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**Guth et al.**

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(54) **BREATH TEST SIMULATOR AND METHOD**

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This patent is subject to a terminal disclaimer.

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**Related U.S. Application Data**

(63) Continuation of application No. 12/574,921, filed on Oct. 7, 2009, now Pat. No. 7,895,878.

(51) **Int. Cl.**

**G01N 21/00** (2006.01)

**G01N 31/00** (2006.01)

(52) **U.S. Cl.**

USPC ..... **73/1.03**; 436/9

(58) **Field of Classification Search**

USPC ..... 73/1.03, 1.06, 23.3; 436/9

See application file for complete search history.

(56)

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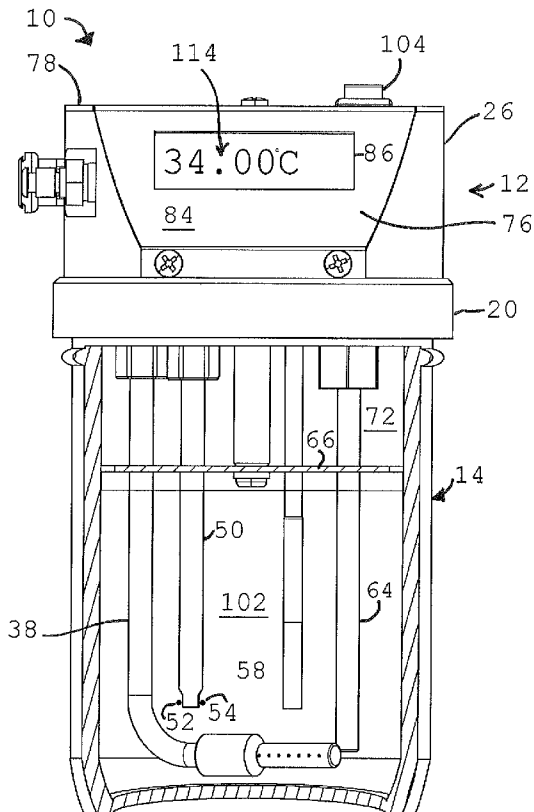
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(57)

**ABSTRACT**

A breath test simulator for supplying a breath test analyzer with a vapor including ethyl alcohol includes a heated thermal mass to heat an inlet passage.

