Dec. 14, 1965 M. J. LUCKEY 3,223,488

DEVICE FOR ALCOHOL DETERMINATION

Filed Aug. 6, 1962

FIG. 1

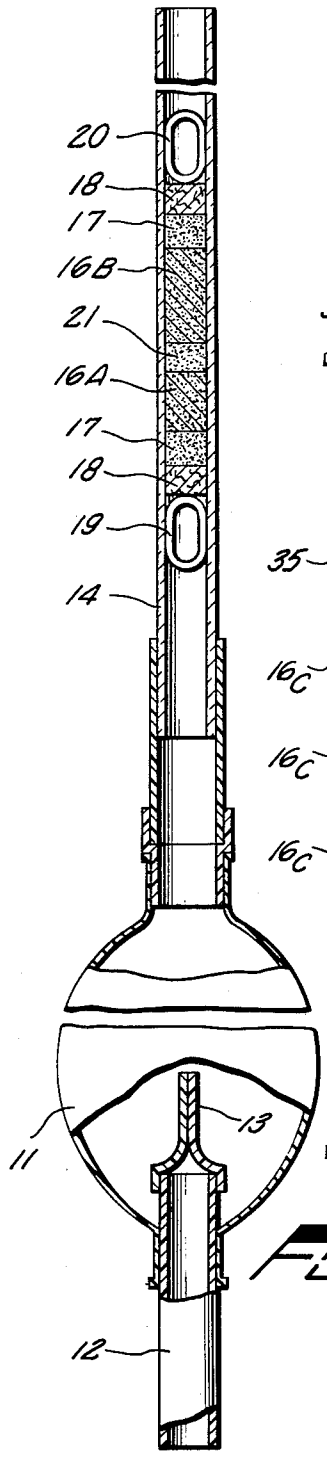


FIG. 2

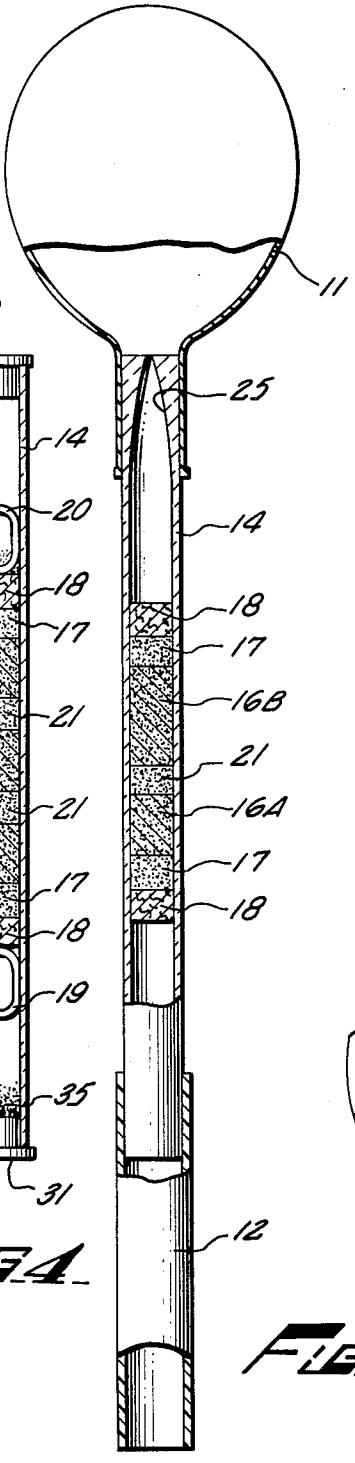


FIG. 4

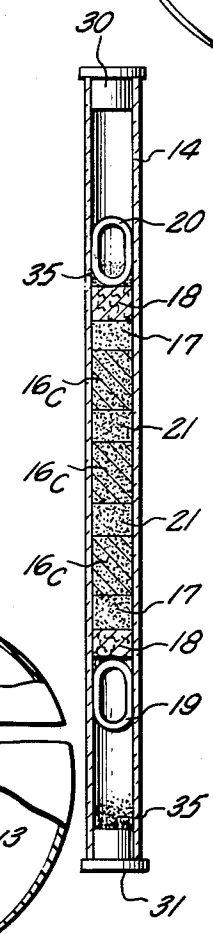
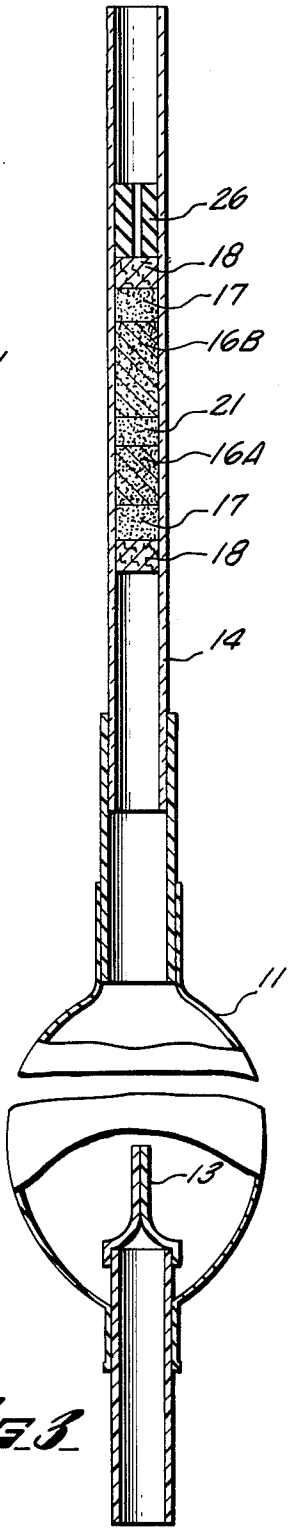


FIG. 3



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3,223,488

DEVICE FOR ALCOHOL DETERMINATION

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11 Claims. (Cl. 23—254)

This application is a continuation-in-part of my co-pending application Serial No. 168,925, filed Jan. 26, 1962, entitled Formula for Alcohol Determination and Device for Using Same, and now abandoned.

This invention relates to an alcohol indicator, and more particularly to an indicator for visual determination of the alcohol content in human alveolar breath.

It is known that there is a fixed relationship between the concentration of alcohol in the alveolar breath, which is lung breath, and the concentration of alcohol in the blood circulatory system. Many devices are therefore presently utilized by law enforcement agencies and others for measurement of breath alcohol content. Although certain of these devices are concerned with collecting quantitative samples of alcohol from the breath, such apparatus must be returned to a laboratory for chemical analysis before the final results are obtained. This invention is concerned with a device to permit an immediate visual approximation of the degree of intoxication of the subject, such determination to be made by a chemically untrained police officer or other individual.

Apparatus for visual determination of intoxication due to the level of breath alcohol concentration is known in the art, but prior devices have had several disadvantages which have hindered their effective use. First of all, prior art devices of the type described in United States Patent No. 2,591,691, do not permit an approximation of the extent of breath alcohol concentration to be made visually, and, further, provide no lasting record of such approximation as is made. In such devices, the degree of