June 9, 1959 G. AXT ET AL 2,890,406

ELECTRIC ANALYZER FOR SUPERVISING SUBSTANCES DISSOLVED IN A FLOW OF LIQUID

Filed Dec. 17, 1956

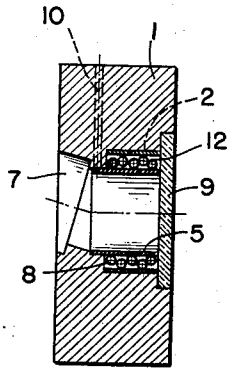

FIG. 1

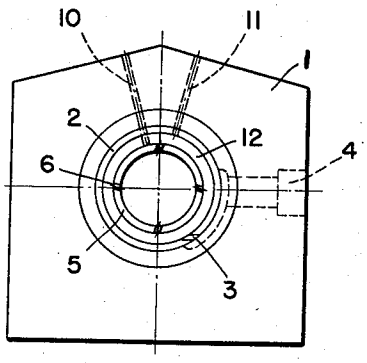

FIG. 2

INVENTORS
GÜNTER AXT
HEINZ EHRHART

BY Hane and Nydick

ATTORNEYS

United States Patent Office 2,890,406
Patented June 9, 1959

2,890,406

ELECTRIC ANALYZER FOR SUPERVISING SUBSTANCES DISSOLVED IN A FLOW OF LIQUID

Günter Axt, Karlsruhe-Durlach, and Heinz Ehrhart, Grotzingen, Karlsruhe, Germany, assignors to Chlorator G.m.b.H., Karlsruhe, Germany, a German firm

Application December 17, 1956, Serial No. 628,776

10 Claims. (Cl. 324—30)

The present invention relates to an analyzer or measuring cell for supervising the content of one or several gases or chemicals dissolved in a flow of liquid, and more particularly, to an electric analyzer utilizing the flow of current between two juxtaposed measuring electrodes as a function of the electrical properties of the liquid flow to be supervised for actuating suitable indicating means, recording means or control means.

Analyzers or measuring cells of the general kind above referred to, are used for instance, to indicate the oxygen content in water, or to supervise the content of chlorine or other oxidizing agents in water. As mentioned before, instruments of this kind utilize the current flow between the electrodes and, hence, it is essential to maintain the utilized measuring currents free of interfering influences for a prolonged period of service. Such interferences may be due, for instance, to impurities in the liquid to be supervised and the resulting changes in the structure and area of the surfaces of the electrodes. As is evident, accurate measuring results can be obtained only when the condition of the electrodes which control the magnitude of the measuring currents remains practically constant and possesses well defined and fixed values.

It has been proposed for this purpose to subject the electrodes to a continuous cleansing operation by means of a granular or powdery mechanical cleansing agent to which circular and eddy motions are imparted by the flowing liquid. The cleansing agents which have been heretofore used are granular or powdery grinding substances such as glass powder, corundum in powder or granular form, quartz sand etc.

However, it has been found that this method of cleansing entails disadvantages, the elimination of which is one of the objects of the present invention. The grinding effect of the grinding agents which pass continually along the surfaces of the electrodes results in an undesirable wear of the electrodes. This jeopardizes the economy of the operation, especially when the electrodes are made of precious metals such as platinum, gold or silver. Furthermore, the use of hard granular grinding agents having sharp edges does not assure that the surface areas of the electrodes remain substantially constant as is essential for maintaining constant the electrical starting conditions in accordance with which the control signals supplied by the instrument are adjusted. It has been observed that after a prolonged use of grinding agents for the cleansing of the electrodes grooves are formed in the surfaces of the electrodes. Such grooves obviously cause corresponding changes in the surface areas of the electrodes irrespective of the material of which the same are made. These changes, in turn, cause corresponding and undesired changes in the measuring currents. Finally, in instruments of this kind as heretofore known, the grinding agent is admitted and agitated at the lower part of the standing electrodes. Consequently, the cleansing effect tends to decline with increasing distance from the points of entry of the flowing liquid; in other words, the more remote parts of the electrodes are less thoroughly cleansed than the closer ones.

Accordingly, one of the objects of the present invention is to provide a novel and improved analyzer or measuring cell of the general kind above referred to, in which constant measuring conditions are maintained for a prolonged period of time or service.

Another object of the invention is to provide a novel and improved analyzer or measuring cell, the electrodes of which are automatically and continually cleansed without materially altering the effective surface areas of the electrodes.

Still another object of the invention is to provide a novel and improved analyzer or measuring cell, the cleansing means of which affords the additional advantage of gradually up-grading the quality of the electrode surfaces by increasing the density or the hardness thereof.