**21 Claims, 7 Drawing Sheets**



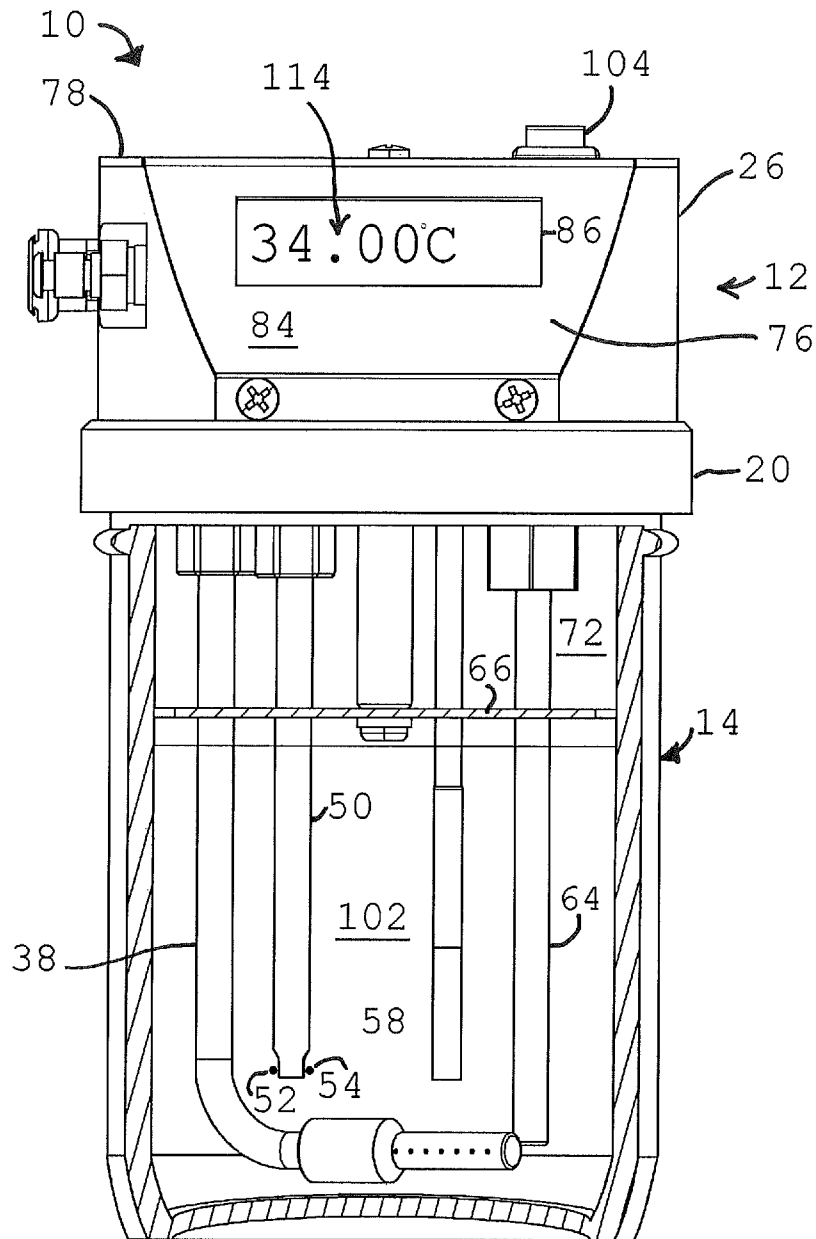


Fig. 1

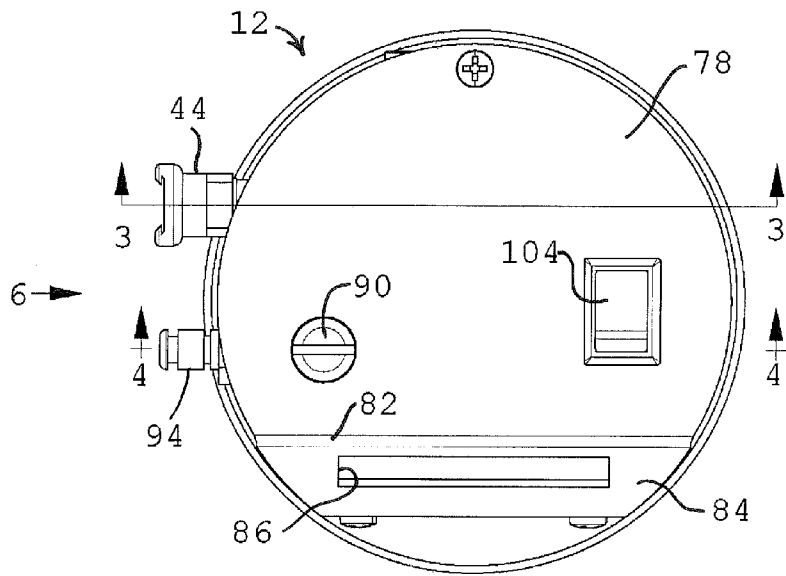


Fig. 2

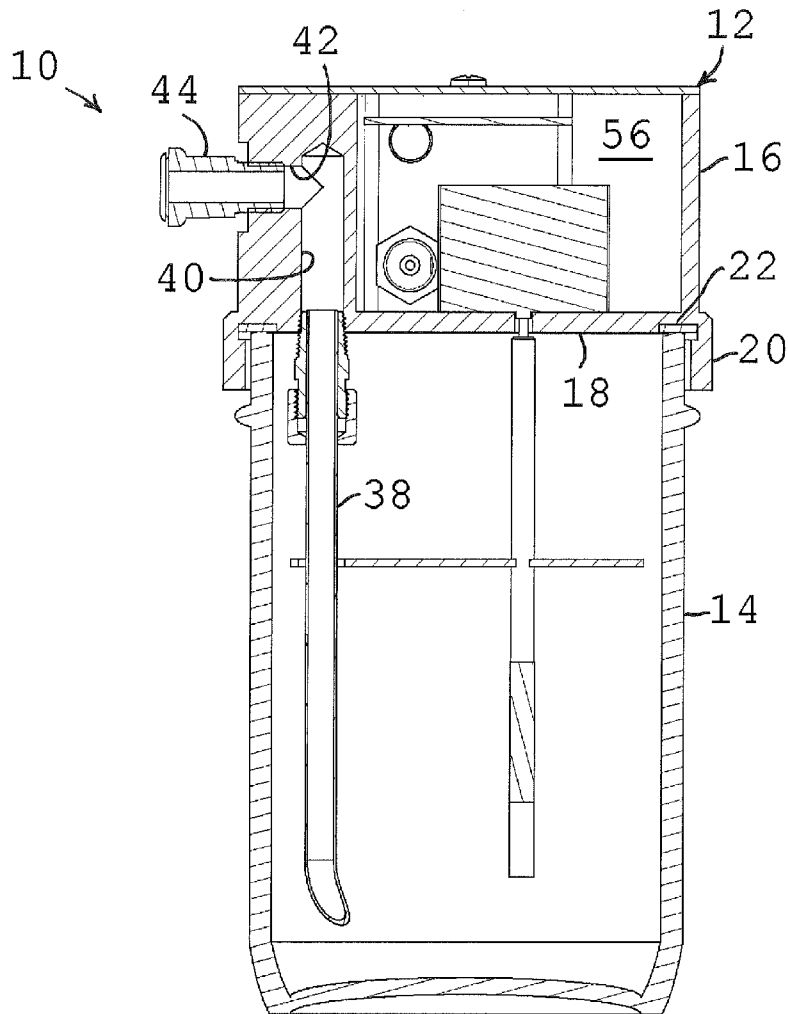


Fig. 3

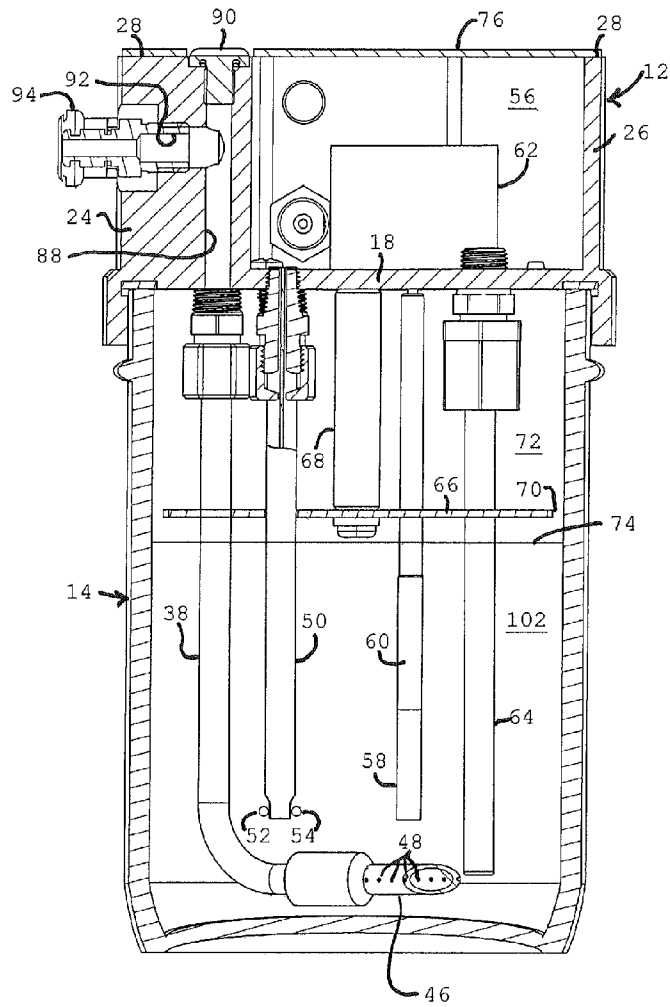


Fig. 4

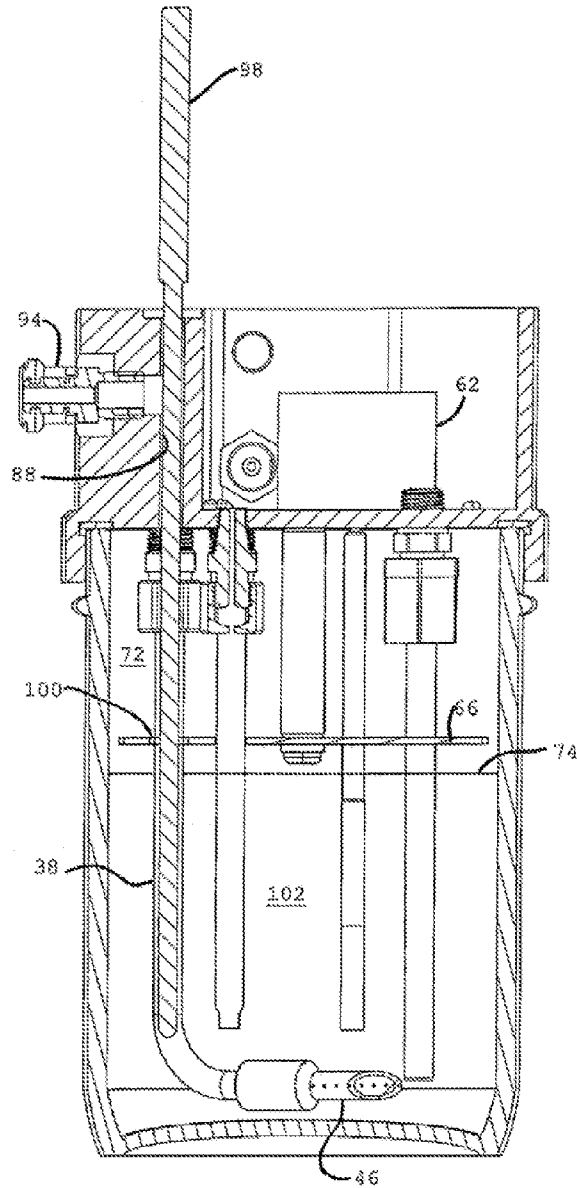


Fig. 5

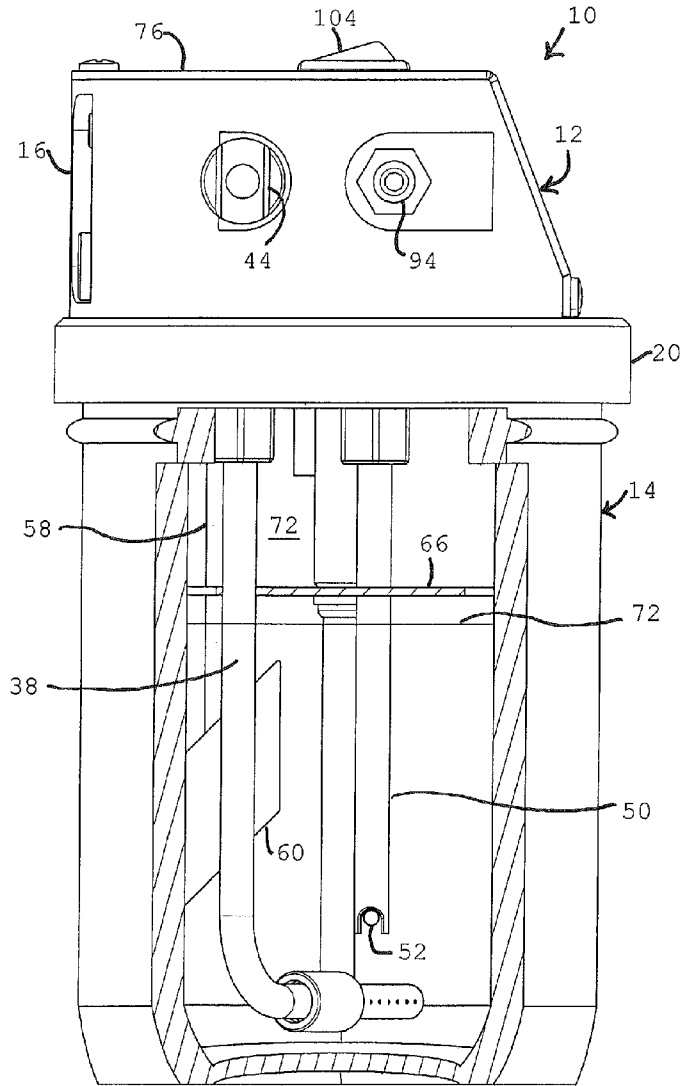


Fig. 6

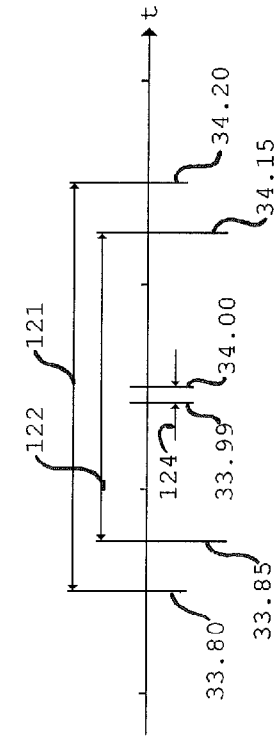


Fig. 9

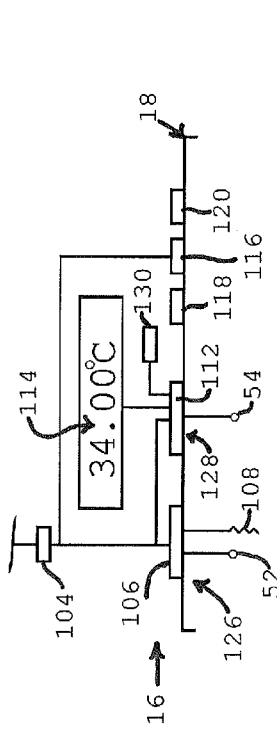


Fig. 10

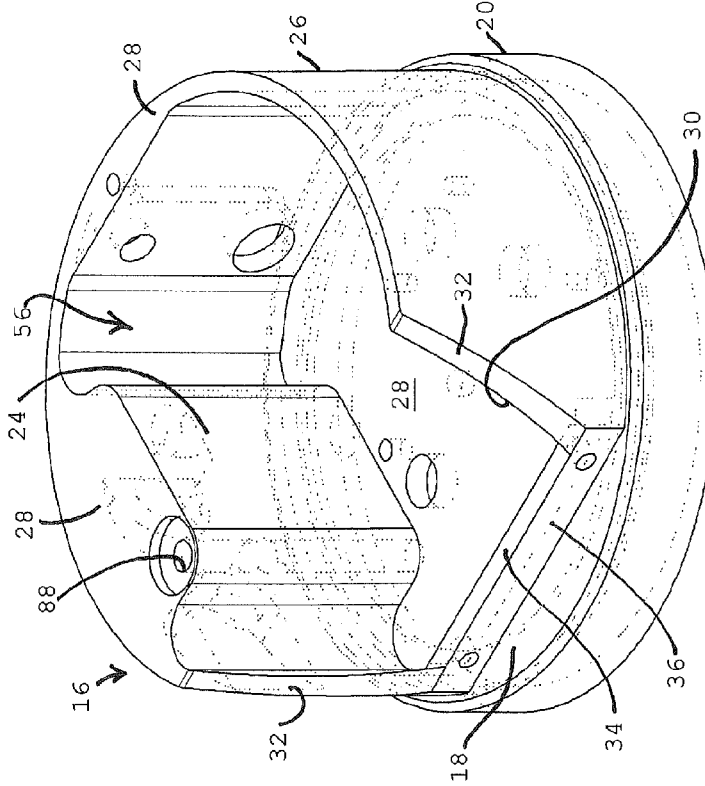


Fig. 7

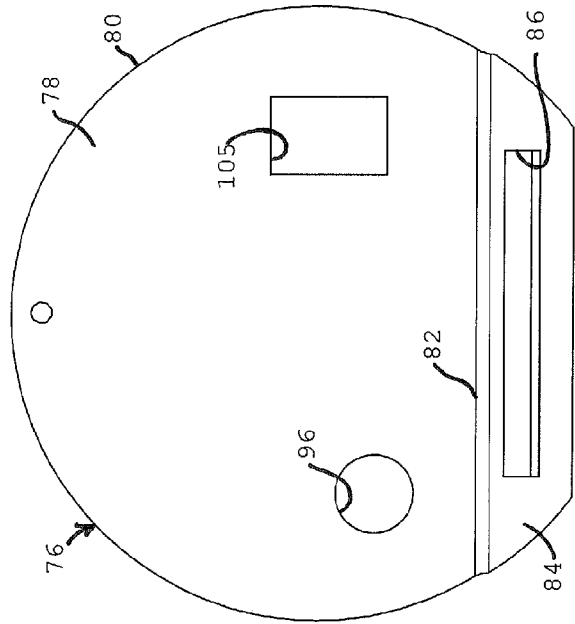


Fig. 8



**BREATH TEST SIMULATOR AND METHOD**

## FIELD OF THE DISCLOSURE

The disclosure relates to a breath test simulators that generates a vapor sample containing a precisely controlled concentration of ethyl alcohol and flows the vapor sample to a breath test analyzer for calibrating the analyzer.

## DESCRIPTION OF THE PRIOR ART

U.S. Pat. No. 7,493,793 describes an efficient breath test simulator with a thermally conductive aluminum lid closing the top of a jar containing a water/ethyl alcohol solution having a known concentration of ethyl alcohol. The solution is heated to a regulatory allowable operating temperature range between 33.80° C. and 34.20° C. The headspace above the solution is also heated. The regulatory allowable operating temperature range for the solution is determined in the United States by the National Highway Traffic Safety Administration (NHTSA).

