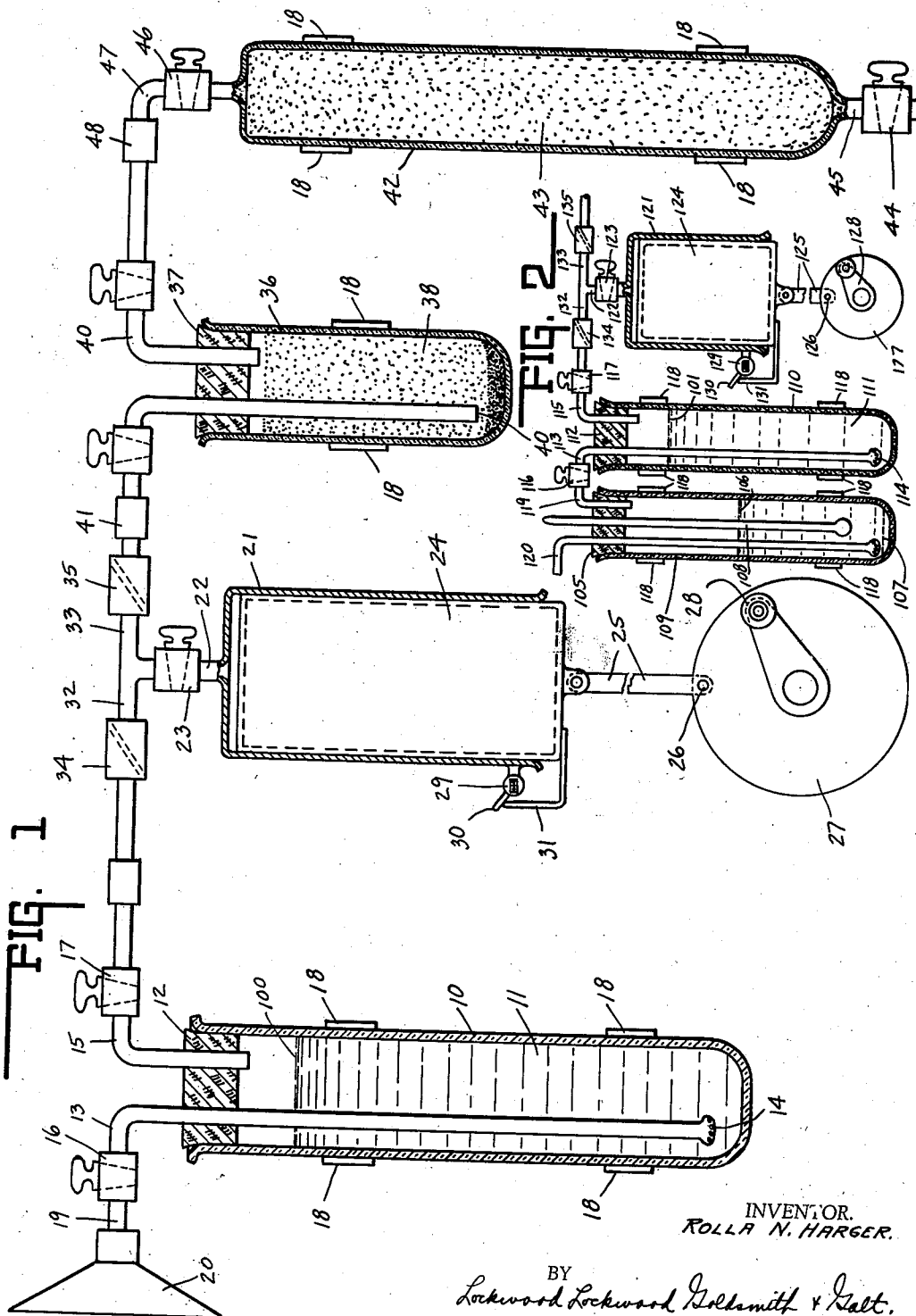


Dec. 1, 1936.

936. **R. N. HARGER** 2.0
APPARATUS FOR AND PROCESS OF READILY DETERMINING ALCOHOL
CONCENTRATIONS IN LIVE ANIMALS AND SOLUTIONS
Filed June 11, 1932

2,062,785



INVENTOR.
ROLLA N. HARGER.

BY
Lockwood Lockwood Goldsmith & Salt.

ATTORNEYS.

