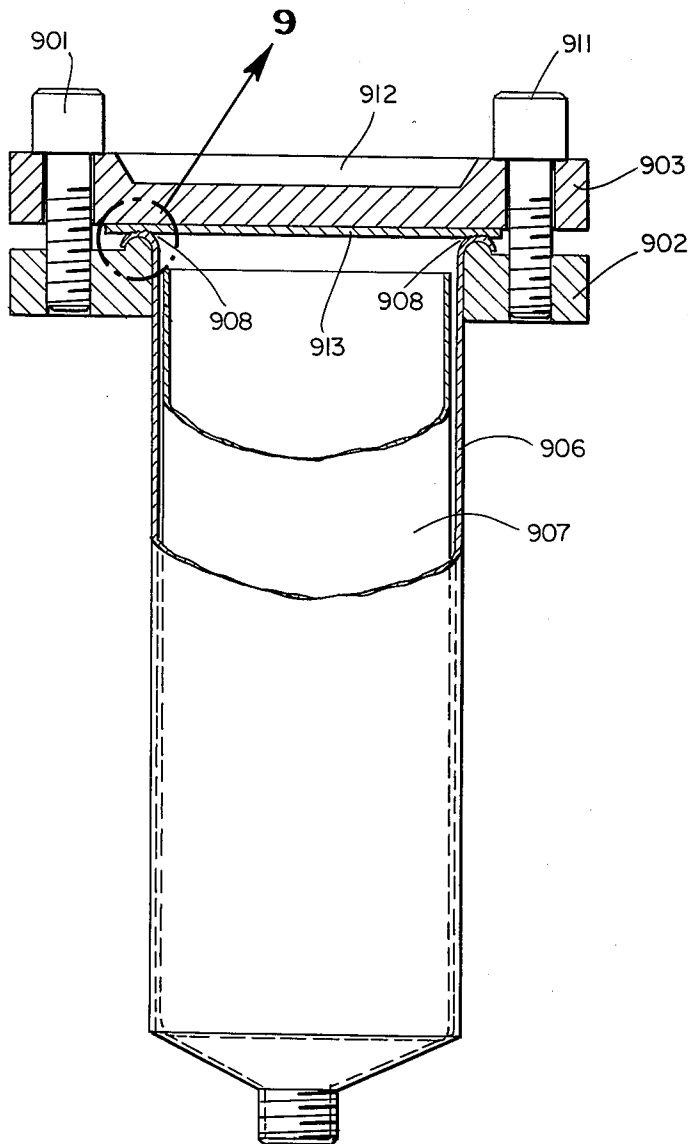


Fig. 8

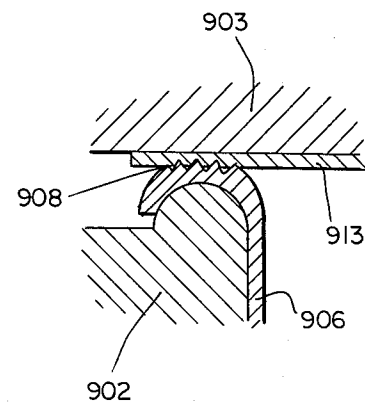


Fig. 9

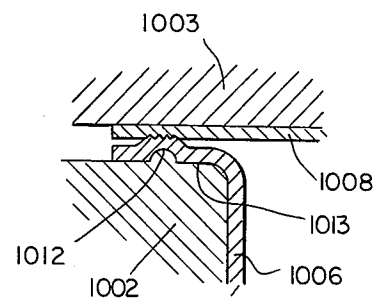


Fig. 10

GAS SAMPLING DEVICE

This invention is related to gas analysis, such as may be necessary to detect the presence of anesthetic gases in an operating room atmosphere, and particularly to sampling devices for removing an uncontaminated sample of the gaseous atmosphere to be tested and transferring the sample to a gas analysis apparatus with a minimum of contamination.

Gas analysis for the detection of very small concentrations, on the order of parts per million or parts per billion, of objectionable gases are often necessary. For example, there is increasing evidence that very minute concentrations of anesthetic gases in an operating room atmosphere may have some adverse physiological consequences on persons exposed to the atmosphere. Such contamination may result from an inefficient or ineffective scavenging system for removing such anesthetic gases.