An unheated breath sample is flowed through a thin wall air inlet tube into the jar and bubbles up through the solution to absorb a known amount of ethyl alcohol from the solution. The resulting vapor is collected in the headspace above the solution. The inlet tube is in a cavity above the lid and can cool the breath sample so that the sample cools the solution. Vapor is flowed from the headspace through an air outlet tube to a breath test analyzer for calibrating the analyzer.

The solution is heated by a small immersion heater actuated by a temperature control circuit having a temperature sensor in the solution. The temperature control circuit maintains the solution in a normal range in the center of the regulatory allowable operating range. A display indicates the temperature of the solution as determined by the temperature sensor used by the temperature control circuit.

A resistance heater on the lid maintains the lid at a temperature slightly above the solution temperature. The heated lid heats the headspace. Heat from the heater is conducted through the lid to the air inlet and outlet tubes. The tubes are in the cavity and cool rapidly when the lid heater is off.

The outlet and inlet tubes of the simulator illustrated in U.S. Pat. No. 7,493,793 are formed by welding brass tubing which is subsequently plated to provide a protective metal coating. This manufacturing process is expensive and time consuming.

## SUMMARY OF THE DISCLOSURE

The disclosure is an improved breath test simulator with a top housing mounted over the mouth of a jar containing a water/ethyl alcohol solution. The housing is preferably formed from a machined body of conductive metal and includes a lid and a passage projection on the lid. A breath test sample inlet passage and a vapor outlet passage extend through the passage projection. The projection is preferably formed from the same piece of metal forming the lid and serves as a thermal mass for warming the inlet and outlet passages. The simulator includes a heater for the lid. The heater heats the lid, the passage projection and the passages in the projection.

The passage projection is surrounded by air. The metal in the projection prevents this air, which typically is cooler than the solution, from cooling the passages.

The metal in the projection surrounding the passages prevents rapid fluctuation of the temperature in the passages despite on/off cycling of the lid heater. Maintaining the inlet

passage at a stable temperature close to the temperature of the solution heats the inlet air so that when the heated inlet air is bubbled into the solution it does not cool the solution. The heated inlet air reduces the need to heat the solution.

