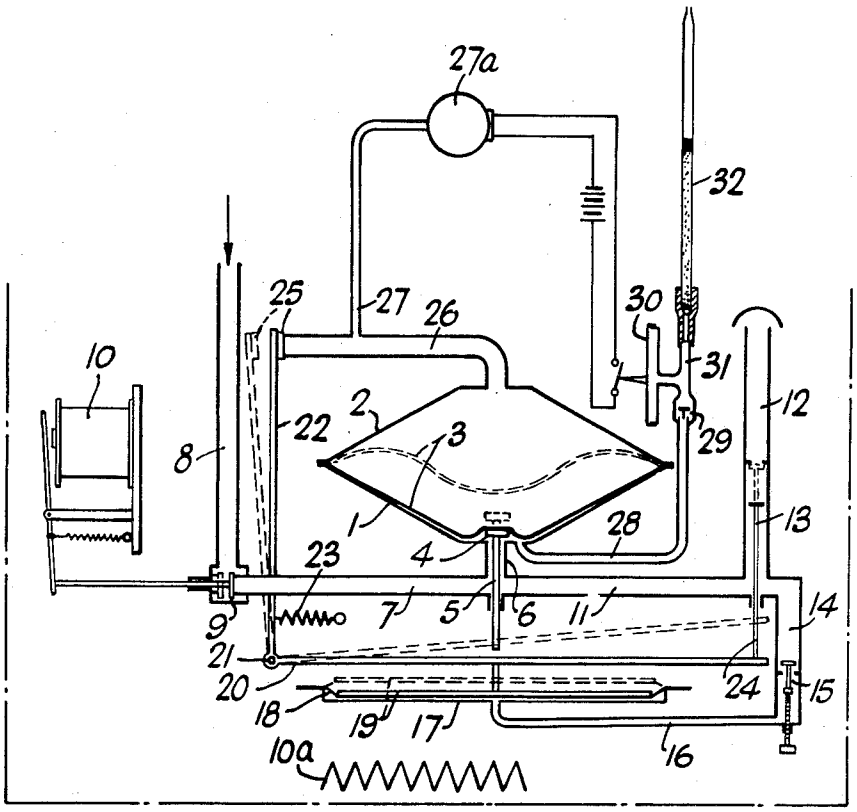
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BREATH SAMPLING APPARATUS

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BREATH SAMPLING APPARATUS

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This invention relates to apparatus for analysing the alcohol content of human breath.

In the apparatus known as the "Breathalyzer," a 50 ml. sample of breath is collected in a heated reservoir and is then bubbled through an ampoule containing a dilute solution of $K_2Cr_2O_7$ in 50% H_2SO_4. The reduction of the bichromate by alcohol in the breath sample is measured photometrically. Although the apparatus is sufficiently accurate for practical purposes, the liquid reagent employed is highly corrosive and great care must be taken in handling the ampoules and in disposing of them after use. In addition, some care and vigilance on the part of the operator, and co-operation by the subject, are needed to ensure that a true alveolar of breath is obtained in a standard way. Also, collection of the sample in this apparatus is by means of a piston and cylinder which must be very accurately made to avoid leakage of sample so adding to the cost of the apparatus.

It is the object of the present invention to provide an apparatus which is of simpler construction and simpler to use than the breathalyzer, and therefore requires less skill in the operator, and which is suitable for use with a more convenient alcohol-estimating device specially developed for the purpose. A preferred aspect of the invention is the obtaining of an accurate volume of alveolar air from the subject being tested, by means which are out of the control of the operator or the subject.

The apparatus of the present invention comprises the following features in combination:

(1) Heating means for maintaining the apptaratus at a temperature above the dew point of breath.

(2) A breath inlet passage leading to a breath sample chamber which chamber is initially closed by a valve and leading also to a vent to atmosphere.

(3) Means operated by breath blown into the inlet passage to close the vent and then to open the valve controlling access to the sample chamber said valve being arranged to return to the closed position on termination of breath supply.

(4) A diaphragm which constitutes a flexible wall of the sample chamber and which is movable by breath blown into the chamber from an initial position in which the chamber is collapsed to a final position in which the chamber is expanded to contain a breath sample of predetermined volume.

(5) An auxiliary breath passage connected ot the sample chamber and in which breath pressure rises when the sample has been taken, and means operated by pressure rise in the auxiliary passage to actuate a pump which moves the diaphragm to collapse the sample chamber expelling the breath sample thereform for admission to an alcohol estimating device.

