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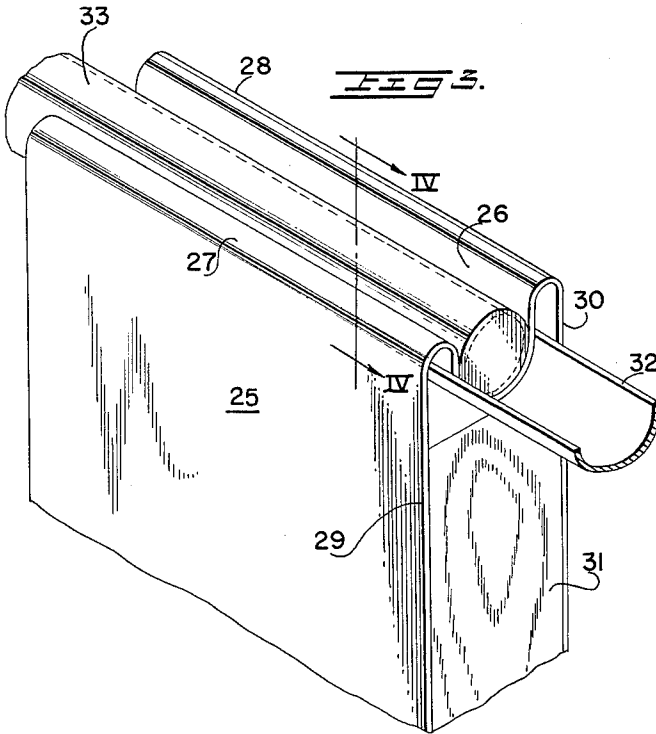
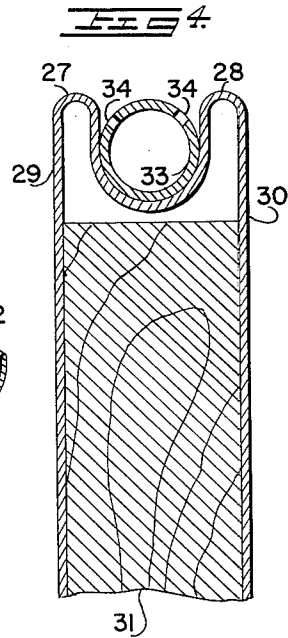
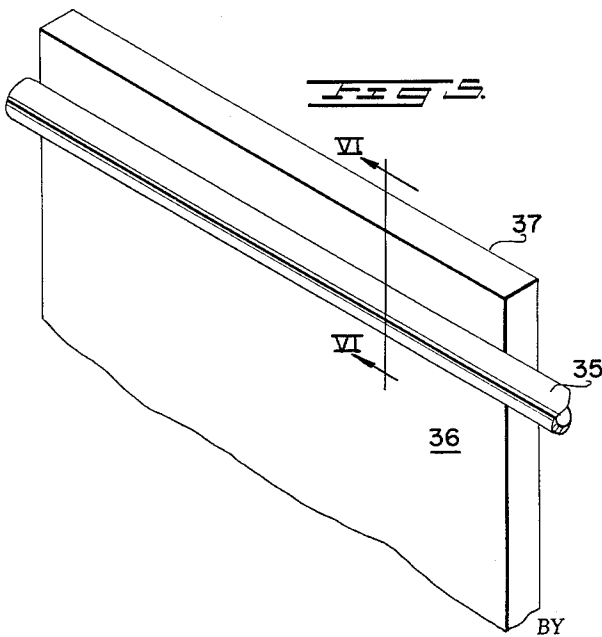
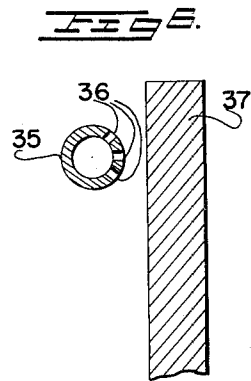
P. M. SULLIVAN ET AL

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ELECTROLYTIC CELL WITH VERTICAL MERCURY ELECTRODE

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2 Sheets-Sheet 2



INVENTORS
PAUL M. SULLIVAN
and DAVID H. CHAMBERS

Donald G. Welch

ATTORNEY

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ELECTROLYTIC CELL WITH VERTICAL MERCURY ELECTRODE

Paul M. Sullivan, Hyattsville, and David H. Chambers, Catonsville, Md., assignors to the United States of America as represented by the Secretary of the Interior
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The invention herein described and claimed may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of royalties therein or therefor.