Forming the top housing from a single piece of conductive metal reduces manufacturing cost and reduces the time required for making the housing.

The disclosed breath test simulator uses two independent control circuits. An independent temperature control circuit maintains the temperature of the solution in the jar within a normal operating range located at the approximate center of the regulatory allowable operating range. An independent temperature monitoring circuit generates a solution temperature signal which is displayed on the lid and is used to determine if the solution temperature is outside a simulator allowable operating range located inside the regulatory allowable temperature range. The simulator allowable range has upper and lower temperature limits very close to and inside the limits of the regulatory allowable operating range.

When the temperature of the solution is within the simulator allowable operating range, the temperature monitoring circuit displays the solution temperature. When the temperature of the solution is above or below the simulator allowable operating range, the temperature monitoring circuit displays alternate error messages and "Temperature High" or "Temperature Low" messages, and turns off the solution and lid heaters, turns off the agitator drive, and actuates an audible alarm indicating the solution temperature is outside the simulator allowable operating range.

The temperature control circuit and the temperature monitoring circuit are independent of each other. Each circuit includes a dedicated temperature sensor located in the solution in the jar. The two independent circuits assure that the temperature of the solution in the simulator is in the regulatory allowable operating range during calibration of a breath test analyzer. If the solution temperature approaches the limits of the regulatory allowable operating range, the simulator is shut down and alarm signals are displayed and broadcast.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a breath test simulator, partially broken away;

FIG. 2 is a top view of the simulator of FIG. 1;

FIG. 3 is a sectional view taken along line 3--3 of FIG. 2;

FIG. 4 is a sectional view taken along line 4--4 of FIG. 3;

FIG. 5 is a sectional view similar to the view of FIG. 4;

FIG. 6 is a side view of the simulator taken in the direction of arrow 6 shown in FIG. 2, partially broken away;

FIG. 7 is a perspective view of a top housing body used in the simulator;

FIG. 8 is a top view of a cover mounted on top of the body of FIG. 7;

FIG. 9 is a diagram illustrating temperature control circuitry for the simulator; and

FIG. 10 is a temperature scale for the heated solution in the jar.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Breath test simulator 10 includes top housing 12 and a plastic or glass container or jar 14 mounted on the housing. The housing includes a metal body 16 including a flat, circular lid 18 with downwardly extending circumferential lip 20. The inner surface of the lip 20 and outer surface of the top of jar 14 include complementary threads which permit threaded

engagement of the housing on the top of the jar. A circular sealing gasket **22** is mounted in a recess on the edge of the bottom of lid **18** to engage the top of the jar **14** when the housing is mounted on the jar, as shown in FIG. 3.

Body **16** as shown in FIG. 7 and includes a passage projection **24** and circumferential wall **26** extending upwardly above the top surface **28**<sup>1</sup> of lid **18**. The circumferential wall **26** extends from one side of the projection **24** around the circumference of the lid to the other side of the projection **24**. The projection **24** and wall **26** have a flat top surface **28** extending from the projection around the wall to angled wall recess **30** having opposed sides **32** angling down from the top surface **28** of wall **26** to the top surface **34** of lower wall **36**. If desired, the projection may extend below the lid.

Body **16** is preferably formed from a single piece of metal having a high co-efficient of thermal conductivity, and may be made from aluminum. The single piece construction of body **16** improves heat flow throughout the body during heating of the lid and heating of the projection **24** and the passages in the projection. If desired, the body may be made of a number of metal parts where the parts are held together in tight surface-to-surface contact to promote flow of heat throughout the body. The metal in the passage projection forms a large thermal mass for heating the inlet and outlet passages extending through the projection and maintaining the temperature in the passages constant, despite cycling of the lid heater **118**.

The lid **18** supports a number of components extending downwardly into the interior of jar **14**. Air inlet tube **38** is mounted on the lid in flow communication with vertical inlet passage portion **40** and intersecting horizontal inlet passage portion **42**. Passage portions **40** and **42** are formed in projection **24**. Air inlet port **44** is connected to passage portion **42** on one side of housing **12**. An air inlet line is connected to port **44** to flow air through the air inlet passage **42**, **40** and to tube **38**. Tube **38** has a lower end **46** at the bottom of the jar. Small air dispersion holes **48** are provided at tube end **46** for dispersing air flowed through the tube into the water/ethyl alcohol solution in the jar.

Temperature sensor rod **50** is mounted on lid **18** and extends downwardly into the solution in jar **14**. Two independent temperature sensors **52** and **54** are secured to the lower end of rod **50** in the solution. The sensors may be thermistors. Electrical leads for the two sensors extend upwardly through the interior of the rod and into cavity **56** formed in body **16**. The leads are connected to controllers mounted in the cavity and illustrated in FIG. 9, as described below.

Rotary stirrer rod **58** extends downwardly into the solution in jar **14** from the lid and carries agitator **60**. The rod **58** extends through an opening in the lid and is mounted on the output shaft of electric stirrer motor **62** mounted on the top of the lid in cavity **56**.

Circular solution baffle plate **66** is mounted on support rod **68** extending downwardly from lid **18**. Plate **66** has an outer edge spaced a short distance in from the inner wall of the jar to provide a narrow circumferential gap **70** between the plate and jar. Air bubbled up through the solution from holes **48** rises to the top of the solution and the bubbles collapse. The plate **66** prevents droplets of solution released by the collapse of the bubbles from entering the headspace **72** in the top of the jar between plate **66** and lid **18**. Tube **38**, and rods **50**, **58** and **64** extend through plate **66** as shown in FIG. 4.

The lower portion of jar **14** is filled with an ethyl alcohol-water solution having a known concentration of ethyl alcohol. The top surface **74** of the water-ethyl alcohol solution is located a short distance below plate **66**.

Heater rod **64** is mounted on lid **18** and extends downwardly into the solution in jar **14**. The heater rod includes a

heater, which may be an electric resistance heater, a small halogen light or other electrical heating element for heating the solution in the jar when actuated by circuitry mounted in cavity **56**.

