

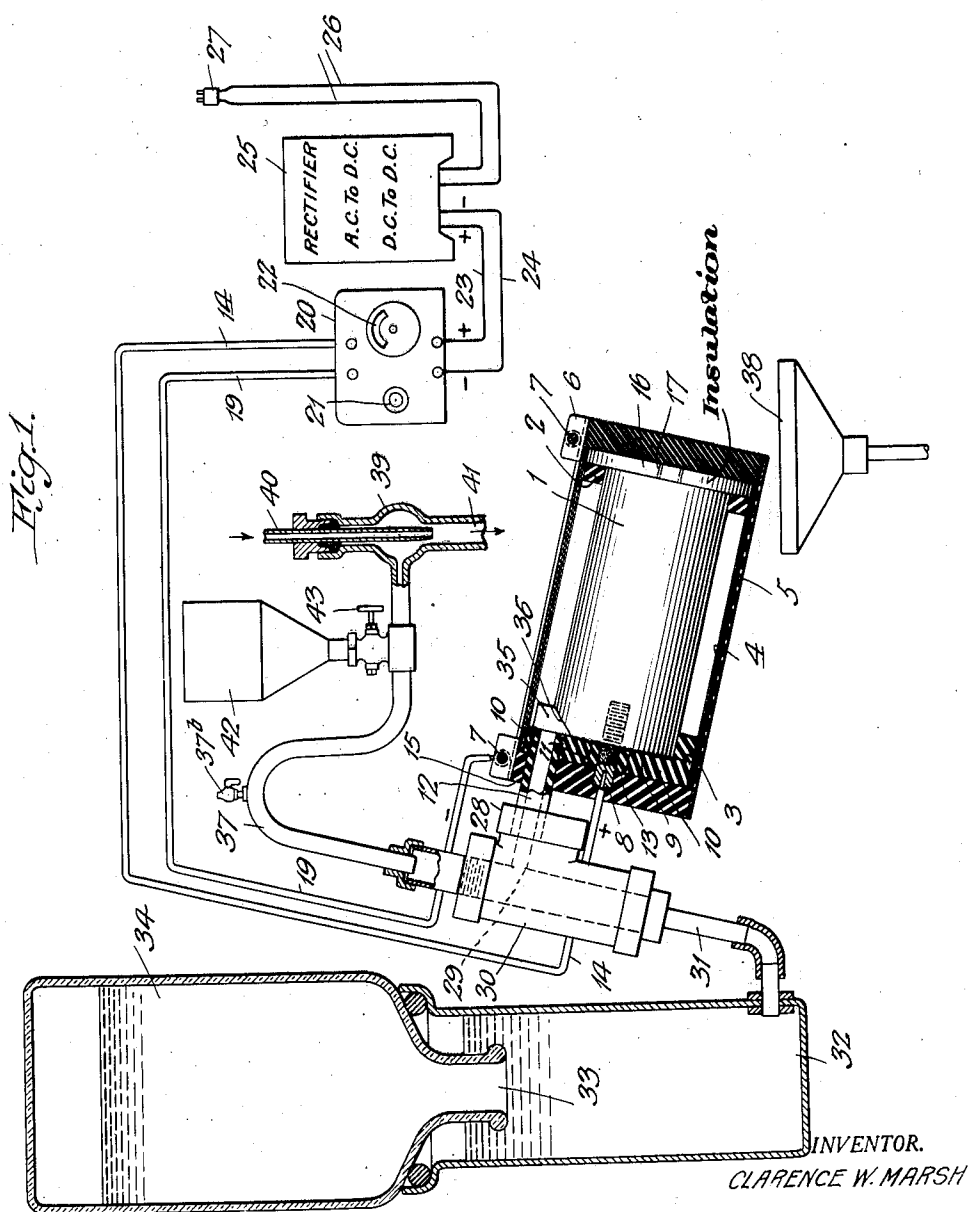
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C. W. MARSH
ELECTROLYTIC CELL

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2.