intoxication is approximated by timing the length of time required for an alcohol sensitive reagent to change color when exposed to alcohol-containing breath. Failure to keep the time accurately impairs the accuracy of results, and once the reaction of color change has occurred, there is no means for subsequently checking the results other than the observer's recollection of the passage of time. The chemicals used in the reactions of such prior art devices must be kept in a liquid form and physically placed upon a glass frit when the devices are to be used. Since such placement usually has to occur under field conditions, errors frequently occur due to spillage and the like.

Improved reagents have been provided in order to avoid mixing together of the materials in the field, such as that disclosed in United States Patent No. 2,939,768. Such reagents still have the disadvantage that once the reaction with alcohol has occurred, there is no remaining visual indication of the approximate breath alcohol concentration of the subject, other than an observer's recollection of the time required to produce a color change. It is a further disadvantage of such reagents that additional materials serving a catalytic function are required. Another disadvantage is that potassium dichromate, such as disclosed in the foregoing patent, has a very low water solubility. As a result, the ingredients are required to be mixed in a dry state with a silica gel carrier. Extensive shaking is required to approach a uniform distribution of the dry powders over the carrier, and frequently there is a lack of uniformity which impairs the uniformity of color change and accuracy of the results obtained.

This invention resolves the foregoing difficulties by providing a device for breath alcohol content determination which produces a substantially permanent visual indication of the approximate alcohol concentration in the subject's breath. This invention also provides a novel alcohol sensitive reagent in liquid form, thereby assuring uniform distribution of the reactive materials of the reagent over the silica gel carrier.

