A electrolytic cell which is provided with a relatively simple, effective mechanical scraper for removing the deposited metal from the cathode and for lifting the metal out of the electrolytic solution. The blade pushes the metal up a portion of the bottom, which slopes upward and extends above the electrolytic solution surface, and into a receptacle exterior of the cell.

BACKGROUND OF THE INVENTION

The electrolytic refinement of various metals has generally been performed in electrolytic cells of either the Thum or the Moebius type wherein the metal to be refined is suspended as an anode within a tank containing the proper electrolytic solution and an electric current is applied between the metal being refined and a cathode surface which is spaced from the metal anode in the cell. In the Thum cell the anode is generally suspended horizontally in the electrolytic solution which is contained in a shallow rectangular tank, the bottom of which forms the cathode. In the Moebius cell, the anode and the cathode are arranged vertically within a deeper tank with the cathode often forming the sides of the tank.

In the operation of the foregoing electrolytic cells, the source metal, containing various impurities, is cast as an anode plate which is suspended in the electrolytic solution. Generally, the anode plate is enclosed in a canvas bag and is supported by a basket in the electrolytic solution. The canvas bag prevents the contamination of both the electrolytic solution and the refined metal by insoluble impurities as the anode plate is disintegrated by the electrolytic process.

Moebius type refining cells have heretofore been provided with mechanical scrapers to dislodge the deposited metal from the vertical cathode surfaces so that the refined metal particles fall to the bottom of the cell. However, to remove these metal particles from the bottom of the Moebius cell requires that the refining operation be interrupted. Thum cells have the advantage over Moebius cells in that, operationally, they are simpler and easier to construct and of permitting removal of a portion of the deposited metal without completely interrupting the operation of the cell. However, it still has been necessary to manually remove the deposited metal from the bottom of the Thum cell.

The manual removal of deposited metal from the bottom of the Thum and Moebius type electrolytic cells is undesirable in part because of the fact that the metals must be removed relatively frequently to prevent their accumulation which may cause the gap between the cathode and the source metal anode to be bridged and thus short out the cell. Moreover, manual removal of the metal requires that the operator reach into the electrolytic solution (silver nitrate in the case of silver refining) and manually dig it out. This results in splashing and dripping of the solution, which may be hazardous to the operator and to the equipment. Moreover, this operation generally results in the operator being subjected to a fume-laden atmosphere which may have harmful effects.

ABSTRACT OF THE DISCLOSURE

A electrolytic cell arrangement generally results in the operator being subjected to a fume-laden atmosphere which may have harmful effects. As a result, the efficiency of the cell per unit volume is considerably lower than might otherwise be possible, requiring excessive operating floor space and volume of electrolytic solution. Furthermore, the value of the metal held in inventory in the electrolytic cell, especially when precious metals are involved, often substantially increases the cost of performing the refining operation.

Attempts have been made at overcoming the foregoing disadvantages. However, due to the complexity of the apparatus and the relatively short lifetime of the parts in the electrolytic solution, they have not been generally adopted. One of the major disadvantages of prior art apparatus for automatically removing metal from electrolytic cells is the use of metal parts which are susceptible to electrolysis and thus require frequent replacement. Other apparatus utilizing materials which are substantially inert in the cell environment utilize rotating or other complex moving parts which are subject to severe wear from the fine particles of metal in the electrolytic solution. As a result of the foregoing drawbacks, automatic removal of metal from electrolytic cells has not gained widespread acceptance and manual removal of the metal from the bottom of the cell is still the common mode of operation.

Similarly, electrolytic cells employing cathodes in the form of a moving conveyor belt in the bottom of the cell have been proposed in an attempt to provide for mechanical removal of the refined metal. However, it has been found that such arrangements do not provide for acceptable equipment life and the electrical connections to the moving cathode element make the resulting apparatus unduly complex. Moreover, it has been found that such prior art arrangements have the undesirable characteristic of providing very uneven current densities over the area of the cathode. Thus at some point in the cathode the current density may be so low that practically no electrolysis takes place while at other locations the current density is so great that impurities are also plated out, resulting in incomplete metal refinement.