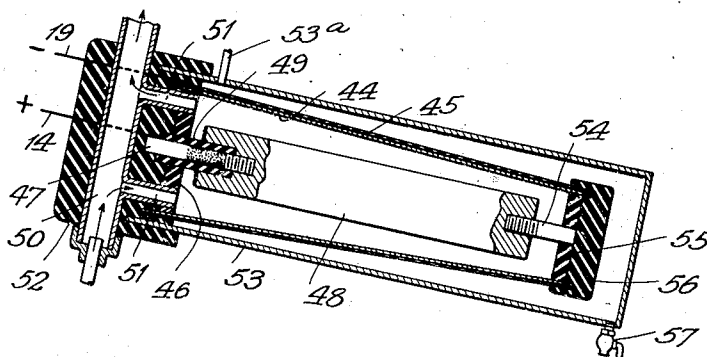


Fig. 3.

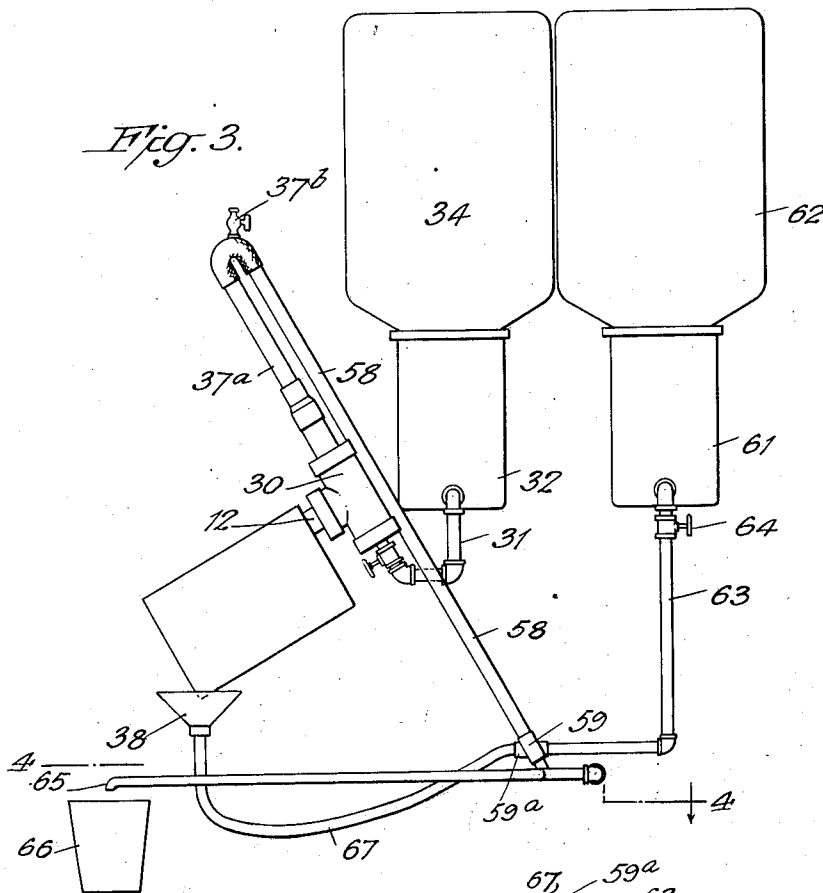
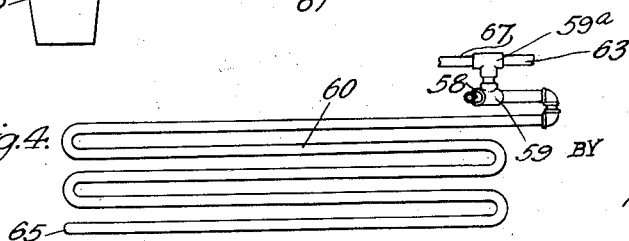


Fig. 4.



