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(54) MEASURING APPARATUS

MESSGERÄT

APPAREIL DE MESURE

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Description

This invention relates to apparatus for measuring the concentration of a volatile component in a gas and in particular, but not exclusively, to breath alcohol testing apparatus.

There are in general two types of breath alcohol testing apparatus; screening and evidential. For the latter the Courts of most countries require that the detector for alcohol (ethanol) is re-calibrated before each breath sample is taken. One of the ways of achieving this calibration is to release into the detector a quantity of a gas containing a known concentration of ethanol from a pressurised cylinder which has been prepared in the laboratory. However, this concentration is only accurate for a single atmospheric pressure and accordingly the calibration can cause the detector to read too high or too low, depending on the altitude at which the reading is taken and the local ambient atmospheric conditions. To date attempts have been made to overcome this problem by artificially weighting the detector output in accordance with the altitude at which the reading is taken. This is unsatisfactory because the altitude is often not known accurately and the atmospheric pressure at any given altitude is not constant.

The present invention consists in breath testing apparatus for measuring the concentration of ethanol in breath, including a detector for detecting the ethanol and producing an output signal representing the detected concentration of ethanol in breath, a gas standard container containing a predetermined concentration of ethanol in a diluent pressurised gas, the standard being prepared to have a predetermined concentration for a predetermined atmospheric pressure, sampling means for delivering alternately a sample from the standard and a test sample to the detector, means for feeding from the detector successively one signal representative of the concentration of ethanol in the test sample and another signal representative of the concentration of ethanol in the sample from the standard, means for measuring the ambient atmospheric pressure when the standard sample is delivered, means for determining the difference between the measured ambient atmospheric pressure and said predetermined atmospheric pressure, and output means responsive to the pressure difference and the detector output signals for generating a representation of the concentration of ethanol in the test sample.

The output means may calculate the value of the measured concentration S from the following formula:

$$S = Cx \frac{Vcsamp}{Vccal} \times falt$$

wherein

C is the concentration of volatile component in the gas standard
Vc samp is the value of the detector output signal for the test sample
Vc cal is the value of the detector output signal from the standard sample
falt is the ratio of the measured pressure to a calibration pressure

The pressure sensor may measure absolute pressure.

The detector may be a fuel cell, a semiconductor or an infrared detector or indeed any other suitable detector. It may operate in conjunction with a gas chromatographic column.

Although the invention has been defined above it is to be understood it includes any inventive combination of the features set out above or in the following description:

The invention may be performed in various ways and a specific embodiment will now be described, by way of example, with reference to the accompanying drawing, which is a schematic circuit diagram of the circuitry of a breath testing apparatus.

A breath testing apparatus is diagrammatically illustrated in the Figure and generally indicated at 10. The apparatus essentially comprises a fuel cell 11 which can be supplied with samples either from a gas standard in a pressurised cylinder 12 or a subject breath tube 13, processing circuitry 14, a pressure transducer 15 and a read-out 16.

The operation of the fuel cell is well known and will not be described in detail but it will be seen that it is provided with a breath flow detector at 17 to ensure that the sample is taken from the alveolar breath.

The outputs of the fuel cell 11 and the breath flow detector 17 are supplied to a multiplexer 18 which also receives a signal from the ambient pressure transducer 15 via suitable conditioning circuitry generally indicated at 19. The multiplexer 18 scans the various outputs and supplies them sequentially via an analogue to digital converter 20 to a microprocessor 21 which, having processed the signals set out below, provides a read-out at 16 corresponding to the concentrations of ethanol in the subject's breath.

The output of the transducer 15 as a function of the atmospheric pressure p is conditioned by the circuitry 19 to produce a voltage Vp in accordance with the following relationship:

$$Vp=\frac{p}{80.8}-12.5$$

where p is measured in millibars. From this voltage the microprocessor can work out a pressure (altitude) correction factor falt where:

$$falt = \frac{p}{1010} = \frac{Vp}{12.5} + 1$$

This correction factor assumes that the gas standard has been prepared when the ambient pressure is at one atmosphere.

