Nov. 13, 1923. 1,474,151

E. A. KEELER

ELECTRODE FOR ION CONCENTRATION EFFECTS

Filed Nov. 30, 1921

Fig. 1.

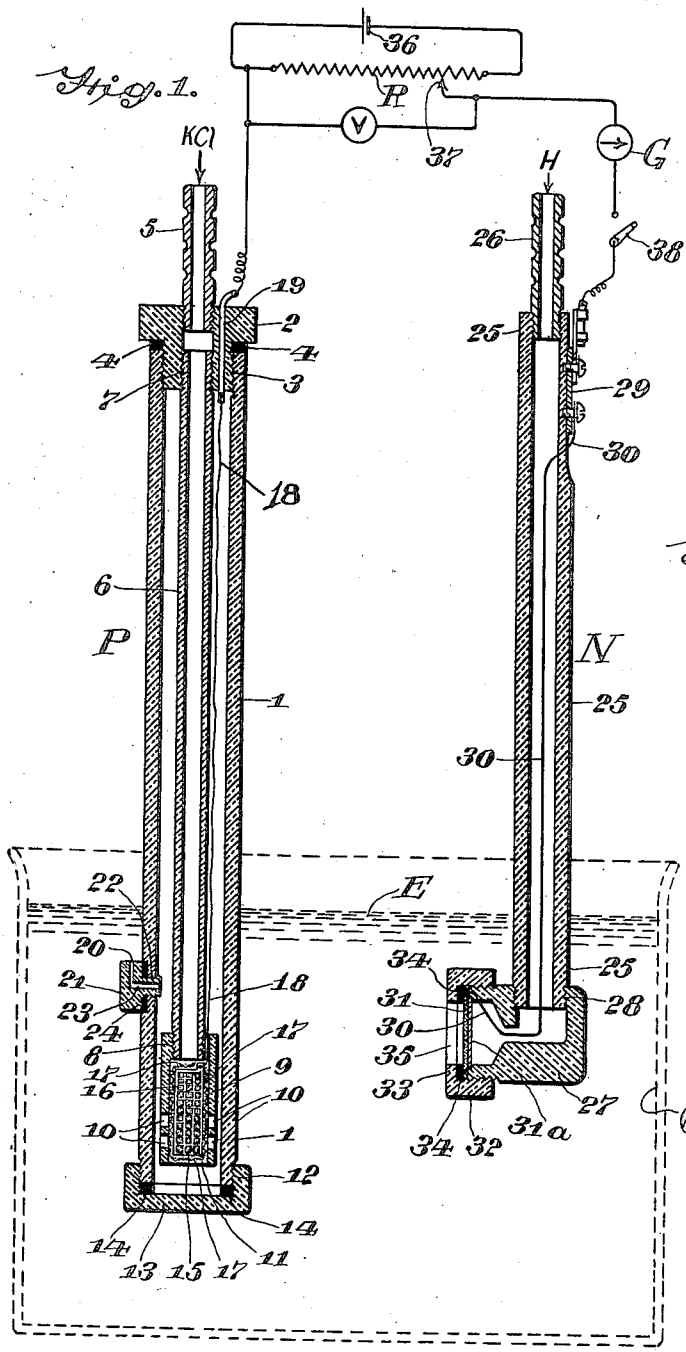


Fig. 2.

