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MERCURY CATHODE ELECTROLYSIS APPARATUS

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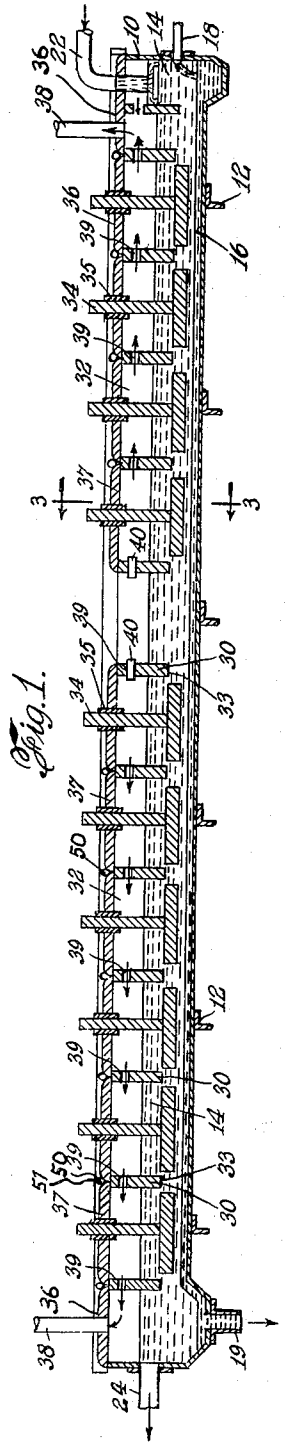


Fig. 1.

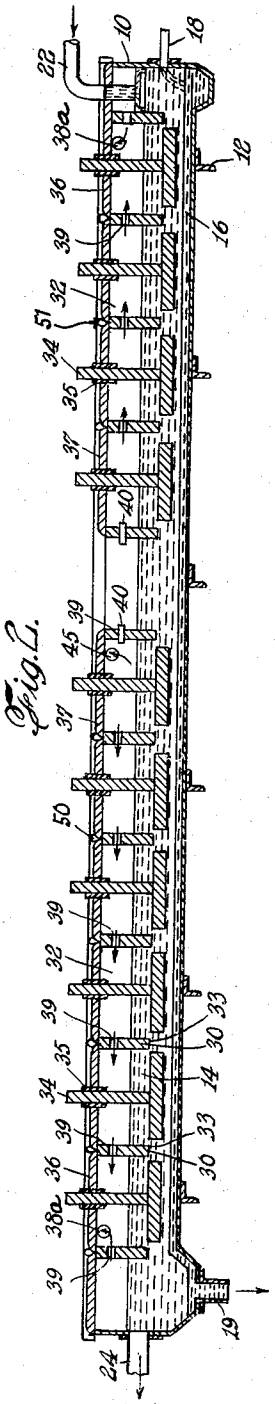


Fig. 2.

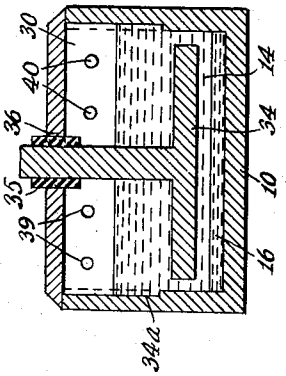


Fig. 3.

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## MERCURY CATHODE ELECTROLYSIS APPARATUS

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6 Claims. (Cl. 204—219)

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This invention relates to electrolysis apparatus wherein a chemical compound is decomposed by electrical current to produce a gas as at least one of the products of the decomposition, and is more particularly concerned with electrolytic apparatus of the mercury cathode type comprising elongated substantially horizontal cells.

Mercury cathode cells of the type used commercially for example to decompose sodium chloride in aqueous solution to produce chlorine and sodium, comprise relatively narrow elongated troughs slightly inclined to permit the longitudinal gravity flow of mercury over the bottom thereof and are provided with depending graphite anodes having a lower face spaced at a predetermined distance from the surface of the flowing mercury cathode. In operation, the liberated sodium or other metal forms an amalgam with the mercury which flows out of the cell by gravity. The chlorine or other gas liberated in the reaction is removed by suitable means.

Cells of this type have one or more covers which support the graphite anodes and rest upon the side and end walls of the trough. To clean the apparatus, a procedure which is required from time to time in order to insure efficient operation, it is necessary to remove the cover. Since the apparatus operates under a slight vacuum, when the cover is removed there is an appreciable in-rush of air. This incoming air not only greatly dilutes the chlorine or other gas formed in the cell but contaminates the gas to an extent which renders it unsuitable for many purposes and thus necessitating a difficult separation.

