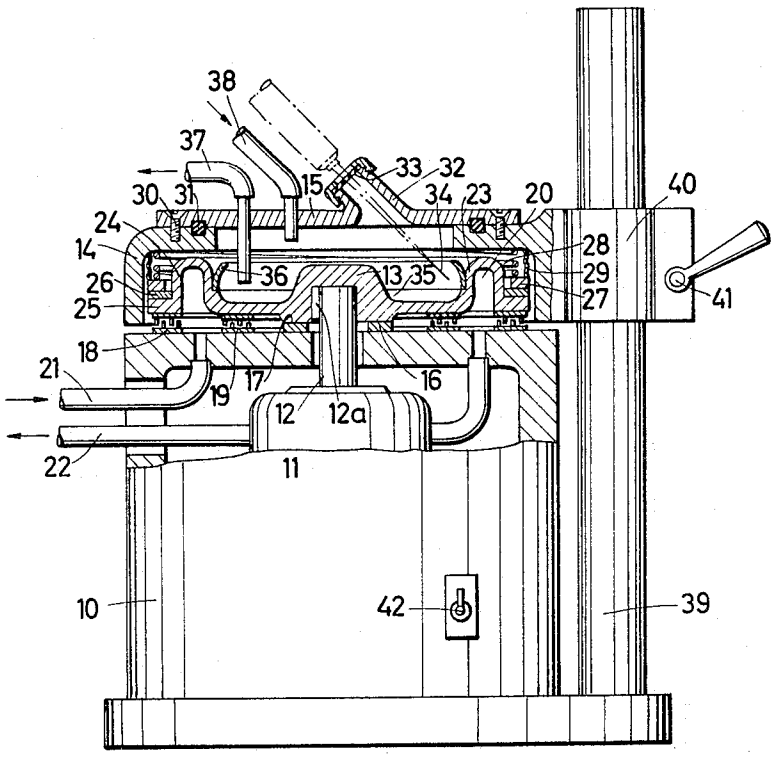
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APPARATUS FOR DEGASSIFYING A LIQUID

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APPARATUS FOR DEGASSIFYING A LIQUID

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The present invention relates to a procedure for the analysis of blood gases and an apparatus for use in this procedure.

The determination of the content of various gases in the blood is of major importance in medicine. The gases may consist of respiratory oxygen and carbon dioxide of of anaesthetic agents. It may also be required to know the ratio between the amounts of ordinary water vapour and heavy-water vapour in the blood. It is the oxygen content, however, that is of particular importance.

The usua techniques for determining the oxygen content of the blood are exeremely time-consuming, and large quantities of blood are required.

With the development of gas chromatography the estimation of the oxygen content of the blood has been considerably simplified, and both the time and the quantities required have been much reduced. A rapid technique for such an estimation has been reported which depends upon the liberation of oxygen and carbon dioxide from the blood sample by means of chemicals in aqueous solution. This method has a number of disadvantages; for instance, not all of the oxygen in the sample is liberated, moreover, the aqueous solution of chemicals is rapidly exhausted and must be replaced after a few analyses. Because of the large amount of water vapour in the chamber in which the blood gases are liberated—as a consequence of the use of aqueous solutions—the gases must be dried before gas chromatography is performed, for otherwise the columns will be impaired by the vapour. Since a gas chromatograph is extremely sensitive to variations in gas flow and since the perviousness of the drying agent to gas will vary according to its water content of the former, the calibration of the apparatus will vary in an inadmissible fashion.

The object of the present invention is to avoid the above disadvantages and in other respects simplify the analysis of blood gases; the proceduce in accordance with the invention is eminently suitable for this purpose. The essential features of the method are that (i) the blood sample is centrifuged, (ii) at the same time it is heated to a temperature at which the blood gases are liberated, and (iii) a continuous current of gas is maintained through the centrifuge bowl.

In accordance with the invention the blood sample is injected against the inner surface of a rotating centrifuge bowl; this is raised to the required temperature at least at the places with which the blood comes into contact.

The apparatus in accordance with the invention has the following essential features: it contains a centrifuge bowl, a device for injection of a blood sample against the inner surface of the rotating bowl, devices for heating at least the part of the centrifuge drum with which the blood comes into contact, and devices for ensuring a continuous current of gas through the centrifuge bowl, the object being that this stream of gas will carry with it the blood gases liberated on injection and vaporization of the sample.

The invention will be explained in greater detail below with reference to the attached diagram showing, in side elevation, a device in accordance with the invention.

The apparatus that is illustrated by way of example consists of the following components: A housing **10** for an electric motor with a vertical shaft **12**. The

motor **11** drives a shallow centrifuge bowl **13** which is detachably mounted on the upper end of the shaft **12**. The bowl has a fitting cover **14** with a central hole, which is closed by a lid **15**. On the upper surface of the housing **10** and surrounding the shaft **12** is a ring bearing **16** of, for instance, Phosphor bronze. The bowl has a plane ground area on its under surface which runs on the ring bearing **16**, so that when the bowl is rotating it is kept at a constant level. On the upper surface of the housing **10** and concentrically with the shaft **12** there are also two rings, which have concentric ridges; these ridges intermesh with corresponding ridges of two similar rings on the under surface of the centrifuge bowl **13** so that two labyrinth seals **18** and **19** are formed.

The rim of the centrifuge bowl **13** is bent over so as to form an annular channel **20**, which opens downwards. When the bowl is placed on the shaft **12** in such a manner that the ground surface **17** on the under side of the bowl rests on the ring bearing **16**, the annular channel **20** is completely isolated from the outside by the labyrinth seals **18** and **19**. When the centrifuge is running, a heating medium such as water vapour or hot air is conducted to the channel **20** through a tube **21** and away from the channel through a tube **22**. In this way the radial outer wall **23** of the centrifuge bowl will be heated.