After the fuel cell has received samples both from the standard and from the subject's breath, the microprocessor applies the correction for atmospheric pressure because the concentration of the ethanol in the standard is proportional to it but the concentration of ethanol in the breath is (effectively) constant. Thus, a true breath ethanol concentration S can be calculated from the following formula:

$$S = C \times \frac{Vcsamp}{Vccal} x falt$$

where C is the calibration concentration (i.e., the standards concentration at one atmosphere) and Vc samp and Vc cal are the respective fuel cell output voltages from the breath sample and the standard sample.

Thus, for a gas cylinder prepared at standard atmospheric pressure of 1010 mB the following examples will result:

p = 606 mB	Vp = 5.000V	falt = 0.600	(altitude = 4000m)
p = 1010mB	Vp = 0.000V	falt = 1,000	
p = 1100mB	Vp = +1.114V	falt = 1,089	

It will be appreciated that the apparatus described above not only provides for variations in altitude, as are experienced in mountainous countries particularly when mobile units are being used, but also allows for local pressure variations. The result is a particularly accurate breath testing apparatus which will become more and more applicable as legal alcohol level limits drop and errors become more and more significant.

Claims

1. Breath testing apparatus for measuring the concentration of ethanol in breath, including a detector for detecting the ethanol and producing an output signal representing the detected concentration of ethanol in breath, a gas standard container containing a predetermined concentration of ethanol in a diluent pressurised gas, the standard being prepared to have a predetermined concentration for a predetermined atmospheric pressure, sampling means for delivering alternately a sample from the standard and a test sample to the detector, means for feeding from the detector successively one signal representative of the concentration of ethanol in the test sample and another signal representative of the concentration of ethanol in the sample from the standard, means for measuring the ambient atmospheric pressure when the standard sample is delivered, means for determining the difference between the measured ambient atmospheric pressure and said predetermined atmospheric pressure, and output means responsive to the pressure difference and the detector output signals for generating a representation of the concentration of ethanol in the test sample.

2. Apparatus as claimed in Claim 1, wherein the output means calculates the value of the ethanol concentration S from the following formula:

$$S = C \times \frac{Vcsamp}{Vccal} \times falt$$

wherein

C is the concentration of volatile component in the gas standard
Vc samp is the value of the detector output signal for the test sample

Vc cal is the value of the detector output signal from the standard sample
falt is the ratio of the measured pressure to a calibration pressure.

3. Apparatus as claimed in Claim 1 or Claim 2, wherein the pressure sensor measures absolute atmospheric pressure.

4. Apparatus as claimed in any one of the preceding Claims, wherein the detector is a fuel cell, a semiconductor or an infrared detector.

Patentansprüche

1. Vorrichtung für die Untersuchung der Atemluft zum Messen der darin enthaltenen Alkoholkonzentration, die aus folgenden Teilen besteht: einem Detektor zum Anzeigen des Alkohols und zur Erzeugung eines Ausgangssignals, das die angezeigte Alkoholkonzentration im Atem wiedergibt, einem Bezugsgasbehälter, der eine vorgegebene Konzentration an Alkohol in einem verdünnten, unter Druck stehenden Gas enthält, wobei das Bezugsgas so hergestellt ist, daß es eine vorgegebene Konzentration bei einem vorgegebenen atmosphärischen Druck hat, Probenahmeeinrichtungen, mit denen abwechselnd eine Probe des Bezugsgases oder eine zu untersuchende Probe an den Detektor geliefert wird, Einrichtungen, um nacheinander von dem Detektor ein Signal, das die Alkoholkonzentration in der zu untersuchenden Probe, und ein anderes Signal, das die Alkoholkonzentration in der Probe des Bezugsgases wiedergibt, zu erhalten, Einrichtungen zum Messen des Druckes der umgebenden Atmosphäre, wenn die Probe des Bezugsgases geliefert wird, Einrichtungen zum Bestimmen der Differenz zwischen dem gemessenen atmosphärischen Druck und dem vorgegebenen atmosphärischen Druck, und Ausgangssignaleinrichtungen, die auf die Druckdifferenz und die Ausgangssignale des Detektors ansprechen, um einen für die Alkoholkonzentration in der zu untersuchenden Probe repräsentativen Wert zu erzeugen.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** die Ausgangssignaleinrichtungen den Wert der gemessenen Alkoholkonzentration S mit Hilfe der folgenden Formel berechnen: wobei i