The afore pointed out objects, features and advantages of the invention and other objects, features and advantages which will be pointed out hereinafter and set forth in the appended claims constituting part of this application are attained by providing as measuring electrodes a pair of concentrically and radially spaced rotation symmetric hollow bodies such as sleeves and placing in the annular space defined between these bodies, cleansing means in the form of spherical bodies and hardened non-conductive material such as glass, porcelain or plastic. These spheres are caused by the flow of liquid to roll continuously over and along the wall surfaces of the electrodes to be cleansed. The spheres have preferably a comparatively large diameter, but the diameter must be such that the spheres are freely movable within the space between the electrodes. However, it is also possible to use small spherical bodies such as pearls of glass, porcelain, plastic, etc., or sand, the grains of which are polished to be substantially round. It is primarily essential that the cleansing effect applied to the material of the electrodes is a gentle one, yet sufficient to prevent the accumulation of any interfering substances which may be deposited upon the surfaces of the electrodes out of the liquid to be supervised. It has been found that the use of spheres or balls as cleansing means affords the additional advantage that the pressure continuously exerted by the revolving spheres upon the surfaces of the electrodes causes an increase of the density of the surfaces and a resulting surface hardening of the electrode material. Tests have shown that the area of the electrode surfaces retains its initial value for a prolonged period of operation. As a result, uncontrollable changes in the current output of the instrument which, in turn, controls the signals supplied by the instrument for indicating, recording or control purposes, are eliminated for all practical purposes.

The pairs of electrodes may be made of gold and copper respectively when used, for instance, for the measuring of chlorine and platinum and cadmium respectively when used for measuring oxygen.

According to a preferred embodiment which employs only five to ten cleansing spheres, the radial spacing between the two electrodes is only slightly larger than the diameter of the spheres. It has been found that thus the danger of jamming of the spheres can be safely avoided. Due to the centrifugal force acting upon the spheres, the same roll predominantly over and along the outer electrode. As a result, this electrode is more thoroughly cleaned than the inner electrode which comes in contact with the spheres only when the same occasionally collide. However, this does not constitute a disadvantage provided the electrodes are suitably arranged. It has been found that when, for instance,

chlorine is measured even substantial accumulations of impurities on the copper electrode do not have an appreciable influence upon the measured value provided only the gold electrode is kept clean which, in such case, has to be used as the outer electrode. This is in accordance with the theoretical expectations since the phenomenon of the depolarization which is influenced by the chlorine and is utilized for the measuring operation occurs at the electrode of the nobler metal only.

The aforedescribed arrangement affords, in addition to a simplified structure, the advantage that the resistance of the electrolyte is reduced to a minimum. By making the inlet and outlet slots through which the liquid to be measured enters and leaves the measuring space between the electrodes slightly narrower than the diameter of the spheres, the spheres are in effect placed in a closed cage which they cannot leave even if the liquid flow is interrupted.

A particularly advantageous arrangement resides in a horizontal disposition of the common axis of the concentric sleeve or cylindrically shaped electrodes. In such an arrangement the cleansing spheres are uniformly distributed over the entire length of the electrodes and are uniformly revolved. As a result, no localized depositions of impurities can occur which would jeopardize the uniform cleansing of the total surface of the electrodes.

A horizontal arrangement of the measuring space or chamber containing the cleansing spheres also facilitates a visual supervision by providing an observation window at one end of the space or chamber between the electrodes. Such an observation window which is vertically disposed due to the horizontal disposition of the electrodes permits a convenient supervision even from a remote point of observation. Furthermore, the cleansing spheres constitute, in effect, a flow indicator so that observation of the measuring chamber or space through the window permits a continuous supervision of the operation of the measuring cell or analyzer and its content.

In the accompanying drawing a preferred embodiment of the invention is shown by way of illustration and not by way of limitation.

In the drawing:

Fig. 1 is a cross section of an analyzer according to the invention, and

Fig. 2 is a front view of the analyzer seen from the side mounting the observation window, the cleaning spheres being removed.

Referring now to the figures in detail, the exemplified analyzer comprises a holder **1** of rigid non-conductive material. The holder body is formed with a transverse horizontal bore in which the measuring electrodes **2** and **5** are fitted shown in the form of two sleeves of which the outer electrode **2** is the shorter one. The outer electrode, which is made of a material depending upon the properties of the dissolved gases or chemicals to be supervised, for instance gold in the case of chlorine has in its wall one or preferably several tangential bores or slots **3** to which the liquid to be supervised is fed through an inlet bore or duct **4**. The inner electrode **5** which is concentric with the outer electrode, but spaced therefrom to define an annular measuring space or chamber **12** between the electrodes is also made of a suitable material, for instance copper for use in connection with chlorine. Electrode **5** has one or several tangentially disposed bores or slots **6** through which the liquid leaves the measuring chamber. The liquid is discharged from the analyzer through a central outlet duct **7**. Connectors **10** and **11**, shown as being embedded in the body of holder **1**, serve to connect the electrodes to a supervisory circuit. This circuit is presumed to be of conventional design and should be visualized as including a suitable indicating, recording or control means. A detailed description of the supervisory circuit is not believed to be essential for the understanding of the invention.