In practice the apparatus may also incorporate other desirable features designed to make it more self regulating. Thus the breath inlet tube preferably has incorporated therein a valve which is closed at ambient temperature but which opens to allow free passage of breath into the apparatus when the latter has acquired the correct temperature. Again, means are preferably provided for switching off the pump automatically when the sample has been fully expelled from the sample chamber.

In one very advantageous form of device, the sample chamber is formed by two generally conical half-elements connected together base to base and gripping between them the diaphgram which is of resilient material shaped to confirm closely to the internal surface of one or other of the half-elements when the chamber is collapsed or expanded respectively. The diaphragm is of suitable alcohol-resistant material e.g. a suitable polyester.

Closure of the vent and opening of the valve to admit breath to the sample chamber may be achieved by providing an extension of the breath inlet passage having a meeting a metering valve and leading to an expandible chamber closed by a diaphgram which moves upon expansion of the chamber and actuates a lever which operates first to close a valve in the vent to atmosphere and then to open the valve to the sample chamber. The lever may conveniently have two arms, one of which operates the valves as aforesaid, whilst the other arm opens a vent in an air passage through which the pump is connected to the diaphragm, said other arm being arranged to close said vent when the lever returns to its original position on termination of breath supply to the apparatus.

The apparatus is designed for use with an alcohol estimating device known as the "Kitagawa Tube." This consists of a narrow-bore glass tube containing powdered silica as a carrier for the reagent which is an anhydrous form of chromic acid which is normally yellow but changes to bluish-grey on reduction by alcohol. In such a tube the length of the strain gives a measure of the quantity of alcohol passed through it.

The invention is illustrated by way of example in the accompanying diagrammatic drawing.

The apparatus comprises a sample chamber formed by means of two shallow truncated cones **1**, **2** of thin sheet aluminum bolted together base to base and gripping between them a polyethylene terephthalate diaphgram **3** of thickness 0.002 inch. The diaphragm **3** is moulded so as to fit closely against the internal surface of the lower cone **1** when the sample chamber is collapsed to zero volume, and is capable of being turned inside out to fit in like manner against the upper cone **2** when the sample chamber is expanded to its full volume upon intake of breath as hereinafter described.

Entry into the sample chamber is by way of an opening in the apex region of the lower cone **1** which is nomally closed by a mushroom valve **4** held against its seating by means of a spring (not shown). The stem **5** of this valve operates in gas-tight manner in a tube **6** connected with the opening in the cone **1** and connected also with a horizontal tube **7** leading at its lefthand end as shown to a vertical tube **8** which extends outwardly from the apparatus and into which breath is blown by the person under test. The horizontal tube **7** and vertical tube **8** thus constitute two sections of a breath inlet passage. A removable filter (not shown) is incorporated in the tube **8**.

At normal room temperature the horizontal tube **7** is closed by means of a valve **9** so that breath blown into the vertical tube **8** cannot enter the sample chamber. The valve **9** is opened by means of an electromagnet **10** which comes into operation when the apparatus reaches its correct working temperature under the influence of a heater **10***a*. At the same time an indicating light (not shown) is switched off to indicate that the apparatus is at the required temperature for use.

The tube **7** is connected at its right hand end to a horizontal extension **11** of the breath inlet passage which leads to a vent passage **12** closable by means of a valve **13** and to a further extension **14** containing a needle valve for metering a supply of breath to a valve-actuating mechanism. The extension **14** leads by a narrow tube **16** to a dish-shaped chamber **17** closed by a movable

diaphragm 18 on the upper surface of which rests a metal disc 19. Air passed into the chamber 17 will raise the diaphragm 18 and disc 19 into the dotted position shown in the drawing. The disc 19 is connected to the horizontal arm 20 of an L-shaped lever arrangement having a fulcrum at 21 and a vertical arm 22 held normally by means of a tension spring 23 in the position shown by full lines in the drawing. The horizontal arm 20 is connected at its right-hand end to the valve stem 24 of the valve 13 which controls the passage of breath through the vent 12 to atmosphere. The vertical arm 22 of the lever is provided at its upper end with a sealing device 25 which seals the open end of a tube 26 which is connected at its other end to the upper cone 2. The tube 26 has a branch 27 leading to a pump 27*a*.

Also connected to the sample chamber through the lower cone 1 is a narrow tube 28 connected through a ball valve 29 with a pneumatically operated switching device shown schematically at 30 for switching on the pump. The tube 28 also leads to an outlet 31 in which alcohol-estimating Kitagawa tube 32 is mounted.

