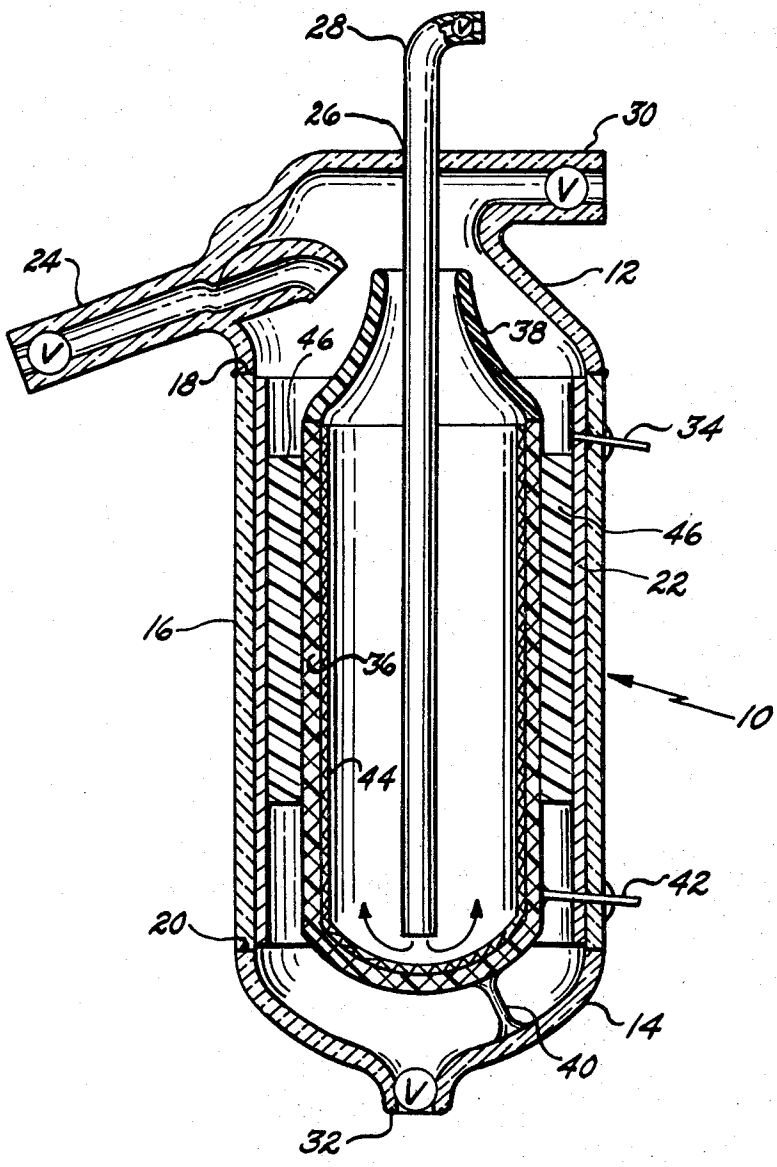
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CONTINUOUS FLOW GAS CHROMATOGRAPHY APPARATUS
HAVING A WIRE MESH ELECTRODE
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CONTINUOUS FLOW GAS CHROMATOGRAPHY APPARATUS HAVING A WIRE MESH ELECTRODE

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ABSTRACT OF THE DISCLOSURE

A continuous flow, electrolytic, gas chromatography apparatus, which allows continuous flow of a fluid to produce standardized liberation of gaseous products by having a cup-shaped porous mesh center electrode with a gas permeable membrane lining therein and a concentric electrode spaced from the cup-shaped electrode with spacing means therebetween. Electrode assembly is provided in a casing which has a fluid inlet and a gas inlet tube to enable the gaseous end product to be taken from the casing at an outlet.

The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to us of any royalty thereon.

This invention relates generally to a continuous flow, electrolytic preprocessor for gas chromatography, and more particularly to an apparatus which allows for a continuous flow of a fluid to produce standardized liberation of gaseous products from substances in the fluid solution.

Like most electrolytic apparatus, the invention basically comprises a casing with a pair of electrodes therein; however, the apparatus of this invention differs from the usual electrolytic apparatus in that the center electrode is a cup-shaped porous mesh which has a gas permeable membrane lining therein. In addition, a gas inlet tube is arranged to control the flow of gas at the interior of the cup-shaped inner electrode in order to enable the Bernoulli effect to encourage the passage of gas through the membrane and out through the top of the inner electrode.

Accordingly, it is a primary object of this invention to provide a continuous flow, electrolytic preprocessor which enables the conversion of substances in solution into gaseous products suitable for an analysis by gas chromatography.

It is another object of this invention to provide a continuous flow, electrolytic preprocessing apparatus for gas chromatography which permits evaluation of samples in rapid sequence.

It is still another object of this invention to provide an electrolytic apparatus of the continuous flow type wherein the electrodes are amounted in close proximity in order to control the rate of flow of the reactant solution through the interspace.

A further object of this invention involves the provision of an electrolytic preprocessing apparatus for gas chromatography wherein the liberation of gaseous products from electrolytic reaction involving substances in solution which are required to be quantitated by gas chromatography is standardized.

A still further object of this invention involves the provision of an electrolytic preprocessing apparatus for gas chromatography which is both easy and economical to produce of conventional currently available materials that lend themselves to standard mass production manufacturing technique.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiment in the accompanying drawing wherein the figure comprises a partly schematic cross-sectional representation of the electrolytic preprocessor of this invention.

Referring to the figure, there is shown an outer case **10** of the electrolytic preprocessor which is made in separable parts for convenience of assembly. Either glass or an inert plastic, such as Teflon may be used for the case. The top **12** and bottom **14** are joined to center cylindrical section **16** at **18** and **20**. The joints at **18** and **20** may be designed in a conventional manner with flanges and bolts for easy disassembly, or alternatively, the device could be assembled and cemented to appear as an integral casing, as shown.