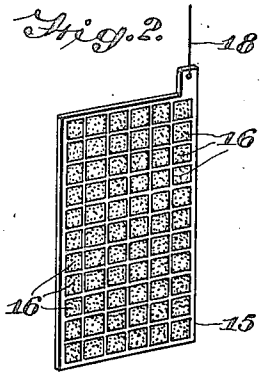
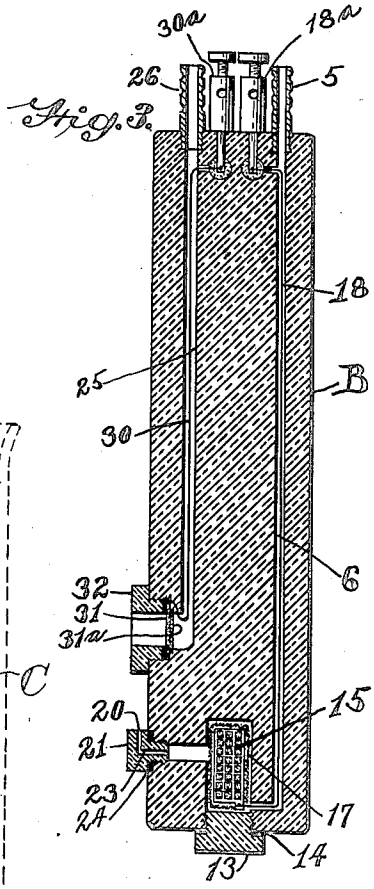


Fig. 3.



INVENTOR.

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UNITED STATES PATENT OFFICE.

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ELECTRODE FOR ION CONCENTRATION EFFECTS.

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To all whom it may concern:

Be it known that I, EARL A. KEELER, a citizen of the United States, residing in Norristown, county of Montgomery, State of Pennsylvania, have invented certain new and useful Improvements in Electrodes for Ion Concentration Effects, of which the following is a specification.

My invention relates to electrodes for ion concentration effects utilizable for various purposes, such as the determination or measurement of ion concentration, for effecting any suitable control in response to changes in ion concentration, or for maintaining a predetermined ion concentration, and for any other suitable purpose.

So far as I am aware, heretofore electrodes of this character have been of a type utilized in laboratories, more or less fragile, and of structure and character more or less unsuited for portability or for practical or commercial uses.

It is the object of my invention to provide electrode structures of the character referred to which are rugged, portable, simple in construction, with parts easily removable or accessible for rejuvenation, cleansing or other treatment, or for replacement, and in general suitable for the harder usage encountered in practice and commercial operations.

To these ends I have devised electrode structures hereinafter described.

For an illustration of some of the numerous forms my invention may take, reference is to be had to the accompanying drawing, in which:

Fig. 1 comprises sectional views of the electrode structures, parts in elevation, in conjunction with one of numerous circuit arrangements in connection with which they are utilizable.

Fig. 2 is a perspective view of a grid of one of the electrodes.

Fig. 3 is a sectional view of a modified structure.

Referring to the drawing, C is any suitable container, in which is disposed a batch of, or through which continuously flows a body of, electrolyte or equivalent solution E in which the electrodes are immersed. The positive electrode structure P comprises a tube 1 of insulating material, such as hard rubber, condensite, bakelite or other suitable material, which may be formed in any suitable manner, as by molding or otherwise. The upper end of the tube carries a cap 2, of any suitable material, as insulating material of the character employed for the tube 1, which may be threaded, as at 3, into the tube 1, a rubber or other gasket 4 forming a tight joint when required. Preferably attached to the cap 2, or in any event communicating with a nipple or connection 5, of metal, hard rubber or other suitable material, is the inner tube 6, which may be threaded into the bore of the cap 2 at 7 and may consist of any suitable material, as hard ruber, bakelite, etc., as in the case of the tube 1. To the lower end of the tube 6 is attached, as by threading at 8, a hollow member or bell 9, of hard rubber or any other suitable material, which may have the perforations 10 or the open end 11, or both. Attached to the lower end of the tube 1, as by threading 12, is a closure cap 13 of hard rubber or other suitable insulating material, a rubber or other gasket 14 being employed to effect a tight joint.

Within the casing 9 is disposed a grid 15, Figs. 1 and 2, as gauze or the like, of conducting material, for example, platinum or equivalent wire gauze. The grid may be disposed in any suitable conformation, either flat, as shown, cylindrical, a spiral roll, etc. There is applied to the grid 15 as a coating a suitable material or paste 16, contacting with the grid elements and extending into the openings of the grid and covering its faces.