Briefly, this invention provides a container such as a balloon for receiving the breath of the subject, the balloon or container being calibrated to exert a pressure within a predetermined range of pressures when inflated to a predetermined point. A transparent indicator tube is arranged to communicate with the interior of the container for receiving breath therefrom. Flow restricting means are provided to restrict the rate of flow of breath through the tube to a predetermined flow rate at the pressure of the breath from the container. A granular alcohol sensitive indicator is disposed within the transparent tube and is comprised of a silica gel impregnated with a liquid alcohol sensitive reagent. The granular alcohol sensitive indicator is adapted to chemically react with alcohol to produce a progressive color change, due to the novel composition of the reagent. The alcohol-containing breath will cause the color change to progress only partially through the granular alcohol sensitive indicator, unless the subject is extremely intoxicated, so that by visual observation of the distance to which the color change has progressed, an approximation of the breath alcohol concentration of the subject may be made from visual observation. Visual marking means are also provided along the granular alcohol sensitive indicator for indicating a point therealong to which the color change will progress during a predetermined length of time in response to the passage of breath therethrough at the predetermined balloon pressure and flow rate when such breath contains that percentage of alcohol which indicates a blood alcohol content at any selected predetermined level, in order to provide a reference point for approximation of the subject's degree of intoxication.

This invention will be more clearly understood with reference to the accompanying drawings in which:

FIG. 1 is a cross-section view of a device for visual determination of breath alcohol concentration according to the present invention;

FIG. 2 is a cross-section view of a portion of another embodiment of the present invention;

FIG. 3 is a cross-section view of a portion of yet another embodiment of the present invention; and

FIG. 4 is a cross-section view of yet another embodiment of the present invention.

Referring now to the drawings, attention is directed to FIG. 1 for a detailed consideration of one embodiment of the present invention. A container for breath is provided, such as a balloon **11** to be inflated, having a mouthpiece **12** for receiving alveolar air from the subject. A flutter valve **13** attached to the mouthpiece **12** prevents the air from passing back out of the balloon **11** after inflation. The end of the balloon **11** opposite the mouthpiece **12** is adapted to receive a transparent alcohol indicator tube **14** which communicates with the interior of the balloon **11**.

The balloon **11** is calibrated to exert a pressure within a predetermined range of pressures upon the air contained therein at times when the balloon is inflated. This calibration may be accomplished by measuring the balloon pressure with a water manometer. In practice, balloon pressure measuring from 11 through 13 inches on the water column of a water manometer has been found to be satisfactory. Other containers for receiving the subject's breath and discharging the same into the tube **14** at a predetermined pressure may be used, and are within the scope of this invention. Although the pressure may lower during deflation, the balloon or container is adapted

to maintain pressure within the predetermined range during such deflation as occurs during testing of the subject's breath.

The alcohol indicator tube **14** is a length of transparent material, such as glass, and may be made from any transparent material which is not reactive with the chemicals used in the granular alcohol sensitive indicator described below.

A granular alcohol sensitive indicator indicated generally at **16** is disposed within the tube **14**. A layer of glass grit **17** may be disposed adjacent each end of the granular indicator **16** to assist in holding it in place. Fibrous packing material **18** may be disposed adjacent each layer of glass grit **17** and may be made from any suitable material which is not chemically reactive with the granular indicator **16**, such as acrilan packing. A pair of retainer members **19** and **20**, preferably in the form of polyethylene O-rings which may be split, are disposed longitudinally within the tube **14**, one O-ring being placed against each wad of packing material **18** to position the packing, indicator, and grit centrally of tube **14**.

Since apparatus of this type is frequently carried on motorcycles and subjected to vibrational forces, and since, as will appear below, the position of the granular alcohol sensitive indicator **16** and the density of packing of all of the materials within the tube **14** must be maintained, the provision of proper positioning means is quite important. Such positioning means must not interfere with the flow of breath through the tube **14**, but must be sturdy enough to withstand the vibrational forces to which the apparatus is subjected. The results obtained by use of the pair of O-rings **19** and **20** have been surprising, and it has been found that the materials have been held within the tube in proper position, even after violent shaking. The diameter of O-rings **19** and **20** is greater than the inner diameter of the tube **14** so that upon insertion of the O-rings **19** and **20** longitudinally within the tube **14**, they are compressed and act in a spring-like manner to maintain their position.