UNITED STATES PATENT OFFICE

2,062,785

APPARATUS FOR AND PROCESS OF READILY DETERMINING ALCOHOL CONCENTRATIONS IN LIVE ANIMALS AND SOLUTIONS

Rolla N. Harger, Indianapolis, Ind.

Application June 11, 1932, Serial No. 616,661

4 Claims. (Cl. 23—232)

This invention relates to a process of and apparatus for determining the presence of alcohol in solutions or a living animal and the amount thereof.

5 It is a well established fact that when air remains in contact with an aqueous solution of alcohol until equilibrium is established, this air will absorb a definite quantity of alcohol so that a fixed ratio will exist between the concentration of alcohol in the air to that of the water. This is called the partition ratio.

10 It has also been chemically determined that the degree of intoxication of any person is proportional to the concentration of absorbed alcohol in the person's blood. When this concentration is one part per thousand in blood, intoxication begins; at about five parts per thousand, the person is "dead drunk" or in a condition of unconsciousness, and the fatal concentration is about six parts per thousand.

20 Blood tests obtained a considerable period after an automobile accident, are, except in extreme cases of intoxication, not reliable or accurate with reference to the possible intoxicated condition of the driver at the time of the accident. Even an interval of an hour is sufficient for one slightly intoxicated to burn up or oxidize sufficient alcohol, that is, to sober up. The odor on the breath is not a reliable test for intoxication.

30 Evidence obtained by blood testing is open to two objections—one legal, the other practical. The legal objection, is, if the results are obtained without the person's express consent, said results are classed with "confessions obtained under duress". The practical objection is that a highly technical laboratory assistant is required to be present to obtain the blood sample of the alleged intoxicated driver and this must be very shortly after the accident, or the evidence will be worthless even if legally admissible.

40 The present invention eliminates both of the aforesaid objections, and is based upon the fundamental fact, determined by experiment, that two litres of breath (alveolar air), contain substantially the same amount of alcohol as one cubic centimeter of blood. Thus, if the blood contains two parts of alcohol per thousand, there will be two cubic centimeters of alcohol for one thousand cubic centimeters of blood, and a breath volume of two thousand litres would contain two cubic centimeters of alcohol.

50 Alveolar air (true breath) contains, experiment demonstrates substantially $5\frac{1}{2}\%$ carbon dioxide. This fixed alcohol-breath (alveolar air)—carbon dioxide— blood ratio is the basis of

the present invention. In brief, the intoxication test determines the alcohol-carbon dioxide ratio.

The present invention is directed to the employment of a process and use of apparatus and materials that do not require the presence of a technician to obtain the necessary sample to be tested.

Likewise, the present invention operates at all ordinary temperatures—that between 10 degrees below zero centigrade to 40 degrees centigrade—requires not more than a pint of breath and each test may be completed in about two minutes.

The present invention has been fully compared with blood testing and the results obtained from numerous tests have proven that the blood alcohol concentration may be accurately determined by this invention.

20 The present invention utilizes permanganic acid or a salt thereof, and in a sufficient amount to produce a distinct color which color undergoes a distinct change upon addition of ethyl or grain alcohol.

25 One of the reagents used is sulphuric acid which is mixed with water, the mixture having a specific gravity of 1.29 to 1.62 with ranges between 1.3 and 1.6 satisfactory, and a specific gravity of about 1.4 to 1.5 preferred. The lower gravity mixture reacts too slow for so-called "spot" testing. With the heavier gravity the acid reacts very rapidly with the permanganate decomposing it as it is added. This prevents the use of the mixture for test purposes.

30 From the foregoing the presence of grain (ethyl) alcohol in the breath can be visually determined promptly for example, at the scene of the accident—in other words, on the spot. Normal atmosphere contains only about 0.04 of one percent of carbon dioxide or four parts per ten thousand. Alveolar air contains $5\frac{1}{2}\%$ percent carbon dioxide. Any so-called dilution by atmospheric air, therefore is relatively negligible in quantitative calculations. All that is necessary is to measure the carbon dioxide in the breath passed through the apparatus and compare same against the known amount of alcohol required to effect the color change in the known amount of color changeable medium. This ratio can then be directly changed into an alcohol-blood ratio which is a measure of intoxication.

45 Precaution should be exercised to remove the moisture from the air handled before passing it through the carbon dioxide fixing or measuring device.

50 One limitation in the present invention is that the color changeable liquid must be fairly fresh

and should be mixed at the time of taking of the sample or testing or very shortly thereafter. This invention is a true test of the degree of intoxication of the testee at the time of the test, irrespective of how much alcohol may have been imbibed. In other words, this invention for testing intoxication is not dependent upon any tolerance factors or when the alcohol was imbibed.