The wall **24** forming the channel **20** is closed by means of a flange **25** which is at right angles to the axis of rotation. On the upper surface of the flange is placed a smooth ring **26**, of for instance, Phosphor bronze or steel. Against this ring **26** a packing ring **27**, for instance a carbon sealing ring, is pressed by means of a number of spring screws **28**. Between the packing ring **27** and the inside of the centrifuge cover **14** is a bellows **29**, which is connected to the packing ring **27** and the inside of the centrifuge cover **14** so as to form a gas-tight joint.

The lid **15** is fastened on the centrifuge cover **14** by screws **30** and a gas-tight seal between these is provided by a ring washer **31**.

The lid **15** has an opening **32** in which is fitted a rubber membrane **33** designed to resist the gas pressure in the centrifuge when it is running, but which is also easily pierced by a syringe needle **34** for injecting the blood sample into the centrifuge chamber **13**. The membrane **33** is set in an inclined position so that the blood sample can be sprayed against the wall **23** of the centrifuge bowl. On the floor of the bowl there are radial ridges **35**, the purpose of which is to facilitate transport of the injected blood towards the wall **23**. Near the top of the wall **23** the bowl is provided with a metal ring **36**, which curves slightly inwards. The purpose of this ring is to prevent the blood sample flowing over the edge of the centrifuge bowl during centrifugation.

The lid **15** contains an inlet tube **38** and an outlet tube **37** for gas.

The device functions in the following manner:

The centrifuge bowl **13** is first placed on the upper end of the motor shaft **12** and a firm grip is ensured by means of the axial wedge **12A**. The centrifuge bowl **13** should then rest with its ground surface **17** supported on the ring bearing **16** and the engagement of the labyrinth seals **18** and **19** is then ensured. The centrifuge cover **14** with the lid **15** then occupies an elevated position, in which it is clamped at the pillar **39**, a slotted clamp **40** being held firmly around the pillar **39** by a locking device **41**. The locking device **41** is then released, after which the centrifuge cover **14** with the lid **15** are moved downwards so that the packing **27** rests against the ring **26**. The motor **11** is then set running by means of the switch **42** on the housing **10**. The centrifuge bowl **13** is then set in rotation. In connection with this operation the supply of heating medium is connected by means of a valve (not shown) through the tube **21**, so that the heating medium

flows through the tube **21** and the annular channel **20**, to flow out by way of the tube **22**. In the process the outer wall **23** of the centrifuge bowl will be heated to a temperature which is high enough to ensure liberation of the gases in the blood sample. A valve is then opened to admit a suitable gas, such as helium, through the supply tube **37**; the interior of the centrifuge then fills with the gas, which flows out through the tube **38**. The apparatus is now ready for injection of the blood sample.

The blood sample, of about 0.1 ml., the volume of which has been accurately determined, is injected through the membrane **33** which is pierced by the syringe needle **34**. In this operation the needle **34** should be directed against the outer wall **23** of the centrifuge bowl which is heated in the manner described above. If a small part of the injected blood sample should reach the floor of the centrifuge bowl **13** the radial ridges **35** ensure that it is immediately set in rotation so that it will be thrown out towards the outer wall **23** by the centrifugal force. Because the blood comes into contact with the comparatively large wall surface which has been heated to the required temperature, the vaporizable part of the injected blood sample will be immediately vaporized; the blood gases will pass off through the outlet tube **37** together with the stream af gas passing through the centrifuge. All constituents of the injected blood sample that cannot be vaporized will, of course, be thrown out to the periphery of the bowl **13** where they will be retained without any risk of them being carried in the gas stream through the outlet tube **37**. There will clearly be no large quantities of water vapour and hence no need to dry the sample of blood gases, and therefore all forms of drying tower and suchlike are avoided.

By virtue of the fact that the blood sample comes into contact with the large heated surface so that it is immediately vaporized in its entirety, an extremely well-defined reading on the analysis apparatus is obtained so that the evaluation of the reading with respect to the quantity of gas analysed on each occasion is facilitated.

No chemicals are required in the procedure according to the invention and the centrifuge bowl **13** is easily cleaned after a number of analyses have been performed. If required, a number of similar bowls might be used in succession.

A number of modifications and alterations in detail may be made within the framework of the principal idea covered by the invention.

What I claim is:

An apparatus for analyzing a sample of a vaporizable material for gases contained therein, comprising a housing, a motor mounted in said housing having a vertical shaft extending upwardly through said housing, a centrifuge bowl removably mounted on the upper end of said vertical shaft above the housing, said bowl being a shallow bowl having a rim which is turned over and extends downwardly to define an annular channel in the under surface of the bowl, said annular channel opening downwardly toward said housing, a bearing on said housing on which said bowl rotates, sealing means between the bottom of said bowl and said housing and comprising a first seal radially outwardly of said annular channel and a second seal radially inwardly of said annular channel, a system of tubes opening into said annular channel through said housing at points opposite said annular channel for conducting a heating medium to and from said annular channel, a cover above said bowl, a gas seal means extending between the inside surface of said cover and the periphery of said bowl and permitting relative rotation between the cover and the bowl, means extending through said cover for projecting a sample into the bowl against the inside surface of the bowl, a gas inlet opening through said cover into the radially inner portion of said bowl and a gas outlet means opening out through the cover from the radially outer portion of said bowl for picking up gases vaporized when a sample is centrifuged and heated, a fixed pillar on said housing, and clamping means vertically movable on said pillar and on which said cover is mounted.

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