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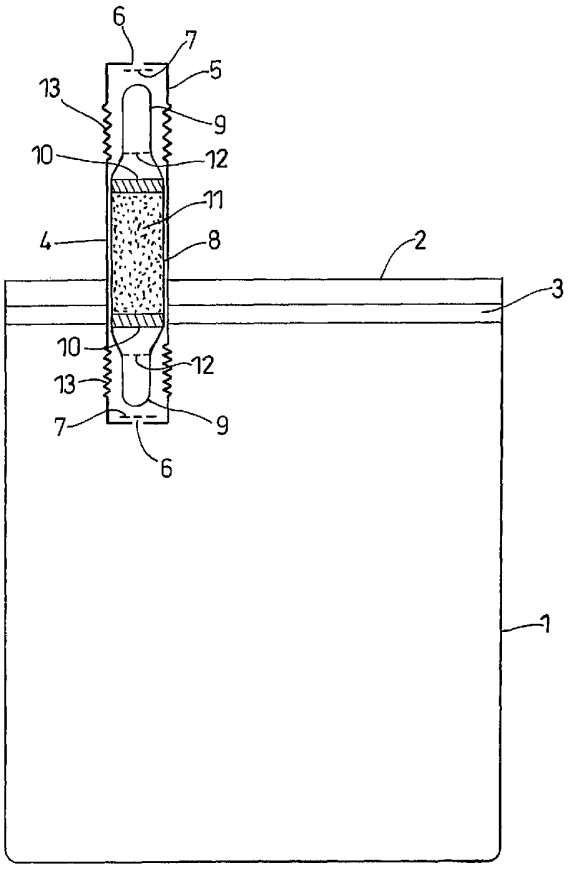
(54) Title: TESTING OF BREATH



(57) Abstract: A device and method for testing breath odour. An expired breath sample is passed through a device containing a material that undergoes a visible colour change on reaction with hydrogen sulphide.

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TESTING OF BREATH

Technical Field

This invention relates to the testing of breath, and more particularly provides methods and devices for the qualitative and quantitative assessment of malodorous or bad breath.

Background Art

Bad breath (halitosis) is a common social problem, but simple and effective methods for its assessment have not become available. Efforts have been made to establish testing criteria, using human testers, but this is not practical for everyday assessment. Attempts to establish instrumental methods have generally involved the use of laboratory-scale equipment, such as gas chromatographs, which are relatively expensive and cumbersome to use. See the references listed below.

Hydrogen sulphide (H_2S) in the breath is known to be a major cause or bad breath. Portable apparatus for measurement of the hydrogen sulphide concentration in the atmosphere is known, one manufacturer being Dräger. The Dräger apparatus has a tube containing mercuric chloride ($HgCl_2$) supported on a suitable carrier. A predetermined amount of air is sucked through the tube, by a pump or a spring-loaded bellows. Hydrogen sulphide reacts with the mercuric chloride to produce mercuric sulphide, resulting in a colour change. The length of the tube, over which the colour change occurs, provides a quantitative estimate of the hydrogen sulphide content of the air. The pressure required to draw air through this tube is

about 250 mmHg (1 mmHg = 133 Pa). This device has not been proposed for use in analysis of breath.

Summary of the Invention

The present inventors have realised that a similar method can be employed for the detection of hydrogen sulphide in breath, making possible the assessment, both qualitative and quantitative, of a breath sample, to provide an indication of the degree to which it constitutes "bad breath". Such a device is particular for use by a person who wishes to test their own breath alone e.g. at home.

In one aspect of the invention, there is provided a method of testing breath, comprising passing an expired breath sample through a flow passage containing a porous body of material carrying a component which undergoes a visible colour change on reaction with hydrogen sulphide. The method may be performed by a direct expiration from the lungs into the flow passage, or by capturing an expired sample, for example in an inflatable bag, and subsequently passing the sample through the flow passage. In both cases, a predetermined volume of breath is preferably passed through the flow passage. However, for a qualitative assessment, the volume of the sample does not need to be accurately determined. Breathing through the flow passage for an approximate amount of time, for example between 5 and 15 seconds, can provide an approximate qualitative assessment.