To hold the coating in contact with the grid, there is preferably utilized a bag, cover or retainer 17, of any suitable porous material, as non-conducting or non-metallic fabric, as cloth. For example, the cover or bag 17 may be of silk cloth suitably bound around the grid and its coating. To the grid 15 is connected a wire or conductor 18, as of platinum or other suitable material, which passes to the exterior of the casing 9 and extends along the tube 6 and connects to the exterior, as through a conductor 19 in the cap 2.

A solution of suitable character is delivered from any suitable reservoir or supply thereof through hose or other conduit, not shown, to the nipple 5, through which it flows into

and through the tube 6, into the chamber 9, wetting the paste or coating and the grid 15. Such solution passes also into the space surrounding the chamber 9 within the tube 1.

The positive electrode proper is at grid 15, and the liquid at the capillary or other restricted orifice 20 communicates with the interior of the tube 1, solution finding its way from the interior of the tube 1 to the orifice 20, where the solution contacts with the electrolyte E.

As indicated, and preferably, the orifice 20 is formed in a plug 21, of hard rubber or other suitable material, detachably secured, as by threading 22, to the tube 1, there being formed in the plug 21 a passage 23 communicating with the interior of the tube 1 and extending to the orifice 20. To effect a tight joint between the plug 21 and tube 1, there may be employed the rubber or other gasket 24.

The negative electrode structure N comprises the tube 25, of any suitable insulating material, as hard rubber, bakelite, etc., and may be formed in any suitable way, as by molding or otherwise. Attached to and communicating with the upper end of the tube 25 is the nipple or connection 26 through which there is delivered into the tube 25, from any suitable supply, not shown, a suitable fluid, as a gas. This fluid passes downwardly through the tube 25 into the casing or chamber 27, of suitable insulating material, detachable from or integral with the tube 25. In the example illustrated, the casing 27 is threaded at 28 to the tube 25 and is detachable therefrom. Upon the tube 25 may be carried or secured the binding post structure 29, with which is connected a wire 30, of any suitable material, as platinum, which passes through the wall of the tube 25 and extends through the same to the mouth of the casing 27. The wire 30 may extend through the wall of the casing 27 near its mouth, as indicated, whereby there is an exposed portion of the wire 30 upon the left edge of the casing 27. Against this bare portion of the wire 30 is held one or more perforated disks 31 of conducting material, as metallic gauze, a perforated plate, or equivalent. The member 31 is held in position in contact with the wire 30 by the cap 32 threaded or otherwise attached to the casing 27, the cap 32 exerting pressure upon the member 31 to hold it firmly in contact with the conductor 30. Between the flange 33 of the cap 32 and the member 31 may be utilized a washer or gasket 34, preferably of insulating material. The fluid delivered through the nipple 26 passes through the tube 25 and chamber 27 through the member 31 and through the opening 35 in the cap 32 into the electrolyte E, through which it passes upwardly and escapes.

The nature of the material of the member 31 is suited to the conditions under which employed, or is so chosen as to be adapted to the nature of the particular ion or ions of the electrolyte E which are involved. Ordinarily, the member 31 may be of platinum or gold, and is usually covered with platinum black or the black of iridium, palladium or the like. When hydrogen ion concentration is involved, hydrogen gas is delivered into the tube 25 and through the member 31. When the concentration of other than hydrogen ions is involved, the negative electrode, instead of being a hydrogen electrode, will be suitably different. For example, if concentration of chlorine ions is involved, chlorine gas may be delivered through the tube 25 and the member 31. For oxidation and reduction determinations or effects the negative electrode may be the member 31, of platinum, and no gas is delivered through the tube 25, because of which in such case the member 31 need not be perforated, and in lieu of it may be used any ordinary platinum electrode structure.

When the concentration of hydrogen ions is involved, the nature of the liquid introduced through the nipple 5 and the tube 6 may be a solution of potassium chloride, for example, a tenth normal solution. The paste or coating 16 upon the grid 15 may be mercury, water and calomel (monochloride of mercury), beaten or otherwise suitably worked together, the positive electrode structure accordingly, in this example, constituting a so-called calomel half cell.