The granular alcohol sensitive indicator **16** is comprised of a silica gel impregnated with a liquid alcohol sensitive reagent. It is a feature of this invention that the granular alcohol sensitive indicator **16** is adapted to react with alcohol to produce a progressive color change, so that only a portion of the indicator **16** may change color, that portion of the granular alcohol sensitive indicator **16** which has changed color being directly proportional to the amount of alcohol present in the breath passing through the tube. In order to obtain such a reaction, rather than a complete color change of the entire indicator as has been found in prior devices, it is necessary that gel of a small size be used together with a reagent adapted to supply an excess of chromate ions over the amount necessary to react with the amount of alcohol expected to be supplied through the tube.

Preferably, the silica gel should be of a mesh size as small as possible, consistent with the necessity for providing passage therethrough of the breath. In practice, it has been found that silica gel of 35 to 60 mesh size provides optimum results. The small mesh size gel places each granule in close proximity to other granules so that the molecular action, after impregnation, is similar to that of a liquid, yet there remains room for circulation of the breath therethrough. The silica gel should also have a high absorption capacity, preferably having the ability to absorb from 50 to 100% of its own weight. By way of example, one gram of the silica gel utilized in the indicator has been determined to have an absorption capacity of from .8 to 1 milliliter of the liquid alcohol sensitive reagent described below.

The liquid alcohol sensitive reagent is made from a mixture of concentrated reagent grade sulfuric acid, distilled water, and a substance for supplying a source of chromate ions. Preferably, the sulfuric acid is 95–98% pure. The chromate ion-supplying substance must have a high water solubility, in order that a liquid reagent may be made. In practice, it has been found that hydrated sodium dichromate ($Na_2Cr_2O_7$–$2H_2O$) meets the foregoing requirements as a source of chromate ions, although other chemicals may be used, such as ammonium dichromate. Sodium dichromate has a solubility in water of 207 grams per 100 grams of water, as compared with potassium dichromate used in certain prior devices which has a solubility of only about 4.9 grams per 100 grams of water. The alcohol sensitive reagent provided as a part of this invention has from .00100–.00167 gram moles of chromate salt (exclusive of waters of hydration) dissolved in 10 milliliters of sulfuric acid at substantially 1.75 specific gravity. More specifically, the indicator of this invention may be prepared by dissolving 300–500 milligrams of sodium dichromate in acid solution and passing a quantity of this solution over granulated silica gel sufficient to provide from 9–20 milligrams of sodium dichromate per gram of silica gel. By way of example, and not by way of restriction of the scope of this invention, a preferred formulation of the liquid alcohol sensitive reagent is according to the following formula:

425 milligrams sodium dichromate
2 milliliters distilled water
8 milliliters (97%) reagent grade sulfuric acid

The amount of liquid reagent with which the silica gel is impregnated must be substantially less than that amount which would fully impregnate the silica gel, in order that the moisture and alcohol from the breath may be subsequently absorbed. When the liquid alcohol sensitive reagent is made in accordance with the foregoing formula, it has been found that satisfactory results will be obtained if approximately 0.3 milliliters of the reagent is added to each gram of silica gel, although up to 0.4 millilters may be added. For a stronger and more immediate color reaction, an additional quantity of the liquid reagent may be added to the silica gel after the initial quantity has been absorbed. In practice, the moisture from the subject's breath combines with the sulfuric acid, producing heat, which heat serves as a catalyst to the alcohol-sodium dichromate reaction. It has been discovered that metallic ions can be used as catalysts if heat is not available.

A granular alcohol sensitive indicator **16** made in accordance with the present invention, according to the foregoing formula, has a dark yellow or orange color, and upon exposure to alcohol, turns to a dark green color which progresses along the length of the indicator **16**. At the cessation of breath passage, the progression of the color change ceases, leaving a clear and substantially permanent demarcation line. The progressive color change is therefore controllable.

The use of a highly soluble source of chromate ions makes possible the preparation of a liquid alcohol sensitive reagent. The use of a liquid reagent, in turn, makes possible precise measurement of the chemical quantities used on the silica gel carrier. This creates a tremendous increase in accuracy and dependability over prior devices.