Apparatus suitable for practicing the invention is illustrated in the drawing and said disclosure is to be considered as merely illustrative of mechanism suitable for practicing the invention.

In the drawing, Fig. 1 is a diagrammatic view of apparatus necessary for obtaining quantitative and qualitative tests for alcohol in blood.

Fig. 2 is a similar view of apparatus necessary for obtaining quantitative and qualitative tests for alcohol in solutions.

In Fig. 1 of the drawing 10 indicates a suitable container in which is placed a predetermined amount of a mixture of sulphuric acid and water of a known specific gravity to which is added a small measured amount of permanganic acid, or the salt of permanganic acid, the amount being sufficient to produce a distinct color change upon exposure to ethyl alcohol or alcoholic vapor. A salt which has proven satisfactorily is potassium permanganate. To one volume of N-20th permanganate add 15 to 16 volumes of sulphuric acid having a specific gravity of 1.4 to 1.5 (1.42 being preferred).

The resulting chemical equation can be determined and this particular mixture has the property of reacting rapidly with ethyl alcohol and what is more important while the mixture is cold. The test liquid is a color changeable liquid. This test liquid has the usual reddish purple color. The proper shade is approximately that known as "orchid". Upon the passage of sufficient ethyl alcohol vapor through the liquid or addition of sufficient alcohol to the liquid, the color changes to almost clear or a very faint light brown color.

The vessel 10 includes a suitable closure such as a stopper 12 and an intake line 13 passes through the cork or closure, and terminates near the bottom of the container in a distributing head 14. A discharge line 15 also passes through the cork 12 and the air to be tested is taken in through line 13, discharged at 14 and bubbles up through the liquid 11 and discharges through the line 15. The line 13 includes a shut-off valve 16 and the discharge line 15 includes a shut-off valve 17. This tube with its intake and discharge line and control valves may be detachably mounted on a suitable base in a clip bracket 18. The valve is connected to an intake 19 and this intake is arranged to be detachably associated with a hood or mask 20.

When the testee is "dead drunk", semi or fully unconscious, the mask may be utilized and it is held immediately adjacent the testee's nose and as the testee exhales, the air is promptly sucked through the mask, lines 19 and 13 and into the container or test tube 10, and then passed out through the discharge line 15. An indicator not shown may be utilized to show the operator when the testee is exhaling. Such an element may be a strip of light weight paper or a feather. The mask may be omitted if the operator is sufficiently skilled in taking samples.

When the testee is sufficiently jubilant or exhilarated and conscious and is agreeable, the mask 20 may have substituted for it a mouth piece and the testee may then blow through the lines 19 and 20 and in this way no additional means for

sucking or pushing the air through the color changing liquid need be provided. The testee usually is quite agreeable to blowing through the liquid to see the color change. The foregoing represents the various conditions under which the qualitative presence of alcohol in the blood in an amount sufficient to cause even the slightest degree of intoxication, may be determined.

The means for passing the air or rather the breath of the testee through the test liquid when the testee is semi-conscious or unconscious, includes a combination pump and compressor. In the drawing, 21 indicates the cylinder with the combination inlet and outlet 22, controlled by a valve 23. Mounted in the cylinder is a piston 24 and the same may be power operable or manually operable. Herein, the piston is shown connected by a connecting rod 25 pivoted eccentrically at 26 upon a rotatably mounted disc 27 with which is associated a crank handle 28. As the handle 28 is rotated, the piston is reciprocated to and fro. Each reciprocation is of a predetermined stroke so that the total amount of air handled may be ascertained by providing a counting device 29 having an actuable finger 30 engaged by a tripping member 31 so that at each reciprocation the counting device records said reciprocation and the reciprocations are progressively tabulated.

The combination intake and outlet 22 in addition to having the valve 23, includes an intake 32 and a discharge 33. Intake 32 includes a check valve 34 and discharge 33 includes a check valve 35. Herein this unit device is shown connected to the discharge line 15 of the test liquid containing container. This device, however, may be connected to the line 19 and when so connected, the hood 20 is connected to the line 32 ahead of the check valve. In this latter arrangement, the piston and cylinder act as a suction pump upon the suction stroke and act as a force pump to force the breath through the testing liquid. When connected, as illustrated in the drawing, the piston acts as a suction pump and the breath of the testee passes through the hood 20, lines 19 and 13, through the liquid and then is sucked through discharge line 15 into the cylinder 21, and is exhausted through line 33.