Top housing **12** includes a sheet metal cover **76** which closes the top of cavity **56**. Cover **76** is illustrated in FIG. 8. The cover **76** includes a flat, partial circular top having a round outer edge **80** overlying the partial circular wall top surface **28** and extending between the ends of chord **82**. A flat, angled display wall **84** extends downwardly at an angle from a bend at chord **82**. Rectangular display window **86** is formed in wall **84**. An electronic temperature display panel on wall **84** is viewed through window **86**. The cover is mounted on the top of body **16** by use of screws to engage the body top surface **28**, angled sides **32** and the outer surface of lower wall **36** as illustrated.

Master on/off switch **104** is mounted in opening **105** on top **78** of cover **76**. Switch **104** actuates and de-actuates the electrical components of simulator **10**.

Body **16** includes a vapor outlet passage having a section **88** extending vertically up from the bottom of the lid through projection **24** to the top of the projection. Threaded plug **90** moveably closes a port at the top of passage section **88**. Horizontal outlet passage section **92** in projection **24** is located below plug **90** and extends from passage section **88** to the circumferential side of housing **12**. Vapor outlet port **94** is mounted on the end of passage section **92** to permit connection of a tube to flow headspace vapor discharged from the simulator to a breath test analyzer to be calibrated by the simulator. Outlet port **94** is adjacent inlet port **44** as illustrated in FIG. 6.

Plug **90** is exposed through circular opening **96** in cover **76**. When the plug **90** is removed, a temperature sensor **98** may be inserted through passage section **88**, down through headspace **72**, through an aligned opening **100** in plate **66** and into the water/ethyl alcohol solution **102** in the bottom of jar **14** as illustrated in FIG. 5 in order to determine the temperature of the solution accurately, independently of sensors **52** and **54**. Sensor **98** may be the temperature-sensing probe of an electronic thermometer.

FIG. 9 illustrates electrical circuitry used to monitor and control the temperature of the solution in the jar and the temperature of the lid **18** and projection **24** during operation of the simulator.

Temperature control circuit **126** includes a set point switch controller **106** which actuates the heater **108** in the lower end of heater rod **64** to maintain the solution temperature in a normal operating range **124** of 33.99° C. to 34.00° C. as illustrated in FIG. 10. Circuit **126** actuates heater **108** when the solution temperature falls to 33.99° C. and deactuates the heater when the temperature of the solution rises to 34.00° C. as determined by sensor **52**.

Temperature monitoring circuit **128** includes a set point switch controller **112** responsive to temperature sensor **54** in solution **102**. The circuit **128** also includes display **114** and alarm sounder **130**. Controller **112** generates a solution temperature signal for solution temperature display **114** when the temperature for the solution is in simulator allowable operating range **122** between 33.85° C. and 34.15° C. as determined by sensor **54**. The normal operating range **124** is located in the center of the allowable operating range **122**, essentially equidistance between range **122** high temperature 34.15° C. and range **122** low temperature of 33.85° C.

Simulator **10** includes a lid temperature controller **116**, a resistance heater **118** on the lid, and a temperature sensor **120** on lid **18**. The sensor **120** sends a lid temperature signal to controller **116**, which actuates heater **118** when the tempera-

ture of the lid falls below a set point temperature. The on set point temperature may be 35.8° C. so that the heater **118** heats conductive aluminum body **16** when the temperature in the lid falls below 35.8° C. The controller may have an off set point temperature of 36.2° C.

Heater **118** heats the metal body **16**, including the passage projection **24**. The heated projection forms a thermal mass which stores heat and heats the breath sample flowed through the inlet passage and the vapor flowed through the outlet passage. If desired, another heater also actuated by controller **116** may be mounted on the thermal mass to heat the mass directly.

Controller **116** maintains the temperature of body **16** at a temperature higher than the solution temperature in order to maintain the temperature of the vapor in the headspace at a temperature of 34°±0.5° C. The higher temperature is required because of heat loss. The operation of controller **116** to maintain the temperature of the vapor in the head space is more fully explained in U.S. Pat. No. 7,493,793, assigned to Guth Laboratories, Inc. of Harrisburg, Pa., assignee of the present application. The disclosure of U.S. Pat. No. 7,493,793 is incorporated herein by reference, in its entirety.

NHTSA standards require that the temperature of the solution be maintained within a regulatory allowable operating range **121** between 33.8° C. and 34.2° C. during operation of the simulator to calibrate a breath test analyzer. The regulatory allowable operating range has a width of 0.4° C. as shown in FIG. **10**. The range extends 0.2° C. to either side of a nominal solution temperature of 34.0° C.

Temperature control circuit **126** maintains the temperature of the solution in the jar within a narrow normal operating range **124** of 0.01° C. Range **124** has a high limit of 34.00° C. and a low limit of 33.99° C. The range **124** is located in the center of the NHTSA allowable range **121** and has a temperature width 1/40th of the width of range **121**.

Temperature monitoring circuit **128** monitors the temperature of the solution in the jar as determined by sensor **54**. Circuit **128** is completely separate from circuit **126**. When the temperature of the solution in the jar is within a simulator allowable operating range **122** the controller **112** of circuit **128** generates a temperature signal for the solution which is shown on display **114**. During normal operation of the simulator, the temperature on display **114** will be within the narrow normal operating range **124**, close to the nominal temperature of 34.00° C.

In the event the temperature of the solution falls below the range **122** lower limit of 33.85° C. or rises above range **122** upper limit of 34.15° C., circuit **128** automatically shuts down the simulator by deactivating temperature control circuit **126**, the lid heater and the agitator motor **62**. The temperature display is blanked. Alternate "Error" and "Temperature High" or "Temperature Low" signals are shown on display **114** and an alarm signal is broadcast by sounder **130** to indicate that the simulator has been shut down.

During operation of the simulator, components of the temperature control circuit **126** may drift so that the temperature at which heater **108** is actuated may move slightly from the desired low temperature of 33.99° C. and the temperature at which the heater **108** is deactuated may move slightly from the desired high temperature of 34.00° C. The effect of drift in circuit **126** is to move the on and off temperature limits for range **124** slightly. Movement of range **124** due to drift does not move range **124** outside of the simulator allowable operating range **122**. See FIG. **10**.

