

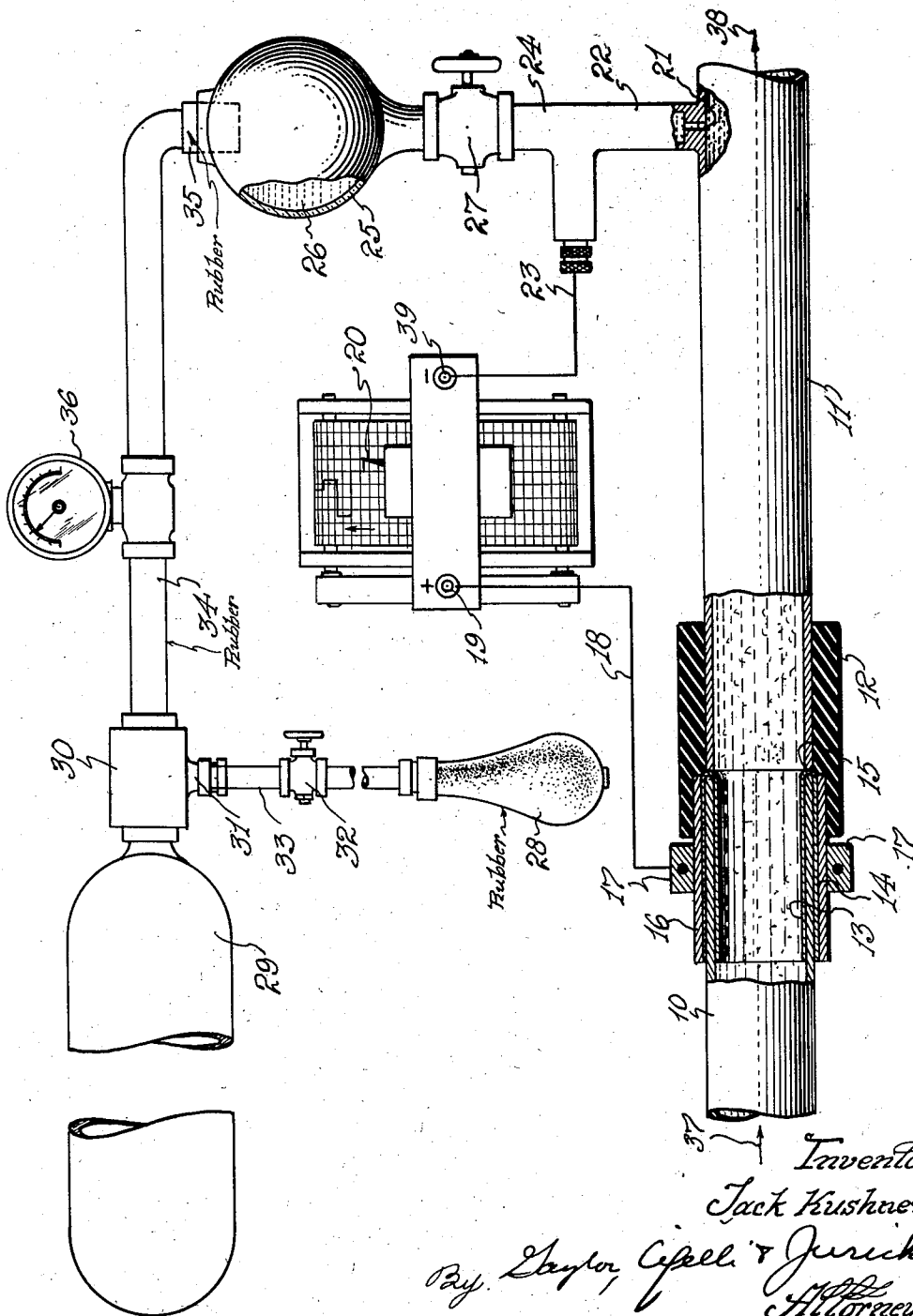
Jan. 20, 1959

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2,870,077

CELLS FOR ELECTRO-CHEMICAL MEASUREMENTS

Filed Aug. 14, 1953



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CELLS FOR ELECTRO-CHEMICAL MEASUREMENTS

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Application August 14, 1953, Serial No. 374,309

5 Claims. (Cl. 204—195)

This invention relates to novel cells for use in making electro-chemical measurements.