The apparatus is used in the following way. When it is at the required temperature, as indicated by the indicating light, the valve 9 is open so allowing breath to be blown into the vertical tube 8 from which it passes via the horizontal tube 7 and extensions 11 and 14 through the metering valve 15 and into the dish 17 where it raises the diaphragm 18 and disc 19 into the dotted position. Thus movement is transferred to the lever which pivots about its fulcrum 21 and the horizontal arm 20 moves into the dotted position closing first the valve 13. After the valve 13 has closed, the lever arm 20 bears upon and raises the valve stem 5 opening the mushroom valve 4 to admit breath into the sample chamber. It will thus be appreciated that before the valve 4 is opened breath blown in has had the effect of flushing out a substantial part of the apparatus. Thereafter the ensuing breath which is alveolar in character, blown in by the person under test flows through valve 4 into the sample chamber.

The sample chamber is initially collapsed with the diaphragm 3 lying in close contact with the lower cone 1. When breath enters the chamber the diaphragm 3 is raised until it is pressed flat against the upper cone 2 thus controlling the volume of breath at an accurate and known value. At this point there is a pressure rise in the tube 28 which is employed through the switching device 30 to close an electrical circuit and operate a warning light (not shown) which tells the person that he may stop blowing. When the person stops blowing the valve 4 returns under its spring loading into the closed position trapping the breath sample and the lever returns to its original position closing the tube 26. The pressure rise in tube 28 also actuates the circuit which brings the pump 27*a* into operation. The action of the pump forces the diaphragm 3 downwards expelling the breath sample through the narrow tube 28 and hence through the Kitagawa tube 32 in which alcohol present in the sample reacts with the reagent producing a colour change. The pressure in the switching device 30 is prevented from falling by the action of the valve 29 and the high resistance to flow in the indicator tube 32 for long enough to keep the pump in operation until the lever arm 25 has closed the tube 26 again and allowed the pressure in the sample chamber and in tube 28 to rise again. When the entire breath sample has been expelled through the tube 32 the pressure in the system falls and the switch 30 is automatically released to switch off the pump.

In practice the sample chamber may be dimensioned to collect a 100 ml. sample of breath and may be housed, together with most of the apparatus shown in the drawing, in a lagged compartment of a box having another compartment which houses electrical equipment containing the pump, neon lights, transformer, relay and other devices. Two electrical heaters of 65 watt capacity connected in series may be used to heat the apparatus after which they are connected in series with a 25 watt heater to reduce the heat input to about 12 watts which is controlled by a thermostat to maintain a temperature of 60°±2° C.

It will be readily seen that whether the person being tested gives a long hard blow, or whethers he blows in short bursts, the same volume of breath is collected in the sample chamber before the warning light comes on. In the latter case after each burst of breath the valve will close so retaining the breath blown into the chamber and will open again to admit more breath when the next burst takes place but a further volume of breath will be discarded each time.

Thus the whole process of discarding the dead space air and collecting and analysing an alveolar sample is completely automatic and standardised, and out of the control of either operator or subject. All the operator has to do is to cut off the sealed ends of the detector tube 32, insert it in its socket, and instruct the subject to blow into a mouthpiece until the red light comes on, and afterwards measure the length of the stain.

The stain can be read easily in good daylight, but since this often not available a reading device with built-in illumination is preferably provided on the box. With this, stain lengths can be measured readily to the nearest 1 milligram per 100 ml. of blood.

If the ends of the tube are sealed with rubber caps, the stain will remain readable, and substantially unchanged, for several weeks. It can thus be produced as evidence in court if required. This is a substantial advantage over any other method in existence, unless expensive and cumbersome recording equipment is used.

I claim:

1. Breath-sampling apparatus comprising a breath sample chamber, a diaphragm constituting a flexible wall of said chamber and movable by breath entering the chamber to expand said chamber to a predetermined volume, a breath inlet passage leading to said chamber and having a vent to atmosphere, a valve controlling admission of breath into said chamber from said passage and which remains closed while said passage is open to atmosphere, means operated by pressure in said passage to close said vent and open said valve to admit breath into said chamber, a breath outlet passage connected to the sample chamber for the expulsion of the breath sample therefrom and a pump operatively connected with said diaphragm for expelling the breath sample through said outlet passage.