$$S = C \times \frac{Vcsamp}{Vccal} \times falt$$

C die Konzentration des flüchtigen Bestandteils in dem Bezugsgas,

Vc samp der Wert des Ausgangssignals des Detektors für die Probe des zu untersuchenden Gases,

Vc cal der Wert des Ausgangssignals des Detektors für die Probe des Bezugsgases und

falt das Verhältnis des gemessenen Druckes zu einem Eichdruck ist.

3. Vorrichtung nach den Ansprüchen 1 oder 2, **dadurch gekennzeichnet, daß** die Vorrichtung zur Messung des Druckes den absoluten atmosphärischen Druck mißt.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** der Detektor eine Brennstoffzelle, ein Halbleiter oder ein Infrarot-Detektor ist.

Revendications

1. Appareil de contrôle de l'haleine permettant de mesurer la concentration de l'éthanol dans l'haleine, qui comporte un détecteur servant à détecter l'éthanol et à produire un signal de sortie représentant la concentration détectée de l'éthanol dans l'haleine, un conteneur d'étalon de gaz contenant une concentration prédéterminée d'éthanol dans un gaz sous pression diluant, l'étalon étant préparé de façon à présenter une concentration prédéterminée pour une pression atmosphérique prédéterminée, un moyen d'échantillonnage servant à délivrer en alternance au détecteur un échantillon provenant de l'étalon et un échantillon de contrôle, un moyen servant à fournir successivement, en provenance du détecteur, un signal représentatif de la concentration de l'éthanol dans l'échantillon de contrôle et un autre signal représentatif de la concentration de l'éthanol dans l'échantillon provenant de l'étalon, un moyen servant à mesurer la pression atmosphérique ambiante au moment où l'échantillon de l'étalon est délivré, un moyen servant à déterminer la différence entre la pression atmosphérique ambiante mesurée et ladite pression

atmosphérique prédéterminée, et un moyen de sortie qui répond à la différence de pression et aux signaux de sortie du détecteur en produisant une représentation de la concentration de l'éthanol dans l'échantillon de contrôle.

