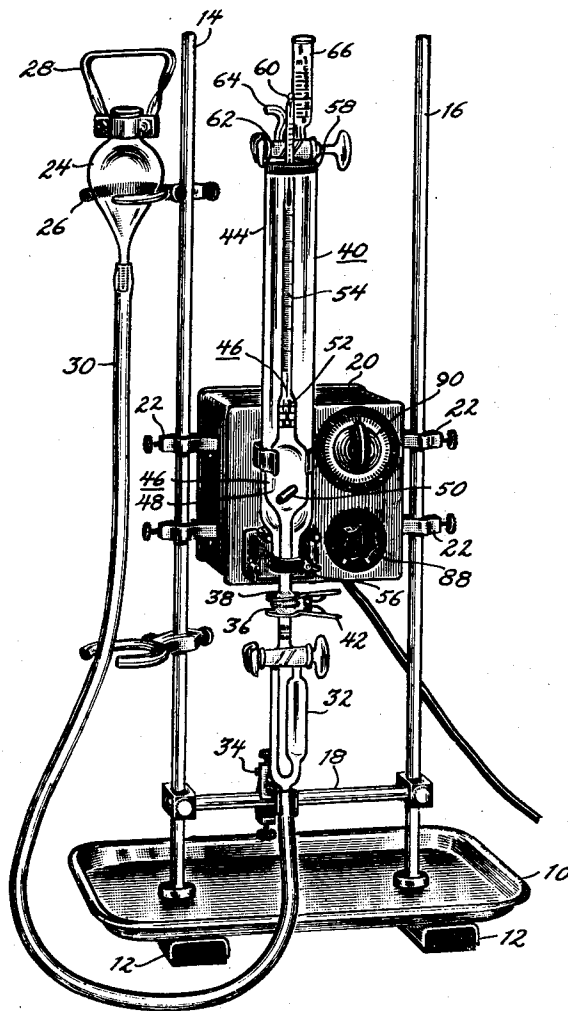


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Fig. 1.



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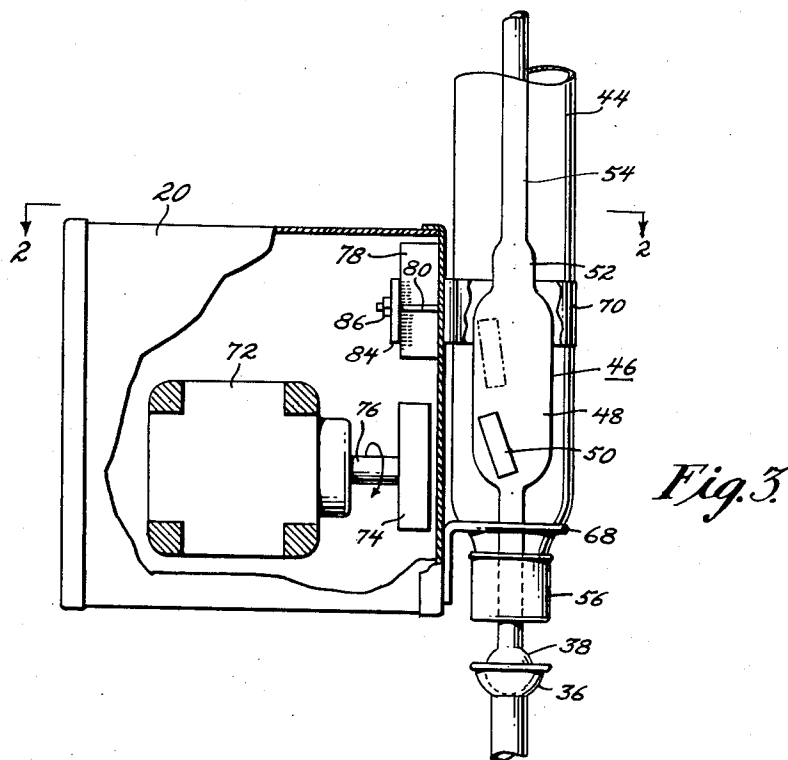
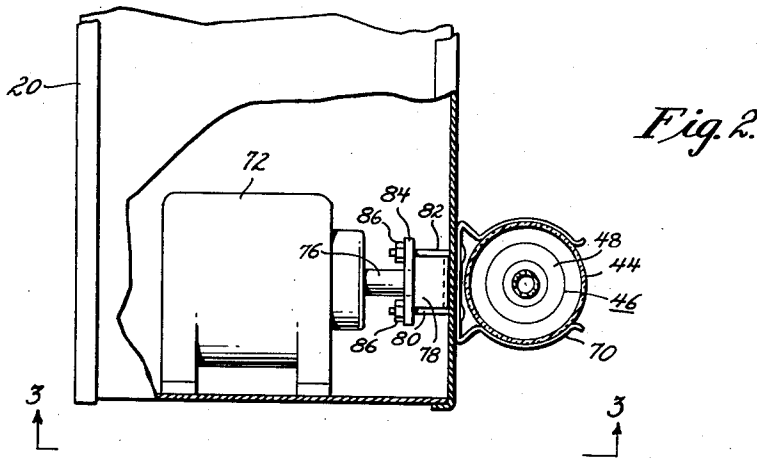
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VOLUMETRIC APPARATUS FOR DETERMINING
THE GAS CONTENT OF LIQUIDS