It has, therefore, been considered necessary in practice to shut down the cell completely when any prolonged opening of the apparatus is necessary, e. g. for cleaning or inspection. It has not been heretofore thought possible to clean or make a complete inspection of an electrolytic cell while it is in operation. The cleaning and inspection of cells has, therefore, resulted in appreciable lost production. The cell must be completely shut down during the entire cleaning or inspecting operation.

The principal object of the invention is to provide means for permitting the inspection and cleaning of an electrolytic cell without necessitating the shutting down of the cell and without causing contamination by air of the gas evolved in the cell.

In accordance with the invention, I provide an electrolytic cell of a type having a gas outlet at each end thereof, and preferably a third outlet, and having a plurality of transverse partitions dividing the cell into a series of compartments. The partitions extend from the top of the cell downwardly below the surface of the electrolyte but terminate short of the bottom or "sole" of the cell so that flow of electrolyte and mercury is not impeded. The cell is provided with electrolyte outlet means which determine the level of the electrolyte and the partitions are of sufficient height to extend into the electrolyte a sufficient distance to form a gas seal but to permit free flow of amalgam and electrolyte. In the upper portion of each partition there is provided at least one opening, preferably of circular cross-section. These openings are sufficiently high that they will be positioned above the level of the electrolyte when the cell is in normal operation. Cooperating with these openings or apertures are stoppers adapted to fit into the apertures and to form a fluid-tight closure therefor.

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The cover for the cell is formed from a plurality of cover plates or slabs which are dimensioned to rest upon the side walls of the cell and advantageously are formed to rest upon the partitions as well. An anode is supported by each cover slab and extends downwardly into the respective cell compartment. It is a feature of the invention that each cover plate or slab is adapted to be removed independently of the other slabs, and when a cover is removed the stoppers are readily insertable in the apertures of the thus-opened cell compartment to prevent flow of air into the adjacent compartments and thereby to permit cleaning of the opened compartment without interrupting the operation of the cell.

Other objects and features of the invention will be apparent from the following detailed description thereof and from the drawings wherein,

Fig. 1 shows in cross-section, a mercury cathode electrolytic cell embodying features of the invention;

Fig. 2 is a similar view of another embodiment of the cell;

Fig. 3 is a sectional view taken approximately along the line 3—3 in Fig. 1.

Referring to the drawing, the numeral 10 designates an elongated electrolysis trough which is supported by members 12 and is adapted to contain the electrolyte 14, e. g., aqueous sodium chloride solution, and the flowing mercury cathode 16. An inlet 18 for the mercury is shown at one end of trough 10 and an outlet 19 for

the amalgam formed by the mercury and the metal liberated during the electrolysis at the opposite end of the trough. The electrolyte inlet is shown at **22** and the electrolyte outlet is shown at **24**, the outlet **24** serving to determine the level of the electrolyte in the cell and may be conveniently provided with a trap or like means to insure the maintenance of the desired level. Extending between the side walls of trough **10** are lateral partitions **30** which divide the upper portion of the trough **10** into a series of adjoining and communicating compartments **32**. It will be observed that the partitions **30** extend downwardly below the surface of the electrolyte **14** but do not extend to the surface of the flowing mercury cathode **16**, thereby permitting free flow of the cathode and the electrolyte **14** under the partitions. The partitions are conveniently removably received in recesses **34***a* formed in the side walls of trough **10** as shown in Fig. 3 in substantially gas-tight engagement, or the partitions **30** may be formed integrally with the walls of trough **10**, as by welding. Preferably, as shown, the lower edge **33** of partitions **30** is above the surface of the horizontal anodes **34** and are below the electrolyte level a sufficient distance to form a gas seal to prevent flow of gas under the partitions. The spacing of the lower edge **33** of the partitions **30** with respect to the bottom of the cell may vary, but generally speaking the partitions **30** will extend downwardly for ⅔ to ¾ of the trough height. As shown in the embodiments of Figs. 1 and 2, resting upon the upper edge of each pair of partitions **30** is a cover slab in which is supported the anode **34** which extends through the cover slab and is sealed thereto as by luting **35** or other like sealing and insulating composition. Suitable luting or packing material also seals the space between adjoining cover plates and between the cover plates and the side walls of trough **10**. As shown in Fig. 1, the end compartments of the cell beyond the anode compartments are provided with cover slabs **36** and the cover slabs for the intermediate anode compartments are indicated by the reference numeral **37**.