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ELECTROLYTIC CELL

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This invention relates to electrolytic units particularly adapted to the manufacture of chlorine gas for various usages, such as the treatment of water, industrial or sewerage waste, air, gas, or for purposes of disinfection, sterilization, deodorization and the manufacture of hypochlorite solutions and other chlorine compounds of sodium.

An object of the invention is to provide an improved apparatus for this purpose which is practical, economical and efficient for the generation of small quantities of chlorine gas, and dosing it accurately to water, fluids, liquids or other substances in regular or variable amounts; and with which the manufacture of fresh Dakin solution, hypochlorite solutions or other various chlorine compounds of sodium is made economical, convenient and feasible as well as inexpensive.

A further object is to provide an improved electrolytic cell of such simple and inexpensive structural features that such cells or groups of cells can be replaced with new cells when worn out, more economically than they can be repaired or rebuilt.

A further object is to provide an improved cell which may operate on a low amperage and voltage in connection with the forms of the various types of small rectifiers now on the market, at the same time being comparatively inexpensive, efficient, practical, light, compact, of low maintenance and cost, and which may operate over comparatively long periods of time without attention.

A further object is to provide an improved cell in which the internal resistance and polarization by gas bubbles, will be considerably reduced especially at the higher current densities, and which may be combined in groups to deliver the desired quantity of chlorine gas.

Various other objects and advantages will be apparent from the following description of embodiments of the invention, and the novel features will be particularly pointed out hereinafter in claims.

In the accompanying drawings:

Fig. 1 is an elevation somewhat diagrammatic and partially in section of an electro-

lytic unit constructed in accordance with the invention.

Fig. 2 is a sectional view of an electrolytic cell constructed in accordance with the invention but illustrating a modification of the type of cell shown in Fig. 1.

Fig. 3 is an elevation of apparatus for making a fresh hypochlorite solution such as Dakin solution, and

Fig. 4 is a sectional view of the same taken substantially along the line 4—4 of Fig. 3.

Referring particularly to Fig. 1, the construction of the electrolytic cell therein illustrated, will be first described. An anode 1 of suitable material, such as graphite, is provided adjacent to its ends with suitable peripherally extending spacing rings 2 and 3 which may be formed of any suitable insulating material such as asbestos board, hard rubber, or asphaltic compounds. A diaphragm sheet 4 is wrapped around the anode and spacing rings any desired number of times so as to provide an encasing shell or cylinder of a thickness corresponding to the combined thickness of the layers and spaced from the anode by the rings. This sheet diaphragm may be of any suitable material commonly used in electrolytic cells, such as asbestos paper and various parchment papers.

The cathode 5 comprises a longitudinally slit tubular metal shell formed of perforated sheet metal, which is adapted to embrace the anode and diaphragm constructed as just explained. The shell, along the edges of the slit, is provided with clamping ears 6 and corresponding ears upon opposite sides of the slit are connected by clamping screws 7. When the screws 7 are tightened, the cathode shell will be contracted and tightened so as to be clamped over the diaphragm and secure it to the anode and spacing rings 2 and 3. A terminal conductor 8 of suitable material such as lead, is connected into one end of the anode 1, and projects to some extent from the end of the anode as shown in Fig. 1.

The end of the anode having this connector and the periphery of the connector for

some distance from the anode are preferably provided with a coating 9 of any suitable adhering material such as an asphaltic cement or paint. A disk 10 of suitable insulating material such as asbestos board, is placed over the connector 8, and fitting snugly within the diaphragm 4, but having an aperture 11 surrounding the connector 8 of a larger diameter or width than the diameter of the connector, so as to provide a space leading to the end of the anode.

A tube 12 of suitable insulating material such as hard rubber, glass or porcelain, passes through and is secured in the disk 10 near its periphery and extends endwise therefrom. The aperture 11 in the disk 10 is then filled with a suitable insulating material 13 such as plastic asphalt or asphaltic cement which will adhere firmly to the coating 9 upon the connector and the end of the anode 1.