In a second aspect, the invention provides a device for use in testing breath, having a flow passage containing a porous body of material carrying a component which undergoes a visible colour change on reaction with hydrogen sulphide, the

flow property of the passage being such that a gas volume of at least 500 ml passes through the porous body in 5 s when the pressure difference between the ends of the passage is 5 mmHg. Since normal out-breathing pressure (pressure of expired breath) during gentle breathing is at a pressure in the range of 1 to 5 mmHg above atmospheric pressure, this device is suitable for use in the method of testing by breathing through it. A typical volume of expired air to be passed through the device is in the range 200 to 1000 ml, which amounts to 1 or 2 normal breaths.

Preferably the colour change occurs progressively along the porous body as the amount of hydrogen sulphide reacted increases, so that the location of the boundary of the colour change provides a measure of the total amount of hydrogen sulphide in the air sample passed.

The flow passage is preferably in a tube having openable seals at each end, to protect the colour-change compound from contact with the atmosphere and moisture before the breath test. The porous material carrying the colour change compound may be held between porous plugs in the tube. The tube may be of glass or suitable transparent or translucent plastics material, and the seals may be flexible non-porous removable plugs or caps or adhesive peelable foils.

Alternatively the seals may be breakable elements, for example glass end closures of a glass tube, which can be readily snapped off. Such a glass tube, having breakable glass closures, may be enclosed within a second tube which is flexible in order to permit breakage of the glass closures, without direct contact of the user with the glass. Such a tube may be a plastics material tube having locations of

relatively high flexibility (e.g. bellows portions) permitting localised flexing of the tube to allow breakage of the glass closures. Preferably the broken-off parts of the glass closures are retained within the second tube, without hindering the air flow, to avoid risk of harm to the user.

The preferred compound which undergoes a visible colour change on reaction with hydrogen sulphide is mercuric chloride. The reaction is $H_2S\uparrow + HgCl_2 \rightarrow HgS + 2HCl\uparrow$. Other compounds which provide a suitable colour change are lead acetate ($Pb(CH_3COO)_2$) and silver chloride (AgCl). This material is mounted on a suitable support, which provides the porous body. The support may be a monolithic body, or may be in the form of a body of particles held in place within the device, for example between porous walls in a tube.

In the case of mercuric chloride, a suitable concentration of mercuric chloride in the porous body through which the breath sample is passed is in the range 10^{-8} to 10^{-5} g/cm^3, more preferably 5×10^{-8} to 2.5×10^{-6} g/cm^3, most preferably 2.5×10^{-7} to 1.25×10^{-6} g/cm^3.

Suitable materials of the support are silica, alumina and glass or plastics material beads of high surface area.

The device of the invention may be in a form of a tube which has one end suitable for the user to blow into and a second end which opens into a inflatable bag sealed to the tube. The volume of the inflatable bag is suitable for receive a sample of expired breath which permits the desired measurement. This volume is preferably in the range of 200 to 1000 ml.

One embodiment of the device of the invention is a tube 5 cm long and 1 cm in diameter, having a volume of

approximately 4 cm^3. With a packed density of the carrier for the colour-change compound of 1, about 4 g of the substrate is loaded with an amount of mercuric chloride in the range $2x10^{-7}$ g to 10^{-4} g of mercuric chloride, preferably in the range $1x10^{-6}$ to $5x10^{-5}$ g. Such a device containing mercuric chloride in an amount at or near the upper end of the range is suitable to give a detectable colour change for a sample on one litre of breath, containing in the range 20 parts per billion (ppb) to 6 parts per million (ppm) of hydrogen sulphide (by weight). 1 litre of air containing H_2S at 20 ppb has a weight content of H_2S of 2.586×10^{-8} g, which reacts with 2.075×10^{-7} g of $HgCl_2$. The colour change caused even by 20 ppb of H_2S is visible.

Brief Description of the Drawings

Fig. 1 of the accompanying drawings shows a test device of the invention. Fig. 2 shows a modified part of the device of Fig. 1. Fig. 3 shows alternative test devices.