Because of the very low level of concentrations of the objectionable gases in such situations, it is often necessary to detect their presence using specialized equipment found only in certain locations in the U.S. therefore requiring transport by mail.

Furthermore, it is usually impractical, if not impossible, to deliver uncontaminated gas samples from such atmospheres to the sophisticated gas analysis apparatus necessary to detect a very low level of objectionable gases or conversely to move the sophisticated analytical apparatus into the atmosphere to be tested. All of the known existing systems use syringes with their inherent leakage of the pistons or bags made of flexible material with potentially serious leakage, adsorption, and absorption problems.

In view of all of these circumstances, it is apparent that there is a need for a gas sampling technique or device which permits the transfer of an uncontaminated sample from a gaseous atmosphere to be tested to the gas analysis apparatus. Plastic and glass containers, particularly syringe-type devices, have not been satisfactory due to the absorbent nature of plastic to many gases, particularly objectionable gases such as anesthetics, and the unavoidable leakage around syringe body and piston particularly when such equipment is composed of glass. Such leakage permits ready access of contaminant gases (defined for purposes of the present invention as any gas not part of the gaseous atmosphere to be sampled) into the gaseous sample, more likely, or, migration of the gas to be sampled out of the container.

It is therefore an object of the present invention to provide a gas sample device adapted to receive and hold an uncontaminated gas sample for transfer to gas analysis apparatus.

It is a more specific object of this invention to provide a non-absorbent, inert device which facilitates the transfer of the gaseous sample into the gas analysis apparatus.

It is a further object of this invention to provide a variety of optional designs for ensuring the sealed enclosure of the gas sample in a relatively simple and economic manner.

These and other objects, which will become apparent in the course of the subsequent discussion of this invention, are met, briefly, by a sealed crushable tube having a puncturable segment and a removable piston snugly fitting within the tube and removable through an opening in the tube, which is in turn covered by a sealable

closure. Generally, the device is composed of a material inert and non-absorbent with respect to any gases to be tested. In many cases, this excludes plastics as a primary material of construction due to their absorbent nature, although vacuum metalized plastic may provide a suitable alternative to metallic materials and some of the more advanced plastics now being developed may prove to be sufficiently non-absorbent and inert to be used in the present invention. Glass is generally not suitable due to its fragile nature and the cost of including a puncturable segment in the glass, as well as the inability to urge the sample out of the tube by squeezing. Therefore, the preferred material of construction is a metal such as aluminum, zinc, lead, tin-lead alloys and other relatively soft and easily formable metals, or alternatively the metallized plastics.

In the preferred form of the present invention, the puncturable segment of the tube is surrounded by a mating means through which the tube may be connected to an inert gas purgeable passageway to a gas analysis apparatus, the delivery means including a sharp tipped tubular member, such as a hypodermic needle, which penetrates the puncturable segment and through which the gas sample in the tube is delivered, again with a minimum of contamination, directly to the gas analysis apparatus.

This invention may be better understood by reference to the following detailed description thereof and the appended claims, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an assembly view, partially in cross-section, of one form of gas sampling device within the scope of the present invention, including an internal piston as is included at the time of manufacture and showing the tube assembled with means for transferring the gas sample to a gas analysis apparatus;

FIG. 2 is a sectional view of the assembly shown in FIG. 1 with the internal piston removed;

FIG. 3 is a sectional detail view of a particular feature of the present invention;

FIG. 4 is a view, partially in cross-section, showing a gas sampling tube of the type shown in FIG. 1 with a modified form of internal piston and sealing means;

FIG. 5 is a partially sectioned assembly view of a gas sampling tube, similar to that shown in FIG. 1 but having a different sealing means, in a shipping container for transporting the gas sample to suitable gas analysis apparatus; and

FIGS. 6 and 7 are detail views showing other forms of closure seals which may be used in the gas sampling device of the present invention.

FIGS. 8, 9, and 10 show alternative forms of closure seals which may be used in the gas sampling device of the present invention.