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2 Sheets-Sheet 2



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VOLUMETRIC APPARATUS FOR DETERMINING THE GAS CONTENT OF LIQUIDS

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The present invention is directed to volumetric apparatus for determining the gas content of liquids, and more particularly to Van Slyke volumetric apparatus of the type where mercury is used as the confining fluid.

The Van Slyke clinical apparatus for determining the gas content of blood has been modified so as to eliminate the need for shaking. Thus, United States Letters Patent 2,773,747, issued December 11, 1956, in the names of Duncan E. King and myself discloses such apparatus comprising a magnetic stirring bar which is actuated by an externally spinning driving magnet.

The apparatus disclosed in aforesaid Patent 2,773,747 constitutes the most efficient Van Slyke apparatus heretofore developed, and has virtually obsoleted all prior types of Van Slyke equipment. However, it has been found that a problem arises in Van Slyke volumetric equipment wherein mercury is used as the confining fluid, issuing through the lower tubulation to raise and lower liquid reactants in the apparatus, and to compress and expand gases evolved from such reactants. The magnetic stirring bar, which comprises a magnetic metal alloy covered with an essentially inert envelope such as a monochlorofluoroethylene polymer, is of lower density than the mercury. Thus, the magnetic stirring bar tends to float on the surface of the mercury. Since such apparatus is best built with the extraction chamber comprising a relatively large circular cross-section portion surmounted by a smaller circular cross-section portion surmounted by a graduated tube, the magnetic stirring bar is prone to pass into the smaller circular cross-section portion upon the raising of the mercury. This is most undesirable since the presence of the magnetic stirring bar within the upper tubulation must be avoided as otherwise blocking of the upper tubulation in which the gases to be measured will occur.

The use of a manually applied exterior magnet to limit the extent of movement of the magnetic stirring bar has been attempted, but has not proved to be satisfactory. Thus, the use of such magnet requires manipulation by the operator and is inconvenient. In addition, the manually applied magnet is subject to being lost.

This invention has as an object the provision of improved volumetric apparatus for determining the gas content of liquids.

This invention has as another object the provision of improved apparatus of the aforesaid type in which mercury is used as the confining fluid and is passed from the lower tubulation directly into the extraction chamber.

Another object of the present invention is the provision of Van Slyke apparatus comprising an extraction chamber having a relatively large circular cross-section portion surmounted by a smaller circular cross-section portion surmounted by a graduated tube with a magnetic stirrer within the extraction chamber in which the possibility of the magnetic stirrer ascending into the smaller circular cross-section portion of the extraction chamber is eliminated.

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Other objects will appear hereinafter.

For the purpose of illustrating the invention there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

Figure 1 is a perspective view of a preferred embodiment of the volumetric apparatus of the present invention.

Figure 2 is a view taken on line 2—2 of Figure 3 with parts broken away for clarity and the stirring bar removed.

Figure 3 is a view taken from the position shown on line 3—3 of Figure 2 with parts broken away for clarity and with the graduations on the extraction chamber deleted.

Referring to the drawings, the volumetric apparatus of the present invention comprises a base 10, which may be in the form of a tray carried on supports 12.

A pair of standards 14 and 16 extend upwardly from the base 10, and may be anchored in the supports 12.

The standards 14 and 16 are braced by means of brace bar 18 which joins such standards and maintains them in rigid disposition. The housing 20 is carried intermediate the standards 14 and 16 by clamps 22. As clamps 22 may be adjustably tightened along the vertical height of the standards 14 and 16, the relative disposition of the housing 20 in reference to the base 10 may be regulated.