An object of this invention is to provide a compact cell suitable for taking electro-chemical measurements in a continuous and substantially instantaneous manner on liquids flowing there-through.

Other objects of my invention will become apparent from the following description.

A specific example of my novel cell is described herein by way of example only and in accordance with the manner in which I now prefer to practice the invention, the following detailed description, taken in connection with the accompanying drawing, being intended for the purpose of illustration.

Referring to the drawing, which is a side elevation, in part section, in part schematic, and in part broken away, my cell comprises a left tube 10 and right tube 11 in butt-alinement therewith. The tubes are of glass or other electrically non-conducting material and are preferably transparent. Rubber tubing 12 or other suitable support is used to hold tubes 10 and 11 in alinement. A thin coating of platinum or other noble metal is on the interior 13 and exterior 14 of tube 10 near and over an end 15 thereof. In other words, the platinum coating, which is applied in known manner, is a unitary one and electrically and otherwise continuous from 13 to 15 to 14. A protective band 16 of metal such as copper, is secured around the film 14. Electrical contact with the platinum is made by means of suitable metal clips 17, which may be joined by wire 18 to one terminal 19 of an automatic recording device 20.

Tube 11 is joined to a calomel half-cell unit by means of a capillary tube 21 at the junction of tube 11 and a T tube 22. One arm of this T tube 22 contains calomel material (mercurous chloride and mercury) and a wire 23 which is in contact with terminal 39 of recorder 20. The other arm 24 is joined together, at its upper end, to a reservoir 25 for suitable solution, preferably potassium chloride 26. To help control the flow of the solution 26 through the capillary 21 a valve or screw clamp 27 is advantageously employed.

To prevent the contamination of the solution 26 by whatever liquid is flowing through tube 11, means for insuring a positive downward pressure on the solution 26 in the capillary 21 are provided. The illustrated means comprise a conventional air bulb 28 which is joined to air reservoir 29 by means of a fitting 30 having a check valve 31 to prevent the escape of air from reservoir 29 to bulb 28. A screw clamp or valve 32 also is provided for closing rubber tubing 33, if desired. Fitting 30 also has another opening to which one end of tubing 34 is secured. The other end of tubing 34 terminates in liquid reservoir 25, a stopper 35, through which the end of tubing 34 passes, affording air-tightness to the top of the reservoir 25. An air gauge 36 for determining the pressure on the capillary 21 is provided in series with tubing 34.

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In addition to the novel combination of parts set forth as constituting by invention, my invention also encompasses certain other advantageous features. Thus, I have found that optimum results are obtained when careful control of the viscosity of the potassium chloride solution 26 is exercised. This is an important consideration as practical reasons limit one cell to a particular size of capillary; and hence if the solution 26 is not viscous enough too much of it may flow into the capillary, with undesirable consequences. On the other hand, a solution having too high a viscosity is not desirable for practical reasons.

Accordingly, I prefer to employ an aqueous, saturated solution of potassium chloride which contains any natural gum soluble in water to an extent sufficient to increase the viscosity so that positive pressure is required to cause the solution to pass through the capillary 21 at a desirable rate.

In preparing the solution 26 a concentrated solution of the gum in water is first prepared, filtered and diluted. Potassium chloride is added at 10° C. until the solution is saturated.

It will be understood that variations in the thickness and area of the noble metal film, in the size of the capillary tube 21, and in the composition of the electrolyte solution 26 may be made in order to obtain optimum results. Without limiting myself to the figures herein-after given, I can state as follows:

The thickness of the noble metal film 13 is not of critical importance unless it becomes so great as to offer material resistance to the flow of the material being tested. Film thicknesses within the range of 0.001 to 0.05 millimeter have, however, been found to yield satisfactory results.

The area of the noble metal coating is likewise not critical. I have found that areas less than ½ square centimeter are not to be recommended, however. For a cell with an inside diameter of tubes 10, 11 of ¾", an area of 5 square centimeters is desirable.