Referring now more specifically to FIGS. 1 and 2, there is shown a closure member 1 threadably engaging a retaining collar 2 secured by means of a swaged upper lip 4a to a crushable tube 4, composed of an inert and non-absorbent material with respect to any gas to be sampled, typical materials including metals such as aluminum, zinc, lead, tin, and tinlead alloys.

To ensure a proper non-absorbent seal, a deformable metallic facing 3 on closure member 1 abuts swaged upper lip 4a as closure member 1 is drawn into engagement with tube 4 by turning within retaining collar 2.

As shown in FIG. 1, disposed within tube 4 prior to the time a gas sample is to be taken, is a snugly fitted

piston 15, removable through the opening of tube 4 created upon removal of closure member 1 to permit the filling of the interior space in tube 4 with the gaseous atmosphere to be sampled. The assembly, with piston 15 removed as it would be when the gas sample is taken, is shown in FIG. 2. Puncturable segment 7 in tube 4 in this preferred form of the present invention is surrounded by protrusion 6 threadedly engagable with a transfer means for removing the gas sample from tube 4 and delivering it to a gas sampling apparatus, not shown but typically consisting of a gas chromatograph or infrared spectrum analyzer.

While the particular transfer means may take a variety of forms, it generally includes a sharp tipped tubular member 12 which penetrates puncturable segment 7 for delivery of sampled gas from the interior of tube 4, upon the collapse or forced crushing of tube 4 to a connection 14 to the gas analyzing apparatus. In the transfer means shown, tube 12 is mounted within a mounting block 8 with an opening 9 therein through which tubular piercing member 12 passes. Mounting block 8 also includes a resilient bushing or bearing member 8a facing puncturable segment 7 and an o-ring seal 10, both of which are intended to minimize the introduction of contaminant gas into tubular passageway 9. Further to minimize leakage of contaminant gas into the gas analyzer along with the sampled gas in tube 4, an inert gas purge passageway 9a is adapted to exhaust inert purged gas from tubular passageway 9 and around tubular piercing member 12 prior to the piercing of puncturable segment 7 by tubular member 12. The needle is arranged to be withdrawn clear of elements 8a and 10 so as to provide for this scrubbing action. Connecting member 14 is also secured within a second mounting block 11 which by means such as a spring 13 urges mounting block 8 away from second mounting block 11.

In using the assembly shown in FIGS. 1 and 2, tube 4 assembled with piston 15 and top closure member 1, together with retaining collar 2 and facing seal 3 is opened to the ambient atmosphere to be sampled by removing closure member 1 and facing seal 3 and withdrawing piston 15 from tube 4. Facing seal 3 is then replaced along with closure member 1 and urged into engagement with swaged upper lip 4a by the threaded engagement of closure member 1 and retaining collar 2. Thus, an uncontaminated sample of gas air to be tested is enclosed in the sealed interior space of tube 4.

Tube 4 is then taken or transmitted (and in fact can be shipped over great distances to a central test facility) to a gas analysis apparatus where it is mounted in a sample transfer means such as by threadedly engaging protrusion 6 in a mounting block 8. Inert gas is then passed through the needle, exhausting out passageway 9a to purge the space surrounding tubular piercing member 12 and the entire assembly of tube 4 with closure member 1 and mounting block 8 is forced against the resistive pressure of spring 13 and against piercing tubular member 12 so that piercing member 12 extends and remains in the interior space of tube 4. Upon crushing or collapsing tube 4, the sampled gas within the interior space of tube 4 is forced through tubular member 12 and connection 14 to the gas analyzing apparatus.

In FIG. 4, there is shown an alternative form of tube 4 wherein retaining collar 2, which may be composed of aluminum, for example, includes a hard metal (alu-

minum or steel, for example) lip ring 2a for mating with and deforming a corresponding deformable facing seal member (not shown) on closure member 1. Also seen in FIG. 4 is a modified piston 15a including a long tubular gas inlet for admitting the gas to be sampled into the interior space of tube 4 as piston 15a is moved back toward the opening in tube 4 surrounded by retaining collar 2.

Note that a liquid or solid or particulate material could be used to fill the internal space of tube 4 in place of piston 15. Gas sample is then introduced into tube 4 simply by emptying the liquid or solid particulate material from tube 4.