When a quantitative test is desired, the breath after passing through the testing liquid, is passed through preferably a carbon dioxide fixing unit which includes a dehydrator indicated at 36. The dehydrator is conventionally illustrated as a test tube closed by a stopper 37. Mounted therein is a dehydrating material 38 which is normally non-reactive to carbon dioxide. Such a material is calcium chloride. The tube 39 passes through the closure or stopper 37 and terminates in an open end 40 so that the air passed through the color changing liquid passes into the dehydrator, then passes upwardly through the material 38 and is finally discharged through the outlet 40. Line 39 is herein illustrated as connected by the detachable connection 41 to the line 33 of the pump unit.

The carbon dioxide fixing unit also includes a vessel 42 having a known weight of material 43 which will readily react with the carbon dioxide in the dehydrated breath as it passes through the same and will abstract the carbon dioxide. This material may be soda lime. The change in weight of the carbon dioxide fixation device is the weight of the carbon dioxide which has passed into the vessel 42 and has been trapped therein. Vessel 42 includes a discharge valve 44 included in the discharge line 45. The intake valve 46 is

included in the intake line 47 which is connected by a flexible or detachable connection 48 to the discharge line 40 of the dehydrator unit. The valves 44 and 46 are provided so that the carbon dioxide fixation unit may be readily applied to the arrangement and then removed for replacement with another such device for multiple testing.

A portable testing device including the color changing vessel, pump, dehydrator and carbon dioxide fixation device, all may be included in a box or container and supported by portions thereof. A box or container having approximate dimensions of 5" or 6" in width, 6" to 8" in length and 2" to 3" in depth has been found sufficient. More elaborate apparatus could include racks to support additional carbon dioxide fixation devices and color changing units, these being detachably supported in clips, such as shown at 18. Each device 42 would have its total initial weight, including the weight of the carbon dioxide fixing material, indicated thereon.

Each color changing unit may be provided with a calibration mark 190 for indicating a predetermined amount of a color changing liquid. When that liquid changes from a violet or orchid shade to a clear or slightly brown tinge, then sufficient alcohol vapor or alcohol has passed through the same to effect that change. This amount is known. If all the air containing this known amount of alcohol is forced through the carbon dioxide fixation device and the weight of the carbon dioxide measured, then the amount of alveolar air which has passed through the color changing vessel is accurately determined and from this the degree of intoxication can be accurately determined.

As before stated, the apparatus disclosed in Fig. 1 is conventional and suitable for practicing the invention for alcohol-blood concentration determinations.

For the qualitative and quantitative analysis of determining the alcohol content of solutions and particularly of aqueous solutions, such as beverages and medicines, the present invention offers an easy and inexpensive method and without the use of expensive apparatus or highly skilled technicians.

In Fig. 2 of the drawing, such an apparatus is illustrated. In said figure numerals of the one hundred series indicate like or similar parts. 118 indicates clips supporting vessel or container 110 having therein the color changing liquid 111 previously described. Alcohol included air or other inert gas, such as nitrogen, is introduced at 114 by supply line 113. It passes through the liquid 111 having a level 101 and escapes through pipe 115 to a combination pump and measuring apparatus having the cylinder 121, piston 124, connecting rod 125, crank shaft 127 and power (handle) 128. Indicator mechanism 129, 130 and 131 records the volume of air passed through the liquid 111.

This air initially passes check 134 and by way of pipes 132 and 122 into cylinder 121. Extraneous air cannot enter because of check valve 135 in line 133. Upon comparison, the air in the cylinder is discharged from line 133 because check valve 134 prevents its reverse flow through liquid 111.

The liquid to be tested is placed in vessel 109 and to the level indicated at 107. Water is added as a diluent to level 106 and the vessel shaken to intimately mix the same. Stopper

105 is applied and valve 116 opened. Thermometer 108 indicates the temperature.

Upon the pump being actuated, air is taken in at 120, passed through the liquid in test tube 109 supported by clips 118 and supplied to vessel 110 by pipe 119.

The pump is reciprocated until the color change before mentioned is obtained, or if not obtained until a predetermined minimum amount of air is passed through liquid 111. In the later event, it can be said that there is no substantial amount or measurable quantity of alcohol in vessel 109.