A conductor 14 is secured to the outer end of the connector 8, and the end of the cathode shell outwardly of the disk 10, is filled with an insulating material 15, such as a plastic asphalt or asbestos cement or of any of the wax or tarry fillers commonly used, for example, as a seal for the ends of dry battery cells. Preferably, the portions 13 and 15 which fill the aperture 11 in the disk 10 and the outer end of the cathode shell, may be poured or placed at the same time and form one integral part, which thus eliminates one extra operation.

A disk 16 of suitable insulating material such as asbestos board, is placed within the diaphragm and cathode shell at the opposite end of the anode, and is provided with an aperture or recess 17 into which a pin on the end of the anode may extend so as to assist in spacing that end of the anode from the diaphragm.

The end of the cathode shell, outwardly from the disk 16, is then filled and sealed with a suitable insulating material such as asphaltic cement or plastic asphalt.

The material of the cathode shell may be the same as commonly employed for cathodes in electrolytic cells such as nickel or iron but preferably nickel is utilized because the electrolyte and the caustic soda produced by the electrolytic action will not corrode or materially affect the nickel. The cathodes, are perforated or reticulated for the passage of the hydrogen and caustic soda and, if iron is used as the material of the cathode, it will rust and corrode during periods of inactivity of the cell, the corrosion and rusting soon filling the apertures in the cathode and interfering with the passage of the caustic soda and hydrogen. With cathodes of nickel or with nickel surfaces, there will be little or no corrosion and never sufficient to fill the apertures during the periods of inactivity of the cells and, therefore, such a cell, when

used for the production of chlorine, may be used advantageously in cases where it is operated only intermittently.

A conductor 19 is electrically connected to the cathode in any suitable manner such as by one of the clamping screws 7. The two conductors 14 and 19 are connected to a suitable panel board 20, upon which suitable regulating mechanism such as a resistance device 21 and ammeter 22 may be mounted for controlling and indicating the quantity of current passing to the cell. Conductors 23 and 24 connect the panel board with any suitable rectifier, and the rectifier is then connected by wires 26 to a plug 27 for connection to any source of current.

The tube 12 is connected through a detachable connection 28 to a branch passage 29 in a supply conduit 30, and the cell and conduit are preferably supported in inclined positions as shown in Fig. 1. The lower end of the supply conduit 30 is connected by a pipe 31 to the lower part of a well 32, in the upper end of which is immersed the neck or mouth 33, of an inverted bottle or container 34 containing a supply of electrolyte. The electrolyte will flow from the bottle or container 34 into the well 32, until the level of the electrolyte reaches the mouth of the container inverted therein, at which time the electrolyte in the well will serve as an air seal preventing the escape of further electrolyte from the container until the level of the electrolyte in the well falls so as to open the mouth of the container.

The electrolyte will flow from the well through the conduits 31 and 30 until the level in the latter corresponds with the level in the well. The supply conduit 30 is so positioned that the normal level of the electrolyte therein will be above the branch 29 leading into the interior of the cell, in order that the electrolyte from the supply conduit will pass through the branch 29 and the tube 12 into the chamber in the electrolytic cell, it being understood that the spacing ring 3 is provided with an aperture or notch 35 permitting the passage of the electrolyte from the tube 12 to the space between the anode and the diaphragm. In this manner, the interior of the cell will be automatically maintained and filled under a constant head. If desired, the corner edge of the anode may be cut away as at 36 to provide necessary clearance or space for the passage of electrolyte from the tube 12 to the interior of the cell.