Gas outlets **38** for the ends of the cell are provided in the cover slabs **36**. Gas outlets **38** may conveniently be connected, as by a separable flanged-joint, to a common header (not shown) for carrying the evolved gas to storage receptacles. Alternatively, the gas outlets may be provided in the upper portions of the side walls of the trough **10**.

Each of the partitions **30** is provided with at least one aperture **39** positioned in the upper portion of the partition above the level of the electrolyte but preferably substantially below the top of the partition. The gas evolved during the operation of the cell flows through these apertures **39** from compartment to compartment until one of the gas outlets **38** is reached.

When it is desired to inspect or clean the cell, the cover slab of one of the compartments is removed, the anode supported thereby having previously been disconnected from the power source. When the cover slab has been removed, stoppers **40** are inserted in the apertures **39** of the partitions **30** forming the end walls of the opened compartment. The stoppers are, of course, formed to fit the apertures and are made from a chemically resistant material such as ebonite. With the compartment thus opened and sealed from the adjoining compartments, it may be readily cleaned or inspected. Operation of the cell as a whole, however, continues without interruption. The gases evolved at one side of the opened compartment are removed through one of the outlets **38** while the gases formed on the other side of the opened compartment are removed through the other outlet **38**. The apertures **39** in the partition walls permit the uninterrupted flow of gas from compartment to compartment until one of the two gas outlets is reached. Since the compartment partitions **30** do not extend to the bottom of the cell, flow of electrolyte and mercury cathode continues during the cleaning operation. Thus, the only loss in production is that of the particular compartment which is opened. After the compartment has been cleaned the cover slab is replaced, the anode connected to the circuit, and the compartment is thus again placed in operation. This procedure is repeated in each of the remaining compartments until the entire cell has been cleaned or inspected, without, however, being completely shut down or out of operation at any time.

While in the embodiment illustrated in Fig. 1 I have shown a cell having a gas outlet at each end of the cell and positioned in each of the end anode compartments, I advantageously also provide a third gas outlet. Referring to Fig. 2, there is shown a mercury cathode electrolytic cell similar to that of Fig. 1 but having end gas outlets **38***a* in the upper portion of the cell side wall and a third gas outlet **45** in the side wall of the center anode compartment. This center outlet is of value during normal operation of the cell whereas the end outlets are of primary value during cleaning and inspecting when the individual compartments are opened. Thus, the end gas outlets **38** may be connected to one chlorine receiver while the center outlet **45** may be connected to another. During the cleaning of the cell by successive removal of the cover plates, as previously described, the chlorine is slightly diluted but in a usable commercial concentration and is removed to the receiver to which the end outlets **38***a* are collected. When, however, during normal operation of the cell substantially pure chlorine is removed, this gas may be removed through central outlet **45** and separately collected. Obviously, the outlets **38***a* and **45** are provided with valve means and it will be apparent that the third outlet **45** does not have to be at the exact center of the cell. It will also be apparent that the gas outlets **38***a* and **45** may be provided in the cover plates as in Fig. 1 rather than in the side walls, although the construction shown in Fig. 3 is preferred.

It will be understood that a fluid-tight seal between the various separable parts of the cell is provided in known manner by luting, gaskets or other convenient means, as indicated at **50** in the drawing, and may be held in place by bars or other convenient clamp means, as indicated at **51**.

While I have shown and described preferred embodiments of my invention and I have pointed out certain possible modifications, it will be apparent to those skilled in the art that various other changes and modifications may be made without departing from the scope of the invention as defined in the appended claims and it is intended, therefore, that all matter contained in the foregoing description and in the drawings shall be interpreted as illustrative and not in a limiting sense.

This application is a continuation-in-part of

my copending application, Serial No. 761,701, filed July 17, 1947, now abandoned.