The standard 14 carries the mercury reservoir 24, whose height may be selectively adjusted in respect to the standard 14. This is accomplished by carrying the mercury reservoir 24 on the ring clamp 26. Handle means 28 are provided on the mercury reservoir 24 for manipulation of such reservoir if the same is desired.

A flexible tube 30 of impervious plastic or the like extends from the mercury reservoir 24 to the reservoir and lower stopcock member 32. Such reservoir and lower stopcock member 32 may be supported by means of clamp 34 on the brace bar 18. The upper end of the reservoir and lower stopcock member 32 is provided with a ball-and-socket joint 36 which may be matingly secured to a mating ball-and-socket joint member 38 carried at the bottom end of the burette assembly, which burette assembly is designated generally as 40. A conventional pinch clamp 42 or like spring clip may be used to secure the ball-and-socket joints 36 and 38 together. The presence of the ball-and-socket joints 36 and 38 intermediate the reservoir and lower stopcock member 32 and the burette assembly 40 enables a gas-tight seal to be obtained between the reservoir and lower stopcock member 32 and the burette assembly 40 while permitting facile connection and separation of these units. Moreover, the presence of the ball-and-socket joints 36 and 38 permits the apparatus to accommodate to shock, since a rigid system is avoided.

The burette assembly 40 comprises the outer jacket 44 within which is disposed the extraction chamber designated generally as 46.

The extraction chamber 46 comprises a relatively large circular cross-section portion 48 within which is disposed the magnetic stirrer or stirring bar 50. The magnetic stirrer or stirring bar 50 comprises a magnetic metal, such as iron, coated with an inert plastic, such as monochlorofluoroethylene polymer. The stirring bar 50 may be in the shape of an elongated rectangular prism, or as a cylinder.

The extraction chamber 46 comprises a smaller circular cross-section portion 52 surmounted upon the relatively large circular cross-section portion 48. As seen particularly in Figure 1 the smaller circular cross-section portion 52 is graduated so as to facilitate volumetric readings. A graduated tube 54 is mounted upon the

smaller circular cross-section portion. The bore of graduated tube 54 is of smaller diameter than the smaller circular cross-section portion 52, and the graduations on such graduated tube 54 are scaled to permit precision readings. The extraction chamber 46 including its relatively large circular cross-section portion 48, smaller circular cross-section portion 52, and graduated tube 54 is an integral member, preferably formed of high grade glass. The outer jacket 44 is sealed at its bottom end by stopper 56 and at its top end by stopper 58. An aperture may be provided in stopper 58 for receiving a thermometer 60. Thermometer 60 may be utilized to determine the temperature within the outer jacket 44.

A stopcock 62 having an exhaust outlet 64 and a graduated liquid inlet 66 is provided at the top of the burette assembly 40 in communication with the graduated tube 54 of the extraction chamber 46.

The burette assembly 40 is supported in reference to the housing 20 by supports 68 which are disposed beneath a shoulder on the outer jacket 44 and by the spring clamp 70 which engages the outer jacket 44.

Electric motor 72 is disposed within housing 20 and is secured to the inner surface of a wall thereof. A permanent bar magnet 74 is mounted at its center on the shaft 76 of motor 72. Rotation of the permanent bar magnet 74 provides a rotating magnetic field resulting in the movement of the stirring bar 50 within the relatively large circular cross-section portion 48 of extraction chamber 46.

A fixed permanent bar magnet 78 is vertically disposed within housing 20 adjacent the upper portion of relatively large circular cross-section portion 48 and smaller circular cross-section portion 52 of extraction chamber 46 as seen particularly in Figure 3. The fixed permanent bar magnet 78 is preferably maintained in its vertical disposition by means of bolts 80 and 82 which hold the spring clamp 70 against the housing 20. A flat plate 84 joining the bolts 80 and 82 secures the fixed permanent bar magnet 78 against the inside surface of its juxtaposed housing wall. Nuts 86 carried on the bolts 80 and 82 retain the flat plate 84 against the fixed permanent bar magnet and provide for its securement.

As can be seen from Figure 2, the vertically disposed fixed permanent bar magnet 78 is in axial alignment with the permanent bar magnet 74 carried by the shaft 76 of electric motor 72 when the permanent bar magnet 74 is vertically disposed.