Detailed Description of the Drawings

In the device of Fig. 1, an inflatable air-impermeable plastics material bag 1 has an open side 2 across which the bag walls are heat-sealed together along a seal line 3. Passing through the open side 2 and sealed to the bas walls is a double tube structure 4. The tube structure 4 has an outer plastics material tube 5 having apertures 6 in its ends covered by metal mesh 7. Held inside the tube 5 is a glass tube 8 having narrower elongated closed ends 9.

Within the glass tube 8 and confined between fixed porous plugs 10 is a porous body of particulate carrier material 11 supporting the compound which undergoes colour

change on reaction with hydrogen sulphide, as described above.

The closed ends 9 are circumscribed by score lines 12 so that they are easily snapped off, to allow air passage through the tube 8. The outer tube 5 has circumferential locations 13 of bellows-like conformation which are relatively more flexible than the remainder of the tube 5. To use the device, the user flexes the tube 5 to break off the ends 9 and then blows through the tube structure 4 to fill the bag 1 (which starts empty) with a predetermined volume of expired breath. The volume of the bag 1 when filled and the flow properties of the tube structure 4 (when open for through flow) are described above.

Fig. 2 shows a modified form of the glass tube 8 of Fig. 1. Between the porous plugs 10, the porous body 11 of particles carrying the mercuric chloride or other colour-change material is conical in shape, increasing in cross-sectional area in the flow direction. This increases accuracy of assessment of H_2S concentration at the lower end of the detectable concentration range.

Figs. 3A, 3B and 3C show other forms of test devices of the invention, having the flow properties defined above. Each device is a substantially rigid tube 20 of transparent plastics material containing a body 21 of particulate material, such as silica, carrying the colour change material, such as $HgCl_2$, held between fixed porous plugs 22. In Fig. 3A, the tube has removable seals in the form of impermeable plugs 23 inserted into its ends to create a seal. In Fig. 3B, the end seals are flexible impermeable caps 24 which seal over the tube ends. In Fig. 3C the end seals are peelable discs 25 of impermeable film or foil sealed by adhesive to the tube ends.

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CLAIMS

1. Breath testing device comprising a flow passage containing a porous body of material carrying a component that undergoes a visible colour change on reaction with hydrogen sulphide.

2. A device according to claim 1, wherein said passage has a flow property such that a gas volume of at least 500 ml passes through the porous body in 5 s when the pressure difference between the ends of the passage is 5 mmHg.

3. A device according to claim 1 or claim 2, wherein said visible colour change occurs progressively along the porous body of material as the amount of hydrogen sulphide increases.

4. A device according to any one of claims 1 to 3, wherein the porous material carrying the colour-change compound is held between porous plugs in the tube.

5. A device according to any one of claims 1 to 4, wherein said flow passage is a tube, and openable seals are provided at each end that protect the colour-change compound from contact with the atmosphere and moisture before the breath test.

6. A device according to claim 5, wherein said tube is made of glass or a transparent or translucent plastics material.

7. A device according to claim 5 or 6, wherein the seals are flexible non-porous removable plugs or caps, or adhesive peelable foils.

8. A device according to claim 5 or 6, wherein the seals are breakable elements that can be readily snapped off.

9. A device according to claim 8, wherein said breakable elements are glass end closures of a glass tube.

10. A device according to claim 8 or 9, wherein said tube is enclosed within a flexible second tube that permits breakage of the seals without the direct contact of the user with the breakable elements.

11. A device according to claim 10, wherein said second tube is a plastics material having locations of relatively high flexibility that permit localised flexing of said second tube to allow breakage of said breakable elements.

12. A device according to claim 10 or 11, wherein the second tube retains said elements after breakage without hindering the air flow of the device.

13. A device according to any one of claims 1 to 12, wherein the component that undergoes a visible colour change on reaction with hydrogen sulphide is selected from mercuric chloride, lead acetate and silver chloride.

14. A device according to claim 13, wherein said visible colour change compound is mercuric chloride in a concentration of 10^{-8} to 10^{-5} g/cm^3 in the porous body.

15. A device according to any one of claims 1 to 14 having the form of a tube that has one end suitable for the user to blow into and a second end that opens into an inflatable bag sealed to the tube.