The capillary tube advantageously should permit a flow of solution 26 at the rate of 0.05 to 2 milliliters per hour.

The solution 26 gives desirable results when it has a concentration of about 10 percent by weight of gum. In addition to ghatti gum, other gums such as arabic, agar and accacia can be used. In general, solution 26 having a relative viscosity of 16 to 20, compared to water at 25° C. is desirable.

In using my cell, liquid which is to be tested is fed into tube 10 in the direction shown by the arrow 37 alongside of tube 10 and the liquid flows out of tube 11 as shown by arrow 38.

Sufficient pressure is applied to the solution 26 in the capillary 21 by compressing the air bulb 28. As the liquid in tube 11 passes the capillary opening a liquid-liquid interface is formed by the liquid under test and the solution 26 from reservoir 25. The resulting potential can be read from the recorder 20 and, if desired, a permanent record of this potential, showing fluctuations, if any, during every moment of the test, may be obtained by suitable conventional, recording charts and instruments (not shown) all of which are encompassed by the general term "recorder."

My novel cells may be employed to yield excellent results on a variety of flowing liquids whose electro-chemical characteristics are being determined. Thus, in the case of boiler feed water, it is important to know the concentration of dissolved oxygen therein at all times. By simply placing my novel cell in series with the boiler feed water, and substituting a polarograph for the recorder, electrical readings are quickly and accurately ob-

tained, and from these readings, by suitable calculations well understood in the art, the desired data on dissolved oxygen concentration can be obtained. Any necessary corrective action can then be taken as indicated by the readings and/or calculations.

In similar manner, my novel cell lends itself to the determination of the concentration of chlorine, chromates, organic matter, sulfites, oxidation-reduction potential, e. g. in dye baths, and the obtaining of measurements on any material that gives a stable potential.

It will now be apparent to those skilled in the art that my novel cells have certain unique advantages. They lend themselves in a technically-simple manner to utilization in connection with liquids which can be passed there-through without causing any adverse effects on the apparatus and hence on the data obtained. This is a special consideration in the treatment of liquids such as slurries, raw sewage and semi-liquids which normally may contain fibrous inclusions and abrasive particles. Also, a continuous, liquid-liquid junction, between the KCl solution 26 and the liquid under test is assured because of the pressure on the solution. The capillary tube 21, moreover, is such that the KCl will flow into tube 11 at a slow rate, thereby minimizing the amount of contamination of one liquid by the other. A clean, sharp, liquid junction which remains stable at all rates of liquid flow is obtained. A further advantage of my novel cell is that any bubbles of gas which may accumulate in the T tube 22 will not interfere with the readings as they will be blown through the capillary 21 by reason of the aforesaid pressure.

While I have described my invention in detail in its preferred embodiment, it will be obvious to those skilled in the art, after understanding my invention, that various changes and modifications may be made therein without

departing from the spirit or scope thereof. I aim in the appended claims to cover all such modifications and changes.

I claim:

- 5 1. A cell suitable for making continuous electrochemical measurements on liquids flowing therethrough which comprises, in combination, straight tubular means providing continuously substantially unobstructed flow for said liquids to be measured, means at the end of said
- 10 means providing for the introduction and discharge of liquids, a noble metal electrode comprising a thin coating on a zone of the inner surface of said tubular means, means for establishing electrical contact with said coating, a half cell having a reservoir for an electrolyte, said
- 15 reservoir communicating with said tubular means through a restricted flow passage, means for establishing electrical contact with said half-cell, and means for applying a substantially constant pressure capable of maintaining substantially constant flow of the electrolyte into said
- 20 tubular means.
2. A cell in accordance with claim 1, wherein said straight tubular means comprise two members in abutting alinement with each other and said noble metal electrode coating is on the inner and outer surface of one end
- 25 of one of said members.
3. A cell in accordance with claim 1, wherein means for continuously recording the voltage are also provided.
4. A cell in accordance with claim 1, wherein said constant pressure means comprise air under pressure.
- 30 5. A cell in accordance with claim 2, wherein said constant pressure means comprise air under pressure.

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