What I claim and desire to secure by Letters Patent is:

1. In an electrolysis apparatus of the mercury cathode type, the combination of an elongated substantially horizontal cell adapted to contain a flowing mercury cathode and a flowing aqueous electrolyte, means for maintaining the electrolyte at a fixed predetermined level, transverse partitions dividing said cell into a succession of chambers, said partitions extending from the top of said cell to below the level of the electrolyte but terminating a substantial distance from the bottom of the cell, whereby to permit unimpeded flow of mercury and electrolyte, each of said partitions being provided with at least one aperture in the upper portion of but substantially below the top of the partition, each of said apertures being adapted to receive and be closed by a stopper, and individual covers for each of said chambers removably positioned on said cell in fluid-tight relationship with the top of the cell walls and the tops of the adjacent partitions, and gas outlets at opposite ends of the cell for removing evolved gases from said cell.

2. In an electrolysis apparatus of the mercury cathode type, the combination of an elongated substantially horizontal cell adapted to contain a flowing mercury cathode and a flowing aqueous electrolyte, means for maintaining the electrolyte at a fixed predetermined level, transverse partitions dividing said cell into a succession of chambers, said partitions extending from the top of said cell to below the level of the electrolyte but terminating a substantial distance from the bottom of the cell, whereby to permit unimpeded flow of mercury and electrolyte, each of said partitions being provided with at least one circular aperture in the upper portion of but substantially below the top of the partition, each of said apertures being adapted to receive and be closed by a stopper, and individual covers for each of said chambers removably positioned on said cell in fluid-tight relationship with the top of the cell walls and the tops of the adjacent partitions, said covers supporting the anodes, and gas outlets at opposite ends of the cell for removing evolved gases from said cell.

3. In an electrolysis apparatus of the mercury cathode type, the combination of an elongated substantially horizontal cell adapted to contain a flowing mercury cathode and a flowing aqueous electrolyte, means for maintaining the electrolyte at a fixed predetermined level, transverse rectangular partitions dividing said cell into a succession of chambers, said partitions extending from the top of said cell to below the level of the electrolyte but terminating a substantial distance from the bottom of the cell, whereby to permit unimpeded flow of mercury and electrolyte, each of said partitions being provided with a plurality of apertures in the upper portion of but substantially below the top of the partition, each of said apertures being adapted to receive and be closed by a stopper, and individual covers for each of said chambers removably positioned on said cell in fluid-tight relationship with the top of the cell walls and the tops of the adjacent partitions, and gas outlets at opposite ends of the cell for removing evolved gases from said cell.

4. In an electrolysis apparatus of the mercury cathode type adapted to contain a flowing mercury cathode and a flowing electrolyte, the combination of an elongated substantially horizontal cell having gas outlets at each end thereof and horizontal graphite anodes depending therein, means for maintaining the electrolyte at a fixed predetermined level, transverse partitions dividing said cell into a succession of chambers, removable individual covers for each of said chambers, said partitions extending from the top of said cell to below the level of the electrolyte but terminating a substantial distance from the bottom of said cell and having apertures in the upper portions of but substantially below the tops of the partitions, each of said apertures being adapted to receive and be closed by a stopper, whereby to permit cleaning of one of said chambers without interrupting the electrolysis process in the adjacent chambers.

5. In an electrolysis apparatus of the mercury cathode type adapted to contain a flowing mercury cathode and a flowing electrolyte, the combination of an elongated substantially horizontal cell having gas outlets at each end thereof and horizontal graphite anodes depending therein, means for maintaining the electrolyte at a fixed predetermined level, transverse partitions dividing said cell into a succession of chambers, removable slabs serving as covers for said chambers, said slabs cooperating with both sides of said cell and the top of said partitions to form fluid-tight seals, and gas outlets at opposite ends of said cell, said partitions extending from the top of said cell to below the level of the electrolyte but terminating a substantial distance from the bottom of said cell and having apertures in the upper portions thereof, each of said apertures being adapted to receive and be closed by a stopper, whereby to permit cleaning of one of said chambers without interrupting the electrolysis process in the adjacent chambers.

6. In an electrolysis apparatus of the mercury cathode type adapted to contain a flowing mercury cathode and a flowing electrolyte, the combination of elongated substantially horizontal cell having graphite anodes depending therein, a gas outlet at each end and at approximately the center of said cell, means for maintaining the electrolyte at a fixed predetermined level, transverse partitions dividing the cell into a succession of chambers, removable individual covers for each of said chambers, said partitions extending from the top of said cell to below the level of the electrolyte but terminating a substantial distance from the bottom of the cell and having apertures in the upper portions thereof, each of said apertures being adapted to receive and be closed by a stopper, whereby to permit cleaning of one of said chambers without interrupting the electrolysis process in the adjacent chambers.

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