When a current is passed through the cell, an electrolytic action, well known in the art, will occur, in which the electrolyte, commonly of salt solution, will be decomposed into chlorine gas and caustic soda. The chlorine gas will be liberated in the space between the anode and diaphragm and will rise and pass out through the tube 12 and the branch conduit 29 into the supply conduit 30, and then

rise therein, entering a conduit 37, which rises to a height above the level of the electrolyte in the well, so that nothing but gas will pass through this conduit. The caustic soda will collect upon the cathode shell and run down the same to the lowermost corner edge and then drip into a suitable container or receptacle 38. An enclosing shell for the cathode may of course be provided if desired.

The conduit 37 is connected to a point of delivery of the chlorine gas, but in Fig. 1, this conduit is connected to the suction side of an injector device 39 through which a stream of fluid is passed by means of a pipe 40, the gas and fluid mixture being discharged therefrom through the pipe 41. This fluid is preferably the water or liquid to be treated, and by its velocity creates a suction which will draw the chlorine gas collecting in the conduit 37 into the injector device and thence with the injector fluid to a tank or other point of disposal. This apparatus may be used for adding chlorine gas to swimming tanks or water supply systems, but in many cases it is desirable to also add a hypochlorite solution. Accordingly a suitable substance such as caustic soda or sodium carbonate may be conducted from a supply container 42 through a controlling device 43 to the conduit 37 before it enters the injector device, and this sodium carbonate or caustic soda solution entering the conduit 37, will react with the chlorine gas therein and form the hypochlorite solution which will be drawn off by the injector.

To prevent too strong a suction upon the conduit 37 which might siphon over the electrolyte, the conduit 37 may be provided, such as at its highest point, with an air valve 37b which will admit to the conduit more or less air as desired, so as to lessen the suction leading to the electrolytic cell. This valve may be a mere pet cock or an automatic valve such as one opening automatically against the action of a spring to admit air to the conduit when the suction in the conduit exceeds a definite amount which may be varied by varying the stress in the spring.

In Fig. 2, a modified embodiment of the cell is illustrated. The diaphragm 44 is arranged along the inner surface of the cathode shell 45, and one end of the shell and diaphragm is closed by a disc 46 of suitable insulating material, such as asbestos board, and the terminal connector 47 is anchored in the anode 48 in the same manner as explained in connection with Fig. 1. If desired, a shell 49 of suitable insulating material such as hard rubber, may be provided around the projecting end of the connector 47. The connector 47 and its protecting sleeve 49, project through the disc 46 and the conductor 14 is connected thereto. A supply conduit 50 has a pair of branches 51 extending laterally

therefrom, and this conduit is supported so that its branches 51 extend through an aperture in the disc 46 and communicate with the interior of the cell. A head of suitable insulating material such as asphaltic cement, plastic asphalt, or other insulating plastic compounds, is then placed around the supply conduit 50 and its branches as well as against the disc 46 so as to seal that end of the cell. If desired an enclosing casing 53 may have its ends formed within the head 52, but the casing should have a vent 53a for the escape of hydrogen gas which is formed during the electrolytic process.

The inner end of the anode is supported by an insulating pin 54 from a disc 55 of suitable insulating material such as asbestos board, which is fitted into the corresponding end of the diaphragm and cathode shell. A closure 56 of material similar to the head 52 is formed about the cathode shell and diaphragm and against the disk 55 so as to effectively seal that end of the cathode shell. A conductor 19 may be connected to the cathode shell so as to be embedded in the head 52, or so as to pass through the casing 53. A valve or a cock 57 is provided in the lower end of the casing 53 so as to permit removal of the caustic soda formed during the electrolytic action.

The action of this cell is similar to that shown in Fig. 1 except that in Fig. 1, the electrolyte enters the interior of the cell through the same opening that the chlorine gas passes through in leaving the cell, whereas in the type of cell shown in Fig. 2, the electrolyte will enter through both of the branch conduits 51 and the chlorine gas will leave the cell through the uppermost of the branch conduits.