2. Apparatus according to claim 1 comprising indicating means for indicating when the breath sample chamber is full.

3. Breath-sampling apparatus comprising a breath sample chamber, a diaphragm constituting a flexible wall of said chamber and movable by breath entering the chamber to expand said chamber to a predetermined volume, a breath inlet passage leading to said chamber and having a vent to atmosphere, a valve controlling admission of breath into said chamber from said passage and which remains closed while said passage is open to atmosphere, means operated by pressure in said passage to close said vent and open said valve to admit breath into said chamber, a breath outlet passage connected to the sample chamber for the expulsion of the breath sample therefrom, a pump operatively connected with said diaphragm for expelling the breath sample through said outlet passage, and means adapted to operate at a predetermined pressure of breath in the sample chamber to actuate said pump to expel the breath sample.

4. Apparatus according to claim 3 comprising indicating means responsive to pressure in the breath sample chamber for indicating when said chamber is full.

5. Apparatus according to claim 3 in which the sample chamber is formed by two generally conical half-elements connected together base to base, said diaphragm being

gripped between said half-elements and capable of conforming to the internal surface of one of said half-elements so as to present a sample chamber which is substantially collapsed prior to intake of breath and of conforming to the internal surface of the other of said half-elements when said chamber is expanded.

6. Apparatus according to claim **3** in which the pressure-operated means for closing said vent and opening said valve comprises a movable diaphragm, a lever connected therewith and arranged to operate said valve, and a further valve in said vent operatively connected with said lever, said lever being adapted to close said further valve prior to opening said valve controlling admission to breath to the sample chamber.

7. Apparatus according to claim **6** comprising a pneumatic circuit through which said pump acts on the exterior surface of said diaphragm and sealing means for opening and closing said circuit to and from the atmosphere.

8. Breath-sampling apparatus comprising a breath sample chamber, a diaphragm constituting a flexible wall of said chamber and movable by breath entering the chamber to expand said chamber to a predetermined volume, a breath inlet passage leading to said chamber and having a vent to atmosphere, a valve controlling admission of breath into said chamber from said passage and which remains closed while said passage is open to atmosphere, means operated by pressure in said passage to close said vent and open said valve to admit breath into said chamber, a breath outlet passage connected to the sample chamber, a breath outlet passage connected to the sample chamber for the expulsion of the breath sample therefrom, heating means for maintaining the path traversed by the breath at a temperature above the dew point thereof, a pump operatively connected with said diaphragm for expelling the breath sample through said outlet passage, and means adapted to operate at a predetermined pressure of breath in the sample chamber to actuate said pump to expel the breath sample.

9. Apparatus according to claim **8** comprising a valve controlled by said heating means for preventing passage of breath into said chamber at a temperature below the dew point thereof.

10. Apparatus for obtaining a sample of a subject's breath for alcohol analysis and adapted for use with an

alcohol-estimating device comprising a pair of generally conical members connected together base to base, a resilient diaphragm interposed in fluid-tight manner between said elements and gripped between their bases so as to constitute with one of said members a breath sample chamber of expandible dimensions, said diaphragm being capable of assuming close contact with the internal surface of either member and of movement from one to the other of its respective positions in which the sample chamber is substantially collapsed or expanded to a predetermined volume respectively, a breath inlet passage leading to the sample chamber, a first valve controlling flow of breath between said inlet passage and said chamber said valve being based to the closed position but movable to the open position in response to inrceased pressure in said inlet passage, a vent to atmosphere connected to said inlet passage through which an initial proportion of the subject's breath can escape, a second valve controlling said vent, valve-operating means responsive to breath pressure in said inlet passage for operating said second valve to close said vent and then to open said first valve, a breath outlet passage connected to said sample chamber for expulsion of the breath sample and adapted for connection with an alcohol estimating device, a pump forming part of a pneumatic circuit connected with said diaphragm exteriorly of said chamber, and means adapted to operate at a predetermined pressure in said outlet pump to actuate said pump to collapse said chamber expelling the breath sample through said outlet passage.

11. Apparatus according to claim **10** fitted with a quantitative alcohol estimating device comprising a tube containing a solid reagent system which changes color upon reaction with alcohol, said tube being connected with said breath outlet passage.

References Cited by the Examiner

UNITED STATES PATENTS

2,489,654	11/1949	Main-Smith et al.	73—421.5
2,592,464	4/1952	Plank	73—422
2,824,789	2/1958	Borkenstein	23—232 X
2,999,495	9/1961	Shipley	128—2

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