16. A device according to claim 15, wherein said inflatable bag has a volume in the range of 200 to 1000 ml.

17. A method for testing breath, comprising the step of passing an expired breath sample through a flow passage

containing a porous body of material carrying a component that undergoes a visible colour change on reaction with hydrogen sulphide

18. A method according to claim 17, wherein the breath passed through the flow passage has a predetermined total volume.

19. A method according to claim 17 or 18, wherein said expired breath is passed through a flow passage for a period of time lasting between 5 and 15 seconds.

20. A method according to any one of claims 17 to 19, wherein said breath sample is expired directly from the lungs into said flow passage.

21. A method according to any one of claims 17 to 20, wherein said expired breath sample is captured within a container and said container is used for introducing said breath sample into said flow passage.

22. A method according to claim 17, using the device according to any one of claims 1 to 16.

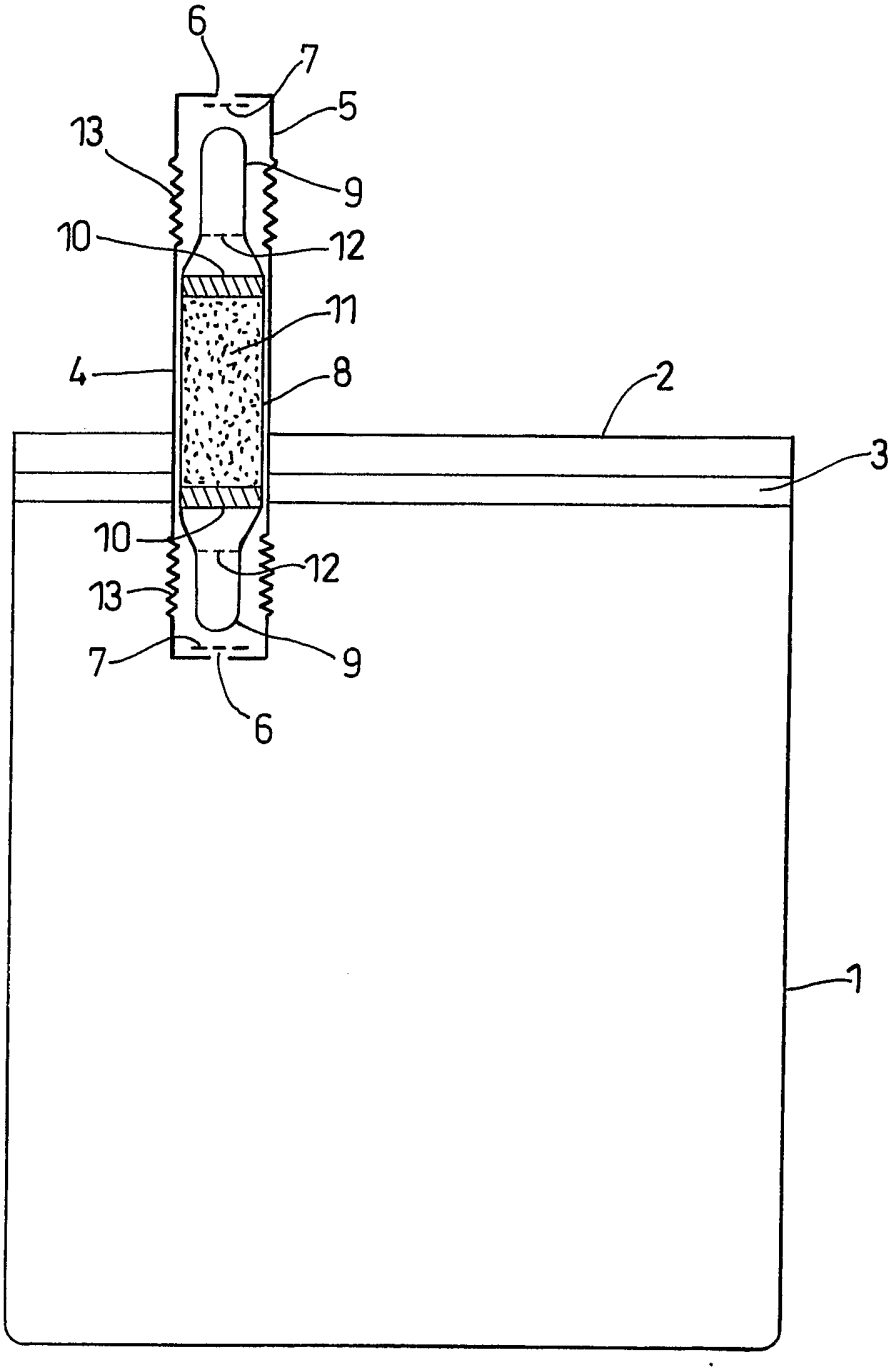

Fig. 1

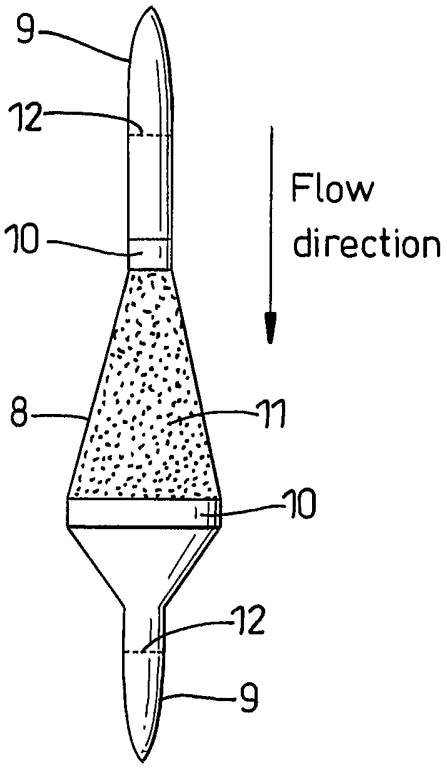

Fig. 2

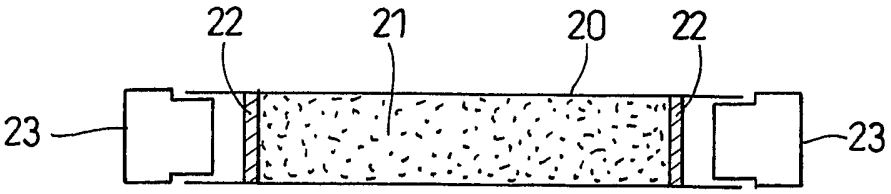

Fig. 3A

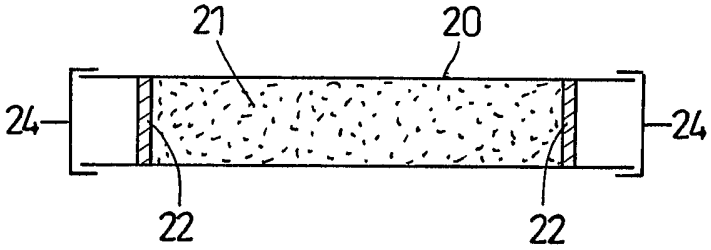

Fig. 3B

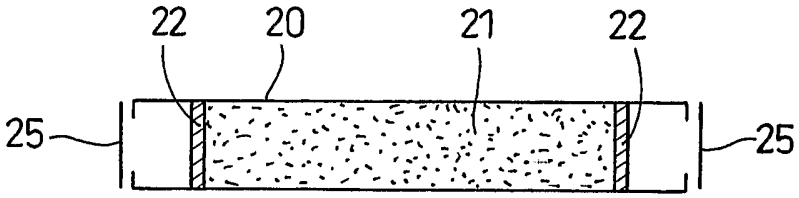

Fig. 3C

INTERNATIONAL SEARCH REPORT

Intern[illegible] Application No
PCT/GB2005/001517

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N31/22 G01N33/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 01, 31 January 1997 (1997-01-31) & JP 08 224239 A (UEDA HIDEO), 3 September 1996 (1996-09-03) abstract -----	1,6,13, 15-22
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 02, 29 February 2000 (2000-02-29) & JP 11 316223 A (OYA HIROSHI), 16 November 1999 (1999-11-16) abstract -----	1,6,13, 17,20,22
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
18 July 2005	02/08/2005

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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