It will be understood that my invention is not limited, as to either the positive or negative electrode, to the particular materials described, it being within the skill of the art to vary the fluids, liquids and gases employed, the nature of the material of the member 31 and nature of the paste or coating 16, to adapt the electrode structures to the particular conditions or circumstances under which they are to be employed.

From the foregoing description it is apparent that I have devised electrode structures which are rugged and practically unbreakable in ordinary usage, portable, and suited for shipment from place to place.

The positive electrode structure is of a character which may be shipped ready for use, it being only necessary to connect the nipple 5 with a reservoir of suitable solution to flow into the electrode structure, intermittently or continuously, to flush out the orifice 20. Respecting the negative electrode structure, it is apparent that the gas or fluid delivered through the tube 25 passes from one side to the other of the member 31, that is, passes through it, as distinguished from around it or in contact with opposite faces, as in the case of the ordinary hydrogen electrode heretofore commonly used.

This structure accordingly minimizes the effect of deposits from the solution E upon the electrode member, and accordingly saturation of the electrode member, as 31, with gas or fluid delivered through the tube 25 is not prevented or long delayed. Furthermore, the gauze disk or perforated member 31 is readily removable, by simply removing the cap 32, for platinizing or otherwise coating with suitable black, or for ready insertion of a new or substitute member 31.

As indicated in Figs. 1 and 3, the gauze or other perforated disk or disks 31 may be backed by a disk or baffle member 31^a, preferably of insulating material, either porous or suitable perforated, for causing distribution over the disk or disks 31 of the gas delivered through the tube 25.

While I have illustrated the positive and negative structures P and N as separate and distinct, it will be understood that they may be formed in a single unit, as by suitably molding integral with each other the tubes 1 and 25, or other parts, as in Fig. 3.

Referring to Fig. 3, the positive and negative electrode structures are shown combined as a unit by recourse to the block or mass B of molded or otherwise formed insulating material, as hard rubber, condensite, bakelite, etc. The grid 15 of the positive electrode structure is disposed in a cavity in the block B, the coated grid being inserted upon removal of the plug 13 sealed by gasket 14. The solution is, as before, delivered through the connection or nipple 5 and passes through the bore or tube 6 over the grid and through the bore 23 of the plug 21 to the restricted or capillary orifice 20. Connection is made from the grid 15 by the conductor 18, which may be molded in the block B, or, as indicated, may extend through the tube 6 to the binding post 18^a secured to or molded on the block B. Similarly, the gas for the negative electrode is delivered through the connection or nipple 26 and passes through the bore or tube 25 through the distributing member 31^a to the gauze or other electrode 31 held in position in a recess communicating with the tube 25 by the removable plug 32, as in Fig. 1. The conductor 30 connecting with the disk 31 may be molded within the block B, or, as indicated. may extend through the tube 25 to the binding post 30^a secured to or molded on the block B.

This arrangement constitutes a unit of both positive and negative electrode structures, which is decidedly rugged and compact.

For purposes of illustration merely, and without limitation of my invention, the electrodes are shown as connected with suitable apparatus for measuring voltages or differences of potential which are representative of the ion concentration. The measuring apparatus comprises a potentiometer having a source of current or battery 36 delivering current through the resistance R, one terminal of which is connected to the conductor or binding post 19 and therefore with the positive electrode. Movable along the resistance R is the contact 37 connected with the galvanometer G, which is connected, upon closure of the switch 38, with the binding post 29 and therefore with the perforated member 31. The contact 37 is moved along the resistance R to such position that the deflection of the galvanometer G is nil, in which case the fall of potential across that part of the resistance R to the left of the contact 37 is equal to the potential difference or voltage produced by the calomel half cell and hydrogen electrode in contact with the electrolyte E. Such potential difference or voltage may then be directly read upon the deflecting voltmeter V.