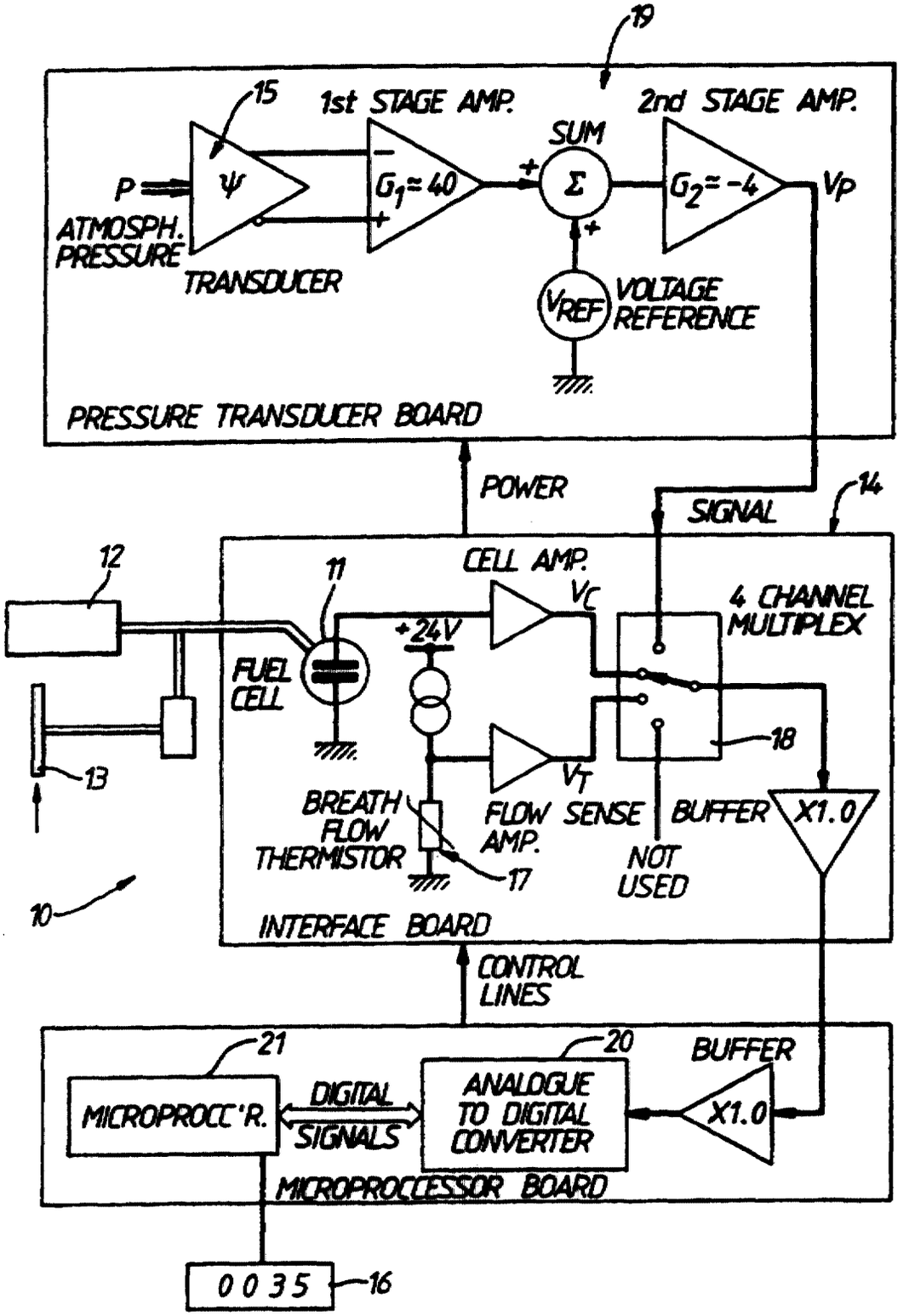
2. Appareil selon la revendication 1, où le moyen de sortie calcule la valeur de la concentration d'éthanol S à partir de la formule suivante :

$$S = C \times \frac{Vcsamp}{Vccal} \times falt$$

où C est la concentration du composant volatil dans l'étalon de gaz,
Vc samp est la valeur du signal de sortie du détecteur pour l'échantillon de contrôle,
Vc cal est la valeur du signal de sortie du détecteur obtenu à partir de l'échantillon de l'étalon, et
falt est le rapport de la pression mesurée à une pression d'étalonnage.

3. Appareil selon l'une quelconque des revendications 1 et 2, où le capteur de pression mesure la pression atmosphérique absolue.

4. Appareil selon l'une quelconque des revendications précédentes, où le détecteur est une pile à combustible, un détecteur à semiconducteur ou un détecteur à infrarouge.


19
15
1st STAGE AMP.
2nd STAGE AMP.
SUM
P
ATMOSPH. PRESSURE
TRANSDUCER
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G2= -4
VP
VREF
VOLTAGE REFERENCE
PRESSURE TRANSDUCER BOARD
POWER
SIGNAL
14
12
11
CELL AMP.
VC
4 CHANNEL MULTIPLEX
+24V
FUEL CELL
18
13
VT
BREATH FLOW THERMISTOR
FLOW SENSE AMP.
BUFFER
X1.0
NOT USED
17
10
INTERFACE BOARD
CONTROL LINES
21
20
BUFFER
MICROPROCC'R.
DIGITAL SIGNALS
ANALOGUE TO DIGITAL CONVERTER
X1.0
MICROPROCESSOR BOARD
0035
16