

[54] **AUTOMATIC LIQUID BUBBLER**

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261/142, 261/151, 261/160

[51] Int. Cl. **B01d 45/08**

[58] Field of Search 261/142, 121 R, 151,
261/160; 128/186, 188, 190, 192, 194, 196,
197; 202/163; 203/49; 55/256, 257

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[57] **ABSTRACT**

An automatic liquid bubbler for providing measured quantities of a gas with a known moisture content. A gas in metered quantities is applied to the bottom of a sphere partially filled with a liquid. A further sphere encloses the first sphere and is partially filled with a liquid that is heated to boil continuously to maintain the inner sphere liquid at a constant temperature: the boiling point of the liquid in the outer sphere. The liquid levels of both spheres are continually replenished to maintain substantially constant levels. Gas bubbled up through the inner sphere liquid is collected and passed out of the spheres to provide a gas having a known moisture quantity.

11 Claims, 3 Drawing Figures

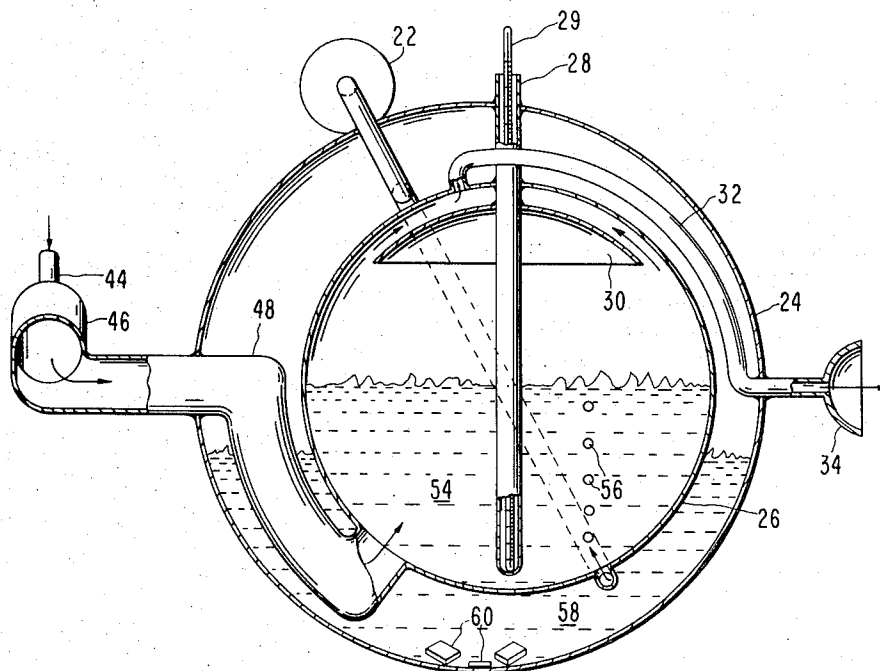


FIG. 1

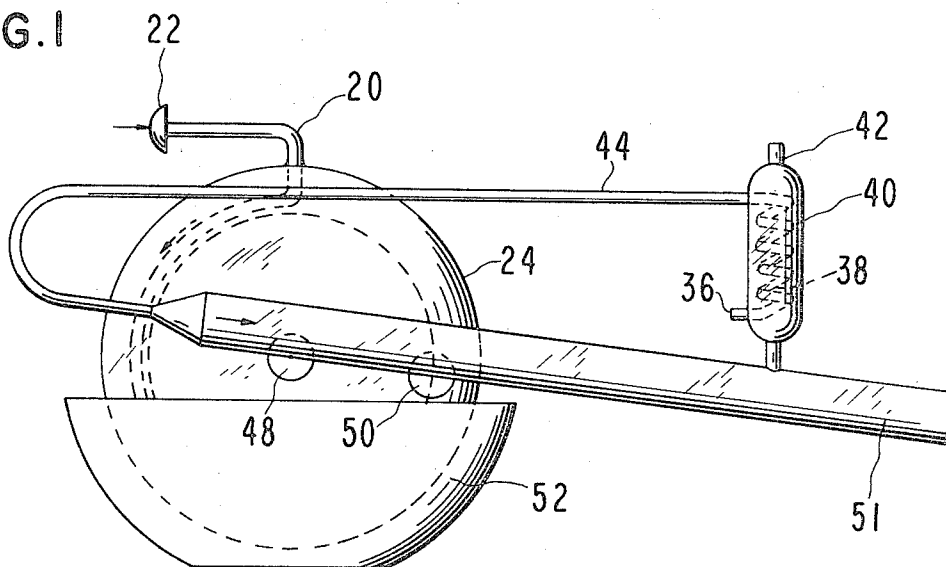
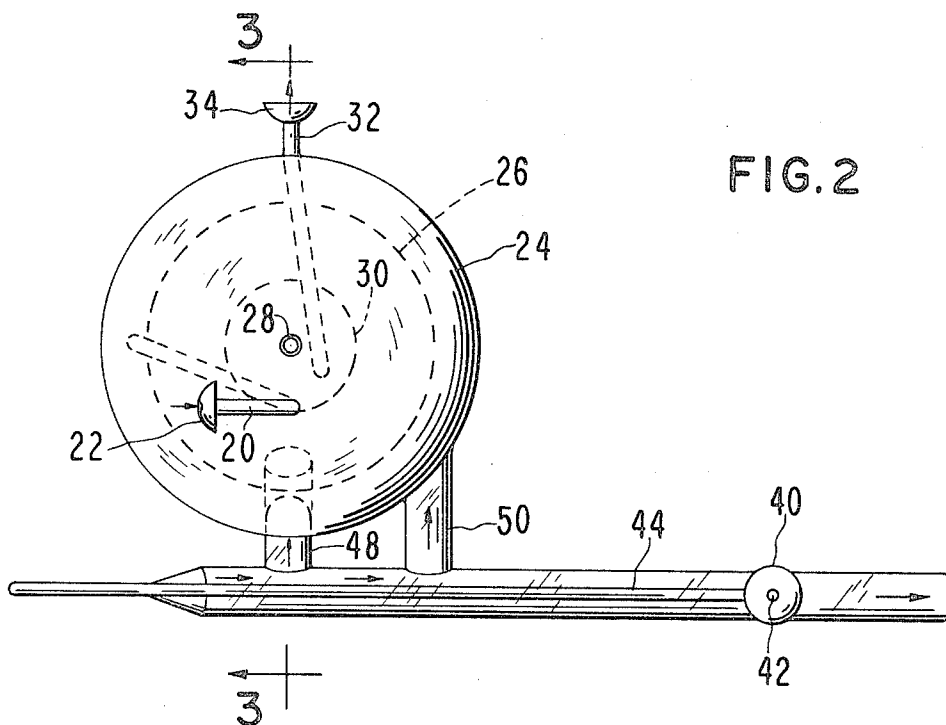