The invention relates to a moving mercury electrode for use in an electrolytic cell, and more particularly to the structure of a vertical-type mercury amalgam electrode.

Horizontally disposed amalgam electrodes are commonly employed in various types of electrolytic processes. Serious disadvantages, however, attend their use since they require large mercury inventories, large floor areas, have low production rates per unit of electrode area, and are impractical for the recovery of high purity metals. Vertical mercury electrodes have been proposed, but the main difficulty has been in obtaining a uniform downwardly flowing sheet of mercury, which completely covers the supporting surface. Mercury films have a distressing tendency to separate into thin streams exposing the underlying plate. Various methods have been proposed in the past to distribute the mercury evenly, such as sprays, grooves cut in the supporting sheets, rotating supporting discs, etc. However, all proposals made heretofore require relatively complicated structures and many would not completely remedy the difficulties. Our invention supplies a surprisingly simple solution to the problem which has plagued the art for many years.

Broadly, our invention consists in a novel supporting base for the flowing mercury film, said base being a sheet of hot-dipped galvanized iron. We have found that the use of hot-dipped galvanized iron for the electrode plate permits the mercury to wet the surface readily and without difficulty in a uniform film. Satisfactory operation for long periods of time have been achieved with this seemingly simple expedient.

It is the primary object of this invention to provide an improved mercury electrode of superior design wherein a thin film of mercury is uniformly distributed over a vertical metallic supporting surface.

A further object of this invention is an electrode comprising a vertical sheet of hot-dipped galvanized iron provided with a trough at its upper end for uniformly distributing mercury thereover.

A further object of this invention is a vertically inclined sheet or plate of hot-dipped galvanized iron having a mercury spray at its upper end, to form a uniform thin film of downwardly flowing mercury.

A further object of this invention is to provide a mercury electrode requiring a relatively small mercury inventory.

It is a further object of this invention to provide an electrolytic cell for mounting the vertical mercury electrode and having provisions for collecting the mercury flowing from the electrode.

Further objects will be apparent from a consideration of the following description of the invention and the appended claims.

In the drawing, FIG. 1 shows partly cut-away perspective view of an electrolytic cell employing one modification of our electrode.

FIG. 2 is a sectional view taken along line II—II of FIG. 1.

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FIG. 3 is a perspective view showing another modification of the electrode.

FIG. 4 is a sectional view taken along line IV—IV of FIG. 3.

FIG. 5 illustrates a further modification of the electrode.

FIG. 6 is a sectional view taken along line VI—VI of FIG. 5.

In FIG. 1, electrolytic cell 1 is shown having vertical sides 2 and a horizontal bottom section 3, made of any suitable construction material. In the embodiment shown wood is used since it is a cheap and readily available material, all surfaces being coated with a chemically resistant paint. Filler blocks 4 are fastened to the cell bottom and sides as shown to create a sump for mercury, as will be described presently. In the bottom section 3 is located a hole 6 into which an exit tube 7 is fitted.

Electrode 8, consists of two metal members 9 and 10, having a general Z shape as shown, rigidly joined together by metal bars 11 and 12, with a metal electrode lead 13 rigidly fastened to bars 11 and 12, so that the various elements of the electrode act form a single electrically inter-connected unit. Slots 14 are cut into each of the opposing sides 2 to receive the edges of electrode 8.