An outer cylindrical electrode **22** is provided on the inner wall of the center section **16** of the outer case **10**, such that the electrode could be inserted into the case as one would install a sleeve or bearing. Alternatively, the electrode could be plated on the interior of **16**. The top section **12** of the outer case **10** has three openings therein. A solution inlet is provided at **24**, while a hole at **26** is arranged to have a pipe **28** sealed thereto in order to direct an inert carrier gas into the system to aid in purging the system of its products. The location of the pipe **28** also aids in the removal of gas generated in the apparatus, as will be later explained. The third outlet in the top section **12** is the gas outlet **30** for the products for directing them to gas chromatographic apparatus. The bottom section **14** contains the solution outlet **32**. Of course, all of the openings would be provided with conventional valve means for aiding in controlling fluid flow, as schematically shown.

In order to apply the proper voltage to the electrode **22**, a lead **34** is arranged to connect with the electrode **22** and passes through the wall of the center section **16** in a sealed relationship therewith. An inner cup-shaped, porous mesh, platinized platinum grid electrode **36** is arranged in section **16** to be concentric with the outer electrode **22**. The concentric arrangement increases exposure of the electrode surfaces to solution to permit rapid transit of samples for a given amount of gas product formation. On the top thereof and extending into the section **12** is a glass or inert plastic portion **38** which reduces the diameter of the inner electrode **36** to form a throat section.

Within the cup-shaped electrode **36** there is provided a gas permeable membrane **44** in close proximity to or attached to the inner surface of said electrode. The membrane **44** should inhibit, however, the flow of the liquid solution through to the interior of the inner electrode **36**.

In order to support the cup-shaped, porous mesh electrode grid **36**, one or more support posts **40** are provided to secure the base of the grid to the bottom section **14** of the outer case **10**. An electrode lead **42** is provided through the wall **16** of the outer case **10** to perform the same function for its electrode as does lead **34**. Also, a series of four plastic spacer elements **46** are arranged between the inner electrode **36** and the outer electrode **22**. The plastic spacers **46** are of a size to aid in the lateral support of the inner electrode and control the space between the electrodes so as not to preclude rapid filling of this space with fluid and also the adhesion of the fluid to the electrodes by surface tension and capillarity. The spacer elements also enables the assembling of the electrodes prior to installation of the top and bottom case sections **12** and **14**.

The continuous flow feature of the device allows for the accommodation of large sums of samples in rapid sequence with minimum attendance. The device has par-

ticular utility in measuring total body water volume using D_2O dilution. Body fluids containing D_2O may be passed over the platinized platinum inner electrode and H_2, HD, and D_2 would be liberated into H_2 as a carrier. The D could then be quantitated and related to total body water volume.

For example, a blood plasma solution of dilute, acidic D_2O containing a surface active agent would be pumped into the system at a controlled rate. The gas carrier entering through the inlet pipe **28** would be turned on and the solution outlet **32** would be closed. The gas outlet **30** would be open and connected with an automatically controlled expanding volume chamber of gas chromatography apparatus which enhances liberation of the gas from the liquid phase. These conditions would prevail until the space between the electrodes **22** and **36** is filled.

Purging of the system of air from the expanded collection chamber of the gas chromatography apparatus is effected and a gradual expansion is repeated with the solution outlet **32** opened. The solution continues to pump in through inlet **24** and an E.M.F. is applied across the inner platinized platinum electrode **36** and the outer electrode **22**. H_2, HD, and D_2 formed at the inner electrode **36** passes through the gas permeable membrane **44** with the passage enhanced by Bernoulli effect of the controlled hydrogen carrier gas flow from the carrier gas inlet pipe **28**. The gas remaining in the electrode interspace would also pass upwardly and out through the gas outlet **30** into the space gas chamber. Precisely controlled flow rates may be maintained by appropriate valve means and auxiliary pumps.

The cycle may be repeated indefinitely with water and air or purging gas rinses being effected between samples. It is contemplated that sonic vibration during gas evolution would minimize adherence of gas bubbles to the electrodes. The close proximity of the inner and outer electrodes to each other allows the reactant solution to flow at a controlled rate through interspace. The range of reactants capable of being utilized with this device is a function of the electrolyte and electrode composition, the pH, ionic strength, applied E.M.F. and polarity, while the size of the device is dictated by the volume of sample flow through the apparatus.

Thus, there has been described a continuous flow electronic gas chromatography preprocessor which, with proper pressure balancing, allows for rapid and accurate preparation of gaseous sample.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

We claim:

1. A continuous flow electrolytic apparatus comprising
closed, generally cylindrical casing,
a cylindrical electrode on the inner wall of said casing,
a cup-shaped, mesh electrode concentric with and spaced from said cylindrical electrode,
a gas permeable membrane lining the interior of said cup-shaped, mesh electrode,
spacer means between said electrodes,
support means for spacing the bottom of said cup-shaped electrode and said casing,
solution inlet means connected with said casing,
solution outlet means at the lowermost portion of and connected with said casing,
gas outlet means at the upper end of and connected with said casing, and
carrier gas inlet means connected with said casing for directing a carrier gas to the interior of said mesh electrode.

2. An apparatus as defined in claim **1** including means on said cup-shaped, mesh electrode for forming a throat for passage of a carrier gas and gaseous products liberated from the solution presented at said solution inlet to said gas outlet means.

3. An apparatus as defined in claim **1** wherein said cup-shaped electrode is of platinized platinum.

4. An apparatus as defined in claim **1** wherein said carrier gas inlet means enhances the passage of gas through said membrane by the Bernoulli effect of a gas into said cup-shaped electrode.

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