In Figs. 3 and 4, I have illustrated apparatus by which the manufacture of fresh Dakin solution, hypochlorite solutions, or various other compounds, may be carried on in a very simple, continuous, inexpensive, and practical manner. In this apparatus, I have illustrated an electrolytic cell of the type shown in Fig. 1 with the same means of supplying a constant supply of electrolyte to the cell and thus maintain the electrolytic chamber completely filled. The chlorine gas collecting in the conduit 37a corresponding to the conduit 37 of Fig. 1, will be conducted upwardly to a point above the level of the electrolyte in the well and then downwardly through a pipe or conduit 58 to a point below the lowermost part of the electrolytic cell where it enters a T conduit 59 to one branch of which a coil or reaction tube 60 is connected.

A second well, 61, is supplied with a constant level of reaction solution, such as a sodium carbonate solution, from a bottle or container 62, and a conduit 63 from this well, controlled by the valve 64, is connected to

one branch of a T conduit 59^a, another branch of this T conduit connects with the T conduit 59 so that the reaction solution from the well 61, will enter the T conduit 59^a and pass therefrom into the T conduit 59 and mix with the chlorine gas, the two then passing downwardly into and along the reaction tube 60. This reaction tube or pipe 60 is arranged in a position substantially horizontal, so that the mixture of the chlorine gas and the reaction solution will pass slowly along the same to afford sufficient opportunity for the reaction to occur, the product being discharged at 65 into any suitable container 66. The valve 37^b in the conduit 37^a serves by the admission of some air to vary the amount of chlorine entering the reaction tube and also prevents the application of too strong a suction upon the electrolytic cell chamber.

In many instances, a pure product is not necessary and therefore the caustic soda resulting from the electrolytic action may be utilized to supply at least a portion of the reaction liquid. I have illustrated a connection 67 between the receptacle 38, in which the caustic soda is collected from the electrolytic cell, and the T conduit 59^a through which the reaction liquid passes to the T conduit 59. In some cases, the caustic soda supplied by the electrolytic action may not be sufficient to combine with the chlorine gas liberated, but by regulating the valve 64, sufficient additional reaction fluid may be allowed to mix with the caustic soda to supply the desired quantity of reaction fluid. If it is desired not to use the caustic soda, the connection between the conduit 67 and receptacle 38 may be interrupted or the conduit 67 closed. More or less of the salt solution in the cell may pass through the diaphragm and mix with the caustic soda formed by the electrolytic action, but in many instances, the salt solution will not be objectionable in the final product.

The reaction liquid from the well 61, the caustic soda from the electrolytic cell, or both, enters the inclined conduit 58 before it reaches its lowest level and connects with the reaction tube 60 so that the liquid entering conduit 58 and then passing downwardly will create a slight suction upon the conduit 37^a and draw over the chlorine gas which has been accumulating in the conduit 37^a.

When the electrolytic cell is arranged with its axis inclined to the horizontal, the chlorine gas will rise in bubbles and pass directly to the upper part of the cathode and then along the same to the outlet, instead of passing along the surface of the anode as is the case when such cells are in a strictly vertical position. The gas bubbles, in passing along the narrow strip of the cathode or diaphragm, will not materially increase internal resistance of the cell by polarization since the surface of the anode will be practically free of

the gas. In this manner, the efficiency of the cell is considerably increased by reason of its inclined position, particularly with greater current densities. It will be understood that any number of these electrolytic cells may be connected in parallel to a common supply conduit or to a common well and in series, parallel, or series-parallel in an electric circuit, thus giving any desired quantity production of gas, with a minimum of necessary apparatus. By utilizing the supply conduit for the removal of the gas and for maintaining the cell completely filled with electrolyte, a gas chamber in the cell will be unnecessary.