The components of temperature monitoring circuit **128** may also drift so that the solution temperature indicated on display **114** may vary slightly from the actual temperature of

the solution. The operating range **124** is small relative to the simulator allowable operating range **122** so that during normal operation of the simulator, drift of components in the temperature monitoring circuit **128** does not result in display of a temperature outside of range **122**.

In the event of failure of components of the temperature monitoring circuit **128**, the circuit blanks the temperature display **114** and generates a shut down display and actuates alarm **130**.

Prior to use of simulator **10** to calibrate a breath test analyzer, the simulator must be calibrated to assure that it accurately maintains the temperature of the solution in the jar in range **124**, and to assure that the temperature display **114** accurately displays solution temperature. Calibrating of the simulator is performed by turning on the circuitry and motor **62**, and heating the solution in the jar, the vapor in headspace and the top housing to operational temperatures as described.

After the simulator is at operational temperatures, plug is removed and temperature sensor **98** is inserted into passage portion **88** and down into solution **102** in the jar, as illustrated in FIG. **5**. The temperature of the solution determined by sensor **98** is noted. If the temperature of the solution determined by sensor **98** is not within range **124**, the set points for controller **106** are adjusted so that the temperature control circuit **126** maintains the temperature of the solution in range **124**.

After the temperature control circuit **106** has been adjusted to maintain the temperature of the solution in range **124**, controller **112** of the temperature monitoring circuit **128** is adjusted so that the temperature of display **114** corresponds to the solution temperature.

After calibration of the simulator **10** is completed, the sensor **98** is removed from passage portion **88** and plug **90** is reattached to close the outlet passage.

During operation of the simulator **10**, display of a "Temperature High" or "Temperature Low" or "Error" signal and sounding of alarm **130** indicates that the temperature of the solution in the jar, as determined by sensor **54**, is outside simulator allowable range **122** and close to the high or low limits of the regulatory allowable operating range **121** and, as a result, the simulator should not be used to calibrate a breath test analyzer. The simulator is shut down when the solution temperature is outside the simulator allowable range but still inside the regulatory allowable range. Shut down of the simulator while the solution temperature is in the regulatory allowable range assures that the simulator cannot be used to calibrate an analyzer when the solution temperature is outside the regulatory allowable operating range.

When the simulator is shut down, it must be withdrawn from use and serviced to assure that the circuit components are operating properly, following which the simulator must be recalibrated, as indicated above.

Operation of simulator **10** to calibrate a breath test analyzer will now be described.

Prior to calibrating a breath test analyzer, jar **14** is filled with an appropriate volume of water/ethyl alcohol solution up to a level slightly below plate **66** as illustrated in the drawings. The simulator vapor outlet port **94** is connected to the vapor inlet of the breath test analyzer. The air inlet port **44** of the simulator is connected to a tube for delivery of breath sample air to the simulator to generate a volume of vapor saturated with a known concentration of alcohol for delivery to the analyzer.

The simulator is then turned on to rotate agitator **60**, heat the solution **102** in the jar and the vapor in the headspace and heat the lid and the passage projection thermal mass and the passages in the mass as described. Heating of the simulator

and solution from an ambient temperature to a stable operational temperature may take as little as ten minutes, depending upon the ambient temperature. After heating and stabilization of the simulator, the solution will be at temperature in range 124 and temperature display 114 will indicate the solution temperature.

The operator then checks to assure that the temperature display 114 indicates the solution temperature and the temperature is in range 121. The presence of a temperature display indicates that the simulator is operating properly.

Breath sample air is then blown into the simulator through port 44. The breath sample passes through warmed inlet passage 42, 40 and is bubbled up into the solution. The heated and temperature stable thermal mass in projection 24 warms the breath sample to the temperature of the solution so that the sample does not cool the solution. Flow of an unheated inlet sample into the solution would undesirably lower the temperature of the solution, requiring additional heating to maintain the solution in range 124.

The breath sample is bubbled up through the solution to form a headspace vapor saturated with alcohol vapor. The vapor is flowed through outlet passage 88, 92 to the analyzer being calibrated.

If sensor 54 determines the temperature of the solution in the jar is outside the simulator operating range 122, the temperature display is blanked and alternate "Error" and "Temperature High" or "Temperature Low" signals are displayed. The circuitry 128 for display 114 is independent of the circuitry 126 for heater 108 and is not affected by drift or possible failure of components in the circuitry 126.

Display 114 is blanked when the components of either circuit drift or fail and the solution temperature is or is sensed to be outside of range 122. The simulator 10 uses independent temperature control circuit 126 and independent temperature monitoring circuit 128 to assure automatic indication when the solution temperature moves outside of the simulator allowable operating range 122. The use of two independent circuits assures that malfunction of either circuit will alert the operator of a malfunction so that the simulator can be withdrawn from use and the problem can be corrected.

While we have illustrated and described preferred embodiments, it is understood that these are capable of modification, and we therefore do not wish to be limited to the precise details set forth, but desire to avail ourselves of such changes and alterations as fall within the purview of the following claims.

What we claim as our invention:

1. A breath test simulator for producing breath test vapor having a known concentration of ethyl alcohol at a simulator outlet port for flow from the outlet port, through an outlet tube to a breath test analyzer;

the simulator comprising a container adapted to receive a water/ethyl alcohol solution having a known concentration of ethyl alcohol; a top housing comprising a lid closing the top of the container and a one-piece thermally conductive metal body, the metal body forming at least a portion of the lid and including a thermal mass extending a distance above the lid and having an exterior surface above the lid; an inlet port on the thermal mass exterior surface; an inlet passage in the thermal mass and lid extending from the inlet port to the interior of the container; an outlet port on the thermal mass exterior surface; an outlet passage in the thermal mass and lid extending from the interior of the container to the outlet port, wherein said one-piece thermally conductive body forms the interior walls of said passages;

a first heater on said metal body for heating the lid by conduction to heat the head space in the container and for heating the thermal mass by conduction to heat the inlet and outlet passages; a first control circuit for actuating and deactuating the first heater to maintain the temperature of the head space within a first operating range; a second heater located in the interior of the container; and a second control circuit for actuating and deactuating the second heater to maintain the temperature of a water/ethyl alcohol solution in the container within a second operating range; wherein said first heater heats both inlet air flowed through the inlet passage and into the interior of the container and breath test vapor flowed through the outlet passage to the outlet port by conduction through the metal body.