In FIG. 5, there is shown a schematic view of another assembly, similar to that shown in FIG. 1, but differing in that closure member 1 is mated with retaining collar 2 by means of threaded post members 18 with retaining bolt heads 19 or nuts. Further, the assembly of tube 4 in closure member 1 is retained in a shipping container 20 with a screw cap 21 and a spacer 22 for preventing movement of the sampling device within the shipping container. Such a shipping container may be used for shipping the originally manufactured sampling device to the point of use and would be necessary for shipping the sampling device after the internal support has been removed therefrom and after the sampled gas has been introduced into the interior space of tube 4 to some remote facility where complex and sophisticated gas analysis apparatus may be located.

Various other details and auxiliary features may be incorporated in tubular member 4 and the means by which it is sealably closed by closure member 1.

One such feature, not pertaining to closure member 1, but intended to facilitate the shipment by air of tubular member 4 without causing its inadvertent collapse due to the reduced ambient atmosphere such as might be present in the cargo compartment of a commercial airliner, is a dimpled recess 23, as seen in FIG. 3. A corresponding dimpled recess 23a would, of course, be included in piston 15. Rather than overall collapse or deformation of tube 4 upon being subjected to dissimilar ambient pressures on the interior and exterior of tube 4, dimple 23 is adapted to spring inwardly or outwardly to compensate for such differential pressures.

Two other means by which closure member 1 may be mated with tube 4 are seen in FIGS. 6 and 7. In FIG. 6, for example, tube 4 includes a flared upper section 4b. Closure member 1 includes a protruding plug 24 with coining ridges 25 on its outer face. As closure member 1 is turned and pressed into tube 4, coining ridges 25 deform the relatively soft metal of tube 4 at the flared upper portion 4b and produce, in effect, a threaded seal on engagement of the members. In addition, a back up resilient seal 26, which may be composed, for example, of teflon, may be included to provide a complete seal between closure member 1 and tube 4.

In still another embodiment of closure member 1, as seen in FIG. 7, a resilient plate 27 may be forced against the top of tube 4 (not shown in FIG. 7) by a pressure plate 28 retained against the periphery of plate 27 and including a threaded tightening plug 29 having a tapered face for engaging ball pressure members 30. Tightening of plug 29 presses on ball members 30 and in turn on resilient member 27 pressing resilient member 27 against the top of tube 4.

In FIGS. 8 and 9, an impact extrusion tube 906 is provided to capture the sample by removing the cap 903 and exercising the piston 907 in and out, approximately 6 times to introduce a representative sample, waiting a reasonable time interval on the order of 5 minutes. The piston 907 may be discarded in that it too is of an inexpensive impact extrusion construction. The cap 902 is tightened to the base ring 902 by uniformly tightening socket head cap screws 901, 911, etc. The torque is limited by use of smooth surfaces on ring 902 and cap 903 to encourage hand slipping and by use of a short (eg 3 inch) hex key wrench, not shown. A depression 912 is formed in the cap 903 to save weight for shipping. A "thumb print" depression, not shown, may be formed in the side of the tube 906 to provide for gas expansion in the tube during shipping or the like. This depression also prevents the piston 907 from moving within the tube 906 during shipping. A closed threaded end 908 is provided for adaption to the sampling fixture. The cap 903 is lined with lead foil 913, or other similar soft inert material, which is fastened to the cap 903 with double faced pressure sensitive tape, not shown. When tightened by screws 901, 911, etc., the cap 903 swages the lead 913 into the sealing grooves 908, which are preformed in the flange 908 of the tube 906 by a coining operation using a master tool. Preferentially, the base ring 902 includes a raised ring, not shown, which increases the unit stress for a given load calculated so that the yield point of the lead is exceeded and flow takes place. A paper insert 10 is provided to prevent shipping damage to the lead or grooves. Preliminarily, a paper insert is provided to overlay the meeting point between the grooves 908 and the foil 913. When gas is to be sealed in the tube, the paper is discarded and a seal as described above is achieved by tightening the screws 901, 911, etc.