It is apparent that apparatus for the automatic removal of refined metal from electrolytic cells of the type described, which is sufficiently dependable, maintenance-free and without the foregoing disadvantages would be extremely desirable. Not only would such an arrangement minimize the hazards to which cell operators are now exposed during operation of the cell, but it also would result in substantial economies both in the labor and the operating space required, as well as a reduction in the value of metal in inventory at the bottom of the cell. This last factor would further result in a savings in the associated interest charges which is often assessed against such an inventory of precious metals.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides an electrolytic cell for refining metal comprising a tank containing an electrolytic solution having a liquid surface. A pair of electrodes are arranged in spaced relationship in the electrolytic solution with at least a portion of an inner surface of the tank forming the cathode. At least one surface in the tank slopes upward from the bottom and extends above the surface of the electrolytic solution. A means is arranged to pull a scraper along the bottom
of the tank to remove deposited metal from that portion of the tank forming the cathode.

The arrangement of the present invention provides a scraper means wherein substantially the only relative motion is between the edge of the scraper blade and the cathode surface whereby lifetime of the parts is substantially lengthened, making the operation economically feasible.

More specifically, a scraper assembly is provided which has a canopy plate over the scraper blade, which canopy extends a substantial distance ahead of the leading edge of the blade. The canopy plate is supported by side plates which are closely adjacent the side of the cell. The assembly of the canopy and side plates thereby prevent the metal removed from the bottom of the cell from spilling over the top of the blade or piling up in front of it to the extent that it bridges the gap between the anode and the cathode and short out the cell.

Furthermore, the side plates of the scraper assembly may be provided with scraper edges at either end to assist the main scraper blade in removing the refined metal.

The present invention also provides an arrangement wherein a substantially uniform current supply may be provided to both the anode and the cathode.

The various features of novelty which characterize the present invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and the specific objects obtained by its use, reference should be had to the accompanying drawings and descriptive matter in which the preferred embodiments of the present invention are illustrated and described.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional elevation view of an electrolytic cell incorporating a specific embodiment of the present invention;

FIG. 2 is a section taken across the cell along line 2—2 of FIG. 1;

FIG. 3 is a perspective view, looking upward at the bottom of the scraper assembly utilized in the foregoing specific embodiment;

FIG. 4 is a sectional elevation view of an electrolytic cell incorporating an alternate embodiment of the present invention;

FIG. 5 is a sectional view of the alternate embodiment taken along line 5—5 of FIG. 4; and

FIG. 6 is a perspective view of the scraper assembly used in the alternate embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An electrolytic cell 10 incorporating a specific embodiment of the present invention is illustrated in FIG. 1 and comprises an elongated tank having a bottom 12 and a pair of side members 14. The cell normally contains an electrolytic solution having a liquid surface 16 adjacent to the bottom of the cell. At one end of the cell is a portion 18 of the bottom slopes upwardly therefrom and extends above the solution surface 16. A plurality of anode support baskets 20 are disposed in the upper portion of the cell and may be suspended from the side members 14 in a manner well known in the art. The support baskets 20 are provided with a plurality of cells arranged to be supported on the top of the side members. The bottom of the support basket may be formed of a plurality of spaced bars 24 or other structure which provides the necessary support to an anode plate 26 while permitting the electrolytic solution to come into contact with the metal being refined.

In the cell illustrated, the bottom 12 is formed of stainless steel which forms the cathode of the cell. Bus bars 28, formed of copper bars, are attached to the bottom or exterior of the cathode by a plurality of clamps 30, which also join the bottom 12 with the flanges 32 of the side members 14. The bus bars assure that the cathode will receive a substantially uniform supply of current throughout the cell. The anode 26 of the cell is formed of a plurality of plates of metal being refined which may be cast with a side plate 34 over the top surface thereof. The anode current connection is provided by a mechanical clamp 36 which is removably attached to the rib 34. The anode plate is normally disposed in a cloth bag 38 to prevent the introduction of impurities into the refined metal at the bottom of the cell. The anode plate and the enclosing cloth bag are then supported in a basket 20 so that at least the lower surface of the anode is submerged in the electrolytic solution.