FIG. 2



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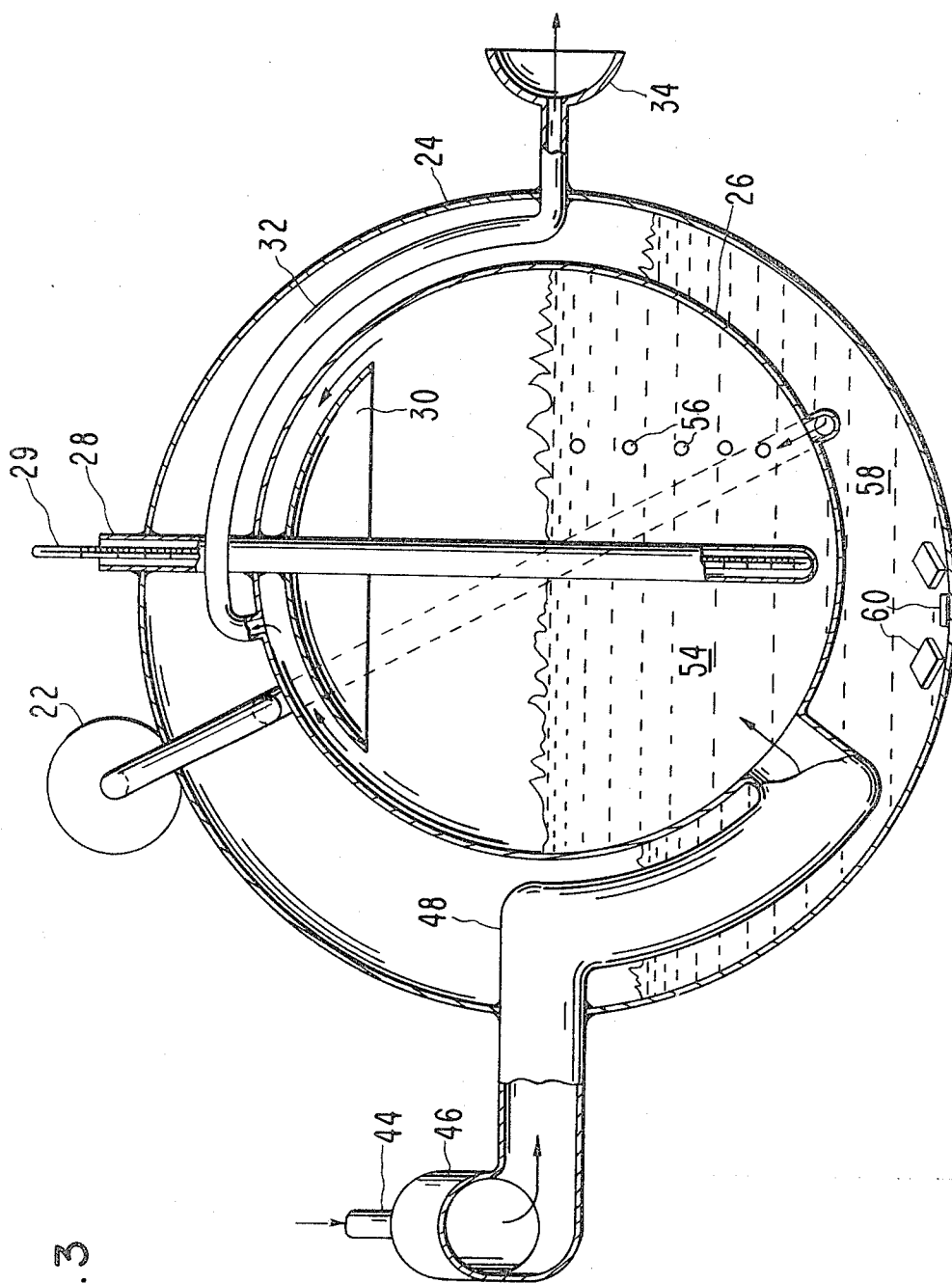


FIG. 3

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AUTOMATIC LIQUID BUBBLER

BACKGROUND OF THE INVENTION

The present invention is related to apparatus for adding moisture content to a gas and, more particularly, to an automatic bubbler for adding a controlled amount of moisture to a metered source of gas.

Many industrial and laboratory techniques require a source of gas having a predetermined moisture content. For example, in the manufacture of electronic microcircuits a furnace requires an input of oxygen having a known water vapor content. Heretofore elaborate apparatus using temperature sensors, switches, solenoid valves, etc. have been used to provide such a source of oxygen with a known moisture content. Such apparatus are not only costly, but complex to trouble shoot and difficult to maintain sanitary.