In order that accurate results may be obtained, it is necessary that a known quantity of breath be passed through the granular alcohol sensitive indicator, which contains known quantities of the alcohol sensitive reagent. Since the pressure of the breath emerging from the balloon or other container is known, because of the use of a calibrated container, flow restricting means are provided to restrict the flow of breath through the tube to a predetermined rate. In the embodiment shown in FIG. 1, the flow restricting means consists of all of the contents of the tube **14**, that is, the granular alcohol sensitive indicator **16**, the glass grit **17**, and the packing material **18**. Such material is packed into a tube **14** at a sufficient density, or tightness, to restrict the breath flow to the desired rate. For example, in the embodiment illustrated in FIG. 1, the material may be packed to provide a flow rate of substantially

800 cubic centimeters per minute when used with a calibrated container as described above.

In order that the extent of progressive color change may be correlated to specific corresponding percentages of blood alcohol content, visible marking means **21** may be provided as a reference point. The visible marking means **21** may be a layer of glass grit, not subject to color change, as shown in FIG. 1, or may be any other suitable marking such as a line placed upon the exterior of the tube **14**. The marking means **21** are disposed along tube **14** so as to separate the indicator **16** into a portion **16A** adjacent the air source and into a portion **16B** remote from the air source. Indicator portion **16A** is of a shorter extent axially of tube **14** than portion **16B** as shown in FIG. 1, but it is within the scope of the invention that both portions **16A** and **16B** may be of equal extent. Since the flow rate is known, and the quantities of liquid alcohol sensitive reagent present in each indicator portion **16A** and **16B** are known, the extent of progression of the color change in the presence of breath indicating a particular blood alcohol content during any predetermined length of time may be calculated. Since only alveolar breath has alcohol content, the calculations must be adjusted accordingly for accuracy. It has been found after extensive experimentation that the proportion of alveolar air in the container will never exceed 80% of the total, and may be less. The calculations of alveolar alcohol content, however, are made upon the basis that 75%, or even 60–75% of the breath passing through the tube is alveolar. The 75% value takes into consideration the relaxed and shallow breath character of a subject who is intoxicated and increases the admissibility as evidence of the results of a test performed with the device. As the percentage may be less, but never more than 75–80% in such cases, any error thereafter will be in favor of the subject. The visible marking means **21** is normally placed at that point indicating the presence of a sufficient amount of breath alcohol to show a blood alcohol content at the level of legally-presumed intoxication. The extent of color change on either side of the visible marking means **21** provides a basis for approximation of the degree of intoxication of the subject. In practice, a period of flow of one minute is used as the basis for calculations. During such period the container or balloon **11** will not have deflated sufficiently to have substantially altered the predetermined pressure.

It is not necessary to restrict the rate of breath flow by means of the packing density of the materials in the tube **14**. In the embodiment of the invention shown in FIG. 2, tube **14** is disposed between mouthpiece **12** and balloon **11** and includes a constriction or orifice, indicated generally at **25**, adjacent balloon **11**. As in the apparatus shown in FIG. 1, the shorter length of indicator **16A** is adjacent the source of breath air. The device is operated by having the subject blow into mouthpiece **12** until balloon **11** is inflated to a predetermined size. When the balloon reaches the predetermined size, the proper amount of alveolar air has passed through tube **14**. The orifice **25** regulates the rate at which breath air passes through tube **14**.

FIG. 3 shows a third embodiment of the invention; the order of components with respect to breath flow is similar to that shown in FIG. 1 and the method of operation of the device shown in FIG. 3 is like that of the device shown in FIG. 1. The structure shown in FIG. 3 includes a metering or breath flow regulating plug **26** disposed in tube **14** abutting the fiber packing **18** opposite indicator portion **16B** from balloon **11**.