The other electrode 15 consists of a vertical sheet 16 of hot-dipped galvanized iron bent at its upper end to form a horizontal gutter 17 of relatively small volume, having an upper edge 18 higher than lower edge 19. By making the width of the electrode equal to the inner width of cell 1, the ends of the gutter abut tightly against the walls to form a trough. Electrode lead 20 is fastened to the back portion of gutter 17.

A distributing tube 21 passes through one cell wall and is disposed within the bend of gutter 17. As shown in FIG. 2, that portion of tube 21 lying within gutter 17 has a plurality of holes 22 whereby mercury is distributed into the trough from a source outside the cell. By admitting mercury into the trough at a suitable rate, a steady amount overflows the lower edge 19 and flows downwardly over galvanized iron sheet 16 in a uniform evenly distributed film. At the bottom of the sheet 16, the mercury drips off and collects into the lower sump portion 23 of cell 1 and is removed by tube 7 for further treatment.

Electrolyte is led into the cell via tube 24 and is removed by a corresponding tube (not seen in FIG. 1) at the opposite cell wall. Both tubes are located adjacent electrode 8, whereby the circulation of electrolyte acts to continuously wash the electrode face.

As used above, the term "mercury" includes both mercury per se, and mercury amalgam. The cell may be employed in electrolysis where the mercury electrode is the cathode (here mercury per se), as in electrolysis of salt solutions whose cations are capable of forming amalgams with mercury. Or the mercury electrode may be employed as an anode in a refining electrolysis cell (in this case the mercury being amalgamated), wherein the metal forming the amalgam with mercury is recovered on a cathode.

The reasons for the superior mercury film-supporting properties of the hot-dipped galvanized sheet are obscure. Other sheets such as steel plate or electrolytically galvanized iron, are not as effective, and do not maintain the mercury film. Without being bound to any theory, it is believed that the layer of zinc-iron alloy which is formed during the hot-dip process of galvanizing, and which is found underneath the top layer of pure zinc, is the active agent in causing the even spreading of the mercury film. This alloy becomes exposed after the top zinc layer is dissolved in the mercury. Apparently, the alloy layer is not appreciably soluble in the mercury.

In one particularly effective embodiment, the cell de-

scribed above was employed to refine zinc from zinc amalgam formed by leaching galvanizers' dross with mercury. Electrode 8, having dimensions of 5¼ x 8 inches, was made of aluminum and was the cathode. A zinc chloride electrolyte was admitted via line 24, and the nearly saturated zinc amalgam was led into the trough 17 via line 21. Electrode 15 of hot-dipped galvanized iron, 6 x 8 inches in dimension, was the anode, and the spacing between the electrodes was ¾ of an inch.

Typical electrolyte which may be employed has the composition: zinc chloride, 97.2 grams; ammonium chloride, 153 grams; glue solution, 20 ml. (containing 10 grams glue); wetting agent (Aerosol, 10% solution), 0.7 ml.; water, 1 liter. The quantity of the various ingredients may be varied by about 50% with acceptable zinc deposits still being produced.

The rate of amalgam flow was easily controlled, and quite slow rates could be obtained without interrupting the continuity of the film. Current density employed at the beginning of the run was 20 amperes per square foot, which was raised after 6 hours to 40 amperes per square foot. Cell voltage varied from 0.20 volt to 0.42 volt, depending on the current density. After 22 hours, 585 grams of zinc was recovered, the thickness on the aluminum cathode averaging .13 inch. The amalgam anode remained apparently unchanged, and held its film when mercury flow stopped.

Instead of the mercury electrode shown in FIGURE 1, which has a single face, a double surfaced electrode may be employed as the cathode, with correspondingly, two anodes. This embodiment is shown in FIGS. 3 and 4. Here the galvanized sheet 25 is bent so as to form a trough 26 on top having parallel, horizontal edges 27 and 28 and vertical dependent sides 29 and 30. An insulating filler block 31, which may be wood, rubber, or plastic, for example, spaces these sides. Anode lead 32 in contact with the bottom of trough 26 passes through and projects beyond the cell wall 2. Mercury is admitted via distributing tube 33 and holes 34 (FIG. 4), and overflows edges 27 and 28 to form a vertically film flowing down the faces of sides 29 and 30.