SUMMARY OF THE INVENTION

Many of the above problems are solved by the present invention which uses in one preferred embodiment a pair of substantially concentric spheres, the outer sphere partially filled with a liquid and heated to maintain boiling of the liquid. The inner sphere is partially filled with a liquid that is kept at the boiling point of the liquid in the outer sphere. A gas to which vapor of the inner liquid is to be added is bubbled through the inner sphere and collected. A thermometer well is provided for monitoring the inner sphere liquid temperature. No other temperature sensors, switches, or valves are required. The geometry of the liquid supply tubes maintains constant liquid levels in the two spheres.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of the automatic liquid bubbler according to one embodiment of the invention.

FIG. 2 is a plan view of the automatic liquid bubbler according to one embodiment of the invention.

FIG. 3 is a cross-sectional view through section lines 3—3 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein the automatic water bubbler according to one embodiment of the present invention comprises a multi-element structure formed preferably from quartz or a heat resistant glass material such as Pyrex. The structure may be formed manually by glass blowing techniques or by other means; the method of manufacturing the invention will be apparent to those of ordinary skill in the art when the present specification is read and understood, and such method of manufacture forms no part of the invention.

The main portion of the structure includes two generally concentric spheres, an outer sphere 24 and an inner sphere 26. As will be apparent hereinafter, the outside wall of inner sphere 26 is held in a spaced apart relationship from the inside walls of outer sphere 24.

An input tube 20 having a lip 22 at the end thereof for attachment to an external hose or line (not shown) is intended to receive a gaseous input such as oxygen preferably in metered quantities. Tube 20 enters the outer sphere 24 near the top thereof in a fluid-tight relationship thereto and curves around the outer surface of inner sphere 26 to a point near the bottom thereof where it opens into inner sphere 26. Thus a gas supply

applied to the input of tube 20 ultimately reaches the bottom of inner sphere 26.

An outlet tube 32 is provided near the top of inner sphere 26; tube 32 curves over the top surface of inner sphere 32 and exits through the side of outer sphere 24 in a fluid-tight relationship. A lip 34 is provided at the exit end of tube 32 for connection to an external line or hose (not shown).

A cylindrical open topped, closed bottomed thermometer well 28 is provided vertically through the outer sphere 24 and inner sphere 26. The bottom of well 28 comes near but does not touch the inside bottom surface of inner sphere 26. A thermometer 29 may be inserted in well 28.

An input 36 for a liquid supply, such as water, is provided at the base of a condenser coil 38. The input 36 is a portion of coil 38 that passes through the side wall of a cooling tower 40, having a vapor chimney 42 on top as explained further hereinafter. Coil 38 passes through the top of cooling tower 40 to become tube 44 that extends horizontally and loops downward to join a generally horizontal larger diameter tube 46 that is angled downward. A pair of consecutive exit tubes 48 and 50 extend substantially horizontally from outer sphere 24 and connect to the lower or underneath part of tube 46.

Tube 48 passes through the side wall of outer sphere 24, in a fluid-tight relationship, curves downward and connects to the bottom side of the inside sphere 26. Tube 50 connects to the side wall of outer sphere 26. Tube 50 is disposed somewhat lower than tube 48.

The bottom portion of cooling tower 40 connects to the top of tube 46 below the connection of tube 50. The portion of tube 46 below the cooling tower 40 constitutes an outlet 51.

It will now be apparent that inner sphere 26 is held in place principally by the thermometer well 28 and liquid input tube 48.