Upon the color changing in vessel 110, the quantitative presence of alcohol in vessel 109 is determined. The volume handled, indicated by the pumpage, determines the alcohol percentage in the liquid tested. Levels 107 and 106 bear a known volume ratio. The amount of alcohol necessary to change the color in tube 110 is known. The amount of air or other inert gas pumped is known. Therefore, the alcohol inert gas ratio is known. If this gas be air, then the alcohol percentage is directly determinable as follows:—

The partition ratio is a function of the temperature. Thus at 37 degrees centigrade the ratio is approximately 1.2000; that is, at 37 degrees centigrade, 2000 volumes of air will contain the same weight of alcohol as one volume of water.

The determination of the concentration of alcohol in an aqueous solution of alcohol is obtained by simply analyzing air which has come to equilibrium with this solution at a given temperature. This is accomplished by passing a current of air through the solution to be tested and then through the alcohol sensitive reagent described. The number of strokes of the pump measures the volume of air containing the predetermined amount of alcohol necessary to change the color of the alcohol sensitive reagent. This gives the concentration of alcohol in the air analyzed and, the temperature being known, this is a measure of the concentration of alcohol in the fluid being tested.

For fluids high in alcohol such as whiskey, it is usually necessary to dilute with a known amount of water, say 100 volumes, before making the analysis. This dilution arrangement is indicated by reference to levels 106 and 107.

This method furnishes an easy rapid method for determining the alcohol content of beverages, etc., without the use of expensive apparatus or time consuming procedures.

While the invention has been described in great detail in the foregoing specification and the apparatus for practicing the same has been illustrated and described in the same detail, such detail description is not to be considered as of a restrictive character but the invention in its broad phases is to be considered solely from the scope of the appended claims.

The invention claimed is:—

1. A process of determining the degree of intoxication of a person who has imbibed ethyl alcohol, including passing the person's breath through a measured amount of an alcohol responsive color changeable liquid including a permanganic acid or a permanganate, sulphuric acid and water, the sulphuric acid and water having a specific gravity of from 1.3 to 1.6 and at a temperature not to exceed 40° C. until the color has changed, the liquid including a solution of a permanganate in a mixture of sul-

phuric acid and water of a specific gravity of from 1.3 to 1.6, dehydrating the breath after passing through the color changeable liquid, and then abstracting the carbon dioxide from the dehydrated breath for determining the alcohol-blood concentration therefrom.

2. The process of determining the degree of concentration of ethyl alcohol in a gas having a relatively constant percentage of carbon dioxide therein, including passing a sufficient amount of the gas through a predetermined amount of colored liquid including a permanganic acid or a permanganate, sulphuric acid and water, the sulphuric acid and water having a specific gravity of from 1.3 to 1.6 and at a temperature not to exceed 40° C. for changing the color of said liquid, the liquid including a solution of a permanganate in a mixture of sulphuric acid and water of a specific gravity of from 1.3 to 1.6, the amount of ethyl alcohol necessary to change the color of a unit volume of the liquid being known, dehydrating the gas after passing through the liquid, completely abstracting from the dehydrated gas the carbon dioxide, and then determining the amount of carbon dioxide abstracted for determining the amount of gas including ethyl alcohol necessary to change the color of the liquid after determining the alcohol gas ratio.

3. The process of determining the degree of concentration of ethyl alcohol in a gas having a

relatively constant percentage of carbon dioxide therein, including passing a sufficient amount of the gas through a predetermined amount of colored liquid including a permanganic acid or a permanganate, sulphuric acid and water, the sulphuric acid and water having a specific gravity of from 1.3 to 1.6 and at a temperature not to exceed 40° C. for changing the color of said liquid, the liquid including a solution of a permanganate in a mixture of sulphuric acid and water of a specific gravity of from 1.3 to 1.6, the amount of ethyl alcohol necessary to change the color of a unit volume of the liquid being known, said liquid-alcohol reaction producing no carbon dioxide as a reaction product, dehydrating the gas after passing through the liquid, completely abstracting from the dehydrated gas the carbon dioxide, and then determining the amount of carbon dioxide abstracted for determining the amount of gas including ethyl alcohol necessary to change the color of the liquid for determining the alcohol gas ratio.

4. A solution of a permanganate in sufficient concentration to yield a violet to orchid color with sulphuric acid and water, the latter two having a specific gravity of from 1.3 to 1.6, and which solution is changeable to a clear or light brown color at ordinary temperatures when subjected to sufficient ethyl alcohol.

ROLLA N. HARGER. 30