FIG. 4 shows a preferred embodiment of the indicator tube **14** for use in conjunction with balloon **11**. In FIGS. 1, 2 and 3 the indicator portions **16A** and **16B** of the contents of the tubes **14** are of unequal length longitudinally of the tubes. It has been recognized generally that an alveolar air alcohol content of 0.15% or greater has significant relation to the legal question of whether or not a person is under the influence of alcohol; below 0.15% the intoxication of a person is questionable. In FIGS. 1, 2 and 3 the shorter **16A** of the alcohol sensitive indicator portions **16** is adjacent the source of air to be tested. The length of the shorter indicator portion **16A** is predetermined to indicate 0.15% breath alcohol content if the entire portion changes color. The longer of the indicator portions **16B** corresponds to an additional 0.30% breath alcohol content. Since only two color portions **16** are provided in the tubes shown in FIGS. 1, 2 and 3, it is important that the person administering the test connect the proper end of tube **14** to the balloon **11** so that indicator portion **16A** is the alveolar air source. In this way, a comparison of the condition of the subject with respect to the legal threshold of intoxication may be determined with accuracy.

In many cases, however, the person administering the test must work under adverse conditions, such conditions often producing errors in the manner of connection of a tube to a balloon so as to destroy the legal effectiveness of the results of the test. The tube shown in FIG. 4 is prepared so that either end of tube **14** may be connected to balloon **11** merely by removing one of the stoppers **30** or **31** fitted into the opposite ends of the tube to seal the contents of the tube from contamination until the tube is to be used. Three equilength reagent alcohol sensitive indicator portions **16C** are provided in conjunction with two glass grit marker portions **21**. Each of the three indicator portions **16** has a predetermined length such that a change of color of the entire indicator portion signifies 0.15% alcohol content in the breath of the subject. Preferably stoppers **30** and **31** are fabricated of a material, such as polyethylene, which is not reactive with the reagent contained within the tube. It is to be understood that the tube illustrated in FIG. 4 may incorporate the features of the tubes shown in FIGS. 2 and 3.

In FIG. 4, a quantity of silica gel **35** is disposed loosely in the tube **14** between the plugs of fiber packing **18** and the stoppers **30**, **31** to stabilize the tube prior to use. It has been found that the indicator bands **16** tend to show a slight color change prior to use of the device unless precautions are taken to stabilize the chemicals in the reagent. Between the time the tube **14** is made up and the time the tube is connected to a balloon **11** for testing the breath alcohol content of a subject, sulfur dioxide (SO_2) is given off from the reagent in the indicator bands **16** and reacts as a reducing agent. This and other reducing materials react with the reagent and cause a slight degree of color change of the reagent. The result is that a spurious indication of a subject's breath alcohol content is obtained.

The silica gel particles **35** are chemically inert and have a selective affinity for gases such as freons, methyl chloride, methylene chloride, sulfur dioxide, for example. The gel particles **35** preferably have a mesh size of from 12–28 mesh. Approximately 1–3 grams of these crystals are placed in each end of the tube **14** and are dumped from the tube when the tube is used in a test. Silica gel particles having the above qualities are commercially available from Davidson Co., Baltimore, Maryland, under the designation PA–400.

Gel particles **35** absorb sulphur dioxide vapors and other spurious gases such as water vapor given off by the reagent to stabilize the characteristics of the tube as prepared. It is still preferred, however, that the material used in preparing the tube **14** be chemically inert with respect to the agent.

It is possible, consistent with the scope of this invention, to use potassium permanganate ($KMnO_4$) and an acid carrier in an indicator reagent. In such a case, however, the reagent rapidly reduces of its own accord and results in a short-lived indicator tube **14**. It was for this reason that the apparatus disclosed in Patent 2,591,691 requires the addition of a quantity of liquid $KMnO_4$ to the granular material at the time the breath analysis is to be made. It has been found that use of a reagent consisting of $KMnO_4$

and H_2SO_4, in conjunction with silica gel, is satisfactory as an indicator for only approximately twenty-four (24) hours, after which time the reagent is reduced and changes from a pink to a brown color. Addition of a buffer to the reagent to control the activity of the OH- ion of the reagent may extend the life of a $KMnO_4$-type reagent. Alternatively, an inert gas such as nitrogen may be passed through the tube to stabilize the reagent. In either case, the indistinct color differential is still a problem which is not encountered with the chromate-type reagent.

This invention, utilizing a chromate reagent in its preferred form, has advantages over a permanganate reagent in that a permanganate is sensitive to vapors other than alcohol vapors. For example, permanganate reacts very rapidly to the presence of acetone which is present in small amounts in the breath of a diabetic. It is recognized that a diabetic may at times behave in a manner similar to that of a person who is under the influence of alcohol. A permanganate-type reagent used in testing the breath of a diabetic therefore would be inconclusive; on the other hand, a chromate-type reagent as compounded according to this invention is substantially insensitive to the presence of acetone in alveolar breath and use of a chromate-type indicator is fair to a diabetic subject.