In operation, the outer sphere 24 is placed in a heating mantle 52. A continuous flow of a liquid, water, for example, is supplied to inlet 36. The inner and outer spheres 26 and 24 fill to their maximum levels determined by the relative heights of tubes 48 and 50, respectively. The inner sphere 26 tends to fill first since tube 48 is located above tube 50. The level of the liquid 54 in inner sphere 26 will be above that of the liquid 58 in the outer sphere 24. The heating mantle 52 is chosen to produce continuous boiling in the liquid 58 of the outer sphere 24. So long as the input liquid rate to tube 50 is adequate to compensate for the vapor or steam conversion it does not matter how strongly the liquid 58 boils. Heating mantle 52 need not be controlled by a thermostat or other regulating means. Boiling chips 60 made from porous Al_2O_3 or porous SiO_2 or a mixture thereof, assist in maintaining liquid 58 at its boiling point to reduce surging and thermal overshoot in the inner sphere 26. Because tube 50 is below tube 48 liquid surging from tube 50 does not enter tube 48. This is significant to prevent contamination from boiling chips 60 in the outer sphere liquid 58 from reaching the clean inner liquid 54.

Metered quantities of a gas, oxygen, for example, are supplied continuously to tube 20. The gas is thus applied to the bottom of inner sphere 26 and it rises as bubbles 56 through liquid 54. The gas is preheated as it passes through a tube 20 by the steam in the top of outer sphere 24. Splash skirt 30, an umbrella-like shield

fixed to thermometer well 28, prevents any splashing into gas outlet tube 32. Liquid 54 of the inner sphere 26 is maintained at the boiling point of the liquid 58 in outer sphere 24, 100°C. in the case of water. The vapor or steam above the liquid level from the boiling liquid 58 in the outer sphere 24 also aids in holding the inner sphere liquid 54 at a fixed temperature.

Excess liquid that does not flow into tubes 48 or 50, and liquid that surges from boiling in sphere 24 flows through the outlet 51 of tube 46 to a sump (not shown). Vapor or steam from sphere 24 flows out tubes 50 and 46 to the cooling tower 40 and out chimney 42. Steam or vapor rising in cooling tower 40 functions to pre-heat the liquid input flowing through coil 38.

The gas in output tube 32 will have a known amount of moisture as a result of bubbling through the fixed temperature liquid.

Although other liquids and gases may be employed in the bubbler according to the present invention, and the invention may have applications in other technologies, in the manufacture of electronic micro-circuits a source of clean oxygen having a predetermined moisture content is essential. For such an application, the liquid provided at input 36 is de-ionized bacteria-free water and the gas source to tube 22 is oxygen. The outer sphere water 58 thus provides a constant 100°C. for the inner sphere water 54.

It will be apparent to those of ordinary skill in the art that other gases and liquids may be employed in the invention.

The invention thus described provides a simple yet effective means for providing a controlled amount of a gas with a known moisture content.

I claim:

1. Automatic liquid bubbler apparatus comprising a first enclosed container defined by an enclosing wall adapted to contain a liquid, a second enclosed container defined by an enclosing wall adapted to contain a liquid, means for holding said second container within said first container in surrounding relationship, means adapted to receive a gas including conduit means for communicating said gas to said second container at a point adjacent the bottom of the second container and below a predetermined liquid level in said container when said container contains a liquid, whereby said gas bubbles through said liquid, means communicating with the top of said second container for collecting and transmitting gas that has bubbled through said liquid and passing the gas externally of the first container, means supplying a liquid to said first container for maintaining a predetermined liquid level having air space thereabove, means supplying a liquid to said second container for maintaining its said predetermined liquid level, and means for applying heat directly to said first container sufficient to maintain boiling of the liquid in the first container, thereby to maintain the liquid in the second container at the boiling point temperature of the liquid in the first container.

2. Apparatus according to claim 1 wherein said means for supplying a liquid to said first container and said means for supplying a liquid to said second container comprises

a liquid supply tube sloping downward from the horizontal adapted to receive a liquid supply at the higher end thereof,

means for supplying a liquid to said liquid supply tube,

a second container liquid input tube communicating with said liquid supply tube, said tube extending substantially horizontally from said liquid supply tube, passing through said first container in a fluid-tight relationship and opening into said second container whereby the liquid level in said container is determined by the axis of the horizontal portion of said second container input tube extending from said input tube, and

a first container liquid input tube communicating with said liquid supply tube downstream from said second container liquid input tube, said first container liquid input tube extending substantially horizontally from said liquid supply tube and opening into said first container, whereby the liquid level in said first container determined by the axis of said first container liquid input tube is lower than the liquid level in said second container so that liquid surging from said first container does not enter said second container liquid input tube.