It will be understood that the details and arrangements of parts, which have been herein described and illustrated for the purpose of explaining the nature of the invention, may be varied and modified by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

I claim:

1. An electrolytic unit comprising a cell having a cathode, an anode, and an inlet conduit leading downwardly into the uppermost part of the electrolytic chamber for supplying an electrolyte to the space between the anode and cathode and removing the gas formed in said space, means including a supply conduit connected to the inlet conduit for maintaining automatically a level of the electrolyte in said conduit so that the interior of the cell will be kept constantly filled; and a gas exit conduit from a portion of the supply conduit which is unoccupied by the electrolyte.

2. An electrolytic unit comprising a conduit, a source of electrolyte supply connected to one end of the conduit, a gas removal conduit connected to the other end of the conduit, an electrolytic cell having a gas chamber, and a branch connection between the said conduit and the upper end of the gas chamber of said cell.

3. An electrolytic unit comprising a cell having a relatively long concentric anode and cathode, and means for supporting said cell with its anode and cathode making a considerable angle to the vertical, whereby the gas bubbles will move along the cathode and not along the anode to any material extent.

4. An electrolytic unit comprising a cell having a cathode, an anode, and an inlet conduit leading downwardly into the uppermost part of the electrolytic chamber for supplying electrolyte to the chamber and removing the gas from the chamber, a supply conduit connected to said inlet conduit for supplying electrolyte to the inlet conduit by gravity, a reservoir device for maintaining a quantity of electrolyte in said supply conduit sufficient always to feed the inlet conduit, and a gas removal conduit connected to the upper end of the supply conduit.

5. An electrolytic cell comprising an

anode, spacing rings of insulating material surrounding the ends of the anode, a diaphragm extending peripherally around the rings and anode and spaced from the anode by the rings, a longitudinally slit perforated cathode shell embracing the diaphragm and clamping it to the rings, means for adjusting the slit edges of the shell toward one another to provide the desired clamping action, a filler sheet in both ends of the cathode shell for closing the ends, and a tube passing through one of the end filler sheets through which the evolved gas may be removed from the interior of the cell.

6. An electrolytic cell comprising an anode, spacing rings of insulating material surrounding the ends of the anode, a diaphragm extending peripherally around the rings and anode and spaced from the anode by the rings, a longitudinally slit perforated cathode shell embracing the diaphragm and clamping it to the rings, means for adjusting the slit edges of the shell toward one another to provide the desired clamping action, a filler sheet in both ends of the cathode shell for closing the ends, and a tube passing through one of the end filler sheets through which the evolved gas may be removed from the interior of the cell, the ring at the end adjacent the tube having a passage therethrough from face to face for establishing communication between the tube and the electrolytic chamber between the diaphragm and anode.

7. A cell having an electrolyte chamber provided with a gas outlet, a conduit connected therewith and extending upward and downward with respect thereto, and means for automatically supplying liquid to the lower portion of said conduit comprising a barometric feed reservoir having a discharge opening above the level of said outlet and below the upper part of said conduit, and means for receiving gas from the upper portion of said conduit.

8. In an electrolytic apparatus, the combination of a cell, a conduit for supplying electrolyte thereto and for the flow of gas therefrom, said conduit rising to a point substantially above the level of the cell, means for applying suction to the elevated portion of said conduit and a valve in said elevated portion of the conduit for regulating the degree of suction.

9. In an electrolytic apparatus, the combination of a cell, a conduit for supplying electrolyte thereto and for the flow of gas therefrom, means for applying suction to said conduit, a reagent reservoir, a connection between said reservoir and said conduit at a point intermediate said cell and said suction means, and valve means for regulating the degree of suction.

10. In an electrolytic apparatus, the combination of a cell, a conduit for supplying

electrolyte thereto and for the flow of gas therefrom, said conduit rising to a point substantially above the level of the cell, means for applying suction thereto, a reagent reservoir, a connection between said reservoir and conduit at a point intermediate the cell and suction means, and a barometric feed device connected to said conduit to maintain a liquid level at a point between its elevated portion and the cell.

In witness whereof, I hereunto subscribe my signature.

CLARENCE W. MARSH.