A scraper assembly 40 is disposed in the bottom of the cell and is movable longitudinally along the cell. The scraper assembly comprises a canopy which is formed of a stationary horizontal plate member 42 which extends across the cell and is supported from the bottom of the cell by a pair of side members or plates 44. A scraper blade 46 is disposed between the side plates at one end thereof beneath the canopy plate. The scraper blade 46 may be pivotally supported by the side plates 44 and has a lower edge which is arranged to engage the upper surface of the bottom or cathode 12 of the cell. The lower scraping edge of the blade may be provided with a plastic tip 48 to minimize the possibility of damage to the smooth surface of the cathode. Each end of the side plates 44 is provided with a scraper-like blade 50 to remove any deposited metal from the intersection of the cathode 12 and the side members 14 of the cell. A cable 52, preferably formed of a plastic material inert in the electrolytic solution, is connected to the top of the leading edge of the scraper blade 46, and extends horizontally along the cell to the end thereof provided with the upward sloping bottom portion 18 which may be part of the cathode 12 or a non-conducting extension thereof. The cable extends upward to a drive motor 53 which, when activated, pulls the blade assembly along the bottom of the cell scraping any deposited metal from the cathode and eventually pushing it up the sloping bottom portion 18 of the cell and into a receptacle 54 exterior of the cell. Means is provided for returning the blade to the opposite end of the cell to repeat the scraping operation. In the embodiment illustrated, the cable extends from the drive motor above the cell to the opposite end where it re-enters the solution and is connected to the opposite side of the scraper blade 46. In the present arrangement, the blade is pivoted so that it provides little or no scraping action as it is drawn back to the starting point. However, it will be readily apparent that both ends of the electrolytic cell may be provided with an upward sloping bottom portion and an associated metal receptacle so that the scraper blade could remove metal while traveling in either direction. In such an arrangement the scraper blade could be fixed in position and the anode blade would extend substantially equi-distant on either side of the blade.

The leading and trailing ends of the anode blade may be provided with a triangular tongue blade 56 which is provided with a magnetic member 58 that may be attached extending from the scraper blade 46. This arrangement assists in guiding the scraper assembly and maintaining its alignment in the cell throughout its travel. Moreover, a bearing means, such as rollers 60 and 62, may be provided at each end of the cell to guide the cable 52 as it travels upwardly with the electrolytic solution.

The scraper assembly is preferably formed of stainless steel encased in a plastic material which is inert in the electrolytic solution. The stainless steel provides sufficient
weight to the assembly to prevent it from floating in the solution and thereby not completely removing the deposited metal from the cathode plate. Except for the stain-
less steel assembly mentioned above, the cathode plate and the anode plates, the remainder of the cell structure in contact with the electrolytic solution may be formed of a plastic material or of plastic-encased metal parts.

Normally, a ventilating hood 64 is disposed over the top of the cell to remove any fumes generated thereby. Access doors may be provided in the hood to permit the ready addition of new anode plates.

In operation, the cell is filled with a suitable electrolytic solution substantially to the top of the side members 14, and a plurality of anode plates of the source metal, en-
cased in a cloth bag, are supported in the basket with at least a portion of the plates being submerged in the electrolytic solution. Each of the anode plates is connected by a clamp 36 to an electric lead 66 from a suitable source of electric current, the opposite side of which is substi-
tially permanently connected to the cathode 12 through the bus bars 28. The current flow is initiated and the metal of the anode plate is electrolyzed and is deposited onto the surface of the cathode. Simultaneously with the commencement of current flow through the cell, the scraper assembly drive motor 53 is started, pulling the scraper assembly 40 along the bottom of the cell. The scraper blade removes any metal which has been deposited on the cathode and pushes it ahead. The canopy plate 42 and side plates 44 guide the collected metal and prevent it from being washed over or around the scraper blade 46. Furthermore, the canopy plate prevents the metal from building up to the extent that it might short out the cell. As the scraper assembly reaches the upward sloping portion of the bottom, the metal is moved up and out of the electrolytic solution and is finally pushed over the edge of the cell into the collection receptacle. A limit switch may be provided to stop the drive motor when the scraper assembly reaches the uppermost end of the sloping portion of the cell. At that time, the drive motor is reversed and the scraper assembly is returned to the starting end of the cell where it again reverses direction and repeats the scraping operation.

It will be appreciated that while the specific embodi-
ment illustrated is arranged such that the scraper blade removes metal during travel in only one direction, a cell arrangement can be employed wherein metal removal takes place in both directions. Figure 4 of the present invention is shown with one end thereof sloping upward from the bottom, it is possible that either of the sides of the cell could likewise slope outwardly toward the top whereby the scraper assembly would extend throughout the length of the cell and would be arranged to move across it. However, it has been found most eco-
nomical to construct such cells with a length substan-
tially greater than the width so that the end of the cell is the most practical location at which to remove the refined metal.