It will be understood that the electrodes may be used in any other suitable relation, as for control, by the potential difference produced by them, of any suitable apparatus for any suitable purpose, or in any suitable relation.

What I claim is:

1. Electrode structure comprising a member of insulating material having a passage, a second perforated member of conducting material extending across said passage and adapted for immersion in liquid, an electrical connection with said second member, and means for conducting fluid through said passage to said second member.

2. Electrode structure comprising a member of insulating material having a passage, a second perforated member of conducting material extending across said passage and adapted for immersion in liquid, an electrical connection with said second member extending through said passage, and means for conducting fluid through said passage to said second member.

3. Gas e'ectrode structure comprising a member having a gas passage, and a perforated conducting member extending across said passage and through which said gas passes.

4. Gas electrode structure comprising a gas conducting tube and a perforated conducting member supported by said tube and through which gas passes from said tube.

5. Electrode structure comprising a tube of insulating material, a casing on one end thereof, and a perforated conducting member forming a wall of said casing and through which gas passes from said tube and casing.

6. Electrode structure comprising a tube of insulating material, a casing on one end thereof, a perforated conducting member forming a wall of said casing and through which gas passes from said tube and casing,

and an electrical connection with said perforated member extending through said casing and said tube.

7. Electrode structure comprising a tubular member terminating in a chamber, a perforated conducting member forming a wall of said chamber and through which fluid is passed from said tube and chamber, and means detachably connected to said chamber securing said perforated member on said casing.

8. Electrode structure comprising a fluid conducting stem, a casing detachably secured thereon, a cap detachably secured to said casing, and a perforated conducting member held between said cap and said casing.

9. Electrode structure comprising a fluid conducting stem, a casing detachably secured thereon, a cap detachably secured to said casing, a perforated conducting member held between said cap and said casing, and a conductor against which said perforated member is held by said cap.

10. Electrode structure comprising a fluid conducting stem, a casing detachably secured thereon, a cap detachably secured to said casing, a perforated conducting member held between said cap and said casing, and a conductor against which said perforated member is held by said cap, said conductor extending through said casing and said stem.

11. Electrode structure comprising structure forming a fluid passage, a perforated conducting member extending across said passage, a conductor, and a member having an aperture registering with said perforated member detachably secured to said structure for holding said first named member in contact with said conductor.

12. A gas electrode comprising a gas conducting tube, a wire gauze disk on said tube and through which gas is passed from said tube, and an electrical connection with said disk.

13. Electrode structure comprising a tube, means for delivering fluid therethrough, and a member detachably secured to said tube having a passage communicating with said tube and terminating in a restricted orifice.

14. Electrode structure comprising a tube, means for delivering fluid therethrough, and a member detachably secured to said tube having a passage communicating with said tube and terminating in a capillary orifice.

15. Electrode structure comprising a grid, a coating thereon, means forming a restricted fluid orifice, and fluid conducting structure for delivering fluid past said grid to said orifice.

16. Electrode structure comprising an outer tube, an inner tube, a passage from said outer tube having a restricted orifice, means for delivering fluid through said inner tube into said outer tube, and a grid traversed by the fluid and disposed within said outer tube.

17. Electrode structure comprising an outer tube, an inner tube through which fluid is delivered into said outer tube, a grid carried by said inner tube in the path of the fluid delivered from said inner tube to said outer tube, said outer tube having a passage to the exterior having a restricted orifice.

18. Liquid electrode structure comprising a tube into which fluid is delivered, a member carried by and detachable from said tube having a passage communicating with the interior of said tube and terminating in a restricted orifice, a grid within said tube, and an electrical connection with said grid.

19. Electrode structure comprising an outer tube, a cap thereon, an inner tube supported by said cap, a casing on the end of said inner tube, a coated grid within said casing, and a restricted fluid connection from the interior to the exterior of said outer tube.

20. Electrode structure comprising a fluid conducting tube, a coated grid carried by said tube, a fabric covering for said grid and its coating, and a passage terminating in a restricted orifice through which fluid is delivered over said grid.