2. The breath test simulator as in claim 1 wherein the thermal mass includes a side surface extending above the lid, and one of said inlet port and said outlet port is located on said side surface.

3. The breath test simulator as in claim 2 wherein both said inlet port and said outlet port are located on said side surface.

4. The breath test simulator as in claim 2 wherein the thermal mass extends partially around the circumference of the container, and the thermally conductive metal body includes a wall joined to the thermal mass and extending around the circumference of the container.

5. The breath test simulator as in claim 4 including a cover overlying the thermal mass and the wall to define an interior space above the lid, said first and said second control circuits in said space.

6. The breath test simulator as in claim 5 wherein said wall and said thermal mass extend completely around the circumference of the container, and said cover includes a portion on one side of the container; and a temperature display responsive to a control circuit on said cover portion.

7. The breath test simulator as in claim 1 wherein said one-piece thermally conductive body is made of aluminum.

8. The breath test simulator as in claim 1 wherein the first control circuit and the second control circuit are independent of each other.

9. The breath test simulator as in claim 1 wherein said thermally conductive body includes one-piece heat flow paths extending from said first heater through said thermal mass and to said inlet and outlet passages.

10. A breath test simulator for producing breath test vapor having a known concentration of ethyl alcohol for flow to a breath test analyzer, the simulator comprising a container adapted to receive a water/ethyl alcohol solution having a known concentration of ethyl alcohol; a thermally conductive metal body, the body comprising a heat radiating lid facing the interior of the container and a heat storage thermal mass extending above the lid and having a surface above the lid; an inlet port; an inlet passage extending from the inlet port to the interior of the container; an outlet port on the surface of the thermal mass; an outlet passage extending through the lid and the thermal mass from an opening on the lid to the outlet port; said lid and thermal mass forming the interior wall of the outlet passage for heat flow from the thermal mass into the passage; a first heater located in the container; a first control circuit for actuating and deactuating the first heater to maintain the temperature of a solution in the container within a first temperature range; a second heater on the conductive body; a second control circuit for actuating and deactuating the second heater to maintain the temperature of the lid within a second temperature range substantially the same as or above the first temperature range;

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wherein said heat storage thermal mass stores thermal energy and heats the length of the outlet passage to heat breath test vapor flowed from the container through the outlet passage when the second heater is not actuated.

**11.** The breath test simulator as in claim **10** wherein said inlet passage extends through the heat storage thermal mass so that the mass heats breath test sample air flowed through the inlet passage and into the water/ethyl alcohol solution in the container.

**12.** The breath test simulator as in claim **11** wherein said inlet passage and said outlet passage are located side-by-side in the thermal mass, and the thermal mass is formed from a one-piece metal body.

**13.** The method of calibrating a breath test analyzer comprising the steps of:

- a. maintaining a water/ethyl alcohol solution in a simulator chamber at a temperature in a first operating range by actuating and deactuating a first heater in the solution;
- b. maintaining a headspace in the chamber above the solution at a temperature in a second operating range by actuating and deactuating a second heater mounted on a one-piece conductive metal top member above the simulator chamber;
- c. flowing heat from the second heater to a thermal mass forming part of the top member and extending above the chamber to heat the thermal mass;
- d. storing heat in the thermal mass when the second heater is actuated and when the second heater is deactuated;
- e. flowing breath test vapor from the head space through an outlet passage in the heated thermal mass and to an outlet port on the outside of the simulator; and
- f. flowing heat stored in the heated thermal mass into the outlet passage along the length of the passage to the outlet port to heat the breath test vapor when the second heater is actuated and when the second heater is deactuated.

**14.** The method of claim **13** including the step of:

- g. flowing a breath test sample through an inlet passage extending through the thermal mass and into the simulator chamber and flowing heat from the thermal mass into the breath test sample in the inlet passage to heat the

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breath test sample and reduce the time required to warm a solution in the chamber to the first operating range.

**15.** A breath test simulator for producing breath test vapor having a known concentration of ethyl alcohol at a simulator outlet port for flow from the outlet port, through an outlet tube and to a breath test analyzer; the simulator comprising a container adapted to receive a water/ethyl alcohol solution having a known concentration of ethyl alcohol; a top housing comprising a lid closing the top of the container and a thermally conductive body forming a portion of the lid and having an interior surface facing the interior of the container and an exterior surface facing out from the container; an inlet port on the top housing; an inlet passage in the top housing and extending from the inlet port to the interior of the container; an outlet port on the conductive body exterior surface; an outlet passage in the conductive body extending from the interior of the container to the outlet port, the conductive body forming the interior wall of the outlet passage extending from the interior of the container to the outlet port; a heater for heating the conductive body; and a first control circuit for actuating and deactuating the heater; wherein the heater heats the conductive body to store heat in the conductive body and stored heat from the conductive body flows through the interior wall of the outlet passage to heat breath test vapor in the outlet passage both when the heater is actuated and deactuated.

**16.** The breath test simulator as in claim **15** wherein the conductive body includes a side surface extending above the lid and said outlet port is located on said side surface.

**17.** The breath test simulator as in claim **16** wherein said inlet passage is located in said conductive body.

**18.** The breath test simulator as in claim **15** wherein the top housing includes an interior space and a cover over the interior space, said control circuit and heater in said space.

**19.** The breath test simulator as in claim **18** wherein the cover includes a portion on one side of the container, and a temperature display on said cover portion.

**20.** The breath test simulator as in claim **15** wherein the conductive body comprises a one-part metal piece.

**21.** The breath test simulator as in claim **15** wherein the conductive body comprising plural metal pieces.

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