In another embodiment, shown in FIGS. 5 and 6, the mercury is sprayed out of perforated tube 35 in a fine stream through holes 36 directed against the upper part of galvanized sheet 37, which may be slightly inclined from the vertical. A mercury film is formed which uniformly coats the surface of the sheet as in the other embodiments employing troughs.

Various modifications may be made in the embodiments described above by the substitution of equivalents without changing the essence of the invention. For example, the mercury spray means shown in FIG. 5 may be modified so as to have both sides of the galvanized plate covered by a film of mercury. This may be done by directing fine streams of mercury at both sides of the upper portion of a vertically hanging galvanized plate.

We claim:

1. A mercury electrode for use in an electrolytic cell which comprises, a generally vertically disposed flat sheet of hot-dipped galvanized iron, said sheet having an upper edge portion formed as a smooth continuous surface joining an outer surface, trough means at the upper edge of said sheet, said trough means including an overflow portion disposed along and comprising the said upper edge, means for feeding mercury into said trough means, whereby the mercury flows from the trough means over the smooth continuous surface and is uniformly distributed over the outer surface of said galvanized sheet.

2. A mercury electrode for use in an electrolytic cell which comprises an upper trough means, said trough

means having a pair of substantially parallel sides and horizontal upper edges formed as smooth continuous surfaces, a pair of generally vertically disposed sheets of hot-dipped galvanized iron, said sheets being joined by means of said edges, respectively, to said parallel trough sides, the sheets being substantially parallel and extending downwardly from said trough means, said sheets having outer surfaces, means for feeding mercury into said trough means, whereby the mercury flows from the trough means over the smooth continuous surfaces of the said upper edges and is uniformly distributed over the outer surfaces of said hot-dipped galvanized sheets.

3. An electrode for use in an electrolytic cell which comprises, a trough of relatively small volume having parallel and horizontally disposed upper edges, a pair of metal sheets joined to said edges and depending vertically therefrom, a spacer block between said sheets whereby they are maintained in parallel relationship, said sheets having exposed outer surfaces, the sheets and trough being integral and formed of hot-dipped galvanized iron, retaining means at the ends of said gutter to form a trough, means for feeding mercury into said trough whereby the mercury overflows the edges of said trough and forms a uniform film over the the surfaces of said dependent sheets.

4. An electrolytic cell which comprises, a pair of vertical walls, a mercury electrode comprising a single vertically disposed sheet of hot-dipped galvanized iron, the upper portion of said sheet being bent in a U to form a horizontal gutter of relatively small volume, said gutter having a pair of edges, one of said edges being lower than the other and the remaining portion of said sheet depending from said lower edge, the ends of said gutter abutting said cell walls to form a trough, means for feeding mercury into said trough, whereby the mercury overflows the lower edge of said trough and forms a uniform downwardly flowing film over the surfaces of said sheet, and means for collecting mercury at the bottom of said cell.

5. An electrolytic cell which comprises, a pair of vertical walls, a mercury electrode comprising an upper and generally horizontally disposed gutter means, said gutter means having a pair of generally parallel edges which are disposed in a substantially horizontal plane, a pair of generally vertically depending metallic sheets each having an outer surface and an upper portion formed as a smooth continuous surface, said sheet extending from said edges by means of its upper portion, the ends of said gutters abutting said cell walls to form a trough therewith, means for feeding mercury into said trough, the gutter means and sheet means being made of hot-dipped galvanized iron, whereby the mercury overflows said edges over the smooth continuous surfaces of said upper portions and flows uniformly down the outer surfaces of said pair of sheets, and means for collecting mercury at the bottom of said cell.

6. The electrolytic cell of claim 5 wherein the trough and depending metal sheets are formed from a single sheet of galvanized iron.

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