Finally, the embodiment of FIG. 10 shows an alternative to the one of FIG. 9. In FIG. 10, the base ring 1002 is formed differently from the one of FIG. 9, in that a small lip 1012 and a land area 1013 are utilized. This structure reduces sensitivity to over- or undertightening the cap 1003. That is, the lip 1012 increases unit stress to handle light assembly cases while the land area 1013 "bottoms" on the cap 1003 before the lip 1012 can cut through the tube 1006 or the lead seal 1008 (such as for example, in cases of heavy assembly pressures).

Having described my invention particularly with respect to specific embodiments thereof, I should like it understood that the invention is not necessarily limited to these specific embodiments, which have been chosen primarily to illustrate a variety of designs within the true spirit and scope of the present invention and with which the objectives of the present invention can be met. It should be understood, however, that this invention comprehends and the appended claims are intended to be construed to include all other modifications and variations of this invention as would be apparent to those skilled in the art and within the true spirit and scope of the present invention.

I claim:

1. Gas sampling device comprising a sealed crushable tube having a puncturable segment therein, an opening closed by a resealable, openable closure and a piston snugly fitting within said tube and removable through said opening, said tube, said closure, and said piston all

being composed of a material inert and non-absorbent with respect to any gases to be tested.

2. Gas sampling device, as recited in claim 1, wherein said material is a metal.

3. Gas sampling device, as recited in claim 1, wherein said material is a metal selected from the group consisting of aluminum, zinc, lead, tin, and tin-lead alloys.

4. Gas sampling device, as recited in claim 1, wherein said opening and closure consists of an opening in said tube surrounded by a means for retaining said closure in firm contact therewith, said closure abutting said opening with a metallic seal and being retained thereagainst by means mating with said retaining means surrounding said opening.

5. Gas sampling device, as recited in claim 4, wherein said retaining means consists of a deformable segment extending circumferentially about said tube and a mating non-deformable segment on said closure, said closure being adapted to engage said deformable segment in a manner to cause deformation thereof with a resultant gripping and sealing effect between said tube and said closure.

6. Gas sampling device, as recited in claim 4, wherein said retaining means consists of threaded members adapted to mate with correspondingly threaded members attached to said closure, said members including posts extending between said retaining means and said closure.

7. Gas sampling means, as recited in claim 1, wherein said tube includes a dimple projecting inwardly in said tube and adapted to be bent outward in response to a decrease in the ambient pressure surrounding said tube.

8. Gas sampling device, as recited in claim 1, wherein said puncturable segment is surrounded by a projection in said tube, said projection being adapted to receive and retain, in sealed engagement, a means including a pointed tubular member adapted to puncture said segment and to protrude into said tube through said punctured segment and to withdraw a gas sample therefrom.

9. Gas sampling device, as recited in claim 8, further including a gas sample withdrawing means adapted first to engage and to be retained in sealed engagement with said puncturable segment-surrounding projection, and then to flush inert gas through the closed space between said segment and said sample withdrawing means, and finally to puncture said segment with a pointed tubular member and to withdraw a gas sample from said tube through said tubular member.

10. Gas sampling device, as recited in claim 9, wherein said tubular member is connected directly to a gas analysis means.

11. Gas sampling device comprising a sealed crushable tube having a puncturable segment therein and an opening closed by an openable and sealable closure, said tube and said closure being composed of a material inert and non absorbent with respect to any gases to be tested, wherein the space within said tube is occupied by an inert solid material adapted to be removed through said opening upon removal of said closure.

12. A device as recited in claim 11 wherein said inert solid material is in particulate form.

13. Gas sampling device comprising a sealed crushable tube having a puncturable segment therein and an opening closed by an openable and sealable closure, said tube and said closure being composed of a material inert and non-absorbent with respect to any gasses to

be tested, wherein the surface of said tube at said opening defines at least on preformed ridge, and said closure includes a sheet of inert, malleable material to fit in sealable registry with said ridge.

14. Gas sampling device, as recited in claim 13, wherein said sheet of inert, malleable material is lead foil secured to said closure, said ridges penetrating said

foil as said closure is secured to said tube.

15. Gas sampling device, as recited in claim 14, wherein a band is provided to grip the tube in concert with the ridge for stress raising in order to prevent over tightening and in order to mechanically secure the tube.

* * * * *

10

15

20

25

30

35

40

45

50

55

60

65