The speed of rotation of the shaft 76 of electric motor 72 may be controlled by a rheostat 88 mounted on the front face of housing 20 in order to control the degree of vigor of stirring. An automatic interval timer 90 may also be provided on the front face of housing 20 to control the time duration of stirring.

The operation of the volumetric apparatus of the subject invention is as follows:

Van Slyke determinations are made in accordance with the standard Van Slyke procedure involving the flow of mercury from the mercury reservoir 24 into the extraction chamber 46, both prior and subsequent to the rotation of the stirring bar 50 induced by the rotation of the motor-mounted magnet 74. The stirring bar 50 will float on the surface of the mercury.

In the absence of fixed permanent bar magnet 78, the stirring bar 50 would rise with the rising mercury. Notwithstanding the field of the permanent bar magnet 74 the stirring bar 50 is prone to leave the relatively large circular cross-section portion 48 of the extraction chamber 46 and enter into the smaller circular cross-section portion 52. This capturing of the stirring bar 50 by the permanent bar magnet 78 prevents the stirring bar 50 from blocking the smaller circular cross-section portion 52 and the tube 54, which would interfere with the Van Slyke determination.

In the apparatus of the present invention the fixed permanent bar magnet 78 maintains the stirring bar 50

in the upper portion of the relatively large circular cross-section portion of the extraction chamber 46 when the stirring bar has risen to such height by the upward movement of the mercury within the extraction chamber 46 (see the phantom line position of the stirring bar 50 in Figure 3). After the mercury has been brought down below the relatively large circular cross-section portion 48, the stirring bar 50 is released from the magnetic field of the permanent bar magnet 78. This is accomplished by rotating the shaft 76 which carries the bar magnet 74. Thus, after one turn, the bar magnets 74 and 78 are fully opposed weakening the magnetic field of the bar magnet 78. During such weakening of the magnetic field the stirring bar 50 drops from its own weight from the magnetic field of the magnet 78 and becomes captured within the magnetic field of the rotating permanent bar magnet 74, as the magnetic field of the bar magnet 78 is weakened to such an extent that it can no longer bear the weight of the stirring bar 50.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. Apparatus comprising an upright vessel containing a stirring bar comprising magnetic material, an elongated first magnet uprightly mounted adjacent said vessel, means for rotating said first magnet, and an elongated second magnet fixedly mounted adjacent to and above said first magnet, with said second magnet being adjacent said upright vessel.

2. Apparatus in accordance with claim 1 in which said first and second magnets comprise permanent bar magnets.

3. Apparatus in accordance with claim 2 in which the second magnet is fixedly mounted in vertical disposition.

4. Apparatus in accordance with claim 3 in which the first and second magnets are in axial alignment when the first magnet is vertically disposed.

5. Apparatus in accordance with claim 3 in which the second magnet is spaced a distance from the first magnet within which the magnetic field of the second magnet is reduced to such a level upon the rotation of the first magnet that the stirring bar when held by the second magnet is released.

6. A volumetric apparatus for ascertaining the gas content of a liquid of the Van Slyke type in which mercury is introduced into an extraction chamber including an extraction chamber comprising a portion of relatively large interior cross-section surmounted by a portion of relatively small interior cross-section, a mercury reservoir in communication with said extraction chamber, a stirring bar comprising magnetic material within said extraction chamber, an elongated first magnet uprightly mounted adjacent said portion of the extraction chamber having a relatively large interior cross-section, means for rotating said first magnet, and an elongated second magnet fixedly mounted adjacent the upper portion of the portion of the extraction chamber having a relatively large interior cross-section with said second magnet being above and adjacent said first magnet.

7. A volumetric apparatus in accordance with claim 6 in which each of the magnets is a permanent bar magnet.

8. A volumetric apparatus in accordance with claim 7 in which the second magnet is fixedly mounted in vertical disposition.

9. A volumetric apparatus in accordance with claim 8 in which the two magnets are in axial alignment when the first magnet is disposed in vertical disposition.

10. A volumetric apparatus in accordance with claim 9 in which the second magnet is spaced a distance from the first magnet within which the magnetic field of the second magnet is reduced to such a level upon the rotation of the

first magnet that the stirring bar when held by the second magnet is released.

11. A volumetric apparatus in accordance with claim 6 in which a ball-and-socket joint is disposed intermediate the mercury reservoir and the extraction chamber, which joint is held together by spring clip means, and which joint permits the absorption of shock and the facile separation of the extraction chamber from the mercury reservoir.

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