3. Apparatus according to claim 1 wherein said means adapted to receive a gas comprises an inlet tube entering the top of said first container in a fluid-tight relationship, following the outer surface of said second container, and opening into the bottom of said second container, whereby the gas in said tube is preheated by the vapor and liquid in said first container.

4. Apparatus according to claim 1 wherein said means for collecting and transmitting gas comprises an outlet tube entering the side of said first enclosure in a fluid-tight relationship and opening into the top of said second enclosure.

5. Apparatus according to claim 4 further comprising splash skirt means located below the top inside of said second container to prevent liquid in said second container from splashing into said outlet tube.

6. Automatic liquid bubbler apparatus, comprising: a first enclosed container adapted to contain a liquid, a second enclosed container adapted to contain a liquid,

means for holding said second container within said first container,

means adapted to receive a gas for communicating said gas to said second container at a point below the liquid level in said container when said container contains a liquid, whereby said gas bubbles through said liquid, said gas receiving means including an inlet tube entering the top of said first container in a fluid-tight relationship, following the outer surface of said second container, and opening into the bottom of said second container, whereby the gas in said tube is preheated by the vapor and liquid in said first container,

means communicating with the top of said second container for collecting and transmitting gas that has bubbled through said liquid, said gas collecting means including an outlet tube entering the side of said first enclosure in a fluid-tight relationship and opening into the top of said second enclosure, splash skirt means located below the top inside of said second container to prevent liquid in said second container from splashing into said outlet tube,

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a liquid supply tube sloping downward from the horizontal adapted to receive a liquid supply at the higher end thereof,

means for supplying a liquid to said liquid supply tube,

a second container liquid input tube communicating with said liquid supply tube, said tube extending substantially horizontally from said liquid supply tube, passing through said first container in a fluid-tight relationship and opening into said second container whereby the liquid level in said container is determined by the axis of the horizontal portion of said second container input tube extending from said input tube, and

a first container liquid input tube communicating with said liquid supply tube downstream from said second container liquid input tube, said first container liquid input tube extending substantially horizontally from said liquid supply tube and opening into said first container, whereby the liquid level in said first container determined by the axis of said first container liquid input tube is lower than the liquid level in said second container so that liquid surging from said first container does not enter said second container liquid input tube, whereby the application of heat to said first container sufficient to maintain boiling of the liquid in the first container maintains the liquid in the second container at the boiling point temperature of the liquid in the first container.

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7. Apparatus according to claim 6 wherein said means for supplying a liquid to said liquid supply tube comprises

a cooling tower having a chimney communicating with said liquid supply tube downstream from said first and second container liquid input tubes,

a tube adapted for receiving a liquid supply entering said cooling tower, coiled upward through said cooling tower, and passing out of said cooling tower, said tube extending above and substantially parallel to said liquid supply tube and curving downward into a loop to open into said liquid supply tube, whereby said liquid supply flowing through said coil is pre-heated by vapor in said cooling tower.

8. Apparatus according to claim 7 wherein said means for holding said second enclosure within and spaced apart from said first enclosure comprises a thermometer well extending in a fluid-tight relationship through the tops of and fixed to said first and second enclosures, the bottom of said well extending to near the bottom of said second enclosure.

9. Apparatus according to claim 8 wherein said first and second enclosures are substantially concentric containers.

10. Apparatus according to claim 9 wherein said apparatus is formed from quartz.

11. Apparatus according to claim 9 wherein said apparatus is formed from heat-resistant glass.

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