It was mentioned above that the chromate reagent provided in a preferred form of this invention manifests a progressive color change when alcohol-bearing alveolar breath is passed through the tube **14** at a constant rate for a predetermined period of time. This progressive color change is the result of providing an excess of chromate ions in the silica gel disposed in tube **14**. The inventive teachings of this invention may also be accomplished by providing a reagent which has a predetermined number of chromate ions therein which predetermined number corresponds to a predetermined percentage of alcohol in alveolar breath. In such a reagent, the subject's breath is passed through the silica gel matrix for a predetermined period at a predetermined flow rate. If the subject's breath has an alcohol content equal to or greater than the predetermined quantity to which the indicator reagent is calibrated, then the reagent will change color within, or at the end of, the predetermined period of time. If the color change is to occur in a reagent which does not provide an excess of chromate ions, the color change occurs substantially instantaneously and may not be progressive. It was pointed out above, however, that providing a progressive color change enables the administrator of the test to determine the extent to which the subject's breath alcohol content exceeds the predetermined level. Such is not the case where the color change occurs instantaneously, as in devices according to the prior art and in devices wherein the reagent may be dry but does not provide an excess of chromate ions.

In any of the several embodiments of indicator tubes **14** described above, the sodium dichromate saturated gel may be mixed uniformly with a quantity of glass grit having particle sizes of the same mesh size as the silica gel. This provides a variation in apparent reagent concentration and allows a longer body of reagent gel **16** to be used to indicate a fixed breath alcohol concentration. Spreading a fixed amount of reagent over a greater axial extent of a tube **14** increases the accuracy of visual observations of color change so that smaller amounts of alcohol may be detected with the same accuracy as larger amounts in an unmodified tube.

While the invention has been described above in connection with specific apparatus, chemical constituents and ranges of percentages of constituents, this has been by way of example and explanation, and is not to be considered as limiting the scope of the invention, except as specified in the following claims.

I claim:

1. In apparatus for determining the alcohol content of human alveolar breath including a container for breath calibrated to exert a pressure within a predetermined range of pressures upon breath contained therein, and a mouthpiece communicating with the interior of the container for filling the container with alveolar breath, an improved article of manufacture for visually indicating said alcohol content comprising a transparent indicator tube communicating with the interior of the container, flow restricting means within the length of the tube for restricting the rate of flow of breath from the container through the indicator tube to substantially a predetermined rate at the predetermined range of pressures, a body of granular material disposed in the tube and impregnated with an alcohol sensitive indicator which chemically reacts with alcohol in breath flowing through the tube to produce a color change, whereby the indicator changes color progressively along the tube in proportion to the quantity of alcohol reacting therewith, and a layer of inert grit material in the body of granular material for visually indicating a point along the body to which the color change will progress during a predetermined period of time in response to the passage of breath therethrough at the predetermined flow rate when such breath contains that percentage of alcohol which indicates a blood alcohol content at a predetermined level, whereby the approximate percentage of alcohol in the blood of the person whose breath is passed through the tube is visually determinable by comparison of the extent of progressive color change actually produced in said period of time relative to the layer of inert grit material.

2. Apparatus according to claim **1** wherein the flow restricting means comprises the granular material, inert grit material, and packing material, all of which is packed within the tube at a predetermined density for restricting the flow of breath through the tube.

3. In apparatus for indicating the approximate alcohol content in the alveolar breath of a human subject including an expansible container for the subject's breath calibrated to exert a pressure within a predetermined range of pressures upon breath introduced thereinto when inflated to a predetermined size, and an inlet into the container adapted to be engaged with the mouth of the subject for inflating the container with alveolar breath, an improved article of manufacture for visably indicating said alcohol content comprising an elongated transparent hollow tube having spaced apart open ends, one of the ends being connected to the container whereby the interior of the tube communicates with the interior of the container, flow restricting means in the tube for restricting flow of breath through the tube to substantially a predetermined rate at said pressure, at least two bodies of granular material disposed in the tube and impregnated with an alcohol sensitive indicator substance, the bodies having a characteristic color which changes as alcohol vapor is absorbed in and reacts with the indicator substance, whereby the color change progresses along the tube away from the container in proportion to the quantity of alcohol vapor absorbed in the substance, a body of glass grit disposed between the bodies of granular material, means in the tube proximate the bodies of granular material opposite from the glass grit for positioning the granular material and the glass grit in the tube, the extent of color change of the substance first in one body of granular material and then in the other relative to the body of glass grit being visually observable through the tube to indicate the percentage of alcohol present in the breath passed through the tube.