The cleansing means according to the invention are placed in the annular space **12**. They are shown as balls **8** made of glass, porcelain, plastic or other suitable non-conductive material, preferably having a specific weight higher than that of the liquid to be supervised. The diameter of the balls is slightly less than the radial width of space **12**, but slightly more than the maximum width of apertures **3** and **6**. As a result, the balls, when revolving, cannot leave the chamber, but may occupy slightly staggered positions relative one to another as is indicated in Fig. 1. This affords the advantage that even with a low velocity of the liquid flow, a highly effective cleansing of the active electrode surfaces is obtained. A measuring cell having approximately the dimensions shown in the drawing will operate at a flow of approximately 30 liters per hour.

The invention affords the further advantage that the electrode surfaces due to the continuous impact of the balls rolling along the same, experience hardening and densifying causing an upgrading of the surfaces.

It has been found that the useful life of the electrodes in an anlyzer according to the invention is materially higher than when grinding means having sharp edges are employed. Furthermore, the measuring constancy is preserved during the entire lifetime of the analyzer.

The ends of the electrodes at the front side of the analyzer, that is, the right hand side in Fig. 1, are covered with an observation window **9** so that the operation of the analyzer can be continually supervised. The observation window, which is preferably detachably mounted, also affords a convenient access to the measuring chamber.

Any air bubbles that may be carried in the liquid and enter the measuring chamber are rapidly removed therefrom through the outlet slots so that such air bubbles cannot adversely affect the accuracy of the measuring.

While the invention has been described in detail with respect to a certain now preferred example and embodiment of the invention it will be understood by those skilled in the art after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended, therefore, to cover all such changes and modifications in the appended claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An electric analyzer for supervising an electrical magnitude as a function of the content of a substance dissolved in a continuous flow of liquid through the analyzer, comprising two rotation symmetric hollow electrodes disposed concentrically and radially spaced apart to define therebetween an annular space for the flow of liquid to be supervised, and generally spherically rounded bodies of hard non-conductive material placed freely movable in said space whereby said bodies are revolved and agitated by the liquid flow through said space and along the facing walls of said electrodes for cleansing the same.

2. An electric analyzer for supervising an electrical magnitude as a function of the content of a substance dissolved in a continuous flow of liquid through the analyzer, comprising two rotation symmetric hollow electrodes disposed concentrically and radially spaced apart to define therebetween an annular space for the flow of liquid to be supervised, and generally spherically rounded bodies of hard insulation material placed freely movable in said space, the diameter of said bodies being slightly less than the radial distance between said electrodes whereby said bodies are revolved and agitated by the liquid flow through said space and along the facing walls of said electrodes for cleansing the same.

3. An electrical analyzer for supervising an electrical magnitude as a function of the content of a substance

dissolved in a continuous flow of liquid through the analyzer, comprising two rotation symmetric hollow electrodes disposed concentrically and radially spaced apart to define therebetween an annular space for the flow of liquid to be supervised, and generally spherically rounded bodies of hard insulation material placed freely movable in said space, and conduit means connecting with said space through the walls of said electrodes for guiding the liquid flow through said space whereby said bodies are revolved and agitated by the liquid flow through said space and along the facing walls of said sleeves for cleansing the same.

4. An electric analyzer for supervising an electrical magnitude as a function of the content of a substance dissolved in a continuous flow of liquid through the analyzer, comprising two rotation symmetric hollow electrodes disposed concentrically and radially spaced to define therebetween an annular space for the flow of liquid to be supervised, the walls of said electrodes including inlet and outlet apertures, conduit means connecting with said apertures for directing the liquid flow through said space, and spheres of hard insulation material placed freely movable in said space, the diameter of said spheres being slightly less than the radial distance between said electrodes and slightly more than the maximum width of said apertures whereby said spheres are revolved and agitated by the liquid flow through said space and along the facing walls of said sleeves for cleansing the same.

5. An analyzer according to claim 4, wherein said apertures extend through the walls of said electrodes in tangential direction.

6. An analyzer according to claim 1, wherein said electrodes are in the form of cylindrical sleeves.

7. An electric analyzer for supervising an electrical magnitude as a function of the content of a substance dissolved in a continuous flow of liquid through the analyzer, comprising a holder body, two sleeve-shaped electrodes embedded in said holder in a concentric spaced apart relationship to define therebetween an annular space open at one end for the liquid to be supervised, one of the electrodes including in its wall at least one inlet aperture and the other at least one outlet aperture, conduits extending through said holder and connecting with said aperture for feeding the liquid flow through said space, and spheres of hard insulation material disposed in said space freely movable therein, the diameter of said spheres being slightly less than the radial distance between said sleeves and slightly more than the maximum width of said apertures whereby said spheres are revolved and agitated by the liquid flow through said space and along the facing walls of said sleeves for cleansing the latter.

8. An analyzer according to claim 7, wherein electric conductors adapted for connecting the analyzer to electric supervisory means are connected to each of said sleeves, said conductors being embedded in said body.

9. An analyzer according to claim 7, wherein the common axis of said electrodes is horizontally disposed.

10. An analyzer according to claim 7, wherein said electrodes issue at one end in a wall of said holder, and wherein a transparent observation member is fitted upon said open end of the annular space to close said space at said end.

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