An alternate embodiment of the present invention is illustrated in FIGS. 4, 5, and 6 wherein an electrolytic cell of the Moebius type is arranged for automatic removal of the refined metal. In this arrangement, the anode plates 70 are suspended substantially vertically within a deep cell with all of the cell tank walls 72 forming the cathode surface. In this arrangement it is necessary to provide a scraper assembly 74 which extends across the bottom of the cell and up the adjacent sides to remove any metal deposited on all three surfaces. As shown in FIGS. 4 and 6 the scraper assembly 74 of this arrangement is provided with a canopy 76 which also extends upwardly along the vertical portion of the scraper blade 78 to prevent the metal from being washed over by the scraper assembly against the anode plates 70 and shorting out the cell. The alternate embodiment illustrated is arranged for removal of the refined metal from either end so that the scraper blades may be stationary. Otherwise, the operation of this alternate embodiment is substantially the same as that described with respect to the preferred embodiment.

Accordingly, it will be seen that the present invention provides an arrangement for continuously removing refined metal from an electrolytic cell which is both of simple construction and economical operation and which also permits improved operating efficiencies in the cell itself. At the same time, the present invention substan-
tially eliminates the hazards to the operator attendant in the manual cleaning procedures of the prior art. More-
over, the amount of operating space necessary for the operation of the electrolytic cell incorporating the present invention is substantially reduced with the attendant economies. Furthermore, the amount of metal retained in the cell between removal operations is greatly reduced, resulting in a substantial reduction in inventory costs. The present invention similarly provides a scraper arrange-
ment which simply and efficiently removes the refined metal without the possibility of shorting out the cell. In addition, the construction is simple and rugged, reducing the maintenance required and extending the operating life thereof.

The invention has been described in detail with particu-
lar reference to preferred embodiments thereof, but it will be understood that variations and modifications can be ef-
fected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

I claim:

1. An electrolytic cell for the refinement of a metal comprising a tank arranged to contain an electrolytic solution having a liquid level therein, a plurality of anode plate support baskets arranged in said tank with at least a portion thereof below the liquid level of the electrolytic solution, a metal cathode plate having an exposed upper surface in contact with said electrolytic solution and forming the bottom of said tank, a bus bar extending along and connected to the bottom surface of said cathode plate, means for connecting said cathode plate to a source of electric current, one end of said cathode plate arranged to slope upwardly and outwardly therefrom and to ex-
tend above the level of the electrolytic solution, a scraper assembly arranged for movement longitudinally along said tank and supported by the cathode plate, said scraper assembly comprising a pair of side members disposed adjacent the sides of said tank, a canopy plate extending between said cathode plate and below said support basket, a scraper blade sup-
ported by and between said side members, said canopy plate, said scraper blade having a lower scraping edge arranged to engage the upper surface of said cathode plate, cable means connected to the scraper assembly and extending in both directions substantially perpendicular thereto, and means for driving said cable means to move said scraper assembly along the cathode plate and up the sloping portion thereof to remove metal deposited on the cathode plate from said electrolytic solution.

2. An electrolytic cell for the refinement of a metal comprising a tank arranged to contain an electrolytic solution having a liquid level therein, a plurality of plate support baskets arranged in said tank with at least a portion thereof in said electrolytic solution, a plurality of anode plates supported in said support baskets in con-
tact with said electrolytic solution, a metal cathode plate extending between said supports having an exposed upper surface in contact with said electrolytic solution and forming the bottom of said tank, a bus bar extending along and connected to the bottom surface of said cathode plate, means for connecting said anode plate and said cathode plate to a source of electric current, one end of said cathode plate arranged to slope upwardly and outwardly therefrom and to extend above the level of the electrolytic solution, a scraper assembly arranged for movement longitudinally along said tank and supported by the cathode plate, said scraper assembly comprising a pair of side members disposed adjacent the
sides of said tank, a canopy plate extending between said side members above the cathode plate and below said support basket, a scraper blade supported by and between said side members beneath said canopy plate, said scraper blade being disposed substantially at one end of said side members, said scraper blade having a lower scraping edge arranged to engage the upper surface of said cathode plate, said blade being pivotally supported by said members, cable means connected to the top edge of said scraper blade and extending in both directions substantially perpendicular thereto, and means for driving said cable means to move said scraper assembly along the cathode plate and up the sloping portion thereof to remove metal deposited on the cathode plate from said electrolytic solution.

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