4. In apparatus for indicating the approximate alcohol content in the alveolar breath of a human subject including an expansible container for the subject's breath calibrated to exert a pressure within a predetermined range of pressures upon breath introduced thereinto when inflated to a predetermined size, and an inlet into the container adapted to be engaged with the mouth of the subject for inflating the container with alveolar breath, an improved article of manufacture for indicating said alcohol content comprising an elongated transparent hol-

low tube of predetermined internal diameter having spaced apart open ends, one of the ends being connected to the container whereby the interior of the tube communicates with the interior of the container, flow restricting means in the tube for restricting flow of breath from the container through the tube to substantially a predetermined rate at said pressure, at least two bodies of granular material disposed in the tube, each body of granular material being impregnated with an alcohol sensitive indicator substance and extending a predetermined distance along the tube, the bodies being essentially dry and having a characteristic color which changes to a contrasting color as alcohol vapor is absorbed in and reacts with the indicator substance, whereby the color change progresses along first one body of granular material and then the other away from the container in proportion to the quantity of alcohol vapor absorbed in the substance, a body of glass grit disposed between and abutted by the bodies of granular material, and means in the tube proximate the end of each body of granular material opposite from the glass grit for positioning the indicator material and the glass grit in the tube, complete change of color of each body within a predetermined time when breath flows through the tube at said predetermined rate indicating to a predetermined percentage of alcohol in the subject's breath, the extent of color change in the bodies of granular material relative to the body of glass grit being visually observable through the tube to indicate the percentage of alcohol present in the breath passed through the tube.

5. Apparatus according to claim **1** wherein the flow-restricting means comprises a constriction adjacent one end of the tube.

6. Apparatus according to claim **1** wherein the flow-restricting means comprises a metering valve disposed within the tube.

7. Apparatus according to claim **1** wherein the granular material and the alcohol sensitive indicator comprise, respectively, silica gel and a liquid alcohol sensitive reagent made from a mixture of concentrated sulfuric acid, distilled water, and a chromate ion-producing substance having water solubility characteristics at least high enough so that the weight of that quantity of water required to dissolve the substance is less than the weight of the substance to be dissolved therein.

8. Apparatus according to claim **7** wherein the silica gel has an absorption capacity in the range of from 50% to 100% of its own weight.

9. An alcohol sensitive indicator according to claim **7** wherein the chromate ion-producing substance is sodium dichromate.

10. Apparatus according to claim **4** wherein the granular material comprises particles of silica gel and wherein the indicator substance comprises a quantity of a solution of

(a) from .00100–.00167 gram moles of a salt which when hydrolyzed provides chromate ions and

(b) substantially 10 milliliters of sulfuric acid at a specific gravity of substantially 1.75, the quantity of solution being present in the silica gel in an amount sufficient to provide from .000030 to .000067 gram moles of salt per gram of silica gel.

11. Apparatus according to claim **10** wherein the indicator substance comprises a quantity of a solution of

(a) about 425 milligrams of sodium dichromate

(b) about 2 milliliters of distilled water

(c) about 8 milliliters of 97% pure sulfuric acid, and wherein the solution is present in the silica gel in an amount sufficient to provide from 9–20 milligrams of sodium dichromate per gram of silica gel.

References Cited by the Examiner

UNITED STATES PATENTS

2,174,349	9/1939	Littlefield	23—232
2,569,895	10/1951	Main-Smith et al.	23—254
2,591,691	4/1952	Forrester	23—232
3,119,670	1/1964	Mitchell	23—232

FOREIGN PATENTS

578,745	7/1946	Great Britain.

OTHER REFERENCES

Dragerwerk 1,037,725, 8/1958, German printed application (3 pp. spec.; 1 sht. dwg.).

Hobbs: "Anal. Chem." 30, 778–792 (1958).

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