21. Electrode structure comprising a fluid conducting tube, a grid, and a coating therefor comprising calomel and mercury.

22. Electrode structure comprising a fluid conducting tube, a grid, a coating therefor comprising calomel and mercury, and a fabric covering for said grid and its coating.

23. A calomel half cell comprising an outer tube, an inner tube for conducting fluid into said outer tube, a passage having a capillary orifice communicating with the interior of said outer tube, and a grid coated with a mixture of calomel and mercury disposed in the fluid path between said inner tube and said orifice.

24. Electrode structure for ion concentration effects comprising a grid, a coating thereon, means for holding said coating on said grid, means forming a capillary orifice, and means for conducting fluid past said grid to said orifice.

25. Electrode structure comprising means forming a restricted orifice, a conducting member having a coating, means forming a passage for fluid past said coated member to said orifice, and an electrical connection with said conducting member.

26. Electrode structure comprising an outer tube, an inner tube, a passage from said outer tube having a restricted orifice, means for delivering fluid through said inner tube into said outer tube, a grid traversed by the fluid and disposed within said outer tube, and an electrical connection with said grid extending between said tubes.

27. Electrode structure comprising an

outer tube, an inner tube through which fluid is delivered into said outer tube, a grid carried by said inner tube in the path of the fluid delivered from said inner tube to said outer tube, said outer tube having a passage to the exterior having a restricted orifice, and an electrical connection with said grid extending between said tubes.

28. Electrode structure comprising an outer tube, a cap thereon, an inner tube supported by said cap, a casing on the end of said inner tube, a coated grid within said casing, a restricted fluid connection from the interior to the exterior of said outer tube, and an electrical connection with said grid extending between said tubes.

29. A calomel half cell comprising an outer tube, an inner tube for conducting fluid into said outer tube, a passage having a capillary orifice communicating with the interior of said outer tube, a grid coated with a mixture of calomel and mercury disposed in the fluid path between said inner tube and said orifice, and an electrical connection with said grid extending between said tubes.

30. Gas electrode structure comprising a member having a gas passage, a perforated conducting member extending across said passage and through which said gas passes, and gas distributing means between said passage and said conducting member.

31. Gas electrode structure comprising a member having a gas passage, a perforated conducting member extending across said passage and through which said gas passes, and a gas distributing member backing said conducting member.

32. An electrode unit comprising a block of insulating material having a plurality of independent fluid passages therein, a perforated conducting member disposed across one of said passages, a conductor connected with said member, a member having a fluid passage communicating with another of said passages and terminating in a restricted orifice, a grid disposed between said other of said passages and said orifice, and an electrical connection with said grid.

33. An electrode unit comprising a block having a plurality of fluid passages therein one of which is provided with a restricted orifice, a perforated conducting member disposed across another of said passages, a conductor connected with said member, a grid disposed in the first named passage, and an electrical connection with said grid.

34. An electrode unit comprising a structure provided with fluid passages, one end of each passage being adapted to be placed in communication with a body of electrolyte, a perforated conducting member disposed across one of said passages, a conducting member disposed within another of said fluid passages, and electrical connections for said conducting members.

35. An electrode unit comprising a structure provided with fluid passages, one end of each passage being adapted to be placed in communication with a body of electrolyte, a perforated conducting member disposed across one of said passages, a conducting member disposed within another of said fluid passages, and electrical connections for said conducting members, communication between said second named passage and said body of electrolyte being through a restricted orifice.

36. An electrode unit comprising a structure provided with fluid passages, one end of each passage being adapted to be placed in communication with a body of electrolyte, a conducting member disposed within each of said passages, and electrical connections for said conducting members, communication between one of said passages and said body of electrolyte being through a capillary orifice.

37. Gas electrode structure comprising means for directing a flow of gas along a definite path, and a perforated conducting member disposed entirely across said path and through which said gas passes.

In testimony whereof I have hereunto affixed my signature this 23rd day of November, 1921.

EARL A. KEELER.